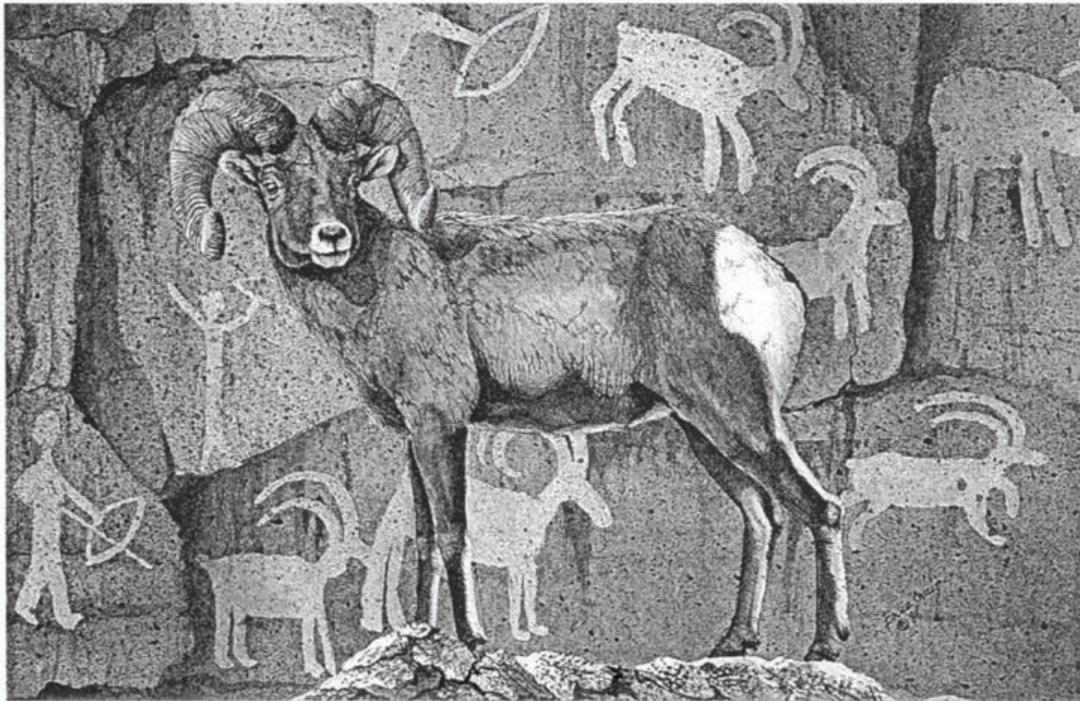


**TRANSACTIONS**

**2ND NORTH AMERICAN  
WILD SHEEP CONFERENCE**

**April 6-9, 1999  
Reno, Nevada**



**Co-hosted by the Desert Bighorn Council  
and the Northern Wild Sheep and Goat Council**

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# **2ND NORTH AMERICAN WILD SHEEP CONFERENCE**

**APRIL 6 - 9, 1999  
RENO, NEVADA**

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RICK BRIGHAM**

**PROGRAM CO-CHAIRS:  
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**Program Co-Chairs:** Amy Fisher, New Mexico Department of Game and Fish  
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**2ND NORTH AMERICAN WILD SHEEP CONFERENCE  
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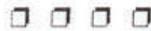
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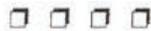
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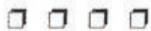
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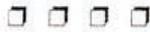
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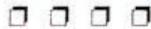


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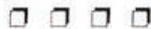
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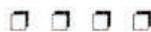
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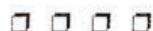
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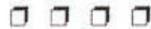
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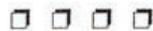
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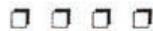
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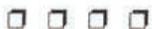
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**WELCOMING REMARKS TO ATTENDEES OF THE 2ND NORTH AMERICAN WILD SHEEP CONFERENCE, APRIL 1999, RENO, NEVADA - KEVIN HURLEY, EXECUTIVE DIRECTOR, NORTHERN WILD SHEEP AND GOAT COUNCIL**

On behalf of the Northern Wild Sheep and Goat Council (NWSGC), let me welcome you to Reno, and the 2ND North American Wild Sheep Conference. We in the Northern Council are very grateful to the Desert Bighorn Council (DBC) for co-hosting this historic conference. In the spring of 1997, I attended my first DBC meeting, to establish a connection and begin a relationship with our desert counterparts. As I listened to the papers presented there, similarities between our respective conferences kept coming to mind. Issues discussed, management challenges involved, composition of the attendees, and the energy and commitment of all struck a familiar note. As I visited with several key players in the Desert Council about a joint meeting, I received very positive feedback. At the DBC business meeting, I offered the possibility of a joint conference between the two councils (something which had never been done in their histories, going back to 1957 for the DBC and 1968 for the Northern Council, respectively). The 60+ people attending the DBC business meeting were unanimous in support of the idea. Northern Council members and the Northern Council board gave an equally warm reception to the idea. So, we embarked on a two-year journey, which has led us to this point. I have often used the terms “cross-pollination” and “hybrid vigor” to describe the anticipated exchange of ideas and perspectives which is about to happen; it’s very exciting!

Over the past two years, a number of actions have occurred to help this conference become a reality. We received official sanction for both the DBC and the NWSGC from the Western Association of Fish and Wildlife Agencies, the umbrella organization for wildlife management in western North America. This sanction should support current and future efforts of both councils, improve attendance at conferences in this era of shrinking budgets and travel restrictions, as well as heightened interest and success in wild sheep management.

Over the past two years, the seed planted at the 1997 DBC meeting has grown into a very focused, management-oriented conference, with input from numerous people. We have relied heavily on products of two previous conferences. In 1971, Colorado State University and the Colorado Division of Game, Fish, and Parks organized a conference in Fort Collins advertised as the North American Wild Sheep Conference. During the course of 2 days, 111 attendees heard status reports from 5 states (AK,AZ,CO,NM,UT). Technical sessions focused on Physiology and Pathology, Research Techniques, and Management Problems/Needs/Procedures. The transactions of that conference captured the state of knowledge at that time, and remain a historic reference.

In 1974, Boone and Crockett Club, National Audubon Society, and the Wildlife Management Institute (WMI) organized and co-hosted a *Workshop on the Management Biology of North American Wild Sheep* in Missoula, Montana. This 3-day workshop attended by 78 people was the first truly international effort addressing wild sheep management in North America; it served as a template for what we are attempting here 25 years later. Status reports from 18 states/provinces/territories and from Mexico were presented. Keynote remarks from Dr. Valerius Geist on theoretical considerations of wild sheep management were heard, and challenges and strategies for wild sheep management were identified by subspecies working groups. This workshop resulted in a classic reference book titled "The Wild Sheep in Modern North America", edited by James Trefethen of the WMI. In a great show of support for this conference, we are pleased to announce the Boone and Crockett Club has graciously donated 220 copies of this book, so that every attendee at this conference can have a copy for their reference library. These books will be available at the publications table.

About this conference, known as the 2ND North American Wild Sheep Conference. Here is how we envision the next four days. Rob Ramey will shortly offer his views on the evolution and current taxonomy of wild sheep in North America. Wayne Heimer will describe his ideas on developing working hypotheses for wild sheep management, and we have recruited Wayne, Bill Wishart, Dale Toweill, and Ray Lee to present overviews of the history, current status, and working management hypotheses for different subgroups of wild sheep, based in part on questionnaires from each state/province/territory. Fernando Colchero will describe a desert bighorn sheep program in Mexico. Seven sessions will be held over the next 3 days, each one focusing on a different facet of wild sheep management identified as important in the overview just described. Our hope is for a good mix of presented information and interactive discussion, and we have selected very capable session chairs to assure that will happen. On Friday, we hope many of you will stay for what we are calling a "working day". We anticipate breaking up into smaller groups of 10-25 species oriented people to discuss management challenges identified in the working hypotheses manuscripts and the various sessions. Our goal for Friday is to come away with a management-relevant outline for the workshop section of the conference transactions, which we envision as a "Wild Sheep Management Techniques Manual". Aside from publishing the technical papers and presentations you'll hear over the next 3 days, our ambitious goal is to provide a science-based blueprint for wild sheep management for the next 25 years.

To assure a timely publication, we have hired Allan Thomas, a recently-retired BLM biologist from Idaho, as our Technical Editor. Our intent is to have the transactions done and distributed by mid-year of 2000. Allan will be working with the conference/program/session chairs and the authors, to complete this task. We

respectfully request your assistance in helping us meet that timeline.

As conference co-chairs, Rick Brigham and I are deeply indebted to a number of people who helped make this a reality. First and foremost, our program co-chairs Amy Fisher (DBC, New Mexico) and Wayne Heimer (NWSGC, Alaska) deserve a big thank you for a terrific agenda, focusing on issues of great interest and significance to us all. I would like to thank Don Armentrout and Darren Divine for taking care of some of the nitty-gritty details.

At this point, I would like to acknowledge our sponsors for this conference. Both the BLM and the U.S. Forest Service have committed significant dollars to this effort, and we thank them. I have already mentioned the gracious contribution of 220 books from the Boone and Crockett Club. Most gratifying to me is the involvement and contribution from the Foundation for North American Wild Sheep (FNAWS), and its chapters and affiliates. As you can see in your program, 18 of the 20 chapters/affiliates of FNAWS, plus the national organization, have contributed to underwrite this conference and our publication. Many of those organizations are represented in the room today, and we welcome and thank them.

When the 1971 and 1974 conferences were held, FNAWS didn't exist, nor did the network of wild sheep advocates which has developed over the past quarter-century. The synergy between wild sheep managers and wild sheep enthusiasts over the past 25 years has been incredible, and the accomplishments many. I believe that the status and management of wild sheep, as we know them today, rest squarely on the partnership between the advocates and the agencies which serve them. We owe each other our mutual respect and a great thanks.

Once again, thank you all for coming. We look forward to your input, and we hope you enjoy the conference.



**WELCOME AND OPENING REMARKS - WILLIAM R. (RICK) BRIGHAM,  
CONFERENCE CO-CHAIR**

I want to welcome all of you to Reno. This is the 2ND North American Wild Sheep Conference; it is also the 43rd annual meeting of the Desert Bighorn Council (DBC).

I want to thank several people who have put in a great deal of time and effort in this endeavor: Kevin Hurley came up with the idea for this conference two years ago; Amy Fisher has done an excellent job of putting the program together from the DBC side, and publishing the program; to Don Armentrout, who is Arrangements Chairman, and whom we can thank for the facilities here at the Peppermill; and to Darren Divine, who has done an outstanding job as Council Secretary, including putting together the newsletters publicizing this conference, as well as mailing them. Darren stepped up last year when the DBC met at Las Cruces, and volunteered for this job. He has also taken it upon himself to reprint several of the earliest DBC transactions. These, and full sets of DBC transactions, are for sale outside the meeting room here.

Other publications for sale include past proceedings of the Northern Wild Sheep and Goat Council, plus new books published by the Foundation for North American Wild Sheep (FNAWS) and the Boone and Crockett Club. At the rear of this room, the Desert Bighorn Council Ewes have items for sale (T-shirts, mugs, pins, prints), all dealing with desert bighorns. The profits from sale of these items go into the Council's Hansen-Welles Memorial Fund, which provides stipends for needy graduate students and others working with desert bighorns.

I want to acknowledge some of the very old timers from the Council who are here—Dick Weaver, Warren Kelly, and George Welsh.

I also particularly want to thank the many constituent groups which have contributed funds to make this conference a reality: FNAWS and its state chapters; Nevada Bighorns Unlimited Reno and Fallon Chapters, both of which are local; and the Fraternity of the Desert Bighorn, based in Las Vegas.

I have spent my entire career with the Bureau of Land Management (BLM), a federal agency—a habitat managing agency. I attended my first Council meeting in 1971 at Santa Fe, New Mexico. I was working in the Phoenix, Arizona BLM District Office at the time. At that time, the Council was working on a book: The Desert Bighorn: Its Life History, Ecology, and Management. It was edited by Gale Monson and Lowell

Sumner, and was finally published in 1980. When published, it was the best single source document for desert bighorn information at that time. It covered the usual topics: distribution, abundance, physical characteristics, habitat, food, water, behavior, predation, hunting, disease.

We have come a long way since 1980. Diseases transmitted when bighorns and domestic sheep contact each other have become recognized as a major issue resulting in the BLM asking the DBC for guidelines on managing domestic sheep in bighorn habitat. These guidelines were published in 1990 in the DBC transactions. The guidelines were adopted as BLM policy in 1993, following a spirited meeting between wool growers, western state game and fish agency personnel, BLMers, and several wildlife veterinarians. The guidelines were revisited just last year, and expanded to include domestic goats.

We have come a long way in capturing and transplanting bighorns. Several thousand bighorns have been trapped and transplanted during the last 20 years. We have gone from darts and drugs to net capture guns and drop nets. Amy Fisher is chairing a session here later that will bring everybody up to speed on the newest techniques.

Predation was formerly not the issue it has become recently. Management of mountain lions is now a key factor in successful bighorn conservation and restoration, especially small and transplanted populations.

Constituent groups have also proliferated. At first there was the Boone and Crockett Club. Then came FNAWS (1977), and its many chapters, and related groups such as Nevada Bighorns Unlimited, the Fraternity of the Desert Bighorn, the Arizona Desert Bighorn Sheep Society, and California's Society for Conservation of Bighorn Sheep. We will be hearing more from the constituent groups this afternoon, and I am looking forward to it, since they have paid so much of the freight in dollars and sweat equity to put mountain sheep management where it is today. Their comments should be very interesting.

My highest hope for this conference is to see guidelines developed which address the current problems facing the various subspecies of mountain sheep, and provide management direction for the next 25 years.

We have an excellent array of papers, session chairs, and speakers. Enjoy! Thank you.

*IN MEMORIAM*

**DANIEL JAMES HENRY INNES**  
1970-1998

**ADAM GEORGE TREVOR**  
1972-1998

**MARK CHARLES WILLIAMS**  
1973-1998



*Dan Innes releasing a radio-collared desert bighorn ram on Tiburon Island that he captured with Marcus Nurse on the island. Adam Trevor is the pilot pictured in the helicopter. Mark Williams was on the mainland. Photo by Marcus Nurse, taken the morning of the crash, December 19, 1998.*

## *IN MEMORIAM*

The 2ND North American Wild Sheep Conference is dedicated to the memories of Dan Innes, Adam Trevor, and Mark Williams, who died in a helicopter crash while capturing desert bighorn sheep on Tiburon Island, Mexico on December 19, 1998. Considered among the most difficult capture sites in the world, the Helicopter Wildlife Management crew had successfully captured 34 sheep the previous day. Over the previous three years, Dan Innes and his crew had taken about 150 sheep off the island for re-establishing bighorn sheep in other parts of Mexico. The cause of the accident has not yet been determined. The North American bighorn sheep community commemorates their sacrifice and mourns their loss.



### **DANIEL JAMES HENRY INNES**

1970-1998

As the eldest son of James Innes, owner of Helicopter Wildlife Management, Dan grew up in the animal capture business in New Zealand. Dan became an outstanding netgunner and animal handler, known throughout North America for his spirit and skill in capturing elk, deer, wolf, caribou, bison and his favorite—bighorn sheep. Through his efforts, over 600 bighorn were radio-collared for research, tested for disease, and restored to historic habitat.



### **ADAM GEORGE TREVOR**

1972-1998

Adam was a talented pilot who had honed his skills capturing and recovering red deer in New Zealand. Taught by his father, also a helicopter pilot, Adam had accumulated over 5,000 hours of flying time, an incredible number of hours considering his age. Having just come from New Zealand, Adam was highly regarded by his comrades and countrymen.



### **MARK CHARLES WILLIAMS**

1973-1998

Mark had also just come from New Zealand where he had completed studies in turf management, related to golf course and horse racing track design. Mark was bright, talented, and had a promising career ahead of him in his studied field. But like his brother Tim Williams, a veteran netgunner and animal handler, Mark wanted the experience of capture work, and he quickly became a natural with the animals.

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**ROB ROY RAMEY, II - NEW PERSPECTIVES ON THE EVOLUTIONARY ORIGINS,  
HISTORIC PHYLOGEOGRAPHY, AND POPULATION STRUCTURE OF NORTH  
AMERICAN MOUNTAIN SHEEP**

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Rob Roy Ramey II, University of Colorado, EPO Biology, N 122 Ramaley, Boulder, CO 80309-0334

New perspectives in ecology and evolutionary biology are almost always preceded by the development of new analytical tools. These open new avenues of investigation and can produce paradigm shifts as previously untestable hypotheses become the subject of scientific investigation. In the field of mountain sheep evolution, the first revolutionary perspective occurred in 1940 when Ian McTaggart Cowan published the morphometric analysis of horn and skull variation using the recently invented, hand-crank adding machine (Cowan 1940). Cowan's work was also one of the first to overcome typological species concepts, recognize the variation present within species, and apply tests of statistical significance to taxonomy.

More recently, the advent of modern morphometric analysis, and the analysis of DNA sequence variation, has allowed us to refine Cowan's work and help us understand the evolution of mountain sheep in much greater depth: from the fine scale breeding structure of isolated populations to the evolutionary history of species. The refinement will no doubt accelerate as newer methods of analysis are developed.

I present here, several new perspectives on the evolutionary origins of wild sheep, the historic phylogeography of North American sheep, and aspects of bighorn population structure in the Southwest. Understanding the evolutionary history of organisms is important to their conservation. For example, the ultimate explanation for the susceptibility of bighorn sheep to a wide variety of domestic livestock diseases lies in the fact that there is a vast gulf of evolutionary time separating North American bighorn from the diseases that

coevolved with domestic livestock that originated in Eurasia (Ramey 1995).

Evolutionary history and phylogeography are also the basis of modern taxonomic classification, which is important for recognizing biogeographic barriers to movements between populations, for determining the most genetically similar sources for reintroduction stock, and for determining the allocation of scarce conservation resources.

Finally, understanding the population genetic structure of mountain sheep underlies knowing which demographic units should be the units of conservation. Is the traditional view of sheep "populations" as those animals that inhabit a mountain range really an accurate reflection of their biology? How can we conserve genetic diversity over the long-term?

**Evolutionary origins:** The traditional view on the evolutionary origins of wild sheep (Schaller 1977) is that they originated during the Pliocene in the Middle East and spread east across Asia and into North America in what has been termed "the great arc of the wild sheep" (Clark 1978). However, preliminary phylogenetic analysis of mitochondrial DNA sequence data from the ND5 gene suggests a very different scenario (Figure 1): there is a major split within the genus *Ovis*. One clade includes the mouflon (*O. musimon*), urial (*O. orientalis*), and argali (*O. ammon*) of west/central Asia, while the other clade includes the snow sheep (*O. nivicola*) of Siberia, and Dall (*O. dalli*) and bighorn sheep (*O. canadensis*) of North America. This split is well-supported using bootstrap resampling of the data, and is consistent with sequence data from the Cytochrome B gene (Hassanin et al. 1998, E. Randi, unpublished data).

Dall and bighorn sheep appear to share a most recent common ancestor with snow sheep, rather than with argali.

Within Asia, the argali appear to have evolved recently relative to other species of *Ovis*. Also, the DNA sequence divergence across the range of argali is less than that found between desert bighorn and Rocky Mountain bighorn in North America (Figure 1). It appears that argali have recently evolved and radiated into the open steppe habitat of central Asia. The 17 subspecies of argali that have been previously described (Nadler et al. 1973) will be reduced in the future as molecular analyses provide new information.

Within North America, Dall sheep (*Ovis dalli*) are paraphyletic with respect to bighorn sheep for mitochondrial DNA (Figure 1). In other words, they do not form a monophyletic group separate from Rocky Mountain and desert sheep. Rather, it appears that bighorn sheep mtDNAs were derived from one of the Dall sheep mtDNA lineages found in northern Alaska. That bighorn sheep are derived from Dall sheep makes sense from a biogeographic perspective. However, the presence of a second mtDNA lineage in Dall sheep that is not found in bighorn sheep suggests that either there was a second colonization into North America, or that there was a single colonization with multiple divergent mtDNAs which were subsequently lost due to founder events during the colonization of ranges south of Alaska.

When did *Ovis* first colonize North America? The oldest *Ovis* fossil was found in alluvial deposits in El Golfo de Sonora by Chris Shaw of the Los Angeles County Museum, and is approximately 500,000 to 750,000 years old (Shaw 1981, 1990, C. Shaw pers. commun.). The next *Ovis* fossils in North America are from Manix Lake, Mojave Desert and dated at 280,000 ybp (Geist 1985, G. Jefferson, pers. commun.). If one is willing to invoke a mtDNA molecular clock, sequence divergence between North American and snow sheep would indicate separation occurred approximately 750,000 years ago (Ramey 1993), a result corroborated by fossil evidence.

#### **Historic phylogeography and subspecies:**

Within bighorn sheep, there is a lack of concordance between traditionally accepted taxonomic categories. For example, California sheep from the Sierra Nevada, (*Ovis canadensis californiana*), appear to share a most recent common ancestor with desert bighorn sheep rather than with members of the California/Rocky Mountain bighorn sheep clade. Also, the phylo-genetic analysis does not support the hypothesis of Geist (1971) that Rocky Mountain bighorn sheep are more recently derived relative to desert bighorn sheep. If Rocky Mountain bighorn sheep were recently derived, they would appear as a branch of the desert bighorn lineage.

Cowan's (1940) original taxonomic designations were made with substantial zones of intergradation among subspecies, however, over the years these have hardened into taxonomic "boundaries" and in some cases these lines have been redrawn without any data or analysis whatsoever (Wehausen and Ramey 1993). The transplant history of North American sheep has largely depended on the subspecies categories of Cowan (1940) and much uncritical guesswork. This has resulted in several long-distance translocations of essentially exotic animals, such as the translocation of Rocky Mountain bighorn from Banff, Alberta into northern New Mexico (Figure 2).

A large part of the problem with the application of the term "subspecies", is that it has lacked sound conceptual basis until very recently. Ball and Avise (1992) were the first to present a realistic solution to the subspecies problem by proposing that subspecies should represent a major subdivision in the gene pool diversity of species, as indicated by the concordant distributions of multiple, independent, genetically-based traits. Ryder (1986) introduced the term Evolutionarily Significant Units (ESUs) to aid in prioritizing the conservation of biodiversity because traditional species/subspecies categories were poorly defined. Moritz (1994a,b) subsequently added that ESU's must show patterns of reciprocal monophyly for mitochondrial DNA, a pattern which would be expected to occur within approximately 4Ne

generations of initial population separation. Reciprocal monophyly refers to the pattern of mtDNA haplotypes found in each population, representing an evolutionarily distinct lineage. More recently, John Wehausen and I added the criteria of morphometric distinguishability based on discriminant analysis (Wehausen and Ramey 2000). Using this morphometric criteria and reciprocal monophyly, we considered ESU's and subspecies to be equivalent. Overall, these conceptual refinements require that subspecies/ESUs have both a quantitative and evolutionary basis. By treating traditional subspecies categories as testable evolutionary hypotheses, the taxonomy of subspecies becomes the subject of scientific inquiry.

Since Cowan's work in 1940 was the basis of our management and conservation of North American sheep for nearly 60 years, I decided to reexamine his conclusions using a more sophisticated statistical analysis of his original raw data. This was possible because Cowan had saved his original raw data sheets in his attic, thinking they might be of use someday, and he made these freely available to me. I found that his results were influenced by small sample sizes, age-related effects on size, and violation of statistical assumptions (Ramey 1993). I found no support for most of his subspecific designations.

Subsequent to that study, John Wehausen and I examined Cowan's taxonomic conclusions with a more refined sampling design, larger sample sizes, modern methods of morphometric analysis, and the conceptual approaches outlined above. Our first paper (Wehausen and Ramey 1993) focused on testing the putative uniqueness of peninsular bighorn sheep (*O.c. cremnobates*) relative to desert bighorn sheep (*O.c. nelsoni*). We synonymized *cremnobates* with *nelsoni* because they were not morphometrically distinguishable and there were no convincing long term biogeographic barriers to suggest genetic isolation. Initially, this paper was not well received because it challenged the *status quo* and some long held beliefs.

That paper, however, was not the first to challenge the old taxonomy. Gonzales (1967) showed that *weemsi* and *cremnobates* were morphometrically indistinguishable, and Bradley and Baker (1967) found the same result for *mexicana* vs *nelsoni*, however, the authors of these papers used simple univariate methods and only suggested that these subspecies be synonymized.

I further tested subspecies categories and examined phylogeography in the Southwest using restriction site analysis of mtDNA (Ramey 1995). The evolutionary validity of subspecies was tested by asking if there was significantly greater mtDNA nucleotide diversity within or among putative subspecies. Based on that analysis and the lack of convincing biogeographic barriers separating putative subspecies, I concluded that all desert-dwelling bighorn sheep should be considered a single polytypic subspecies (*O. c. nelsoni*). This conclusion has also been corroborated by both microsatellite and MHC data (Gutierrez-Espeleta et al. in prep, Boyce et al. 1997).

One surprising result of the mtDNA restriction site study, was the discovery that California bighorn sheep from the Sierra Nevada (*O.c. californiana*) are genetically unique relative to populations of desert bighorn sheep in the mountains across the Owens Valley. The only plausible explanation for this genetic separation is the long term presence of Pleistocene pluvial lakes (e.g., Mono and Owens Lakes) and a riparian corridor in the bottom of the valley that acted as a barrier to dispersal.

In a similar study of mtDNA variation within the Rocky Mountains, Luikart (1992) found reduced levels of mtDNA variation in Alberta and British Columbia relative to populations in Montana. This result is consistent with the expected loss of genetic variation due to founder events as bighorn colonized previously glaciated habitat, in what is now Canada, at the opening of the Holocene, 12,000 years ago.

The next morphometric project that John Wehausen and I undertook was much more extensive because we examined the variation in the

northern regions of *O. canadensis* (Wehausean and Ramey 2000), including *nelsoni*, *canadensis*, *californiana*, and *auduboni*. In that study, we synonymized several subspecies and uncovered previously undescribed variation. *Auduboni* and the northern populations of *californiana* were synonymized with *canadensis*, and Sierra Nevada bighorn turned out to be unique relative to the northern populations of *californiana* and nearby populations of *nelsoni* from the Great Basin. These differences were apparent in skull shape and not simply skull size alone. Overall, these results were corroborated by mitochondrial DNA data from Ramey (1993), however no DNA samples were available for the extinct *auduboni*. Sierra Nevada bighorn, of which fewer than 100 remain, are the only remaining population of *californiana* and are now classified as endangered.

Morphometrically, there was substantial overlap between Rocky Mountain and California bighorn sheep in skull shape, making them indistinguishable using discriminant analysis. We suspect that the apparent size differences between Rocky Mountain bighorn and California bighorn may be because California bighorn in British Columbia have been living on river breaks and have a non-migratory life history. That means they are not growing as large because of differences in nutrition and not genetics. Our morphometric results were consistent with those obtained from analysis of mtDNA (Ramey 1993) and allozymes (Jessup and Ramey 1995) which show them to be virtually indistinguishable genetically.

When John Wehausean and I examined the variation in bighorn sheep within the larger context of variation that included Dall sheep, we found a north-south cline in the length of horn cores relative to horn volume. In other words, Dall sheep in the far north have substantially shorter horn cores than desert bighorn sheep in the hot deserts of the south, for the same horn volume. This pattern is even evident within the desert bighorn sheep from the cooler Great Basin south into the hot deserts. Because horn cores are vascularized and therefore potential sources of heat loss, there appears to be a selective constraint on horn core length in the

more northern ranges. The northern sheep have their horns on much shorter horn cores that lose less heat than the long horn cores found in the desert regions (Wehausean and Ramey 1993, 2000).

There is a similar north-south cline in lambing period described by Bunnell (1982). In that paper he describes a selective constraint on lambing periods in the northern ranges, starting at approximately 37 degrees north. In the northern ranges, there is a narrow optimal window for lambs to be born in the late spring. If lambs are born too early, they are at risk for perishing in late season storms. If they are born too late in the summer, they will not have grown large enough to survive the coming winter. In the hot deserts of the south there is no such selective constraint because winters are mild.

**Population structure:** Traditionally, wildlife researchers and managers have considered a "population" of bighorn sheep to be those animals that occupy a mountain range. This view has changed over time, however, as metapopulation theory and a long-term conservation perspective have been applied to bighorn sheep (Schwartz et al. 1986, Bleich et al. 1990). Observations of philopatry by ewes and long-distance dispersal by rams, along with analysis of genetic data (Ough and deVos 1984, Bleich et al. 1996, Ramey 1995, Boyce et al. 1999) reveal a clearer picture of metapopulation structure in bighorn sheep. It now appears that bighorn sheep in the Southwest can be viewed at three different scales: female subpopulations, populations, and metapopulations (Figure 3).

The value that this new perspective brings to conservation and management is that: 1) female subpopulations, which appear to be stable over time, are the most basic demographic units that should be identified and monitored in the wild, and 2) for long term conservation of genetic variation and population persistence, movement corridors must be maintained between female subpopulations that provide an opportunity for male-mediated gene flow, and the potential for recolonization of female subpopulations. Due to

the rapidly spreading urbanization across the desert valleys of southern California, Nevada, and Arizona, identifying and prioritizing the conservation of movement corridors between female bighorn subpopulations is urgently needed.

**The future:** New non-invasive sampling techniques that use fecal DNA, rather than the physical capture of animals, will become increasingly important for understanding the fine scale breeding structure of small populations of bighorn, and will contribute greatly to our understanding of phylogeography, especially for endangered populations (Taberlet et al. 1996, 1997). Additionally, "neutrality tests" for genetic data will be used to infer aspects of a population's demographic history and/or intensity of natural selection (Rand 1996, Cornuet and Luikart, 1996, Ramey et al. in press). These new analytical methods, that are based on neutral models of molecular evolution, can be used to test for genetic signatures of population bottlenecks, rapid population expansion, and natural selection (Luikart et al., 1998a,b; Rand, 1996). Like other advances in methodology that I have discussed earlier, we can expect these methods to yield new insights into the evolution, phylogeography, and population structure of mountain sheep.

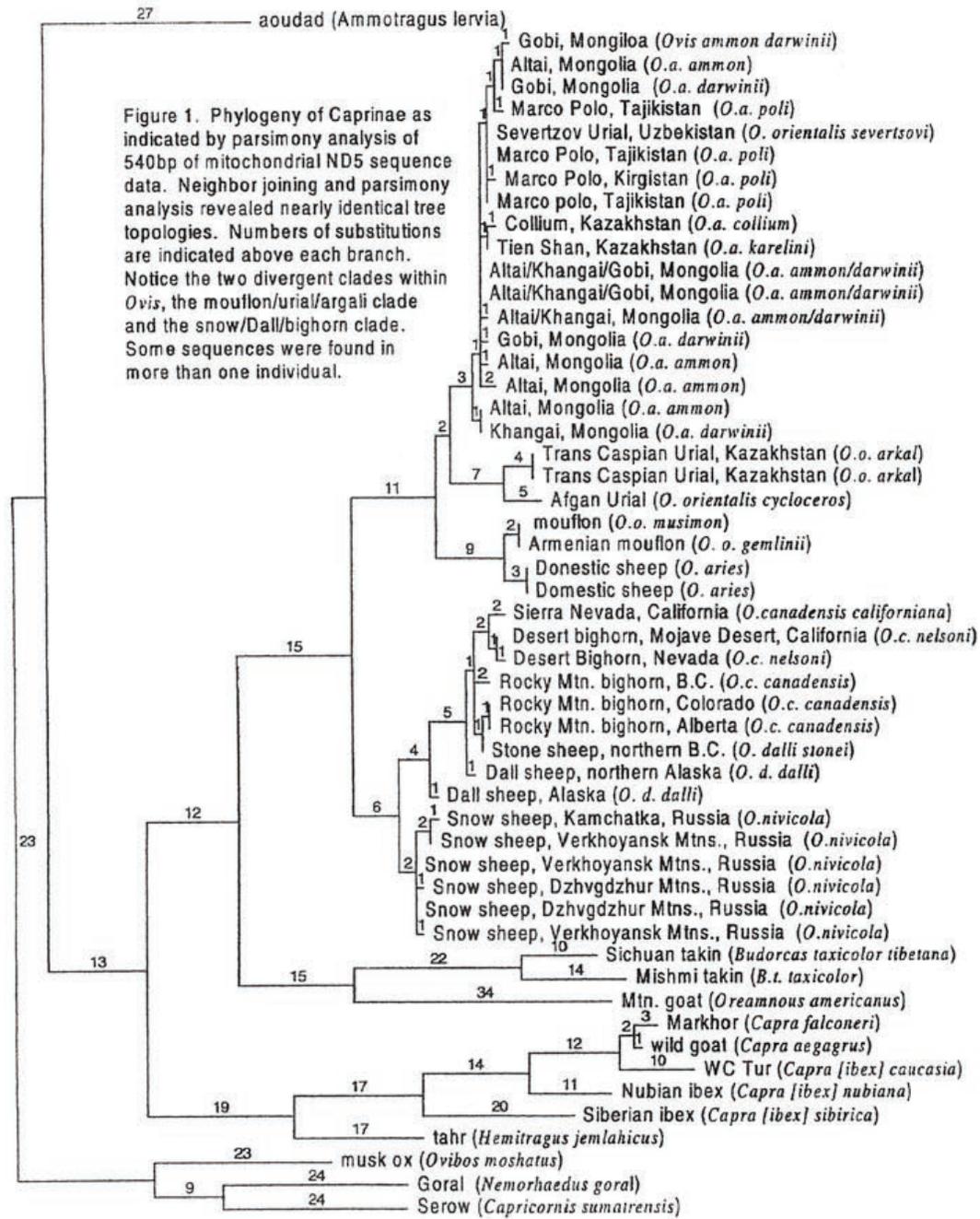
#### LITERATURE CITED

- Ball, M.R., and J.C. Avise. 1992. Mitochondrial DNA phylogeographic differentiation among avian populations and the evolutionary significance of subspecies. *Auk* 109(3):626-636.
- Bleich, V.C., J.D. Wehausen, and S.A. Holl. 1990. Desert-dwelling mountain sheep: conservation implications of a naturally fragmented distribution. *Conservation Biology* 4(4):383-390.
- \_\_\_\_\_, J.D. Wehausen, R.R. Ramey II, and J.L. Rechel. 1996. Metapopulation theory and mountain sheep: implications for conservation. Pages 353-373 in *Metapopulations and Wildlife Conservation*. D.R. McCullough, ed. Island Press, Washington, D.C. 429pp.
- Boyce, W.M., P.W. Hedrick, N.E. Muggli-Cockett, C.T. Pendo, and R.R. Ramey. 1997. Comparative analysis of intra and interpopulation genetic variation in mountain sheep at major histocompatibility complex and microsatellite loci. *Genetics* 145:421-433.
- \_\_\_\_\_, R.R. Ramey, T.C. Rodwell, E.S. Rubin, and R.S. Singer. (1999). Population subdivision among desert bighorn sheep (*Ovis canadensis*) ewes revealed by mitochondrial DNA analysis. *Molecular Ecology* 8, 99-106.
- Bunnell, F.L. 1982. The lambing period of mountain sheep: synthesis, hypothesis, and tests. *Canadian Journal of Zoology* 60:1-14.
- Clark, J.L. 1978. *The Great Arc of the Wild Sheep*. University of Oklahoma Press, Norman, OK.
- Cornuet J.M., and Luikart G. 1996. Description and power analysis of two tests for detecting recent population bottlenecks from allele frequency data. *Genetics* 144:2001-2014.
- Cowan, I.M. 1940. The distribution and variation in the native sheep of North America. *American Midland Naturalist* 24:505-580.
- Geist, V. 1971. *Mountain Sheep: A Study in Behavior and Evolution*. U. of Chicago Press. 383 pp.
- \_\_\_\_\_. 1985. On Pleistocene bighorn sheep: some problems of adaptation and relevance to today's American megafauna. *Wildlife Society Bulletin* 13:351-359.
- Gonzalez, P.D. 1976. Skull measurements of male desert bighorns from Baja California, Mexico. *Transactions of the Desert Bighorn Council* 1984:27-29.
- Gutierrez-Espeleta, G., S.T. Kalinowski, W.M. Boyce, and P. Hedrick. 1998. Genetic Variation in desert bighorn sheep. *Desert Bighorn Council Transactions* 42:1-10.

- Jessup, D.A. 1985. Diseases of domestic livestock which threaten bighorn sheep populations. Desert Bighorn Council Transactions 1985:29-33.
- \_\_\_\_\_, and R.R. Ramey. 1995. Blood protein variation in bighorn sheep (*Ovis canadensis*). Desert Bighorn Council Transactions 39:1-5.
- Hassanin, A., E. Pasquet, and J.D. Vigne. Molecular systematics of the subfamily Caprinae (Artiodactyla, Bovidae) as determined from Cytochrome b sequences. Journal of Mammalian Evolution 5(3):217-236.
- Luikhart, G. 1992. Genetic population structure and conservation of Rocky Mountain sheep (*Ovis canadensis canadensis*). Unpublished masters thesis. University of Montana, Missoula, MT.
- \_\_\_\_\_, W.B. Sherwin, B.M. Steele, and F.W. Allendorf. 1998a. Usefulness of molecular markers for detecting population bottlenecks via monitoring genetic change. Molecular Ecology 7:963-974.
- \_\_\_\_\_, F.W. Allendorf, J.M. Cornuet, and W.B. Sherwin. 1998b. Distortion of allele frequency distributions provides a test for recent population bottlenecks. Journal of Heredity 89(3):238-247.
- Moritz, C. 1994a. Defining 'Evolutionary significant units' for conservation. Trends in Ecology and Evolution. 9:373-375.
- \_\_\_\_\_, 1994b. Applications of mitochondrial DNA analysis to conservation: a critical review. Molecular Ecology 3:401-411.
- Nadler, C.F., K.V. Korobitsina, R.S. Hoffman, and N.N. Voronov. 1973. Cytogenetic differentiation, geographic distribution and domestication in Palearctic sheep (*Ovis*). Zeitschrift für Säugetierkunde 38:109-125.
- Ough, W.D., and J.C. deVos. 1984. Intermountain travel corridors and their management implications for bighorn sheep. Desert Bighorn Council Transactions. 28:32-36.
- Ramey, R.R. II. 1993. Evolutionary genetics and systematics of American mountain sheep: implications for conservation. PhD dissertation. Cornell University, Ithaca, NY. 212 pp.
- \_\_\_\_\_, 1995. Mitochondrial DNA variation, population structure, and evolution of mountain sheep in the southwestern United States and Mexico. Molecular Ecology 4(4):429-439.
- \_\_\_\_\_, G. Luikart, and F.J. Singer. (in press). Genetic bottlenecks resulting from restoration efforts: the case of bighorn sheep in Badlands National Park. (Journal of Restoration Ecology).
- Rand, D.M. 1996. Neutrality Tests of Molecular Markers and the Connection Between DNA Polymorphism, Demography, and Conservation Biology. Conservation Biology. 10:665-671.
- Ryder, O. 1986. Species conservation and systematics. Trends in Ecology and Evolution. 1:9-10.
- Schaller, G.B. 1977. Mountain Monarchs: wild sheep and goats of the Himalaya. University of Chicago Press, Chicago, IL.
- Shaw, C. 1981. The middle Pleistocene El Golfo local fauna from northwestern Sonora, Mexico. Unpublished masters thesis, California State University, Long Beach, CA.
- \_\_\_\_\_. 1990. The El Golfo vertebrate fauna. In O.K. Davis ed., Quaternary Geology of Bahia Adair and the Grand Desierto Region, Past and Future Evolution of Deserts, International Geological Correlation Program 252:5-7.
- Taberlet, P., S. Griffin, B. Goossens, S. Questiau, V. Manceau, N., Escaravage, L.P. Waits, and J. Bouvet. 1996. Reliable genotyping of samples with very low DNA quantities using PCR. Nucleic Acids Research 24(16):3189-3194.
- \_\_\_\_\_, J.J. Camarra, S. Griffin, E. Uhres, O. Hanotte, L.P. Waits, C. Dubois-Paganon, T. Burke, and J. Bouvet. 1997. Noninvasive genetic tracking of the endangered Pyrenean brown bear population. Molec. Ecology. 6: 869-876.

Wehausen, J.D., and R.R. Ramey. 1993. A morphometric reevaluation of the Peninsular bighorn subspecies. Desert Bighorn Council Transactions 37:1-10.

\_\_\_\_\_, and R.R. Ramey. 2000. Cranial morphometric and evolutionary relationships in the northern range of *Ovis canadensis*. Journal of Mammalogy 81:145-161.



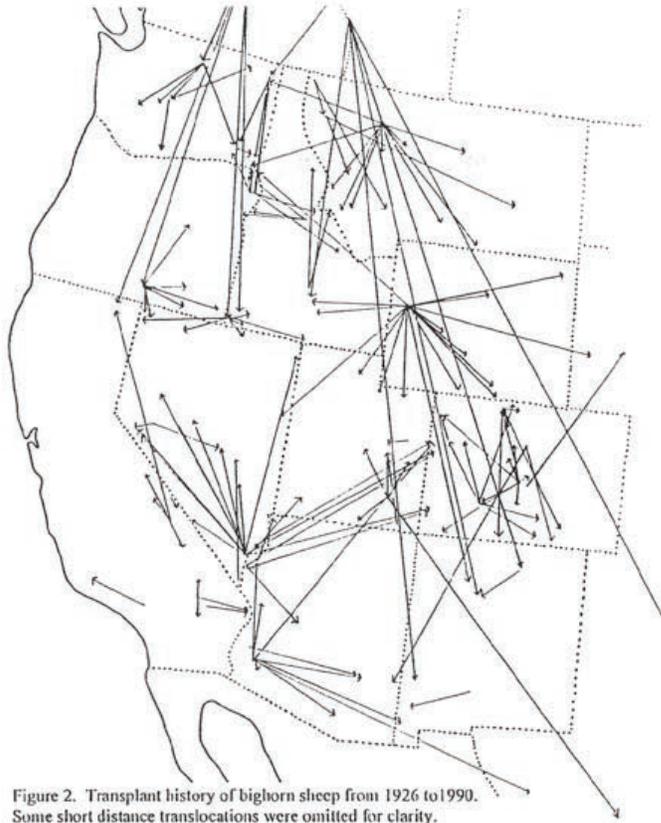
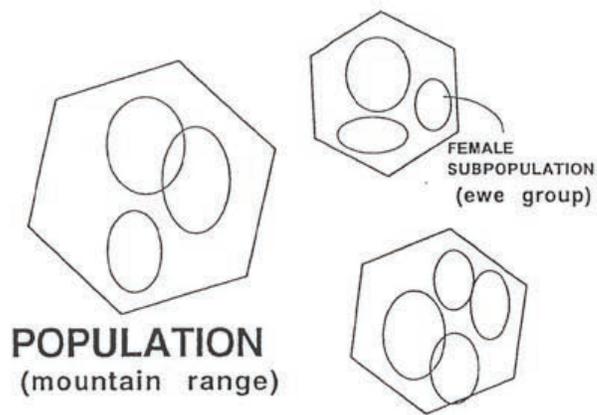


Figure 2. Transplant history of bighorn sheep from 1926 to 1990. Some short distance translocations were omitted for clarity.



## METAPOPULATION

(group of populations linked genetically by male migration and potential for female recolonization.)

Figure 3. The metapopulation model of bighorn sheep population structure.

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## QUESTIONS, ANSWERS AND COMMENTS - ROB RAMEY PRESENTATION

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**STACEY OSTERMANN, CALIFORNIA:** How would you describe the size of the difference that you found between Sierra Nevada sheep and other California sheep compared to the differences you found between peninsula sheep and nearby *nelsoni*.

**ROB RAMEY:** In the mitochondrial control region there were 27 base pair differences between those supposed California sheep from British Columbia and Sierra Nevada sheep. The difference between Sierra Nevada sheep and those in the desert to the east, was on the order of between 12 to 15 mutational steps. That's actually slightly higher than we found between, for example, those in the peninsula ranges and those in the Mojave Desert. There's quite a bit of difference there. I think the largest mutational step we have is about 12 mutations out of the 1200.

Once again, Sierra sheep appear to be on separate lineage, they're different morphometrically. Morphometrics is a combination of both genes and environment. There are shape differences that are not related to size.

I'm going to venture to guess that that's reasonable evidence for understanding their nuclear differences. We haven't gotten that data just yet.

**RAY DEMARCHI, BRITISH COLUMBIA:** I came to the same conclusion about Seton's estimates as you have, but from a different direction, and I actually gave a paper back, I don't know, probably 20, 25 years ago. I figure that Seton was about ten times too high in all of his estimates. He estimated between 16 and 20 million barren ground caribou. His estimates of bison were way out to lunch, and certainly his North American bighorn sheep estimates were not substantiated.

I came at it from a different direction from you and it's interesting to see that your genetic work supports the estimates. My estimates were based on habitat. My brother Dennis was at that workshop 25 years ago, and he's with me today. We're doing a lot of work on habitat, habitat mapping and so on, and we've got some stuff and hopefully somewhere along the way we can fit it in. It's interesting stuff.

**RAMEY:** You should write a paper about it.

**DEMARCHI:** I read the one and a half million to two million figure and know that people are still using it. I saw it the other day in a publication in which one esteemed sheep biologist quoting there were one and a half to two million bighorn sheep in North America. I don't believe it. It's closer to 150,000 to 200,000, maximum. All you have to do is look at Dall sheep and Stone sheep where the habitat hasn't changed. The numbers haven't changed compared to the habitat. We just didn't have it.

**RAMEY:** Those are just guesses as to how many animals Seton thought there could have been. These old traditions die hard. Similarly, the problem with sheep taxonomy. People are using subspecies names that have essentially died and gone by the wayside. Instead of adopting a new evolutionary perspective and more mature understanding of population structure, they tend to hold on to those old names and such. And I think it's much to the detriment of the sheep overall that those stay. Not to say all these are right, but this is what the data supports right now, and my interpretation of it.

**DEMARCHI:** The same applies to the numbers. I agree with you totally on that. If you have the idea that there were one and a half to two million bighorn sheep in North America and you're trying to recover the species, you're never going to get there. If it's 150,000 to 200,000, a more reasonable number, maybe you could get there and it's a more achievable number.

**RAMEY:** Yes.

**DEMARCHI:** Same thing as using outdated taxonomic classifications and so on. This frustrates you when you're trying to do a conservation plan.

**RAMEY:** I think John Wehausen looked at the demographics of trying to get 10,000 to 20,000 sheep in the desert area in Southern California, and what rate of increase we would need to achieve that goal and it was totally unrealistic.

**JIM BAILEY, NEW MEXICO:** I wonder if you'd comment on the accepted practice of using California bighorn for transplants into what was supposedly *auduboni* habitat, why California bighorn?

**RAMEY:** Presumably, the reason people have done that is these animals live on river breaks. They're going to put a similar kind of animal that has a similar kind of habitat memory out into those river breaks. I think we really need to ask a hard question, what is our goal in trying to restock historic ranges? Is it to put back what was originally there?

In terms of genetics, are we trying to use the most closely related thing that was originally there, trying to reconstruct the animal's evolutionary history as best we can. Or is it to provide hunting opportunities, bringing in essentially exotic animals from distant locations to provide an opportunity for revenue and support?

Those are potentially conflicting goals. My personal ethic, and this is a personal one, is that we should try to put back what was originally there first and that should be our major emphasis, and the conservation effort should go to the local populations rather than bringing something from a very distant location. I think bringing the animals from a very distant location flies in the face of what we know of sheep evolution.

It might be out of convenience that these sort of things happen, too. That's certainly true of a lot of the early transplants.

**WAYNE HEIMER, ALASKA:** Playing off what Jim Bailey had to say, the question that occurs to me is, you mentioned, I think an ND5 gene; do we know what it does? You talk about cytochrome B variability in a base, and you look at mitochondrial DNA. Is there any measureable, demonstrable significance in the variability that we see? If there isn't, does it really matter? If there is, restocking becomes a philosophical choice.

**RAMEY:** For understanding evolutionary history of groups, you're better off looking at neutral molecular markers. It's true that the ND5 cytochrome genes have a high degree of function and some of the differences that we see amongst the groups can be the result of selection.

So the more modern methods of analysis use information on trying to determine which base pairs are under selective constraint versus which are neutral.

When you look at microsatellite data, which largely happens to be neutral, they are good indicators of gene flow amongst populations and of understanding the evolutionary history of groups, independent of selection.

So that's why we are trying to look at those presumably neutral markers. They give us a good estimate and we don't know where the selection is occurring. We can determine that at some particular bases in a sequence, but overall we prefer these neutral markers to try to understand the genealogy of these animals, and my interest in working with morphometrics is to try to understand where there's been some sort of selective constraints on some inheritable feature of the organism.

**HEIMER:** As a manager, I hope you can understand why it might be difficult for some of us who sort of think that adaptive significance is what determines speciation, and to have trouble following why things that have nothing discernible to do with adaptation would be a better mark than something which determines whether you survive or not.

**RAMEY:** You've highlighted a difference between the schools of selectionists thinking. That's what drives speciation, realizing that there's a lot of selection which can drive adaptation, but a lot of the differentiation we see is the result of random stochastic changes and in gene frequencies in evolution over time.

I'd say we can learn a lot about the pattern of evolution by looking at the neutral markers and that it is very interesting when we find nonneutral evolution that has gone on. And we can go in and test in the sequence data bases and see whether there's some sort of adaptation going on.

To try to strictly base all of your taxonomic classification on sort of a selectionist view I think really ignores most of the development and evolutionary thought over the last century that, yes, adaptation has certainly occurred, but, animals came into North America and they split on the different evolutionary pathways, perhaps by chance, and there's been some local adaptation following so it's not as if selection has driven the change all the way along.

**BILL DUNN, NEW MEXICO:** I was looking at your map. You've got the north as north and south as south and neither the twain shall meet. How do you reconcile a subspeciation in large mammals that we know are linked by mountain ranges that are within distances we know bighorn sheep can move? New Mexico is not quite as simple as that. We've got mountain ranges that are linked from southern New Mexico to Colorado, from Wyoming on to Banff. How do you reconcile clearly stating subspeciation on a large mammal capable of moving between all the mountains?

**RAMEY:** I think of subspecies as having these major fuzzy differentiations, not even boundaries between the subspecies. I don't believe in this notation of subspecies boundaries for the most part.

I think what you're trying to get at is there probably was some conductivity between the southern Rocky Mountains through New Mexico sometime in the past. I'll agree, I think that's highly likely, and that if we went back in sequence, both nuclear genes and mitochondrial for across that area, we'll find some gradation in the nuclear gene of those animals.

Our morphometric data suggests that those northern New Mexico to southern New Mexico sheep are more aligned from the desert than they are from the Rocky Mountains. I think it's a reasonable working hypothesis. There's gradation that occurs. There's no major separation. There's no line between desert and Rocky Mountain sheep in that area.

**PHIL HEDRICK, ARIZONA:** I'm going to answer Heimer's question. These neutral markers give you an idea for the potential of adaptive differences between groups, and you may have them or you may not. You don't know how closely these neutral markers trace adaptive differences, but if there are no differences in neutral markers, you suggest there may be little difference in adaptive differences, although that's not true in all cases either.

I was going to say that the other system that we're looking at besides the neutral markers are genes, a major histocompatibility process which is involved with pathogen resistance in humans and other organisms.

Our idea is to look at different populations for variation of these genes, which we think has an adaptive significance and see if we can correlate that with resistance or susceptibility to different diseases.

There's a gene that we're looking at specifically to determine if there are adaptive differences, and what we found so far is a lot of variation and difference, say, desert bighorn groups have different variations. I'm not going to say that it's similar to our microsatellite data, but it seems to be following the same pattern of how different California populations and Arizona populations are differentiated.

I think you potentially can look at genes that you know have some adaptive significance. I think that's one thing we can go to in the future.

**RAMEY:** That's the candidate gene approach. If you know some physiological trait in the animals that you think is under selection, there is enough understanding of what genes control what characteristic, we can go to a particular gene and ask the question, is this under selection for this particular group of animals?

**DUNN:** Rob, did you find any variation in the Rocky Mountain sheep that you sampled throughout the range?

**RAMEY:** Yes. In fact, the best work is Luikart's thesis from Montana that for mitochondrial DNA, he found fairly substantial differences among groups, north/south in the Rocky Mountains. And that's just for mitochondrial DNA. The only other data sets are fragmentary and not enough to make a major conclusion. John Wehausen and I found some differentiation between Colorado and New Mexico and southern and northern Alberta. There's variation out there. It seems to be mostly, as you would expect, sort of isolation by distance. I think the way you think of subspecies is groups flowing across the landscape and integrating in areas.

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## WAYNE E. HEIMER - INTRODUCTION TO THE 2ND NORTH AMERICAN WILD SHEEP CONFERENCE

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Wayne E. Heimer, 1098 Chena Pump Road, Fairbanks, AK 99709, Alaska Dept. Fish and Game (Ret.), Program Co-chair

Management of wildlife in North America has been the outstanding conservation success story of human history. In their 1999 book "Return of Royalty", Toweill and Geist traced the history of this success to a jointly-derived U.S./Canadian principle which bears the name of U.S. President Theodore Roosevelt. Toweill and Geist wrote:

Roosevelt gave a unique twist to the North American philosophy of wildlife conservation, one that bears his name to date: the Roosevelt Doctrine. The Roosevelt Doctrine proclaimed that the management of wildlife was to be based on the best science and scholarship available.

Management has evolved considerably from this simple statement. Nevertheless, this doctrine continues as the implicit, though seldom-stated basis, for modern wildlife management. Today, management decisions are most commonly thought to be driven by management plans which implement management policy. Hence, in modern terms, successful application of the Roosevelt Doctrine requires that the best science and scholarship available (biological research findings and interpretation) must drive policy development, management planning, and ultimately each "on-the-ground" decision. Unfortunately, in the modern management milieu, policy makers, planners, and field managers sometimes lose sight of this basic principle.

Although successful restoration and conservation of North American wild sheep continues, it has occasionally been hindered by loss of accountability to wild sheep biology. The most difficult obstacle for successful sheep management has been the newness of the discipline. Modern sheep

management is barely 40 years old. After the decline of North American wild sheep which accompanied the settlement of the American West (Buechner 1960), scientific management driven by social and legal mandates to provide human benefits derived from hunting eventually brought many populations back to huntable numbers (Trefethen 1975, Hoefs 1985, Toweill and Geist 1999). These population recoveries began with decreased mortality associated with hunting by humans (which coincided with a human-related low in predator abundance [Heimer, this proceeding]). Subsequent increases in more modern times have been accomplished primarily through reintroduction of wild sheep into previously-occupied habitats and continued protection from overharvest by humans (see proceedings of Transplant workshop Northern Wild Sheep and Goat Council 1998 for a review of northern subspecies).

As sheep populations returned to viability, managers sought a balance between protection and use. This meant allowing for harvest, either by hunting or transplant, within the limits of biological safety and herd growth. Unfortunately, then as now, sheep managers lacked access to large, situation-specific data bases for making management decisions. Typically they relied on established principles of wild ungulate management occasionally tempered by local knowledge. Periodically, "new" sheep-specific research findings dramatically influenced management practice. An example was the breakthrough in wild sheep management resulting from understanding sheep behavior based on work by Geist (1971). This breakthrough was used to formulate management guidelines disseminated by Trefethen (1975), and later applied to yield significantly increased Dall ram harvests in Alaska (Heimer and Watson 1990).

Two identifiable associations of sheep managers and researchers arose to meet the need for sheep-specific research and management. The Desert Bighorn Council was organized in 1957, and the Northern Wild Sheep Council began in 1970. In 1971, a small meeting of desert and northern sheep biologists was organized by the Department of Fishery and Wildlife Biology at Colorado State University in Ft. Collins. Transactions of that meeting included 19 papers ranging from status reports through physiology and disease, research techniques, and management problems, procedures and needs (Decker 1971).

Four years later, another more inclusive meeting was organized under the auspices of the Boone and Crockett Club, National Audubon Society, and the Wildlife Management Institute to summarize the status of biology and management of wild sheep in North America. This meeting produced a distribution map of North American wild sheep, as well as a comprehensive review of state and provincial populations for all species of North American wild sheep, and was accompanied by management recommendations (Trefethen 1975). Following that meeting, both the Desert and Northern Councils continued to evolve separately. In 1978, the Northern Council expanded to include mountain goat research and management as well. Both councils continued to meet regularly and publish their region-specific findings in their respective proceedings.

Nevertheless, sheep management has been slow to emerge as a recognized specialty among wildlife educators and managers. Several factors slowed recognition of sheep management as anything beyond a typical application of "ungulate" management principles. Where sheep populations were abundant, and harvest was generally limited to mature rams, there was no attention-demanding management problem. In the contiguous United States, most sheep herds were so small as to be virtually unhuntable. Since there was little to no hunting, managers did not consider sheep a high priority. Consequently, funding was unavailable; research and management effort was focused on higher profile species like deer and elk.

In spite of its low priority, research (some by state and federal agencies, but mostly by academics) on mountain sheep began to rapidly reveal their management-relevant biology. Despite this burgeoning body of knowledge, management decisions in the field continued to flow from the principles of generalized ungulate biology and management (as well as management expedience), more than from sheep-specific biological findings. The failure to broadly recognize sheep management as a specialty was compounded by the mid-1970s emergence of management planning as a specific discipline.

Modern planning, often based on consensus among special interest stakeholders, holds the promise of increasing divergence from the Roosevelt Doctrine and raises the specter of decreasing traditional management success as a result. It is highly unusual for policy makers or planners to be familiar with the specific management-relevant biology for species about which they formulate policies or make plans. This means planning group consensus will outweigh the best science and scholarship extolled by Roosevelt. Additionally, it is rare for field managers to have all the data they need for each management decision. These information deficits raise several potentially dire consequences.

The first consequence is that policies will be formulated outside the envelope of wild sheep biological limitations. Plans to implement these policies are likely to fail biologically.

Secondly, even if policy is biologically grounded, improper management response to management challenges or opportunities may occur. The field manager's response to a sheep management challenge or opportunity is driven by what he or she knows or thinks about sheep biology. If a manager who doesn't happen to be a sheep specialist lacks access to an understandable summary of sheep biology and management, he or she may respond inappropriately.

The third consequence of management-relevant information deficiencies is inefficient and unpro-

ductive use of limited research resources. When research biologists design research, they may or may not be constrained by management applicability, but certainly rely heavily on their mental model of species biology. If researchers are new to sheep biology, or driven by inappropriate management policy or plans, unproductive research may result.

The fourth consequence of inadequate incident-specific information is controversy. When a working model of species biology is not widely understood as such, management actions consistent with the working model in the manager's head may not be understood by the public or peripherally-involved biologists and managers. Controversy seldom increases management effectiveness.

Having seen all of these putative problems in full bloom during 30 years of experience, I suggested development of the 1988 concept of the working management hypothesis as a possible means of mitigating these consequences for the theme of this conference. Program co-chair Amy Fisher and conference co-chairs Kevin Hurley and Rick Brigham graciously agreed.

In 1988, Heimer defined a working hypothesis as:

... a data-based working model of species biology which is relevant to [all] foreseeable species uses or abuses. It should be a predictive statement which integrates the available biological knowledge with management experience and summarizes the known aspects of species biology, management experience, and probable reaction to specific potential management actions or concerns. It should not be thought of as a definitive statement of the natural history of the managed species, and all involved persons should be continually reminded that the hypothesis requires constant testing, reexamination, and modification as management and research proceed. That is, it is just our best guess about how any species will respond to management options.

When the Desert Bighorn Council and the Northern Wild Sheep and Goat Council planned the 2ND North American Wild Sheep Conference, we thought it an opportunity to summarize what has been learned since the last North American Wild Sheep Conference (Trefethen 1975). Additionally, we hoped the established theme of the conference would facilitate making what we do as managers accountable to what we know of sheep biology. In an effort to streamline the information for planners and field managers, we agreed to summarize biological knowledge and management recommendations in the working management hypothesis format.

Consequently, the following synoptic papers on thinhorn, desert, Rocky Mountain, and California bighorn sheep identify what the presenters were able to gather and synthesize into a working management hypothesis for each species and its foreseeable management challenges and opportunities. Status reports and historical data for each state or province with responsibility for management of these sheep are appended to the working management hypothesis for that group.

Following these generalized presentations, the balance of the 2ND North American Wild Sheep Conference was devoted to exploration and discussion of current findings, ideas, and their applications to management. Presented papers and discussions are included. At the end is a series of management recommendations for managers of each general grouping of sheep, and a synthesized summary on management of wild sheep in North America.

#### LITERATURE CITED

- Buechner, H.K. 1960. The bighorn sheep in the United States: its past, present and future. Wildl. Monogr. 4. The Wildlife Society, Washington D.C. 174 pp.
- Decker, E. ed. 1971. Transactions of the North American wild sheep conference. Dept. Fishery and Wildl. Biol., Colorado St. Univ., Ft. Collins, CO. 188 pp.

Geist, V. 1971. Mountain sheep: a study in behavior and evolution. Univ. Chicago Press, Chicago, IL. 383 pp.

Heimer, W.E. 1988. Toward a working hypothesis for mountain sheep. Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 6:39-46.

\_\_\_\_\_, and S.M. Watson. 1990. The effects of progressively more restrictive regulations on ram harvests in the eastern Alaska Range. Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 7:45-55.

Hoefs, M. 1985. Wild sheep: distribution, abundance, management, and conservation of sheep of the world and closely related mountain ungulates. North. Wild Sheep and Goat Council., Spec. Rep., Yukon Wildl. Branch, Whitehorse, YT. 218 pp.

Northern Wild Sheep and Goat Council. 1998. Workshop on trapping and transplanting wild sheep. Proc. Bienn. Symp. North. Wild Sheep and Goat Council. (In press).

Toweill, D.E., and V. Geist. 1999. Return of royalty: wild sheep of North America. Boone and Crockett Club and the Foundation for North American Wild Sheep. Missoula, MT. 214 pp.

Trefethen, J.B., ed. 1975. The wild sheep in modern North America. Proc. Workshop Manage. Biol. North Am. Wild Sheep. Boone and Crockett Club. Missoula, MT. 295 pp.

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## WAYNE HEIMER - A WORKING HYPOTHESIS FOR THINHORN SHEEP MANAGEMENT

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**Abstract:** Thinhorn sheep come in two colors. The white, or Dall sheep (*Ovis dalli dalli*) inhabit more northern, predominantly alpine ecosystems. The colored Stone's sheep (*Ovis dalli stonei*) distributions are more southerly, and while typically alpine, often include forested ecosystems. Modern, management-relevant research on Stone's sheep has been limited to behavioral study while a fairly extensive body of data is available for the varied management-relevant aspects of Dall sheep biology. Hence, a generalized working hypothesis for thinhorn sheep management must presently rely on presumably common biology applied from the more intensively studied, Dall sheep. Both *dalli* subspecies are similar to the thinhorn Asiatic snow sheep (*Ovis nivicola*) in body and horn size/conformation. Both North American forms have 54 chromosomes, and presumably common ontogeny. Even though Dall lambs are born gray, soon to turn white, mid-term fetuses exhibit pelage coloration and markings similar to adult pigmented sheep.

**Distribution, abundance, and population strategies:** Distribution of both *dalli* subspecies is determined by geologic factors (most directly influenced by glacial retreat) driven by macrogeography which subsequently defines local climate. In concert with weather, geography determines distribution and abundance by producing habitats of varying size and suitability for both subspecies. Habitat stability in turn defines seasonal home ranges and apparent fidelity to these ranges. Home range size in Dall sheep is a function of habitat structure which determines quality of essential habitat components such as forage and escape terrain. Better habitats correlate with smaller home ranges that support higher population densities where high range fidelity dominates distribution. Because of these relationships and adaptations to stable climax habitats, thinhorn sheep appear at the more extremely k-selected end of the ungulate population strategy spectrum. Twinning is unknown, and population growth appears dominated by environmental resistance from weather and predation influences. Density-dependent nutritional limitations have never been demonstrated for thinhorn sheep, probably because winter food quality is so low that every thinhorn sheep population may be considered "at or above nutritional carrying capacity" each winter regardless of population size.

**Predation and harvest management:** Predation, by both human and other carnivorous predators, is the most important management-relevant component of environmental resistance, if for no other reason than it is the most management-alterable influence on thinhorn sheep population growth and size. Detailed description of canid predation effects on thinhorn sheep population dynamics is lacking, and opinion on its importance is divided. However, experience managing harvest by humans has shown mature rams constitute the only clear harvestable surplus from thinhorn populations in intact ecosystems. Ewe harvests by human hunters are generally considered additive to other mortality factors. In contrast with thinhorn management, ewe harvests are commonly applied to bighorn populations to check population growth or reduce population size where predators are a lesser factor. Consistent with the behavioral data from Stone's and bighorn sheep, Dall ram harvests resulting in the virtual absence of socially dominant mature rams have been causatively associated with lowered ovulation rate, rare successful consecutive-year lamb production, frequent alternate-year breeding by ewes, and compromised juvenile ram survival. If population maintenance or growth is a management goal for thinhorn sheep, harvest by humans should be limited to mature rams.

**Disease:** Throughout their distribution, thinhorn sheep are presently free of exotic diseases carried by domestic livestock. Consequently, disease-related mortality is not a significant factor in their management. However, preliminary *in vitro* macrophage toxicity studies suggest thinhorns may be more susceptible to *Pasteurella* cytotoxins than bighorns. Penning of healthy domestic sheep with Dall sheep resulted in *Pasteurella* pneumonia among the Dalls. All necessary steps to prevent introduction of exotic diseases, particularly those associated with domestic sheep should be taken. Legislative action excluding domestic sheep from Dall sheep ranges holds the greatest promise.

**Parasites:** Parasites of Dall sheep have been cataloged, and are of academic interest. Presently, parasites are not considered alterable factors in thinhorn management.

**Disturbance:** Although both Dall and Stone's sheep appear, in specific instances, to have survived notable local disturbances (probably because of their seasonal range loyalty and ability to habituate), common sense dictates managers should mitigate disturbance to thinhorn sheep to the maximum extent.

Data for the above synoptic statements will be introduced and discussed. Adherence to the established and rationally deduced biology of thinhorn sheep, educating the publics involved with thinhorn sheep, and empowering those publics to participate in thinhorn sheep policy development and management are identified as the basis of successful thinhorn management.

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Development of a synoptic working hypothesis for thinhorn sheep is a challenging task because of the disparity of research emphasis the *dalli* subspecies have received. In his early behavioral work, Geist (1971) focused heavily on Stone's sheep. Unfortunately, subsequent specific studies of Stone's sheep autecology have been scarce. In contrast, work on Dall sheep has focused on varying, and more directly management-applicable aspects of their biology. As a result, I shall proceed under the assumption that while there may be differences (primarily related to habitat), the subspecies are sufficiently similar that producing a generalized working management hypothesis for thinhorn sheep will produce a net management benefit.

Before beginning, I should briefly review several relevant considerations of the working hypothesis concept I first articulated (Heimer 1988). Consistent with the definition of a working management hypothesis, this one will be a synthesis of all the information which can be brought to bear on thinhorn sheep management. Hence, it will include refereed, "white" literature, less formally reviewed "gray" literature, unpublished data, local knowledge, and personal observations of those inti-

mately familiar with thinhorn sheep. These data will be interpreted within the context of traditional ungulate management theory as tempered by application of evolutionary principles of specific adaptation to environment.

Readers should be aware that my bias lies toward setting aside the generalities of conventional ungulate management when they cannot be rationalized with successful adaptations or specific data at hand. I hold this view because my experience indicates a higher probability of management success attends basing decisions on data which reveal thinhorn autecology rationalized by the evolutionary adaptation model. I prefer this to applying generalized ungulate models derived primarily from successional-adapted cervids inhabiting lower latitude, temperate ecosystems where non-human predators are virtually absent. Virtually all thinhorn sheep populations exist in what I call intact ecosystems, where predators exist at natural or augmented densities.

Synthesis of a working management hypothesis under these conditions requires a manager's (with due respect to our gambling-state meeting venue)

“knowing what to throw away, and knowing what to keep.” For this reason, I suggest formulation of working management hypotheses will be most productively deferred to biologists with extensive practical research and management experience.

This said, it should be emphasized that the working management hypothesis should not be considered a definitive statement of the natural history of Dall or Stone’s sheep. Instead, it is intended to be a framework to guide policy makers, planners, and managers within the “envelope” of thinhorn sheep biology and adaptation. The working hypothesis should be continually subject to testing and modification as new knowledge emerges. It is unlikely the hypothesis will ever be validated as “objective truth,” but if continually tested and refined, it should increase the probability of successful management.

**STRUCTURAL COMPONENTS OF A THINHORN SHEEP WORKING MANAGEMENT HYPOTHESIS:** Successful management results from maintenance or enhancement of thinhorn sheep populations in their existing pristine habitats. Production of human benefits from these managed populations has been the traditional “common currency” of North American wildlife management, and sustained or enhanced benefits will be the cumulative result of management decisions which positively affect population size, growth rate, trend, and human uses of thinhorn sheep.

Because protection of thinhorn habitats is basic to management success, I shall begin with a discussion of the effects of habitat macrostructure on distribution and abundance, and link them to the suite of adaptations to environment which have made thinhorn sheep successful to date. Once this physio-geographic framework for understanding thinhorn biology and adaptation has been presented, I shall discuss more management-alterable components of thinhorn autecology. These will include management of human harvest and predation, disease prevention, and human disturbance management.

**Habitat, distribution, abundance, and population strategy:** At the outset, it should be noted, that interpretation and synthesis of observations which contribute to this rationalization of thinhorn biology hang less upon data gathered in controlled experiments than on thoughtful *post hoc* rationalizations for “the way things are.” This is necessary because gathering objective experimental data to test hypotheses explaining what happened in geologic time and sheep evolution is impossible. The best we can do is to infer from the biological and geologic records and principles of natural selection, “why” things are the way they are. Our implicit assumption in this approach is that the inferred adaptations, which have obviously served sheep well throughout time, are still management-relevant. As stated above, my experience suggests greater management success will result from this approach coupled with specific management-relevant research than applying generalized ungulate models. Certainly sheep are ungulates, but their particular adaptations set them apart from classic “ungulate biology.”

It is biologically axiomatic that animal adaptations are responses to environmental factors. This cause-and-effect relationship is particularly apparent among thinhorn sheep, which are outstanding examples of adaptation to their northern environments. The major components of thinhorn sheep biology, ranging from geographic distribution through physiological and behavioral adaptations, are readily rationalized as adaptations to stable, high latitude alpine environments. These post-glacial habitats and their impacts on selection for specific adaptations were first specifically related to mountain sheep (Geist 1971), and have been conceptually expanded by Geist (1975, 1978).

Along with the glaciated mountainous country they inhabit, climate is an obvious environmental factor driving adaptation in thinhorn sheep. Climate is, of course, a function of geography, and by interpreting thinhorn biology through geography and its effects on terrain, weather, and plant communities, the most basic clues to understanding the “why questions” of thinhorn biology begin to emerge.

Thinhorn sheep distribution and abundance result from the interaction of habitat suitability and environmental resistance. While these terms are certainly linked, I suggest it is profitable to consider them separately.

Throughout their distribution, thinhorn sheep are limited to areas of relatively light snowfall. As a general rule, mean annual snowfalls exceeding 70 inches (178cm) preclude Dall sheep survival (Heimer and Smith, 1975). Simply put, thinhorn sheep don't live where normal snow accumulation is deeper than the length of their legs (Heimer in Toweill and Geist 1999). This limits their distribution to areas of continental or mitigated marine climate. Winter nutritional constraints and predation appear to render thinhorn population density under pristine conditions a moot point as data from Dall sheep demonstrate.

Although mean snow depth, through limitation of sheep movement and food availability, is clearly the deciding factor between suitable and unsuitable habitats, other climatic factors influence Dall sheep abundance and home range size within their distribution (Heimer et al. 1994). Within areas of generally tolerable mean snowfall, some habitats are prime, while others are barely habitable (Heimer 1995a).

These differences result from macro-habitat structure and the effect local topography has on prevailing weather. During winter, the major food source for Dall sheep is dried, frozen forage made available by winds which remove snow from standing grasses and sedges. Nevertheless, Dall sheep have varied diets throughout their distribution (compare Hoefs 1979 with Heimer 1983). These winter forages are uniformly low in available nutrients throughout Dall sheep distribution, and weight losses approaching 10% over winter are typical of Dall sheep (Nichols 1972, Heimer 1983). In the 1983 comparative study, there was no measurable difference in sheep body composition (percent fat, bone, protein, and water in ewe carcasses) or winter food quality between a high-density population with poor lamb production and low individual growth performance and a low-density population

with outstanding lamb production and high individual growth performance. Subsequently, I argued (Heimer 1992) individual Dall sheep welfare should be considered independent of Dall sheep population density because low winter food quality is such a severe nutritional bottleneck that the number of sheep competing for this low quality forage is typically irrelevant. Hence, differences in population quality and performance are unlikely to be functions of density-dependent nutritional constraints (Heimer 1980a, Heimer and Watson 1986a).

Prime thinhorn habitats not only have limited snowfall, but consistent cold, dry winter winds which remove snow from the surplus of low-quality forage. For Dall sheep, better habitats are typically found on the "precipitation shadowed" sides of relatively narrow mountain ranges which lie across the paths traced by ocean-generated winter storms as they move inland. The best of prime habitats are found on the "lee sides" of these mountain ranges adjacent to low passes identified as wind channels (F. Mauer, USFWS sheep specialist, pers. commun.), which accelerate surface winds and consistently remove snow from Dall sheep winter forage. The better habitats also consist of relatively long straight drainages which allow density-driven (catabatic) winds to consistently remove accumulated dry snow from ridges along the major drainages in the absence of major frontal movements (Heimer et al. 1994). Prime habitats contain extensive climax vegetative communities of suitable plants which are consistently available to Dall sheep for winter nutritional sustenance. In prime habitats, Dall sheep home ranges are small and predictable (Heimer et al. 1994). In contrast, where habitats are not "prime," Dall sheep have adapted by having larger and hence less predictable home ranges (Heimer et al. 1994). The validity of applying these inferences from geography and weather to distribution and abundance of Stone's sheep is uncertain.

In spite of variations in home range size resulting from habitat "primeness," thinhorn sheep demonstrate characteristics most biologists (inferred from the *post hoc* rationalizations discussed above)

consider adaptations to stable habitats with a relatively high cumulative environmental resistance. These characteristics differentiate mountain sheep from other North American ungulates, and successful sheep management requires an elevated appreciation of these adaptations as management-relevant constraints. The classic assumptions upon which successful deer management rests are questionably relevant to sheep management in general (Heimer 1992, 1998) and highly suspect in thinhorn sheep management, which is invariably practiced in intact ecosystems where predators are often a major component of environmental resistance (Heimer 1996).

Thinhorn adaptations to a consistent winter nutritional bottleneck based on climax plant communities include low ewe fecundity. Twinning is unknown, and delayed breeding by first-estrous ewes mediated through a rigid social hierarchy among rams is a fact of life in minimally disturbed populations (predicted by Geist 1971, inferred by Nichols 1978, and confirmed by Heimer and Watson 1986a, 1986b, 1990).

The most striking difference between "deer" and "sheep" management is based on differences in the adaptive biology of both groups. While the deer family is adapted to seral plant communities, and thrives as vegetative succession following disturbance of climax plant communities follows its natural course, Dall sheep adaptations are to a stable food source (the climax plant community). Seral-adapted species (such as the deer family) show nutrition-mediated high frequencies of multiple birth and early breeding by females when early successional stages produce nutritional abundance. In contrast, Dall sheep never produce multiple births, and early breeding has been linked directly to the absence of mature rams--not nutritional abundance.

Here, it should be noted that thinhorn responses to their seasonally pulsed nutrition/growth cycle differ from the contemporary Alaskan interpretation of summer drought effects on caribou cow nutrition and fecundity (Valkenburg 1997). Sexual maturity among yearling caribou and

ovulation by mature cows appear exquisitely susceptible to nutritional constraints. Only on unusually high planes of nutrition do female caribou yearlings ovulate, breed, and conceive. Similarly, caribou cows appear at risk of reaching sufficient body mass to successfully reproduce if summer nutrition is compromised. In contrast, all 18-month old Dall ewes appear to ovulate. The sample size of 18-month old Dall sheep ovaries actually examined approached 50, but has no variance. The documented number of Dall ewes which have delivered lambs at 24 months runs into the hundreds. It contains yearlings covering the nutritional spectrum from those fed high quality food, *ad libitum*, in zoos (Heimer and Watson 1986a), through less luxurious diets in game farms (Hoefs 1979), descending the nutritional quality ladder to high-density populations showing low lamb production ratios and low individual growth (yet where documented lamb production by two-year old ewes averaged 25 percent over an eight-year period). The Dall yearling ewe sample also included individuals from low-density populations where, even though lamb production ratios were high and individual growth was outstanding, lamb production by two-year old ewes which would have bred as yearlings (at 18 months) was virtually absent (Heimer and Watson 1986a and Heimer and Watson-Keller, unpublished data). Additionally, Egorov (1967 cited in Hoefs 1979) reported yearling snow sheep ewes in Yakutia, are capable of breeding.

Since all yearling Dall ewes apparently ovulate, it would appear that low body weight due to poor summer nutrition is not as robust an explanation for variations in lamb production in Dall sheep as for calf production in cervid species. Thinhorn sheep may simply be more highly adapted to climax habitats than caribou.

An additional adaptation imputed by Geist (1975) and Toweill and Geist (1999) is learning ability inferred from brain size and behavior among mountain sheep. Learning ability appears to be expressed in high fidelity to seasonal ranges.

These adaptations, coupled with the longevity and

documented age-specific mortality patterns of among Dall ewes (Heimer and Watson-Keller unpublished data) may render interpretation of population size fluctuations in thinhorn sheep problematic for managers (Watson and Heimer 1984). Gathering data on internal population dynamics (Heimer 1994) holds potential for alleviating this problem.

Planners often push sheep managers to identify the critical thinhorn habitats considered most necessary to survival and welfare. Just as seasonal home ranges vary with geography-driven habitat stability, differing populations of thinhorn sheep are likely to show variability in apparent critical seasonal ranges. Some may rut, lamb, use mineral licks, and rear young within a small geographic radius while others travel significant distances between separate regions supporting these activities. For thinhorn sheep to survive as viable populations capable of providing human benefits, all components of their habitats must remain suitable for sheep uses.

**Summary:** Because of their adaptations to seasonally pulsed nutrition, particularly the winter food quality bottleneck, managers should not anticipate major increases in reproduction or individual growth to attend lowered population densities among thinhorn sheep. There is no doubt thinhorn sheep will do better if fed better. Similarly there is every reason to believe thinhorn sheep are biologically capable of the "compound interest effect" demonstrated for bighorn sheep by Wishart et al. (1998, and bighorn working hypothesis this conference). An instance where unusually low environmental resistance due to favorable weather and low predation has resulted in explosive thinhorn population growth resulting in classic density-dependent nutritional constraints has yet to be documented using modern methods. If it is to be seen among thinhorns in intact, pristine ecosystems Wishart's "compounding effect" will have to result from lowered mortality rather than increased reproduction.

**Human harvest management and predation:** If thinhorn sheep exist in intact, pristine ecosystems

and the adaptations discussed above limit potential for managers to increase populations through conventional habitat augmentations or growth rates through population density reductions, the remaining possibility for management success must lie in limiting mortality. Thinhorn sheep mortality sources can be divided into human-caused mortality (primarily hunting) and predation by other animals such as wolves, coyotes, bears, and eagles. The majority of management effort has gone to control human-induced mortality.

**Human harvest management:** A brief review of wild sheep history in North America indicates that after the decline of North American mountain sheep which accompanied the settlement of the American west (Buechner 1960), enlightened approaches to management of wild mountain sheep (typically the total protection from hunting attending the emergence of modern wildlife management) eventually brought many populations back to huntable numbers (Trefethen 1975, Hoefs 1985). Contributing to this recovery was coincidence (from 1930 to the mid-1960s) with the all-time North American low in wolf, coyote, cougar, grizzly bear, and golden eagle abundance. That is, environmental resistance to population growth was suppressed more than at any other time in American history.

As sheep populations returned to viability, managers sought a balance between protection and use. This meant allowing for harvest, either by hunting or transplant, within the limits of biological safety and herd growth. The need to assure continued herd recovery and health was easily understood. Likewise, appreciation of benefits attending maximal hunter use (license and tag fee revenues, and development of guiding and outfitting industries) was growing.

Demarchi's (1978) review of hunting regulations across North America shows the most common attempt to balance herd growth with maximized hunter use was limitation of harvest to surplus males (rams). Historically rams which could be harvested without compromising lamb production were defined as surplus. The intuitive conclusion

of most managers was that harvesting rams at the youngest acceptable age (before natural mortality removed them from the shootable population) would produce the maximum sustainable harvest. The youngest acceptable age was defined as the age at 3/4 curl horn development. Defining legally harvestable rams by degree of horn curl made sense because ram horns grow throughout life and generally describe a full circle (full curl) at maturity. This attempt to limit harvest to mature rams appears to have been designed either to protect younger rams from harvest, or assure larger horns on harvested rams. Its rationale has apparently been lost in history. Interestingly, the 3/4 curl rule (established in 1930) was a data-free assumption which antedated the first sheep mortality study (Murie 1944) by 14 years. Nevertheless, it dominated sheep harvest management for almost half a century.

Among thinhorns, rams have been shown to reach 3/4 curl horn size (Geist's Class III, 1968) at the approximate age of 5.5 years (Heimer and Smith 1975), well after they develop the capacity to sire offspring, usually at 18 months of age (Nichols 1978). In the absence of mature rams, juvenile rams participate actively in breeding activities (Nichols 1978, Heimer and Watson 1986a). Consequently, even total harvest of all rams down to 3/4 curl or 5.5 years of age does not preclude lamb production. For this reason the harmful effects of Dall ram overharvest were overlooked until the late 1980s.

As increasing hunter interest during the late 1960s and 1970s drove Dall ram harvest pressure upward in Alaska, accessible populations were harvested to the legal 3/4 curl limit (Heimer 1980b). That is, virtually every legal 3/4 curl ram in these populations was harvested each year. Subsequent field research where marked ewe reproductive success was monitored over the course of about 20 years revealed consecutive-year reproduction was rare in these populations (Heimer 1978). A high percentage of ewes (almost 25 percent) bred at 18 months of age, ewes maintained lambs on milk throughout winter rather than weaning in October, and ovulation rate was low. The cumulative effect was an

alternate-year reproductive success syndrome (Heimer and Watson 1990). Nutritional and body composition studies (Heimer 1983) showed no difference between populations exhibiting the alternate-year syndrome and comparable populations where consecutive-year reproductive success was high (but yearling ewe breeding was virtually absent (Heimer and Watson 1986a). The obvious difference between these radically different populations was mature ram presence, which was linked with overall higher ram abundance. Subsequent adjustment of harvest regimes from a lower legal limit of 3/4 curl upward to 7/8 curl eliminated the alternate-year reproductive syndrome among ewes (Heimer and Watson 1990), but did not result in the anticipated increase in ram harvests.

Subsequent analysis of marked sublegal ram survivorship from the poor quality population indicated harvests were compromised because physically and socially immature rams were paying the mortality cost of dominance beginning at age three instead of at social and physical maturity at age eight (Heimer and Watson 1986b). That is, mortality rates among marked sublegal rams equaled those calculated by Deevey (1947) from Murie's (1944) age distribution at death. The difference was that, in the absence of dominant rams, the accelerated mortality portion of Deevey's survivorship curve began at age three instead of age eight. These findings were consistent with predictions from Geist (1971 and pers. commun.). Increasing the legal horn size minimum from 7/8 to full curl resulted in highly significant (mean 35 percent increase,  $p < 0.001$ ) increases in realized harvests from this population (Heimer and Watson 1990).

With the exception of the divided Northwest Territories, thinhorn sheep are now harvested at legal minimums defined as full-curl throughout their distribution. The extent of actual horn development differs between Alaska and the Canadian jurisdictions (Heimer 1990, Barichello and Carey 1990, Case 1990, A. Veitch pers. commun.), but intent is to restrict non-subsistence hunting to mature rams.

*Summary:* Mature rams are the only clearly surplus animals in thinhorn populations. Harvest by humans should be limited to fully mature rams if population maintenance and maximized human benefit are management goals.

**Subsistence hunting of thinhorn sheep** is a relatively recent recurrence (Heimer 1998). Man has “always” used thinhorn sheep for food as necessity demanded or opportunity occurred. Most accounts emphasize that sheep were considered a specialty food item or “back up” for use when other resources, e.g. caribou, failed (Campbell 1974). Economy of effort dominated these human enterprises, so the most available sheep were harvested. Hence, it is presumed the historic harvest focused on the more abundant and approachable ewes. This presumption has been validated as contemporary subsistence harvest data show a selection for ewes (Heimer 1998). Historically, human use of sheep for food was practiced sparingly by small populations of humans using primitive technology, and was probably not a significant factor in overall thinhorn population dynamics.

Due to its formal recognition, increased subsistence user populations, and advances in harvest technologies, subsistence hunting is now practiced by a greatly increased human population using advanced technologies. As such, this use poses the real possibility of local population extirpation, with some extirpations being matters of recent historical record (see Heimer 1998 for a review). Most thinhorn subsistence harvests are only loosely monitored, and provide large bag limits which may be taken during extended seasons (Heimer 1998). These factors have made management of subsistence thinhorn harvests an issue of some concern among managers. The concern results from disagreement on whether there is a harvestable surplus of ewes from thinhorn sheep populations.

One school of thought argues that Dall sheep are ungulates, and must therefore be subject to general principles of ungulate management. These principles are dominated by the assumption that ungulate

populations grow until limited by their density at carrying capacity (Heimer 1992). Simply put, this assumption predicts that populations below carrying capacity will grow (by producing “surplus individuals”) until they become sufficiently dense that productivity declines due to nutritional limitations. When this happens, recruitment declines, the population ceases to grow, may decline somewhat, and then appear stable in numbers (Caughley 1970). In populations at carrying capacity, theory predicts reducing the population will result in increased population growth rate (by producing “surplus individuals” resulting from increased reproduction). By extension, this construct predicts any reduction of static populations (assumed to be at density-limited carrying capacity) will result in a compensatory increase in productivity (and recruitment) as the population strives to, again, reach carrying capacity. This is the dominant theory in ungulate biology, and it is taught as the guiding principle of wildlife management.

In contrast, the other school argues the adaptations of thinhorn sheep to high-latitude, climax ecosystems where predation by wolves, coyotes, and other predators is unchecked, limit the biological surplus from thinhorn populations to mature rams. This argument hangs heavily on the “winter nutritional bottleneck” argument presented above.

*Summary:* Biology aside, the political realities of modern times force recognition of and provision for subsistence harvest of thinhorn sheep. This area of thinhorn management will obviously require more management effort in the future. In jurisdictions where subsistence harvests can be regulated, regulations protecting ewes may be required for the long term benefit of sheep populations and the users who depend on them. Where the opportunity to harvest any sheep from an intact ecosystem is not negotiable, education of subsistence hunters so they harvest mature surplus rams must take priority (Heimer 1998).

**Predation management:** Management of non-human predators to benefit wild sheep has been sparingly practiced, if not completely absent, in modern times. This was not always the case. Prior

to the 1960s, predator reduction was considered good management policy by federal governments, and resulted in extirpation of many predators from bighorn sheep habitats in the Western United States. These extirpations resulted primarily from economic pressure by domestic livestock producers; wild sheep were never a significant consideration. Modern predator reductions have been primarily driven by moose and caribou scarcity.

On thinhorn ranges, the wolf has long been considered the chief predator, and several long-term fairly large-scale wolf control programs to benefit thinhorns have been undertaken by private citizens, guides, and outfitters. These efforts were funded by individuals with interests in sheep abundance. Although records were kept of when and how many wolves were removed, and the subsequent high sheep population densities were, in specific cases, studied and maintained for decades, most modern biologists discount these results as "anecdotal." These biologists maintain that no sheep-related benefits resulted from these predator mediated reductions in environmental resistance.

To be persuaded that predator reductions actually benefit prey populations, today's practicing biologists generally demand quantitative assessments of predator and prey population sizes prior to predator reduction. Additionally, standards of rigor and demands for data (e.g., specific locations of predator removal, effects on measured predation rate, and the numeric and functional responses of prey populations) are rising. Unfortunately, data of this quality are prohibitively expensive and virtually impossible to collect where potentially dominant variables (like weather and alternate prey cycles) cannot be controlled. Perhaps more unfortunately, retrospective inference drawn from historical accounts is discouraged as unscientific.

Given these increasingly rigorous standards it isn't surprising that conclusively compelling reports demonstrating benefits associated with reduced thinhorn predation are lacking. Even intensive studies of moose and caribou which are lavishly funded often fall short of the level of assurance demanded by many modern managers in order to

predict a general response (Nat. Res. Council. 1997). Consequently, the issue whether or not predator reductions can be expected to have a predictable positive result on prey population growth remains controversial; and seems dominated more by philosophical positions and standards of academic rigor than whether greater human benefits have been associated with longer-term reductions in environmental resistance resulting from predation. The issue has become one of management appropriateness as much as functional response.

Compounding the problem for thinhorn sheep is the fact that data on thinhorn population responses to predation have most often been gathered as "add ons" to studies where stated research objectives focused on higher profile prey. Hence, the actual yield of thinhorn-specific predator/prey research has been small and its interpretation remains greatly influenced by personal point of view.

This means formulating a working management hypothesis for thinhorn sheep with respect to predator management becomes a matter of judgment and balance. The choice turns on whether one limits the data base to the few inferential conclusions from quantitative studies relating wolves to thinhorn sheep or takes a more inclusive view of the subject.

Several published studies of which I am aware indicate no measurable benefit accrued to Dall sheep from wolf control. These include Gasaway et al. (1983). These authors concluded wolf control (implemented to benefit caribou and moose) did not benefit sheep in the area because yearlings:100 ewes ratios for sheep which should have benefited from wolf control were no different than in a nearby national park where no wolf control was practiced. However, recent neonate lamb mortality studies in the formerly wolf-controlled area (which now has wolf populations estimated equivalent to or higher than before the 1976 wolf control program began) showed wolves seldom preyed on Dall lambs throughout their first year (Scotten 1997). Hence, the early conclusion by Gasaway et

al. (based on the assumption that wolf predation would focus on newborn lambs just as it does on caribou and moose calves) appears to have been in error. Wolf predation on sheep focus on adults (Murie 1944), and by my inference.

Additionally, Barichello and Carey (1988) presented an abstract which reported no changes in Dall sheep populations attributable to an 80 percent reduction in wolf numbers within an 11,200 sq km area containing a Dall sheep population. This population was monitored 1980-1986, and compared with another Dall sheep population where a controlled wolf reduction had not occurred. Both populations showed variability in lamb production, recruitment, and age structure; but no changes the authors could ascribe to decreased wolf predation on the sheep population within the wolf control area. In a creative attempt to control variables in this study, the wolf control and the "experimental control" area (where wolves were not reduced) were given the opposite treatments after the controlled population of wolves had recovered (Hayes et al. in press). In a recent telephone interview, R. Hayes (Yukon Territory wolf specialist, pers. commun.) told me that caribou and moose populations in both areas of wolf reduction responded with significant increases in calf survival and strikingly significant increases in population size. In contrast, there was no notable increase in Dall sheep production, recruitment, or overall population size. Only a slight (but statistically insignificant) increase in full curl ram numbers was noted over five years of study. Hayes suggested that variability in lamb production and survival (which did not appear to correlate with wolf population density) "swamped" (my term) any population changes which might have occurred in the Dall sheep populations as results of wolf population reduction.

*(Author's late note: During the June 2000 meeting of the Northern Wild Sheep and Goat Council in Whitehorse, Yukon, I had the opportunity to interview R. Hayes (Yukon Territory wolf specialist) about final impacts of the wolf control program on Dall sheep. In discussion of the overall impact, Hayes reiterated no statistically signifi-*

*cant changes in lamb: 100 ewes or yearling:100 ewes ratios had been seen. However, he stated the investigators had always suspected their wolf-project sheep count area used to measure the effects of wolf control on sheep was too small. When they finally secured funding to census the entire area affected by wolf control (after the project had ended), they found the number of adult Dall sheep had increased by 35 percent when compared with the pre-wolf control total count. This finding supports the conclusion that wolf predation focuses on adults, and that assessment of lamb or yearling ratios is an inadequate methodology for assessing wolf control impacts on Dall sheep populations. The finding was too late to include in the monograph reporting on the Yukon project. It had already been accepted for publication.)*

On the other side of this argument, Heimer and Stephenson (1982) presented wolf density, wolf population reduction percentage, and sheep population size data which indicated the 1976 Alaska wolf reduction program (Gasaway et al. 1983) was associated with an immediate reversal of a declining trend in presumably affected Dall sheep populations in the Alaska Range. Similarly, Bergerude and Elliott (1998) inferred positive results for thinhorn sheep from wolf population reductions in northern British Columbia. Unlike Barichello and Carey (1988), Bergerude and Elliott took the more inclusive view of their results.

In contrast with the conflicting and fragmentary nature of specific inferences from wolf control programs peripheral to thinhorn sheep, a massive amount of "anecdotal" evidence (with which some modern biologists "lump" Murie 1944) suggests wolf predation is a significant limiter of Dall sheep population size and growth. Rearden (1999) cites Frank Glaser's papers reporting on early market hunting as saying:

That winter [1916-17] I never saw a wolf track or heard a wolf howl in the Alaska Range. I wondered about that, for I had heard wolves were plentiful in

Alaska. Eventually I learned why the animals were scarce.

Market hunters operated in practically every drainage on the north slope of the Alaska Range within dog team freighting distance of Fairbanks. In 1917, a warden estimated that during the previous four years, 2,800 sheep had been killed for the market within 200 miles of Fairbanks. Sheep were far more abundant than they have ever been since.

... I met many market hunters. . .

... To keep foxes, wolves, wolverine, and other animals from eating the meat, they [Lucke and Steele], like other market hunters of the time scattered little pill-like balls of sheep gut-fat laced with strychnine around their meat caches. This at least partly explains the absence of wolves when I arrived. (Rearden 1999, pp 33-34)

Having evaluated much of this anecdotal information, I now think the comparatively high sheep populations of the Eastern Alaska Range, where I've been involved with sheep for almost 30 years, were results of predator control. This country is classic "prime" Dall sheep habitat and readily accessible to sheep hunters. Consequently, it has supported intense hunting by humans for many decades. There are accounts of market hunting, and poisoning in the area (Rearden (1999), and physical evidence of market hunting still exists there (Heimer et al. unpublished data). Additionally, there is considerable evidence for a long-term, effective predator control effort by the Territorial government in the area (mimeo records of Warwick and Palmer, Alaska Dept. Fish and Game files).

When federal territorial predator control programs

ended at Alaska statehood, wolves began to increase. In the 1960s a local guide, Bill Waugaman, commissioned Bill Hutchinson, generally regarded as the greatest aerial wolf hunter in Alaskan history (B. Hinman, Alaska Dept. Fish and Game regional supervisor during the "Hutchinson era", pers. commun.) to implement a wolf control program in the area. By many accounts (B. Waugaman, master guide, M. Rinio and S. Scott, Hutchinson acquaintances, Al Wright, air taxi operator, pers. commun.), this wolf control program was successful, if for no other reason than it kept wolf numbers at levels much lower than today's wolf densities. At the close of the "Hutchinson era," (when aerial shooting, Mr. Hutchinson's forte) was outlawed, moose, caribou, and sheep were at recorded high levels. Whether they were as high as Glaser (Rearden 1999) reported is unknown, but wolves were certainly more abundant than in Glaser's day. Seeing wolf tracks, hearing wolves howl, and sighting wolves was not unusual in the early 1970s when I spent several months each year afield in the area. This prey abundance has been typically assigned to federal predator control during territorial days (Gasaway et al. 1983), but was probably significantly augmented by private wolf control efforts such as Waugaman/Hutchinson. With cessation of private wolf control wolf populations began to increase.

These increasing wolf populations coupled with human overharvests of moose and caribou (Gasaway et al. 1983) soon resulted in declining moose and caribou populations. The Dall sheep population of the area held up longer than the moose and caribou populations, but had begun a slow downward trend by the early 1970s. When the 1976 wolf control program in the area was carried out, moose recovered, caribou populations began to increase, and the sheep population decline apparently stopped (Heimer and Stephenson 1982). Sheep regained their former numbers, and remained stable at high densities until the late 1980s when a series of bad winters resulted in a significant population decline (Whitten and Eagan 1995, Scotten 1997). In the interim, coyotes colonized the area in significant numbers (Heimer, unpublished data), and became a significant docu-

mented mortality source on Dall sheep lambs (Scotten 1997). Additionally, wolves re-established population levels equivalent to or greater than those observed prior to the 1976 wolf control program.

Even though these Dall sheep populations (estimated at 5,000 sheep from a total count of 4,142 sheep reported by Heimer and Smith 1975) remained at high densities through the mid-1980s (in spite of intermittent severe winter events) they showed no credible signs of density-dependent nutritional stress. However, population estimates following a series of consecutive extreme winters from 1989-90 through 1993, suggested a decline of 60 percent (Scotten 1997).

Since 1993, winters have been "normal to mild," and Alaska Department of Fish and Game biologists feel recovery has been underway since 1994 (S. Arthur, Alaska Dept. Fish and Game sheep biologist, pers. commun.). It has now been six years since the last harsh winter was followed by a lamb production failure of the scale which precipitated the population decline. If the "compound interest effect" most recently identified by Wishart et al. (1998, and this conference) had been operating with low environmental resistance, a spectacular population increase should have been noted. There are no indications of such an increase, even though lambs:100 ewes ratios have regained what would have been maintenance levels prior to the advent of coyotes in the area.

Viewed synoptically, these data (defined as "anecdotal" according to the rigor standards of contemporary research biologists) suggest predators, including both wolves and coyotes, are a significant check on Dall sheep population recovery in the Alaska Range. Still predator control to benefit Dall sheep in Alaska is considered not only unthinkable, but against Alaska Department of Fish and Game and Alaska Board of Game policy (K. Whitten, Alaska Dept. Fish and Game Regional Research Coordinator, pers. commun.). I have found no formal record of this Department policy, and have been unable to validate Mr. Whitten's interpretation of Board of Game policy.

Predator control has generally been avoided by modern management agencies because social and political forces acting on agency decisions have made it a *de facto* agency responsibility. As a result, public participation in significant predator reductions has become stigmatized as unacceptable (Heimer, Predation Session this conference). When done by management agencies, predator management is logistically difficult, expensive, and easily curtailed by the increasingly powerful groups which oppose management for human consumptive benefit. A deep schism exists between some sheep-interested publics (primarily hunters, who fund conservation) and the agencies which manage their sheep for them.

My position in this working management hypothesis is that sheep managers should advocate and implement predator control when it appears likely predators are depressing populations below an empirically determined base effective population size (Heimer 1992) or slowing recovery to stated population size or harvest management goals. After all, I argue, what's the worst thing which can happen if we mistakenly control predators to benefit selected thinhorn populations? If it has no effect over the long term, we can stop; and wolf and coyote populations will quickly recover. The major risk is not biological. Additionally, my bias is toward conducting research through management actions. Managers will certainly be more likely to test the validity of a working management hypothesis if it suggests action than if it doesn't.

If a positive effect on thinhorn sheep populations from wolf population reduction exists, data indicate it must result from reduced predation on adults (not lambs). This differing effect of wolf predation on survival of neonates between sheep and other ungulates represents a specific instance where sheep management thinking should differ from generalized ungulate management. Wolf predation continues to be a consistently demonstrable negative influence on moose and caribou calf survival, yet a consistent "non-factor" on lamb survival. Hence, longer-term studies designed to produce data with greater resolving power than those required for moose and caribou will be

necessary if predator biologists are to document whether wolves are, in fact, a controlling factor with respect to thinhorn sheep.

**Summary:** Long-term anecdotal information suggests certain benefit to thinhorn sheep from reducing and maintaining a lowered level of environmental resistance due to predation. Shorter term quantitative studies, favored by most contemporary managers, have failed to demonstrate consistent beneficial results to sheep or sheep hunters. Conclusions regarding the management efficacy of predator control appear to be influenced by individual point of view. Those with a broad point of view and willingness to accept credible "anecdotal" evidence postulate a benefit. Those unwilling to accept anecdotal evidence and holding a narrower focus deny any benefit. The more quantitatively aware modern biologists are, and the more accountable their agencies are to public pressure against wolf control, the less likely they seem to consider a benefit might result from lowering this component of environmental resistance. If I have this right, there may be the attendant risk of inferring "absence of proof is proof of absence." These differences in perspective will be reflected in recommendations to managers at the end of this volume.

**Disease prevention:** Another management-altering component of environmental resistance to wild sheep population growth is the presence of exotic diseases. Unlike bighorn sheep management, which is dominated by introduced diseases from domestic livestock, disease does not seem to be a factor in thinhorn management. Thinhorn sheep presently exist in basically pristine ecosystems, and have never shown any inclination toward periodic disease-related die-offs (Heimer et al. 1982). Large numbers of Dall sheep from Interior and Arctic Alaska have been tested for antibody titers to diseases of domestic livestock, and the tests have been overwhelmingly negative (Heimer et al. 1982, Zarnke 1992). Additionally the pharyngeal microflora of Alaskan Dall sheep from the remote Brooks Range, where exposure to diseases of domestic livestock is least likely, have been characterized (Heimer et al. 1992). While benign

strains of *Pasteurella* bacteria are common in Dall sheep, and presumably in Stone's sheep as well. Those forms of *Pasteurella* which precipitate bighorn die-offs have not been isolated from Dall sheep in the wild. Penned Dall sheep have been experimentally infected with pathologic strains of *Pasteurella* from domestic sheep, and have developed pneumonia. These sheep were euthanized (B. Foreyt, Professor of Veterinary Medicine Wash. St. Univ., pers. commun.). There has never been a disease-related thinhorn die-off in the wild, probably because domestic sheep, generally acknowledged to be the carrier of those *Pasteurella*'s which kill wild sheep, have never come in contact with wild thinhorn sheep. Should this ever happen results would most likely be disastrous. Tests on Dall sheep leukocytes indicated a six-fold greater susceptibility to *Pasteurella* cytotoxins than for bighorns (Foreyt et al. 1996).

The absence of domestic livestock pathogens from thinhorn populations does not mean disease is not a factor in the biology of these sheep. The common diseases identified from thinhorn populations are contagious ecthyma and lumpy jaw (Heimer et al. 1982). Contagious ecthyma is caused by a pox virus, and is not considered a management-alterable factor in thinhorn sheep.

Lumpy jaw may influence longevity in sheep because it deforms the mandible and leads to loss of teeth and poor tooth alignment which may interfere with feeding. Data relating the effects of lumpy jaw to overall survival are lacking. Murie (1944) speculated the high lumpy jaw frequency in the skulls he collected predisposed infected sheep to predation. From this speculation came the romantic notion that wolves prey only on the "unfit," and actually benefit their prey populations (Heimer 1995b). After capturing and examining almost 400 Dall sheep in the Alaska Range, just 50 miles east of where Murie worked, I calculated the frequency of lumpy jaw in living sheep was virtually equal to that among Murie's death assemblage. Hence, I conclude lumpy jaw does not necessarily predispose Dall sheep to predation, and that the frequency which struck Murie as so high was actually just the frequency of infected sheep in

the population. In Dall sheep lumpy jaw is now thought to be caused by a common bacterium, *Corynebacterium pyogenes*, introduced below the gum line as a result of eating coarse forage (Heimer et al. 1982).

**Summary:** While virtually all other management mistakes can be corrected, introduction of exotic diseases cannot. Thinhorn sheep management will be forever changed if domestic sheep ever come in contact with wild thinhorns. For this reason, the highest management priority for thinhorn sheep managers must be continued exclusion of domestic sheep from thinhorn ranges. This exclusion of domestic sheep will be most effectively pursued through legislation.

Often diseases and parasites are considered together. Because thinhorns exist in pristine habitats, their parasites are generally considered to have "come with them" from Asia or be normal faunistic components of their habitats. Parasites of Dall sheep have been reasonably well cataloged (Neilson and Neiland 1974, Veitch et al. 1998).

**Disturbance:** If thinhorn sheep colonized habitats created by retreating glaciers, it should follow that their suite of adaptations includes the ability to adapt to disturbance. After all, glacial habitats are noisy and unstable places. Ice groans, creaks, cracks, and falls from the terminus while unstable moraines produce continual rock falls and land slides. Additionally, glacial winds produce plenty of noise as they sculpt and scour the freshly exposed soils. These disturbances have presumably been, and remain, basic features of thinhorn sheep habitats. Certainly these glacial disturbances are of a somewhat differing character than overflights by military aircraft, helicopter tourism, mining, road-building, heli-mountain biking, and goat packing. However, barring actual habitat degradation, a manager's perception of difference may be more based in aesthetics than biology. For all the disgust which these human activities evoke from thinhorn sheep managers and wilderness advocates, there are scant data which suggest measurable negative effects on population production and growth rate. In fact, a fairly rich literature and large volume of

anecdotal evidence suggests these conventional human disturbances have no measurable effect on thinhorn sheep. Heimer (1981, 1988) reported Dall sheep in Alaska have apparently tolerated road and bridge building, pipeline construction work, coal mining, automobile traffic, intense human contact (both hunting and viewing), and intrusive scientific investigation. Others in this conference will report on the adaptability of bighorn sheep to apparent human disturbance.

Depending on a manager's point of view, this ability to persist and thrive in disturbed habitats can be seen either as a tolerance for disturbance or tenacious, adaptive refusal to leave established functional ranges. While the existing data suggest thinhorn sheep are highly adaptive to human disturbance as long as habitat is not actually degraded, managers focus considerable effort on mitigating or preventing human disturbance, and disturbance studies continue to proliferate (e.g., see Krausman et al. 1998). Usually these studies focus on short-term avoidance reactions or temporary changes in location.

I've found only two references to permanent range abandonment resulting from disturbance. Legendary Alaskan bush pilot, Jack Wilson cites an example of permanent range abandonment in his recent memoir (Wilson 1997). Wilson said sheep were so disturbed by the first helicopters ever flown into Alaska's Wrangell Mountains that lamb/ewe bands left Nikolai Ridge and never returned. Wilson's book is charming, but lacks biological credibility in other details of sheep abundance and distribution. The other account of range abandonment resulting from disturbance comes from the Kenai Peninsula where Dall sheep were alleged to have abandoned traditional range as a result of the disturbance accompanying an either sex hunt to reduce the population. After the hunt, Nichols (1976) was unable to reconcile the reported ewe harvest with the number of ewes counted from aircraft before the harvest effort. Expanding his search area, he subsequently located what he concluded were the missing ewes in a separate but adjoining area. Because no range abandonment had been reported prior to these

observations, and has never been documented since (even using radiocollars); and because a Kenai Refuge biologist and a number of local residents reported the “found sheep” had always occupied the area where they were located (A. Thayer, USFWS Kenai Refuge and Arctic Refuge staff, pers. commun.), I elect to discard these accounts.

I consider it unfortunate that the more advanced modern studies focus on overt short term behaviors or physiological stress indicators because the underlying premise used to extrapolate to harm from disturbance remains unsubstantiated. The conclusion that these indicators demonstrate harm rests on the presumption that there is no “fat in the sheep energy budget” and that every expenditure of energy must be directed toward obtaining enough calories to survive. My observations indicate that there is, in fact, some “disposable income” in a Dall sheep’s energy budget, a surplus of calories which can be expended in “play” or reactions to short-term stress without compromising reproductive fitness. I can’t explain every sheep behavior I’ve observed in terms of energy acquisition or conservation. Furthermore, assuming thinhorn sheep can tolerate no exogenous stress without compromised reproductive fitness fails to consider the adaptive ability to “learn” which disturbances constitute threats and which don’t (Geist 1975, Toweill and Geist 1999). An exogenous stressor, whether it be an industrial development like a mine, road, pipeline, or a capture net (Heimer et al. 1980), which produces no “memorable” negative consequence will eventually be tolerated by sheep.

If there is an exception to this general rule, it may involve aircraft effects. With respect to flying objects, it is rational to postulate an adaptive conflict. Presumably sheep evolved with aerial predators, and Dall sheep respond to fixed-wing aircraft in the same way they respond to eagles. Ewes “bunch up” and lambs “hide” underneath their ewes. I’ve seen both rams and ewes make threat-jump behaviors at SuperCub aircraft, just as they do at eagles. However, the universal response to helicopters is flight (to which I’ve observed no

adaptation during my 20 years of using helicopters (including early piston-driven ships) to study Dall sheep). Recent publications by exponents of small, piston-powered helicopters (Scotten 1997, Scotten and Pletscher 1998) assign sheep helicopter avoidance to flight noise associated with the engines and rotor systems of turbine-powered helicopters. Data which might test this hypothesis have not been gathered. Exponents of these small helicopters also claim sheep respond no differently to them, in spite of their rotary wing design, than to small fixed-wing aircraft. Here too, no data have been presented despite a large body of contrary, experience-based opinion.

I suggest that if sheep evolved non-flight adaptive responses to “fixed-wing” predators (ewes “bunching up” and lambs “hiding” under their ewes) the common flight behavior associated with helicopters may be associated with the absence of “fixed” wings. Clearly, definitive work is required if a consistent position on helicopter disturbance of thinhorn sheep is to emerge.

**Summary:** In spite of the data suggesting disturbance should not compromise thinhorn reproductive fitness, thinhorn managers expend considerable effort, and generate considerable endogenous stress for themselves, attempting to preclude or mitigate disturbance-caused stresses to the sheep they manage. While the existing data suggest this *might not* be necessary for long-term conservation, I still consider it an appropriate approach to management. Most of the great damage done to wild sheep populations has occurred because developments which were, in fact, critical to sheep welfare, were not considered, precluded, or mitigated.

**DISCUSSION:** When I first introduced the working management hypothesis concept to peers at the Alaska Department of Fish and Game, it was not warmly received. In fact, it was actively resisted and harshly criticized. Over the intervening dozen years I’ve wondered why, and have come to some explanatory hypotheses.

One might be inclusion of adaptation theory, local, anecdotal, and “gray” literature as the rationale for

management practices rather than strict adherence to the structured principles which drive selection for papers in the “white” literature. While there is a certain risk associated with consideration of a broader information base, there is a concomitant risk in relying solely on refereed publications. The “white” literature’s filtering process for data and ideas functions well in keeping erroneous conclusions from circulation, but is not infallible. Additionally, the filtering process is so rigorous and the time demands (and delays) so burdensome, that many management-relevant data simply don’t show up in the approved published literature. Most state management agencies do not pay biologists to force their management-relevant data through this “filter,” but only for production of final, in-house, research reports. Additionally, the peer-reviewing or refereeing process tends to select data consistent with existing dogma and reject truly new findings or original ideas because they carry the risk of being “wrong.” “Wrongness” becomes an important consideration because so much professional status (tenure and career advancement) is attached to publication of “white” literature. “Gray” literature carries a greater risk of “wrongness” because it is less rigorously reviewed, but compensates by being more dynamic and of much broader scope.

With these considerations in mind, I decided greatly expanding the data base used to formulate a working hypothesis for management was a risk worth taking. For me, being “wrong” was a lesser consideration than improving management. After all, the reason for making a hypothesis is to test (not protect) it. Science truly progresses when the overall mental construct (usually called the hypothesis) is “wrong,” (i.e. when data compel acceptance of the hypothesis). If we don’t define a working management hypothesis which “risks” being “wrong,” progress in biologically-based management will proceed at a glacial pace.

Hence, I was less interested in producing a definitive or perfect statement of natural history than identifying the hypothetical nature of our decision making process for the publics whose resources we manage. Under this scenario, the public and the

managers share the risk of making “wrong” management decisions for the promise of an improved future. When the public and its managers jointly make a “wrong” decision, both should realize the opportunity for management progress (as opposed to management stasis) has just presented itself. Rather than assigning blame or feeling guilty, both the publics and their managers should factor the experience into the working hypothesis and pursue progress.

Second, I’ve hypothesized managers didn’t embrace the working management hypothesis concept because, in spite of its open-ended approach, it limits options by managers. If there is no defined management framework, such as a publicly-articulated hypothesis, managers have considerably greater latitude to pursue programs driven by unstated principles (usually of wildlife management, with which the public is increasingly unfamiliar). This limitation of management expression is perceived as threatening by many managers.

A part of this “discomfort phenomenon” may result from perceived force toward a consistent rationale for defining positions. Management opinions regarding predation and disturbance effects on thinhorn sheep are contemporary examples. State and provincial thinhorn managers of Dall sheep attending this conference are in general agreement that wolf control will provide no benefit to Dall sheep or humans. As stated earlier, this position derives from a choice to discount voluminous anecdotal data and local knowledge while accepting small, area-specific, short-term studies which have been unable to document measurable responses on the part of the sheep to generalized wolf population reductions. Conversely, when it comes to disturbance from human activities, the same state and provincial managers are in general agreement that human disturbance must be precluded or maximally mitigated. In this case, the choice criteria are the opposite of those driving the predation decision. With respect to disturbance, area-specific, short term studies where disturbance has not affected sheep reproductive fitness are rejected in favor of a generalized assumption that human-caused disturbance must be harmful.

Finally, articulation of a data-based working management hypothesis for sheep indicates several areas where successful sheep management should depart from the generalized ungulate model. Many managers are sufficiently committed to the overarching principles of ungulate management (received from their university professors) they're unwilling to allow the specific consideration of thinhorn sheep adaptations to their environments on equal footing with classic nutritional models.

#### LITERATURE CITED

- Barichello, N., and J. Carey. 1988. The effect of wolf reduction on Dall sheep demography in the southwestern Yukon. *Bienn. Symp. North. Wild Sheep and Goat Council.* 6:307 (abstract only).
- \_\_\_\_\_, and \_\_\_\_\_. 1990. Thinhorn sheep harvest regulations in the Yukon, 1990. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 7:259-265.
- Bergerud, A.T., and J.R. Elliott. 1998. Wolf predation in a multiple-ungulate system in northern British Columbia. *Can. J. Zool.* 76:1551-1569.
- Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present, and future. *Wildlife Monographs* 4: 174 pp.
- Campbell, J.M. 1974. Effects of late prehistoric and early historic Eskimo hunting of Dall sheep in north Alaska: examples of aboriginal overkill. Pages 108-126 in K. Constan and J. Mitchell (eds.) *Proc. Bienn. Symp. North. Wild Sheep Council.* Great Falls, MT.
- Case, R. 1990. Dall sheep harvest regulations in Northwest Territories. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 7:249-251.
- Caughley, G. 1970. Eruption of ungulate populations, with emphasis on the Himalayan thar in New Zealand. *Ecology* 51:53-72.
- Deevey, E.S. Jr. 1947. Life tables for natural populations of animals. *Quart. Rev. Biol.* 22:283-341.
- Demarchi, R.A. 1978. Evolution of bighorn sheep horn curl regulations in British Columbia. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 1:17-29.
- Foreyt, W.J., R.M. Silflow, and J.E. Lagerquist. 1996. Susceptibility of Dall sheep to pneumonia caused by *Pasterurlla haemolytica*. *J. Wildl. Dis.* 30(2):137-145.
- Gasaway, W.C., R.O. Stephenson, J.L. Davis, P.E.K. Shepherd, and O.E. Burris. 1983. Interrelationships of wolves, prey and man in Interior Alaska. *Wildl. Monogr.* 84. 50 pp.
- Geist, V. 1971, Mountain sheep: A study in behavior and evolution. Univ. Chicago Press, Chicago and London. 371 pp.
- \_\_\_\_\_. 1975. On the management of mountain sheep: theoretical considerations. Pages 77-98 in J.B. Trefethen (ed.) *The wild sheep in North America.* Boone and Crockett Club. Missoula, MT. 302 pp.
- \_\_\_\_\_. 1978. Life strategies, human evolution, environmental design. Springer-Verlag, New York, Heidelberg, Berlin. 495 pp.
- Hayes, R.D., R. Farnell, R. Ward, J. Carey, G. Kuzyk, A. Baer, and M. Dehn. (In press). An experimental test for responses of caribou, moose, and Dall sheep to wolf control in the Yukon.
- Heimer, W.E. 1978. Alternate year reproduction in a low quality, declining Dall sheep population: management considerations. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 1:30-41.
- \_\_\_\_\_. 1980a. Can population quality be related to population density through nutrition? *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 2:355-380.

- \_\_\_\_\_. 1980b. A summary of Dall sheep management in Alaska during 1979—or how to cope with a monumental disaster. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 2:355-381.
- \_\_\_\_\_. 1981. Dall sheep responses to human activity. Final Rep. Fed. Aid Wildl. Rest. Proj. W-17-10. Job 6.13R. Alaska Dept. Fish and Game. Juneau, AK. 5 pp.
- \_\_\_\_\_. 1983. Dall sheep body condition and nutritional profile. Final Rep. Fed. Aid in Wildl. Rest. Proj. Nos. W-17-8, 9, 11, W-21-1, 2. Job 6.12R. Alaska Dept. Fish and Game, Juneau, AK. 52 pp.
- \_\_\_\_\_. 1988. Toward a working hypothesis for mountain sheep management. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 6:39-46.
- \_\_\_\_\_. 1990. Dall sheep harvest regulations in Alaska-1990. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 7:232-239.
- \_\_\_\_\_. 1992. Critique of carrying capacity concepts concerning Dall sheep. *Proc. Bienn. Symp. North. Wild Sheep and goat Council.* 8:111-120.
- \_\_\_\_\_. 1994. Aerial survey and Dall sheep population size: comparative usefulness of external and internal population dynamics for management purposes. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 9:43-50.
- \_\_\_\_\_. 1995a. Dall sheep welfare is linked to weather patterns through geography (reprint). Fall issue: *Wild Sheep. Found. North Amer. Wild Sheep.* Cody, WY. Pages 67-70.
- \_\_\_\_\_. 1995b. Lumpy jaw and wolf control. The Ram. Fall issue. *Found. No. Amer. Wild Sheep, Alaska Chapter.* Anchorage, AK. Page 11.
- \_\_\_\_\_. 1996. A new look at predator-prey interactions using a simple enzyme kinetic model. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 10:14-19.
- \_\_\_\_\_. 1998. Consideration of a biologically based approach to management of subsistence sheep hunting through adjustment of bag limit. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 11:162-177.
- \_\_\_\_\_. 1999. Thinhorn sheep. Pages 41-42 in Toweill, D.E., and V. Geist. *Return of Royalty. Boone and Crockett Club and Foundation for North American Wild Sheep.* Missoula, MT and Cody, WY. 214 pp.
- \_\_\_\_\_, S.D. DuBois, and D.G. Kelleyhouse. 1980. The usefulness of rocket nets for Dall sheep capture compared with other capture methods. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 2:601-614.
- \_\_\_\_\_, F.J. Mauer, and S.W. Keller 1994. The effects of physical geography on Dall sheep habitat quality and home range size. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 9:144-148.
- \_\_\_\_\_, and A.C. Smith III. 1975. Dall ram horn growth and population quality and their significance to Dall sheep management in Alaska. *Alaska Dept. Fish and Game, Tech. Bull.* 5. 41 pp.
- \_\_\_\_\_, and R.O. Stephenson. 1982. Responses of Dall sheep populations to wolf control in Interior Alaska. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 3:320-329.
- \_\_\_\_\_, and S.M. Watson. 1986a. Comparative dynamics of dissimilar Dall sheep populations. *Fed. Aid in Wildl. Rest. Final Rep. Proj. W-22-1 through W-22-4. Job 6.9R. Alaska Dept. Fish and Game, Juneau, AK.* 101 pp.
- \_\_\_\_\_, and \_\_\_\_\_. 1986b. Maximizing ram harvests: harvest strategy panel. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 5:24-36.

- \_\_\_\_\_, and \_\_\_\_\_. 1990. The effects of progressively more restrictive regulations on ram harvests in the eastern Alaska Range. Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 7:45-55.
- \_\_\_\_\_, R.L. Zarnke, and D.J. Preston. 1982. Disease surveys in Dall sheep in Alaska (preparing for domestic grazing). Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 3:188-197.
- \_\_\_\_\_, \_\_\_\_\_, and F.J. Mauer. 1992. Pharyngeal microflora of Dall and domestic sheep in Alaska: management implications. 8:193-201.
- Hoefs, M. 1979. Ecological investigation of a population of Dall sheep. Seyes. BC Provincial Museum. Victoria, BC. 81 pp.
- \_\_\_\_\_, (ed.). 1985. Distribution, abundance, management and conservation of the sheep of the world and closely related mountain ungulates. North. Wild Sheep and Goat Council. Whitehorse, YT. 218 pp.
- Krausman, P.R., M.C. Wallace, C.L. Hayes, and D.W. DeYoung. 1998. Effects of jet aircraft on mountain sheep. J. Wild. Mgmt. 62(4):1246-1254.
- Murie, A. 1944. The wolves of Mt. McKinley. U.S. Dept. Int., Nat. Park Serv. Fauna Ser. 5. 282 pp.
- National Research Council (USA) committee on management of wolf and bear populations in Alaska. 1997. Wolves, bears and their prey in Alaska. Nat. Acad. Press. Wash. D.C. 207 pp.
- Nichols, L. 1972. Sheep survey-inventory progress report. Fed. Aid in Wildl. Rest. Prog. Rep. W-17-3 and W-17-4. Job 6.4R. Alaska Dept. Fish and Game, Juneau, AK.
- \_\_\_\_\_. 1976. An experiment in sheep management: progress report. Trans. Second North. Wild Sheep Conf., Colorado State Univ., Ft. Collins, CO. 27 pp.
- \_\_\_\_\_. 1978. Dall sheep reproduction. J. Wildl. Manage. 42:570-580.
- Neilsen, C.A., and K.A. Neiland. 1974. Sheep disease report. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-5 and 6. Job 6.6R. Alaska Dept. Fish and Game, Juneau, AK. 111 pp.
- Rearden, J. 1999. Alaska's Wolf Man-the 1915-1955 wilderness adventures of Frank Glaser. Pictorial Histories Publishing Co. Inc., Missoula, MT. 330 pp.
- Scotten, B.D. 1997. Estimating rates and causes of neonatal mortality of Dall sheep in the Central Alaska Range. Fed. Aid in Wildl. Rest. Final Rep. Grants W-24-4 and 5. Study 6.2. Alaska Dept. Fish and Game, Juneau, AK. 19 pp.
- \_\_\_\_\_, and D.H. Pletscher. 1998. Evaluation of a capture technique for neonatal Dall sheep. Wild. Soc. Bull. 26(3):578-583.
- Toweill, D.E., and V. Geist. 1999. Return of Royalty: Wild sheep of North America. Boone and Crockett Club and Foundation for North American Wild Sheep. Missoula, MT, and Cody, WY. 214 pp.
- Trefethen, J.M. (ed). 1975. The wild sheep in modern North America. Boone and Crockett Club. Missoula, MT. 302 pp.
- Valkenburg, P. 1997. Investigation of regulating and limiting factors in the Delta caribou herd. Fed. Aid in Wildl. Rest. Final Rep. Grants W-23-5, W-24-1, 2,3, and 4. Study 3.37. Alaska Dept. Fish and Game. Juneau, AK. 45 pp.
- Veitch, A., S. Kutz, and B. Elkin. 1998. Dall's sheep disease and parasite studies in the Northwest Territories Canada. Northwest Territories Res. Wildl. And Econ. Dev. Normal Wells, NWT. 14 pp.

Watson, S.M., and W.E. Heimer. 1984. An age specific winter die-off in Dall sheep in Alaska. Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 4:61-66

Whitten, K.R., and R.M. Eagan. 1995. Estimating population size and composition of Dall sheep in Alaska: assessment of previously used methods and experimental implementation of new techniques. Fed. Aid in Wild. Rest. Final Rep. Study 6.11. Alaska Dept. Fish and Game, Juneau, AK.

Wilson, J. 1997. The quest for Dall sheep. Northern Publishing. Wasilla, AK. 220 pp.

Wishart, W.D., B. MacCallum, and J.T. Jorgensen. 1998. Lessons learned from rates of increase in bighorn herds. Proc. Bienn Symp. North. Wild Sheep and Goat Council. 11:126-132.

Zarnke, R.L. 1992. Serologic survey for microbial pathogens. Fed. Aid in Wildl. Rest. Final Rep. Jobs W-22-6, W-23-1 and 2, W-23-3 and 4. Study 18.6. Alaska Dept. Fish and Game, Juneau, AK. 58 pp.

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## QUESTIONS, ANSWERS AND COMMENTS - WAYNE HEIMER PRESENTATION

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**MIKE DUNBAR, OREGON:** Wayne, I have a question on your statements about nutritional range resource limitations. When we were working together in the Brooks Range during the early 1990s, we took blood samples which indicated severe nutritional deficiencies in early winter. Nutritional stress indicators in those samples were equivalent to what we would have seen in western bighorns in January or February, and I predicted some bad things were going to happen there. They subsequently did, yet your hypothesis minimizes concern about nutritional constraints. How do you explain our experiences in the Brooks Range?

**WAYNE HEIMER:** Your prediction was, indeed, correct. Those sheep populations subsequently declined. The decline appears to have been due to reproductive failure which could clearly be nutritionally mediated. I infer this nutritional stress must have resulted from unusual weather. Poor reproductive years aren't unusual for Alaskan Dall sheep. They happen occasionally. I think your predictions were notable because they were associated with a string of bad weather years that led to overall declines of Dall sheep, not only in the Brooks Range, but across Alaska. In discussing sheep adaptations, which I think argue against consistent expectation of density-dependent nutritional constraints, I certainly didn't mean to say that events such as you predicted do not occur. My explanation is events like the Alaska Dall sheep decline are rare and unpredictable. To the extent that sheep are not adapted to handle them, sheep populations will suffer under these unusual stochastic weather influences. However, because such events are rare, particularly in consecutive years, I see no management yield in emphasizing them as conceptual components of the working management hypothesis for thinhorn sheep. I don't think they really bear on density-dependent nutritional constraints. There doesn't seem to be a benefit from trying to reduce population size to prevent them, and we can't go up there and feed the critters. We're stuck managing sheep in a pristine ecosystem.

**KEN WHITTEN, ALASKA:** Between 1989 and 1993, we had the first, third, and I think, the sixth worst winters on record [in the Alaska Range] accompanied by summer droughts, and there's no doubt that there were nutritional problems. We had very low pregnancy rates in caribou in the spring of 1993. In the same area [where Heimer worked], lamb:ewe ratios were below ten lambs per hundred. We doubted that most ewes could get pregnant in these conditions, and we've since then had mild winters and seen a lot of recovery.

But we saw very similar conditions in the early 1970s, and there's basically an alternative hypothesis to explain the temporarily increased harvests than successful full curl management. Currently, we have our lowest harvests ever coming out of this area under full curl. The alternative explanation is that the harvest increases had nothing to do with changes in harvest management, but that the increases resulted from weather and nutritional conditions which changed productivity and survival.

**HEIMER:** It's true that the harvest of full curl rams from my old study area in the Alaska Range is currently the lowest ever recorded. However, I'm sure Ken didn't mean for you all to understand that the populations there are producing low harvests simply because of full curl management. Last year's harvest was just short of half of the average (135-ram) harvest under full curl regulations. Coincidentally, the population reduction after the bad winters was estimated at 60 percent. Additionally, the tiny cohort produced when there were only nine lambs per hundred ewes should have reached full curl a year ago, and you can't harvest rams which were never produced. We've anticipated this decrease in harvest for eight years. Hence, I don't blame the low harvest on full curl management, but on the weather mediated production failures of the early 1990s.

Additionally, coyotes are now a major predator on lambs. We could never even document coyote presence there till the mid-1980s. Conditions have certainly changed with increases in environmental resistance, but I have to question the assumption that ewes couldn't have gotten pregnant because of summer droughts of the 1990s or very similar weather in the 1970s. Here's why:

A minimum of 25 percent of marked yearling ewes in my old study area got pregnant in the early 1970s. That is, over eight years of observation, an average of 25 percent of marked two-year-old ewes had lambs with them two weeks after delivery. This means weather couldn't have been "that bad" in the early 1970s. Also, if 25 percent of the yearlings could get pregnant, adult ewes should have had an even higher pregnancy rate. During this time, only 125 miles down the Alaska Range in my high-quality study area (where there was a low-density population with high lamb production, high growth rates, and an abundance of full curl rams), yearling ewes didn't get pregnant. Once we adjusted the ram abundance and age-structure in the crowded study area (through full curl management), early pregnancy became a rare event in both populations even though all yearling ewes ever studied ovulate at 18 months (confirmed by ovarian histology and lamb production on second birthdays). Hence, I'm leery of speculating about what might have happened to Dall ewe reproduction in the past based on what caribou are doing now. I think Dall sheep and caribou differ more than Ken thinks they do.

As I said in this presentation, the management course we took, adjusting human harvest to favor lamb production and young ram survival (establishing the full curl regulation), was the easiest management approach available at the time. There's nothing we can do about the weather but worry about it. Other management actions to restore the depressed sheep populations in Alaska will involve predator reductions, and be more difficult.

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**WILLIAM D. WISHART - A WORKING HYPOTHESIS FOR ROCKY MOUNTAIN BIGHORN SHEEP MANAGEMENT**

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**Abstract:** Although the genus *Ovis* enjoys a wide distribution throughout much of the mountainous regions of the northern hemisphere, the various species show very site specific responses to climate and predation. In compliance with these restrictions the Rocky Mountain bighorn is distributed along the Rocky Mountains from northern Alberta to New Mexico and presently number approximately 38,000 animals. Their restricted habitats are basically islands from which they fear to tread. As a consequence, bighorns are capable of self regulation by a number of density dependent responses. They are also capable of rapid increases when provided with suitable new or former habitats. Bighorn managers can and have responded to these population features through translocations and ewe seasons with commendable success, however, bighorn susceptibility to domestic livestock diseases continues to be a problem.

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**Distribution and abundance:** In North America, bighorns are represented in the broomed left horn of "the great arc of the wild sheep" that spans from Sardinia (right horn) to the Baja (Clark, 1964). Forced by predators to live on rocky escarpments or cliffs near open grassy and herbaceous pastures bighorns have been confined to unique islands of habitat. These distinctive islands become more clearly defined during the winter. They are found on wind-swept or south facing slopes at both high and low elevations. For Rocky Mountain bighorns this archipelago of habitat extends throughout most of the Rocky Mountains, its foothills and associated river breaks. As of this writing there are approximately 38,000 Rocky Mountain bighorns in North America (Table 1).

Table 1. Rocky Mountain Bighorn Sheep Population Estimates in 1974\* and 1999.

Province or State	Population		Parks Population		Total	
	1974	1999	1974	1999	1974	1999
Alberta	4500	6000	3400	4000	7900	10000
Arizona	0	600			0	600
British Columbia	1300	3100	100	60	1400	3160
Colorado	2200	7245	350	400	2550	7645
Idaho	2700	1640			2700	1640
Montana	2900	4900	200	200	3100	5100
Nebraska	0	70			0	70
New Mexico	400	560			400	560
Nevada	0	250			0	250
Oregon	60	560			60	560
South Dakota	150	375			150	375
Utah	200	800	150	50	350	850
Washington	20	200			20	200
Wyoming	4000	6700	800	450	4800	7150
	18430	33000	5000	5160	23430	38160

\*Maximum estimates from Trefethen (1975)

This 62% increase (from approximately 23,500 bighorns since we met 25 years ago) is due largely to the translocations of about 4,000 bighorns, mostly within Colorado, Wyoming and Montana, as well as their contributions to other states (Hurley 1996). In parallel, during the same time period, Alberta harvested approximately 4,000 ewes and lambs in order to stabilize a resident bighorn population of about 6,000 animals. In other words, nursery herd management by removing ewes and lambs on productive bighorn ranges has been proceeding successfully on both sides of the Canada/U.S. border for several years by using translocations and/or hunting. Meanwhile, the overall numbers of protected park herds without management have remained static at about 5,000 animals for the last 25 years.

**Population strategies:** Rocky Mountain bighorns appear to respond to abundant forage sources as an "r-selected" species and to stable forage sources as a "K-selected" species. In other words, bighorn sheep fecundity and survival may either favor rapid population growth at low population density ( $r$ ) or they can express conservative population strategies at densities approaching carrying capacity ( $K$ ) (Ricklefs 1982).

**Rationale:** On new or expanding ranges bighorns have the capacity to double their numbers every three years (Buechner 1960). The doubling rate of any population can be quickly calculated using the compound interest "rule of 72", e.g., with an annual rate of increase of 24% the population will double in 3 years ( $72/24$ ). In reverse, a population that takes 24 years to double has an average annual rate of increase of 3%. Following Buechner's monograph in 1960 there have been several examples of rapid increases of bighorns, particularly from transplants (McCarty and Miller 1998) and from the creation of new habitats (Wishart et al. 1998). During these expansions on new ranges there are some remarkable examples of exceptional growth rates of large rams, particularly in the chinook regions of Alberta and Montana (Gilchrist 1992, Byers and Bettas 1999).

Since bighorns are confined to unique islands of

habitat, they can quickly reach carrying capacity and as a consequence, a number of density dependent events can occur (Wishart et al. 1998). Rocky Mountain bighorns have exhibited most of the population curves and all three of the age pyramids found in Odum (1971) by increasing rapidly on new range, leveling off and oscillating around  $K$  unless they contract pneumonia at which time there is usually a dramatic crash (Onderka and Wishart 1984, Semmens 1996).

The ability of bighorns to increase rapidly may be related to their history of living near new and adjoining ranges that have been created by receding glaciers, avalanches and fire. By increasing rapidly, their numbers may help to delay plant succession, thus maintaining each new range expansion, particularly in the case of avalanches or fires. In any event, bighorns can quickly exceed their food supply near suitable escape terrain. The consequences of a decreased food supply for bighorns on their confined ranges, especially during winter can result in a classic response to overpopulation, that is, decreased growth in body and horn mass, and increased age at first reproduction (Festa-Bianchet et al. 1995, Jorgenson et al. 1998).

This sequence of events was demonstrated during a long-term research study on an isolated herd of bighorns in Alberta. It was found that the herd could be held at 100 animals (with a 1:1 sex ratio) in a state of rapid growth near the inflection point of the s-shaped curve by manipulating the nursery herd and maintaining a ratio of 20 lambs/40 ewes (1+ yrs) and with no more than 30 ewes (2+ yrs) (Wishart et al. 1998). In fact, this optimum age ratio of ewes and lambs on nursery ranges is basically independent of ram numbers, since the young rams leave the nursery ranges after a few years and remain segregated from the ewes except during the rut; the rams are simply a by-product of the nursery herd (Jorgenson et al. 1993). When ewe removals ceased, the population more than doubled, aged and transformed to an inverted age pyramid. The herd has now declined to less than 100 animals.

**Relevance to Management:** Bighorn managers have to ask themselves whether they want managed bighorns to exhibit “r-selected” or “K-selected” population characteristics. Once this decision is made, managers must determine where, on the population curves, to maintain population sizes and what measures should be taken. Poor lamb crops and poor growth rates are usually coincident with short annual increments in ram horn growth and are considered symptomatic of low population quality (Geist 1971, Shackleton 1973, Jorgenson et al. 1998).

In general, large stable bighorn herds can be reduced to favor lamb production and ram horn growth by translocating ewes from these populations to new or historic ranges (Bailey 1990). Other populations may be reduced or stabilized through human hunter harvests of ewes. Some populations may be left to regulate themselves, as in Parks or with seasons on trophy rams only (Table 2).

**Working Hypothesis of Predator Management:**

Insufficient space on key habitats like winter ranges or lambing grounds can result in increased vulnerability to predation (Bleich et al. 1997). Bighorns have adapted well to wolf, bear and coyote predation by dashing to cliffs and escarpments, but are less adapted to the stalking and ambush techniques of cougars in rough terrain, particularly where there is some tree cover. As a consequence, bighorn managers should not and do not recommend transplants to areas where there are escarpments with an abundance of trees and cervids. In fact, prescribed fires have been recommended in former and potential bighorn ranges to remove cover for species such as elk and deer that provide an attractive food source for cougars (this conference).

The impact of predation on bighorns is reflected on how the sheep are distributed on their ranges (“islands”). In other words, bighorn distribution

Table 2. Rocky Mountain Bighorn Harvest Management Systems used by Wildlife Agencies in 1999.\*

	<u>Province or State</u>													
	AB	AZ	BC	CO	ID	MT	NE	NM	NV	OR	SD	UT	WA	WY
<u>Mgmt.</u>														
<u>Method</u>														
Transplant	X		X	X	X	X		X	X	X	X	X	X	X
Ewe season	X		X	X		X								
Any sheep														X
Any male		X		X		X			X	X	X	X	X	X
Mature male	X				X		X	X						X
Old Male	X		X											
Closed													X	X

\*From Reno Conference questionnaire

and the numbers that their ranges support are dependent on the assortment of predators that confine them to those ranges. For example, during a field trip to a bighorn translocation site in Montana where there were no wolves, cougars or bears, groups of large rams were observed at a considerable distance from any visible escape terrain. In contrast, in Jasper National Park, wolves have confined and maintained a herd of close to 20 adult rams on a small winter range in close proximity to a small escarpment for the past 20 years (D. Dekker pers. commun.). Thus, the carrying capacity of these islands of bighorn habitat may wax or wane depending on the presence or absence and the composition of the bighorn predators. It should be apparent that in some situations predator management would be an option to follow for bighorn range expansion.

**Disease:** In recent history, the most devastating limiting factor for bighorns has been disease, mostly as a result of exposure to domestic livestock (Buechner 1960). Pneumonia (*Pasteurella* spp.) tops the list in causing dramatic declines in bighorns (McCarty and Miller 1998). Miller et al. (1991) suggest that “a comprehensive combination of habitat management and population control that maintains herds at low ecological densities may prove most effective in minimizing herd susceptibility and preventing some pneumonia epizootics in bighorns.” There appears to be a decreasing threshold of susceptibility to pneumonia in mountain sheep from north to south (Foreyt et al. 1996), possibly as an adaptation to a longer exposure to domestic livestock diseases in the more southern ranges. Nevertheless, at this point in time, considerable diligence is required to prevent association of bighorns with domestic sheep. In this regard, fragmented bighorn herds that contract pneumonia are probably of less concern than a pneumonia contact with a metapopulation resulting in a large scale die-off such as the one that occurred in BC, Alberta and Montana in the 1980's (Onderka and Wishart 1986).

**Parasites:** For many years lungworm (*Protostrongylus* spp.) was considered an important source or contributing factor to bighorn

mortality (Forrester 1971, Hibler et al. 1982). As a consequence, antihelminthic treatment programs were introduced into several bighorn herds (Schmidt et al. 1979, Foreyt et al. 1990, Jones and Worley 1997). Miller (in press) concluded that although lungworm infections may in some cases exacerbate pneumonia in bighorns, such infections are relatively benign in the absence of other respiratory pathogens and are basically a product of a complex, coevolved host-parasite relationship.

**Disturbance:** Bighorns can be remarkably adaptable to human caused disturbance such as roadways and tourists particularly in our national parks and other sanctuaries. In studies outside of parks, using heart rate response to measure reaction to disturbance, MacArthur et al. (1979) and Stemp (1983) found a wide range of response to people, dogs, vehicles and aircraft, depending on the level of habituation to human activities and the time of year. Low flying helicopters and free ranging dogs created the highest and longest heart rate responses. These results are not surprising in view of the long association of bighorns with eagles and wolves. Mead and Morgantini (1988) found road and gas wellsite construction on a bighorn winter range resulted in displacement of animals until construction ceased. Helicopter activity caused much stronger reaction than blasting, the use of heavy machinery, or the presence of people. Range abandonment occurred on a small portion of a bighorn winter range that adjoined a new ski development for the 1988 Winter Olympics in Alberta (Jorgenson 1988). Abandonment was due to human activities on the ridge top, helicopter flights, snowmaking, and avalanche blasting. In recent years, bighorn populations have come under increasing disturbance pressure from recreational activities involving commercial helicopter activities such as heli-picnicking, heli-biking, heli-sightseeing, heli-hiking and heli-skiing. The timing of these events and other disturbance events are particularly critical during the winter months and the lambing period and there is a need for planning and strong policy directives to deal with such activities.

**Conclusion:** In spite of their very specific and unique habitat requirements, Rocky Mountain bighorns appear very adaptable to changes in their habitats and to various wildlife management schemes. Their response to these influences are readily observable in the individual and in the herd as a whole. After 45 years of bighorn watching my credo remains that the health of a bighorn herd is dependent on optimizing the number of young and productive animals in the nursery herd. These herds are more likely to thrive and produce more and larger bighorns.

#### LITERATURE CITED

- Bailey, J.A. 1990. Management of Rocky Mountain bighorn sheep herds in Colorado. Colorado Div. of Wildl. Spec. Rep. 66. 24 pp.
- Bleich, V.C., R.T. Bowyer, and J.D. Wehausen. 1997. Sexual segregation in mountain sheep: Resources or predation? Wildl. Monogr. No.134. The Wildlife Society. 50 pp.
- Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present, and future. Wildl. Monogr. No. 4. The Wildlife Society. 174 pp.
- Byers C.R., and G.A. Bettas. 1999. Records of North American big game. 11th ed. Boone and Crockett Club. Missoula, MT.
- Clark, J.L. 1964. The great arc of the wild sheep. Univ. of Oklahoma Press, Norman, OK. 247 pp.
- Festa-Bianchet, M., J.T. Jorgenson, M. Lucherini, and W. Wishart. 1995. Life-history consequences of variation in age of primiparity in bighorn ewes. Ecology 76:871-881.
- Foreyt, W.J., T. Parker, and V. Coggins. 1990. Safety and efficacy of fenbendazole against *Protostrongylus* spp. infections in Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*). Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 7:118-124.
- \_\_\_\_\_, R.M. Silflow, and J.E. Lagerquist. 1996. Susceptibility of Dall sheep to pneumonia caused by *Pasteurella haemolytica*. J. Wildl. Dis. 32(4):586-593.
- Forrester, D.J. 1971. Bighorn sheep lungworm pneumonia complex. Pages 158-173 in J.W. Davis and R.C. Anderson, editors. Parasitic diseases of wild mammals. Iowa State Univ. Press. Ames, IA. 364 pp.
- Gilchrist, D. 1992. Why is Montana the land of giant rams? Bienn. Symp. North. Wild Sheep and Goat Council. 8:8-13.
- Hibler, C.P., T.R. Spraker, and E.T. Thorne. 1982. Protostrongylidosis in bighorn sheep, Pages 208-213 in E.T. Thorne, N. Kingston, W.R. Jolly, and R.C. Bergstrom, editors. Diseases of wildlife in Wyoming. Second edition. Wyoming Game and Fish Department, Cheyenne, WY. 355 pp.
- Hurley, K. (ed ). 1996. History of trapping and transplanting mountain goats and mountain sheep. Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 10: 145-211.
- Jones, L.C., and D.E. Worley. 1997. Use of fenbendazole for long-term control of protostrongylid lungworms in free-ranging Rocky Mountain bighorn sheep. J. Wildl. Dis. 33(3):365-367.
- Jorgenson, J.T., 1988. Environmental impact of the 1988 Winter Olympics on the bighorn sheep of Mt. Allan. Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 6:121-134.
- \_\_\_\_\_, M. Festa-Bianchet, and W.D. Wishart. 1993. Harvesting bighorn ewes: consequences for population size and trophy ram production. J. Wildl. Manage. 57(3):429-435.
- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. 1998. Effects of population density on horn development in bighorn rams. J. Wildl. Manage. 62(4):1011-1020.

- MacArthur, R.A., R.H. Johnston, and V. Geist. 1979. Factors influencing the heart rate in free-ranging bighorn sheep: a physiological approach to the study of wildlife harassment. *Can. J. Zool.* 57(10):2010-2021.
- Mead, D.A., and L.E. Morgantini. 1988. Drilling in sheep country: gas development at Prairie Bluff, Alberta. *Proc. Symp. North. Wild Sheep and Goat Council.* 6:165-167.
- McCarty, G.W., and M.W. Miller. 1998. Modeling the population dynamics of bighorn sheep: A synthesis of literature. *Colorado Div. of Wildl. Spec. Rep.* 73. 35 pp.
- Miller, M.W., N.T. Hobbs, and E.S. Williams. 1991. Spontaneous pasteurellosis in captive Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*): Clinical, laboratory, and epizootiological observations. *J. Wildl. Diseases.* 27(4):534-542.
- \_\_\_\_\_. Pasteurellosis. *In* E.S. Williams and I.K. Baker, editors. *Infectious diseases of wild mammals.* Third edition. Iowa State Univ. Press. Ames, IA. (In press).
- Onderka, D.K., and W.D. Wishart. 1984. A major bighorn die-off from pneumonia in southern Alberta. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 4:356-363.
- Odum, E.P. 1971. *Fundamentals of ecology.* 3rd ed. W.B. Saunders Company, Philadelphia, PA.
- Ricklefs, R.E. 1982. *Ecology.* 2nd ed. Chiron Press Inc. Concord, MA. 966 pp.
- Schmidt, R.L., C.P. Hibler, T.R. Spraker, and W.H. Rutherford. 1979. An evaluation of drug treatment for lungworm in bighorn sheep. *J. Wildl. Manage.* 43(4):461-467.
- Semmens, W.J. 1996. Seasonal movements and habitat use of the Highlands/Pioneer Mountains bighorn sheep herd of southwest Montana. *Bienn. Symp. North. Wild Sheep and Goat Council.* 10:35-44.
- Shackleton, D.M. 1973. Population quality and bighorn sheep (*Ovis canadensis canadensis* Shaw). Ph.D. dissertation, Univ. of Calgary, AB. 227 pp.
- Stemp, R. 1983. Heart rate responses of bighorn sheep to environmental factors and harassment. Master of Environmental Design. Univ. of Calgary, AB. 313 pp.
- Trefethen, J.M. (ed). 1975. *The wild sheep in modern North America.* Boone and Crockett Club. Missoula, MT. 302 pp.
- Wishart, W.D., B. MacCallum, and J.T. Jorgenson. 1998. Lessons learned from rates of increase in bighorn herds. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 11:126-132.

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## QUESTIONS, ANSWERS AND COMMENTS - BILL WISHART PRESENTATION

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**PHIL HEDRICK, ARIZONA:** Is the difference in susceptibility to the disease a genetic problem or do you think it has to do with other environmental factors, or is there any evidence, for example, of transplants going south having higher or lower susceptibility, like in New Mexico?

**BILL WISHART:** We sent some sheep down to Oregon or Idaho a few years ago, and it reminded me of taking the canary into the coal mine, because they keeled over in pretty short order, I think.

What I'm saying is you saw that graph of the Highlands herd and there's a few survivors there and they are probably pretty valuable in a country where you have this problem and it wouldn't be smart, I don't think, to put bighorns on top of that. Mind you, depends on where you're dealing from. My feeling is that, and I'm not sure how long that resistance, if you were to call it that, lasts. It might show up in your blood work, but I still feel that the U.S. sheep have been with domestic sheep a long time and I think you've got some pretty strong sheep here in that sense. They're not all going to die bringing a sheep from like the north into situations like you have further south here. I think that may be the canary in the coal mine.

How do you interpret this? Is it genetic and is it something that they pass on? In the sense that they're resistant after die-offs, you know the survival is very poor, and eventually they get going again. I'm not sure if they retain that resistance.

**UNIDENTIFIED SPEAKER:** Bill, the first slide you showed, I think a herd in Montana, that didn't take off?

**WISHART:** Oh, yeah, the Highlands.

**SPEAKER:** All the bar graphs?

**WISHART:** Yes.

**SPEAKER:** I notice that herd is growing for seven, eight, nine years?

**WISHART:** Yes, that's right.

**SPEAKER:** And appears to get above some threshold, my interpretation anyway, and then it declined?

**WISHART:** That's right. Apparently it moved from one range to two other ranges in that low level, is that correct John McCarthy? I think they had them on one range and then it spilled over to another and then another, so you eventually had three ranges involved.

**SPEAKER:** So it's essentially habitat expansion?

**WISHART:** Yes.

**SPEAKER:** That shoots one of my theories in the foot.

**WISHART:** I hope so.

**SPEAKER:** I have another question. It relates to your emphasis on predation with adequate habitat and what I call visibility. In your experience, is small population size a problem with respect to predation, small size and high predators?

**WISHART:** In our experience, we don't consider predators a problem. Cougars get hungry, they switch from deer to mutton. Someone in Utah had an interesting comment, every time they move sheep into a new area, there're usually deer there. All they're doing is feeding the cougars. I think it's critical that you do not move them into a predominantly deer area that already has a good, high predator population.

In terms of small populations, we only average 60 sheep per winter range. They're doing fine under that system. Boy, it's an awful task for anything to get them in those open slopes. They can see predators coming a mile away. Where you see the open habitat, burn away the stuff that hides the predators.

**FRANCES CASSIRER, IDAHO:** It looked to me like your graph of Ram Mountain showed declining lamb survival when the population was at a high level. Looks like you still have fairly low lamb survival.

**WISHART:** They're back to where they were. And we have old ewes in there now and that population is going to take a while. We've got to go in and kind of freshen it up. If we can bring that population down again to a young, productive herd, I'm sure we can maintain 100 again.

The other thing that worries you with those populations, you have this K that you reach, and often you end up at a lower K, a lower capacity. In other words, it might not support 100 again. We might have to come down to 80 or something like that to get the range back to where it should be. That's worrisome when you see the big peaks and the notion is, I've got to get up there again. Don't do it; that's thin ice.

**KEVIN HURLEY, WYOMING:** Bill, I have a question. How are we doing 25 years later?

**WISHART:** The most spectacular story is what we've done with the translocation. You have problems with translocations and you'll talk about that and you'll get into what age group and how many and where and you have lots of considerations. The predators and the migratory nature, the possibilities, all that stuff. You'll have to discuss that.

You saw the GIS graphs that the DeMarchi brothers brought in. They can tell you the best places to go or not to go. I think you've done a wonderful job. The BLM people are moving domestic sheep out of the country. You're creating brand-new habitats removing domestic stock that will be outstanding for the next few years. Keep it up.

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## DALE TOWEILL - A WORKING HYPOTHESIS FOR CALIFORNIA BIGHORN SHEEP MANAGEMENT

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**Abstract:** California bighorn sheep vary in appearance between herds, with variations due to ecotype. California bighorn sheep are typified by smaller body size (rams from 180-205 pounds; ewes 106-145 pounds) than Rocky Mountain bighorn sheep, darker coloration, less white in the facial pattern, and (among rams) horns that flare away from the face as the horn curl drops along the jawline. Most show a continuous black or brown dorsal stripe dividing the white rump patch to the tip of the tail. Like other bighorn sheep, California bighorn sheep are 'k-strategists' adapted to exploiting climax plant communities, particularly grassland communities of foothills ranges, low isolated mountains, and rocky canyonlands surrounding the Great Basin and extending northward into Canada between the Cascade Range and Rocky Mountains. Most populations that currently exist have resulted from transplants into formerly-occupied range since 1975, and demonstrate the 'dispersal phenotype' described by Geist (1971). Because of limited suitable habitat in canyonlands and isolated ranges, most populations have adapted to year-around occupancy of suitable habitat. Few herds demonstrate seasonal migrations, although exploratory movements and distress dispersal into unoccupied habitat are not uncommon. Critical habitat components include forage and free water in proximity to steep rocky rims, terraces, lava beds, steep clay hills or other terrain features that afford opportunity to escape from potential predators. Potential predators include mountain lions, coyotes, and bobcats; large raptors may kill lambs. Weather is rarely a factor affecting California bighorn sheep populations. Susceptibility to disease (except following contact with domestic sheep) seems to be less than documented for Rocky Mountain bighorns, although extensive die-off among California bighorns following contact with domestic sheep has been recorded. There are only limited data suggesting competition between California bighorn sheep and cattle. Where populations are hunted, harvest should not exceed about eight percent of the total number of rams, or 15 percent of the legal rams if harvested under a 3/4 curl rule. California bighorn may exhibit avoidance of habitats due to human disturbance.

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The California bighorn sheep (*Ovis canadensis californiana*) is one of seven subspecies of bighorn sheep in North America (Valdez and Krausman 1999, Shackleton et al. 1999). The remaining six subspecies include the Rocky Mountain bighorn (*O. c. canadensis*), the extinct Audubon's bighorn (*O. c. auduboni*), and four desert bighorns—Nelson's (*O. c. nelsoni*), Mexican (*O. c. mexicana*), peninsular (*O. c. cremnobates*) and Weem's (*O. c. weemsi*). Current taxonomic classification follows Cowan (1940), and will likely be reviewed based on development of new taxonomic tools including analysis of chromosomal material. Ramey (1993, 1995) has presented arguments that mitochondrial DNA analysis fails to support currently recognized subspecies. Bighorn sheep,

like other Old World species that invaded North America during the Ice Age, are still evolving to fit North America's environments (Geist 1999). Bighorn sheep, elk, moose, and the reindeer/caribou complex, radiated into a wide variety of vacant habitats following the collapse of Ice Age faunas during the past 12,000 years or so (Geist 1999, Toweill and Geist 1999). Like Roosevelt's elk (*Cervus elaphus roosevelti*), the distinctions that set California bighorn sheep apart from other subspecies overlap the ranges of variation for other subspecies and more precisely reflect adaptations to environment and allopatry than strict genetic separation. Unfortunately, because of the rapid extermination of California bighorn herds, little comparative material is available with which to

analyze the range of variability of California bighorns. Their habitats were those most accessible to humans and most desirable for the grazing of domestic livestock, so California bighorns were quickly and completely eliminated from all but two areas of their former range—California's Sierra Nevada and southern British Columbia's interior plateau (Sugden 1961).

California bighorn sheep entered the annals of modern science on December 8, 1825, when one of the hunters attached to Peter Skene Ogden's brigade of fur trappers killed a ram in the Mutton Mountains of eastern Oregon, near the Deschutes River about 45 miles south of the The Dalles. Nine months later, naturalist David Douglas secured the horns of another from an Indian about 6 miles east of The Dalles, and described the species based on those horns and a shirt made from the skin of that animal. Originally named the lava-bed or rimrock bighorn, the name California bighorn was applied by Cowan (1940) in his revision of wild sheep taxonomy because the best-known of the original stocks survived only in California's Sierra Nevada Mountains.

In coloration and body form California bighorns look much like Rocky Mountain bighorn sheep—and for that matter, desert bighorn sheep. Many of the observed variations are due to ecotype, just as Nelson's desert bighorns living in alpine environments quickly assume the look of Rocky Mountain bighorns. While appearance can vary somewhat between herds, Cowan (1940) suggested that smaller body size, darker coloration, less white in the facial pattern, and an open curl among rams (i.e., horns flaring away from the side of the head) were distinguishing characteristics (Hebert and Evans 1991).

California bighorns are less blocky than most Rocky Mountain bighorns, with proportionally longer ears and legs and typically smaller size. Adult rams typically weigh from 180-205 pounds, while adult ewes typically weigh from 106-145 pounds. However, body coloration is somewhat variable. Most California bighorns show a continuous black or dark brown stripe extending forward

dorsally from the tip of the tail, dividing the white rump patch. Unlike the horns of Rocky Mountain bighorn rams, which, when viewed from the front, tend to drop nearly straight down from the top of the curl along the face (or even pinch inward), horns of California bighorns typically flare away from the face. As an example, a ram killed by John Muir in California's Modoc lava beds near Mt. Shasta had horns 33 inches in length, but showed a very wide tip-to-tip measurement of 29 1/2 inches (Clark 1964).

**Ecological Niche:** As glacier followers, all bighorn sheep evolved as prime examples of 'k-strategists'—species adapted to exploitation of climax plant communities, species which exhibit a precise strategy for exploiting all available suitable habitat in both space and time as climatic conditions change. Like all good 'k-strategists', bighorn sheep populations maximize their population size through maximizing the maternal investment in a few young animals, individual longevity, and complex social behavior. Individual longevity and social behavior interact, allowing bighorn populations to maintain social stability while also providing a mechanism whereby populations can pass along traditions of habitat usage through time (Geist 1971), allowing animals to effectively adapt to changing climatic conditions (Geist 1999, Toweill and Geist 1999).

Our understanding of sheep evolution in North America is incomplete, especially since North America's wild sheep evolved as animals adapted to Ice Age habitats, i.e., 'glacier followers' (Geist 1971, 1975, 1999). Glacial and even montane habitats are notoriously poor sites for preservation of fossil material; what little does survive under conditions favorable for fossilization is likely to be pulverized by glacial advance or destroyed by glacial outwash or the combined actions of freezing, thawing, and seasonal precipitation (Horner 1997). Although fossils indicate that bighorn sheep existed in southern California as long as 350,000 years ago and in Wyoming during the interglacial of about 110,000 years ago (Martin and Gilbert 1978, Wang 1984), bighorn sheep were rare habitat specialists until near the end of the late

glacial period of 20,000 to 12,000 years ago. During this period bighorn sheep spread rapidly throughout western North America (Harris and Mundel 1974). With the collapse of the Rancholabrean Ice Age megafauna (which began about 12,000 years ago and continued several thousand years, with a peak at 11,000 years ago and another at 9,000 years ago; see Guthrie 1984), bighorn sheep likely invaded vacant or near-vacant habitats (Geist 1999). It is likely that the California bighorns originated as a result of bighorn sheep invading near-vacant low-elevation habitats following extinction of many Ice Age competitors and predators, during a period of rapidly-fluctuating climatic variation.

However they evolved, California bighorn sheep are animals of the foothills, isolated mountains, and rocky canyonlands. Clark (1964) called them lava-bed or rimrock bighorns, a name that really conveys the habitats selected by the subspecies, and Bailey described their habitat as including "... every canyon, cliff and lava butte as well as many of the rough lava beds ... east of the Cascade Mountains ..." (Bailey 1936).

Restoration of California bighorn sheep to historic habitats has been one of North America's great wildlife conservation success stories. California bighorns were almost completely exterminated by 1930. Despite protection in California, by 1960 only an estimated 390 existed in the United States, with about 1,200 additional animals in British Columbia (Buechner 1960). Although native California herds have continued to struggle (fewer than 170 animals remain), transplants from British Columbia stocks beginning in 1954 have resulted in over 10,000 California bighorns in North America today. In 1999, these populations are distributed among seven states in addition to British Columbia (see Table 1, *from* Toweill and Geist 1999).

Half a century of management aimed at restoration of California bighorns into historic habitats has demonstrated two facts fundamental to California bighorn sheep management:

1. The single best predictor of successful restoration of bighorn sheep in historic California bighorn sheep habitat has resulted from using California bighorn sheep stocks from other areas. Conversely, most failures to re-establish bighorn sheep herds in formerly occupied habitats (either California or Rocky Mountain bighorns) have resulted from transplant wherein an inappropriate source of transplant animals was selected

2. Every state and province where California bighorns now thrive have recognized the distinctive habitat and behavioral requirements of the subspecies. Every state and province manages California bighorns in a manner which will maintain the integrity of the subspecies, a management goal recommended by the California Bighorn Sheep Workgroup chaired by Raymond Demarchi in 1974 (Demarchi 1975).

**WORKING HYPOTHESIS: Population Biology:** California bighorn sheep are a climax species adapted to typically low-elevation semi-arid environments. Populations are increasing or stable in Canada (Krausman 1997, Shackleton et al. 1997, Toweill and Geist 1999). Virtually all herds outside of British Columbia and California are a result of transplants using stock that originated in British Columbia, beginning in 1954; most were established after 1975 (Toweill and Geist 1999). Because these herds were nearly all re-established in suitable habitat formerly occupied by California bighorns, resources (particularly forage) were (and for many herds still are) essentially unlimited. The relationship between unlimited forage and behavior has implications for management of California bighorn sheep.

Briefly summarized, wild sheep in an environment where critical resources are unlimited grow more rapidly, but utilize resources less efficiently, than those animals that occupy an environment wherein resources are limited. As a result, these "dispersal type" bighorns tend to have a shorter life expectancy, on average, than "maintenance phenotype" bighorns found in areas where forage and other

critical resources are in short supply (Geist 1971). This reduced life expectancy is believed associated with reaching sexual maturity at an earlier age, among other factors (Geist 1971). However, because resources are abundant and animals are vigorous, "dispersal phenotype" bighorns are more likely to disperse in unoccupied suitable habitats. Over long periods of time (ten or more generations) "dispersal phenotype" sheep may become "maintenance phenotype" sheep as a result of population growth and associated resource limitation (Geist 1971).

Virtually all herds of California bighorn sheep re-established since about 1975 should be expected to demonstrate the "dispersal phenotype" characterized by rapid body growth, relatively short life span, and relatively high resistance to disease (a result of both high intake of nutrients, promoting resistance to disease, and low incidence of habitats becoming infected with disease-causing organisms). These herds should also demonstrate a relatively high rate of reproduction and lamb survival, based on the prediction that, with food resources abundant, ewes should be expected to give birth to healthy lambs and provide abundant high-quality milk allowing lambs to grow rapidly and wean successfully. Populations of "dispersal phenotype" bighorns should be expected to respond to habitat alteration by exploratory movements into previously unoccupied habitats, as has been recorded for re-established herds of California bighorn sheep in nearly all states where they have been re-introduced.

Managers should, however, be aware that populations of California bighorn sheep established in the 1950s and 1960s might have begun to experience chronic resource shortages, resulting in development of "maintenance phenotype" populations (Geist 1971). Such populations would likely demonstrate:

- (1) a reduction in reproductive rates (associated with reduced average body condition of ewes),
- (2) increased average longevity (associated perhaps with increased horn mass among older-age rams),

- (3) increased susceptibility to disease (as a result of reduced average body condition), and
- (4) greater susceptibility to over-harvest (associated with reduced rates of recruitment of young rams, and full occupancy of suitable habitat).

Such changes should not be unexpected, and may require adjustments to long-term management regimes. Appearance of these indicators in California bighorn sheep herds should prompt managers to investigate resource availability.

**Range Limitation:** California bighorn sheep populations have adapted to year-around occupancy of a limited habitat; i.e., an isolated mountain, series of rimrocks, or rocky canyon system, generally at elevations between 4,000 and 6,500 feet. Although migrational movements of up to 48 km have been recorded in British Columbia (Sugden 1961, Blood 1963) and California's Sierra Nevada (McCulloch and Schneegass 1996), many herds are non-migratory, spending the entire year within a relatively limited range with little elevational gradient, such as isolated desert mountains or canyonlands (Sugden 1961, Towell and Geist 1999). However, even in these ranges short (<10 km) seasonal movements between wintering areas, rutting grounds, and spring/summer ranges are typical. Rams typically isolate themselves from ewes in bachelor groups, either by utilizing suitable habitats on the unoccupied periphery of ewe/lamb ranges or by moving away from typical escape terrain onto associated flats or rolling hills.

As 'dispersal phenotypes,' California bighorn sheep may demonstrate exploratory movements into unoccupied sheep habitat due to rapid phenotypic development. They may also demonstrate distress dispersal due to catastrophic change in range conditions (Geist 1971). Such movements may result in establishment of 'satellite' herds that may (or may not) return to the site of origin. One example of such a move occurred in the summer of 1986 when 10-12 California bighorn sheep moved as a group from Leslie Gulch in Oregon following a wildfire on their home range. These animals dispersed approximately 65 km to the

southeast, and finally established themselves in a small area of suitable terrain on Reynolds Creek in Idaho (Toweill, file data), where they still persist 13 years later. In addition to catastrophe, such dispersal may also be triggered by drought (Geist 1971) and other changes in climatic conditions.

**Habitat Components:** Critical habitat components for California bighorn include sufficient quality of forage and free water in proximity to steep rocky rims, rocky terraces, lava-beds, steep clay hills or other features which allow bighorns an opportunity to escape from mammalian predators (Blood 1961, Bodie et al., Drewek 1970, Kornet 1978, Hansen 1982). California bighorn sheep rarely occupy areas where visibility is impeded by large shrubs or trees. The most critical component of suitable habitat seems to be the presence of rocky terraces on which ewes can isolate themselves for parturition, and which affords ewes an ample supply of forage during the first few weeks after birth. These terraces also provide lambs immediate access to escape terrain from predators able to access the terraces which are typically relatively inaccessible to predatory wolves and coyotes. Females with young lambs are generally found within 100 m of such escape habitat, although distances increase from late spring into summer (Hansen 1982). Rams are much more independent of escape cover, ranging as far as several miles away from cliffs and canyonlands (Hansen 1982).

**Predators:** The primary predators of California bighorn sheep are mammalian, particularly mountain lions (*Felis concolor*) (Harrison and Hebert 1988). Smaller mammalian predators including coyotes (*Canis latrans*) and bobcats (*Lynx rufus*) may occasionally kill adult bighorns, and coyotes (Hebert and Harrison 1988), bobcats, and large avian predators including golden eagles and even ravens may kill lambs.

**Weather Influences:** Weather is rarely a factor affecting California bighorn sheep populations. Sheep selectively forage during winter on steep slopes nearly free of snow, although deep accumulations may result in losses among California

bighorns (Demarchi and Mitchell 1973). Drought that reduces forage quantity and quality can reduce individual fitness and may reduce lamb recruitment rates. Long wet springs may reduce lamb recruitment rates.

**Disease:** California bighorn sheep appear to have greater resistance to a variety of potential pathogens than Rocky Mountain bighorns. Large-scale die-offs associated with disease occur more rarely among California bighorns than among Rocky Mountain bighorns. California bighorn sheep are noticeably absent in a review of wild sheep die-offs (Schwantje 1988). However, devastating die-offs such as that recorded for California's Modoc lava-beds herd (Hunt 1980, Jessup 1980) have been recorded among California bighorn sheep following exposure to apparently healthy domestic sheep (Martin et al. 1996).

**Interactions with Domestic Livestock:** Despite extensive evaluation, there is little evidence of competition between California bighorn sheep and cattle (McCullough and Schneegass 1966, Drewek 1970, Kornet 1978, Estes 1979, Ganskopp and Vavra 1987). While cattle significantly avoided slopes >20%, California bighorn sheep used slopes up to 80% in proportion to availability (Ganskopp and Vavra 1987).

**Hunting:** Harvest of California bighorn sheep can depress populations and when excessive may reduce the amount of suitable habitat utilized. Behavioral evidence (Geist 1971) suggests that mature rams are necessary to pass along traditions relating to seasonal use and travel routes connecting critical areas of suitable habitat.

Harvest should be focused on mature rams, and carefully limited to insure that mature rams always exist in managed populations. More specifically, harvest of mature rams should not exceed 3/4 of the natural replacement rate, or about 8 percent of the total ram population (Geist 1971, 1975). In areas where herds are routinely surveyed, this guideline has been modified to allow tags for harvest of up to 15 percent of the observed 3/4 curl rams (i.e., typically rams aged 4 years and

older). This guideline has proven to provide a safely conservative harvest, since biologists are unable to observe all of the legal rams in a population and not all hunters are successful.

Harvest of ewes may be allowed where the objective is to reduce population size or to reduce the rate of population growth. Annual harvest should not exceed 20 percent of the ewes. If population stabilization is the objective, harvest of ewes to achieve a 1:1 ratio of ewes to rams, or ratios of 40 ewes and 20 lambs per 40 rams, has been recommended on the basis of long-term studies of Rocky Mountain bighorns (Wishart 1999).

**Human Disturbance:** Evidence indicates that California bighorn sheep may avoid some habitats due to human disturbance associated with hikers in occupied habitats (Dunaway 1971, Wehausen et al. 1977, Hicks and Elder 1979, Wehausen 1980). Excessive disturbance by humans may lead to permanent abandonment of suitable habitat (Dunaway 1971). Although disturbance may result in decreased use of habitats frequented by humans, whether human disturbance on summer range affects reproduction is inconclusive (Wehausen 1980). However, hunting seasons should be designed to disperse hunters as widely as possible through both time and space to minimize risk of abandonment of portions suitable habitat.

#### **FUNDAMENTAL BASIS FOR MANAGEMENT:**

1. Locations of California bighorn sheep herds are well-identified and discreet (Toweill and Geist 1999).
2. California bighorn sheep populations are predictably loyal to their home ranges.
3. The number of animals in each population can be estimated with reasonable accuracy (Bodie et al. 1995).
4. Annual fluctuation in adult population size rarely varies more than 15 percent.
5. Annual lamb recruitment typically varies between 10 and 50 lambs per 100 ewes.
6. Predators can significantly affect California bighorn sheep population growth. Mountain lions are effective predators of bighorn sheep of all ages, and coyotes have been implicated in poor lamb recruitment rates.
7. Most herds exist on low-elevation ranges with a continental climate, and weather is rarely a factor influencing population size. Drought is typically a more severe factor than snowfall.
8. Direct contact between California bighorn sheep and domestic sheep may result in catastrophic fatal epizootics leading to the near-complete demise of California bighorn sheep. Other than that, California bighorn sheep appear remarkably resistant to diseases, and disease is rarely a major concern in management of California bighorn sheep.
9. California bighorn sheep may compete with cattle for forage, but there is little indication of behavioral avoidance of cattle.
10. Parasite loads are rarely a factor in California bighorn sheep population growth.
11. Human disturbance is a stressor on California bighorn sheep, and repeated disturbance by human may result in temporary (rarely permanent) range abandonment.
12. The large majority of California bighorn sheep populations have resulted from transplants within the past 25 years, and resultant populations demonstrate 'dispersal phenotypes,' i.e., rapid growth, high rates of lamb production and recruitment, and an average longevity of 7-10 years.
13. Horn growth of rams is reduced relative to Rocky Mountain bighorn sheep populations, particularly those demonstrating 'maintenance phenotypes.' Even old-age rams (aged 8-10 years) rarely exceed 7/8 curl, horn length

greater than 36 inches, or horn base circumferences larger than 14 1/2 inches.

14. Legal harvest of California bighorn sheep can be controlled by permit-based hunting, and evaluated by regulations requiring that horns of all harvested rams be pinned for permanent identification.
15. Illegal harvest does occur in many herds, illegal harvest targets adult rams, and the extent of illegal harvest is rarely known but may equal legal harvest.
16. Harvest of adult (4-years and older, 3/4 curl or larger) rams at a rate less than 3/4 of the ram recruitment rate has little effect on the viability of California bighorn sheep herds.
17. Removal of >20 percent of ewes compromises lamb production and results in population declines.

**DISCUSSION:** Much like Roosevelt's or Tule elk, successful California bighorn sheep management has been based on a collection of ecotype distinctions which may (or may not) be reflected in mitochondrial DNA or other genetic markers. Fifty years of management experience with California bighorn sheep have proven that California bighorn sheep have some apparently unique behavioral and/or physiological adaptations to semiarid, low elevation habitats. Efforts to re-establish bighorns in such habitats have been most successful when animals for transplant have originated from California bighorn stocks.

Some of the past management successes can no doubt be attributed to the familiarity of individual animals with forage species available on low-elevation ranges, learned behavior associated with securing moisture and escaping predators, etc. Another likely factor is that California bighorn sheep, as a largely non-migratory species, have demonstrated less of a tendency to disperse individually from release sites soon after release, thereby enhancing the potential for rapid establishment of a resident population.

While the genetic status of the subspecies may remain uncertain until a taxonomic revision is completed, ecotypic variation has been and will continue to be a major concern for wildlife managers. State and provincial agencies will almost certainly continue to management California bighorns as an ecotype distinct from Rocky Mountain bighorns, much as they continue to manage Roosevelt's elk as an ecotype distinct from Rocky Mountain elk.

Management of California bighorn offers opportunities not available to managers of Rocky Mountain bighorns. Because California bighorns occupy low-elevation habitats and often do not establish migratory traditions due to climatic influences, populations can often be quickly established in very discreet habitats, such as isolated Great Basin mountains or rocky canyonlands.

California bighorns appear to be more resistant to diseases than Rocky Mountain bighorns, and appear to be able to co-exist with cattle grazing and some degree of human interaction. Predation, especially where mountain lion or coyotes numbers are high, is a concern.

Harvest management must be based on removal of only a portion of the mature animals in the population. Mature rams are critical for the behavioral maintenance of social order (Geist 1971). Harvest of adult rams and harvest of ewes (if allowed) should be carefully monitored to insure that the number of animals harvested by hunters plus the number lost to other causes does not exceed the annual recruitment rate of adult into the population.

#### LITERATURE CITED

Bailey, V. 1936. The Mammals and Life Zones of Oregon. North American Fauna 55, USDA, Bureau of Biological Survey, Washington, D.C.

- Blood, D.A. 1961. An ecological study of California bighorn sheep (*Ovis canadensis californiana* Douglas) in southern British Columbia. M.S. Thesis, University of British Columbia, Vancouver, BC.
- \_\_\_\_\_. 1963. Some aspects of behavior of a bighorn herd. *Canadian Field-Naturalist* 77:77-94.
- Bodie, W., E.O. Garton, E.R. Taylor, and M. McCoy. 1995. A sightability model for bighorn sheep in canyon habitats. *J. Wildl. Manage.* 59:832-840.
- Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present and future. *Wildlife Monograph* 4, The Wildlife Society, Washington, D.C.
- Clark, J.L. 1964. The Great Arc of the Wild Sheep. University of Oklahoma Press, Norman, OK.
- Cowan, I. McT. 1940. Distribution and variation in the native sheep of North America. *American Midland Naturalist* 24:505-580.
- Demarchi, D.A., and H.B. Mitchell. 1973. The Chilcotin River bighorn population. *Canadian Field-Naturalist* 87:433-454.
- Drewek, J.R. 1970. Population characteristics and behavior of introduced bighorn sheep in Owyhee County, Idaho. M.S. Thesis, University of Idaho, Moscow, ID.
- Dunaway, D.J. 1971. Human disturbance as a limiting factor of Sierra Nevada bighorn sheep. *Trans. North Am. Wild Sheep Conf.* 1:165-173.
- Ganskopp, D., and M. Vavra. 1987. Slope use by cattle, feral horses, deer, and bighorn sheep. *Northwest Sci.* 61:74-81.
- Geist, V. 1971. *Mountain Sheep: A study in Behavior and Evolution.* University of Chicago Press, Chicago, IL.
- \_\_\_\_\_. 1975. On the management of mountain sheep: theoretical considerations. Pages 77-105 in Trefethen, J.B., ed. 1975. *The Wild Sheep in Modern North America: Proceeding of the Workshop on the Management Biology of North American Wild Sheep.* Boone and Crockett Club.
- \_\_\_\_\_. 1999. Adaptive strategies in American mountain sheep. Pages 192-208 in R. Valdez and P.R. Krausman. *Mountain Sheep of North America.* The University of Arizona Press, Tucson, AZ.
- Guthrie, R.D. 1984. Mosaics, allochemics, and nutrients: an ecological theory of Late Pleistocene megafaunal extinctions. Pages 259-298 in P.S. Martin and R.G. Klein, eds. *Quaternary extinctions.* University of Arizona Press, Tucson, AZ.
- Hansen, M.C. 1982. Status and habitat preference of California bighorn sheep on Sheldon National Wildlife Refuge, Nevada. M.S. Thesis, Oregon State University, Corvallis, OR.
- Harris, A.H., and P. Mundel. 1974. Size reduction in bighorn sheep (*Ovis canadensis*) at the close of the Pleistocene. *J. Mammal.* 55:678-680.
- Harrison, S., and D. Hebert. 1988. Selective predation by cougar within the Junction Wildlife Management Area. *Bienn. Symp. Northern Wild Sheep and Goat Council* 6:292-306.
- Hebert, D., and M. Evans. 1991. A proposal to institute a separate trophy status for California and Rocky Mountain bighorn sheep in North America. British Columbia Ministry of Environment, Williams Lake, BC.
- \_\_\_\_\_, and S. Harrison. 1988. The impact of coyote predation on lamb mortality patterns at the Junction Wildlife Management Area. *Bienn. Symp. Northern Wild Sheep and Goat Council* 6:283-291.
- Hicks, L.L., and J.M. Elder. 1979. Human disturbance of Sierra Nevada bighorn sheep. *J. Wildl. Manage.* 43:909-915.

- Horner, J.R. 1997. *Dinosaur Lives*. Harcourt Brace, New York, NY.
- Hunt, E.G. 1980. Report on Lava Beds National Monument bighorn sheep die-off. California Department of Fish and Game, Sacramento, CA.
- Jessup, D.A. 1980. Pneumonia, bighorn, and domestic sheep. *American Assoc. of Wildlife Veterinarians Newsletter* 4, September 1980.
- Kornet, C.A. 1978. Status and habitat use of California bighorn sheep on Hart Mountain, Oregon. M.S. Thesis, Oregon State University, Corvallis, OR.
- Krausman, P.R. 1997. Regional Summary. Pages 316-317 in D.M. Shackleton, ed. and the IUCN/SSC Caprinae Specialist Group. 1997. *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*. IUCN, Gland, Switzerland and Cambridge, UK.
- Martin, L.D., and B.M. Gilbert. 1978. Excavations at Natural Trap Cave. *Trans. Nebraska Acad. Sci.* 6:107-116.
- Martin, K.D., T. Schommer, and V.L. Coggins. 1996. Literature review regarding the compatibility between bighorns and domestic sheep. *Bienn. Symposium Northern Wild Sheep and Goat Council* 10:72-77.
- McCullough, D.R., and E.R. Schneegass. 1966. Winter observations on the Sierra Nevada bighorn sheep. *California Fish and Game* 52:68-84.
- Ramey, R.R. 1993. Evolutionary genetics and systematics of North American mountain sheep: implications for conservation. Ph.D. Dissertation, Cornell University, Ithaca, NY.
- \_\_\_\_\_. 1995. Mitochondrial DNA variation, population structure, and the evaluation of mountain sheep in the southwestern United States and Mexico. *Mol. Ecol.* 4:429-439.
- Shackleton, D.M., C.C. Shank, and B.M. Wikeem. 1999. Natural history of Rocky Mountain and California bighorn sheep. Pages 78-138 in R. Valdez and P.R. Krausman. *Mountain Sheep of North America*. The University of Arizona Press, Tucson, AZ.
- \_\_\_\_\_, N. Barichello, A. Gunn, D.H. Hebert, and F. Harper. 1997. Canada. in D.M. Shackleton, ed. and the IUCN/SSC Caprinae Specialist Group. 1997. *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*. IUCN, Gland, Switzerland and Cambridge, UK.
- Schwantje, H.M. 1988. Causes of bighorn sheep mortality and die-offs. *Wildlife Working Rep. WR-35*, Wildlife Branch, Ministry of Environment, Victoria, BC.
- Sugden, L.G. 1961. The California Big Horn in British Columbia, with particular reference to the Churn Creek Herd. *British Columbia Ministry of Environment*.
- Toweill, D.E., and V. Geist. 1999. Return of Royalty: Wild Sheep of North America. Boone and Crockett Club and Foundation for North American Wild Sheep.
- Trefethen, J.B., 1975. The Wild Sheep in Modern North America: Proceeding of the Workshop on the Management Biology of North American Wild Sheep. Boone and Crockett Club.
- Valdez, R., and P.R. Krausman. 1999. Description, distribution and abundance of mountain sheep in North America. Pages 3-22, in R. Valdez and P.R. Krausman. *Mountain Sheep of North America*. The University of Arizona Press, Tucson, AZ.
- Wang, X. 1984. Late Pleistocene bighorn sheep (*Ovis canadensis*) of natural Trap Cave, Wyoming. M.A. Thesis, University of Kansas, Lawrence, KS.

Wehausen, J.D. 1980. Sierra Nevada bighorn sheep: history and population ecology. Ph.D. diss., Univ. of Michigan, Ann Arbor, MI.

\_\_\_\_\_, L.L. Hicks, D.P. Garber, and J. Elder. 1977. Bighorn sheep management in the Sierra Nevada. Desert Bighorn Council Trans. 21:30-32.

Wishart, W. 1999. Managing nursery herds of wild sheep. Page 32 *in* D.E. Toweill and V. Geist. Return of Royalty: Wild Sheep of North America. Boone and Crockett Club and Foundation for North American Wild Sheep.

Table 1. Population estimates for California bighorn sheep in North America, 1998 (*from* Toweill and Geist 1999).

Location	1960	1970	1975	1985	1990	1998
British Columbia	1,185	1,764	1,850	3,240	4,645	3,630
California	390	390	195	300	320	170
Idaho	0	90	50	530	1,205	1,460
Nevada	0	8	30	151	484	1,248
North Dakota	0	120	250	--	232	350
Oregon	24	--	210	1,007	1,805	2,890
Utah	0	0	0	0	0	30
Washington	Remnant	303	400	550	586	745
TOTAL	1,609	2,765	2,985	5,778	9,227	10,523

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**QUESTIONS, ANSWERS AND COMMENTS - DALE TOWEILL PRESENTATION**

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**VERN BLEICH, CALIFORNIA:** Dale, why would removal of 20 percent of the ewe cohort compromise lamb recruitment rates?

**DALE TOWEILL:** Fewer factories, basically.

**BLEICH:** You mean you just produce fewer lambs?

**TOWEILL:** Produce fewer lambs and you, in fact, affect the ability of that herd to maintain itself. Again, this is based on our experience in Idaho when we got carried away with our transplant efforts.

**BLEICH:** I'm sorry. I understood you to say that the recruitment rates were compromised.

**TOWEILL:** Excuse me. I misspoke. Recruitment rates may be reduced if ram harvest exceeds the replacement rate. Overharvest or removal of ewes compromises lamb production.

**TOM RYDER, WYOMING:** Dale, I'd be curious to hear your opinion of utilizing California sheep to try and repopulate maybe some distant Audubon ranges in central and eastern Wyoming and like those other folks have already done in Nebraska and South Dakota?

**TOWEILL:** It's my opinion, based on what I know of California bighorn sheep and Rocky Mountain bighorn sheep ranges, that many of the Audubon sheep ranges tend to be isolated. They tend to be patchy habitats, very good in small areas. They appear to be ideally situated to small populations, so that once you dump them out there, they remain relatively loyal to that habitat.

As we all know, when you transplant animals the first worry is if you have enough animals to interact and start a basal population. The number of animals transplanted goes down and may disappear. Whether they disappear to find something better to live in or whether they become coyote fodder, using a population of animals that does not have a migratory tradition maximizes your opportunity to establish a basal population. minimizes a chance that your desired population is going to wind up some place different than where you intended.

**WAYNE HEIMER, ALASKA:** Are you aware of any susceptibility to *Pasteurella* toxins?

**TOWEILL:** I'm not aware of any. There may be some, but I have no personal awareness of those.

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## RAY LEE - A WORKING HYPOTHESIS FOR DESERT BIGHORN SHEEP MANAGEMENT

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**Abstract:** An overview of desert bighorn sheep is presented covering history and distribution; patterns and probable causes of population declines; influences of water developments and transplant programs; hunting and special tags; management practices; and limiting factors.

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**History:** Mountain sheep of North America apparently descended from wild sheep of central Asia. From the highlands of Tibet and the deserts of Mongolia, ancestral mountain sheep crossed the Bering land bridge to North America. Ice age glaciers eventually forced them southward through the western mountains to Mexico. Mountain sheep are thought to have arrived in the more arid "Southwest" only during the last 10,000 years or so.

The original distribution of mountain sheep is not well known because many populations declined rapidly and disappeared at an early date. At their peak, it is thought that North American mountain sheep ranged throughout most western mountain ranges, and extended eastward as far as North Dakota, Nebraska, and Texas. Populations were so large that as late as 1910 mountain sheep were still being commercially harvested. From the crude estimates of "millions" of animals pre-settlement, in 1960 it was estimated that only 25,000 mountain sheep remained on the continent.

**Distribution:** There are essentially 2 types of mountain sheep in North America. The thinhorns, *Ovis dalli*, are found in Alaska and western Canada. The bighorns, *Ovis canadensis*, are found throughout western North America. Desert bighorn sheep currently range from northwestern Sonora, particularly in those mountain ranges along the Sea of Cortez north of Kino Bay, and north of La Paz, Baja Sur, to the middle of Nevada and Utah.

Desert bighorns, so called due more to their habitat than morphological characteristics, are possibly comprised of 5 subspecies. Recent genetic work indicates that some of these groups are likely conspecifics and that "races" would be a more accurate classification. Nevertheless, Baja California is considered to have 2 subspecies, *O. c. weemsi* and *O. c. cremnobates*.

Bighorn sheep in Sonora are of the *mexicana* subspecies. Desert bighorn sheep are distributed throughout most of the mountainous areas of western Arizona, with transplanted populations becoming established in some central and southeastern mountain ranges. In Arizona, the *nelsoni* subspecies occurs primarily in the northwestern portion of the state, while the *mexicana* subspecies occurs primarily in the southwestern portion of the state. In California, the *cremnobates* subspecies occurs in the southwestern ranges in Imperial, Riverside, and San Diego counties, and the *nelsoni* subspecies occurs in the Transverse Ranges and the mountains in the Mojave, Sonoran, and Great Basin deserts. California also supports a small population of *californiana* in the Sierra Nevadas. Utah and Nevada both support populations of *nelsoni* in their southern mountain ranges. Small populations of desert bighorn sheep also occur in a few ranges in west Texas (the result of transplants of both *mexicana* and *nelsoni*), a few ranges in southwestern New Mexico (from *mexicana* transplants), and a few ranges in southwestern Colorado (from *nelsoni* transplants).

At present, occupying only a small portion of their historic range, the desert bighorn sheep population is approximately 23,000. Of these, about 18,000 are found in the United States; with Arizona supporting approximately 5,900, Nevada 5,250, California 3,350, Utah 2,600, Colorado 450, New Mexico 315, and Texas 275. The remainder are found in Baja California (3,000) and Sonora (2,000).

Merely providing the distribution for desert bighorn sheep tells little about the densities at which they occur. The number of animals observed per unit of survey effort represents a method for comparing bighorn sheep densities. In southern Sonora, the mean observation rate has averaged 40 animals per helicopter hour. Observation rates in both Sierra Viejo and Sierra Kun-Kaak, both in Sonora, exceed 90 bighorn sheep per survey hour. By comparison, in Arizona, observation rates traditionally average 10 bighorn sheep per hour.

**Population Decline:** The decline in desert bighorn sheep populations occurred primarily between 1850 and 1900. Causes for these declines included persistent and unregulated harvest; competition for water; and, most importantly, livestock associated diseases and parasites.

The evidence linking the reduction and elimination of bighorn sheep populations with the arrival of man's livestock is overwhelming. Domestic sheep were recognized as a source of disease as early as 1895 in Arizona, when a Territorial Act established an inspector with authority to inspect all domestic sheep entering the territory, and to impound any sheep with infectious disease. The diseases most responsible for impacting bighorn sheep populations were scabies, chronic sinusitis, and pneumonia. Scabies was one of the first diseases reported in bighorn sheep. This is because effects of the disease are easily observed and a large number of animals were affected. The presence of scabies was so severe that in some areas local residents reported that it was difficult to find bighorn sheep that were fit to eat.

Although the pneumonia complex was also among the first diseases described that led to large scale die-offs of bighorn sheep, it is one of the least understood. One of the difficulties in understanding the role of pneumonia in bighorn sheep populations is determining the factor that causes the pneumonia. A variety of bacteria have been isolated from pneumonic bighorn sheep. Stress, in combination with bacterial and viral agents, plays an important role in "triggering" the onset of pneumonia in bighorn sheep.

Due to the marked declines in bighorn sheep populations, most states closed their hunting seasons on bighorn sheep. California was the first in 1878. This action was followed in Arizona when the first game laws enacted by the Territorial government in 1887 provided punishment for the unlawful taking of bighorn sheep from February to October. In 1897, an Amendment of the Penal Code was made to close the bighorn sheep season until such time as judged appropriate by the legislature. New Mexico closed its hunting season for bighorn sheep in 1889, Texas in 1903, Nevada in 1917, and Mexico in 1921.

Concern for desert bighorn sheep gained national attention. Federal Wildlife Refuges were established in Nevada (Desert Game Range), New Mexico (San Andres National Wildlife Refuge), and in Arizona. In 1939, the creation of the Kofa and Cabeza Prieta Game Ranges set aside 1.5 million acres of southwestern Arizona for bighorn sheep and other wildlife. Although state governor's ridiculed these "federal takeovers" as "billy goat pastures," these actions were considered essential if bighorn sheep were going to be saved from extinction. These areas would be patrolled, and most importantly, livestock would be eliminated. Habitat protection, the primary means of retaining viable populations of any wildlife species, had been addressed. Populations outside of these refuges, however, continued to decline. It took active management programs to reverse this trend.

**Waters:** Providing water sources for bighorn sheep, though sometimes questioned, has been a

hallmark of desert bighorn sheep management activity. Each state with desert bighorn sheep has developed partnerships with conservation organizations to help in the construction of wildlife waters. In Arizona, the Game and Fish Department (AGFD), in cooperation with the Bureau of Land Management and the Arizona Desert Bighorn Sheep Society, and more recently with Desert Wildlife Unlimited, develops up to 10 bighorn sheep waters annually. These water projects vary from simple *tinaja* modifications, to extensive artificial water collection and storage systems. The goal is to develop the most cost-effective, environmentally sensitive, maintenance free waters possible. In Nevada, 113 bighorn sheep waters have been developed in this fashion. Water development projects for the benefit of desert bighorn sheep are also common in other states.

**Transplants:** Transplanting bighorn sheep from areas of high density into historic habitat is a management activity used to enhance bighorn sheep populations. Arizona has been involved in an aggressive bighorn sheep transplant program since 1955. Arizona has transplanted 1,210 desert bighorn sheep, with 206 being sent to other states. Nevada has been even more active; since 1968, Nevada has transplanted 1,268 animals, with 280 being sent to other states. In both Arizona and Nevada approximately 1/3 of the hunting permits available are for populations that have been started by transplant within the past 20 years. Beginning in 1973, Utah has been involved in the transplant of 546 animals. Colorado, where there is little evidence that desert bighorn sheep ever existed, has transplanted 216 animals since 1979. California has transplanted 387 desert bighorn sheep since 1983.

In Sonora, a 1975 transplant of desert bighorn sheep was made with animals from the adjacent mainland to Tiburon Island. This transplant eventually resulted in a large population of bighorn sheep on the island. In the last 2 years, 3 transplants totaling nearly 150 animals have occurred from Tiburon Island to the mainland.

**Hunting:** Bighorn sheep have always been one of the most sought after hunting trophies. From prehistoric man to the modern hunter, the "King of the Mountain" has proven to be an elusive, even mystical, prey. Bighorn sheep, like most North American ungulates, have been hunted since their first interaction with man. Aboriginal hunters avidly pursued bighorn sheep. Bighorn sheep bones have been found in archaeological sites dated over 8,000 years old. After the invention of the bow and arrow, ungulate harvest, determined from bones found in archaeological sites, increased nearly 3-fold. Prehistoric men set up rock walls and drove bighorn sheep past concealed hunters. Several groups even built "dummy" hunters out of stone to help drive bighorn sheep into their traps. Bighorn sheep played an important role in Indian mythology. More bighorn sheep related petroglyphs are found in the west than any other animal. While early hunters were primarily seeking food, bighorn sheep, especially the desert varieties, have developed into perhaps the most coveted trophy animal of all time.

Arizona and Nevada began hunting bighorn sheep in the early 1950s. Other western states subsequently legalized bighorn sheep hunting. California opened its bighorn sheep hunting season in 1987. Texas opened hunting in 1988, though the initial season was not available to the general hunting public. Colorado also opened its hunting season in 1988. New Mexico opened for desert bighorn sheep hunting in 1995.

Since Arizona's first season in 1953, 2,363 permits have been authorized. A total of 2,309 hunters have harvested 2,014 rams for a hunter success of 87%. Hunter success rates have varied considerably over the years. From 1955 to 1965, the hunter success averaged 33%. Since 1980, the hunter success has averaged over 91%.

For the 1998 season in Arizona, 7,790 sportsmen applied for 107 permits, a 1 in 73 chance of obtaining a permit. Hunters harvested 100 rams. In Nevada, 109 permits were issued, resulting in the harvest of 85 rams. Hunters in Utah took 29. More

limited hunts took place in the other states with a harvest of 14 rams in California, 5 in Colorado, 4 in Texas, and 2 in New Mexico.

In all the United States, from 1952 to 1998, fewer than 5,000 desert bighorn rams have been legally harvested. Desert bighorn sheep hunting opportunities are now found in Arizona, Nevada (with approximately 1,900 total rams having been harvested since modern seasons were opened), Utah (approximately 300), California (90), Texas (17), and New Mexico (8).

The Mexican Government issued 7 bighorn sheep hunting permits for Sonora in 1995/96. These permits sold for up to \$60,000 and 6 sheep were harvested. There were 13 permits authorized for 1996/97, 25 for 1997/98, and 43 for the 1998/99 season. The value of these permits has decreased from nearly \$60,000 to approximately \$25,000. In Baja Sur, 4 permits were issued in 1996/97, with 3 rams being harvested. Permits in Baja Sur were reduced to 3 in 1997/98, and subsequently increased to 5 in 1998/99. These tags are available only through auction or raffle. One permit was issued for Baja California for the 1998 season.

The world's largest desert bighorn sheep, found in Baja California, scored 205-1/8 Boone and Crockett points. Arizona produced a pick-up skull scoring 201-3/8 points, and produced the largest ram taken by a sport hunter at 197-1/8 points in 1988. The various other sport harvest records for each state are as follows: Baja California 192-5/8; Sonora 187-3/8; Nevada 187-2/8; New Mexico 181-4/8 (1995); California 182-0/8 (1998); Texas 176-1/8 (1997); and Utah 168-2/8 (1997).

Due to the high demand for permits (in some cases exceeding 400 applicants for each permit), some states place limitations on the number of bighorn sheep that can be harvested by an individual hunter. In Arizona, hunters are allowed to take only 1 desert bighorn sheep and 1 Rocky Mountain bighorn sheep in their lifetime. Other states limit hunters to 1 bighorn sheep every 10 years.

**Special Tags:** The dollars generated by the sale of bighorn sheep permit tags annually do not begin to support even a small portion of bighorn sheep management programs. In 1998, a total of 7,790 sportsmen paid the AGFD \$3 each for an opportunity to enter the computer drawing for bighorn sheep permit tags, a total of \$23,370. Of the 107 tags issued, 10 were to non-residents. This produced \$7,500 in tag sales (\$750 each) from the non-residents and \$14,550 from the 97 resident tags (\$150 each) for a total \$45,420 of revenue to the AGFD. At the current contract price for helicopter surveys (\$550/hour), only 83 hours of flight time, not including personnel costs, could be purchased; less than needed to survey the bighorn sheep distribution in only southwestern Arizona.

A relatively recent program that was developed to generate revenue to support wildlife conservation programs is the Special Permit, or Governor's Tag. Originally started in Wyoming in 1980, it is now used by almost every western state to varying degrees. Using Arizona as an example, 2 bighorn sheep permits are issued annually. For the past 14 years, the Game and Fish Department and the Arizona Desert Bighorn Sheep Society have entered into an agreement whereby the Society auctions 1 permit (at the Foundation for North American Wild Sheep convention) and raffles another to raise funds earmarked specifically for bighorn sheep management projects. Since the program started in 1984, \$3,301,805 has been raised from the 28 permits (\$2,066,500 from the 14 auction tags and \$1,235,305 from the 14 raffle tags). Special tags have been issued for bighorn sheep in virtually every state, Mexico, Canada, and various Indian Reservations. Much of the success of the various bighorn sheep management programs are dependent upon the funds derived from these special permits.

**Management:** Desert bighorn sheep are adapted to live under stable conditions at the carrying capacity of the habitat. Populations are dependent upon the ability of subsequent populations to maintain production on the range of their parents and to exploit stable plant communities. This

differs from deer, for example, which are adapted to exploit short lived opportunities for population expansion. Bighorn sheep have relatively low reproductive rates and don't respond well to changes in their habitat, therefore they can't be harvested at rates appropriate for deer.

Being considered a trophy animal has led to management principles uncommon for more utilitarian species. While most state game and fish agencies have mandates to provide maximum recreational opportunities for more common big game species, bighorn sheep are usually hunted in a more conservative fashion to maintain trophy quality.

A common concern in many states has been the harvesting of younger age rams. Each state has attempted to solve this problem by different methods. In Nevada, for example, a 1965 regulation specified that a legal ram must be 7-years old or score 144 Boone and Crockett points. Hunters were also required to carry a spotting scope and were given an indoctrination session to familiarize them with the techniques of judging the size and age of rams. This indoctrination session soon became mandatory. The new regulation and the indoctrination session appeared to help reduce the young ram harvest.

In Arizona, a similar path was taken. In 1966, the first bighorn sheep hunters clinic was held. This was an attempt to familiarize hunters with successful hunting methods and give them the ability to judge trophies in the field. The clinic also attempted to instill the desire to harvest older age rams. This clinic soon led to the formation of the Arizona Desert Bighorn Sheep Society, an organization dedicated to the preservation of bighorn sheep.

Bighorn sheep hunter clinics also provided aspiring hunters with information to help make their hunts more successful. The clinic not only provided a forum for exchange of information, in many cases it enabled a client-guide relationship to be formed.

Perhaps the greatest change seen in bighorn sheep hunting has been in human behavior. This, perhaps more than anything else, has led to the marked increase in hunter success rates. In the early 1950s, hunters commonly took to the field, relatively ill-prepared, and often by themselves. Today, well equipped camps are the norm. Frequently, these camps are manned by past year's permit holders for the unit, as well as friends and just plain sheep aficionados, who met at the sheep clinic and want to experience the hunt, if only vicariously. This results in many eyes scanning a mountain range to produce the best possible ram for the current permit holder.

Most states have developed operational plans to help manage their desert bighorn sheep populations. Arizona's plans call for the hunting permit allocation to result in the harvest of either 6% of the total number of rams estimated in the population, or 12% of the estimated number of older age rams, whichever number is lower. In California, permits are authorized for up to 15% of the estimated number of rams 2 years old or older. Other states have similar harvest strategies. It is doubtful that bighorn sheep populations will ever meet the demand for hunting opportunities; however, sportsmen will continue to have an important role to play in expanding bighorn sheep management programs.

**Limiting Factors:** The primary limiting factor for most desert bighorn sheep populations is adverse climatic conditions, primarily drought, resulting in the reduction in free standing water and succulent forage. While there has recently been considerable debate regarding the value of artificial waters to bighorn sheep populations, there is little question that without them desert mountain ranges would provide wildlife with less water than they did historically. A human related factor which impacts bighorn sheep is the removal of water from bighorn sheep habitat. The majority of natural springs have been modified to provide water for humans, their domestic animals, or for mining operations.

Drought is followed closely as a limiting factor by loss or fragmentation of habitat. This can occur

through direct losses to urban expansion into foothills areas, or indirectly through the expansion of human related recreational activities. The most insidious loss is that of seasonally preferred habitat. While not as obviously critical to bighorn sheep as escape and lambing terrain, the foothills areas, which produce the greatest forage, are much more important to the long term survival of bighorn sheep populations than has typically been considered. By providing protection from humans, the designation of large areas as "Wilderness" may prove beneficial to bighorn sheep - as long as these areas do not serve as attractants for large numbers of outdoor enthusiasts and wildlife management activities are allowed to continue.

The AGFD recently completed a statewide bighorn sheep habitat evaluation. To address the planning requirements for major projects it will become necessary to work on a large scale to properly coordinate transplant, habitat modification, and habitat protection activities.

Predation, particularly upon small releases, has been implicated as the cause of failure for some transplants - and has even been implicated in behavioral changes in some ranges in California. Both Utah and Arizona have recently established predator control projects designed specifically to help desert bighorn sheep populations.

There are a number of factors limiting the distribution and abundance of desert bighorn sheep in Mexico. Perhaps the most important of these are related to economics. Use of bighorn sheep to meet basic food needs still occurs in some areas. As the economic value of these animals becomes more widely known and the proceeds more widely distributed, this type of loss will be reduced. Private landowners, who fully realize the value of bighorn sheep, have developed bighorn sheep breeding facilities on their land. Unfortunately, to ensure that the bighorn sheep stay on their holdings, many landowners have constructed fences. This precludes the bighorn sheep from using seasonally important habitat, reduces genetic exchange, and increases susceptibility to catastrophic events, particularly those disease related.

Cattle, sheep, and goats, along with their diseases and parasites, also compete with bighorn sheep for food and water.

The future for desert bighorn sheep looks relatively bright. Organizations such as the Foundation for North American Wild Sheep represent a large number of people who have been very supportive of programs to enhance bighorn sheep populations and their habitat, and these people have been willing to put both their money and their sweat into seeing that these programs are successful. That combination of money and sweat has put a lot of bighorn sheep back onto the mountains; it will take both to keep them there.

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## QUESTIONS, ANSWERS AND COMMENTS - RAY LEE PRESENTATION

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**FRANCES CASSIRER, IDAHO:** How do you explain the high densities and large body sizes of the desert bighorns in Mexico versus Arizona? Is it just habitat?

**RAY LEE:** I didn't say that body sizes were larger in Mexico. The horn sizes in Baja appear more a genetic trait than anything else. You're looking at record rams in Arizona of 197 points, with a pick-up head of 201 points. Baja has produced a 205 point head.

When you look at sheep densities, yes, I consider it due to forage availability. There's just so much more for them to eat in parts of Mexico. There's a very different climatic pattern where the weather comes on to the mainland from the ocean, it supports a very rich, succulent forage.

Maybe you remember the pictures of Tiburon Island, which show you that more clearly. When we look at sheep in Arizona, there's a plant over there and there's a burro eating on it. In Mexico, you just don't have that same kind of competition and the forage is just much richer.

**ROB RAMEY, COLORADO:** Desert bighorn sheep didn't arrive down in the southwest until just 10,000 years ago. The fossil record shows that 500,000 to 750,000 years ago was the first *Ovis* fossil and 200,000 years ago in the Central Mojave. It's likely that the sheep have been in the southwest much longer than you originally realize there.

**LEE:** One of the things I'd like to reiterate is that what I was presenting here is still plastic. If any of the various state representatives heard me make statements about their state that were inaccurate, I'd like them to come by and pummel me afterwards. I'll admit that I am not a very good reader of the fossil record. I'll accept your wisdom on that. Thank you.

**JIM BAILEY, NEW MEXICO:** I want to point out, I think those early fossil records in the south were not in desert environments.

**ROB RAMEY:** Manix Lake is the central Mojave.

**LEE:** Was.

**RAMEY:** During the pluvial periods there were large lakes in those areas and fossils were in the sediment of the lakes. They're the Sonora sample. I think it's likely to say that there was probably desert in that area. I haven't actually looked at the data for the pack rat middens to say what it is. It's well known there was a desert-like habitat persisting through the Pleistocene.

**BAILEY:** I haven't looked at it in a long time. My recollection of the fossil records is the plants down there were species like spruce and megafloa.

**LEE:** My recollection of the fossil record as well is that the climatic conditions in the southwest that would support desert bighorn sheep have actually occurred relatively recently as shown by pack rat middens, but more by lake cores. Paleoecologists have cored down and gotten pollen out of lakes and looked at the plants in the lake. That's why I lean towards a younger arrival. However, as I said, I'll defer to your recollection.

**RAMEY:** Why don't we say deserts are 10,000 years old? We have good evidence of the opening of the Holocene and that's what's taken place down there. There's been a reduction of the juniper woodland and it's gone towards desertification. There's good evidence for that. It's likely sheep were there and simply adapted to the environment.

**LEE:** I was hoping that is what I was saying during this talk on desert sheep.

**BAILEY:** You said, somewhere along the way, that sheep are only occupying something like 10 to 15 percent of the habitat that was historically available. What are you basing it on?

**LEE:** In Arizona we have records of sheep occurring in various mountain ranges which currently have no sheep. These sorts of data are available from other states as well. Historical records indicate that we had sheep virtually everywhere in Arizona, other than the Chiricahua Mountains in the southeast and the Chuska Mountains in the northeast. We have records of sheep being nearly every place in the state. If you look today, their range is just cookie-cuttered down into the various desert ranges that don't have people living on them. You're looking at something on the order of 10 to 15 percent.

**BAILEY:** Really, I'm not debating it. I'm surprised you had to address transplants. Looking at your map, you reoccupied a lot of ranges, perhaps not with the densities or the distribution within the range as have been historically. I'm trying to figure you were up to 70 percent or something like that right now.

**LEE:** Look at two things. One, it shows how far down we were and two, it shows us how far we have to go. We have a lot of opportunities.

**PHIL HEDRICK, ARIZONA:** Are there plans to transplant to other areas that are old sheep habitats, you know, other than Sky Island areas in Arizona, for example?

**LEE:** November 15th.

**HEDRICK:** And where are they going to be?

**LEE:** They're going to come from near Lake Mojave and be put near Wickenburg.

**HEDRICK:** How about others in the southeastern part of the state?

**LEE:** We may eventually get to that. One of the things that we'll talk about in tomorrow's transplant session is that the number one thing you need is a population that you can transplant from, and Arizona's populations are relatively low at the moment. We don't currently have the transplant stock that we would like to transplant to the southeast. I imagine we will. There's talk of going to Pusch Ridge and doing something in the Catalina Mountains. That's not biological pressure, it's more political pressure to do more for wildlife in that area.

**HEDRICK:** Do you know the reason why this population has declined, and if you put new animals in there, what would be your chance of success, if you don't know what the problems have been?

**LEE:** I'll ask you to hold that till the transplant session tomorrow. Because that, of course, is the crux of any transplant issue. Do you go back to an area that you had sheep in; historic habitat, therefore it should be good. They don't have sheep there now, so do you put them in now without knowing why the original ones went out.

Look at the various transplant schemes. Some people say the later you have sheep documented in an area, the better that area would be. Other people would say, no, it's the worst, because whatever caused them to go out might still be affecting them now. Hopefully in the transplant session those issues will be addressed, because they are the paramount issues when you deal with transplants.

**ROB RAMEY, COLORADO:** One last question. You'll always be my slide presentation subject. I want to point out relative to the old taxonomic issues that die slowly, it is important to realize they're using morphometric data, this notion of *cremnobates* versus *nelsoni* was tested and refuted in the literature in '93. There was a follow-up in 1995 with *mexicana* and statistical tests done refuted that data. *Mexicana* was tested and refuted, but not synonymized. To keep you up with the literature, these issues have been tested and have been dealt with.

**LEE:** This is what we're looking at, old habits. To this point we have been talking about races, and we should give credit where credit is due. There's been a lot of good work done recently; however, until the entire body of bighorn sheep managers in North America comes up here lock step and agrees with you, and obviously that's not quite the case, they're still going to be conservatism in this area of wildlife management.

**RAMEY:** It depends if you want to base your management decisions on science or not, or hearsay and opinion. That's what it comes down to.

**HARLEY METZ, COLORADO:** What do you feel, in 25 words or less, has been the effect of wild burros on your desert bighorn population?

**LEE:** Bad.

**METZ:** Is it bad or is it getting better?

**LEE:** It's getting better. The Bureau of Land Management is an active cooperator in wildlife management activities in Arizona. The Desert Bighorn Council has a burro committee. Each year, they'll take a census of the various states to come up with the number of burros. The Bureau of Land Management is working harder and harder at achieving proper management levels for burros. For some people this is zero burros; however, there are large advocacy groups for burros.

What they're supposed to manage for is a population target in a particular area. We find in Arizona they're getting better and better at doing that. It may be because we're pounding on them harder and harder. But they are doing that. I would say that other than a couple of places in the state where burros are having a fairly adverse impact on the bighorn sheep, most of the areas that we felt had trespass animals are being cleaned out.



NOTE: THIS TEXT WAS EDITED FROM CONFERENCE TRANSCRIPTS

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**FERNANDO COLCHERO - THE TIBURON ISLAND DESERT BIGHORN SHEEP: A CONSERVATION AND SUSTAINABLE DEVELOPMENT PROGRAM IN MEXICO**

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**Abstract:** The desert bighorn sheep (*Ovis canadensis mexicana*) is one of the most valuable faunal resources in Mexico. This species historically cohabited with the Seri Indian community in Sonora. The Seri own 90,000 hectares in mainland coastal Sonora and Tiburon Island where one of the largest desert bighorn sheep populations is found. This population was introduced to the island 24 years ago as strategic transplant stock to recover their natural ranges, such as in Chihuahua, Coahuila and Nuevo Leon, from which the bighorns disappeared during the second half of the 20th century. In 1996, we started working on Tiburon Island with the Seri community to establish a program for conservation and sustainable harvest. The sheep population of the island has grown to an estimated 650 sheep. The island is also inhabited by an endemic subspecies of mule deer. We are quantifying the use of the succulent vegetation in the flats and in the mountains, examining the diet overlap between both ungulates, learning about the sheep's movements around the island, and evaluating its carrying capacity. The Island has already served to establish nine other bighorn sheep populations since 1995 in mainland Sonora, and this year is when the reintroduction to Chihuahua and Coahuila will take place.

Last year, the Tiburon Island program was finally able to support itself due to the auction sale of two ram hunting permits. This allowed the community to start public works in the Seri Indian settlement, and to continue with the research projects. The Tiburon Island population is not only important from a social perspective, but is also a unique research and conservation model, paying for itself based upon a solid research and management program.

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First, I would like to thank the Desert Bighorn Council Ewes as well as the conference organizers for helping me with a grant to attend this conference. Without that, I wouldn't be able to be here.

Before describing the management plan we are using on Tiburon Island, I would like to tell you about myself. My name is Fernando Colchero, and I am doing my bachelor's thesis on Tiburon Island. I'm a student at the Ecology Institute of the National Autonomous University of Mexico. We have been working on the island with Ray Lee, the

Mexican government, and also with a grant from the university.

In discussing the biological situation in Mexico, perhaps some of you know Mexico has been classified as a megadiverse country. That means we have one of the highest species richness in the world. Mexico has between 10 and 15 percent of the species in the world. One explanation suggests we have two biogeographic regions in our area: the neo arctic and neo tropical regions. We also have complex topography features which result in a variety of different biomes and weather conditions.

Like almost every third world country, and maybe all the countries in the world, we are facing a loss in biodiversity caused by desertification, agricultural development, exotic species introductions, illegal hunting, and habitat loss caused by human growth expansion. The national parks and the reserves are not very efficient in species conservation. We think it's because they don't try to relate the work in the reserves to the local people living in the areas. We think we have about five thousand threatened or endangered plant and animal species.

I'm not going to talk to you about the whole legal history of how the government has faced this problem, but in 1994, the government created the SEMARNAP, under the general direction of the National Resource Secretary and the National Ecology Institute. The general guidance comes from some conservation biology researchers at the university and the rural productive diversification program. The national program includes both wildlife conservation and economical problems with the rural sector of our country.

The strategy for reaching the rural sector included creating the UMA, a system to manage the wildlife conservation units. This allows the people to say to the government "I have some natural resources I want to develop. I tell you which are the resources and how I want to manage them, and you give me the permission to do it."

Management of big game animals has been easier than with other kinds of species, but now the people are starting to be more interested in managing their own resources to have some economic profit.

Tiburon Island was declared as a UMA in 1996. Tiburon Island is off the coast of Sonora in the Gulf of California. It has two mountain ranges, the Sierra Kun-Kaak and the Sierra Menor, which run from north to south.

Before talking to you about the sheep, I will tell you about the history of the island. The Seri people

were the original settlers. They've had problems with the government, and some wars with the government, to maintain the island as their own.

In 1975, the Mexican government declared Tiburon Island as property of the Seri people and have since allowed the Seri people to manage the natural resources of the island.

In 1996, the government declared the island as a national reserve, and that's why right now there's nobody living on the island. There is just a military camp in front of the mainland. In 1975, 20 bighorn sheep were introduced into the island. Two rams and two ewes died during the process, so the initial population was 16 animals. We have calculated, with Ray Lee's help, that right now we have about 650 animals.

In 1997, we developed a management plan to work with the bighorn sheep with an idea of trying to work further with other species. The main goal was to develop a management plan to conserve the Mexican sub-species in Mexico as a resource. From which the rural people would generate economic profit.

The particular objectives are: First, we want to maintain a healthy sheep population on the island. We have some research programs designed to help us to do that.

Second, we want to maintain a balanced ecological relationship between the big-horn sheep population and the native animals. We don't consider the bighorn sheep population as an exotic one, although no fossil records of bighorn sheep on the island have been found. The habitat is just the same as on the mainland. It's surrounded by desert with a very good vegetation cover.

Third, we want to establish and maintain a harvest program. We have already established a harvest program to support the research financially and to allow the community begin sustainable development based on the sheep resource.

Finally, we want to put new populations in the historical ranges of the bighorn sheep. Right now we don't have any bighorn sheep in the Chihuahua, Coahuila, or Sonoran parts of the Occidental range in Mexico.

The helicopter surveys we do are not research projects, but they give us enough data to transplant bighorn sheep into the other areas. We're starting to do demographic analysis of the population with the data that we have collected from the helicopter surveys.

We are going to start a habitat use research project. We want to know exactly how the sheep are moving on the island and what are the reasons for that kind of movement.

We must also consider a genetic analysis of the population. As I told you, the initial population was 16 animals. We now have 650 animals, so maybe we need to plan some management strategies to avoid in-breeding problems.

We are also doing infectious diseases analysis. We may use this information to determine if there is some disease in compatibility between the bighorn sheep on the island and those outside of the island.

We also want to know what the real impact of the bighorn sheep on the island is on mule deer and other wildlife species and plant species.

We don't know the exact mule deer population size, but we feel that the population is declining. We don't know if it's because of the bighorn sheep or because of other factors.

We also have coyotes on the island although we have not yet made a survey of them. We think the coyote population is increasing because of bighorn sheep and mule deer. We want to do a fecal analysis of coyote scats to know if they're really hunting lambs of bighorn sheep or what their prey species are.

Our management strategies are tied to the hunting harvest. We had two hunters for the last season on the island. The price of the permits were very, very high, so that allows us to continue with the research work. For the next season, we have two other hunters with permits for hunting. They have already auctioned the permits.

About 150 animals have been captured on the island and translocated to the Sonora mainland. Right now, we want to try to translocate sheep to Chihuahua and Coahuila, rather than to the Sonora mainland. There are too many from the island on the Sonora mainland already.

As an additional activity, we are qualifying a team selected from the Seri community to work as field technicians to collect data and to understand some basics of the biology of the animal, the basics of population ecology, and the use of GPS and optical equipment to collect data.

As far as financial support, we started with CEMEX, one of the largest industries in Mexico who helped us during 1996 and 1997. That allowed us to collect enough data to propose a hunting harvest plan for the island. Since 1998, we have been working with the money collected from the auction of the two permits.

I want to talk a little bit about this because the money goes to the Fele Commission. That is a bank account for the Seri and they can move the money as a community. I think they have to have about 300 signatures before moving the money from the Fele Commission, so no one is allowed to move the money himself and keep some of it.

Advances we have made so far include helicopter surveys since 1996. We have three years of data which helped us to do the demographics. We have the hunting harvest rates. We have transplantation. We have samples from the DNA taken from the captures to do the DNA analysis and we have pathological samples. We have a team already working on the island and we are developing

another team to work on the mainland, because the Seri also own a big part of the mainland.

As to the relationship between the bighorn sheep and the other species, we have one student from the national university who worked for two years collecting fecal samples from bighorn sheep, mule deer and jackrabbit on the island, to compare the diets and to compare the areas where they are living or sharing.

This is one of the first wildlife management based efforts to do sustainable development in Mexico. This effort is one of the most important projects of sustainable development and conservation in a country where we have 56 percent poverty. For me, it's the kind of project that we must implement to have conservation programs and to allow the people to work with those conservation programs.

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## QUESTIONS, ANSWERS AND COMMENTS - FERNANDO COLCHERO PRESENTATION

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**ERIC ROMINGER, NEW MEXICO:** I was wondering, Fernando, what percent of that island do you feel is being used by bighorn sheep at this time, at that population level of 600?

**COLCHERO:** From a map of the Sierra, we know they are moving between 200 meters and 600 meters of altitude, so measuring, we think they're using about 40 percent of the whole territory in the island.

**DALE TOWEILL, IDAHO:** Are sheep moving between the two Sierras?

**COLCHERO:** We think they may be. We have seen some tracks and we have seen sheep walking. We have seen tracks in areas that we have reason to believe relates to the Sierras. We have seen tracks in the south part of the Sierra Menor, that's the Eastern Sierra. It seems that the oldest rams go there during the breeding seasons, so we feel it's one population, not just small populations on the island. But we have to do the habitat project, and some telemetry would be very useful.

**WALT VAN DYKE, OREGON:** How much hunting do the native people, the Seri people, do of deer and bighorn and is it regulated at all?

**COLCHERO:** We don't actually know. They can do whatever they want, because they are the owners. But right now, they realize that it's better to maintain the populations to have a hunting harvest and to have more money. I don't know what the numbers were, but there was a lot of hunting. It's traditional use to hunt mule deer, and they use traditional techniques to do it. Right now they are realizing maybe it's not such a good idea to do that.

**PHIL HEDRICK, ARIZONA:** So you said there were 20 animals originally? Was it four males and 16 females?

**COLCHERO:** That's it, but only 16 sheep successfully relocated.

**HEDRICK:** And that's the only group that was put on the island, is that true, or were there more transplants?

**COLCHERO:** No. That's the only transplanting.

**HEDRICK:** Those came from?

**COLCHERO:** The mainland.

**BILL WISHART, ALBERTA:** Have you calculated that rate of increase?

**COLCHERO:** No. We are doing that. But what we have seen right now is that the population has maintained the numbers during the last three years of surveys. So maybe we are getting to the capacity of the island. We don't know, actually.

**WISHART:** It's probably very close to 26 or 25 percent. It would be about 20 percent, if you level it off.

**COLCHERO:** We don't know the rate yet.

**WISHART:** It's a classic. It's critical.

**JERRY CHURCH, NEBRASKA:** I was wondering if there is domestic livestock on the island?

**COLCHERO:** No, there is not. All the species are wildlife species.

**CHURCH:** Is there any discussion about eliminating sheep from the island, given it's now a bioreserve?

**COLCHERO:** The bighorn sheep? No, not at all. I think it's the biggest population we have in Mexico. It would be a mistake to remove the animals.

**RACHELLE HUDDLESTON-LORTON, NEW MEXICO:** I was wondering, are there any predators on the island?

**COLCHERO:** We just have coyotes. We don't have bobcat or lions.

**KRISTIN LEGG, MONTANA:** I was wondering, the hunting permits that were sold, are they given out to foreigners?

**COLCHERO:** Yes. All the sales have been done through FNAWS at its Reno convention for people from here. They pay more than the Mexican people. We are planning to do a lottery for Mexican hunters, because they also want to hunt there.

**LEGG:** When the foreigners come, then, are there guides from the island?

**COLCHERO:** Yes. The team that we worked with on the island to collect data, also work with us during the hunting as guides. They know the island better than anybody, so they have to reinforce their knowledge about the animals and about organizing hunting. They are very proud people, and they are learning, too.

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## **WILD SHEEP ADVOCACY GROUPS**

**KEVIN HURLEY, EXECUTIVE DIRECTOR, NORTHERN WILD SHEEP AND GOAT COUNCIL**

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**KEVIN HURLEY, WYOMING:** Today's final session is one that we're very pleased to launch. As we mentioned this morning, a network of wild sheep advocacy groups has grown up in the last quarter century and the accomplishments of all of those groups have been incredible. We think it's a great story, and we think there's a strong partnership between the advocates and the agencies. I really believe this partnership is responsible for the sheep resources we all treasure.

Of the 20 FNAWS chapters, 18 have provided financial support for the conference, and we greatly appreciate that. I know I've seen some FNAWS people here. Are any of the other groups represented? I'd like to have these representatives stand up and identify where they're from and be acknowledged.

**CLINT BENTLEY** from Las Vegas with the Fraternity of Desert Bighorn.

**HERB MEYR** from the Idaho Chapter of the Foundation for North American Wild Sheep.

**MATT WOLFE** from Alaska, Foundation for North American Wild Sheep.

**TED SCHUTTE** from Iowa FNAWS, and National FNAWS President..

**HURLEY:** We appreciate your support, and we're glad you could make it. Let me just throw a couple of figures out here. In the last 25 years, collectively, FNAWS and its chapters and affiliates have raised in excess of 25 million dollars for wild sheep in North America. I think that's an awesome total.

I've been involved with FNAWS since they moved their office to Cody, Wyoming in 1982. I'm a life member. I'm on the board of the Wyoming Chapter of FNAWS. Like many of us here, I wear multiple hats. What we'd like to do here is discuss the role of the wild sheep advocacy groups over the next 25 years. We tried to select representative individuals to speak to that. Rather than recounting all the accomplishments that have occurred over the past quarter century, we asked for a vision presentation of how these groups collectively or individually see things going for the next 25 years.

It gives me great pleasure to introduce our next speaker. Leland Speakes, Jr. is the Immediate Past-President of the Foundation for North American Wild Sheep, and one of the finest southern gentlemen you'll ever meet. Leland is a charter and life member of FNAWS, and has been involved with almost every facet and activity FNAWS has undertaken during the past quarter century. Leland has volunteered energy and countless hours to wild sheep in North America, and has followed a progression in FNAWS from active member to hospitality chair, convention chair, board of directors, officer, First Vice-President, and most recently, President of the organization. Leland has been succeeded as President by Ted Schutte of Iowa, who is also here with us today. As Past-President, you might think things would slow down a bit for Leland; that is definitely not the case! He continues, and will continue, his lifelong commitment to wild sheep, with a statesman's approach and effectiveness. Please help me welcome Leland Speakes, Jr.



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## LELAND SPEAKES JR., FOUNDATION FOR NORTH AMERICAN WILD SHEEP, MISSISSIPPI

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Leland Speakes, Jr., 527 Robinson Dr., Cleveland, MS

Thank you, Kevin. What Kevin didn't tell you is I'm from Mississippi. The tallest mountain that we have in Mississippi is a levy that runs along the Mississippi River and there are no sheep on that levy. There are some cattle grazing there. And knowing I was coming out here and would be in the midst of these scientific minds, I myself went to the fossil record and I have discovered that while we have had lots of very big catfish, we don't have any sheep.

I want to thank you for inviting me. It's good to be a part of a meeting which I hope will set the stage for wild sheep in the 21st century. Our theme for the FNAWS convention this year and also the theme for the capital campaign we have going on right now is "New Beginnings, Wild Sheep in the 21st Century." I think that will be in your hands.

The objective of FNAWS, as stated by the constitution, is to promote and enhance increasing populations of indigenous wild sheep on the North American continent, to safeguard against the decline and extinction of such species, and to fund programs for professional management of these populations, keeping all administrative costs to a minimum.

We are active in every phase of wild sheep management from Alaska to Baja Sur. We've been very active in selling state permits. We raised lots and lots of money which goes back to the individual states in the form of grant-in-aid for their sheep projects. We have a stipulation that we will not sell any state permits that the entire proceeds of which is not dedicated to sheep conservation. There may be some exceptions made to the rule; recently, a

state or two was willing to do just that, but because their legislature doesn't want them to do it, they can't put it in their contract with us.

I feel like we are dealing with very fragile animals living in a fragile habitat, subject to disease and predation at every turn.

If everybody was working with us, this job would be made easier, but that's not the case. You've got the animal rights people that want to lock us out completely. You've got federal and state governmental regulations that tie our hands, so often restricting our progress. We hope that management by professional wildlife biologists will become the way to manage wildlife, rather than by the political arena or by the ballot initiative.

I believe without a doubt the foremost problem we have to face during the next 20 years is disease. We must support research such as being done by Karen Rudolph at the Vet Lab at Caldwell, Idaho, and the work done at Washington State University.

I think everybody probably knows this, but I'm so proud of it, I'm going to tell you about it again. Rocky Crate, a veterinarian from Washington was diagnosed with incurable cancer. The first thing he did was to look for the best cures he could find and the second thing he did was sit down and rewrite his will. He left a million and a half dollars to FNAWS and Washington State, to fund a chair for veterinary wildlife medicine at Washington State University. Rocky had some treatments and he told us, look guys, if I get to feeling better, I'm going sheep hunting. Last year, he went on two sheep hunts. If he gets much better, he'll spend that

million and a half dollars on sheep hunting. This is the sort of dedication we've got among the FNAWS members. FNAWS has for many years supported the work of people like Dave Hunter, Bill Foreyt and several other wild animal veterinarians and scientists. We've supported a lot of you, and a lot of your efforts.

We have worked aggressively with government agencies as well, such as the Forest Service. We have an excellent partnership with the Forest Service. Why shouldn't we? About 90 percent of the sheep in the U.S. live on Forest Service land, so we must work cooperatively with them.

We've also worked with the BLM, the state wildlife agencies, and the Department of Agriculture.

We need to form a solution that benefits not only wild sheep, but also domestic sheep. The domestic sheep people, I think, truly would like to find a solution to the problem that we have with *Pasteurella*. I think they have ongoing scientific work in that line. But if we can find a solution that applies to both wild sheep and domestic sheep, we will have done a world of good.

We continue to be active in the retirement of domestic sheep allotments on wild sheep habitats, whenever they're available. With the help of several FNAWS chapters and sportsmen's groups in the various states, last year we bought out two large domestic sheep allotments, from willing sellers, in Oregon and in Idaho.

The second most important thing I think we have to face is predation and I won't dwell on that. We've already talked about it this morning, and I certainly don't know the cure. We haven't done a real good job making friends with our politicians, like in California. Present wild sheep populations cannot stand constant predation, controls must be put in place so we don't face the crisis we have in California.

We are very active on the political front. We're active at the national level and at the state level.

We feel that while we would like to spend 100 percent of our money on wildlife, wildlife management was getting to the point where every year we spend a little bit more in the political arena.

After all, what would it help us if we had sheep on every mountain and they had no management, no hunting, no sportsmen. It would be of little value to us. And as shown this morning by a couple of the speakers here, sheep and probably other wildlife unmanaged is just going to go one way and that's going to be down.

FNAWS sees itself as a catalyst to bring all these issues to the public.

In this way, we hope to support the wild sheep biologists and the conservation community with their effort to restore and enhance wild sheep populations.

We have an enthusiastic membership. They give of their time, they give of their money, you name it, and they'll help you, too. It's hardly anything that takes place that we don't have FNAWS members from across the country come in and put their shoulder to the wheel to accomplish whatever objective that they have. And by the same token, they're out there ready and willing to support you.

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**RICK BRIGHAM, BUREAU OF LAND MANAGEMENT, NEVADA**

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I live here in Reno, as most of you know. I'm a BLM biologist. I have been pleased to work with two constituent groups for the past 12 or 13 years. Both are chapters of Nevada Bighorns Unlimited and today I want to talk about the Nevada Bighorns Unlimited Reno chapter.

This chapter has been extremely active, starting in the early 1980s with trapping and transplanting bighorn sheep, all species. The members have not only bought equipment which is used by the Nevada Division of Wildlife but the members actually participate in some of the captures, particularly where these occur or where these are made in British Columbia for California bighorns.

They've been extremely active in habitat improvement, not only with dollars, but also with sweat equity. And I've been blessed with at least 20 guzzlers for bighorn sheep in the last 12 years working with NBU Reno.

Not only do they worry about bighorns, they worry about other species as well. They put their money where their mouth is when it comes to rehabilitation of burned areas. There are at least four or five areas, maybe more, in Nevada where NBU has contributed \$25,000.00 per burn area.

I went before them in 1994 and I didn't know how much to ask for. I finally hemmed and hawed and Larry Johnson said: How much do you want? And I said: \$10,000.00. And he said: Okay. And we got \$10,000.00 and we bought some seed for wildlife forage we could not have bought otherwise with the limited funds that the BLM had at the time.

The NBU Reno is also involved in other activities such as public education. They have paid for a slide show that was put together for The Wildlife Society, Nevada chapter on Silver State wildlife. They have established a memorial fund, a scholarship, and they actually pay many thousands of dollars a year for deserving students to go to college where they wish.

They've been involved with "Project Wild" and they provide money for "Operation Game Thief." One of the prime movers from my standpoint, and the standpoint of Craig Stevenson and George Tsukamoto, has been Larry Johnson sitting here on my right. Larry has been on the board since 1982. He's the emcee for the fund raiser that is held annually by NBU Reno. They held it the 12th of March. Some 1670 people sat down to steak dinners and it was one of the extremely well-orchestrated, excellent fund raisers.

And Larry is right there in terms of being right at the forefront of all of it. He owns his own engineering firm and he spends up to a third of his actual work time on wildlife related issues, especially when the Nevada legislature is in session. Right now it's in session and I very much appreciate him taking time from his busy schedule. He's due to testify tomorrow morning in Carson City at the Legislature on issues that affect wildlife, not just bighorn sheep.

He's founder of the Nevada Conservation Coalition, which has given that group enough political muscle to go ahead and be heard and be reckoned with by the Nevada legislators. He was also granted the Wildlife Conservationist of the Year award in 1996 by the Western Section of The Wildlife Society. With that, I'll give you Larry Johnson.



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## LARRY JOHNSON, NEVADA BIGHORNS UNLIMITED, RENO

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Larry Johnson, Reno, NV

Thanks, Rick. I don't know if I'm deserving of all of that. I really appreciate it. I'd like to welcome all of you to sunny Nevada and hope you brought your galoshes.

I want to discuss a little bit of past along with the future, because I'm kind of a student of history and I strongly feel that understanding the past and how we got here really guides us into formulating how to treat and not make these mistakes in the future.

Before the coming of white man (you might gather that I'm Native American here), bighorn sheep were the most numerous of our big game animals and those populations were pretty much decimated by the turn of the century.

We were blessed with three subspecies of sheep; California, Rocky Mountain, as well as the desert sheep, and two of the three went completely extinct in the State of Nevada.

By 1940, a publication stated that wild sheep remained in but 12 of the over 200 mountain ranges that once contained bighorn sheep. These were all desert sheep. We completely lost our California bighorns, completely lost our Rocky Mountain bighorns. There were less than 700 animals estimated at that time in these 12 mountain ranges.

The Division of Wildlife started a fledging transplant program as early as 1967. It really got under way in the late '70s through the '80s and '90s, and we've been on a hell of a roll. I think we've got the most ambitious sheep transplant program in North America. We've got 35 mountain ranges with desert sheep, 12 ranges with California bighorns, seven ranges with Rocky Mountain bighorns. We really appreciate the states and provinces who have

donated these animals and made it all possible to us.

It's been a partnership. All of this has been accomplished on public land. A great majority of our land is Bureau of Land Management, with a lesser amount of Forest Service land since Nevada is the most arid state in the union. But again, a tremendous partnership between private interests, state agencies and federal land management agencies.

There is a tremendous number of incredibly dedicated biologists in all of those agencies who have really done the foot work. We have provided money and political support. Quite frankly, we've greased a bunch of skids.

We started off in 1981 when we had a little fund raising barbecue in a cow pasture about 20 miles south of town.

A bunch of sportsmen thought it would be neat to gather a bunch of money to fund a transplant. It's grown to our last fund raiser where we have the Governor and our U.S. Senators and so forth attend our banquets, and we make a whole bunch of money in one night. And at this point, we're averaging about \$150,000 to put back into Nevada annually.

Our Board of Directors are all private businessmen and come from all walks of life. We just have a common love of the outdoors and love of wildlife, and are very, very thankful for the opportunity to help make all of this happen.

The challenge in the next 25 years is to keep the momentum going.

We were kind of the model for all of the wildlife fund raisers for a lot of other fund raising groups. In fact, at our last fund raiser, we had a table reserved by the University of Nevada who wanted to come view our operations to see what they could learn from our fund raising because we're pretty successful at it.

We started out as being nonpolitical. We avoided any controversy like the plague. But with changing times, we realize that didn't make much difference how successful we were within a couple of decades. If we could not carry forth our programs in the future, we might as well sit around patting ourselves on the back. We weren't going to do anything in the future or do anything for the future generations.

So, as Rick indicated, we united the major sportsmen groups of the state as a coalition for Nevada's wildlife, and there were 27 sportsmen's groups in that coalition. I chair the group for Nevada Bighorns. We have hired a full-time lobbyist in the Legislature. I was in the Legislature yesterday, testifying in one assembly bill, one senate bill, and I'm there tomorrow on a bill that hopefully will remove elk from the list of alternative livestock and essentially outlaw elk ranching in the State of Nevada.

It remains to be seen whether we'll be successful in that endeavor, but it's pretty important to us philosophically that we make this attempt.

We work very closely with the agricultural groups in the state. We've come a long way there as well, and that's a necessity for the future. I was just on the phone to the president of the Nevada Cattlemen's Association discussing the elk that will be introduced by the Division of Wildlife. We'll sit down in the morning and try to work out our differences so we can provide a unified front in the legislature and the senate tomorrow.

I told you we've come a long way. At the first state convention of the Nevada Cattlemen's Association which I addressed, in 1983, I was asked to go

outside and fight, and I was about to. It was an interesting and spirited discussion. We've always tried to stress that we users of public land and the lovers of the land have a lot more in common than we will ever have differences.

We know the Nevada Wool Growers Association feels threatened. Their numbers are decreasing, particularly with the repeal of the wool subsidy on the federal level. They feel attacked on all sides. In the State of Nevada, these are awfully good people, just magnificent people.

We've bent over backwards not to hasten their demise, although we've participated in willing buyer retirement of domestic sheep allotments. We have never proposed reduction of AUMs or cancelling allotments to make room for bighorn sheep. We never will. That's now a policy in the Nevada Division of Wildlife. We want to be right, we want to be fair, and we want to perpetuate as much cooperation as we can into the future. That's a pretty good challenge here in the next couple of decades.

The agricultural community in an arid state like Nevada also feel attacked on all fronts and they're extremely defensive of domestic livestock and wildlife issues.

About a decade ago, we recognized the importance of education. We studied the statistics on American sportsmen and saw his average age increasing and increasing. I believe the average holder of a hunting license in the United States is now 44 years old.

We need to impart knowledge and love of the outdoors and wildlife to the next generation and that's difficult simply because we're becoming increasingly urbanized. It's tough to believe in the State of Nevada where 86 percent of our total area is under federal ownership, but actually Nevada is the most urbanized state in the nation in that the overwhelming percentage of our population either lives in downtown Las Vegas, downtown Reno, or the suburbs. We are a state where the populations

live in cities, and our youth have almost no exposure to wildlife and the importance of outdoors in general.

So we've embarked on a whole series of programs and some of these are just starting. A tremendous challenge for the next few decades is bringing up a generation that will carry on our work or what we're doing is all for naught. We do all sorts of youth programs. We sponsor fishing derbies, we sponsor science fairs. In fact, right now we're buying little hatcheries for elementary schools so they can incubate trout eggs, hatch them out into fry, raise them, release them into the local rivers. We give four college summer internships to Nevada high school graduates who are majoring in wildlife management.

We feel one of our challenges is the next generation of biologists. We're seeing more and more wildlife biologists who are not hunters. We feel we are the ultimate conservationists and we would like to perpetuate that versus a next generation of biologists who views hunters as the enemy.

We do newsletters. In cooperation with the Rocky Mountain Elk Foundation, we've put out a kids' magazine to every fourth grader in the state five times a year. We want our youth really appreciating the outdoors and wildlife in general.

We're heavily involved in habitat programs and those challenges. In the next few decades we really are going to see "everybody wanting a larger piece of the pie". Whether that's wilderness groups who essentially want to lock us out, the federal land management agencies' restrictions and needed approvals, etc. Eventually, challenges to our programs are going to involve a lot of time.

We're going to reintroduce animals at a healthy clip as fast as we can go. Sooner or later we'll run out of space. We'll have conflicts in areas that have domestic sheep operations. We'll run out of areas to put sheep where they haven't been for a long time. We can expand our habitat programs and

habitat programs of our sister groups, like the Fraternity of Desert Bighorn in Las Vegas.

We have had tremendous success, but sooner or later we're going to run out of space. Then the challenge is going to be disease and predation, and how do we maintain what we've got and what we've worked so hard for.

Like FNAWS, we've funded and cofunded disease studies at Washington State, Idaho, Utah, and UC Davis. A solution to the disease problem is imperative. We've got to work in that direction or we're going to hit a wall and every once in a while we're going to face disaster.

We occasionally have a mountain range that has a die-off and unfortunately, it takes a decade for it to climb back out. As we spread more and more sheep across the state that's going to be an ever increasing problem.

The State of Nevada has increased pressure on our public land. Everybody really wants a piece of it, whether it's military withdrawal of land, where we get locked out, or livestock grazing. Of course, they're defensive and they want protection. Recreation interests, the dirt bikers and the four-wheelers, often aren't entirely conducive to wildlife population growth and maintainence.

Mining is king, of course, in the State of Nevada. We've lost large areas of habitat to the open pit mines. We're the largest gold producer in the nation and the third largest gold producer of any country in the world. Those are areas where we try to work in cooperation. These people have paid tremendous mitigation monies and do wonderful habitat programs. We try to turn these into a positive for wildlife rather than lawsuit battles.

The wilderness is an issue in itself. I personally am a great proponent of wild places. But they must be administered in a sound manner. We had a Rocky Mountain sheep die-off in the Ruby Mountains in a population which was extremely dear to us. We

got them from Alberta. And guess what, they grew huge. We lost a great proportion of that population a few years ago. The Division of Wildlife was precluded from helicopter capture and blood sampling of the survivors because it was in a wilderness area.

While the intent of legislation may be admirable, by the time it gets down to the drafting of regulations, often-times that intent is completely lost and we're faced with completely unreasonable restrictions.

We're going to be faced with a similar type situation when the wilderness bill for the Bureau of Land Management comes before Congress. Right now, we have huge blocks of land that are locked off from us in wilderness study areas. They are treated in the interim as and are administered as wilderness, so there can be no guzzlers, very difficult aerial surveys result, and there are difficulties working around these areas.

One of my goals, after this Legislature is over, is to sit down with all working groups (mining, agriculture, environmentalists, wildlife groups, state and federal agencies), and try to hammer out a reasonable bill and get it passed. Let's get on with life. That's going to be one of our next challenges.

After that, I want to take on the wild horses. So you see, I'm a glutton for punishment. But it's been an absolutely magnificent run. And in conclusion, quite frankly, I'm kind of a lifer at this, as are a lot of the people I see here in the audience. Working together, I don't think there's anything we can't accomplish.

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## QUESTIONS, ANSWERS AND COMMENTS - SPEAKES/JOHNSON PRESENTATIONS

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**KEVIN HURLEY, WYOMING:** Thank you, Larry. Thank you, Leland. How we envision this next 30 to 40 minutes is for an interactive discussion. I know there are folks out there with questions. Obviously, it has to be moderated. I view it as an open discussion.

What I'm going to do is throw it open to the audience. If you have a question, even if you want to address it to somebody from one of the other groups, it's a structured free-for-all, but please identify yourself for the record. Thank you.

**DICK WEAVER, CALIFORNIA:** It's not a question, it's a comment on the speaker. If I didn't learn anything else in 40 years of government service, I learned one thing: God bless pressure groups. They are what make government move.

We public servants are relatively ineffective inside the government, so the government stands at whatever level, county on up to the federal, on dead center. They move whichever way they're pushed and God bless the pressure groups. The pressure group sometimes is one person. God bless them because they make it move.

I'm an advocate. You know, we can accomplish anything we want to if we don't care who gets the credit, and I think this is where we work together. One of our members in the Desert Bighorn Council, long deceased, said a long time ago: "We know how to manage bighorn sheep. We have to have the will." I think these people are the will.

**RACHELLE HUDDLESTON-LORTON, NEW MEXICO:** This is a comment for Larry Johnson. Wilderness areas are set up to protect certain regions from over use, and use might be considered reasonable to other groups. As wildlife managers, if we ask their activities be exempted from those regulations and that protection, don't you think that tends to open the door or set a precedent for other groups to say our use of the wilderness area is reasonable, and therefore we should be able to do what we feel is necessary?

**LARRY JOHNSON, NEVADA:** I look at my particular example of the die-off of Rocky Mountain bighorn sheep in the Ruby Mountains. We had Rocky Mountain sheep in the Rubys long before we meddled and their die-off was due to our meddling, because we have a domestic sheep operation that runs in the foothills there.

I still see no reason why other scientific studies that greatly benefited not only the resource, but the people of Nevada, could remotely damage the wilderness status of that land, particularly in light of the Forest Service managing the directly adjacent area, which permits helicopter skiing all the way to the top of the mountain range. I think all we're asking for is a degree of common sense in wilderness regulations.

**VERN BLEICH, CALIFORNIA:** What you had to say with respect to wilderness, first of all, came from the bottom of your heart, and secondly is probably as true as anything I've ever heard said about wilderness. It's problematic in many ways. Modern wilderness has been designed to provide those of us, who sociologists say we need it, the opportunity to have a Neanderthal experience in a pristine environment.

If you improve water flow in the spring, of course, the action might compromise the wilderness experience, but an F16 flying overhead won't.

I'm the biggest critic of wilderness legislation in the United States in this room. If there's somebody who is more critical I'd like to meet you. The programs that I am involved with in California have probably been impacted by wilderness designation more-so-than anybody's activities in this room.

If I can be of any help to you in an official capacity, that is, in terms of providing you with examples of the abuse, misuse and lack of common sense with respect to wilderness designations as you proceed through the legislative process regarding the wilderness study areas, I'd be more than happy to do so. I live four hours south of here in Bishop. I'll make sure that you get my name and I would be voicing my concerns as a private citizen. I think Wayne Heimer has survived as I have, and it's really good to hear the way you've approached it from a common sense approach. What you had to say will become reality if that legislation goes through as it did in California.

**DAVE SMITH, ARIZONA:** Has any chapter affiliated with FNAWS been involved with the purchase of private land holdings in bighorn habitat, or has ever worked with conservation agreements, in order to prevent these lands from being developed? That's a real concern we have with the Black Mountains. I'm sure we're not unique as far as everybody wanting their 40-acre ranch in the west now. That's a real threat. We're looking at northwestern Arizona now.

**LELAND SPEAKES, MISSISSIPPI:** We don't participate in any ownership of property. We've been quite active in acquiring domestic sheep allotments. Some of the chapters, in Utah I would say, have acquired land. They are familiar with conservation easements, things like that. We have, in Montana, recently put a piece of bighorn winter range under conservation easement. Yes, some of our chapters have been very active in land acquisition, but I don't think any of them take ownership of it. We have helped other people to acquire land, and buying a piece of prime property and putting a conservation easement on it so it never can be developed is one of the things we're definitely interested in doing.

**HURLEY:** Larry, do you have an additional comment?

**JOHNSON:** I probably do. We've facilitated land acquisition. First of all, like Leland said, we're not interested in owning land, although we had many thousands of acres donated to us through the state planning effort. We have facilitated acquisition of prime properties, particularly the Massacre Ranch in Northern Washoe County. It wound up as a federal land exchange when the purchase price was in excess of the appraised value. The federal exchange could not go through because of the difference in costs. We essentially stepped in and made up the difference in asking price allowing the purchase to go forward. The land winds up in federal ownership, our money goes to the seller and everybody walks away happy. We have a willing-seller, willing-buyer type of relationship.

**HERB MEYR, IDAHO:** We've worked with The Nature Conservancy on a recent project on the Owyhee River in southern Idaho not too far away from here. Fund raising worked out pretty well. We ended up buying the base property, 240 acres, which controlled about 190,000 acres of BLM allotment. They're still running cattle on it, but we have a conservation committee trying to demonstrate that we can manage cattle and wildlife all on the same property. That's worked out pretty well so far.

Also, in an area near Sun Valley, the Silver Creek Area, The Nature Conservancy bought the easements and have a conservation agreement with the ranchers so the lands won't be developed in the future. The big thing is being able to avoid the inheritance problems and their being able to give it to their relatives in the future.

**HURLEY:** As I mentioned, I'm on the board of Wyoming FNAWS. We're a small chapter, but we have spent money not on ownership but in helping to facilitate easements and acquisitions with The Nature Conservancy, the Jackson Hole Land Trust, or some equivalent land trust alliance.

**AMY FISHER, NEW MEXICO:** Leland, I understand that the process of reviewing the grant-in-aid applications has been a daunting task. You have hundreds of proposals and they're reviewed by all the chapters and a technical board of three or four biologists.

Would it be helpful to review that whole system again, to help FNAWS choose the best long-term type projects, to improve the status of sheep nationwide?

**SPEAKES:** I don't think there would be any doubt, the more you fine-tuned, the better you would be able to do it.

**HURLEY:** I would carry it one step further. During the review process, each chapter gets to look at funding requests, each of the national board members gets to review requests and give their input, and the three individuals who are on the technical review committee provide their input to the board.

I'm wondering how much impact that has, compared with preconceived ideas on the board's part: "I know what we're going to fund, we'll look at this, but we still know what we want to fund."

**SPEAKES:** This year we had 60 grant-in-aid applications; they were right at 60 applications for various sized grants. Total grant requests were nearly \$700,000. Well, that is way in excess of the money that we have and it's usually that way. We put first priority on projects that put sheep on the mountain.

Now, we've had each state chapter, each affiliate, these technical advisors Kevin mentioned, plus the 11 directors go over these applications and they have rated them. Yes, the affect of the advisors that we have is very, very important. We take each project individually and we discuss it, we look at the comments that the advisors have given us there, and then we make our decision.

**HURLEY:** Again, Larry and Herb and some of the other groups that are represented, do you have the same kind of outside review on submitted projects? What sort of review process do your organizations have?

**SPEAKES:** Our chapters are all invited to our grant-in-aid meeting, and when they see a project, they volunteer either to fund the project or participate in it and they've already had their little pow-wow back home and they say: "Boy, we like this or we like that."

**JOHNSON:** We have probably a little bit less formal grant request process. Everything from NDOW is requested to come through the state office through the Chief of Game, and that's so we don't get conflicts within the division itself as far as who gets what. And we're advised from NDOW as to priorities they would like to see first on a statewide basis.

We're kind of inundated with funding requests at board meetings every month, and we approve projects on a monthly basis. In fact, sometimes we even approve projects in between our board meetings on the basis of a simple phone poll if there is an emergency request that is deemed an actual emergency.

We're pretty mobile because we don't have the organization that FNAWS does, and so we receive funding requests on a monthly basis and act on them immediately.

For those that require scientific review, we request it through the NDOW, and, in fact, we oftentimes have NDOW representation at our board meetings, so that we can analyze the technical merit of any individual request.

**WAYNE HEIMER, ALASKA:** I'd like to speak about the grant-in-aid proposals. I've been on the technical review board for three years and I won't be doing it anymore, because I'm now on the Board. The impression I have from three years of reviewing requests is that the process with National FNAWS could use some refinement.

FNAWS started out as a very grass roots, downhome business and has done a wonderful job. We all appreciate that, and are pleased to be associated with it in every way. However, as a reviewer of grants, I'm afraid I have to tell you that most of the grants that come in are marginal in preparation, many times marginal in thought.

It's perceived that FNAWS has a vast pot of money and any time there is a vast pot of money available to human beings, every human artifice will be employed to obtain part of that money. There's just an amazing array of requests that come in, many times several from a single state that don't seem to hang together in any particular coordinated effort.

One of the things which has troubled me most about the projects that I have reviewed is that the FNAWS protocol calls for somebody from a management agency to sign off on the application, and there's always a signature in that part on the application. I think it is understood that this implies some assent or participation on the part of the management agencies. Many times that simply isn't so. You need a signature. You get somebody to sign it. I've applied for FNAWS grants, sometimes successfully. I've employed every human artifice there is thinking I had the right way to go as well. But to those of you that who will be writing grants, I think you need to take the Foundation for North American Wild Sheep much more seriously than has become traditional or has become common practice. There are excellent proposals that are well-backgrounded and there are many that aren't.

It's depressing as a sheep biologist to look through 60 proposals and find eight that you think are red-hot, eight that you would say don't go near being adequate and the rest are somewhere in the middle.

It takes a lot of time on the part of the reviewers and the board, and many proposals simply don't have biological, technical or management merit or are inconsistent with the goals FNAWS has established.

So my encouragement to you as grant writers and hopeful grant recipients is to take this business a lot more seriously, particularly when you coordinate with the management agency who will be receiving or participating in spending the money, because that is something that has been very casual in the three years that I've looked at them.

**HURLEY:** For those of you who aren't aware, Wayne's just been elected to the FNAWS Board. He'll be reviewing project requests but in a different capacity.

Ted, you worked your way up from Iowa FNAWS to the national board, and being a nonsheep state, how does Iowa FNAWS sift good requests from the bad ones?

**TED SCHUTTE, IOWA:** That's right. I came from the Iowa ranks and now I'm on the national board and let me just say that as a board member from Iowa, when I was president of the Iowa chapter, we looked at what the experts said. We basically didn't have any idea on the state chapter level what these projects were. So basically speaking from the state chapter level, I think that they put 50 percent of their faith and their ideas in the opinions of the FNAWS technical reviewers.

Let me say one more thing. A lot of the chapters, and I give them credit, are the growing parts of the Foundation for North American Wild Sheep. All of them are holding better and bigger conventions. They're making more money. I've seen this going to a lot of those conventions as a representative of FNAWS. Those people out in Iowa, Minnesota, Wisconsin, eastern states, have money. They don't have any wild sheep, but that group, all of those groups in those nonsheep states, I'm telling you, have money and they want to put it towards wild sheep.

So we are counting on them, as Leland mentioned, to come to us at National and help us with our grant-in-aids. That is to help us in funding a lot of these projects, and I think that they will be very major players. I think about FNAWS chapters in states like Idaho, Wyoming, and Oregon. They've got wild sheep in their states, so they tend to spend money on their projects within the state. This is very good, and we need that. But don't forget those chapters back east. They could help you out and they're going to be helping us out. As far as the expertise of the people back there, they don't know much about the wild sheep, the biology end. They will go by the recommendations we give them as a board of what we have determined through the recommendations by the experts.

**HURLEY:** Matt, do you have anything you want to add from Alaska FNAWS, now that you're on the national board?

**MATT WOLFE, ALASKA:** In Alaska, we don't have many sheep problems, and our populations are in fairly good shape. We find that a lot of requests that come out of Alaska are for subsistence problems, and we're fighting a huge battle helping some of the organizations. Alaska Professional Hunters Association, for example. We help them work with the Forest Service to try to implement regulations. We were successful with Fish and Wildlife Service and National Park Service. The unique thing also in Alaska is that with the money the Alaska tag brings at auction, there's a joint committee, two members from Alaska chapter FNAWS and two from the Alaska Fish and Game that look at and spend that money for sheep, I think it's very encouraging.

**HURLEY:** Clint, we haven't heard from the Fraternity of the Desert Bighorn.

**CLINT BENTLEY, NEVADA:** Our board meets to see who we're going to talk to to help fund our projects. We are the workers. We put projects on the mountain to help put the sheep on the mountain. We will be installing our 99th and 100th project in ten days on the weekend of the 17th and 18th. We're coming to a point, as Larry said, where we don't have a lot of projects left to do. We have a handful left, but we're beginning to close in on all the areas that require or are going to require water for the future. We're going to have an extensive maintenance project that we'll be on from that point forward.

We do have one brain child that they'll definitely be trying to work on. At this point, we have a large tract of land that basically doesn't have any interruptions that it would be an ideal desert bighorn recovery area. We don't know how exactly to attack trying to get this going. It's going to require federal, it's going to require state, it's going to require all other conservation groups and help from these management people. We would like to get this area managed exclusively by the state instead of the federal government.

**DALE TOWELL, IDAHO:** I'd like to add a few perspectives from being involved in the process. Beginning in 1985, FNAWS asked me to co-chair and put together a committee to look at how grant-in-aid monies could be expended. I've been involved more or less continuously since that time. There are a couple of things to remember, a couple of things I've learned in the process. Number one, proposals flow to money like water flows down hill.

Wayne put it succinctly that there's always more people to spend money than there is money to go around. So when you review a proposal, what should you look for? What you see depends on where you see it. Where we sit as biologists, we want to see the money put out on the ground to benefit the sheep in our state or province. That's as it should be, but that's not always the best use of those funds.

As Dick Weaver said, it's also important that funds be expended judiciously to make politicians move, to make decisions happen, and that's a difficult issue for me as a biologist to provide real, significant input to. I can provide input based on where I sit, but so can board members who are not biologists.

The second thing is that it's very difficult to evaluate multiple proposals from individual states or provinces that are totally unconnected and totally unprioritized. It's easy to get a signature, it's difficult to make tough choices, and if the states and provinces don't make tough choices, the committee has to, sometimes right, sometimes wrong. Depending on what we know about the proposals and so forth.

So when I evaluate a proposal lacking other kinds of information, I look for partners. If you've got a good project, don't ask for nominal funding, fund the whole thing. If you've got one where you can't find partners, there may be a reason for it. Not always, but things to keep in mind.

**JIM BAILEY, NEW MEXICO:** My view on proposals for national FNAWS covers ten years. I've been happy with it, enough said about that.

I would like to comment about the main goal being putting sheep on the mountain. I think that has merit, however, at times it's shortsighted. Ten years ago and maybe looking at the next 25 years, it's perhaps even more shortsighted. There's a tendency not to fund research. Maybe that can be justified a little bit, but I think it's shortsighted. There's a tendency not to fund evaluation of the success of projects that FNAWS has funded, which I think is very shortsighted, and there's a tendency not to fund educational issues.

The comment was made that we'd like to see the day that biologists make all the decisions. I used to think that way, too, but I've been in a different job for the last few years. I sure don't think that way any more. I think that's wishful thinking. The public is demanding more and more public outreach and explanation, and we're going to have to develop more and more published reports for what we need to do. I think education is a very important issue and will be in the next 25 years. We will be needing financial support for wild sheep education projects.

**MICHELLE BOURASSA, SOUTH DAKOTA:** To what extent is FNAWS willing to support the continued introduction and management of bighorn sheep into historical range if it will result in a nonhunting population?

**SPEAKES:** Our opinion, or our idea, is that is not the most positive thing. We like to think if we're going to relocate sheep into an area, they should be hunting, eventually. However, we have done some transplants in areas that were not hunting. An example, on the Flathead Indian Reservation in Montana, we funded a transplant request from the Tribe. They wouldn't give us any sheep to hunt, but they wanted to transplant some sheep into other areas of their land up there, and we financed that. We would do that occasionally, but if we have a choice between a hunting population or nonhunting population, we would take the hunting.

**HURLEY:** In Wyoming, both national FNAWS and Wyoming FNAWS have supported reintroduction for non-hunted, nonconsumptive sheep ranges. To me, that's the best ammunition against an antihunter argument. We know we're not going to hunt them, but we're still willing to put our effort and dollars into getting the sheep out.

**SPEAKES:** Let me say, we are the Foundation for North American Wild Sheep. We're not the Foundation for North American Wild Sheep Hunters.

**BLEICH:** Leland, thank you for the contributions in California for populations that aren't hunted, may not be hunted, but might be hunted someday. We appreciate the efforts.

With respect to the statements earlier about putting sheep on the mountain, I would urge you to maybe think about the urgency or the critical nature of rephrasing that and saying "We want to keep sheep on the mountain." I think that's what Jim Bailey and others have been alluding to. Putting sheep on the mountain is great, but if you can't keep them there after putting them there, we are in for real trouble.

**SPEAKES:** I would say that if you looked at the ledger, we probably spent more money on research and education than we do on transplants.

**MIKE DUNBAR, OREGON:** You say that disease is the number one priority over the next several years, and that you'll probably be funding those projects, I appreciate that. I've been there.

**SPEAKES:** Right. I definitely think that we will. It will be a prime thing. It's been a prime thing for us here. We like to brag about some of the good things we do. When you had a die-off in Hell's Canyon, we got a call from the guys out there who said we've got all these sheep out here that are sick. They were getting ready to shoot them. We said, wait a minute, let's not do that. Let's capture them and take them and see if we can save the sheep.

We helicopter netgunned 75 sheep, transported them to Caldwell, Idaho, and had them in a pen alive. We tried our very best to treat them. It was unsuccessful. But as a result of that, we had blood, tissue, and swabs. We had more data to use to analyze the cause. Karen Rudolph is our molecular biologist, and she is going through every sample that we have. She's looking for the cause and cure of *Pasteurella*. She's looking for a gene. It's over my head what all she's doing, but she is doing some great things, and we captured the sheep in hopes we would save more sheep. We didn't, but we're getting a benefit from it.

**DUNBAR:** I was the biologist that did the original studies on *Pasteurella*. One of the greatest obstacles in working with disease in bighorn sheep is not having the opportunity for a lot of people in the field to have the ability to work on captured sheep. We have three or four places in the United States it's being done. Those are political because it's under different state ownership and those sheep projects come and go depending upon funding. Would FNAWS ever consider establishing a captive wild sheep situation somewhere in the United States, so these different people could have an unlimited ability, especially as it relates to disease?

**SPEAKES:** My answer as an individual is, "Yes", although I can't speak for the rest of the board. We are not going to feed them. Somebody else would have to take care of them, but I wouldn't mind financial support, but somebody else would have to care for these sheep.

**DUNBAR:** Some other independent group, such as FNAWS with an established committee that oversees projects and funding, would oversee projects working on the sheep, and it could be funded by FNAWS.

**SPEAKES:** I think FNAWS would definitely be interested in that.

**RAUL VALDEZ, NEW MEXICO:** The next great frontier in wild sheep management is putting sheep on private lands. Wildlife biologists have been very narrow-minded, nearsighted, downright resistant to that notion. Why shouldn't we transplant wild sheep onto private lands? I bring this up as something to discuss and something that really needs an urgent discussion.

**JOHNSON:** We've had a controversy here in Nevada for the past decade over whether we wanted to donate desert bighorn sheep to Texas that would end up on private land, and it's kind of an emotional issue for a state in which 86 percent of the total land is federal.

One of the problems in putting bighorn sheep on private land is proper conservation easements to make sure that rancher or his successor, isn't going to allow domestic sheep on that same ranch to cause a disease problem that could spread from range to range and have really widespread detrimental effects.

The Nevada Division of Wildlife has tried to ask the state of Texas for landowner agreements that would allow public access during hunting season, for instance, for a certain percentage of any tags, but it is very difficult on private land. Owners of large holdings don't want to give up what they feel are their private property rights. I think that is the reason there is a reluctance to put wild sheep on private lands. Again, that doesn't mean it can't be done and it can't be done successfully, but it's got to be done very carefully.

**HUDDLESTON-LORTON:** There are Rocky Mountain sheep on private land in southwestern New Mexico. It's very successful. The sheep were not introduced there. They moved there on their own. In the relationship that I, as a researcher, have with the landowner, I feel that they're excited. They're open to being educated to some of the issues, like diseases, like fences, interaction with cattle, water sources and other things.

I think this goes back to what Jim Bailey was saying, education is not just for those of us in the university setting, but everyone who is old enough to walk. Three-year-olds, four-year-olds, anybody you can reach and educate, whether it's a landowner or a child or anybody else, we have a responsibility to reach out and help those people understand what the issues are. As sheep people, we're not just about wild sheep management, but the land issues.

**HURLEY:** According to my mental map, most of the states and provinces have at least one wild sheep advocacy group; there are some states and provinces which do not. In Oregon, FNAWS is a brand-new chapter, formed within the last six months.

**JON JORGENSEN, ALBERTA:** Currently, we don't have any sheep advocacy group. Our auction generates funds for the Rocky Mountain Elk Foundation to administer, and those funds currently are not specifically identified as having to go towards sheep projects. They can go towards any wildlife projects. They tend to go mostly towards elk projects, but there are some sheep projects. We don't have a FNAWS chapter at all.

**HURLEY:** I know there's a strong relationship with Minnesota/Wisconsin FNAWS in North Dakota. Has there been any discussion about trying to getting something going in South Dakota?

**BOURASSA:** Not to my knowledge.

**JEAN CAREY, YUKON:** We don't have any advocacy groups specifically for sheep. We haven't had real sheep problems to work with, but there are certainly members of FNAWS living there.

Alasdair Veitch from NWT is not here. I don't think we have anybody here from the Northwest Territories. Perhaps they don't need an advocacy group yet; maybe in time they will.

**HEIMER:** I believe at the last Northern Council meeting, I alienated almost everyone. It's time for me to take that opportunity here. I'm as grateful as anybody and perhaps more appreciative than some for the work that special interest groups do. Those of you who work as agency biologists, particularly state agencies, assume advocacy groups are necessary. However, when you depend on advocacy groups for funding, ideas, or pressures, it's because you haven't done your job as managers.

It may be to the credit of those who don't have local advocacy groups that they're doing their job. I infer from what Dick Weaver said that the reason special advocacy groups arise is because the government, the people in charge of the public trust and management of everybody's property, are not pleasing the people that they're working for, and when that happens, somebody has got to make the move, and as Dick said, "God bless you."

**KEVIN CHURCH, NEBRASKA:** I'm not a sheep biologist, but in Nebraska I play with them. I had a chance a couple years ago to do a study of attitudes of state and federal biologists towards non-governmental organizations (NGOs) pertaining to upland game birds. What we found when we queried biologists regarding the contributions that advocates could make, there were four areas where biologists thought there were contributions. One obviously is management, which can be similar to translocation efforts, research, education and political action. Invariably, the biologists felt that political action was probably the most valuable service NGOs provided. They also felt research was underfunded and management was overfunded in terms of how the dollars were spent. Education was also an area requiring greater emphasis. I don't know how it relates to the sheep, but I think it's probably very similar.

**HURLEY:** We're drawing right up on 5:00 o'clock; we should wrap it up. I guess the way I look at it in any marriage, any long-term marriage, there are rocky spots. I think anybody who has been married for 25 years or more is hopefully happy, and wants to stay together. I see some real issues that need to be addressed. But I also see a very solid foundation. We've had 25 years growth in this network of wild sheep advocacy groups, and I just hope the relationship continues to strengthen. Thanks to everybody for participating.



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## HABITAT PROBLEMS AND HUMAN DISTURBANCE

CHAIR: JIM BAILEY, NEW MEXICO DEPARTMENT OF GAME AND FISH

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### GUY WAGNER - ACTIVITY PATTERNS OF ROCKY MOUNTAIN BIGHORN EWES IN CENTRAL IDAHO

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**Abstract:** Changes in Rocky Mountain bighorn ewe activity patterns were observed in response to season, forage quality, and weather in the Big Creek drainage of central Idaho. The study population was relatively undisturbed by modern development or agriculture, and thus the activity data provides a baseline for similar studies of bighorn populations inhabiting areas with greater human disturbance. Ewes were equipped with motion-sensitive collars and monitored by automated remote telemetry and direct observation from 1994-1997. Bighorn ewes reduced activity during winter when forage resources were of low quality, and increased activity during spring and early summer. Ewes were most active during daylight hours, but during mid- and late-winter nocturnal activity increased. Within days, activity patterns were strongly bimodal during mid-winter, but exhibited several activity peaks during seasons with greater day-length. Ewes moved an average distance of 3.6 km/day during mid-winter, and 4.6 km/day throughout the remainder of the year. Ewes increased activity levels during the third trimester of gestation and while lactating. During this period of nutritional stress, they moved frequently while seeking high quality grasses and forbs. Managers should minimize disturbance of bighorn bands during winter, and ensure that human disturbance does not limit access to habitat providing important sources of nutrients during late gestation and lactation.

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Activity patterns may reveal how animals deal with changing environmental influences and nutrient sources. Furthermore, estimation of energy requirements necessitates a knowledge of activity patterns. Such knowledge may explain foraging strategies and trophic dynamics. Knowledge of activity patterns may also help managers plan aerial surveys to coincide with time periods when animals are most active and visible, and delineate seasons and daily time periods when animals are most vulnerable to human disturbance.

Bighorn sheep (*Ovis canadensis canadensis*) activity patterns have been studied by Mills (1937), Davis (1938), Blood (1963), Woolf et al. (1970), Geist (1971), Van Dyke (1978), Eccles (1978, 1983), Stemp (1983), Belovsky and Slade (1986), Goodson et al. (1991), and Sayre and Seabloom (1994). Most authors reported from 2-4

daily activity peaks. Geist (1971) noted activity peaks were closer to mid-day in winter months compared to summer, presumably, in response to higher temperatures. Smith (1954) observed the daily activities of bighorn sheep on our study area. He found bighorns generally lacked a strict routine, but usually bedded following morning and mid-day feeding bouts. Weather nor season influenced activity patterns, except during periods of deep snow, when bighorns spent more time feeding, because they were forced to paw through snow to obtain adequate forage.

We collected activity data on adult ewes at lower elevations throughout the year, and constructed seasonal time budgets. We used these data to examine the hypotheses that bighorn ewes altered time budgets to adapt to changes in season, forage, day-length, and environmental variables. In addi-

tion, activity-time budgets were used to construct models of energy expenditure and intake (Wagner 1999).

Due to its isolation in the heart of the largest wilderness in the lower 48 states, the study population is relatively undisturbed by modern development or agriculture. Only the older male segment of the population is hunted (6 permits/year). Therefore, the activity data provides a useful baseline for studies of other bighorn populations in areas more impacted by human developments and habitat changes.

**STUDY AREA:** Big Creek flowed predominantly west to east through the Frank Church River of No Return Wilderness, and drained into the Middle Fork of the Salmon River. Elevations within the drainage ranged from 3500 feet to 9500 feet, and contained some of the greatest relief in Idaho. Southern exposures comprised most of the terrain on the north side of Big Creek. This area served as important winter range to bighorn sheep, mule deer (*Odocoileus hemionus*), and elk (*Cervus elaphus*). Snow depths were generally low and southern aspects usually remained snow-free for much of the winter. Bighorn sheep occupied mainly the lower 12 miles of this range.

Topography at lower elevations was characterized by steep V-shaped canyons. Abrupt changes in aspect resulted in markedly different plant associations. Southern exposures at lower elevations, where soil development was adequate, were dominated by grasslands. Soils were formed from granitic Idaho batholith parent material (Claar 1973), and were generally shallow and rocky. Numerous rock outcrops, cliffs, and talus slopes were present.

Bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), junegrass (*Koeleria cristata*), needle and thread grass (*Stipa comata*), Sandberg's bluegrass (*Poa sandbergii*), and cheat grass (*Bromus tectorum*) comprised the majority of graminoid biomass. Big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus nauseosus*), and bitterbrush

(*Purshia tridentata*) were important shrub species associated with grasslands. Curl-leaf mountain mahogany (*Cercocarpus ledifolius*) formed extensive stands on steep rocky outcrops. Arrowleaf balsamroot (*Balsamorhiza sagittata*), Western yarrow (*Achillea millefolium*), and lupine (*Lupinus* spp.) were important forbs. Douglas-fir forests (*Pseudotsuga menziesii*) were encountered on north aspects and ridgetops. Small stands and individual Douglas-fir were also scattered throughout the grasslands.

Summers were typically hot and dry with maximum July temperatures averaging 35°C. The majority of precipitation fell from late fall through spring in the form of snow. However the lower elevations of the winter range received periodic rain even in mid-winter. Annual precipitation averaged 38.1 cm.

**METHODS: Remote Telemetry.** Automated remote telemetry systems were used to study the activity patterns of red deer (*Cervus elaphus* L.) in Germany (Georgii 1981), moose (*Alces alces*) in Alaska (Risenhoover 1986; Miquelle 1990, Miquelle et al. 1992; MacCracken 1992), mule deer (*Odocoileus hemionus*) in California (Kie et al. 1991), black-tailed deer (*O. hemionus columbianus*) in British Columbia (Gillingham and Bunnell 1985), and white-tailed deer in Michigan (Beier and McCullough 1988). Automated remote telemetry systems enabled researchers to continuously monitor several animals, and record nocturnal behavior.

**System Description:** Nine ewes were captured using a dart gun and collared with Telonics radio-transmitters containing motion-sensitive tip switches. Signals were received from radio-collared animals by a Telonics TR-2 receiver using a Telonics RA-10 Omni-directional antenna, relayed to a Telonics TDP-2 digital processor, and recorded on a Gulton Rustrak (Manchester, New Hampshire) dual-channel strip-chart recorder. Three systems were placed in separate 30 gallon plastic coolers for protection. Chart speed was set at 12.7 cm/hr (5 inches/hour).

**Chart Interpretation:** During operation, 2 lines were recorded: for signal strength and for motion/behavior changes. Motion/behavior lines reflected changes in pulse rate determined by the animal's head position. A lowered head position produced a faster pulse rate than a raised position. Different behaviors recorded different patterns. Experience in chart interpretation was obtained by simultaneously observing the behavior of transmitting ewes and watching data being recorded. Variations in signal strength aided interpretation of the pulse rate line. Both beginning and ending times were marked on the chart paper, and intermediate times were also marked whenever a unit was checked. Upon retrieving a chart, the interpreter placed tick marks at changes in behavior and, then measured the time between changes. Focal animals were monitored continuously up to 6 days, the time between battery and chart paper changes. If possible, monitored animals were selected randomly, but selection was frequently determined by signal strength.

The validity of activity data collected by remote means was questioned by Gillingham and Bunnell (1985). However, other authors have rated their system accuracy at > 90% (Van Ballenberghe and Miquelle 1990). Our system accuracy was dependent upon the degree of behavioral detail selected for sampling. The finer the behavioral detail desired the less certain the estimates. We distinguished active from inactive behavior, and within the inactive category, separated bedded (lying with head up) from sleeping (lying with head down). Other behaviors were measured by direct observation. The accuracy of remote telemetry data interpretation was checked by comparing strip-chart data to information recorded independently in field notes. Eighty-one individual observations from the strip-chart were randomly selected and the interpreted behavior verified from direct observations. Accuracy was expressed as the percentage of correct classifications.

**Direct Observations:** Within active and inactive bouts randomly selected focal animals were observed with 16 x 80 binoculars from 100 to 500 m distance, and their behaviors recorded for 15 min

using a cassette recorder. Later the cassette was replayed and behaviors timed using a stopwatch. Total time spent in each behavioral category was converted to a percentage of the 15 minute observation. Categories included feeding, pawing through snow or gravel, moving, chewing cropped vegetation with head erect, standing alert and/or alarmed, and interacting socially. Feeding was defined as actually biting vegetation. During an observation, individual movements and total distance moved were estimated in meters. During inactive bouts, times spent ruminating and sleeping were estimated by similar observations, except 3 ewes were monitored simultaneously.

**Environmental Variables:** Hourly weather data was collected by an automated meteorological station located at the base of the winter range. Each hour the station's Campbell Scientific CR10 datalogger (Campbell Scientific; Logan, Ut.) recorded maximum wind speed, wind vector, average wind speed, temperature, humidity, solar energy, precipitation, and barometric pressure.

**Data Analysis:** Based upon the annual reproductive cycle of bighorn ewes and plant phenology a year was divided into 5 periods. Summer or period 1 (1 June to 16 August) corresponded to peak lamb drop and lactation, and availability of early summer forage. Late-summer-fall or period 2 (17 August to 15 November) corresponded to decreased lactation, gradual senescence of most herbaceous forage, possible fall resprouting of some grass species, and beginning of fall weather. Winter or period 3 (16 November to February 15) corresponded to mid-winter conditions of frequent snowfall, relatively low temperatures, senescent forage, and mating. Late-winter or period 4 (February 16 to 31 March) corresponded to approximately the second trimester of gestation, and earliest green-up of some grasses. Spring green-up or period 5 (1 April to 31 May) corresponded to the third trimester of gestation, green-up of all forages, and eventually movement to lambing ranges.

For remote telemetry data a sample unit was defined as 24 hr of continuous data collection on

a radio-collared ewe. Due to migrations, deaths, and an irregular capture schedule, it was impossible to use a balanced factorial design that included all animals to test for differences among animals and years. Therefore, these differences were examined with separate t-tests or 1-way analysis of variance (ANOVA). The null hypothesis that no period differences existed in mean minutes engaged in a behavioral category within a 24 hr day was tested with multivariate analysis of variance (MANOVA). Also, mean minutes active, mean bout-length, and mean number of bouts within daylight, night, dusk, and dawn, were tested with separate MANOVA's with period as the main effect. Dusk and dawn were defined as 1 hr before and after morning and evening civil twilight. Civil twilight was defined by the U.S. Naval Observatory, Astronomical Applications Department as beginning or ending when the center of the sun was geometrically 6 degrees below the horizon. Separate univariate ANOVA's for each behavioral category, mean min active per day-part, bout-length, and number of bouts were conducted with period as the main effect. Means were separated with Duncan's multiple range test. A graphical analysis of the mean number of minutes active during each hour of the day was conducted separately for each period. Direct observation data was analyzed using a G-factor test of homogeneity (Sokal and Rohlf 1981, Ott 1993).

Distance moved each 24 hr was estimated by randomly choosing individual distance movements from the direct observation data. These distances were averaged and multiplied by the average number of movements per minute producing an estimate of meters moved per active minute. This rate was then multiplied by the number of active minutes in a 24 hr period obtained from Rustrak recordings. The null hypothesis that no differences existed between periods in mean distance moved/24 hr was tested by ANOVA, and means were separated using Duncan's multiple range tests.

A second method of estimating distance traveled/24 hr was used as a check. When possible, ewes were directly observed for an entire activity

bout. The average distance moved/bout was then multiplied times the number of bouts determined from Rustrak recordings. The estimates of distance moved during a 24 hr day obtained by the 2 methods were compared within periods using t-tests.

Moonlight's effect on the activity patterns of big-horn ewes was examined by regressing minutes active at night on the fraction of the moon illuminated obtained from tables supplied by the U.S. Naval Observatory. A linear regression was conducted for each period, and for the period July 14 to Oct. 11, 1994. This period was chosen because nights were known to be cloudless.

The effects of environmental variables on bighorn ewe behavior were assessed by developing a multiple regression model with minutes active each hour as the dependent variable and weather data serving as the independent variables. Four model-selection methods were used: forward selection, backward elimination, stepwise selection, and maximum  $R^2$  improvement as defined in the SAS/STAT Guide for Personal Computers (SAS Institute; Cary, NC 1987). Independent variables were examined for multicollinearity, and the dependent variable was examined for autocorrelation using the Durbin-Watson statistic. An additional regressor consisting of the dependent variable from the previous time step was added to the model to address autocorrelation (Myers 1990).

All statistical tests were conducted at the  $\alpha = 0.05$  level of significance, except the significance level for entry into the multiple regression model was set at  $\alpha = 0.15$ .

**RESULTS:** A total of 6,504 hours (271 sample units) of activity data on 9 ewes were collected by remote telemetry from 1994 to 1997. Ewes frequently moved behind rock outcrops or across ridges interrupting signal reception. Fragments of data less than 24 hr were not included in the analysis. System accuracy was estimated to be 84%. Behaviors where sheep held heads erect for relatively long periods, such as stand alert, moving, feeding on shrubs, or feeding uphill on steep

slopes were occasionally misinterpreted as inactive-bedded behavior.

No significant differences in behavior existed among years or animals, except during summer 1994. One adult ewe was more active than other radio-collared ewes, this was also apparent from direct observation. However, by fall 1994, her activity patterns were no longer distinct.

The amount of time bighorn ewes spent in different behaviors (active, inactive, bedded, and sleeping) during a 24 hr day differed among periods (MANOVA, Wilks' lambda  $P = 0.019$ ). Ewes were significantly less active and spent more time bedded and inactive during winter than during other periods (ANOVA,  $P = 0.001$ ). The amount of time ewes slept did not differ between periods (ANOVA,  $P = 0.334$ ) (Table 1).

Ewe activity varied between periods when the 24 hr day was divided into daylight, night, dusk, and dawn (MANOVA,  $P = 0.001$  Wilks' lambda). Ewes spent more time active in daylight hours during summer and spring green-up, than during winter (ANOVA,  $P = 0.001$ ). During dawn hours, ewes were most active during late summer-fall and late winter, and least active during winter and spring green-up (ANOVA,  $P = 0.0145$ ). The amount of time ewes were active at night did not differ significantly between periods (ANOVA,  $P = 0.052$ ), although ewes tended to be more active at night during late winter. At dusk, ewe activity did not differ between periods (ANOVA,  $P = 0.5870$ ) (Table 2).

Average bout length differed between periods (MANOVA, Wilks' lambda = 0.011). Night foraging bouts were longer in winter and late winter than during summer (ANOVA,  $P = 0.025$ ) (Table 3).

Average number of active bouts differed between periods (MANOVA, Wilks' lambda = 0.001). During a 24 hr day, the number of active bouts were significantly lower during winter (ANOVA,  $P = 0.014$ ). Ewes tended to have few night feeding bouts during summer and spring green-up, when

daylight was longest, and also during winter. However, during late winter ewes tended to increase the number of nocturnal feeding bouts (Table 4).

Ewe activity generally followed a bimodal pattern through a 24 hr day (Figures 1 - 5). However, during summer, ewes were more active throughout the day and the bimodal pattern, although present, was not as evident. During late summer-fall and winter, the first peak in activity occurred shortly after dawn, followed by a decline in activity at mid-day; then activity increased to a second peak before dusk. As day-length increased during late winter and spring green-up, ewes had several feeding bouts late in the day interspersed with bedding. During all periods, the majority of activity occurred during daylight hours. Generally, lowest levels of activity occurred immediately preceding the morning feeding bout, and following dusk activity peaks.

Within individual active bouts, frequencies of behaviors based on direct observation did not vary significantly among periods ( $G = 27.807$ , d. f. = 20). On average, ewes spent 53% of time feeding, 12% moving, 14% head-up and chewing, 17% at stand alert, 1% pawing, and 3% socializing. Ewes tended to spend more time moving and alert and less time feeding when lambs were present, and tended to spend a greater portion of an active bout feeding during winter. While inactive, ewes ruminated an average of 65% of the time during all periods.

Bighorn ewes covered an average of 4804, 4494, 3558, 4722, and 4548 m/24 hr day for periods 1,2,3,4, and 5, respectively; and traveled an average of 474 m/active bout. Ewes moved significantly less distance during winter (ANOVA,  $P = 0.001$ ,  $N = 60$ ).

During late summer-fall, winter, late winter, and spring green-up bighorn ewes were not significantly more active at night when a greater portion of the moon was visible. Ewes were apparently influenced by lunar phase during summer ( $P = 0.001$ ,  $R^2 = 0.497$ ) (Fig. 6).

Hourly meteorological station data was matched to 3,355 hours of activity data collected by remote telemetry. Environmental variables generally did not greatly influence the hourly activity patterns of resident bighorn ewes ( $R^2 = 0.1125$ ). Adding number of minutes active the previous hour as an additional independent variable (to address autocorrelation) increased  $R^2$  to 0.3584. Solar energy and average wind speed were positively correlated with minutes active per hour ( $r = 0.29$  and  $r = 0.27$ , respectively). Other environmental variables were not included in the model.

**DISCUSSION:** Reduced bighorn ewe activity during winter was consistent with the well documented seasonal cycle of northern ruminant energy metabolism (Silver et al. 1969, 1971; McEwan and Whitehead 1970; Thompson et al. 1973; Holter et al. 1975; McEwan 1975; Weiner 1977). Captive bighorns have demonstrated seasonal changes in metabolism, with resting metabolic rates (RMR) lowest in February and highest in May (Chappel and Hudson 1978, 1980). California bighorns (*O. c. californiana*) in British Columbia spent fewer daylight minutes feeding during winter than at other seasons (Eccles 1983). Declines in basal metabolism, activity, and body weight, plus voluntary restriction of food intake have been considered adaptations for dealing with winter's period of decreased temperatures, less than optimum forage conditions, and increased snow depth (Parker et al. 1993). Risenhoover (1986) argued that reduced forage quality and patterns of forage distribution, rather than snow conditions or food scarcity, mainly cause ungulates to reduce activity levels. Seasonal changes in ewe activity paralleled trends in the crude protein and energy content of important forage species (Wagner 1999). Winter forage, higher in fiber and less digestible, may have slowed passage rate and required more rumination time to reduce particle size sufficiently to permit passage into the omasum (Van Soest 1982, Robbins 1993). Total amount of time ewes spent bedded increased during winter, consequently, absolute amount of time spent ruminating increased. Moose in Alaska ruminated an average of 67% of time spent bedded in winter (Risenhoover 1986), compared to 65% for ewes in our study. In

winter, ewes evidently maximized the amount of nutrition obtained while active and minimized the proportion of time spent in behaviors that did not acquire food. Movements not associated with acquiring food were uncommon for moose during winter (Risenhoover 1986).

With the onset of spring and improved forage quality, ewes increased activity levels and distance traveled per day reflecting an increase in metabolic rate and nutritional requirements for gestation and lactation. Ewes possibly moved greater distances while searching for the most nutritious forage (Warrick 1985). Predator avoidance may have also contributed to the increased distance traveled each day. Similar increases in activity and metabolic rate have been observed in desert bighorns (Alderman et al. 1989), red deer (Georgii 1981), moose (Risenhoover 1986, Regelin et al. 1985, Van Ballenberghe and Miquelle 1990), and white-tailed deer (Silver et al. 1969, 1971; Thompson et al. 1973; Holter et al. 1975). Bighorn sheep in Montana were active 773 min/24 hr day during summer (Belovsky and Slade 1986) compared to 677 min/24 hr day in our study. In general, ewes did not increase bout length during the day, but increased forage intake by increasing the number of daily feeding bouts. With improved forage digestibility and consequent increased passage rates, ewes may have maintained gut fill by feeding more frequently. Increased foraging during summer and fall may be necessary to prepare northern ruminants for the rigors of winter, making foraging an important activity, even though food may be highly abundant (Van Ballenberghe and Miquelle 1990). In British Columbia, captive bighorns averaged 5 diurnal activity peaks (Eccles 1978), where studies of wild bighorns averaged 2 to 3 daily activity peaks in summer (Davis 1938, Van Dyke 1978, Sayre and Seabloom 1994). Geist (1971) and Hoefs (1974) reported Stone's sheep (*Ovis dalli stonei*) and Dall's sheep (*O. d. dalli*), respectively, averaged 4 activity peaks during summer with fewer activity peaks during mid-winter.

Dividing the 24 hr day into daylight, night, dusk, and dawn showed that following parturition, ewes

tended to be less active at night compared to winter or late winter. Ewes may have reduced nocturnal activity to protect lambs (Alderman et al. 1989). The small amount of nocturnal activity observed in summer could be attributed to the regular repositioning of ewes between beds (Sayre and Seabloom 1994, Woolf 1970). The duration of nocturnal activity bouts during winter and late winter suggested actual feeding bouts occurred. Ruminants may need to feed nocturnally during seasons with shortened daylight, because periodic food intake is necessary to keep the digestive system operating (Balch 1955, Welch 1969). Red deer (Georgii 1981) and moose (Risenhoover 1986) were more active at night during late winter and early spring compared to summer. Similar to ewes in Big Creek, bighorn ewes in North Dakota were more active at dusk than dawn (Sayre and Seabloom 1994).

The reasons lunar phase should influence activity during summer and not other periods were unclear. Small sample sizes during this period may account for an apparent relationship. Elk nocturnal activity patterns in Utah were not affected by lunar phases (Collins et al. 1978).

Sunlight, represented by solar energy in the model, and average wind speed were the 2 environmental variables that were related to bighorn ewe activity patterns. Bighorn sheep rely primarily on vision to detect predators (Geist 1971), and may have minimized the amount of activity during darkness to reduce vulnerability to predators. Graphical analysis of hourly activity averages also showed the majority of activity occurred during daylight. Direct observations of bighorns on windy days indicated a heightened alertness or nervousness. Elk in Utah were more nervous on windy days (Collins et al. 1978), however, Bowyer (1981) reported a lack of correlation between elk activity and wind speed, temperature, or humidity in California.

Other variables, such as temperature, humidity, atmospheric pressure, precipitation, and wind direction, apparently did not greatly influence bighorn ewe activity. Previous studies have re-

ported desert bighorns reduced movement during periods of high temperature (Alderman et al. 1989, Simmons 1969, Welch 1969, McCutchen 1984, and Krausman et al. 1985). Rocky mountain bighorn ewes in North Dakota did not alter activity patterns significantly at temperatures >23 C (Sayre and Seabloom 1994). However, Stemp (1983) demonstrated using heart-rate monitors that bighorn sheep were stressed physiologically by temperatures above or below the seasonal thermoneutral zone. Bighorn ewes in Big Creek responded to high temperatures by seeking shade, similar to ewes in North Dakota (Sayre and Seabloom 1994). The physiological stress of high or low temperatures as indicated by increased heart-rates, panting, shade- and shelter-seeking, and postural adjustments may not be reflected in activity patterns recorded by changes in head position.

The form of precipitation may influence bighorn ewe activity more than the absolute amount. Following deep snowfall events bighorns remained inactive for extended periods of time in British Columbia (Eccles 1978). Snowfall may reduce the availability of certain forages, and even small amounts may negatively affect foraging efficiency and diet quality (Goodson et al. 1991), thus slowing passage rates and altering activity patterns.

Rocky Mountain bighorns may adjust their daily feeding and ruminating cycles to optimally fit seasonal forage conditions. Possibly, the physiological state and reproductive condition of bighorn ewes, as well as social interactions, may produce greater influences on activity patterns, and obscure the effects of environmental variables on an hourly scale.

**MANAGEMENT IMPLICATIONS:** Activity patterns of bighorn ewes can be interpreted on annual and daily temporal scales. Annually ewes adapt to the stress of winter by reducing activity levels. Consequently, human disturbances that force ewes to increase their activity levels during midwinter may increase energy requirements at a time when ewes may be operating at a negative energy balance. Likewise, following parturition

nursing ewes are faced with the energetic demands of lactation, possibly before they have completely recovered from winter. They appear to search out the most nutritious grasses and forbs. Human disturbance should also be limited at this time of year to avoid stressing lactating ewes and preventing access to important nutritional sources.

Ewes were the least active shortly before daylight, and after the morning and evening feeding bouts. Since ewes typically bed in or near escape terrain, human disturbances may have less impact during these hours. Mid-day, when ewes bed following the morning feeding bout, would be the most appropriate time to allow human disturbance. Aerial censuses scheduled opposite bedded periods may observe ewes while they are usually foraging in more open areas.

If bighorns adopt feeding-ruminating cycles that optimally fit seasonal forage conditions, then disturbances may disrupt these patterns. Bighorn ewes must have evolved to deal with occasional disruptions. However, if frequent disturbances prevent ewes from following adaptive feeding-ruminating cycles, then ewes may decline in body condition over time. Repeated disturbances may lower survival and fecundity, even though the tangible effects may be delayed to future seasons or years. Managers should allow bighorns a chance to recover from periods of repeated disturbance.

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#### LITERATURE CITED

- Alderman, J.A., P.R. Krausman, B.D. Leopold. 1989. Diel activity of female desert bighorn sheep in western Arizona. *J. Wildl. Manage.* 53:264-271.
- Balch, C.C. 1955. Sleep in ruminants. *Nature* 175:940-941.
- Belovsky, G.E., and J.B. Slade. 1986. Time budgets of grassland herbivores: body size similarities. *Oecologia* 70:53-62.
- Bier, P., and D.R. McCullough. 1988. Motion-sensitive radio collars for estimating white-tailed deer activity. *J. Wildl. Manage.* 52:1-13.
- Blood, D.A. 1963. Some aspects of behavior of a bighorn herd. *Can. Field-Natur.* 77(2):77-94.
- Bowyer, R.T. 1981. Activity, movement, and distribution of Roosevelt elk during the rut. *J. Mamm.* 62(3):574-582.
- Chappel, R.W., and R.J. Hudson. 1978. Winter bioenergetics of Rocky Mountain bighorn sheep. *Can. J. Zool.* 56:2388-2393.
- \_\_\_\_\_, and \_\_\_\_\_. 1980. Prediction of energy expenditures by Rocky Mountain bighorn sheep. *Can. J. Zool.* 58:1908-1912.
- Claar, J.J. 1973. Correlation of ungulate food habits and winter range conditions in the Idaho Primitive Area. M.S. Thesis. Univ. of Idaho, Moscow, ID. 85 pp.
- Collins, W.B., P.J. Urness, and D.D. Austin. 1978. Elk diets and activities on different lodgepole pine habitat segments. *J. Wildl. Manage.* 42:799-810.
- Davis, W.B. 1938. Summer activity of mountain sheep in Mt. Washburn, Yellowstone National Park. *J. Mammal.* 19:88-94.
- Eccles, T.R. 1978. Activity patterns of captive California bighorn sheep (*Ovis canadensis californiana*) at Penticon, B.C. *Bienn. Symp. North. Wild Sheep and Goat Council.* 1:274-292.

- \_\_\_\_\_. 1983. Aspects of social organization and diurnal activity patterns of California bighorn sheep. Fish and Wildlife Report ISBN 0701-581X, no.R-8. British Columbia Ministry of Environment. Victoria, B.C. 71 pp.
- Geist, V. 1971. Mountain sheep: A study in behavior and evolution. The Univ. of Chicago Press, Chicago, IL. 383 pp.
- Georgii, B. 1981. Activity patterns of female red deer (*Cervus elaphus L.*) in the Alps. *Oecologia* 49:127-136.
- Gillingham, M.P., and F.L. Bunnell. 1985. Reliability of motion-sensitive collars for estimating activity for black-tailed deer. *J. Wildl. Manage.* 49:951-958.
- Goodson, N.J., D.R. Stevens, and J.A. Bailey. 1991. Effects of snow on foraging ecology and nutrition of bighorn sheep. *J. Wildl. Manage.* 55:214-222.
- Hoefs, M. 1974. Food selection by Dall's sheep (*Ovis dalli dalli* Nelson) IUCN Pub. 24 2:759-786.
- Holter, J.B., W.E. Urban, H.H. Hayes, H. Silver, and H.R. Skutt. 1975. Ambient temperature effects of physiological traits of white-tailed deer. *Can. J. Zool.* 53:679-685.
- Kie, J.G., C.J. Evans, E.R. Loft, and J.W. Menke. 1991. Foraging behavior by mule deer: the influence of cattle grazing. *J. Wildl. Manage.* 55:665-674.
- Krausman, P.R., S. Torres, L.L. Ordway, J.J. Herver, and M. Brown. 1985. Diel activity of ewes in the Little Harquahala Mountains, Arizona. Desert Bighorn Counc. Trans. 29:24-26.
- MacCracken, J.G. 1992. Ecology of moose in the Copper River Delta, Alaska. Ph.D. Diss., Univ. of Idaho, Moscow, ID. 386 pp.
- McCutchen, H.E. 1984. Summer activity patterns of free-ranging desert bighorns, Zion National Park, Utah. Desert Bighorn Counc. Trans. 28:9-11.
- McEwan, E.H., and P.E. Whitehead. 1970. Seasonal changes in the energy and nitrogen intake in reindeer and caribou. *Can. J. Zool.* 48:905-913.
- \_\_\_\_\_. 1975. The adaptive significance of the growth patterns in cervid compared with other ungulate species. *Zool. Zh.* 54:1221-1232.
- Mills, H.B. 1937. A preliminary study of the bighorn of Yellowstone National Park. *J. Mammal.* 18(2):205-212.
- Miquelle, D.G. 1990. Behavioral ecology of moose in Denali National Park and Preserve, Alaska. Ph.D. Diss., Univ. of Idaho, Moscow, ID. 141 pp.
- \_\_\_\_\_, J.M. Peek, and V. Van Ballenberghe 1992. Sexual segregation in Alaskan moose. *Wildl. Monogr.* 122:1-57.
- Myers, R.H. 1990. Classical and modern regression with applications. Second ed. PWS-KENT Publ. Co. Boston, MA.
- Ott, R.L. 1993. An introduction to statistical methods and data analysis. Fourth ed. Duxbury Press, Belmont, CA. 1051 pp.
- Parker, K.L., M.P. Gillingham, T.A. Hanley, and C.T. Robbins. 1993. Seasonal patterns in body mass, body composition, and water transfer rates of free-ranging and captive black-tailed deer (*Odocoileus hemionus sitkensis*) in Alaska. *Can. J. Zool.* 71:1397-1404.
- Regelin, W.L., C.C. Schwartz, and A.W. Franzmann. 1985. Seasonal energy metabolism of adult moose. *J. Wildl. Manage.* 49:388-393.
- Robbins, C.T. 1993. Wildlife feeding and nutrition. Second ed. Academic Press, New York, NY. 352 pp.

- Risenhoover, K.L. 1986. Winter-activity patterns of moose in interior Alaska. *J. Wildl. Manage.* 50:727-734.
- Sayre, R.W., and R.W. Seabloom. 1994. Summer activity patterns of bighorn ewes in the northern Great Plains. *Bien. Symp. North. Wild Sheep and Goat Counc.* 9:104-109.
- Silver, H.H., J.B. Holter, N.F. Colovos, and H.H. Hayes. 1969. Fasting metabolism of white-tailed deer. *J. Wildl. Manage.* 33:490-498.
- \_\_\_\_\_. 1971. Effect of falling temperature on heat production in fasting white-tailed deer. *J. Wildl. Manage.* 35:37-46.
- Simmons, N.M. 1969. Heat stress and bighorn behavior in the Cabeza Prieta Game Range, Arizona Desert Bighorn Counc. *Trans.* 13:55-63.
- Smith, D.R. 1954. The bighorn sheep in Idaho, its status, life history and management. Idaho Fish and Game Dept. *Wildl. Bull.* 1. 154 pp.
- Sokal, R.R., and F.J. Rohlf. 1981. *Biometry*. Second ed. W.H. Freeman and Co., New York, NY. 859 pp.
- Stemp, R. 1983. Heart-rate responses of bighorn sheep to environmental factors and harassment. M.S. Thesis. Univ. of Calgary, AB. 313 pp.
- Thompson, G.B., J.B. Holter, H.H. Hayes, H. Silver, and W.E. Urban. 1973. Nutrition of white-tailed deer I. Energy requirements of fawns. *J. Wildl. Manage.* 37:301-311.
- Van Ballenberghe, V., and D.G. Miquelle. 1990. Activity of moose during summer in interior Alaska. *J. Wildl. Manage.* 54:391-396.
- Van Dyke, W.A. 1978. Population characteristics and habitat utilization of bighorn sheep, Steens Mountain, Oregon. M.S. Thesis. Oregon State University. Corvallis, OR. 87 pp.
- Van Soest, P.J. 1982. *Nutritional ecology of the ruminant*. O&B Books Inc., Corvallis, OR. 374 pp.
- Wagner, G.D. 1999 (In press). Diet selection, activity patterns, and bioenergetics of bighorn ewes in central Idaho. Ph.D. Thesis, Univ. of Idaho, Moscow, ID.
- Warrick, G.D. 1985. Mountain sheep foraging behavior. M.S. Thesis, Univ. of Arizona, Tucson, AZ. 28 pp.
- Weiner, J. 1977. Energy metabolism of the roe deer. *Acta. Theriol.* 22:3-24.
- Welch, R.D. 1969. Behavioral patterns of desert bighorn sheep in south-central New Mexico. *Desert Bighorn Counc. Trans.* 13:114-129.
- Wolf, A., T. O'Shea, and D.L. Gilbert. 1970. Movements and behavior of bighorn sheep on summer ranges in Yellowstone Park. *J. Wildl. Manage.* 34:446-450.

Table 1 Average minutes/24 hour day bighorn ewes engaged in active, inactive, bedded, and sleeping behaviors from 1994-1997 at Big Creek, Idaho.

Period <sup>a</sup>	Active	SE	Inactive	SE	Bedded	SE	Sleeping	SE
1	677.50A <sup>b</sup>	41.82	762.50A	41.82	732.65A	42.43	23.45A	3.83
2	633.75A	38.06	806.25A	38.06	790.40A	37.01	21.45A	7.22
3	501.75B	25.13	938.25B	25.13	918.10B	27.42	15.10A	4.94
4	665.90A	25.07	774.10A	25.07	744.00A	22.96	26.00A	6.81
5	641.45A	26.34	798.55A	26.34	733.75A	26.65	17.35A	4.41

<sup>a</sup>Period 1 = 1 June to 15 Aug., period 2 = 16 Aug. to 15 Nov., period 3 = 16 Nov. to 15 Feb., period 4 = 16 Feb. to 31 March, period 5 = April 1 to May 31.

<sup>b</sup>Means with the same letters are not different (ANOVA,  $\alpha = 0.05$ ).

Table 2 Average minutes bighorn ewes were active during daylight, night, dusk, and dawn at Big Creek, Idaho 1994-1997.

Period <sup>a</sup>	Daylight	SE	Night	SE	Dusk	SE	Dawn	SE
1	528.55A <sup>b</sup>	27.89	47.70A	10.44	61.85A	9.54	39.40A	7.78
2	416.80B	31.57	85.60A	19.57	60.20A	8.90	54.95AB	7.18
3	333.55C	15.29	93.30A	17.63	64.75A	8.87	22.25AC	5.24
4	434.15B	24.36	121.95A	23.74	60.00A	9.26	49.60ABD	9.38
5	481.55AB	23.23	54.45A	11.08	78.05A	8.20	29.70ACD	7.22

<sup>a</sup>Period 1 = 1 June to 15 Aug., period 2 = 16 Aug. to 15 Nov., period 3 = 16 Nov. to 15 Feb., period 4 = 16 Feb. to 31 March, period 5 = April 1 to May 31.

<sup>b</sup>Means with the same letters are not different (ANOVA,  $\alpha = 0.05$ ).

Table 3 Average activity bout length (min) of bighorn ewes from Big Creek, Idaho 1994-1997.

Period <sup>a</sup>	Full Day	SE	Daylight	SE	Night	SE	Dusk	SE	Dawn	SE
1	87.82A <sup>b</sup>	10.91	94.99A	9.05	15.49A	3.99	58.67A	9.84	35.93A	7.83
2	77.09A	7.41	101.09A	12.53	23.65AC	6.23	52.96A	9.42	52.30A	7.31
3	91.13A	8.63	93.91A	9.87	52.22BC	11.82	61.68A	8.94	22.60A	5.16
4	91.60A	11.38	129.12A	9.89	32.48BC	4.78	47.14A	8.81	42.81A	9.18
5	112.49A	14.01	108.27A	11.55	26.12AC	5.34	71.58A	8.49	26.78A	6.40

<sup>a</sup>Period 1 = 1 June to 15 Aug., period 2 = 16 Aug. to 15 Nov., period 3 = 16 Nov. to 15 Feb., period 4 = 16 Feb. to 31 March, period 5 = April 1 to May 31.

<sup>b</sup>Means with the same letters are not different (ANOVA,  $\alpha = 0.05$ ).

Table 4 Average number of activity bouts for bighorn ewes in Big Creek, Idaho 1994-1997.

Period <sup>a</sup>	Full day	SE	Daylight	SE	Night	SE	Dusk	SE	Dawn	SE
1	9.80A <sup>b</sup>	1.11	6.30A	0.47	2.75ABC	0.58	0.95A	0.15	1.00A	0.16
2	9.00A	1.11	4.65B	0.31	3.35ABC	0.49	1.30A	0.16	1.00A	0.10
3	6.20B	0.52	4.15B	0.34	1.75AC	0.25	0.90A	0.12	0.65A	0.11
4	9.20A	1.00	4.35B	0.41	3.65ABC	0.46	1.30A	0.21	1.30A	0.18
5	7.20A	0.74	5.15A	0.40	2.20AB	0.38	1.10A	0.10	0.75A	0.14

<sup>a</sup>Period 1 = 1 June to 15 Aug., period 2 = 16 Aug. to 15 Nov., period 3 = 16 Nov. to 15 Feb., period 4 = 16 Feb. to 31 March, period 5 = April 1 to May 31.

<sup>b</sup>Means with the same letters are not different (ANOVA,  $\alpha = 0.05$ ).

Figure 1: Period 1 (June 1- Aug. 15) average minutes active each hour for bighorn ewes from Big Creek, Idaho (1994-1997)

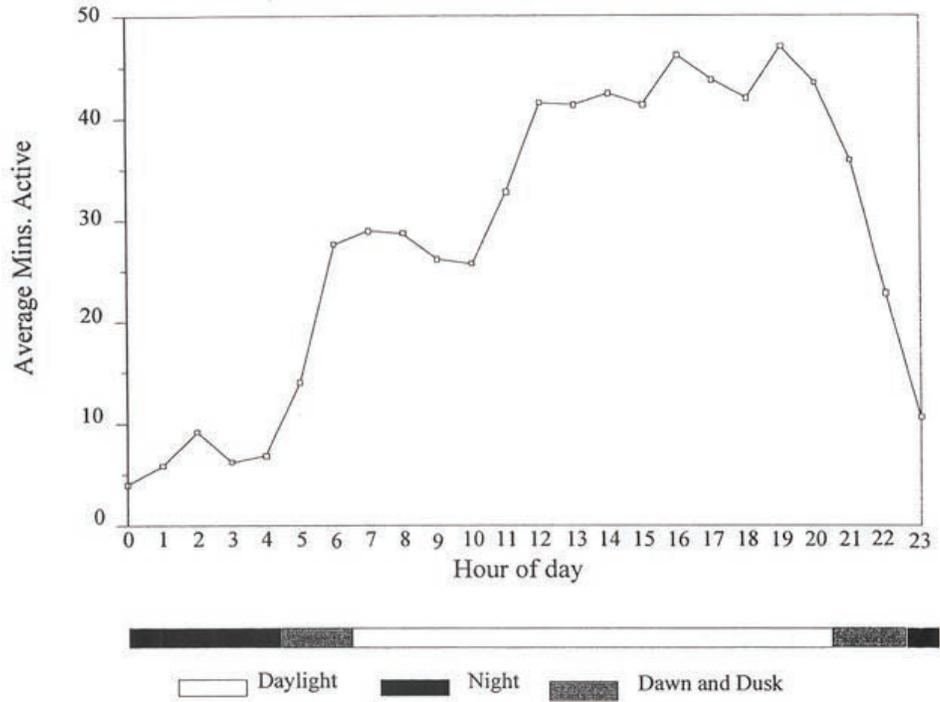


Figure 2: Period 2 (Aug. 16 - Nov. 30) average minutes active each hour for bighorn ewes from Big Creek, Idaho (1994-1997)

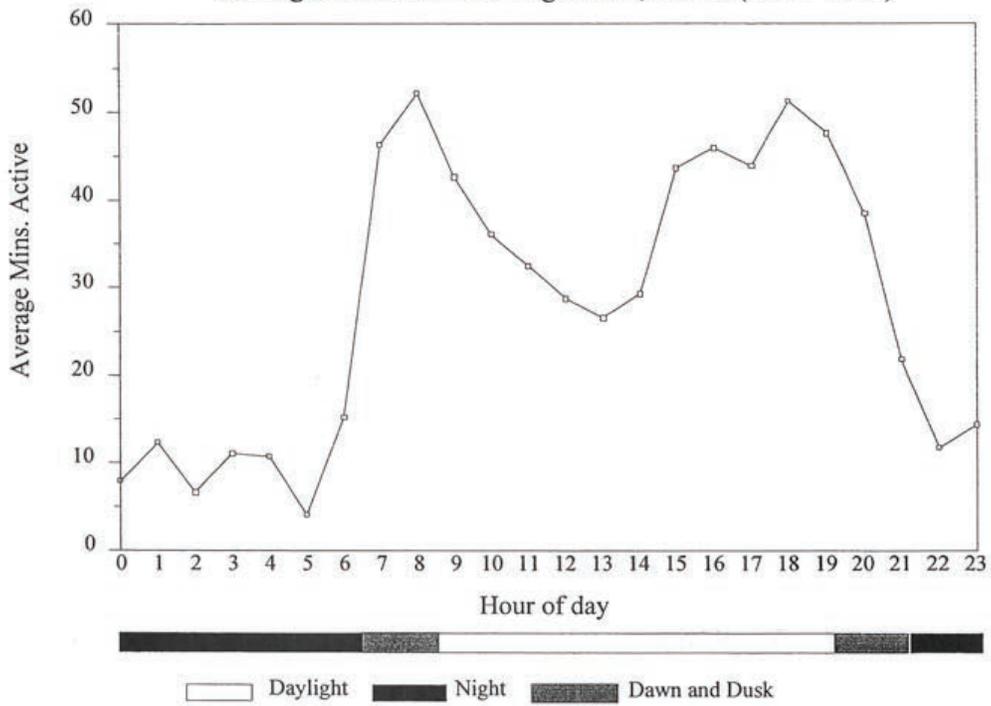


Figure 3: Period 3 (Dec. 1 - Feb. 15) average minutes active each hour for bighorn ewes from Big Creek, Idaho (1994-1997)

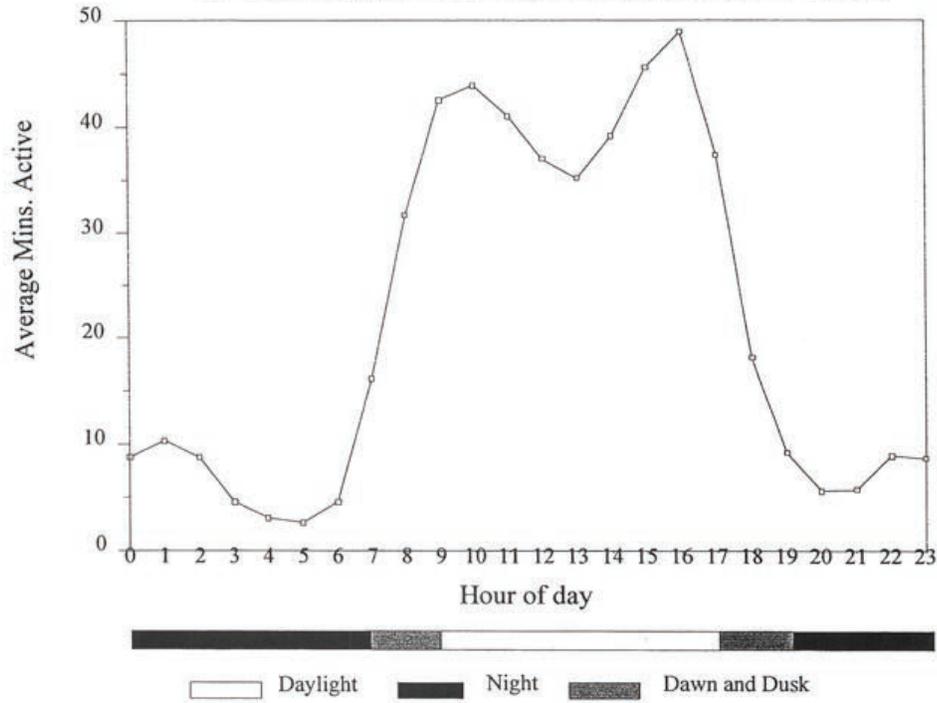


Figure 4: Period 4 (Feb. 16 - March 31) average minutes active each hour for bighorn ewes from Big Creek, Idaho (1994-1997)

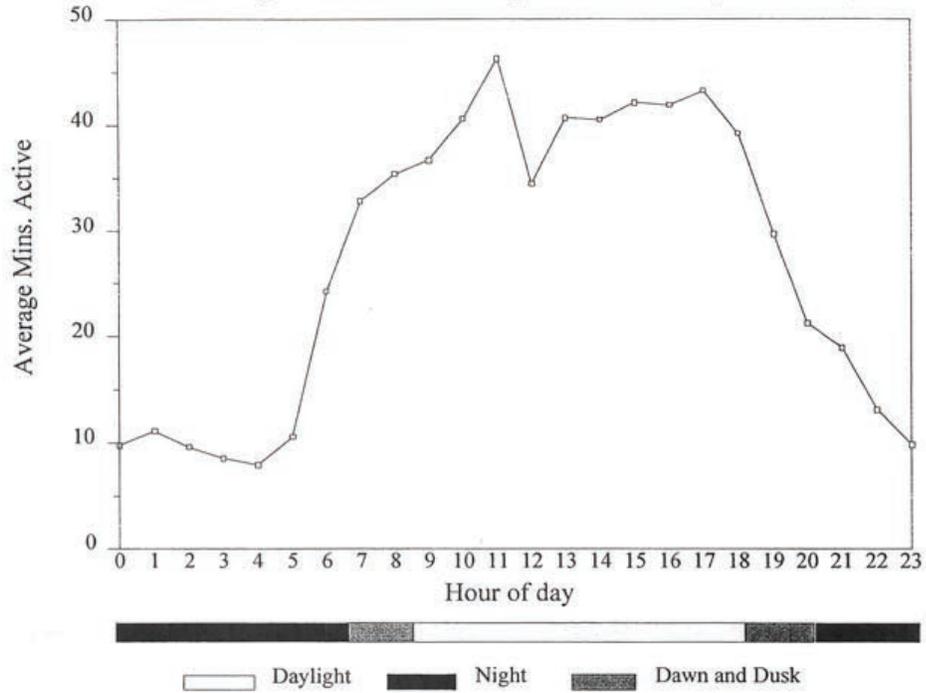


Figure 5: Period 5 (April 1 - May 31) average minutes active each hour for bighorn ewes from Big Creek, Idaho (1994-1997)

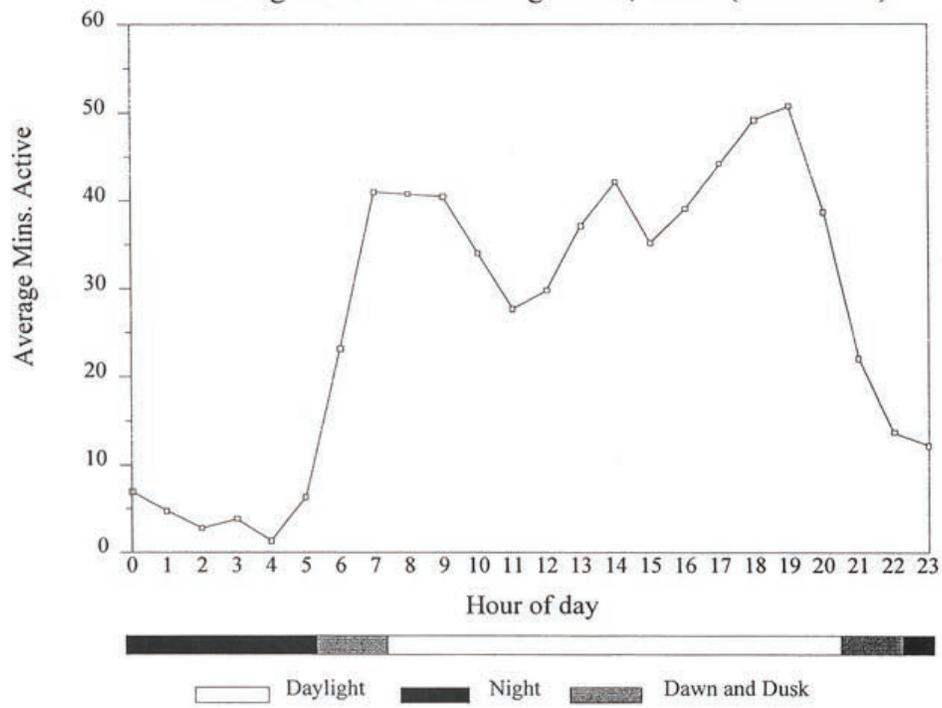
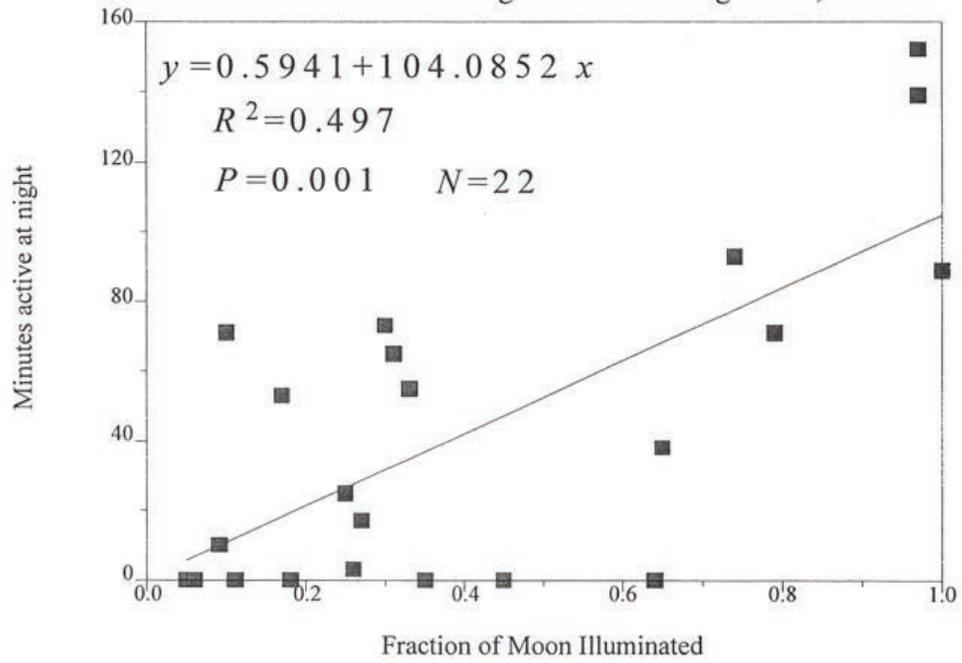


Figure 6: Period 1 (June 1 to Aug. 15) minutes active at night predicted by fraction of Moon illuminated for bighorn ewes in Big Creek, Idaho 1994-97



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## QUESTIONS, ANSWERS AND COMMENTS - GUY WAGNER PRESENTATION

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**DALE TOWEILL, IDAHO:** I noticed in your activity diagram you showed increased pawing behavior in late summer and early fall. Would that selection be for thermal relief bedding sites with the ewes pawing down to wet soil or do they select for shade?

**GUY WAGNER:** They always kind of paw out a place to bed. But most of the diagramed pawing behavior was pawing for tubers and roots. At that time of year, certain favorite forages would cure out, including the thistles. The leaves would cure out and the ewes would dig for the roots, also biscuitroot, *Lomatium dissectum*. They would dig whenever they could for biscuitroot, especially in mid-winter if the ground wasn't frozen too hard. Ewes would get on the gravel beds where the talus wasn't quite so large in diameter and spend a lot of time pawing up the tubers.

**TOWEILL:** The pawing should be attributed to the feeding behavior rather than the bedding behavior?

**WAGNER:** Correct.



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## NIKE GOODSON - EFFECTS OF RIVER-BASED RECREATION AND LIVESTOCK GRAZING ON DESERT BIGHORN SHEEP ON THE NAVAJO NATION

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**Abstract:** During the first 2 years of study of a desert bighorn sheep (*Ovis canadensis nelsoni*) population on the Navajo Nation, responses of bighorn sheep to changes in management of river-based recreation and livestock grazing were investigated. Rapid growth of the bighorn sheep population coincided with above-average precipitation and abundant forage production, providing evidence that the bighorn population was limited by forage availability. Forage availability was related to precipitation, livestock competition, and (to a lesser extent) conflicts with humans in areas of the river corridor used frequently for camping. Conflicts between boaters and bighorn sheep were reduced following implementation of regulations that eliminated dogs accompanying people and that closed areas of important habitat to camping. Heavy cattle grazing reduced available forage at feeding sites used by bighorn sheep; and bighorn sheep used areas less after they were grazed heavily by cattle. A decline in numbers of horses on the mesa top adjacent to the primary bighorn sheep range was followed by an increase in use of the mesa top by the sheep. These shifts in distribution indicated that bighorn sheep responded to changes in forage availability within their range. A lack of mountain lions and few coyotes on the bighorn range may have contributed to the ability of the bighorn herd to increase rapidly in response to increased forage availability.

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Many factors influence the ability of desert bighorn sheep populations to persist in environments altered by human activities. Among the most important of these are human recreation and livestock grazing both of which are prevalent on bighorn ranges. Relatively few studies have addressed effects of either factor on bighorn populations, and even fewer have reported bighorn responses to changes in recreation management or livestock grazing. During a study of population dynamics and ecology of an indigenous desert bighorn population on the Navajo Nation we collected data on impacts of river-based human recreation and livestock grazing on the bighorn herd. We also monitored responses of bighorn sheep to changes in cattle grazing and recreation management.

Our study was initiated by the Navajo Nation Department of Fish and Wildlife. The objective was to discover information necessary to conserve

and enhance a native desert bighorn sheep population inhabiting the San Juan River Canyon on the Navajo Nation in southeast Utah. We present evidence that the population is limited by forage resources, depends on the San Juan River for water, and relies on the riparian zone along the river for green forage during late spring and summer. We report effects of human recreation on bighorn access to the river and effects of livestock grazing on forage availability and bighorn distribution. We also report findings on two other potential limiting factors: illegal hunting, and disease.

**STUDY AREA AND METHODS:** We are studying a native desert bighorn sheep population that inhabits the upper San Juan River Canyon in southeast Utah (Fig. 1), and is isolated from other bighorn sheep populations. The bighorn use only the south side of the river canyon which lies entirely within the Navajo Nation. The area is a cold desert. From late spring through summer high

temperatures range from 95 - 115°F. Winters can be mild or severe. Temperatures may drop below 0°F, and snow cover may persist for weeks. Average annual precipitation is 15 - 23 cm (6 - 9 in). Precipitation is extremely variable from month to month and year to year.

Ten ewes and seven rams were radio-collared during a drop-net capture operation by Helicopter Wildlife Management. We visually located radio-collared bighorn using telemetry tracking equipment approximately once per week year-round. For each observation we recorded location, group size and sex- and age-composition, marked bighorn present, habitat utilization, and movements. We recorded interactions of bighorn sheep with humans and livestock, and mapped observations of livestock on the bighorn range. We recorded vehicle traffic off established roads and on gated roads in the study area. We noted possible signs of sinusitis including persistent sneezing, head-shaking and eye and horn abnormalities, as well as signs that could indicate other health problems.

When we began observations, 10 of 13 ewes aged 3 years or older and 7 of 8 rams aged 3 years or older were radio-collared. Because of the high proportion of radio-collared individuals, we were able to estimate the total population by observing radio-collared individuals and counting and classifying their unmarked companions. We estimated mortality of lambs and yearlings by observing all radio-collared bighorn sheep within a few days when no marked bighorn moved between groups. We counted and classified their unmarked companions, and compared unduplicated counts of lambs and yearlings in succeeding weeks to estimate mortality in each age class. Radio-collared ewes were closely observed during the lambing season to determine if and when each lambed. In most cases, ewes were observed alone with their lambs before they rejoined other bighorn sheep.

Forage biomass available to bighorn sheep was measured at foraging sites which were sampled during late winter and spring, 1998. Foraging sites were located wherever it was possible to observe ewe groups feeding. At each site, available shrub

biomass was estimated by counting leaders of shrubs by species and weighing a sample of each. Biomass of forbs and grasses was estimated by clipping. Shrub biomass was estimated and forbs were clipped in 5 to 6 2-meter square plots per site, and grasses were clipped in 5 1-meter square plots per site.

**RESULTS: Population Growth:** Our study began in January 1997 following a 9 - year period of below-normal precipitation and a serious drought in 1996. Heavy cattle grazing occurred on most of the river corridor throughout the bighorn range during the summers of 1994 and 1995. The first year of the study (1997) was an El Nino year with abundant winter, spring and late-summer-fall precipitation. The desert responded with abundant growth of annual and perennial forbs and grasses.

There were 31 bighorn sheep in the population, including 13 ewes 3 years or older, and 3 2-year-old ewes. Lamb production was excellent in 1997. All healthy ewes 3 years and older (one ewe with sinusitis did not lamb) and 2 of 3 2-year-old ewes produced lambs. One set of twins was born. Precipitation was near normal and lamb production was good in 1998. Eleven of 15 ewes age 3 or older and 1 of 4 2 - year - old ewes produced lambs. No twin lambs were born in 1998.

Survival of lambs and yearlings was excellent both years. Fourteen lambs were born in 1997 and 10 lambs survived through winter. All were still alive in early April 1999. In 1998, 12 lambs were born and 10 survived. The 10 lambs born in 1998 were still alive in early April 1999.

We documented mortalities due to natural causes (one ewe died in lamb birth, a ram fell off a cliff, a second ram died of an unspecified infection possibly related to an injury). Human-related mortalities included one ram that was killed by an illegal hunter and a ewe that died from sinusitis (a disease believed to be introduced from domestic sheep and the incidence of which is related to proximity to domestic sheep; Bunch et al. 1978, Jessup 1985).

In the 2 years since the study began, the population grew from 31 to 47 bighorn sheep, a 52% increase. The greater percentage increase (26%) occurred in 1997 apparently in response to above-normal precipitation, abundant forage production and reduced competition from cattle. The population continued to increase in 1998 although the rate of growth (20%) declined coincident with a return to normal precipitation and increased cattle grazing on the bighorn range.

**Impacts of River-based Recreation:** The San Juan River is the only permanent year-round water source on the bighorn range. The bighorn access the river to drink at a limited number of areas where they have good visibility, protection of nearby cliffs, and secure footing. The number of areas that bighorn access the river to drink is most limited for lactating ewes with young lambs.

Bighorn clearly preferred areas near the river in summer. During July through September 1998, only 4 locations of 130 visual locations of bighorn groups were >1 km from the river. Two of these observations were of a single ram and 2 were of ewe-juvenile groups. During July through September we saw ewe-juvenile groups drinking at the river 18 times. We observed bighorn groups within 30 m of the river 30 times. The same radio-collared ewes were observed drinking on consecutive days twice (August 6 and 7, and August 23 and 24). Tracks at the river's edge and visual observations indicated that groups including lactating radio-collared ewes drank on successive days on three more occasions. Bighorn usually drank and fed on vegetation in the riparian zone when they were near the river. It was clear that the river attracted bighorn because it provided water and riparian vegetation remained green after upland herbaceous vegetation was uniformly dry.

The San Juan River is a very popular and busy recreation river. Numbers of boaters are regulated by permits allocated by the Bureau of Land Management. When the study began dogs were allowed with boaters floating through the bighorn range. Although permits were nominally required for camping on the Navajo side there were no effec-

tive restrictions on landing, camping, or picnicking within the bighorn range.

Early in the study we noted conflicts between recreation and bighorn in the Eight-Foot Rapid area. There were two very popular and heavily-used campsites above the rapid and three sites below the rapid. We also learned that the sandy beach above the rapid was the primary river access for bighorn using the central valley of their range. During the first year of the study we observed bighorn access the river to drink at Eight-Foot Rapid seven times (more times than at any other site). We also observed hikers and campers prevent bighorn from accessing the river. We never saw bighorn drink from the river when campers were present. The loose dogs that accompanied many groups were particularly disturbing to the bighorn.

We worked with the Bureau of Land Management to develop new regulations to reduce conflicts. The following changes were implemented in 1998: Dogs were not allowed on the river through the bighorn range and two popular campsites above Eight-Foot Rapid were closed to camping from April 15 through September 15. Three heavily used campsites immediately below the rapid were left open, but below these 3.2 km of shoreline on the Navajo side were closed to camping for the same period. This area had not been used heavily for camping in the past, however, we were concerned that the new limitations would cause an increase of use in this area which was an important lambing and nursery range.

In 1998, we monitored compliance with the new regulations. We observed no campers in the closed areas during the closure period. Groups continued to use the area above Eight-Foot Rapid for picnicking. We observed no groups hiking on the Navajo side with dogs in 1998, although a few parties were observed floating with dogs in their boats.

We saw bighorn drink at Eight-Foot Rapid twice as many times in 1998 following the closure as we did in 1997 before the closure was established

(Table 1). However, conflicts were not eliminated. On four occasions in 1998 some or all bighorn were prevented from drinking by people picnicking at the closed campsites or hiking into the valley from the lower campsites. We observed bighorn drink without being disturbed more times in 1998. In 1998 we saw one group with a week old lamb drink at Eight-Foot Rapid. In 1997 no lambs younger than one month old were observed drinking at Eight-Foot Rapid. In 1998 in comparison with 1997, bighorn appeared to better tolerate people using the shoreline, and were more likely to stay in the area remaining watchful, rather than leave the area when they saw humans.

#### **Livestock Grazing and the Bighorn Sheep**

**Range:** The range of the San Juan Canyon bighorn sheep population includes approximately 26 km<sup>2</sup>. The range consists of the upper and lower river corridors (7.2 and 5.2 km in length, respectively; about 6 km<sup>2</sup> in area) the central valley and ridges extending into it from Raplee Ridge (9 km<sup>2</sup>), Raplee Ridge and its west ridges (8 km<sup>2</sup>), and the mesa top adjacent to the central valley and the river corridor (3 km<sup>2</sup>). Of this total, about 60% is used exclusively by bighorn sheep. This includes the ridges east and west off Raplee Ridge and steeper areas of the river corridor. Cattle graze the riparian zone and gentler slopes on over 90% of the river corridor through the bighorn range (approximately 2 km<sup>2</sup>) and the bottom and lower slopes of the central valley (3 km<sup>2</sup>). Horses and burros graze the top and upper benches of Raplee Ridge and the mesa top adjacent to the central valley and river corridor (5 km<sup>2</sup>). Areas grazed by livestock were generally areas of greater natural productivity and included much of the gentler terrain and over 90% of the productive riparian zone within the bighorn range.

Most of the Navajo Nation is open range with no fences. Livestock wander over large traditional grazing areas that are passed down within families. Our knowledge of the grazing history of the area is based on interviews with Charles DeLorme, owner of Wild Rivers Expeditions, Bluff, Utah, a rafting company which has run the San Juan River through the bighorn range regularly since 1957.

He told us that the central valley of the bighorn range was grazed by horses from about 1977 to 1994 when the entire herd (15-20 head) was removed. The river corridor was grazed sporadically by cattle from 1970 through the early 1990's, and very heavily by cattle in 1994 and 1995.

From local grazing officials of the Navajo Nation we learned that cattle grazing the upper and lower river corridors during the first two years of our study belonged to Navajo ranchers who did not have traditional permits for these areas. The upper river corridor was grazed by cattle that graze on adjacent area by permit. They drift or are herded into the canyon periodically. The lower river corridor was grazed by cattle belonging to a resident of a nearby village (Halchita) who did not have a traditional permit, but allows his cattle to roam freely in the area. The central valley area was grazed under traditional permit.

**Domestic Sheep and Goats:** A primary reason for the survival of this bighorn sheep population is the lack of water and, therefore, lack of Navajo homes for 8 km south from the canyon rim. Navajos traditionally pasture their sheep and goats close to their homes and pen them at night for protection from predators. The closest domestic sheep herd south of the river is about 8 km from the bighorn range, although a small herd of domestic sheep is grazed about 5 km east of the bighorn range on the north side of the river.

**Horses and Burros:** Horses and burros are capable of traveling long distances for water and use areas with water inadequate for sheep or cattle. In 1997, higher elevations of the study area were grazed by at least 15 horses, 2 colts, and a burro on a regular basis. Other small groups of horses and burros were observed occasionally near the bighorn range. Following years of below normal precipitation, the mesa top vegetation had been overgrazed.

During summer 1997 most of the horses on the mesa were removed leaving about 7 head. The decline in utilization and excellent precipitation in 1997 resulted in improvement of vegetation condi-

tions on the mesa top. We did not observe any bighorn ewe groups on the mesa top during 1997. During January-late March in 1998 7% of observations of ewe groups were on the mesa top in the area used by horses.

**Cattle:** During 1997, cattle grazing on the bighorn range was limited to small groups that drifted in from both ends of the canyon when river levels dropped. High river flows during much of spring and summer 1997 blocked access by cattle along the river banks above and below the bighorn range and limited cattle grazing to low levels.

During the second year of the study, use of the bighorn range by cattle increased dramatically. In late December 1997, 29 head of cattle were herded into the central valley of the bighorn range. They produced 20 calves during February and March. At first they foraged on the flat areas and shallow slopes, but as forage was consumed in these areas the cattle moved higher on the slopes and up the side drainages.

By April, they were foraging above the lower rims, on slopes greater than 80% and had moved a half kilometer below Eight-Foot Rapid. On May 2, Navajo herders separated the 20 cows with calves and moved them out of the valley - leaving 9 head of yearlings and young cows. The remaining cattle concentrated their use in the riparian zone and the valley bottom. These areas were severely overgrazed by late July when the rest of the cattle were removed.

We compared biomass of herbs and shrubs among sites with different levels of cattle grazing in 1998. Comparisons were made within the desert shrub type which is the most abundant habitat. Comparisons made in late winter (mid-February - late March) when cattle had been on the range for 7 - 12 weeks, indicated a decline in biomass of herbs and shrubs in moderately to heavily grazed areas (Table 2). Comparisons in spring (early April - early June) when cattle had been on the range for 14 - 22 weeks indicated significant reductions in availability of herbs and shrubs with grazing (Table 2).

In 1997 prior to grazing by cattle, the central valley was preferred by bighorn sheep during late winter and spring. During January - March 21 of 1997, 71% of observations of ewe groups were in the central valley, although it comprised only 12% of the total bighorn range. In January - March 21 of 1998, after cattle were introduced to the range in late December, bighorn use of the central valley declined to 40% of total observations. During March 22 - June 21 in 1997, prior to cattle grazing, 24% of observations of ewe groups were in the grazed area. In March 22 - June 21 of 1998 after cattle had been on the bighorn range for more than 2 months, observations in the area used by cattle declined to 11% of total observations of ewe groups. By spring of 1998, most of the few observations in the grazed area were in marginal, steeper areas where cattle use was moderate or light.

During the first week of July, 1998, over 30 head of cattle belonging to a different Navajo rancher moved into the upper river corridor. By July 18, the cattle had moved down river to near the center of the bighorn range. Representatives of the Navajo Nation Department of Fish and Wildlife determined that the rancher did not have a permit for the area. Grazing officials contacted the rancher who removed his cattle the following week. Because of the prompt removal of the cattle, damage to the riparian zone was limited although heavy use occurred in some areas.

During late summer of 1998, normal monsoonal precipitation was scant and bighorn sheep were dependent on the riparian zone along the river corridor for green forage. Twenty-seven percent of total observations of bighorn during July - September 1998, occurred within the area used by cattle in the upper river corridor and within 0.1 km of the river. Had the cattle remained they would have grazed this area heavily and significantly reduced the amount of green forage available to the bighorn.

During 1997 and 1998 groups of up to 6 cattle grazed the lower river corridor intermittently. Less grazing occurred in 1997 because of high river flows that blocked access by cattle during much of

the summer.

**Social Interactions between Bighorn Sheep and Cattle:** We observed several interactions between bighorn and cattle. On March 19, 1998, after cattle had been on the bighorn range for approximately 2.5 months, a group of 6 bighorn ewes and juveniles moved down the side of a draw toward a sandy wash in the central valley. Approximately 12 cattle were in the valley bottom, mostly bedded. Several cattle rose and started moving along a trail in the bottom of the wash. One steer appeared to be curious and approached to within about 100 m of the bighorn. Frightened, the bighorn ran uphill away from the cattle about 100 m and then moved quickly across the slope parallel to the wash. Finally, they dashed down and across the valley through an area where cattle were absent and up the side of the opposite slope to the first rocky outcrops.

We also observed groups of bighorn avoid cattle on the beach above Eight-Foot Rapid on 2 occasions when the bighorn approached the river to drink. On May 31, 1998, 4 bighorn (3 lactating ewes and a female yearling) drank from the river above Eight-Foot Rapid when cattle were present. The cattle were at the beach area where the bighorn normally went to the river. On this occasion bighorn did not use their normal approach route, but accessed the river along the edge of a neighboring cliff apparently to avoid proximity to cattle occupying the beach.

**Impacts of Illegal Hunting:** Prior to our study, poaching was suspected but not documented for this herd. During early November 1997, a radio-collared ram was poached by a group of Navajos that accessed the study area through a gate that was vandalized in July. We found the collar under a gut pile a couple of days after the ram was shot. Following an investigation by a Wildlife Conservation Officer, 6 men were cited.

**Impacts of Disease:** In order to mark bighorn for this study, 24 bighorn 1.5 years of age or older were captured during helicopter operations in 1997, from a total of 30 bighorn over 1.5 years of

age. Of these 1 ram had 1 horn, having lost the other, including the entire core, due to sinusitis. A ewe had 1 horn that was severely infected and the horn sheath was loose. The ram was still alive in early April 1999. The ewe was captured in February of 1997, lost 1 horn including the entire core between February 1997 and May 1997, was observed looking emaciated and weak in July of 1998, and died in the late summer or fall of 1998. Her death was confirmed in spring 1999 when we found her skull and partial skeleton.

**DISCUSSION:** When our study began the bighorn population was precariously low following 9 dry years and 2 years of heavy grazing by cattle on the river corridor within their range. The population grew rapidly in response to increases in moisture and forage production, and declines in cattle and horse grazing on the bighorn range. This response provided evidence that forage availability was a primary limiting factor for the bighorn population.

Our observations indicated that the bighorn were dependent upon the river for water and on its adjacent riparian zone for high-quality green forage during summer. The beach above Eight Foot Rapid was both an important access to the river for the bighorn and a popular camping area for boaters. Bighorn were frequently disturbed there in 1997. Regulations that eliminated dogs on the river and closed the Eight-Foot Beach to camping appeared to benefit the bighorn, although they did not eliminate disturbance. We believe that bighorn habituated to humans more easily once the regulations were established because boaters were no longer accompanied by dogs and human recreation use was confined to a smaller area, thus becoming more concentrated and predictable.

The Navajo pattern of grazing livestock differs in major ways from livestock management on public lands in the rest of the United States. On U.S. Forest Service and Bureau of Land Management lands permits are based on the number of animals that areas can support during annual grazing seasons. Under normal conditions the areas are grazed similarly each year with the same stocking

rate, and the same season of use. Under unusually dry, wet, or snowy conditions, season of use and/or stocking rates may be modified.

In contrast, Navajo ranchers graze their cattle in an opportunistic way. An area with poor access, such as the central valley of the bighorn range, may not be grazed for several years, especially if conditions are dry and little forage is available. When they do graze, high stocking levels may devastate the vegetation. The grazing patterns that we observed were not unusual. In 1998, the stocking rate of cattle in the central valley was approximately 5 acres per animal-unit-month (AUM) which is about 4 times the stocking rate (20 acres per AUM) that the Bureau of Land Management uses as a general rule for similar range north of the San Juan River (pers. commun. Paul Curtis, Range Conservationist, Bureau of Land Management, Monticello, UT).

The heavy grazing by cattle reduced forage availability causing declines in use of the grazed area by bighorn sheep. On the mesa top surrounding the central valley, forage availability improved in 1998 relative to 1997 after horse use was reduced and late summer rains stimulated growth of perennial grasses and shrubs. Our observations indicated bighorn ewes responded positively to increased forage availability on the mesa top. These shifts in distribution demonstrated the capacity of desert bighorn to adapt their habitat use in response to changes in forage conditions.

During the 2 years of this study, illegal hunting and disease caused few deaths and did not appear to be important limiting factors. However, both of these factors were confounded by effects of the study itself. Navajo hunters probably prefer rams as targets because of the greater value of their horns for ceremonial purposes. It was well known among the local Navajos that a study was being conducted on the bighorn, all but 1 of the adult rams carried radio transmitters, and 6 hunters who killed a bighorn ram illegally in 1997 were cited. These factors may have made potential poachers hesitant to hunt bighorn.

A large proportion of the bighorn population was captured in 1997 for marking and each captured bighorn was treated for parasites. This treatment should have killed any bot fly larvae present in the bighorn and reduced the probability that any bighorn would develop sinusitis during the next year.

It is possible that illegal hunting which is suspected to be common on the Navajo Nation and heavy periodic grazing by cattle may benefit the bighorn sheep population by reducing the prey base for large predators. Desert mule deer populations are sparse on the study area, likely due to lack of forage and to both permitted and illegal hunting. Coyotes are uncommon. We have observed no evidence of mountain lions in the study area. It is possible that heavy livestock grazing and hunting have combined to keep mule deer populations low, and prevent lions from establishing territories on the bighorn range.

Lack of large predators may significantly benefit the bighorn. New Mexico desert bighorn populations coexist with mule deer populations. Lion predation is the most important mortality factor for many herds and may limit some populations (Rominger and Weisenberger 2000). We may not have observed the rapid population increase that occurred over the last 2 years had large predators been more abundant on our study area.

#### LITERATURE CITED

- Bunch, T.D., S.R. Paul, and H. McCutchen. 1978. Chronic sinusitis in the desert bighorn (*Ovis canadensis nelsoni*). Desert Bighorn Council Trans. 1978: 16-20.
- Jessup, D.A. 1985. Diseases of domestic livestock which threaten bighorn sheep populations. Desert Bighorn Council Trans. 1985: 29-33.
- Rominger, E.M. and M.D. Weisenberger. (2000). Biological extinction of desert bighorn sheep in the San Andres Mountains. Transactions, 2ND North American Wild Sheep Conference. 293-307.

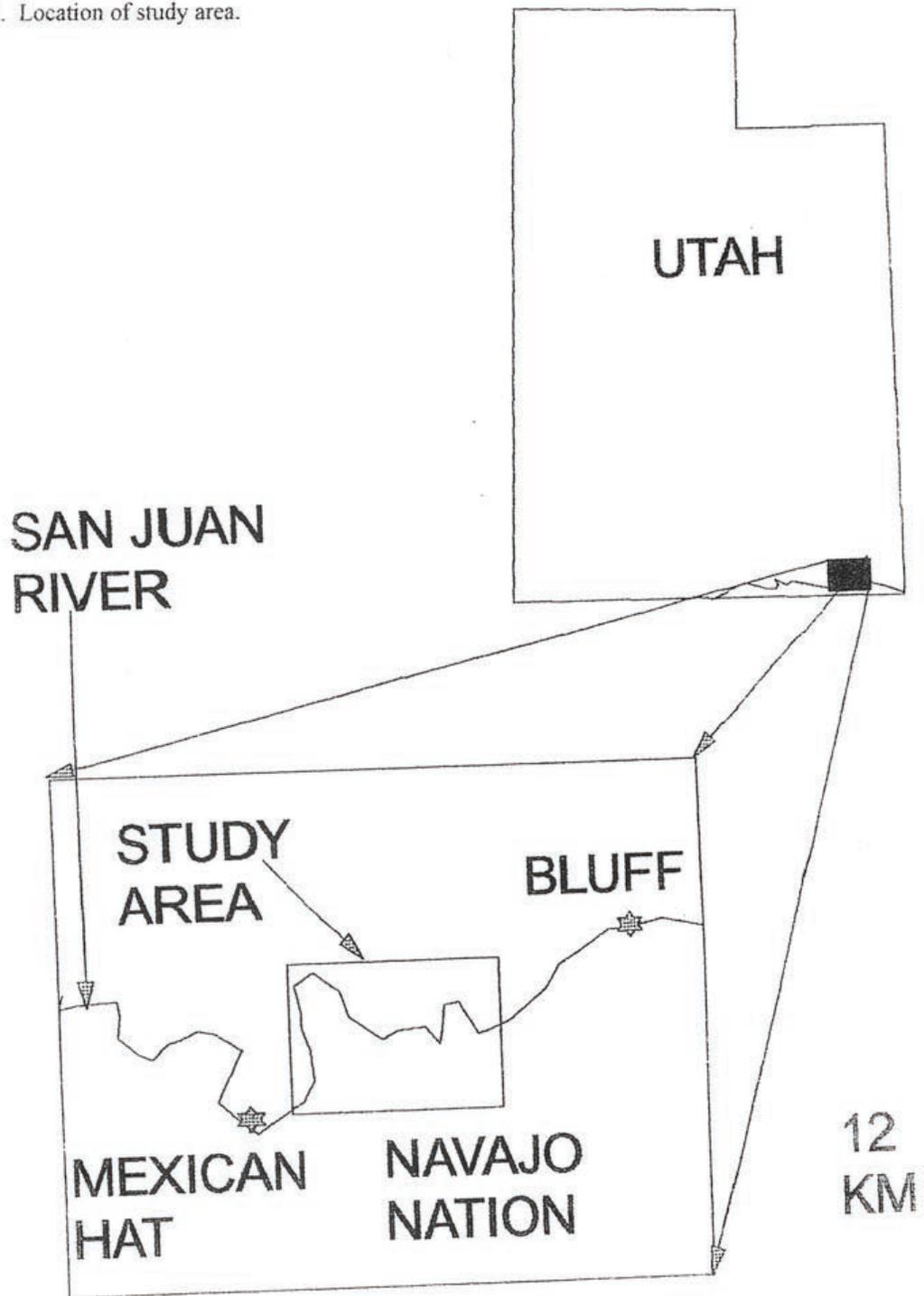
Table 1. Observations of bighorn sheep at the beach above the Eight-Foot Rapid during March - September 1997 when the area was open to camping compared with the same period in 1998 after regulations closed the beach to camping.

Number of Observations	1997	1998
Total Observations	11	16
Bighorn Drink at River	7	14
Bighorn Interact with Boaters	3	4
Boaters Prevent Bighorn from Drinking	3	4
Bighorn Drink Undisturbed	4	10

Table 2. Biomasses of forages at feeding sites of bighorn sheep in the desert shrub vegetation type in relation to intensity of grazing by cattle, 1998.

Period	Grazing Intensity	Number of Sites	Herb Biomass g/10m <sup>2</sup> (SE)	Shrub Leader Weight g/10m <sup>2</sup> (SE)
Feb-Mar	None	4	125 (22.8)	189 (47.5)
	Light	5	119 (21.2)	175 (38.3)
	Mod-Heavy	4	109 (18.2)	76 (33.6)
Apr-Jun	None	8	160 (22.9)	237 (53.1)
	Light	7	130 (12.0)	150 (54.5)
	Heavy	2	31 (2.4)	97 (3.7)

Figure 1. Location of study area.



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## QUESTIONS, ANSWERS AND COMMENTS - NIKE GOODSON PRESENTATION

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**JON HANNA, ARIZONA:** I didn't see that you mentioned any loss of radio collared sheep due to predation. Is that because there are no lions or coyotes there or are these predators present?

**NIKE GOODSON:** I know predation is a problem in many study areas. There are coyote and fox on our study area. We didn't document any losses due to predation. We haven't documented any lions. There are very low populations of deer on our study area and we think that may be one reason why we don't have lions and we haven't seen predation losses.

But we do have coyotes. We had a ewe that broke a leg and was vulnerable for a period of weeks because she was pretty helpless until her leg healed, but she was not predated.

**NORMAN McKEE, UTAH:** Is there any thought of putting water catchments away from the rivers so you have an alternative water source? Secondly, I remember a few years ago the Navajo Nations offered a bid permit on this herd. How was that received and what is the future of that program?

**GOODSON:** There's been a little discussion of water catchments, however, I don't think that's a very good idea. The water situation is the reason we don't have domestic sheep grazing and is the main limitation on grazing of cattle. If we were to put in water sources for bighorns, the Navajo would probably use them to water domestic stock. They don't graze domestic herds or live close to the river because there are no water resources. We're concerned about developing water resources that would encourage them to increase their grazing in the area.

With regard to the permit, there were two permits offered, they were sold, and that's one of the sources for funding this study. The permits were offered and sold through the Foundation for North American Wild Sheep. There have been none since then, because the purpose of selling those permits was to obtain funding to obtain better information on the population and to establish an idea of whether we had surplus rams for auction. If the herd continues to increase, it is likely that more permits will be auctioned in the future.

**NOTE: THIS PAPER IS PRESENTED IN THESE TRANSACTIONS AS AN ABSTRACT ONLY  
AT THE REQUEST OF THE AUTHORS**

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**W. DAVID HACKER - MANAGEMENT OF ROCKY MOUNTAIN BIGHORN SHEEP ON ALPINE  
RANGES IN THE ROCKY MOUNTAIN STATES AND PROVINCES**

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**Abstract:** Rocky Mountain bighorn sheep managers from the western United States and Canada were polled to gain a better understanding of management techniques used to regulate populations of Rocky Mountain bighorn sheep on alpine ranges. A questionnaire was developed and mailed to 27 sheep managers in 10 States and four Canadian provinces. The returned surveys reported on 121 populations of Rocky Mountain bighorn sheep. An attempt to identify effective management schemes from the survey indicated expanded ram hunts and ewe hunts may be cost effective means of controlling populations at or near carrying capacity.

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**WILLIAM C. DUNN - MAN AND WILD SHEEP: WHEN IS IT COEXISTENCE AND WHEN IS IT ENCROACHMENT?**

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**Abstract:** Rocky Mountain bighorn sheep have remained at a carrying capacity of 300-400 animals for 10 years in the Pecos Wilderness of New Mexico, one of the most heavily used wilderness areas in the Southwest. Bighorn are easily approached and often can be hand fed. Conversely, a Rocky Mountain bighorn population in the Sandia Mountains Wilderness near Albuquerque, New Mexico grew to greater than 100 in the 1960's but was extinct by 1990. Increased human disturbance has been implicated in the decline. Although most development did not directly encroach into bighorn habitat, the distance between housing developments and sheep habitat decreased over time. Close proximity to the mountains probably contributed to an increase in recreational use by nearby residents, an increase in feral dogs and a decreased probability of prescribed burning to reverse vegetation encroachment. Bighorns thrive in the Pecos Wilderness despite intense recreational use probably because they are afforded temporal and spatial isolation from humans, something that became increasingly rare for the Sandia bighorn after the 1960's.

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**NOTE: THIS PAPER HAS BEEN SUBMITTED TO THE JOURNAL OF WILDLIFE MANAGEMENT FOR POSSIBLE PUBLICATION. ONLY THE ABSTRACT HAS BEEN INCLUDED IN THESE TRANSACTIONS AT THE REQUEST OF THE AUTHORS.**

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**CHRISTOPHER M. PAPOUCHIS - EFFECTS OF INCREASING RECREATIONAL ACTIVITY ON DESERT BIGHORN SHEEP IN CANYONLANDS NATIONAL PARK, UTAH**

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**Abstract:** The deserts of the southwestern U.S. have experienced a staggering growth in human visitation in recent years, with National Parks bearing a significant portion of the increase, including Canyonlands National Park, Utah, where recreational visitation increased 325% from 1979 to 1994. To gauge the impacts of this increase on desert bighorn sheep (*Ovis canadensis nelsonii*) in the Canyonlands NP, we compared their behavioral responses to recreational activity between a heavily-visited area and a lightly-visited area during 1993 and 1994. We found hikers caused more severe responses in desert bighorn sheep (animals fled in 61% of encounters) than vehicles (17% fled) or mountain bikers (6% fled) ( $P < 0.0001$ ), apparently because hikers were more likely to be in unpredictable locations and sometimes approached sheep. Our findings suggested bighorn sheep in the heavily-visited area were habituating, to some degree, to road traffic as evidenced by a lower average response times to vehicles ( $P = 0.039$ ), lower frequency of visible responses to bicycles ( $P = 0.054$ ), and lower frequency of responses by ewe groups in the spring ( $P = 0.062$ ) when compared to the lightly-visited area. We speculated the reduced responsiveness resulted from an increased avoidance of the road corridor by sheep; bighorn sheep groups in the heavily-visited area were found, on average, 39% farther from the roads than in the lightly-visited area ( $489 \pm 19\text{m}$  versus  $353 \pm 36\text{m}$ ,  $P = 0.001$ ). This avoidance of the road corridor in the heavily-used area represents a 15% increase in loss of suitable habitat over the lightly-used area. We observed an increased responsiveness to hikers in the heavily-used area by ewes and ram groups during critical spring and fall seasons ( $P < 0.05$ ). Other factors determining behavioral responses to disturbance are discussed.

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**OPEN DISCUSSION - WHAT ARE 10 THINGS THAT WE DO KNOW ABOUT WILD SHEEP HABITAT AND EFFECTS OF DISTURBANCE ON WILD SHEEP?  
MODERATOR: JIM BAILEY**

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**JIM BAILEY, NEW MEXICO:** We're supposed to have an audience discussion, and the question is "What are ten things that we do know about wild sheep habitat and the effects of disturbance on wild sheep?" Now's the time to discuss your biases and opinions.

At the first North American Wild Sheep Conference in 1971, there was only one paper on habitat and one paper on disturbance. I think we've come a ways since then, but we'll see how far we've come. The reason for this discussion is to get us started on some ideas for the workshop on Friday when we try to put together a body of knowledge concerning the management of wild sheep in North America.

I thought I'd start this out with an outline that might stimulate some thought and maybe provide a framework for organizing our ideas (Fig. 1).

Fig. 1. Three categories of responses of wild sheep to human activities in their habitats, and expected population effects.

SHEEP RESPONSES	POPULATION EFFECTS
Tolerance, Adaptation	None <sup>1</sup>
Endurance	Negative, including stress
Avoidance, Movement	From limiting range: Negative From non-limiting range: None

Covariables: Sex, age of sheep; season; weather.

<sup>1</sup>Human presence may displace predators and have a positive population effect.

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I thought we'd start with discussing disturbance. First, the responses of the animals might be adaptation and tolerance of a disturbance in their home ranges. By definition, there would be no impacts or at least no measurable impacts. Second, the sheep might endure and suffer the disturbance, but not move to avoid it. There are measurable impacts on these animals and some of those involve what we call stress. The third possibility is avoidance. Avoidance might be interpreted as bad or as good for sheep. They might be able to move to a range of equal quality in which case, by definition, there would be no impacts, or they might be forced to move to an inferior range situation in which case there would be impacts upon the animals. A lot of factors influence these responses, such as the sexes and ages of the animals involved.

An idea that human presence might in fact benefit a population by causing predators to move out has surfaced in the literature a few times. I'm thinking of bighorn sheep that live in Waterton Lakes Park in Alberta. I think

one of the reasons that the sheep have moved into town is that wolves don't come into town. We thought we found the same thing in another Waterton (Waterton Canyon right out of Denver), when there was construction activity. While the construction activity was going on, we saw a sudden increase in production and survival of animals. The only viable explanation was that all this construction had driven one or more mountain lions out of the canyon for a while.

Are the disturbance characteristics predictable or harmful? It's been said that sheep can adapt and learn to live with disturbances that are both predictable and non-negative in their environment. Negative things, of course, are bad, and unpredictability is also a problem.

Here's another good question: If the sheep are going to adapt to a disturbance, how long is it going to take? How long is necessary for sheep adaptation to get along with people. With that, I'll throw it open to your biases. Who wants to kick this off?

**DUNCAN GILCHRIST, MONTANA:** I'm on the Board of Directors of FNAWS. I make a living through the written word and through doing video work, and I spend some 30 to 60 days a year filming wild sheep and filming sheep hunting. I spend an equal amount of time filming other species, primarily bear. I live in Montana and I go to the northwest and Alaska and film. I have a few comments about what I have observed over the years about stress and wild sheep contacts with people.

First of all, I have found sheep greatly more approachable and accepting of humans where they're used to us. This was not related to hunting. I know of a population in Montana where I can touch a large ram, even though the population is hunted. I know other populations that are not hunted whatsoever and they don't see many people. They're very nervous and they flee humans. Another correlation is where there's a lot of predation, as in areas that have high lion populations, and I can't get closer than 300 yards.

I do a lot of my photography up close, I do it literally a few feet away. I don't need telephoto capability. Because my primary use is with a camera, I've learned how to approach animals. I don't act like a predator. I never come in on a sheep from above like recommended in the old sheep literature, because "sheep don't look up." My God, if they look up and they see a human, they're gone.

There is one exception. In the spring, when sheep are having their lambs, they don't like people and this is when they can really stress out. It's almost impossible for me to get photographs or video footage of young lambs.

And the final comment, one time I was talking about this with Val Geist. He was talking about monitoring heartbeats in sheep during contact with people and he said their heart rates go way up even though the humans are 200 yards away and the sheep don't appear alarmed.

**BAILEY:** I think one of the things you said was that hunting does not sensitize the animals to additional human disturbance.

I'll quote Val Geist, too. I think it was in the Boone and Crockett publication that Val expressed concern about harassment of sheep. He said the worst combination was hunters and photographers. Was Val right or wrong?

**DICK WEAVER, CALIFORNIA:** I want to relate how one biologist, me, changed his mind. When I got started doing sheep work full-time, in San Diego County, Interstate 8 was just completed and they hadn't yet built all the fencing along it. I had all these reports of sheep observations by the construction crews, heavy

equipment operators and others. I couldn't find sheep in that area and I thought that this road has taken a big chunk of sheep habitat and the sheep are gone.

Over a short period of time I came to the conclusion that I was wrong. Sheep were there not in spite of the heavy machinery, but they were there because of the heavy machinery. Sheep want to see anything that might be detrimental, whether it's a coyote or a D8 cat. If they can see it, they may be apprehensive. It's been called curiosity, but it's probably not curiosity. They want to see what might be a problem. If it doesn't develop into a problem, then there is no problem. I had to change my mind on this; it wasn't what I had always believed.

**BAILEY:** I think you said a couple of things. Sheep can learn and adapt and if the disturbance is predictable and nonnegative, that's the kind of thing that they can adapt to. Does anybody disagree with that? Are there other anecdotes?

**KEVIN HURLEY, WYOMING:** Jim, during your discussion on avoidance, you asked if sheep are displaced, are they sent to habitats of equal quality? It's an intuitive thing with me but my assumption is if they're moved, they certainly won't go to better habitat. I think they're selecting the best habitats they can find and I am doubtful there are many opportunities for sheep to move to equal quality range. So, I view it that any time they're moved it's to a lesser quality habitat. I'm wondering what other people think of that.

**GLENN LORTON, NEW MEXICO:** I agree. Basically, any time sheep are moved out of habitat, you're looking at a loss of overall habitat quality.

**BAILEY:** That's also loss of overall habitat. Doesn't this imply that none of the habitats individually are limiting? Winter range isn't limiting, snow free range isn't limiting, spring range isn't limiting, they're all equally important. Is that what we're saying?

**WAYNE HEIMER, ALASKA:** I can share an anecdote with you. When we were trapping Dall sheep in Alaska, we went where the sheep were. The sheep were where they either wanted to be or where they had to be. In the Alaskan spring, it was mineral licks. At the time I was trapping, the drop net trap had been developed. If you've ever seen a drop net, you know it's like a circus tent, an incredible visual barrier.

We eventually trapped at a mineral lick where sheep had never seen a drop net. We found they didn't want to go under the net for two years. The first year we couldn't catch any sheep at all. The second year we could catch lambs or yearlings. The third year we could catch any kind of sheep that were in the neighborhood.

Either they had grown accustomed to the net over three years or something else had happened. Traps such as a rocket net (that don't present a huge visual barrier) were much more effective in a much shorter time.

As far as being a non-negative experience being necessary for sheep to adapt to the presence of the "circus tent" under which they had to go to get a lick of natural salt or unnatural salt we had brought in for bait, they had to put up with a fair amount of harassment: having the net dropped on them, being wrestled with in the mud, blindfolded, bled, injected, charted, measured, milked, ear-tagged, and collared. It was not a problem after they had seen the net for a short period of time. There was no initial negative response or negative experience associated with the trap, because they didn't get caught.

Then there's our cumulative experience with development in Alaska. It's pretty depressing to see a bunch of sheep standing underneath the trans-Alaska pipeline. We once assumed they'd had better taste. The revegetation grass is good under the pipeline, but it's not good if they get run over by the semis that go

rumbling by.

Also, we see sheep on the highway down south of Anchorage and once in a while they get hit by cars. I understand they're drawn to road salt, and people feed them potato chips. They've adjusted to all sorts of things that we originally thought would not be a good idea.

I think the way we see disturbance and habituation depends on what we think a sheep is. I note in the papers from this morning that many biologists think sheep are bags of enzymes which, if they can't capture and maintain every last calorie, will perish. That's the nutritional viewpoint.

We have people like Nike who mentioned a population that seems by all accounts to be doing just fine. Nike was concerned that they couldn't drink four times a day because rafters were coming down the river.

Chris suggests that if people don't stay on the trail and remain exactly predictable in their hiking behavior, this could be a problem. Disturbance perception (by humans) is like the blind men seeing an elephant. What you happen to think a sheep is, colors your judgment on what you think habituation is, and whether it's stress or any of these other things.

**BAILEY:** After you dropped the net and caught the sheep and abused them so many ways, did they come back and get netted again in the same way the next year?

**HEIMER:** Yes, sometimes even in the same afternoon.

**BAILEY:** That's been my experience as well.

**WEAVER:** At the risk of oversimplifying, I suggest if sheep use it, they need it. If you expand on that, the more they use it, the more valuable it is to them.

**BILL WISHART, ALBERTA:** What I want to comment on is the response of rams to hunting. We have the Sheep River Sanctuary and rams know that. They can tell you just about where the line is. Another place with no hunting, is at Cardinal River Coals. I think the rams have taken up residence on the lease there. When studying ewes at Sheep River, they were approachable in the Sanctuary but not off the Sanctuary in the high country. They behaved differently on and off the Sanctuary.

**BAILEY:** Do we think hunting sensitizes sheep and makes them more vulnerable or makes them responsive to other kinds of recreation?

**WISHART:** One more point is that hunters will tell you that when they're hunting rams, they're not out on the open slopes. They're somewhere in the timber.

**ROB RAMEY, COLORADO:** I'd like to mention that we need more studies like the one Chris just described, and that Nike had some quantitative basis for disturbance of animals. But we need to go a step further, and we need to be able to state at what point the disturbance has a deleterious effect on the animals, and that is a harder connection to make. It's harder, because there's variances, including disease and the range condition that the animals are in.

I'd like to venture that studies of disturbance would be ideally carried out with multiple samplings over a long period of time. That way you're at least able to get a handle on what some of these other factors and what

effect the long-term disturbance may have on the animals. I think a few well-placed studies would do us a great service.

Finally, I would like to venture that we found genetic differences between Rocky Mountain and desert sheep. I think it's probably reasonable to think about these as different categories to be studied and that studies could be broken out under Rocky Mountain and Dall sheep. I think desert sheep react more than Rocky Mountain sheep do to people.

**BAILEY:** Why do you think so?

**RAMEY:** I don't know. I'd like to measure it.

**HERB MEYR, IDAHO:** I talked to Val Geist about the differences between Rocky Mountain and California bighorn sheep. When he tried to study the California bighorn sheep, he found them much more hyper, scared of people and the study did not go well. I echo that desert sheep are different than Rocky Mountain sheep and maybe Dall sheep, and that the species react differently to disturbance.

**BAILEY:** We don't know whether that's genetic or environmental, populations that are more sensitive may have a different history of whatever causes them to be more sensitive, and it may not be characteristic of the subspecies.

**NIKE GOODSON, UTAH:** I worked with both Rocky Mountain and desert bighorn sheep in field studies, long-term field studies where I did close observations of their behavior and they basically reacted very similarly; however, I think the experience of the population is a very important determinant of how they react.

When we first started studying the desert bighorn sheep on the Navajo Reservation, if we approached them from the canyon rim, the flight distance was about half a mile. This is because they had been typically approached from the canyon rim over the years by Navajos who poached them.

Now, if we approached the bighorn sheep from the river in a boat, they were very tolerant. They didn't do anything. You had to land the boat to get the sheep to react to you. Because they were very used to people floating down the river in boats, sometimes stopping and watching them, but seldom beaching and bothering them. They were very tolerant of people in boats. These are the same sheep, the same area, and completely different reactions.

We had to habituate the sheep to some extent in order to be able to collect data on foraging behavior and nutrition and we did habituate the sheep. Just like Rocky Mountain bighorn, the longer we worked with them, as individuals, the more tolerant they became of us. We were able to watch them from closer and closer distances.

I think that if there are differences between populations in response to people, basic differences, I do not think they are genetic differences. I think there are differences related to the histories of the populations.

**BAILEY:** I might add another experience of Nike's that she's forgotten about. Differences in terms of the experience of the animals within individuals in populations. Nike worked with sheep in Rocky Mountain National Park and I know she told me one time that the same individuals in Horseshoe Park where they expected to see lots of people almost all the time were quite habituated to people. Those same individuals in the high country where there was an occasional unpredictable hiker were very sensitive and would go over the

hill when a hiker would show up.

**HEIMER:** Thank you, Nike and Jim for bringing that up. I would be reluctant to make a big issue of whether one subspecies was more reactive than another because Dall sheep are grandly different and we presume they're all one subspecies.

You can go to equally heavily hunted populations, both at mineral licks, where we presume they need to be, one place they'll put up with you and one place they won't. So that's the same species, we presume, and yet there's a tremendous difference between populations. We don't know what the difference is. Maybe they never met nice people.

**JEAN CAREY, YUKON:** We've been looking at disturbance as equivalent to increased predator reaction. Perhaps a lot of the differences are in the predator complement. We found great differences between helicopters and fixed wing, because there's a different perception. In some areas, there's no reaction. We've seen different reactions depending upon the composition of the groups. Seems like ewes with lambs are far less willing to move because it's a greater risk to run and lose a lamb than it is with a perceived threat from the helicopter. Also the reaction depends on where they're situated. If they're far from escape terrain, you'll see a much greater reaction than if they're already sitting on the cliffs.

I certainly agree with Nike that a lot has to do with the history of the population and whether they perceive the disturbance as a predation threat.

**DALE TOWEILL, IDAHO:** We need to be very careful when we ask this question because while we think we know what hunting does, we don't hunt ewes and lambs. They're quite often in the same areas and in many cases more exposed to more humans on foot than are the rams, which are typically the quarry of choice. The rams most heavily impacted are those that don't have a chance to learn and benefit from the exposure to hunters. So what are we trying to measure? That becomes fundamental to addressing this entire question.

In short, asking the question: What is the impact of hunting? I think we need a fairly controlled situation where we can document both the behaviors of the humans and the responses of the sheep by sex and age class. That's a pretty daunting task. Until we can get there, we're going to be talking mostly in anecdotes.

**BAILEY:** May we end on that? Basically what you're saying is we need more research. That's what Rob said and I'll suggest that we need more experimental research. Our problem is that when we do observational research, we take advantage of the differences among areas, but we are always dealing with confounding differences between the two areas or the two populations. Maybe we need more contrived experiments where we control the nature or the frequency of the disturbance.

**JOHN McCARTHY, MONTANA:** We hunt ewes and lambs on a regular basis. Twenty-five years ago when we began to do that, one of the biggest comments we received from the public is we'll never be able to approach sheep again.

To this day, most ewes are shot within 400 yards of a highway or road or trail. In one of the studies we did on the Sun River, we collected ewes throughout the year. We collected a fairly large number of these animals and it wasn't a matter of not being able to approach them. It was a matter of after you knocked one down, moving the other ones out of the way so you could actually get in and see the animal.

So I think we need to take a look at what we're talking about here: Is disturbance having an effect on the

population? Is it having an effect on the reproduction and recruitment? What are we trying to determine?

Disturbance is going to vary with how you approach an animal, where you approach it, how much time these animals spend adjacent to highways, how much time they're eating marshmallows out of people's hands. I think we need to be looking at what the effects of the disturbance are, we can't come up with one conclusion that disturbance is either good or bad.

**BAILEY:** Looking at habitat requirements of sheep in the literature, Val Geist lists seven seasonal ranges in his wild sheep book (Fig. 2). I think Val was the only one that says that rams need or have a pre-rut range. I haven't seen that term come up again in the literature. I added migration corridors and metapopulation connections. Several covariables, including the sex and ages of the sheep, influence the needs for these ranges (Fig. 2).

Fig. 2. Range requirements of wild sheep, at landscape and local levels of resolution.

<u>Landscape Requirements</u>	<u>Habitat Requirements</u>
Pre-rut range - Rams	Security Factors
Rutting range - Rams and ewes	Visibility, Escape terrain
Winter range - Rams, ewes	Forage
Spring range - Rams, ewes	Quantity
Lambing range - Ewes	Continuity, dispersion
Salt-lick range - Rams and ewes	Quality, composition
Summer range - Rams, ewes	Reliability, diversity
Migration corridors - Between ranges	Water
Metapopulation corridors - Between herds	Minerals
	<u>Juxtaposition of factors</u>
Covariables: Sex, age, number of sheep; predator types and abundance; human disturbance; biotic disturbance (e.g. fire), and succession; proximity to domestic sheep; season; weather.	

There may be different needs for these ranges relative to predator abundance or relative to the amount of human disturbance. Fire and vegetative succession are certainly processes that influence these ranges. Then there's the issue that is somewhat new since the earlier publications, the proximity to domestic sheep.

We can also look at local habitat requirements (Fig. 2). Sheep need security features in their habitat, and that's a combination of visibility and escape terrain and these compensate for one another in terms of how the sheep perceive them and respond to them, and how well they fulfill the needs of the sheep.

Obviously, sheep need forage. We've often looked at quantity, but not at continuity of forage, continuity in terms of dispersion of the forage. It's my opinion that sheep operate best in a large group size and a more dispersed forage resource allows sheep to be feeding together and in view of one another while not competing for the same bush.

Quality of forage, of course, is an issue. Then there's reliability, which is related to diversity of the forage resource. I'm thinking of more reliable in terms of quantity and quality forage. In terms of species composition, in particular having both browse and herbage, might provide reliability, through all times of the year. There's value in having forage resources at different sites on different slopes, aspects and elevations, that

reach their peak in quality at different times of the year, and allow the sheep to exploit the diversity.

Water is a factor we might get some arguments on. Free water is proposed as a habitat requirement. Mineral licks are another.

Juxtaposition, the location or the close proximity of all these factors should be considered. Visibility next to escape terrain or in escape terrain, for example.

Covariables will include differences in requirements related to sex and age, size of the animal and nutritional requirements, for example, the size of the sheep population. Whether or not there are predators in the environment; do sheep still need escape terrain if there are no predators in the environment? Human disturbance, fire, and plant succession are additional covariables (Fig. 2).

I hope that's some stimulation. What do we know about the habitat requirements of wild sheep in North America?

**PAUL KRAUSMAN, ARIZONA:** I'll pick on the water issue, especially since there are a lot of people in the audience who have made a career out of dealing with water and sheep habitat, especially with desert bighorn sheep. This is an area where we need a tremendous amount of research.

If you look at the literature, you'll find very few studies that have documented that free standing water is critical to desert bighorn sheep. I'm not arguing that sheep don't need water. Of course they do. But the ways they get it are somewhat different than the ways a lot of people think.

There are numerous ranges that have been documented to lack free standing water. Productivity and recruitment are just as elsewhere. The Sierra Viejos population in Mexico is an example. Compare the Kofa where there are numerous water sources, and in the Sierra Viejos where two or three water sources have recently been added, and we've been documenting that the sheep aren't using them. They're using barrel cactus and agave.

I'm not saying it in a detrimental manner. It's for consideration. If in fact freestanding water is not a limiting resource, we're spending a lot of conservation time, effort and money in an effort that perhaps could go somewhere else.

**BAILEY:** I'll add to that. McCarty did a literature review on habitat requirements of desert sheep and the only population response that we could find to the addition of water in desert bighorn environments was the River Mountains case.

A lot of water developments have been put out, and in most cases there hasn't really been any good data for evaluation. Was there a higher yearling/ewe ratio or a higher population? In most cases sheep used the artificial water source. Whether or not anything more than that happened, it really hasn't been looked at or evaluated in most cases.

**JOHN WEHAUSEN, CALIFORNIA:** I was going to say the same thing that Paul said about water. I've studied populations that have never drunk at all that I can figure out, such as the High Sierra populations.

Also, mineral licks, I would say are not a general requirement. There are lots of populations to our knowledge that have no mineral licks at all. I think that's maybe a Rocky Mountain phenomenon; certainly in the deserts,

I've never seen any evidence of mineral licks.

**BAILEY:** Do you think that's a function of the environment? Don't some environments have adequate minerals in the forage while others don't?

**WEHAUSEN:** It's maybe they don't need it as much. Maybe licks are not available.

**BAILEY:** And they get by fine without it.

**WEHAUSEN:** I question it as a general requirement, basically.

**BAILEY:** On the other hand, there are others who say if they use it, they need it.

**WEHAUSEN:** If they use it, they need it. I'm not sure they're using it in places. I've never seen evidence of dirt in the feces. You can say humans don't need salt, yet they salt their food.

**GOODSON:** Humans do need salt. That's sodium. They usually eat ten times as much they do need. They do need it. It's basic nutrition.

**WEHAUSEN:** I would move on to something else: Pre-rut versus rutting ranges. You said nobody has ever come with a pre-rut range. I used to distinguish fall ranges from summer ranges in the Sierra of California, because I saw a change in habitat used by females particularly in the fall. They drop to lower elevations and start seeking nutrition they wouldn't get in summer. So you could call it a pre-rut range. I call it a fall range.

And relative to rutting ranges, I've looked at a lot of populations in the deserts and in the mountains for a lot of years. I have never seen anything that I would call rutting ranges. My interpretation is males find females where they are at the time of the rut. I've never seen anything that suggested that females are going specifically somewhere to rut. It may be a Rocky Mountain phenomenon. I know people have seen that in the Rocky Mountain's.

**BAILEY:** Geist specified the pre-rut range as a ram need in his book. Let's go on with that. Does rutting generally occur in the same area each year, or do the rams go wherever the ewes happen to be, and that's maybe a different place each fall?

**KEN WHITTEN, ALASKA:** It's a long time since I read Geist. As I remember it, he wrote about individual animal's seasonal home ranges, and he found that there were certain rams that predictably, from year to year, went to certain ranges during what he called the pre-rut. That particular spot might be another ram's winter range, might be a ewe winter range, might be a lambing range. I think we're confusing something here. At least among his identifiable sheep, there was something that he could call an individual's pre-rut range. It wasn't necessarily a geographic location that all of the sheep used that needed some special protection.

**BAILEY:** You're right. He was talking about individuals, but he didn't say that sheep needed all seven ranges. He said that rams use up to seven kinds of seasonal ranges and ewes up to, I think, four of those.

**RAY DEMARCHI, BRITISH COLUMBIA:** I wanted to mention that there's research in the Turn Creek Basin, in the Fraser River Country by Patty Oldman and another research contractor being funded by the local chapter of FNAWS. They found some unique things about this one herd. I'm starting to think that each herd has its own behavioral characteristics, and I note that a lot of Geist's work was done in Banff Park and on

Stone's sheep range in fairly undisturbed situations.

I don't think we can generalize on habitat requirements. The herd in the Turn Creek Basin looked like one population, looked like one herd of ewes, one local group. However, there are actually at least three identifiable groups of ewes. They winter together, but they don't summer together. They migrate in groups. One group moves to the east and another group moves to the west. The group that moves to the west splits off. One part of it summers on top of one mountain, and another part keeps going miles past that mountain and summers on another mountain. They do it every year, regularly as clockwork.

In the fall, they migrate off mountain summer range about the same time, but they don't go back to the winter range at the same time. One group comes off the summer range, goes west to rut and ruts at the same place every year.

If that herd got wiped out, or one local herd disappeared after a mining operation went in, the sheep would lose that knowledge of ranges and migration routes. I don't think they would get it back again, except in geological time, a thousand years, two thousand, whenever.

**BAILEY:** So you're suggesting that learned traditions are very important in maintaining the use of various seasonal ranges. I suppose that might support Wishart's example of a population in Montana, which I guess was a transplant, and used a rather large amount of range. Somehow you had undiscovered additional range, and the population grew. That additional range was always there, yet due to learning and tradition, it took a long time for those sheep to change their tradition and start using a wider range of habitat.

**ERIC ROMINGER, NEW MEXICO:** I'd like to change the topic. Every photo series that's been taken in Jackson Hole and Yellowstone Park shows a dramatic increase in the number of conifers. Yet there is very little documentation of the amount of mountain sheep habitat that has been lost over the last century. In fact, the only figure I could find is Krausman's, suggesting two percent per year. My guess is if you take two percent per year from all of our sheep habitats in the West, we have a small fraction of the sheep habitat we once had because of vegetative succession.

In New Mexico, we've had a couple of fires for bighorn sheep. As we move north, is anybody recovering that two percent per year? Since 25 years ago, theoretically, we may have lost 50 percent of the sheep habitat.

Which states are recovering sheep habitat? Are we losing habitat in the juniper and the spruce-fir zones, or is any region getting it back?

**TOM RYDER, WYOMING:** In Wyoming, the state Game and Fish Department has identified burning as a technique that's very necessary on both BLM and Forest Service administered public lands, especially in primary sheep range. A lot of those habitats for bighorns are within designated wilderness areas. This may be a lead-in for future sessions in this conference, but until recently, we've had a heck of a time working with the U.S. Forest Service in wilderness areas to do human-ignited fires to improve bighorn sheep habitat. It has been changing the last three years, but it's been a slow, painful process. We believe it's a very important thing, but we've had interagency problems getting burns accomplished.

**BAILEY:** There's a paper addressing that problem of fire in wilderness areas and the reluctance of the Forest Service to use prescribed ignitions in wilderness areas in the 1992 Northern Wild Sheep and Goat Council Proceedings. Bailey and Woolever are the authors.

**STEVE HOLL, CALIFORNIA:** I can say in the San Gabriels, fire is absolutely necessary to maintain sheep habitat. Without either fire or logging in a number of other ranges, you're losing sheep habitat, so you've got to reinstitute those factors. Those are factors that affect the environment. They affect the amount and quality of sheep habitat and you're remiss in not getting those factors reintroduced.

**HARLEY METZ, COLORADO:** In the case of fire in wilderness areas, we completed an integrated activity plan, and one of the main objectives is to reintroduce fire into the wilderness areas for the benefit of not only vegetative succession but for the desert bighorn population. In the case of a Rocky Mountain herd within our district on the forest, the main objective of fire is the rehabilitation of bighorn habitat. I think that we are using bighorn objectives as a triggering factor to get prescribed fires used in our areas.

**BAILEY:** Which area?

**METZ:** The Uncompahgre, on Battlement Mesa. There has been an emphasis in getting that habitat altered by fires, the only tool available.

**BAILEY:** You've had prescribed ignitions in wilderness areas?

**METZ:** Yes. In fact, I mixed the aluma-gel myself.

**DAVE SMITH, ARIZONA:** The vegetative EIS in wilderness areas for treatment of ponderosa pine, chaparral and other communities, allows the use of prescribed fire in wilderness.

**BAILEY:** I'm glad that the Bailey and Woolever paper of eight years ago has had some influence. At the time we wrote it, we surveyed the western National Forests, and there was a lot of opposition to prescribed fire in wilderness based on a reference to the Wilderness Act and Forest Service regulations. We're certainly glad to see that that's changing. Thank you all very much.



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## STATE/FEDERAL RELATIONSHIPS

CHAIR: VERNON C. BLEICH, CALIFORNIA DEPARTMENT OF FISH AND GAME

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### DENNIS AND RAY DEMARCHI - WILDLIFE AND WILDLIFE HABITAT INVENTORY TO MEET LAND-BASED PROGRAM PLANNING NEEDS FOR MOUNTAIN SHEEP

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**Abstract:** A review of state and federal mapping of North American mountain sheep (*Ovis* spp.) distribution during the past nearly 100 years revealed that despite advancements in mapping technology and the availability of aerial photography, satellite imagery, and computerized geographic information systems, there has been little progress in relating biological and physical properties to actual or potential sheep distribution and abundance. We describe a system designed and applied in British Columbia to predict current habitat suitability (i.e., actual) and habitat capability (i.e., potential) for mountain sheep and other wildlife species. Wildlife and wildlife habitat inventory, as conducted by the British Columbia government, is designed for multi-scales for both planning and management. Planning processes can vary from international cooperation on grizzly bear management: provincial planning, for identifying and protecting areas to be set aside as Provincial Parks; sub-regional, planning, for identifying resource extraction, conservation or management priorities; landscape unit planning and forest development planning for setting forest harvest rates, location and timing; to local planning for operational resource extraction. In order to accommodate that level of complexity a number of resource inventories have been standardized through the multi-agency provincial Resources Inventory Committee. Most of the ecosystem-based inventories and classifications currently being recommended in British Columbia are not stand alone and, in fact, they accommodate portions of classifications or information from many other such inventories. We recommend that an appropriate government agency assume the responsibility of initiating and coordinating a cooperative international mountain sheep habitat mapping project and habitat registry.

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The North American wild sheep literature contains numerous reports and publications that include maps of historic and present mountain sheep including bighorn sheep (*Ovis canadensis*) distribution (Sheldon 1911, Hornaday 1914, Seton 1927, Cowan 1940, Buechner 1960, Trefethen 1975 and USDA and BLM 1995). Comparing the thinhorn sheep (*Ovis dalli dalli*, *O. d. stonei* and *O. d. fannini*) map prepared by Sheldon (1911) prior to the advent of vehicular access and aerial photography with the maps of sheep distribution in recent published literature reveals little progress has been made in this field. State and federal maps of mountain sheep habitat do not rate habitat

quality with habitat availability or suitability. The absence of the application of a relative scale of habitat quality results in maps that over-estimate the area occupied and, therefore, apparent abundance of mountain sheep. Also, the most productive areas may be overlooked or masked by the inclusion of poor quality habitats. This makes it difficult for wildlife agencies to direct their protection and management efforts toward the most important areas or to convince competing land users of their importance to population survival.

Wildlife species recovery programs are based on projections of historic or "potential" population

abundance and distribution from these generalized maps. This has established an erroneous belief that bighorn sheep, for example were far more numerous in pre-Columbian times than is ecologically possible (Demarchi, 1977). These and other maps, including both the historic and current maps of bighorn distribution in the Western U.S. compiled by Buechner (1960), plus that author's acceptance of Seton's (1927) unsubstantiated claim of 1.5 to 2.0 million bighorns have done much to exaggerate both the magnitude of the losses and the expectations for recovery.

The logical progression in the development of habitat capability maps is: Phase One Maps that depict species distributions; Phase Two Maps that include subjective application of density ratings; and, Phase Three Maps that are ecological maps and incorporate a quantitative assessment of species habitat attributes (e.g., Sweanor et al. 1996). Nearly all agencies in the U.S. and Canada have long-since perfected Phase One Maps and some have made progress towards Phase Two Maps by overlaying distribution maps on land status and vegetation zonation maps (Cassidy 1997, ESWG 1995, ONHC 1998). To our knowledge, Phase Three Maps have not yet been developed for any wildlife species in the U.S.

An additional impediment to bighorn recovery is that because of jurisdictional separation there is a resistance to produce cohesive habitat maps that are jurisdictionally neutral. In an attempt to overcome this barrier in one region, the British Columbia Wildlife Branch contracted Demarchi *et al.* (1999) to produce a single Phase Two Map of bighorn distribution and abundance for the Rocky Mountain population of Rocky Mountain bighorn sheep (*O. c. canadensis*) shared between Alberta, British Columbia and Montana. Rocky Mountain bighorn sheep distribution and abundance maps were developed by Blower (1988) for BC and by J. Jorgensen (pers. commun., 1999) for Alberta, while L. Bailey (pers. commun., 1999) produced the maps for Montana. The result of combining these individual jurisdictional maps is shown in Figure 1.

Armentrout and Boyd (1996) attempted unsuccessfully to develop a Phase Three Map for bighorn sheep in the Western U.S. They applied the USFS ecological maps of Bailey et al. (1994) to California (*O. c. californiana*) and Rocky Mountain bighorn sheep distributions and concluded that, "Ecosystem management which includes California and Rocky Mountain bighorn sheep will require boundaries other than those provided on current ecoregion and MLRA (Major Land Resource Area) maps".

Demarchi et al. (1999) attempted a similar exercise utilizing bighorn sheep distribution taken from the map which accompanied the first edition of Trefethen (1974) and overlaying it on the ecological map of Western North America produced by Demarchi (1994). The result is shown in Figure 2. Nearly all bighorn sheep populations appear to fit within Demarchi's (1994) ecozones. Perhaps more significantly, separation into the three North American bighorn subspecies (*O. c. canadensis*, *O. c. californiana* and *O. c. nelsoni*) while only assessed subjectively appears to have a high degree of "fit" at the both the Ecodivision and Ecoprovince levels. This fit appears sufficient to support further habitat map development at the more detailed Ecoregion and Ecosection levels. In the interest of moving mapping of bighorn sheep habitat into the third phase of map development at both strategic and operational mapping scales, we describe the system that has been developed and applied in British Columbia.

**METHODOLOGY: Habitat Mapping in British Columbia:** The overall goal of the wildlife species and wildlife habitat inventory program done for the government of British Columbia is to provide site-specific inventories of those resources across the province in order to meet operational and higher level planning requirements. Those inventories generate the information needed for the designation and management of specific wildlife populations, and habitats for the development of various plans, guidelines and practices in order to meet the requirements set out in a number of provincial and regional planning processes.

Wildlife habitat identification in British Columbia is the result of interpreting the ecological or site series (Pfister et al. 1977) information from detailed ecosystem mapping products, for the purpose of assigning values for select wildlife species such as, bighorn sheep, Rocky Mountain elk (*Cervus elaphus*), or grizzly bear (*Ursus arctos*) etc. (Resources Inventory Committee 1998a, b, c, d). Such habitat values may be a measure of either the current suitability of the habitat to support those species' living requirements, or the potential capability of the habitat in the correct successional stage under specific management to meet those wildlife species' living requirements (Resources Inventory Committee 1998d). All such values are based on benchmark densities for the best habitats for each species within the province of British Columbia. Thus, the bunchgrass terraces above the Fraser River in the Junction Provincial Park become the benchmark habitats for rating all other habitat for California bighorn sheep in the province; while the early seral stage bunchgrass terraces above the Wigwam River become the benchmark habitats for rating habitat for all other Rocky Mountain bighorn sheep in the province; and the early seral stage northern ryegrass/trembling aspen rocky slopes in the Muskwa Foothills in northeastern British Columbia become the benchmark for rating all habitat for Stone sheep in the province.

**The Input of Scale:** Wildlife and wildlife habitat inventory projects must be balanced between scale and level of survey intensity and the planning level that the inventories are to be used in. Inventory projects must also meet the planning horizon of the intended plan if they are to be useful, and they must meet a prioritized planning schedule for input into various plans (assuming that all planning is being generated from broad to site-specific levels). For example, Land and Resource Management Plans (LRMP) are higher level plans that form a bridge between international or national and provincial strategic resource use plans and the Landscape Unit, Forest Development, and Resource Use plans (Figure 3). The wildlife species and wildlife habitat inventories that are conducted for these higher level plans are done at a broad level, but they provide guidance for prioritizing

areas requiring more detailed inventories.

Through its Resources Inventory Committee the Province of British Columbia has defined a hierarchical ecosystem classification that has four levels: regional, local, vegetation development and field data collection (Figure 4). Each of those levels can be further subdivided into different classifications or can be subdivided into different levels. For example, the Regional Ecosystem Level is composed of the Ecoregion (Demarchi 1996) and the Zonal (Pojar et al. 1987) classifications, and each of those classifications can be further subdivided into a number of classes - 5 for the Ecoregions, and 4 for the Zonal Classification.

There are a number of cases where wildlife species and wildlife habitat inventories are directly or indirectly linked to other resource inventories. In some cases this can mean supplying required data or being an interim step in a more detailed inventory. In other cases, such as the highest level of habitat inventory, Ecoregion mapping that is done by the BC Ministry of Environment, Lands and Parks (1998) is based in part on a product (the Zonal Ecosystem Classification) that has been developed and mapped by the BC Ministry of Forests (1994). Even though the two classifications are mutually exclusive, they are supportive of each other.

There are also linkages between species and habitat inventory. For example, habitat mapping is used as a tool for species surveys, such as stratified random sampling. Also, habitat inventory is used to support species population estimates and the habitat maps provide the spatial level that is required to turn sampling into a population estimate. Conversely, species inventories are essential in providing quantified data for fine tuning capability and habitat suitability ratings; all rating done in the province are measured against the best densities ever counted in the benchmark habitats. In order to calibrate a project area that is not in the benchmark area, animal density determinations are necessary.

**Information Levels and Input Criteria:** At the national and provincial levels, Ecoregion

(Demarchi 1995 and 1996) and Biogeoclimatic Zonation classifications (Ministry of Forests 1994, Pojar et al. 1987, Meidinger and Pojar 1991) are sufficient tools to provide wildlife and wildlife habitat information for resource planning. These levels are mapped at 1:250,000 but are often presented at much smaller scales. The Ecodomain and Ecodivision levels, and even Ecoprovince levels, are useful for determining the ecological characteristics of species. For example, most of the thinhorn sheep are located in the Boreal Ecodomain, with all of the Stone sheep in the Boreal Cordillera Ecodivision and the Dall sheep located in the Subarctic Highland and the western portion of the Boreal Cordillera ecodivisions (Demarchi et al. 1999).

At the regional and sub-regional (LRMP) levels, overview ecosystem classifications that incorporate Ecosections, Biogeoclimatic sub-zone/variants and Broad Ecosystem classes (Resources Inventory Committee 1998a) provide the most meaningful information. These surveys add field information on wildlife species presence where little is known or documented. They are required, primarily for broad area strategic planning, but also for prioritizing landscape units for more detailed assessments. Overview species surveys provide data for habitat management options over broad areas - more intensive work is used for defining cut-block activities, identifying Wildlife Habitat Areas (WHA - which is a specific land use designation for protecting habitat for Species at Risk in British Columbia), and for determining the scope of general wildlife habitat conservation measures within the Managing Identified Wildlife, Biodiversity, and Riparian Management Area guidebooks under the provincial Forest Practices Code. Each of the units can be defined by geographical area (Ecosections) climatic parameters (Biogeoclimatic subzones), potential climax communities (Broad Ecosystem Units), stand age (succession), and edaphic characteristics (site modifiers), which combine to identify general ecosystem units (Figure 4). Each of those units can be evaluated on their ability to produce species such as bighorn and thinhorn sheep, either in the potential habitat condition that is ideal for those species or in the

current successional stage. Such evaluations are important for delimiting the potential habitat for those species and for determining habitat management potential. Due to the coarse nature of this scale, usually only winter range and summer range habitats are identified for ungulates.

At the landscape unit level, general ecosystem classifications (Resources Inventory Committee 1998b) that provide some detail on landforms, terrain and site series, while incorporating Ecosections and Biogeoclimatic sub-zone information provide a meaningful level of information for resource planning. Sample-based (1:50,000) inventory is required for forest management areas having high wildlife values that will not be undergoing forest development within the next 10 years. The 1:50,000 general-level habitat inventories and relative abundance wildlife species surveys provide information about the characteristics and distribution of wildlife species and their habitats and about approximate and potential locations of WHA's. This level of information contributes to decisions in the early stages of landscape-level planning about sensitive habitats and to the establishment of some landscape-level biodiversity objectives. The general-level inventories also provide the framework for limiting and focusing the detailed habitat information requirements in logging plans and silvicultural prescriptions. The rating of habitat units at this scale provides information on existing and potential habitats, for winter and summer ranges, as well as lambing habitat for species such as bighorn and thinhorn sheep.

At the logging or cut-block level, detailed ecosystem information is required in order to make sound resource management decisions. The sample-based (1:20,000) inventory is required for all forest management areas that within the next ten years will be undergoing active forest development planning. Detailed 1:20,000 wildlife habitat inventories and absolute abundance wildlife surveys provide information about the characteristics and distribution of wildlife species and their habitats and about potential locations of WHA's. This level of information contributes to decisions in the early

stages of forest development planning about where to log, and to the establishment of landscape-level biodiversity objectives. They also provide the framework for limiting and focusing the detailed habitat requirements in logging plans and silvicultural prescriptions. The rating of habitat use by each species at this scale can be precise, with habitat use by season and life history requisite (cover, foraging, migration, lambing, rutting, etc.).

Wildlife species and population inventories further address government's responsibility under the FPC to provide landscape-level biodiversity objectives, to identify and characterize species at risk, and to determine the measures required to protect critical habitats of those species that have been designated as *Identified Wildlife* in the *Managing Identified Wildlife Guidebook* (MIWG).

**DISCUSSION AND CONCLUSION:** The lack of progress towards the development of habitat-based capability maps in nearly 100 years of sheep mapping history has hampered bighorn sheep recovery efforts in the United States and Canada. If bighorn sheep populations are to be restored to any semblance of their past we should have a good handle on how many there were, where they were, how many there are, where they are, and where they could be. We believe that, because of the wide range in ecological diversity in British Columbia the habitat capability mapping method developed there is applicable to all ecosystems and many vertebrate species. The opportunity to take this system, develop it and apply it to both bighorn and thinhorn sheep is available to any agency or corporation willing to undertake this project.

**ACKNOWLEDGEMENTS:** We thank Diana Demarchi for preparing the figures 3 and 4 and Rick Pawlas for preparing the maps.

#### LITERATURE CITED

- Armentrout, D.J., and R.J. Boyd. 1996. Consequences of habitat fragmentation on wild sheep metapopulation management within USA. *Bienn. Symp. North. Wild Sheep and Goat Counc.* 9:149-158.
- Bailey, R.G., P.E. Avers, T. King, W.H. McNab (editors). 1994. *Map of Ecoregions and Subregions of the United States*. U.S. Department of Agriculture, Forest Service, Washington D.C. 1:750,000.
- Blower, D. 1988. Mountain sheep distribution and relative abundance in British Columbia. *Wildlife distribution mapping*. Big game series. Wildlife Branch. Victoria, BC.
- British Columbia Ministry of Environment, Lands and Parks and BC Ministry of Forests. 1998. *Field manual for describing terrestrial ecosystems*. 3rd Edition, *Land Management Handbook No. 25*. Province of BC, Victoria BC.
- British Columbia Ministry of Forests. 1994. *Biogeoclimatic Zones of British Columbia*. Victoria, BC.
- Buechner, H.K. 1960. The bighorn sheep in the United States-its past, present and future. *Wildlife Monograph No. 4*. 174 pp.
- Cassidy, K.M. 1997. *Land Cover of Washington State: Description and Management*. Volume 1 in *Washington State Gap Analysis Project Final Report* (K.M. Cassidy, C.E. Grue, M.R. Smith and K.M. Dvornich, eds.) *Washington Cooperative Fish and Wildlife Research Unit*, University of Washington, Seattle WA.
- Cowan, I. McT. 1940. Distribution and variation in the native sheep of North America. *Am. Midl. Nat.* 24(3):505-580.
- Demarchi, D.A. 1994. *Ecoprovinces of the Central North American Cordillera and Adjacent Plains*, Appendix A. *in* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, W.J. Zileinski (technical editors). *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx, and Wolverine in the Western United States*. General Technical Report RM-254, Ft. Collins, CO, U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 184 pp.

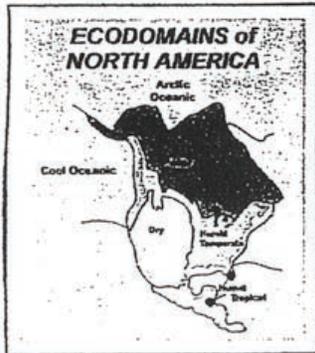
- \_\_\_\_\_. 1995. Ecoregions of British Columbia. BC Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, BC.
- \_\_\_\_\_. 1996 (author's draft). An introduction to the Ecoregions of British Columbia. BC Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, BC. 46 pp plus appendix and map (1:5,000,000).
- Demarchi, R.A. 1977. Canada's mountain sheep - their present status and future prospects. Pages 46-50 in T. Mosquin and C. Suchal (eds.). Canada's threatened species and habitats. Proceedings of the symposium on Canada's threatened species and habitats. Canadian Nature Federation and World Wildlife Fund: Ottawa, ON.
- \_\_\_\_\_, C Hartwig, and Donald A. Demarchi. 1999. The status of Rocky Mountain bighorn sheep in British Columbia. BC Wildlife Branch. Victoria, BC (In press).
- Ecological Stratification Working Group. 1995. A national Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa, ON.
- Forest Practices Code of British Columbia. 1997. Species and plant community accounts for identified wildlife: volume 1. BC Environment, Victoria, BC. 171 pp.
- Hornaday, W.T. 1914. The American natural history. Vol. II, Fireside edition. Charles Scribner's Sons. New York, NY. 332 pp.
- Meidinger, D., and J. Pojar. 1991. Ecosystems of British Columbia. Special Report Series 6. BC Ministry of Forests, Research Branch, Victoria, BC. 330 pp.
- Oregon Natural Heritage Council. 1998. 1998 Oregon Natural Heritage Plan. Oregon State Land Board. Salem, OR.
- Pfister, R.D., B.L. Kovalchik, S.F. Arno and R.C. Presley. 1977. Forest Habitat Types of Montana. U.S. Department of Agriculture, Forest Service General Technical Report INT-34, Intermountain Forest and Range Experiment Station, Ogden UT. 174 pp.
- Pojar, J., K. Klinka and D.V. Meidinger. 1987. Biogeoclimatic Ecosystem Classification in British Columbia. Forest Ecology and Management 22:119-154.
- Resources Inventory Committee. 1998a. Standards for Broad Terrestrial Ecosystem classification and mapping for British Columbia. Version 2.0. Terrestrial Ecosystems Task Force, Ecosystems Working Group, Victoria BC. 174 pp.
- \_\_\_\_\_. 1998b. Standards for Terrestrial Ecosystem Mapping in British Columbia. Ecosystems Working Group. 73 pp.
- \_\_\_\_\_. 1998c. British Columbia Wildlife Habitat Rating Standards. Version 2.0, Wildlife Interpretation Subcommittee. 55 pp.
- \_\_\_\_\_. 1998d. Species inventory fundamentals: standards for components of British Columbia's Biodiversity. No 1. Version 2.0. Terrestrial Ecosystems Task Force, Prepared by Ministry of Environment, Lands and Parks, Resources Inventory Branch, Victoria BC. 75 pp.
- Seton, E.T. 1927. Lives of Game Animals. Doubleday Page and Co., New York, NY. 780 pp.
- Sheldon, C. 1911. The Wilderness of the Upper Yukon. Charles Scribner's Sons. New York, NY. 354 pp.
- Swenar, P.Y., M. Gudorf and F.J. Singer. 1996. Application of a GIS-based bighorn sheep habitat model in Rocky Mountain Region National Parks. Bienn. Symp. North. Wild Sheep and Goat Council. 10:118-125.

Trefethen, J.B. 1975. The wild sheep in modern North America., Proc. Workshop on Manage. Biol. of North Am. Wild Sheep. The Winchester Press. New York, NY. 302 pp.

U.S. Department of the Interior, Bureau of Land Management. 1995. Mountain sheep ecosystem management strategy in the 11 western states and Alaska. Fish and Wildlife 2000. National Strategy Plans. Washington, D.C. 79 pp.

# DISTRIBUTION OF CALIFORNIA, ROCKY MOUNTAIN AND DESERT BIGHORN SHEEP IN BRITISH COLUMBIA AND THE UNITED STATES

Credits:  
 DATA COMPILED BY;  
 Raymond A. Demarchi,  
 Dennis A. Demarchi



## LEGEND

### ECODIVISIONS

- 1 BOREAL PLAINS
- 2 HUMID CONTINENTAL HIGHLANDS
- 3 HUMID CONTINENTAL PLAINS
- 4 HUMID MARITIME AND HIGHLANDS
- 5 MEDITERRANEAN HIGHLANDS
- 6 SEMI-ARID STEPPE HIGHLANDS
- 7 SUB-TROPICAL DESERTS
- 8 SUB-TROPICAL SEMI-DESERT HIGHLANDS
- 9 TEMPERATE SEMI-DESERTS
- 10 TEMPERATE SEMI-DESERT HIGHLANDS
- 11 TEMPERATE STEPPE PLAINS
- 12 SUB-TROPICAL STEPPE PLAINS

- ECODIVISIONS
- ECOPROVINCES
- INTERNATIONAL BOUNDARY
- PROVINCIAL / STATE BOUNDARY
- CONTINENTAL DIVIDE
- LAKES
- RIVERS
- PROVINCIAL AND STATE CAPITALS

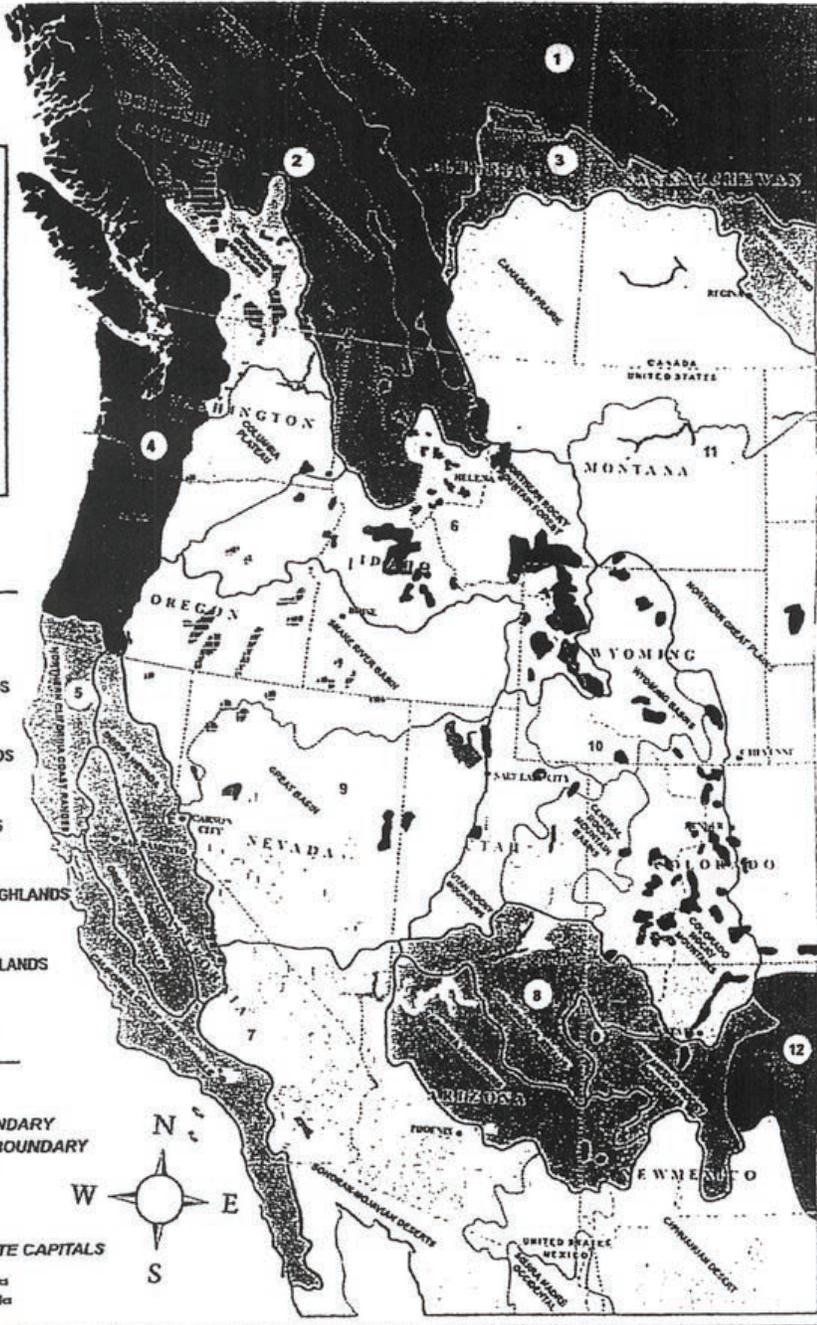


Figure 1

**DISTRIBUTION AND RELATIVE ABUNDANCE OF  
CALIFORNIA AND ROCKY MOUNTAIN BIGHORN SHEEP IN  
BRITISH COLUMBIA, ALBERTA AND ADJOINING UNITED STATES**

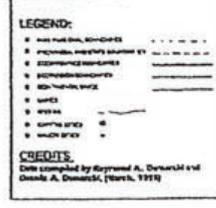
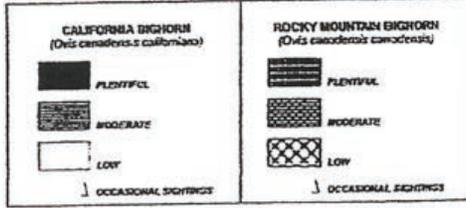
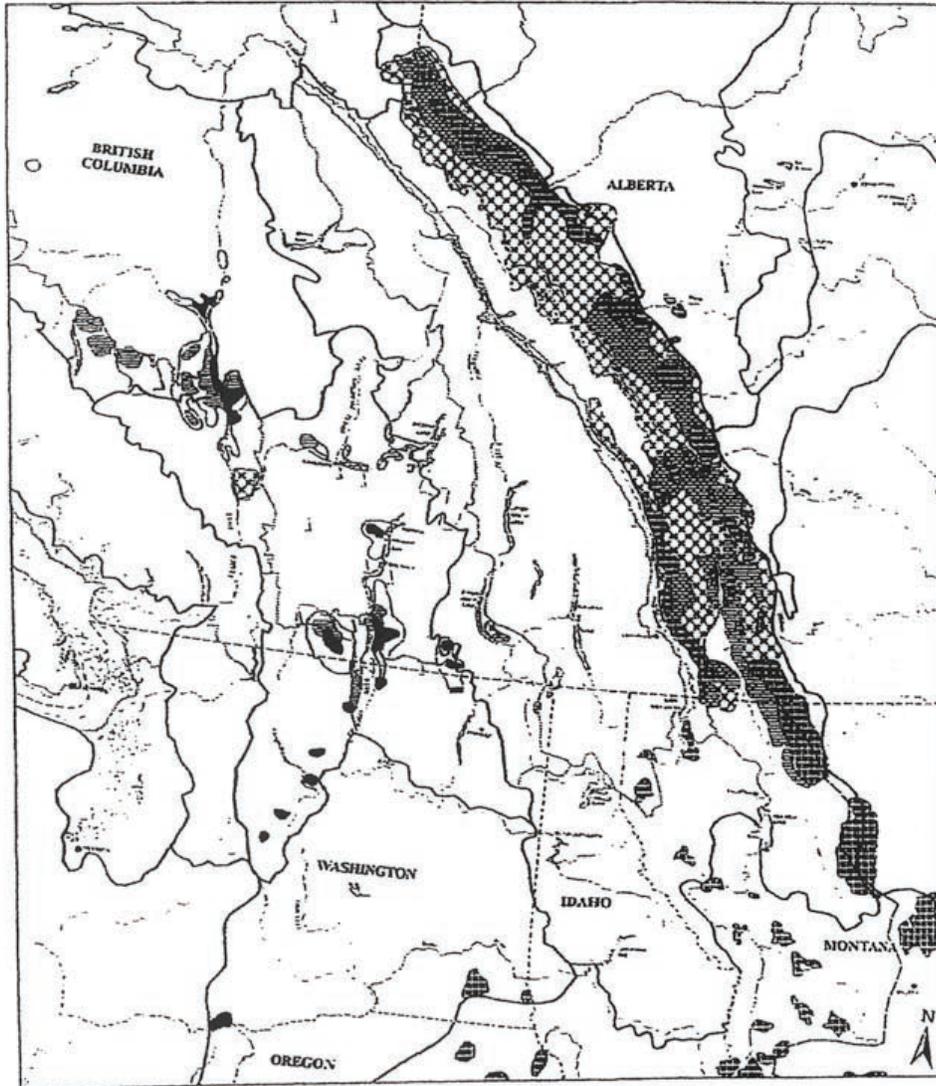


Figure 2

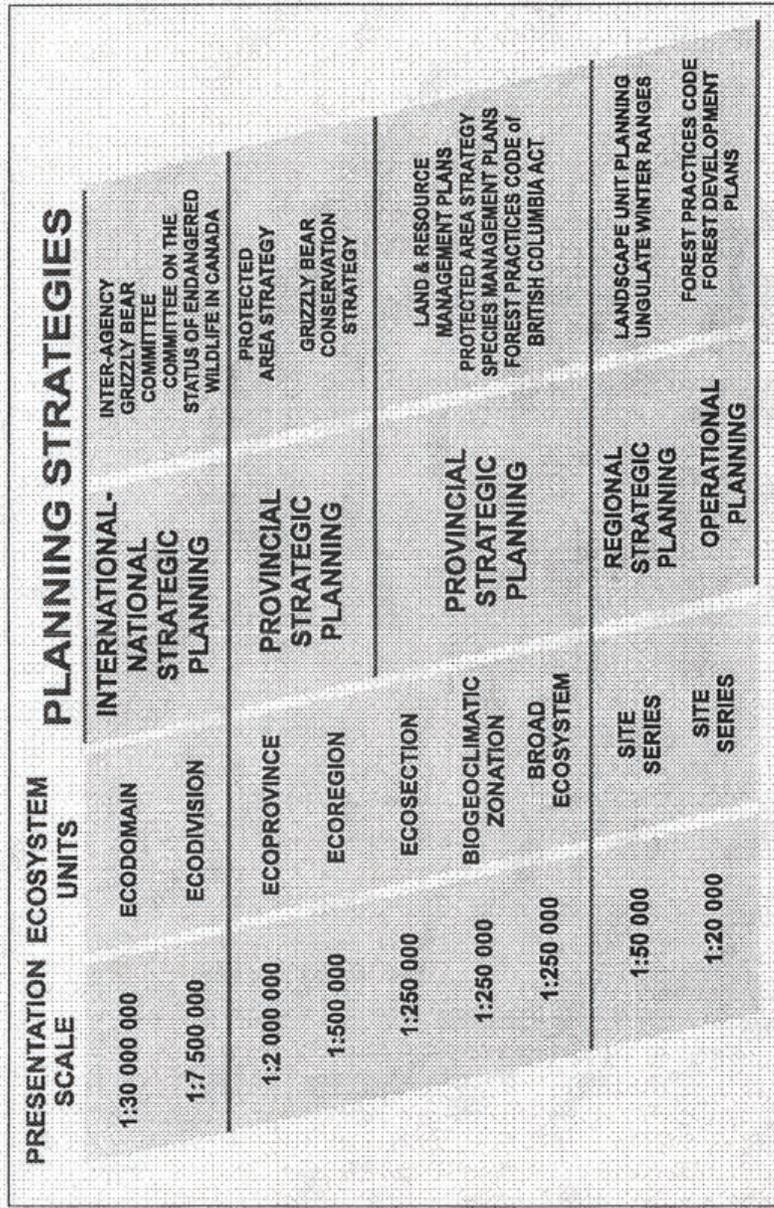


Figure 3. Ecosystem identification level and map scale used in various land based planning strategies that have been initiated by the British Columbia Provincial Government.

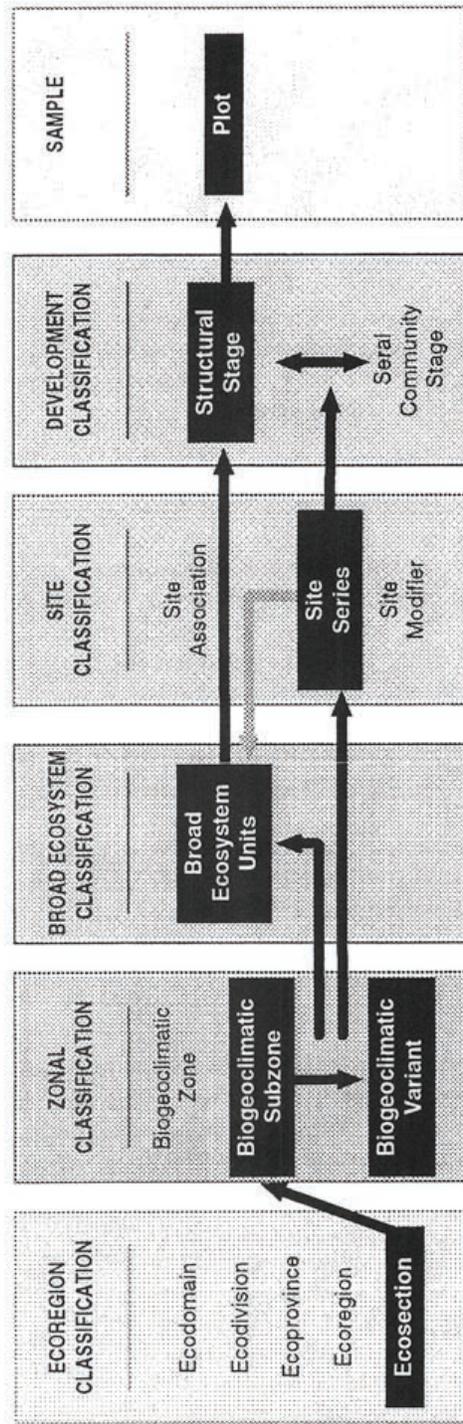


Figure 4. Relationship amongst the various ecosystem classification used for land based resource management by the British Columbia Provincial Government (Modified from Resources Inventory Committee, 1998b).

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## QUESTIONS, ANSWERS AND COMMENTS - DENNIS AND RAY DEMARCHI PRESENTATION

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**CRAIG FOSTER, OREGON:** This question is for Ray on the international registry for sheep. How often do you see that needing to be updated?

**RAY DEMARCHI:** I would say that you would have to update it at least every five years, and you probably would want to update it more often than that. The way we're operating electronically now, there's no reason why you can't update it every two years when you're going to conferences.

I wanted to say that this knowledge is in all your heads. We've just presented an objective way of mapping habitat. There was a comment made yesterday: Well, the habitat has changed so much in my state over the last 400 years, I haven't got any idea what the capability is. I don't know if you can figure that out, but I think you can. I mean, has the land changed, has the climate changed?

There are ways to figure out if the climate has changed. You only change the land form when you mine. There are very few other things that change the land form. A lot of the things have stayed basically the same.

What we're doing is a historical review of big game in British Columbia in an attempt to turn back the clock to what we had in the mid-1900s. We already did it for grizzlies. It worked pretty well. We're going to refine it as we go, and you learn as you go. But the thing is, right now, I don't think your ordinary mapping system for habitat is really that organized. I got this information and I've been writing to the states. We've got something that you should take a good, hard look at, because it's very, very useful.

**KEVIN HURLEY, WYOMING:** Ray, is there a report that might be available, that interested folks could contact you and perhaps get on a mailing list for more information about this?

**R. DEMARCHI:** Dennis has produced some publications. They're not in the refereed literature. We've got some map products and a lot of this stuff is still evolving. It's old GIS and it's evolving. There are reports but there is no mailing list per se. What we're trying to do is capture some interest so we can stimulate some discussion around this and get a project going. There's no such thing as the Flathead Island habitat or the Southern Selkirk Island habitat. They're all connected. If they're not connected, then maybe the challenge is to get them connected.

People are worried about endangered species. Look what happened to the salmon in the Pacific Northwest. It will change land use, agriculture, and everything forever in that area. So we have a pretty powerful argument. But we haven't applied the tools. You've got the wheels and you've got the axle. You need the bed of the wagon and you put it together and make a wagon. There's no official registry or anything, but it's starting to develop.

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**DONALD J. ARMENTROUT - SOMETIMES WILDLIFE SURVIVE BECAUSE OF BUREAU OF LAND MANAGEMENT/STATE FISH AND GAME AGENCY RELATIONSHIPS; SOMETIMES IN SPITE OF THEM**

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**Abstract:** Successful wildlife issue solving occurs on public lands when the Bureau of Land Management (BLM) - State Fish and Game Agency relationship focuses on what they can do for wildlife. Unfortunately all too many times these successes are overshadowed by misunderstandings of agency roles and missions, territorialism, and miscommunication on the part of one or both agencies. I provide a history of the legislative, judicial, and regulatory actions which have defined the BLM's role in wildlife management. Recommendations are provided which should help in moving beyond past errors and into a more successful record of cooperation.

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Successful management of wildlife on lands administered by the Bureau of Land Management (BLM), normally referred to as public lands, requires constant, effective coordination, and cooperation between the BLM and state wildlife agencies. This need for coordination and cooperation has been brought about by a history of legislation, judicial review, and regulation which mandates that the BLM is the land management agency for public lands and, therefore, the habitat manager on public lands. This fact only conflicts politically with the fact that Congress recognizes, and the Legislature in each of the 50 states has determined, that wildlife belong to the state in which they reside, and wildlife population management is the responsibility of their state wildlife agency. Adding to the confusion is the Endangered Species Act of 1973, as amended, which gives the U.S. Fish and Wildlife Service jurisdiction over how federally listed wildlife species are managed on public, and other federal lands.

Misunderstanding, and failure to accept each agency's jurisdictional role in wildlife management, leads to confusion, territorialism, and harm to the wildlife resource. The objective of this paper is to provide the reader with a historical background which defines the BLM's role in wildlife management. It is my hope that the information

provided here leads to a better understanding of the shared responsibility BLM and state wildlife agencies have for the wildlife resource and allows for more effective wildlife management.

**1934 TO 1946:** The Taylor Grazing Act of 1934 institutionalized the first significant recognition of the importance of wildlife on public lands (Muhn and Stuart 1988). Lands within Grazing Districts were officially opened to hunting and fishing, and the Secretary of the Interior was allowed to work with state wildlife agencies in managing wildlife habitat. Beginning in New Mexico and Oregon, one wildlife representative was added to the grazing advisory board. By 1939 all grazing advisory boards had at least one wildlife representative.

The Oregon and California Revested Lands Act of 1937 mandated the General Land Office more conservation responsibilities (Muhn and Stuart 1988). The revested lands were those lands granted to the Oregon and California Railroad Company in 1866 for construction of a railroad line from Portland, Oregon to the California border. To enhance the Government Land Office's (GLO) administration of the O&C lands the law called for implementation of a sustained yield cutting program. Lumber production was not to exceed forest

regeneration so that continuous forest production could be assured. The law also stated the lands could be used for grazing, recreation, watersheds, and wildlife.

President Harry Truman using his 1946 Reorganization Plan No. 3, merged the General Land Office and the Grazing Service forming the Bureau of Land Management (Muhn and Stuart 1988). U.S. Senator Guy Gordon, Oregon, read a prophetic statement into the Congressional Record, July 13, 1946. *I frankly say...that the very title of the bureau raises a very big question mark in my mind. It seems to me that the very purpose to be subserved is to change the historical policy of the United States from one of holding the public lands for transfer to ownership under private persons, to one of proprietary handling on the part of the United States government.*

**1946 to 1960:** BLM continued the Grazing Service's policy toward wildlife. Wildlife was reported to be an important part of BLM's range program (Muhn and Stuart 1988). District managers were instructed to work closely with their advisory board's wildlife representative and state officials in managing wildlife on public lands. Some states did help the BLM in rangeland reseeding projects which increased forage for wildlife as well as for livestock. During 1955, the BLM's basic policy toward wildlife continued to be concern for habitat. BLM Director Wozzley explained: *The management of wildlife [was] strictly on a basis of cooperation between the BLM as administrator of vast public land acreages, supporting large wildlife populations, and the respective states recognized as the owners of the wildlife* (Muhn and Stuart 1988).

**THE 1960s:** A young multiple use philosophy was endorsed within the BLM with passage of the Classification and Multiple Use Act (CMU Act) of 1964. BLM was reorganized to reflect new programs and authorities under this mandate. Concerns for wildlife, recreation, soil, and water resources were integrated into traditional programs (range, forestry, lands, and minerals) through a land use planning process.

Inventories of wildlife habitat on the public lands began in earnest after passage of the CMU Act. These inventories documented that public lands provide important habitat for wildlife, including approximately 3 million big game animals. Eighty-five percent of the desert bighorn sheep's habitat existed on BLM lands (Muhn and Stuart 1988).

In 1961 BLM hired its first biologist. Bob Smith, former Chief of Arizona Game and Fish Department, was brought into the Washington Office to lead BLM's newly created Wildlife Division. District Offices began hiring wildlife biologists in 1965, and began to enter into research projects with other agencies. Also in 1961, BLM signed a cooperative agreement for wildlife habitat management with the Arizona Game and Fish Department, and proceeded to reintroduce wild turkey and pronghorns on public lands in the Arizona Strip District.

**THE 1970s:** The Bald Eagle Protection Act of 1972 prohibited the poisoning of bald or golden eagles. This caused significant changes in the U.S. Fish and Wildlife Service's (USFWS) Animal Damage Control program (now in the Department of Agriculture) and the activities of livestock operators on public lands. In January 1977, the USFWS published guidelines forbidding activities resulting in disturbance to the birds (Muhn and Stuart 1988).

The Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.* 1973) provided for the federal listing of wildlife threatened with extinction and for designation of critical habitat by the USFWS. The act requires BLM to protect listed species and their habitats, and to consult with USFWS on activities which may affect species or on critical habitats. The act also provided for closer working relationships between the agencies in developing recovery plans for threatened or endangered species. In most states a Memorandum of Understanding (MOU) between the BLM and the state wildlife agency requires that the BLM consult with the state wildlife agency on any activities which may affect state listed species.

A test of the constitutionality of the Wild and Free Roaming Horse and Burro Act resulted in the Supreme Court hearing arguments from Thomas S. Kleppe, Secretary of the Interior, Appellant versus State of New Mexico et al. The decision of Kleppe, Secretary of the Interior v New Mexico et al. was rendered June 17, 1976 (426 U.S. 529, 96 S. Ct. 2285). A rehearing was denied October 4, 1976. The Supreme Court found in favor of the Secretary of the Interior. However, the Court did not restrict itself to the question of the Wild and Free Roaming Horse and Burro Act. In the opinion delivered by Mr. Justice Marshall, the Court discussed the power of Congress under the property and treaty clauses including, their powers in relation to wildlife. The treaty clause permits Congress to enter into and enforce treaty to protect migratory birds despite state objections. As pointed out by the Court, under the property clause Congress has the power to thin overpopulated herds of deer on federal lands contrary to state law (Hunt v United States, 278 U.S. 96 1928). Justice Marshall wrote...But Hunt, which upheld the government's right to kill deer that were damaging foliage in the national forests, only holds that damage to the land is a sufficient basis for regulation; it contains no suggestion that it is a necessary one. Basically, the Court in Kleppe v New Mexico held that Congress had full powers over the care, treatment, and management of public and federal lands.

On October 21, 1976, the Federal Land Policy and Management Act of 1976 was signed into law (90 Stat. 2744, 43 U.S.C. 1701 *et seq.*). The Federal Land Policy and Management Act of 1976 (FLPMA) defined the BLM's role in wildlife management. Within Sec. 102. (a) *The Congress declares that it is the policy of the United States that-(8) the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occu-*

*pancy and use;....* The BLM manages for the health of the public lands, and where appropriate provides food and habitat for fish and wildlife along with other uses. Section 103 (l) defines fish and wildlife development and utilization as a principal or major use, along with domestic livestock grazing, mineral exploration and production, rights-of-way, outdoor recreation, and timber production. FLPMA requires that the BLM maintain the health of the land while balancing principal and major uses as appropriate.

**1980 TO PRESENT:** Throughout the 1980s the BLM moved strongly toward cooperative and coordinated wildlife management through development of approximately 400 Habitat Management Plans (HMP) in cooperation with state wildlife agencies. To date over half of these plans have been implemented. Fish and Wildlife 2000, a strategic plan for the wildlife program was put into action. Since its inception the Fish and Wildlife 2000 program has been responsible for development of 20 National Strategy Plans for managing habitats used by several groups of fish and wildlife such as the *Mountain Sheep Ecosystem Management Strategy in the 11 Western States and Alaska*, dated 1995. Most of these plans were developed through active cooperation and coordination between the BLM and state wildlife agencies. Implementation of these plans has been slower than first anticipated.

On March 18, 1983, the Secretary of the Interior signed 43 CFR§ 24 entitled *Department of the Interior Fish and Wildlife Policy; State-Federal Relationships*. The Secretary's intent in issuing this regulation is to ... *strengthen and support, to the maximum legal extent possible, the missions of the States and the Department of the Interior to conserve and manage effectively the nation's fish and wildlife*. A primary purpose for issuing this regulation is to clarify and provide support for cooperative interagency management relationships in order to foster improved conservation of fish and wildlife. This cooperation is to be based upon a clear understanding of federal as well as state responsibilities in management of fish and wildlife resources. An example of this form of understand-

ing specific to the BLM is that the Secretary is empowered to close areas to hunting, fishing or trapping for specific reasons such as public safety, administration, or compliance with provisions of applicable law. This closure power is a power... to close areas to particular activities for particular reasons and does not in and of itself constitute a grant of authority to the Secretary to manage wildlife or require or authorize the issuance of hunting and/or fishing permits or licenses. This authority is not normally exercised without the concurrence of the state wildlife agency.

To further direct the BLM toward management of healthy rangelands the Secretary of the Interior, on February 22, 1995, enacted 43 CFR§ 4180 entitled *Fundamentals of Rangeland Health and Standards and Guidelines for Grazing Administration*. Within these regulations the Secretary directed that minimum standards developed under this regulation must address the following:...(4) *Habitat for endangered, threatened, proposed, Candidate 1 or 2, or special status species; and (5) Habitat quality for native plant and animal populations and communities*. These Rangeland Health Standards are developed through a Resource Advisory Committee (RAC) whose membership represents a cross section of the regional population and interests including representatives for the environment and wildlife. In some cases state wildlife agencies have been active on the RAC while others have not. The RACs also developed grazing guidelines to insure the Rangeland Health Standards are going to be met. Once established by the RACs, these standards apply at all times. If guidelines are needed to insure other uses such as off-highway vehicle (OHV) traffic is not adversely impacting rangeland health then the RAC can develop necessary OHV guidelines. Monitoring to determine if standards for native species are being met requires a cooperative effort between the BLM and state wildlife agencies.

**CONCLUSION:** Based on law and politics, those who manage the land, manage the habitat while those who are deemed owners of wildlife manage the populations. Leopold (1933) however, pointed out that without a mixture of sound habitat and, in

the case of game animals, sound harvest management, healthy wildlife populations cannot exist. Since the beginning of the Grazing Service, the BLM has been a land management agency. The right of the states to manage wildlife populations is also a matter of law. These laws, regulations, policies, and other political issues tend to separate the BLM biologists and state wildlife agency biologists from a fundamental truth. Just as there are not loose ends in an ecosystem, there is no conceivable way wildlife will survive without the merging of habitat and population management.

**RECOMMENDATIONS:** What must happen more than it does at present, and continue to grow into the future, is that wildlife habitat, and wildlife population biologists and managers, focus solely on the biology of the issue. We all must admit that no individual or agency among us fully understands the ecological fundamentals which drive wildlife habitat and population dynamics (Noss and Cooperrider 1994). We must recognize differences between the BLM and state wildlife agencies only to the extent that each agency must operate under different sets of laws and directions. Recognizing these differences and accepting them provides the platform for mutual working benefit. I have often wondered who is really watching out for the wildlife resource while agencies and their biologists struggle to see who is king-of-the-hill. Total adaptive management requires that all participants recognize that ecosystems as well as procedures are not clearly understood by everyone. We, as wildlife biologists, must recognize the strength in total adaptive management and practice it continually, remembering the only goal is wildlife health.

#### LITERATURE CITED

- Leopold, A. 1933. Game management. Charles Scribners Sons, New York, NY. 481 pp.
- Muhn, J., and H.R. Stuart. 1988. Opportunity and challenge - the story of BLM. USDI, BLM Washington D.C. BLM/YA/G1-88/001+1701. 303 pp.

Noss, R.F., and A.Y. Cooperrider. 1994. Saving nature's legacy - protecting and restoring biodiversity. Island Press, Wash. D.C. 416 pp.

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## QUESTIONS, ANSWERS AND COMMENTS - DONALD ARMENTROUT PRESENTATION

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**KEVIN HURLEY, WYOMING:** Don, I've got a question. I'll address it to you, and perhaps some other people can help answer this. Let me say at the outset, in Wyoming we have a really good working relationship with both the BLM and the Forest Service. Still, I do question some policies. When we as a state fish and game agency plan a transplant from point A to point B, the Forest Service has told us according to their manuals and policies, that is a state wildlife agency action, go for it. But the BLM tells us they need to do a NEPA analysis and issue a decision on our proposal.

I'm trying to figure out why the two systems are so different. We've had two examples of sheep transplants in recent years which the BLM and the department have been very much in sync on, but the public perception, especially by landowners, has been very adverse. Why does BLM have to approve our agency's proposal? Why does there need to be a decision by BLM on a state wildlife agency transplant proposal?

**DON ARMENTROUT:** Because BLM is under FLPMA, which is the act which tells BLM what to do, and this is not a categorically excluded action under NEPA. The Department of Interior regs are implemented. Now, the Forest Service works for the Department of Agriculture, their regulations may be different and they have a different act that authorizes how they manage the land; that's the difference.

**HURLEY:** I cannot figure out why there are two different interpretations of NEPA.

**ARMENTROUT:** There are categorical exclusions that exclude certain actions from NEPA. The Interior Department's categorical exclusion list may be different than the Forest Service's. Under some conditions, there are categorical exclusions, but when you hit a wilderness study area or a wilderness area on BLM, all bets are off. Categorical exclusions do not apply. It's different regulations. The Council On Environmental Quality directs each agency to develop their own regulations. DOD's regulations are different than Interior that are different than Agriculture that are different than Commerce.

**UNIDENTIFIED SPEAKER:** The difference appears to me as an interpretation on whether NEPA is only required for federal actions so the Forest Service has interpreted a transplant as not being a federal action. It is not a federal action and consequently, we don't do NEPA. It may be the BLM interprets transplants as a federal action and that's the reason why you must follow NEPA. It sounds like it's not regulation, it's an interpretation of whose action it really is.

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## WAYNE E. HEIMER - FEDERAL ASSUMPTION OF FISH AND WILDLIFE MANAGEMENT IN ALASKA

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**Abstract:** Shared opposition to the Alaska oil pipeline in the early 1970s resulted in alliance of Alaska Natives with environmental protectionists. For helping Alaska Natives forestall oil development until aboriginal claims were settled, protectionists received Alaska Native support of a congressional mandate placing at least 80 million acres of land in federal conservation systems. Legislative designation of these lands required another act of Congress. This act was drafted by environmental protection interests in cooperation with Alaska Natives. In deference to their former partners, preservationists wrote a racial "subsistence preference" for Natives into their legislation when it was introduced in the House of Representatives. Realizing that racial preference (along with its converse, racial discrimination) would have to be coerced in the equality-based state of Alaska, authors of the legislation identified a "hammer" to force racial preference. This "hammer" was threat of federal takeover of fish and wildlife management if the state didn't institutionalize racial preference/discrimination. In the Senate, both race preference and the "hammer" of federal takeover were deleted from the preservationist's legislation before it became law. Nevertheless, ever since passage of federal subsistence preference, the federal bureaucracy has threatened the State of Alaska with federal takeover if it fails to institutionalize "rural" (alternate language for Native) preference.

Alaska's constitution precludes discrimination among Alaskans, so Alaska could not comply with the federal preference law. As a result of its inferential interpretation (that federal takeover language is still operative even though it was deleted from the legislation before passage), the U.S. Department of the Interior exploited a passive Alaska Governor to take over wildlife management responsibilities on federal lands in 1990. The next governor, who insisted on the state's right to manage, filed a lawsuit to clarify state and federal management roles. The state lost at the Federal District Court level, and appealed the decision to the Ninth Circuit Court of Appeals. However, the subsequent governor (who succeeded the "state's rights governor") dropped the appeal to keep a campaign promise he'd made to secure Alaska Native endorsement of his candidacy. (Native power brokers, hoping for federal establishment of race-based preference, preferred federal management.) The dual (state/federal) management system created by these events persists even though it has proven spectacularly inefficient, and demonstrably harmful to "jointly" managed resources. Reasons "dual management" has failed include the increasing tendency toward political rather than biologically sustainable harvest allocations based on social considerations rather than biological data, particularly with respect to Dall sheep.

Expanded federal takeover of fisheries, navigable waters, and other uses on state lands which might affect subsistence harvests on federal lands is scheduled for October 1999. Presently the situation is at impasse. Wealthy and politically powerful Alaska Native corporations favor a federal management takeover, which offers the illusion of exclusive, unlimited use of fish and wildlife to Alaska Natives plus lucrative federal contracts for their tribes to manage Alaska's fish and wildlife. Alaska's Congressional delegation and Governor insist the only way to eliminate the federal takeover is to amend Alaska's Constitution to allow preference/discrimination. Other Alaskans, including senior Alaska Legislators who may control the legislature on this issue, remain committed to equality and, to date, have not allowed amendment of Alaska's constitution to comply with U.S. Department of Interior interpretation of the federal subsistence preference law. When the rhetoric surrounding this issue is stripped away, the federal side must maintain that even though the law does

not provide for federal takeover, federal takeover is permissible because the original "committee intent" (remember the federal "hammer" to force Alaskan preference/discrimination) "trumps" actual Senate amendments prohibiting federal takeover.

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The two preceding papers by the Demarchi brothers and Donald Armentrout discuss and extol the necessity of preserving the traditional cooperative roles of state and federal management agencies. This traditional arrangement has been that the states take ownership and assume management responsibility for resident fish and wildlife as part of their statehood agreements. On federal lands within the states, federal land management agencies protect and manage the habitats used by the state's fish and wildlife. "State management" has traditionally included primary responsibility for research on resident wildlife as well as allocation of harvests through setting of seasons and bag limits. This has been a highly successful arrangement, where a spirit of cooperation in conservation and enhancement of wildlife for the public good has prospered along with the wildlife and fish resources of the states.

In present day Alaska, this traditional and highly successful arrangement has been set aside in favor of what can be most politely defined as a social experiment in federal fish and wildlife management where the state has no real role. Based on their anticipation of amendments to the Alaska National Interest Lands Conservation Act (ANILCA), which would empower them to take over actual wildlife management on federal lands, the U.S. Departments of Interior and Agriculture usurped the traditional role reserved to the states (management through allocation of harvests, seasons, and bag limits) in 1990. The anticipated amendments never materialized, but the takeover occurred anyway. It is to be expanded to fisheries management on October 1, 1999.

**METHODS:** Federal takeover of wildlife management in Alaska occurred as the result of a series of events which I present in a lengthy annotated chronology (Appendix A). I prepared this chronological history as a "roadmap" to navigate among key elements of the ANILCA subsistence prefer-

ence controversy during the 4.5 years I spent as a "dual management" researcher, analyst, and historian assigned to the now-defunct Alaska Department of Fish and Game ANILCA Team. Initially, my team assignment was to provide evidence of harm to Alaska's wildlife management programs resulting from the federal wildlife management takeover of 1990. That is, I was assigned to document "harm" so the state would have "standing in court" to sue the federal government (*Alaska v. Lujan/Babbitt*) for return to the traditional management arrangement (referenced above) called for under the Alaska Statehood Compact. We succeeded in showing harm to state management resulting from federal usurpation of wildlife management on federal lands, were granted standing in court, and the Babbitt suit, as it came to be called, began its journey through the courts.

**RESULTS AND DISCUSSION:** When I presented a paper (Heimer 1980) on this topic almost 20 years ago at the Northern Wild Sheep and Goat Council, Bill Wishart asked if my concerns were for conservation or for state management control. At that time, I couldn't say. My answer is now, emphatically, "I am concerned about conservation!" Here's why.

Throughout human history, there have been few conservation successes. The most prominent and well documented of these successes have been localized in North America, and have been tightly linked to high status of publicly owned and available natural resources in which all citizens hold a vested interest. Historically this interest has been focused on harvesting the surpluses produced by modern wildlife management of these common property resources. If, as I conclude, conservation success flows from the linkage between public ownership and a broad base of interested user-conservationists, a departure from this conservation strategy should carry some risk of failure. This risk would result from limiting harvest oppor-

tunity to a small, elite segment of the formerly-broad user base. Predictably, if successful conservation results from a broad owner/user base, the results of limiting use to a small privileged group will compromise the status of resources in the broad public mind, and eventually compromise effective conservation. If through no other mechanism, conservation funding would be reduced.

The move toward federal management represents such a change, in that it essentially privatizes the ownership of fish and wildlife resources by reserving harvest opportunities for a socially-perceived racial minority that presumably “deserves” the privilege as restitution for past grievances. Under the federal plan, the broad user base, which formerly funded conservation through self-imposed taxes, would be excluded to provide a euphemistic “rural preference.” The essence of “rural preference” in Title VIII of ANILCA has historically been, and continues to be, racial preference for Alaska Natives. Alaska Native power brokers make no secret of the fact they hold being Native should convey different rights of use on Natives than on non-Natives because of spiritual ties between Native traditions associated with fish and wildlife harvests and Native existence as Natives. This position has resonated well with federal policy makers in Washington, D.C., although it’s theological underpinnings are slightly attenuated by replacement of emphasis on religion with emphasis on “cultural diversity.” As recently as summer 1998, Alaska Senator Frank Murkowski reported U.S. Secretary of Interior, Bruce Babbitt, told the Senator, “We have an agenda here, so stay out of our way.”

Of course we may only infer what the federal agenda is. I suggest two possibilities. The first, and most obvious (inferred from repeated Department of Interior justification of federal takeover on the basis of “Indian trust responsibility”) is compensation for past wrongs done to other American Indians by the federal government. It may seem reactionary or pretentious on my part to make this assessment and declare it a violation of law, but I think it logical because of the clarity of evidence on the subject. The legal intricacies that define

“trust responsibility” require that the federal government be the major superintending force in the lives of American Indians for which the government has trust responsibility. When Alaska Natives accepted the settlement terms of their aboriginal claims in 1971, all parties agreed the existing federal trust responsibility/tribal reservation system had been a failure, and pointedly defined a new relationship between Alaska Natives and the federal government. Settlement of the Alaska Native claims was pointedly race-neutral, and it was established that the federal government was no longer to be the major superintending factor in lives of Alaska Natives. They were essentially freed from second class citizenship as “incapable wards” for which the federal government had trust responsibility, and allowed to chart their own path independent of federal superintendence. The U.S. Supreme Court rendered this decision in 1998.

The relationship between Alaska Natives and the federal government contrasts markedly with the relationship between the federal government and other treated Indian tribes in the continental U.S. and Canada. Neither Alaska Native leaders nor the U.S. Department of Interior is willing to recognize this as a fact stated by the U.S. Supreme Court. As a result, the well-intentioned, beneficent federal government is more than willing to again relegate Alaska Natives to second class citizenship for which it claims “trust responsibility”, although the preposition “for” has been casually changed to “to”, which clearly allows the “trust” to manage the “trustees.” Hence, my conclusion is that grievance politics is a major factor driving the federal program.

Reversion to the outmoded doctrine of “federal trust responsibility” manifests itself through blind federal management board acceptance of what has come to be known and recognized as “Traditional Ecological Knowledge”, or TEK. At its best, TEK represents the cumulative knowledge of humans with long practical experience relating to the managed resources in their area of residence. The Alaska Native/federal management axis holds this source of information has been steadfastly ignored

by state managers over time, and has resulted in injustice to Alaska Natives who had insufficient influence on state management regulations. This position ignores the state's fish and game advisory committee system which has been operative in assuring local input to the Alaska Boards of Fish and Game since statehood.

In my 25 years of management experience and during my specific ANILCA team assignment to review game regulation histories since statehood, I found no cases where ignoring local input could be documented. The Alaska Board of Game has, historically established a record of considerations and findings prior to making decisions. Still, there are numerous examples of Alaska fish and game regulatory Boards denying petitions for special and specific uses, some of which were from local Native groups. However, just as many or more were from other special interests. Over the last 20 years, it has become increasingly uncommon for the Alaska Boards of Fish and Game (which make regulations on seasons, bag limits, etc.) to simply "grant" any local or special interest group's request without careful review of all aspects of the proposal, including supporting biological and management data. Typically, it takes several attempts for groups other than the Alaska Department of Fish and Game to achieve a regulatory change. This is because it usually takes several "rejections" over several regulatory board cycles for the special interest to gather and present all the information required to justify their proposed changes. Alaska Natives and federal managers portray this reasoned caution (to institute or change existing regulations) on the part of Alaska's regulatory boards as refractory to rural (i.e., Alaska Native) input. In fact, Alaska's wildlife regulatory history indicates the contrary. Perhaps a contrasting case could be made for fisheries regulations. I did not review fisheries management history. Grievance may be in the eye of the beholder.

Under the rubric of increasing responsiveness to "local" input, the federal system has implemented a policy (precipitated by a Bureau of Indian Affairs (BIA) solicitor's application of ANILCA Title VIII from state to federal regulators—see

Appendix A) of accepting TEK on an equal or preferential basis with biological data from the managed populations. When use of TEK is at its best, this should not cause a problem. However, application of TEK is not always "at its best." When not "at its best," TEK ranges from folklore or "just so stories" with no factual basis (e.g., that caribou will be suffocated by shed muskoxen hair), to synthesized or broadly translocated TEK used to manipulate the Federal Subsistence Board, usually to exclude non-local users.

Unquestioning federal acceptance of TEK does not bode well for the long-term conservation of wildlife. Where biology and modern science have not been applied to the management of wildlife harvests and habitats, conservation has failed. Frequently, regulations implemented by the federal government since its takeover of wildlife management in 1990 have been based more on political expedience (often involving spurious TEK) than on biological data. The results have been social stress and resource failures (Heimer 1993a, b, c and Heimer 1996a, b, c, d, e, f) as well as arbitrary discrimination against non-Native rural residents (Heimer 1996g). A detailed case history of Dall sheep management for subsistence use in Alaska (Heimer 1998) illustrates these failures.

An additional hazard to long-term conservation is that federal management (based on limiting participation justified by local bias using TEK of questionable validity) is that it pushes otherwise-competent state managers into bad decisions. With respect to subsistence management of Dall sheep, the state's managers have, for politically recursive reasons, maintained female sheep harvests from depressed and declining populations, allowed unprecedented liberal, high-risk subsistence harvest seasons with no realistic harvest reporting requirements in place, and invested heavily in esoteric federal studies that have no apparent management value (Heimer 1998). The following paper in this conference will review historic Alaskan state/federal cooperative efforts relating to Dall sheep which occurred primarily under the traditional state/federal model of shared responsibility for managing wildlife and habitat. (I was

responsible for many of them under the traditional arrangement.) Additionally, the next paper will review examples of “post-takeover era” studies that now pass for cooperation, but hold no promise for sustaining or increasing human benefits through federal or state management. While projects such as these new-era cooperative efforts appear worthwhile because they keep state managers involved in research or surveys on federal lands, they actually represent cooperation for cooperation’s sake.

[Supplemental note: With respect to federal fisheries takeover, the era of cooperation, even for cooperation’s sake, appears to have ended. In a recent example, high-ranking ADF&G managers, some with decades of commercial fisheries and subsistence management experience, spent nearly two years working on a cooperative fisheries management strategy to protect fisheries resources and minimize user trauma at federal takeover. When these experienced state managers took their work to the federal management board in late August of 1999 their efforts were dismissed without consideration; their input was not needed. Indications are that much federal management will be contracted to Alaska Native tribal entities.]

The cumulative result of political pressures and continual arbitrary actions by the federal management board has been loss, by state managers, of the very will to manage for human benefits, which I suggest was fundamental to the unique success of North American wildlife restoration and conservation. Should successful management, as I suggested earlier in this discussion, be linked to production of broad human benefits from commonly held resources, loss of the will to manage by trained professional managers will result in their being content to “rearrange deck chairs on the ‘Titanic’ of wildlife conservation,” which has clearly hit a “federal iceberg.” Cooperation *may* occur; management to sustain or increase human benefits is highly unlikely to follow.

The other possible federal motivation, to which I alluded many paragraphs ago, is the perhaps sincere belief that federal management will result

in a considerable improvement in conservation. I doubt the ability of the federal government to improve on conservation by transforming it from the cumulative, voluntary societal decision (by “owners” with a vested interest to practice self-interest conservation by obeying hunting regulations which assure a greater harvest over time) into an exclusive and expensive government activity.

This federal, or central government, approach to conservation is not new. It has been generally applied to conservation in Africa for almost as long as the successful North American system has been in effect. Compare the results. In most cases African governments are exclusively responsible for conservation, and too often must practice extreme coercive management of their citizens to protect wildlife populations. Paradoxically, they are often dependent on funds generated by hunter-conservationists from North America. How successful have these African efforts been in comparison with North America? Will application of the “African central government model” result in improved conservation in Alaska?

The most visible federal management effort to date has been the Endangered Species Act. Evaluating federal management effectiveness under this program may indicate how effectively central government conservation can be expected to function. Interior Secretary Babbitt’s disingenuous and self-aggrandizing pronouncements in early 1999 notwithstanding, for the money spent, results in this admittedly difficult area of management have produced vanishingly little. Secretary Babbitt’s repeated glowing accounts of species “saved” wither under scrutiny, which shows most federal “successes” were not results of federal management, but consisted of de-listing species that were erroneously listed in the first place. Data suggesting central government conservation will succeed are scarce. Data suggesting it will fail (at least in comparison to the traditional North American system) are abundant.

In summary, what we have in Alaska is a social experiment with an unproved approach to conservation in North America. Is there an answer?

Generally, the issue is at impasse. Reference to law, history, and recent U.S. Supreme Court decisions suggests the answer is clearly that fish and wildlife management is a right reserved to the individual states (Seekins et al. 1998). Nevertheless, administrative federal expropriation of the state's right is far advanced in Alaska. It seems obvious that today's U.S. Supreme Court would reaffirm the right to manage lies with the states, but getting the issue before the Supreme Court for adjudication is extremely difficult. Both federal interests and the present administration of the State of Alaska resist resolution of the issue by the U.S. Supreme Court because, they publicly state, Alaska Natives won't like the result. This contention is verified by Alaska Native positions of record. In Alaska, electoral politics involving Alaska Native money and influence appear to drive the present state administration (which has openly acknowledged it owes its initial election to Native interests by withdrawing the Babbitt suit, thus preventing it from reaching the Supreme Court). At the federal level, the broader social agenda of minority preference to recompense for past sins is acknowledged. The fact that environmental preservationists (which are major players in national electoral politics) favor federal management, with its already highly and increasingly restrictive elimination of consumptive uses of fish and wildlife, remains unacknowledged. However, recent proposed amendments to ban trapping on all federal wildlife refuges certainly appear to buttress the validity of this linkage.

The current proposed solution supported by those averse to adjudication is amendment of Alaska's Constitution to allow preference (or discrimination depending on how it affects you personally) consistent with federal interpretation of ANILCA to do things that the text of the law itself will not allow (see Appendix A). The suggested method of changing basic equality among Alaskans would be a popular vote on a constitutional amendment proposed by the Governor and Senator Stevens. To date, equality-driven Alaska legislators opposed to acceding to federal coercion by codifying federal preference/discrimination in Alaskan law have been able to block placing the proposed

constitutional amendment before Alaska voters. This has not been simple. These legislators have had to resist intense pressure during five special sessions of the Alaska Legislature called specifically to force them to concede to federal demands.

Alaska Natives have allocated millions of dollars for advertising to assure the amendment is placed on the general election ballot and passed. I consider it unfortunate that the major "pro-preference players" are more interested in an emotional "settlement by vote" than in a reasoned decision on whether laws are made on the floor of Congress through actions of elected representatives, or by establishing "committee intent" for subsequent interpretation by federal judges and solicitors to further the social agenda of federal bureaucrats. This difference lies at the heart of federal fish and wildlife management takeover in Alaska.

#### LITERATURE CITED

Heimer, W.E. 1980. A summary of Dall sheep management in Alaska during 1979—(or how to cope with a Monumental disaster). Proc. Bienn. Symp. North. Wild Sheep and Goat Counc. 2:355-381

\_\_\_\_\_. 1993a. Complications resulting from "dual management" of Sitka black-tailed deer in Southeastern Alaska. 15 pages *in* Report on dual state and federal management of fish and wildlife harvests. Alaska Dept. Fish and Game ANILCA program. Anchorage, AK. 242 pp.

\_\_\_\_\_. 1993b. Dual management of the Kilbuck caribou herd. 26 pages *in* Report on dual state and federal management of fish and wildlife harvests. Alaska Dept. Fish and Game ANILCA program. Anchorage, AK. 242 pp.

\_\_\_\_\_. 1993c. Complications to management of the Fortymile caribou herd resulting from "dual management. 37 pages *in* Report on dual state and federal management of fish and wildlife harvests. Alaska Dept. Fish and Game ANILCA program. Anchorage, AK. 242 pp.

\_\_\_\_\_. 1996a. Dual management of moose hunting near Lime Village, Alaska. Mimeo report. ANILCA program office files, Alaska Dept. Fish and Game. Anchorage, AK. 83 pp.

\_\_\_\_\_. 1996b. Dual management of deer on Kodiak Island. Mimeo report. ANILCA program office files, Alaska Dept. Fish and Game. Anchorage, AK. 27 pp.

\_\_\_\_\_. 1996c. Dual management of the Mentasta caribou herd. Mimeo report. ANILCA program office files, Alaska Dept. Fish and Game. Anchorage, AK. 71pp.

\_\_\_\_\_. 1996d. Dual management of the Nelchina caribou herd. Mimeo report. ANILCA program office files, Alaska Dept. Fish and Game. Anchorage, AK. 56 pp.

\_\_\_\_\_. 1996e. Dual management of Stikine River moose in Southeastern Alaska. Mimeo report. ANILCA program office files, Alaska Dept. Fish and Game. Anchorage, AK. 44 pp.

\_\_\_\_\_. 1996f. Complications resulting from dual management of moose in Minto Flats, Alaska. Mimeo report. ANILCA program office files, Alaska Dept. Fish and Game. Anchorage, AK. 84 pp.

\_\_\_\_\_. 1996g. Variations in customary and traditional use designation by the Federal Subsistence Board 1990 to the present. Mimeo report. ANILCA program office files, Alaska Dept. Fish and Game. Anchorage, AK. 54 pp.

\_\_\_\_\_. 1998. Consideration of a biological approach to management of subsistence sheep hunting through adjustment of bag limit. Bienn. Proc. North. Wild Sheep and Goat Council. 11:162-193.

Seekins, R., et al. 1998. An examination of U.S. Supreme Court decisions and other authorities of management of fish and wildlife in Alaska. Alaska Wildl. Cons. Assn. Univ. Alaska Library. Fairbanks, AK. 18 pp.

#### **APPENDIX A: AN ANNOTATED CHRONOLOGY OF FEDERAL TAKEOVER OF WILDLIFE AND FISHERIES IN ALASKA:**

[Author's note: Some reviewers of this annotated chronology (and there have been many over the last seven years) were uncomfortable with my selection of events and even more uncomfortable with my interpretive annotations. Where I was demonstrably wrong, I have changed text and comments. Since early reviews, I've found no credible reviewer able to show me where I should make further corrections of fact. The opinions I include (identified as such) are, of course, my own and are subject to change as further facts requiring a change in opinion are documented. I'd rather be right than consistent. WEH]

In Appendix A, I have listed historical events, ancillary facts, and some interpretive comments. I have indented, italicized and highlighted in boldface type the inclusion of related ancillary facts, together with my interpretive comments, so readers will know when I have departed from historic events directly and strictly related to the history of federal assumption of fish and wildlife management in Alaska.

—Prior to the 1960s, Native claims throughout the U.S. had been variously filed, considered, set aside, and scheduled for reconsideration without any real settlement.

—In the 1960s, Indian tribes in the Northeastern U.S. were successful in getting court judgments requiring the government to honor terms of existing federal treaties.

—General interest in aboriginal claims increased along with social awareness of past Native American grievances (remember the "Wounded Knee" demonstrations and a spate of grievance books such as "Bury My Heart at Wounded Knee," and later films such as "Dances With Wolves").

—During the 1960s, Alaskan Natives filed aboriginal claims, sometimes claiming discrete use areas, sometimes the entire state. Nothing much happened other than these claims began to grind their

way through the courts.

—In the mid-to-late 1960s the environmental movement began to define and achieve its agenda. Many historians date "Earth Day" 1965 as the beginning of environmental political power. The first major impact this agenda had on Alaska was passage of the Marine Mammal Protection Act. This act took marine mammal management from the state, placed it in the hands of the federal government, and limited use of marine mammals on the basis of race.

—Also in the late 1960s, oil was discovered on Alaska's north slope.

—After running one ice breaking tanker through the Northwest Passage, it became obvious that getting the oil to market was going to require a pipeline.

—Not everyone thought the pipeline was a great idea. The increasingly influential environmental community opposed it because it would transect what the community saw as the untrammelled, pristine Brooks Range. It was clear that the pipeline would require a road, and the North Slope Natives also opposed the pipeline and road because they would bring "outsiders" into what they saw as "their" country...even though they did not "own" it by any conventional definition.

—In order to meet their common goal, opposition to the pipeline, the environmental community and Alaska Natives formed an alliance in spite of their obviously disparate views on human use of animals. Cynics (or prophets) of the day asserted a devious, anti-hunting agenda drove the environmentalists to form the "unholy alliance" with the long term agenda of limiting the total amount of hunting opportunity in the future.

*Ancillary fact: Whether the cynic/prophets were right in their assertion, federal wildlife management through the Federal Subsistence Board has certainly decreased hunter use of federal public lands.*

—Alaska Natives were the dominant legal force in this alliance because the pipeline could not be built until title to the pipeline right-of-way was secure. This meant the Native land claims had to be settled before the pipeline could be built.

—The alliance was successful. Using the Native land claims as the major issue, and with the support of the environmental community, pipeline construction was delayed until the Alaska Native Claims Settlement Act (ANCSA) was passed in 1971. Alaska Natives got 44 million acres of land and approximately one billion dollars, half of which the state had to pay out of oil and gas development revenues.

*Ancillary fact: The state paid this debt "up front," (which is one reason permanent fund dividend checks are not even larger than they are). This debt is no longer owed.*

—Included in ANCSA was Sec. 17 (d) (2), which was what the environmental community got out of the deal for supporting Native claims interests. This section created the vast new national parks, refuges, forests, and wild and scenic rivers under the Alaska National Interest Lands Conservation Act (ANILCA) in 1980. ANILCA was primarily a land-control act generated by the environmental community and federal land-management agencies that wanted more Alaskan land. Their ties to Alaska Natives were sufficiently strong that Title VIII which, as drafted in the House of Representatives, included not only legal recognition of subsistence on a **racial basis** (like the Marine Mammals Act) but also provision for a **federal management takeover** if the state did not provide race-based subsistence preference on federal public lands. **These committee draft provisions did not make it into the final bill (they were "amended out" by the Senate), which was signed into law by President Carter.**

—The House of Representatives positions on racial preference and federal management takeover were objectionable to many Alaskans. In an effort to keep Congress from including Title VIII (as drafted and presented during committee hearings

on ANILCA), Alaska's Congressional delegation (primarily Senator Ted Stevens) recommended to the Alaska Legislature that it pass a state subsistence law as a preemptive measure. Acting on this advice, the legislature passed the state's first generic subsistence law in 1978.

—In spite of the state's subsistence law (which antedated ANILCA by 2 years), Congress included a modified version of Title VIII (the subsistence provision) in ANILCA anyway.

—In 1980, ANILCA finally made it to the floor of congress (after President Carter forced the issue by creating immense, expansive National Monuments (using the Federal Antiquities Act) that tied up Alaska's economic future so tightly that Senators Stevens and Gravel were willing to compromise).

*Ancillary fact:* The original House version virtually precluded economic development in Alaska. Consequently, Alaskan Senators Stevens and Gravel threatened to block it in the Senate. When they did this, President Carter told them that if they did, he'd hurt them so badly they'd be begging for a compromise in a year. The Senators thought the President was bluffing, and blocked the bill in the interests of Alaskan economic development. President Carter wasn't bluffing. The result was imposition of National Monument status (which ties up all economic development) on almost half of Alaska, a much worse economic situation than the ANILCA land designations.

*Interpretation:* Because Senators Stevens and Gravel were more concerned with economic development than state management of fish and wildlife (which they would eventually "amend out" of the bill) they were willing to make fairly radical compromises to assure further economic development in Alaska. Hence, in retrospect, they compromised the state's right to manage, as called for under both state and federal constitutions, for economic development.

*Opinion which goes beyond interpretation:* This emphasis on economic development, particularly

*in rural Alaska still seems to drive Senator Stevens on this issue. I think he still fears federal takeover will stifle economic development.*

—On the floor of the Senate, two important aspects of the House version of ANILCA Title VIII were changed. The first was **pointed elimination of the racial designator for subsistence preference** in Title VIII.

*Ancillary fact:* ANILCA, as it was finally drafted in committee went through the House without significant modification. That meant it contained **both the racial preference and federal takeover** provisions in Title VIII. However, two important amendments occurred on the Senate floor. The **first** was elimination of racial preference by replacement of "racial" with "rural" preference. It has long been common knowledge that the term, "rural residents," and repetitive use of the term "and non-Native" in the FINDINGS, POLICY, and DEFINITIONS sections of ANILCA were specific to elimination of race as the definer of subsistence preference in the Senate version (which became the text) of ANILCA.

*The second important amendment was substitution of "judicial oversight" (Sec. 807) for "federal takeover" as the "enforcement teeth" that was to assure the state provided the subsistence preference defined in ANILCA Title VIII.*

*These two changes by the Senate were never challenged by the House, but neither were they ever accepted as valid by ANILCA's original authors, the U.S. Department of Interior, or Alaska Native leaders.*

*Interpretation:* This is why we have controversy over federal take-over today.

*Ancillary fact:* The Senate version of ANILCA (which substituted "rural" for "racial" preference and judicial enforcement for the threat of federal takeover) passed a Democrat-controlled Congress during a Democratic administration (President Carter's) at the 11th hour before

Congress adjourned in the fall. Passing legislation that contains differences in detail between House and Senate versions is common. Usually, differences in details are resolved by joint House-Senate conference committee and the committee's compromise version goes on to become law. If a conference committee cannot agree on compromises, the legislation is usually returned to the floor of the originating house for further action.

**Interpretation:** From our vantage point (15 years later, and in the midst of an unprecedented administrative federal takeover of fish and wildlife management) this difference between Senate and House versions doesn't look like it was a "detail." Major policy differences are probably too important to simply work out in conference committee.

**Ancillary fact:** By not asking for a joint House-Senate conference on the bill, its **House sponsors (and the bill's authors) tacitly accepted the Senate version.**

**Interpretation:** Perhaps there were political reasons for this decision. If a conference committee had failed to resolve the differences between Senate and House versions, there was no recourse but to reintroduce the bill (in the House) during the next session. Considering the passion of the Congressmen and the dedication of high level federal agency bureaucrats to "saving the crown jewels of Alaska" (a commonly used phrase during the emotionally charged ANILCA debates), it is logical to believe the oral history that says the House sponsors planned to amend racial preference and federal takeover language "back into" ANILCA during the next Congressional session. Attempting resolution of differences of this significance in a conference committee would have certainly been a major undertaking, and probably would have precluded President Carter (and Democratic Congressmen) from taking credit for "saving the crown jewels of Alaska" during the upcoming election campaign.

**Ancillary fact:** As a result of that November's election, the balance of power changed. Presi-

dent Carter lost to President Reagan, and Democratic control of Congress eroded.

**Interpretation:** This meant the Democratic House leadership (whose specific "race preference or federal takeover" provisions had been replaced by the Senate's "racial preference and judicial oversight") would have to face a decidedly less friendly group during the next session (not to mention a sitting Republican President who favored state's rights, and was certain to veto the amendments).

**Ancillary fact:** With these realities facing them, the House ANILCA sponsors didn't balk at sending the Senate version to President Carter, who signed it into law (even though it didn't contain the race-preference and federal takeover language the House sponsors wanted).

**Interpretation:** Apparently accepting the "imperfect" (as they saw it) subsistence enforcement provision for a year was preferable to risking loss of what they had secured with respect to "saving Alaska's crown jewels."

As passed and without the sort of fine tuning that typically occurs in conference committees, ANILCA is unusually vague and internally inconsistent. This vagueness has allowed interests favoring federal takeover the opportunity to achieve federal management through administrative means even though it appears to be precluded by the language of ANILCA (which has persisted for the last 17 years).

**Ancillary fact:** The Senate's "judicial oversight" provision (which replaced the House's "federal takeover language") was Sec. 807.

**Interpretation:** This section of the law demonstrates the difficulty of working with ANILCA. Finding out just what Sec. 807 actually says is difficult because readily available copies of ANILCA are said to contain a version of Sec. 807 that has since been amended. This amendment allegedly took place almost 15 years ago. The allegation that Sec. 807 was "amended" was clarified by Fairbanks resident, Stan Bloom, who

sent me the following e-mail on July 11, 1998. Stan wrote:

*"I have two copies that BLM put out in the past Sec. 807 was not amended but paragraph (b) was repealed by P.L. 98-620. It [formerly] said:*

*(b) A civil action filed pursuant to this section shall be assigned for hearing at the earliest possible date, shall take precedence over other matters pending on the docket of the United States district court at the time, and shall be expedited in every way by such court and any appellate court.*

*This whole paragraph was repealed. Copies of the laws I have just omit this repealed paragraph and go directly to (c). . . . Sincerely, Stan Bloom"*

*Ancillary fact: The readily available version of ANILCA Sec. 807 provides aggrieved subsistence users (who don't think the state gave them sufficient opportunity or allowed them to meet their needs) access to federal court (after they've exhausted the administrative appeal process). If these users prevail in federal court, the court can direct the state to provide increased subsistence use opportunities according to ANILCA language.*

*Interpretation: Because the Sec. 807 process in the commonly available version of ANILCA was followed exactly in the Lime Village moose and Kilbuck caribou management cases before the federal takeover of 1990, I accept Stan Bloom's explanation. The fact that the House version of ANILCA gave hearing subsistence claims a higher priority than all other activities of the United States District Court and subsequent appellate courts (deleted by P.L. 98-620) may bespeak a zeal leading to questionable rationality attending the subsistence preference issue in the House of Representatives.*

—Once ANILCA was passed, some unknown person or entity in the Interior Department in Washington, D.C. selected "rural residence" as the "litmus test" of whether the state subsistence law

was "of general applicability" as specified (to prevent federal oversight) in ANILCA Sec. 805 (d).

—The Secretary of the Interior immediately threatened a takeover if the state's subsistence law didn't operate according to the federal (rural residence) litmus test.

—The Joint Boards of Fish and Game (Alaska's wildlife regulatory Board) tried to pacify the Secretary by administratively linking rural residence with subsistence preference through regulations (1981).

*Ancillary fact: Governor Jay Hammond and his Attorney General failed, at this point, to assert the state's right to manage indigenous wildlife. For some unknown reason they failed to insist that the feds stick to the letter of Title VIII as passed by Congress.*

—In what came to be known as the Madison case (1985), this administrative (through regulatory) linkage of subsistence preference with rural residence was found to be illegal.

—The Secretary of the Interior immediately notified the State of Alaska, through the Undersecretary for Parks and Wildlife, that it was out of compliance with ANILCA, and threatened yet another federal takeover.

—To avoid this second federal takeover threat, the legislature passed Alaska's second subsistence law, which legally linked preference to rural residence. Once this was done (in 1986), the Undersecretary for Parks and Wildlife, Bill Horn, notified Alaska that it was once again in compliance with ANILCA; and, that a federal takeover would not occur.

—The second subsistence law was challenged by a citizen named McDowell.

—In ruling on the McDowell case (1989), the Alaska Supreme Court said it was unconstitutional to discriminate among Alaskans on the basis of

their residence location.

—Based on the Interior Secretary's judgment that Alaska was again out of compliance (having failed the rural residence litmus test again) the federal government took over subsistence harvest allocation of wildlife on federal lands (about sixty percent of Alaska).

—To accomplish this takeover, the Secretaries of Agriculture and Interior used the administrative federal rulemaking procedures to establish an administrative structure (the Federal Subsistence Board) for this function. Federal rulemaking was the vehicle for establishing the Federal Subsistence Board because ANILCA (as passed by Congress) contained no provision for federal takeover (see compromises above).

*Ancillary fact: Congressional compromise produces vague laws.*

*Interpretation: ANILCA may be the grandest compromise ever produced by Congress, even though it never underwent joint House-Senate conference resolution. Looking at what has happened 20 years after ANILCA passage, it appears the forces behind the House version simply decided to "save" Alaska through federal administrative means instead of risking legislative compromise.*

*Ancillary fact: When Congress passes a vague law, Congress implicitly refers implementation of the law to the responsible agencies (in the case of ANILCA Title VIII, the Depts. of Interior and Agriculture). When this happens, the agencies refer the job of interpreting the vague law to their solicitors. Typically, the solicitors refer to committee testimony to determine legislative intent.*

*Interpretation: The "subsistence problem" relating to ANILCA stems from the fact that the committee intent was different from the law Congress passed on the floor. When federal solicitors went to committee hearing records to establish legislative intent, the problems were*

*obvious because the Senate "amended out" the House committee intent from the final version of the law that it passed on the floor.*

*Ancillary fact: Because of the changes made in the Senate, the Depts. of Interior and Agriculture no longer had takeover language in the bill. Consequently, they had to use administrative means, federal rulemaking, to establish the machinery, called the "administrative structure" (the Federal Subsistence Board) for federal takeover.*

—This Federal Subsistence Board was composed of the regional directors of the federal land-management agencies in Alaska plus the director of the Bureau of Indian Affairs (BIA). In addition to discharging their specific agency responsibilities and mandates, these directors are supposed (according to federal agency interpretation of ANILCA Title VIII) to manage subsistence harvest allocation by passing suitable regulations, seasons, bag limits, and user restrictions for federal public lands.

—Actions of the Federal Subsistence Board were unsatisfactory to the state in many cases.

*Interpretation: To me it seems obvious the two responsibilities, achievement of federal land management agency agenda and subsistence management, conflict for some federal land management directors (most notably the National Park Service).*

*Ancillary fact: The record shows the Regional Directors on the Federal Subsistence Board are not above furthering their agencies' agendas through use of what they call, "ANILCA-mandated (rural) subsistence management authority" inferred from House ANILCA committee intent language (see Discussion section).*

*Interpretation: When it has suited any individual director, each has placed his agency's agenda regarding control of federal land above allowing subsistence uses. For this reason, I suggest federal land-control (the primary job of a federal land-*

management agency regional director) is a primary cause of the symptoms that define "the dual management-subsistence problem."

*Ancillary fact: ANILCA was not a subsistence law, but a federal land-control law, which occurred at the behest of federal land-management agencies and the national environmental community. Subsistence is a secondary priority for ANILCA, just as it is for federal land managers.*

—Creation of the Federal Subsistence Board to take over subsistence harvest allocation, as well as the cumulative effects of "agency interest" actions by individual agencies through the Federal Subsistence Board, eventually led to sufficient state dissatisfaction that legal action was undertaken.

—Alaska Governor Hickel initiated litigation against Secretary of Interior Lujan, and subsequently Secretary Babbitt (1992), in an effort to reestablish state management of indigenous wildlife (as guaranteed in Alaska's Statehood agreement and buttressed in ANILCA) rather than implementation of land-control regulations (driven by *ex post facto* interpretation of committee intent rather than what Congress actually passed). It was particularly onerous to the state that federal management was established by federal agencies through the federal rulemaking process, rather than by deliberated legislation.

—As managed by Hickel's Attorney General, Charles Cole, and the Federal District Court Judge, H. Russell Holland, this suit evolved into a challenge of "the standing" of the federal government to manage indigenous wildlife when it was on federal public land as defined in ANILCA. Judge Holland eventually narrowed the focus of the Babbitt case to what he called the "who" question.

*Interpretation: I don't know whether Attorney General Cole had any control of the direction this suit took, but what started out as an attempt to make the feds abide by the text of their own law, ANILCA, got to be a much larger question. The results of management of the case in this manner*

*(whether it involved the Attorney General or not) were highly significant in that they opened the door to federal takeover after it had been deleted from the text of ANILCA before passage.*

—Alaskan Natives saw this litigation, the state's effort to regain state management of wildlife, as a threat.

*Interpretation: Native opposition is understandable given the racial preference objectives of record by the Alaska Federation of Natives (AFN). After all, if the state were to prevail, the federal agencies, which had been currying favor with Alaskan Natives through permissive subsistence regulations, would no longer be capable of doing so. Also, if the federal system gave way to the state system, "federal trust responsibility for Native Americans" could no longer provide the prospect of federally driven race-based Native preference. Racial preference has been the objective of Alaska Natives since the Marine Mammal Protection Act made it a fact more than 30 years ago.*

*Ancillary fact: Native interest in establishment of "trust responsibility" associated with Alaska Native sovereignty issues was repudiated four times by Judge Holland in 1995. Holland's decision was overturned by the Ninth Circuit Court of Appeals. The issue was eventually decided in favor of the state by the U.S. Supreme Court in what was called the Venetie case.*

*Interpretation: The U.S. Supreme Court ruled that the Venetie Indian Reservation was not "Indian country." Because "trust responsibility" is linked to "Indian country" and because there is no "Indian country" in Alaska, there can be no "trust responsibility" on the part of the federal government for Alaska Natives. Hence, federal "trust responsibility" lost its power as a linkage between Native sovereignty and racially based subsistence preference with the Venetie decision.*

*Ancillary fact: In spite of the U.S. Supreme Court ruling, state management was unacceptable to Alaska Native power brokers. The offi-*

cial AFN position of record still favors maximal federal management in lieu of race-based Native preference.

*Interpretation:* Recalling the racial basis of marine mammal use illuminates the rationale of this position. These facts form the basis of my suggestion that race-power is a contributing cause of the symptoms we call the dual management-subsistence problem.

—The initial ruling in Federal District Court (Alaska v. Babbitt) was unsatisfactory to the state. The state appealed to the Ninth Circuit Court of Appeals (1994).

*Ancillary fact:* In this ruling, Judge Holland reviewed the history of ANILCA passage. The facts about amendments on the Senate floor at the 11th hour come directly from his opinion. He found that the Senate had, in fact, “amended out” federal takeover from ANILCA, but rendered his opinion that Congress surely must have meant to provide federal takeover responsibility. Hence, Judge Holland’s answer to his “who” question about who should manage on federal land was, “the feds.”

*Interpretation:* It is no wonder the state appealed the case to the next higher court, the Ninth Circuit Court of Appeals.

—Governor Hickel retired from the Governorship.

—In the course of a very close campaign for Governor’s office, the Knowles-Ulmer ticket sought endorsement of the Alaska Federation of Natives by promising to drop the state’s litigation against Secretary Babbitt. The Knowles-Ulmer ticket won the endorsement of AFN, and eventually a “three party” election by slightly more than 500 votes.

—Immediately upon election, and only days before the case was to be argued before the Ninth Circuit Court, Governor Knowles canceled the Babbitt suit because, he said, “many Alaskans thought it was anti-subsistence.”

—About this time, President Clinton’s newly appointed Bureau of Indian Affairs Secretary, Ada Deer, appointed an activist lawyer (Robert Anderson) with a background in ANILCA-related Native interest litigation, to the post of BIA solicitor. Shortly after this appointment, the Federal Subsistence Board received a pointed solicitor’s opinion from Mr. Anderson (1995). This opinion essentially told the Federal Board that it could not deny any proposal offered by a Federal Regional Subsistence Advisory Council without explaining why, according to criteria described in ANILCA Sec. 804 (**which deals with state—not federal—management**).

*Ancillary fact:* Sec. 804 says:

*The state rulemaking authority may choose not to follow any recommendation which it determines is not supported by substantial evidence presented during the course of its administrative proceedings, violates recognized principles of fish and wildlife conservation or would be detrimental to the satisfaction of rural subsistence needs. If a recommendation is not adopted by the state rulemaking authority, such authority shall set forth the factual basis and reasons for its decision (emphasis added). [Note: the state rule-making authorities are the Boards of Fish and Game.]*

—Federal land-management directors on the Federal Subsistence Board lacked either the courage or biological understanding to apply these criteria at their April 1995 meeting, as they simply “rubber stamped” all proposals from Federal Regional Subsistence Advisory Councils. Notable results included highly arbitrary and divisive decisions about who could and could not hunt moose in the Kenai Peninsula, closure of the pipeline corridor to bowhunting (later reversed upon public outcry), and elimination of caribou hunting on the Bristol Bay side of the Alaska Peninsula (presumably so caribou would migrate unimpeded to the Pacific side—which is not really satisfactory caribou habitat, though caribou sometimes pass through there). Additionally, the Dall River access controversy, and considerable unwar-

ranted expansion of the Arctic Village Subsistence Management Area for Dall sheep, developed.

*Ancillary fact: Accountability to documentable fact or empirical scientific data were not compelling factors in these decisions. Proposal by a Regional Subsistence Advisory Council (but-tressed by what has come to be known as local knowledge or "traditional ecological knowl-edge") was all that was required.*

—After canceling the Babbitt litigation, Governor Knowles appointed Lt. Governor Ulmer to come up with a "consensus plan" to solve the dual management-subsistence problem (1995). Lt. Governor Ulmer used "quiet diplomacy" to derive her "consensus plan." The plan failed.

*Interpretation: I think the plan failed because the Lt. Governor did not seriously consider input from interests outside the Alaska Native community, Alaska's Congressional delegation, and the environmental community. Her "diplomacy" was so "quiet" and her plan so Alaska Native position centered, other user groups felt left out of the plan.*

—In a case related to the Babbitt suit, Judge Holland set out to solve the "where" issue of federal management. The case was called the Katie John case. Alaska Native plaintiffs in this case had asked the Federal District Court Judge (Holland) to rule that navigable waters are federal public lands upon which the federal government has subsistence management jurisdiction. Holland ruled in favor of the Natives. The state appealed.

—Upon appeal, the Ninth Circuit Court of Appeals overturned Holland, but did find that the federal government has reserved water rights for federal installations.

*Interpretation: Federal reserved water rights assure that any federal installation that the federal government may establish automatically has reserved, for it, enough water to serve the functions of that installation. Typically these rights assure the conventional water needs for federal*

*facilities such as military bases or federal hold-ings that may require irrigation water.*

In its ruling, the Ninth Circuit Court found that because subsistence fishing occurs in **some** navigable waters, and the federal government has reserved water rights, the federal government has **some** responsibility for subsistence preference provision in **some** navigable waters.

*Ancillary fact: Reserved water rights is a concept from irrigation law, which basically says an upstream user cannot deprive a downstream user of water to which he is legally entitled. Federal reserved water rights assure Federal agencies of enough downstream flow to fulfill the purpose for which any federal facility may be established.*

*Interpretation: The actual relevance of enough downstream water flow to flush toilets at a National Park headquarters or to cool generators at a Department of Defense radar site may be only distantly related to allocating flow for salmon migrating upstream.*

—Based on the court's reiteration that federal facilities are assured enough water for their intended function, the federal government proposed, through expanded rulemaking, a plan to assume fisheries management in the navigable waters of Alaska (1996). Under these proposed regulations, the federal government could regulate subsistence (as well as conflicting) harvests of fish and wildlife throughout the state of Alaska.

*Interpretation: Until withdrawal of the Babbitt suit and the reserved water rights decision in Katie John, neither the state nor the federal government took dual management all that seriously. Both assumed the courts would decide the issue. Had Governor Knowles not intervened on behalf of AFN, the courts would have decided the issue. Now that court decisions are no longer an option, both state and federal governments appear to be rethinking their approach to dual manage-ment.*

—The feds are moving to take over fisheries based on the claim that, even though “they don’t want to,” they are forced to by ANILCA mandate.

*Ancillary fact:* This is not a credible claim. ANILCA as passed by the Congress of the United States, does not now, nor has it ever contained a mandate for federal takeover.

*Interpretation:* High-level federal bureaucrats wanted federal takeover language in ANILCA, but could not get it into the final bill. Nevertheless, these feds have taken over using administrative, not legislated, means because it suits their ideological agenda (see any of several recent statements by Sec. Babbitt or 9/9/99 statements by President Clinton).

*Ancillary fact:* The Babbitt suit, as decided by Judge Holland’s opinion, represents, to date, the substance of the federal government’s claim that it has standing as managers of wildlife and fisheries on federal (and adjoining state) lands as well as the state’s navigable waters.

*Interpretation:* This situation resulted directly from the Knowles administration’s dropping the Babbitt suit, and its reluctance to appeal the Katie John decision to a higher court for definition of the extent to which reserved federal water rights define the “where” question defined by Judge Holland.

Hence, **federal takeover should not be “blamed on” ANILCA in any way.** If the feds choose to take over, they should clarify the basis of their action. **They are not forced to take over management for subsistence preference by any language in ANILCA.** Most recently (as of 9/9/99) the public justifications offered by Department of Interior spokespersons and President Clinton for the October 1, 1999 federal takeover of fisheries and expansion of wildlife management takeover have been justified exclusively to the public on the basis of Alaska Native subsistence. At least in the eyes of the federal government this is, either “still” or “again,” a racial issue.

*Personal opinion which goes beyond interpretation:* I think the federal government is simply taking over fish and wildlife management in Alaska because it suits the administration’s social agenda. The “legal” basis for this takeover relies solely on Judge Holland’s opinion, in which said he couldn’t imagine that Congress didn’t intend for them to do so. Hence, Title VIII of ANILCA appears to be convenient noble justification for the administration to provide racial preference for Alaska Natives while simplifying land management by eliminating non-Native uses from public land. It is politically more acceptable to wrap federal takeover in ANILCA than simply state the federal government intends to eliminate public use of public lands or that it fears Alaskan’s cannot be trusted to wisely manage and conserve Alaska’s natural resources.

I think this “federal feeling” is generated by national guilt over the exploitation of indigenous peoples and natural resources in the contiguous 48 states, and maintained by the political success of what has become known as the “environmental movement.”

Prior to the Venetie decision, the federal government justified its position by appealing to a manufactured ANILCA mandate to provide preference for “the last indigenous people” by linking “rural preference” to federal trust responsibility for Native Americans. This linkage justified federal takeover by playing on the emotion of a national guilt resulting from the way the American Plains Indians were subjugated 100 years ago. However, in the Venetie decision, the U.S. Supreme Court made it clear that the unsuccessful and antiquated “trust responsibility” doctrine is not to be applied in Alaska. Nevertheless, the Department of Interior clings to “trust responsibility” as a justification (see 9/9/99 comments on the federal takeover issue by President Clinton and Secretary of Interior Babbitt). Although obsolete, this argument continues to be emotionally powerful.

—The present, expanded federal takeover scheduled for October 1, 1999 resulted from Knowles administration decisions to withdraw the Babbitt

suit, and acceptance of the Ninth Circuit Court decision on the Katie John case instead of appealing it to a higher court in an attempt to frame reserved water rights in their traditional context.

—The further incursion of federal management (into fisheries management as well as wildlife allocation) precipitated designation of the fisheries issue as a crisis by the Governor.

*Interpretation:* The crisis appears to be driven by the understanding that federal enforcement of the rural preference will destabilize the Alaskan economy associated with the commercial fishing industry.

—To deal with this crisis, the Governor appointed a Subsistence Task Force on the subject.

—This Task Force prepared a plan involving amendment of the Alaska Constitution to allow preference/discrimination based on residence location so the State could comply with federal interpretation of ANILCA Title VIII. The plan also involved state adoption of ANILCA Title VIII language and other federal procedure as state law, and some technical amendments to ANILCA.

*Ancillary fact:* The Task Force Proposal was basically a reiteration of Lt. Governor Ulmer's failed "quiet diplomacy" plan of a year earlier.

—Unwilling to accept this unprecedented level of federal intrusion into state management, the Alaska Legislature, represented by its standing Legislative Council Committee, filed suit in Federal District Court in Washington, D.C. to reestablish Alaska's statehood rights.

*Ancillary fact:* This suit was not accepted by the District Court (decision in summer of 1999), which ruled the Legislative Council lacked standing to bring suit because the Governor had withdrawn the Babbitt suit with prejudice to secure political endorsement of the Alaska Federation of Natives six years earlier. Further litigation will have to await harm to the state or legislature from the takeover of fisheries man-

agement scheduled for October 1, 1999.

—When the Alaska Legislature met in 1998, there was tremendous pressure from Senator Stevens to amend the Alaska Constitution to allow preference (or discrimination—depending on perspective) so the ANILCA-based federal laws and regulations could be adopted as state law. This position was promoted as "preventing a federal takeover", even though the management process and outcome were entirely those prescribed by the federal government. The legislature tried a number of approaches to resolve the problem, but none were acceptable to Senator Stevens, Governor Knowles, the Federal Government, or the Alaska Native community.

—The issue was successively addressed in two special legislative sessions devoted exclusively to the topic in summer of 1998. Despite intense pressure from the federal government, an intensive lobbying campaign by the AFN, and various commercial interests connected to Native Corporation business, two thirds of the Alaska Legislative House could not be persuaded to pass an amendment institutionalizing preference and discrimination along to the Senate for consideration.

—With this failure, Senator Stevens (chairman of the U.S. Senate appropriations committee) turned up the pressure on the legislature by refusing to block funding for the federal takeover as he had been readily able to do in the past. Moreover, he appropriated 11 million dollars to fund the federal takeover.

*Ancillary fact:* The 11 million dollars was apparently provided to leverage the Alaska Legislators who would not support amending the Alaska Constitution to provide for preference/discrimination. The Department of Interior got one million dollars for planning the takeover immediately upon appropriation. Involved federal agencies are to get the balance (10 million dollars) to implement their takeover if the Alaska Legislature doesn't put Senator Stevens' proposed constitutional amendment on the ballot for approval by Alaskans before October 1, 1999. If the legislature does place

*Senator Stevens' proposed Alaska Constitution change on the ballot (or agrees to) prior to October 1, the State of Alaska is to get the remaining 10 million dollars.*

—Governor Knowles has called a final special session of the Alaska Legislature for September 22, 1999, the last possible date to place a constitutional amendment legalizing the preference/discrimination before the Alaskan public before the scheduled federal takeover. The Governor and other preference advocates represent this special session as the last opportunity to “prevent federal management” of Alaska’s resident fish and wildlife.

*Interpretation: I see little difference between a “hostile” federal takeover or a voluntary agreement for the state to manage at the direction of the federal government.*

*Author's Update: The Governor was unsuccessful in getting the Alaska Legislature to put his proposed amendment before the Alaskan electorate in September. The federal government took over management of subsistence related fisheries on October 1, 1999 along with expanded wildlife management on selected state lands. A number of Alaskans will shortly file lawsuits protesting the federal takeover in yet another attempt to solve the matter by adjudication. The Governor has announced plans to reintroduce his proposed amendment to the Alaska Constitution when the regular session of the legislature convenes in January, 2000. There is serious talk of a Gubernatorial recall drive or impeachment proceedings resulting from the Governor's failure to protect and uphold the state's constitution.*

*After the federal fisheries takeover, the Governor appealed the Katie John decision to the U.S. Supreme Court. That appeal awaits action. Alaska Natives have broken ranks with the Governor on this issue.*

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**KENNETH R. WHITTEN - STATE/FEDERAL RELATIONSHIPS REGARDING DALL SHEEP RESEARCH AND MANAGEMENT IN ALASKA**

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**Abstract:** State and Federal biologists in Alaska generally have cooperated well on Dall sheep management and research and have freely exchanged data on populations, distribution, productivity, and harvest. Federal agencies frequently have requested the Alaska Department of Fish and Game (ADF&G) to participate in sheep surveys, and in some cases have provided contract funds for ADF&G to conduct surveys on federal lands. Federal agencies also regularly seek advice from ADF&G on design of sheep research or inventory projects and routinely ask local ADF&G managers to edit and review federal sheep reports and manuscripts. Several times ADF&G personnel have received permission to gather baseline data on sheep in Denali National Park for comparison with data from state-managed areas outside the Park. Denali has also provided funds for ADF&G biologists to participate in joint surveys of sheep on National Preserve lands (managed by Park Service, but open to sport hunting) and adjacent state managed lands. Gates of the Arctic National Park and Preserve has contracted ADF&G to survey sheep and test new survey techniques. The Bureau of Land Management and Yukon Flats National Wildlife Refuge regularly cooperate with ADF&G on sheep counts in the White Mtns. north of Fairbanks. ADF&G and the Kenai National Wildlife Refuge have cooperated on sheep and goat surveys and development of new counting techniques. ADF&G and Park Service have long cooperated on sheep research and monitoring in the Baird and De Long Mountains of the far western Brooks Range. Disagreements among state and federal biologists have been rare and, for the most part, quickly resolved. In the mid-1970s, Arctic National Wildlife Refuge (ANWR) staff estimated far fewer sheep in the refuge than state biologists thought were present. ANWR provided funds for ADF&G to do more thorough surveys, and estimates were revised substantially upward. In the early 1980s, ANWR feared a sudden increase in sheep hunting due to loss of traditional hunting opportunity in newly created national parks elsewhere in Alaska. ANWR successfully lobbied the State Board of Game into establishing a lottery permit for the refuge, over the objections of ADF&G. Within 2 hunting seasons, however, all parties agreed the fears of increased hunting were unfounded, and the lottery hunt was rescinded. A long period of cooperation in sheep research and inventory in ANWR ultimately ensued, and in the early 1990s ANWR provided funds for ADF&G to survey hunters from throughout the Brooks Range regarding their attitudes toward sheep management.

The State of Alaska and the Federal Government both recognize subsistence as the priority use of fish and game in Alaska but currently are at odds as to how to institutionalize and enforce this priority. The Federal government bases subsistence priority on a history of customary and traditional use by rural residents. A similar rural-based priority in State law was struck down by the State Supreme Court, making it impossible for the State to comply with federal subsistence guidelines. Ultimately, this has led to a complicated “dual management” system in which local and non-local residents are often bound by conflicting regulations on season, bag limit, and/or methods and means of hunting. The State vehemently disagrees with some actions taken by Federal subsistence boards. The most controversial Federal decisions have been based on local opinions and sometimes on social science reports that cannot be supported by hard data. Some decisions, in our opinion at least, have also violated federal legal guidelines for subsistence management. Flawed Federal Board decisions regarding sheep have not resulted from disagreements among state and federal biologists over biological information. So far the flawed decisions have only affected allocation of harvest—who gets to hunt sheep—and have not caused any biological harm to sheep populations. Nevertheless, dual management is

leading to increasing divisiveness among Alaska's hunters and is a serious impediment to effective wildlife management in Alaska.

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Most state fish and game agencies concentrate their efforts on maintaining and supporting consumptive uses of wild game. Our money comes primarily, and in some cases, solely, from fees levied on hunters and taxes on firearms and ammunition. Although we serve a broader public, our traditional constituents have always been hunters. Federal agencies have mandates that differ in several ways from their state counterparts. Some federal agencies (Bureau of Land Management and Forest Service) allow multiple uses, including hunting, but often emphasize competing uses that adversely affect wildlife habitat and populations or result in actions that otherwise restrict or eliminate hunting. Some Federal agencies concentrate on habitat protection or maintaining wildlife population viability (Fish and Wildlife Service), with hunting usually allowed, but not emphasized or promoted. Nationwide, most National Park Service lands are managed for scenic, historic, or aesthetic values and generally are closed to all hunting. Alaska is an exception, however, in that few Park Service lands are totally closed to hunting. Differing mandates among state and federal agencies inevitably lead to differing attitudes among respective personnel and decidedly different corporate cultures. Biologists generally share broad conservation values, but differ on some important and often deeply held attitudes. Although we're talking about state/federal relationships in this workshop, I would wager that the same sorts of problems we're discussing now also occur internally among state agencies in most, if not all, states—fish and game versus forestry, oil and gas, parks and recreation, etc.

I'm going to mostly discuss positive interactions among state and federal biologists in Alaska that come about because of those broader conservation values we all share, but also because most of us are similarly trained and have mutual needs for gathering and sharing information. State and federal biologists in Alaska generally have cooperated well and have freely exchanged data on Dall sheep

populations, distribution, productivity, and harvest. In the early years of Alaska statehood (1960s), many state biologists were former employees of the federal services in Alaska. ADF&G biologists surveyed and managed game with little federal presence or interference on all but a few areas (Mt. McKinley National Park and Glacier Bay and Katmai National Monuments). In the late 1960s and early 1970s ADF&G biologists flew aerial surveys of sheep in McKinley Park to compare composition of those un hunted sheep with some of the heavily hunted populations under state jurisdiction. ADF&G also did foot survey composition counts in the Park during the 1970s. ADF&G worked closely with USFWS and USFS to monitor sheep and goats on the Kenai Peninsula.

Battles over Native land claims and the right-of-way for the Trans Alaska Pipeline prompted movements to designate vast additions to federal conservation lands in Alaska. Federal agency personnel began to proliferate in Alaska during the mid-1970s, but most agencies initially had high personnel turnover rates and, thus, lacked experienced field biologists. This led to sometimes woefully inadequate descriptions of resources in areas nominated as potential additions to parks and refuges. The State challenged many of these wildlife estimates and, as a result, received large sums of federal money for wildlife survey and inventory work on federal lands. Disagreements, for the most part, were quickly resolved. A case in point is the Arctic National Wildlife Refuge (ANWR), where refuge staff estimated far fewer sheep than state biologists knew were present. ANWR provided funds for ADF&G to do more thorough surveys, and estimates were revised substantially upward.

Congress was slow in agreeing on which areas, and how much land, to include in expanded federal conservation areas. In 1979 President Carter broke the stalemate by declaring vast areas of Alaska as new national monuments. The Carter monuments

had an immediate effect on sheep management by closing large portions of the Wrangell Mountains and the Brooks Range to sport hunting. Anticipating crowding and increased competition among hunters on those lands still subject to state management, the State responded by changing from a 3/4 to a 7/8-curl bag limit for Dall rams. In 1980 Congress passed the Alaska National Interest Lands Conservation Act (ANILCA), which voided the Carter monuments, but established most of those same lands as new national parks and wildlife refuges or as additions to existing federal units. Some of the lands closed to sport hunting in 1979 became Park Service preserves, which again allowed hunting, but a large portion of the Wrangells and central Brooks Range remained off-limits to sport hunters as new national parks. For a time, the situation between state and federal biologists remained much as it had been during the 1970s, with the State receiving federal money to work on federal land. Gradually, however, the new federal units recruited more stable staffs and developed expertise for fieldwork under Alaskan conditions. Federal biologists initiated wildlife research projects to meet their own needs, but still tried to keep state biologists on as cooperators. This put ADF&G in the position of eventually having to turn down some federal contract funds because accepting the money and participating in the federal projects would have directed time and effort away from vital State programs. State and federal biologists continued to cooperate, however, on many projects for which their information needs overlapped. ADF&G cooperated in Dall sheep research and monitoring projects in the Noatak National Preserve in the western Brooks Range and continued to work with ANWR staff in the eastern Brooks Range. There were occasional disagreements. ANWR managers feared the new 7/8 –curl rule would not be sufficient to prevent overcrowding and excessive harvest on refuge lands and requested the Alaska Board of Game to require lottery permits for sheep hunting in ANWR. ADF&G opposed the lottery, but federal officials threatened to establish federal permits if the State Board refused their request. The Board acquiesced, and for 2 years a lottery hunt was in place but permits were never fully subscribed.

With no opposition from federal officials, the State Board then rescinded the lottery hunt. Amicable relations between ANWR and ADF&G staff continue to this day, with free interchange of information and cooperation in fieldwork. In the early 1990s, ANWR even funded a state study to survey sheep hunters' attitudes about hunting conditions and management options. The survey covered the entire northern and eastern Brooks Range – not just ANWR lands.

ADF&G regularly cooperates with BLM and the Yukon Flats National Wildlife Refuge to inventory sheep in the White Mountains north of Fairbanks. We have recently worked with the Kenai National Wildlife Refuge to inventory sheep and goats and refine counting techniques. Gates of the Arctic National Park and Preserve has contacted us to survey sheep, refine survey techniques, capture sheep, and give advice on management of subsistence sheep hunting. Denali National Park and Preserve (the ANILCA expanded version of the old Mt. McKinley National Park) still shares sheep productivity and survival data with us and recently contracted us to help count sheep in the seldom inventoried southern and western portions of the Park/Preserve. Yukon/Charley Rivers National Preserve has invited us to review research proposals and assist in sheep capture and inventory. For many years we have coordinated with Noatak National Preserve and Kobuk Valley National Monument to count sheep in the Baird and DeLong Mountains of the western Brooks Range. We have recently agreed to be cooperators with Park Service and BRD/USGS on a new research/monitoring project on sheep in the Baird and DeLong mountains.

Nevertheless, all is not well with state/federal relationships regarding sheep and other wildlife management in Alaska. Subsistence hunting became a major issue during debates over land status and management in Alaska in the 1970s. Ultimately both the state and federal governments recognized subsistence as the priority use of fish and game, but we are currently at odds as to how to institutionalize and enforce this priority. The federal government (as codified in ANILCA)

bases subsistence priority on a history of customary and traditional use by rural residents. A similar rural-based priority in state law was struck down by the state supreme court in 1989, making it impossible for the state to comply with the federal subsistence guidelines in ANILCA. The result is that the federal government now manages subsistence on Federal lands, and may extend its jurisdiction to state lands as necessary to protect federal subsistence. Alaska has a complicated "dual management" system in which local and non-local residents are often bound by conflicting regulations on seasons, bag limits, and/or methods and means of hunting. Dual management is the subject of a separate presentation in this workshop, and I'll deal with it only briefly here, in the context of the generally agreeable relationships among state and federal biologists I described earlier. The state vehemently disagrees with some actions taken by Federal Subsistence Boards. The most controversial Federal Board decisions have been based on local opinions and sometimes on social science reports that cannot be supported by hard data. Some decisions, in our opinion at least, have also violated federal legal guidelines for subsistence management. Alaska has argued against establishing subsistence-hunting-only areas for sheep and caribou in parts of the Brooks Range. Our biological arguments against the need for such areas have been largely echoed in federal biological staff recommendations. Thus flawed Federal Board decisions regarding sheep have not resulted from disagreements among state and federal biologists over biological information. So far the flawed decisions have affected allocation of harvest – who gets to hunt sheep – and have not caused any biological harm to sheep populations. Nevertheless, dual management is leading to increasing divisiveness among Alaska's hunters and is a serious impediment to effective wildlife management in Alaska.

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**QUESTIONS, ANSWERS AND COMMENTS - KENNETH R. WHITTEN PRESENTATION**

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**HARLEY METZ, COLORADO:** What do you think the ultimate solution will be? I understand there are numerous suits and countersuits going on. Do you have a personal feel as to the outcome?

**KEN WHITTEN:** There are two possible outcomes. I think the federal law will continue with dual management until the state caves in and agrees to a rural priority. I think it boils down to that. I don't see a quick solution in the absence of that.

There are movements afoot to amend the state constitution to agree with the federal constitution. If you took a popular vote of Alaskans, I feel it would almost surely go that way, but I doubt it will ever get out of the legislature. It will never appear on the ballots.



**NOTE: THIS PAPER IS PRESENTED IN THESE TRANSACTIONS AS AN ABSTRACT ONLY AT THE REQUEST OF THE AUTHORS.**

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**RAMIRO URANGA-THOMAS - STATE AND FEDERAL WILDLIFE RELATIONSHIPS  
IN MEXICO**

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**Abstract:** In Mexico, all natural resources are the property of the nation. Wildlife administration, law enforcement, and management are under the jurisdiction of the federal government. SEMARNAP, acronym for the federal agency that manages wildlife, developed a four-year (1997-2000) program for wildlife conservation and protected areas that incorporated rural development. The desert bighorn sheep is listed as a priority species in this program. Desert bighorn are the highest priced game species in Mexico. In 1998, SEMARNAP initiated a bighorn capture on Tiburon Island in the Sea of Cortez to obtain animals to translocate in the states of Sonora, Chihuahua, and Coahuila. Prior to the capture, a potential sheep release site within historic sheep habitat was evaluated in Chihuahua. The results of the survey revealed that the area is a suitable release site for reestablishing desert bighorn sheep. However, probably due to political pressure from landowners who manage bighorn on their properties and sell bighorn hunts in Sonora, there was opposition to the translocation of wild sheep to any other state. This points out the tangled politics and inherent difficulties regarding wildlife management in Mexico. There is a lack of cooperation between government agencies, and a strong movement by states to relegate wildlife management to the states. The ownership and management of Mexican wildlife is developing into a contentious issue between private landowners and government agencies.

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## VERNON C. BLEICH - WILDLIFE CONSERVATION AND WILDERNESS MANAGEMENT: UNCOMMON OBJECTIVES AND CONFLICTING PHILOSOPHIES

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**Abstract:** The concept of wilderness was grounded primarily in a sociological context (i.e., “solitude” or “primitiveness”), and largely lacked an ecological perspective. The failure of wilderness advocates to consider the ramifications of wilderness on wildlife conservation activities has been problematic, especially for the conservation of landscape-level processes and for activities associated with the restoration of ecosystems. Wilderness advocates, both within and outside of agencies, often invoke wildlife conservation as the primary benefit of wilderness, and this is especially true when the rationale for wilderness designation must be defended. In reality, wildlife conservation objectives frequently conflict with the goals and objectives of wilderness managers. In this paper, I provide some specific examples of such conflicts. I also discuss the reasons that wildlife conservation and the designation of wilderness in its strictest sense are seemingly incompatible activities. Further, and specific to the conservation of mountain sheep (*Ovis canadensis*) inhabiting the deserts of southeastern California, I discuss the lack of ecological foresight in establishing nearly 70 wilderness areas. There is a need for reasonableness in the application of wilderness management policies, because reasonableness is the key to the conservation of large, vagile mammals and the habitats in which they evolved.

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Wildlife management in legislated wilderness faces many difficult challenges (Haufler et al. 1996). These challenges are the result of differing objectives or mandates affecting the various state wildlife agencies, and those federal agencies charged with managing wilderness. For example, the California Department of Fish and Game (CDFG) has statutory responsibility for the conservation, protection, and management of fish, wildlife, native plants, and the habitats necessary for sustaining biologically viable populations of those species (California Fish and Game Code Section 1802). Those resources are held in trust for the people of California by CDFG (California Fish and Game Code Section 711.7). Wilderness is administered by federal agencies as directed by the Wilderness Act (U.S. Congress 1964). The primary objective of wilderness management is to “protect America’s last remaining wildlands as cultural and scientific enclaves and to protect the natural processes and values from indiscriminate development” (Kloepfer et al. 1994). It is clear, however, that the Wilderness Act emphasizes

aesthetics and the relative absence of humans (Haufler et al. 1996), rather than wildlife conservation. As a result, wildlife and habitat restoration activities frequently conflict with wilderness management objectives (Bleich 1999).

It is not my intent to say that wilderness has no value to wildlife conservation, and I will go to my grave arguing that habitat protection is the key to wildlife survival. Wilderness designations are, in fact, one way of achieving habitat protection. Nonetheless, conflicts between wildlife conservation objectives and wilderness management objectives are real. There is a need to bring reasonableness and some semblance of common sense to policies and to the interpretation and administration of wilderness legislation if wildlife conservation is to be a meaningful goal in legislated wilderness. It is my intent to elaborate upon these concerns, and to issue a plea for the realization that wilderness areas are not a panacea for habitat or ecosystem protection, particularly as they relate to

the viability of populations of mountain sheep (*Ovis canadensis*) in desert ecosystems.

In this paper, I will provide several examples, which I am personally familiar with, that illustrate some conflicts between wildlife conservation objectives and the strict application of wilderness policy. Moreover, some of these examples potentially represent the misapplication of regulations for what I interpret to be obstructionist purposes. I am concerned about the inconsistencies in interpretation and application of wilderness legislation (Bailey and Woolever 1992), resultant impacts on wildlife management and conservation activities, and the potential implications that the overzealous application of some aspects of wilderness law has for the conservation of large mammals. Moreover, the lack of ecological foresight associated with designation of wilderness areas in the deserts of California (United States Congress 1994) has serious implications for the maintenance of viable populations of large mammals. Just as there have been concerns about overzealous application of the Endangered Species Act, I predict in the future that there will be increasing public concern about overzealous application of wilderness policies.

I will initially describe some specific examples of conflicts between wildlife conservation activities and wilderness management policies. I will then comment on the reasons that wildlife conservation and the designation of wilderness in its strictest sense are seemingly incompatible objectives. Finally, I will issue a plea for reasonableness in the application of wilderness policies, because of the effect of those policies on landscape-level processes that occur outside of legislated wilderness. Without realization that the overzealous application of wilderness policies can be detrimental to wildlife conservation objectives (Bailey and Woolever 1992, Bleich 1999), the future existence of large, desert-dwelling mammals will be compromised.

**Some Specific Examples of Conflict:**

(1) During the early 1980s there was much discussion regarding the proposed Sheep Mountain Wilderness, on the Angeles National Forest, and

mining activity in the east end of the San Gabriel Mountains, Los Angeles County, California. Well-intentioned advocates of the Sheep Mountain Wilderness argued that wilderness designation was necessary to prevent a tungsten mine, located in Cattle Canyon, from impacting mountain sheep. Ultimately, the Sheep Mountain Wilderness was established, but the tungsten mine continues, even today, to operate within the wilderness. More onerous, however, the designation of that wilderness has precluded use of prescribed fire to maintain the openness and productivity of vegetation within mountain sheep habitat in that mountain range. Nearly 2 decades ago, Holl and Bleich (1983) made specific recommendations with respect to the management of vegetation in the San Gabriel Mountains. Those recommendations have not been carried out because of wilderness in the east end of that mountain range. There remains a large-scale mining operation in the Sheep Mountain Wilderness, but wildlife biologists cannot use prescribed fire to manipulate vegetation for the benefit of mountain sheep. Inability to use prescribed fire in legislated wilderness has impacted habitat used by other populations of mountain sheep (Etchberger et al. 1989, Bailey 1992, Bailey and Woolever 1982).

(2) In 1985, CDFG identified Cattle Canyon as an area from which mountain sheep could be captured and translocated to Cobblestone Mountain, Ventura County, approximately 100 kilometers away. At that time, the supervisor of the Angeles National Forest denied a request from CDFG to use mechanical equipment and vehicles on an existing road (that was used daily by tungsten mine personnel) to facilitate that translocation, because the trap-site was within the newly designated Sheep Mountain Wilderness. The owner of the tungsten mine, on whose claims the trap-site was located, volunteered his heavy equipment to clear an area (0.1 ha) on which a drop-net could be erected. The forest supervisor, however, refused to allow the owner of the mine to cooperate in that endeavor, because the proposed action was not among the permitted mining activities. As a result, a 15-person hand crew camped and worked in the area for 30 days to prepare the site.

Ironically, the forest supervisor did approve use of a helicopter to transport sheep from the trap-site, in lieu of horses that had been identified as the preferred alternative by wilderness specialists. CDFG was not permitted to use vehicles to drive to the trap-site to transport animals, even though it was adjacent to the aforementioned road and costs would have been reduced substantially. The forest supervisor defended his actions, stating that he, "...would not compromise the integrity of the Sheep Mountain Wilderness..." by allowing wheeled vehicles to use an existing road (Bleich et al. 1991). This capture occurred as bulldozers operated less than 100 m away.

(3) The Manly Peak and Surprise Canyon wilderness areas were established in the Panamint Range in 1994, as a result of the California Desert Protection Act (Act; United States Congress 1994). During the political shenanigans leading to that legislation, the open-pit Briggs Gold Mine was gerrymandered out of the proposed wilderness, but is surrounded on 3 sides by legislated "wilderness". During 1995, when research examining the effects of the mine on mountain sheep was initiated (Oehler 1999), wilderness specialists from the Bureau of Land Management (BLM) prepared an environmental assessment (EA) addressing the potential impacts of research activities on wilderness. They opined that the proposed use of time-lapse cameras to monitor mountain sheep at Redlands Spring would be offensive to wilderness connoisseurs that might visit that water source for solitude and a high-quality wilderness experience. Moreover, they wrote that the presence of a researcher hiking in the mountains could impact others seeking solitude there. Redlands Spring is located about 1 km from the Briggs Mine, and in the same canyon as the mine. More than 19,000,000 metric tons of ore will be processed by the mine during its projected 7-year life; this processing is facilitated by blasting, using high explosives, on a near daily basis (Oehler 1999). In addition, this wilderness lies within an area that is used daily for low-level training missions by pilots flying a variety of subsonic and supersonic military aircraft. Ultimately, use of the time-lapse camera at Redlands Spring was authorized, despite

protests from wilderness advocates among the general populace.

(4) Wilderness areas in the Panamint Range also contain many well-established roads, the use of which was critically important for research purposes. Nevertheless, vehicular access on those roads was disallowed. In fact, one researcher received a ticket from a National Park Service (NPS) Ranger for driving on a well-traveled road that was not posted as closed. Indeed, neither the wilderness boundary nor the boundary of Death Valley National Park were identified as such. Use of the existing roads would greatly have facilitated research, with no further ground disturbance, in an area that has been heavily impacted by humans, and where daily temperatures in excess of 40°C are the norm (Oehler 1999).

As a result of the inability to legally operate a vehicle, data acquisition was compromised. CDFG was, however, allowed to use a helicopter to capture mountain sheep within the wilderness. Section 103(f) of the Act clearly provided for use of motorized vehicles by CDFG for wildlife conservation purposes in newly created wilderness administered by BLM. The Act, however, does not address those wilderness areas administered by NPS.

(5) In an attempt to circumvent access problems in wilderness within the Mojave Desert, members of The Society for the Conservation of Bighorn Sheep developed a method to determine water levels in big game guzzlers (Bleich and Pauli 1990) and to relay that information via satellite link to remote computer terminals (Hill and Bleich 1999). The antenna enabling communication with the satellite extends about 2 m above the top of the water storage tanks which, in turn, are about 2 m in height. These monitoring devices have been installed surreptitiously because some federal employees have opined that the addition of the antenna would impact wilderness or scenic values, despite the intent for these monitoring devices to reduce (but not eliminate) the need for physical inspections of the guzzlers (Hill and Bleich 1999).

(6) In another example of the way that wilderness can hinder restoration efforts, a BLM wilderness specialist provided input for an EA addressing the proposed translocation of mountain sheep to the Bristol Mountains, San Bernardino County, California. In so doing, he noted that the presence of mountain sheep, "...would not enhance wilderness values..." (Bleich et al. 1991). Hence, that individual recommended denial of an application to develop a water source that would facilitate translocation of mountain sheep to the Bristol Mountains. The resource area manager concurred with the wilderness specialist, and denied the water development, even though mountain sheep had been extirpated as a result of human actions (Bleich et al. 1991). The decision to deny the project eventually was reversed by the BLM district manager, but with a delay of >1 year in the implementation of the project. The water development and translocation occurred over the continuing protests of the wilderness specialist and wilderness advocates among the general populace.

(7) Indian Writing Tank is located in the Indian Pass Wilderness in Imperial County, California. This wilderness is inhabited by numerous feral donkeys (Andrew 1994) that compete with mountain sheep for forage and, especially, for water (Andrew et al. 1997). During 1997, a proposal by CDFG to install a fence that would preclude access by feral donkeys to that critically important water source was denied by the BLM area manager, who followed the recommendation of a wilderness specialist. The project was rejected because proposed construction materials (12 mm diameter steel rebar and steel t-posts; Andrew et al. 1997) were not "natural". After the decision was questioned by members of Desert Wildlife Unlimited, a local conservation organization, the area manager approved a re-designed fence that would be installed by BLM personnel (BLM NOPA CA067-97-04). This fence was constructed of "natural" materials, consisting of 150 mm diameter, wooden "peeler cores" that were bolted together and held in place by heavy wire. Apparently, the wilderness specialist determined that those materials would be less offensive to wilderness advocates, both within and outside the agency, even though the volume of

construction materials was ca. 200 times that needed for the fence designed by Andrew et al. (1997), and the resulting structure was much more obtrusive.

(8) As part of the aforementioned project, the BLM area manager stipulated that the barrier was to be monitored to determine its effectiveness (BLM NOPA CA067-97-04). During September 1998, CDFG personnel conducted an aerial survey of mountain sheep in the East Chocolate Mountains, where Indian Writing Tank is located. Because of Section 103(f) of the Act, CDFG personnel volunteered to transport two BLM technicians to Indian Writing Tank to facilitate their monitoring effort. However, the technicians were denied permission to take advantage of that offer, because Section 103(f) did not specifically authorize use of motorized vehicles for wildlife conservation purposes by BLM personnel in wilderness. As a result, the technicians were required to hike to Indian Writing Tank from outside the wilderness area. It is important to note that there is a long-established road to Indian Writing Tank, but the technicians were not allowed to drive on it because use of motorized vehicles for wildlife conservation purposes was not specifically conveyed to BLM for wildlife conservation purposes by the Act. CDFG personnel use that same road for access to Indian Writing Tank on a regular basis.

At approximately mid-morning, CDFG biologists flew over Indian Writing Tank and observed the BLM technicians. After ascertaining their status, CDFG personnel continued the survey. Ambient temperatures in this region routinely exceed 40°C (Andrew et al. 1999). After completing the survey, word was received that ≥ 1 of the technicians had suffered heat exhaustion and, possibly, hyperthermia. The pair had become incapacitated while still several kilometers from their vehicle, and radioed for assistance. Help arrived in the form a Bell UH-1 search and rescue helicopter dispatched from the U.S. Marine Corps air base near Yuma, Arizona.

Reasonable interpretation of Section 103(f), consistent with motorized access for CDFG per-

sonnel for wildlife conservation purposes, would have prevented this life-threatening situation and resultant rescue. Use of the military helicopter to transport the technicians from the wilderness area later was rationalized under Section 103(g) of the Act (BLM NOPA-CA067-98-07). It is ironic that Section 103(g) provides for use of motorized vehicles by federal (including BLM), as well as state and local, law enforcement agencies, but use of existing roads for wildlife conservation purposes by BLM personnel repeatedly has been disallowed.

(9) The stringent application of wilderness regulations has had other serious impacts to wildlife habitat. For example, during July 1996, approximately 2,500 ha were burned in a wildfire on the Round Valley mule deer (*Odocoileus hemionus*) winter range on the Inyo National Forest in Inyo County, California. That fire severely reduced availability of bitterbrush (*Purshia tridentata*), a critically important winter forage for mule deer (Pierce 1999). The probable cause of the fire was a powerline failure. During August 1998, an additional 1,200 ha burned in another fire on the Round Valley winter range, further reducing the availability of forage for mule deer; the cause of that fire was arson. Some of the latter fire burned into the John Muir Wilderness.

Helicopters dispatched to this fire initially obtained water from Horton Lake, located just inside the wilderness boundary: the pilots hovered over the lake and filled their holding tanks via suction hoses, or dipped external buckets into the lake, to obtain water for transport to the fire. The pilots did not land, because such activity was prohibited by the Wilderness Act (United States Congress 1964). Instead, they operated the aircraft at low elevation inside the wilderness, but no ground-disturbance occurred. Round-trips from Horton Lake to the fire and back to the lake required approximately four minutes.

A directive was then issued not to obtain water from Horton Lake because it was within legislated wilderness. Instead, pilots were redirected to Pleasant Valley Reservoir, located ca. 16 km from

the fire. As a result, round-trip times increased from 4 minutes to ca. 18 minutes. The pilots were forced to lose ca. 1,500 vertical m of elevation with empty tanks and to regain it with full tanks. Impacts to bitterbrush (Countryman and Cornelius 1957, Mueggler and Blaisdell 1958) and resultant effects on mule deer were much more severe than would have been with greater fire-fighting efficiency, because less habitat would have burned.

During a meeting following the second fire, diversion of helicopters from Horton Lake to Pleasant Valley Reservoir was questioned by an angry public. An official from the U.S. Forest Service (USFS) stated that CDFG personnel had made that request out of concern for potential impacts to "neotropical migrants and amphibian populations" at Horton Lake. I later ascertained that CDFG personnel had never been contacted regarding that recommendation: the official apparently was attempting to rationalize *her own* desire for helicopter pilots to obtain water from outside the wilderness. During the same meeting, other USFS officials admitted that crews fighting the fire had used chain saws in the wilderness (which also contains a road) to protect some buildings (that, by definition, don't exist in wilderness), and that an aircraft landed in the wilderness to "rescue" some hikers that, in retrospect, were not endangered by the fire.

(10) An additional example of conflicts between wilderness management policies and wildlife conservation objectives also occurred near Round Valley. In the past, large numbers of migratory mule deer have been killed when they slipped while crossing an ice field located near Bishop Pass (Jones 1954). A similar incident occurred in 1995 (Bleich and Pierce *in press*). A proposal to use hand tools to cut a path across the ice field and to deposit native sand and gravel on that path to prevent further losses of deer was made to the Inyo National Forest by well-intentioned citizens. Wilderness specialists denied this request, despite much public interest in the deer population (Clark 1996), and strong public support for that action. The decision was based on the notion that such an action would alter the wilderness characteristics of

the area, and would preclude natural processes from operating. It is important to note that deer are hunted for several months each year in the same wilderness, presumably with resultant effects on the age and sex structure of the deer population.

(11) A final example of why I question many wilderness regulations concerns neither the use of mechanical equipment nor interference with natural processes. Rather, the issue involves inconsistencies with respect to management of livestock. For example, outfitters guiding mountain sheep hunters in wilderness areas in the Mojave Desert have been issued permits to use horses, but were required to carry all food and water that their livestock might require (BLM NOPA CA069-98-05). Coincidentally, these same wilderness areas are open cattle range, and there is no shortage of either cows or donkeys. Those exotic ungulates have done extensive damage to vegetation, and have year-round access to water sources in these wilderness areas. The horses would be present only for the duration of any hunt, which typically are less than 2 weeks in duration (Torres et al. 1993). It is incongruous that requirements such as these are placed on users of public lands because of potential impacts to wilderness, but feral or domestic exotic ungulates are not similarly constrained.

**Related Conservation Concerns:** Incidents described above provide examples of the inconsistencies that are common in wilderness management policies (Bailey and Woolever 1992), particularly as they relate to wildlife management and conservation issues. In California, Section 103(f) of the Act has greatly facilitated the use of motorized equipment for purposes of wildlife conservation in wilderness, particularly those administered by BLM. Nevertheless, use of motorized equipment still is opposed by many wilderness specialists in federal agencies, as well as wilderness advocates among the general public (Bleich 1999). As a result, conflicts continue to arise on a case-by-case basis.

Section 103(f) does not address wildlife conservation activities within national parks or preserves,

and CDFG management activities in wilderness administered by NPS are controversial. Future wilderness legislation, such as that currently being considered for the state of Nevada, should specifically provide that wildlife conservation activities deemed necessary by the state wildlife agency be allowed in any wilderness to be administered by NPS, in addition to those administered by BLM.

The Act established 74 wilderness areas in the deserts of eastern and southeastern California; 69 of these are administered by BLM, 2 by U.S. Fish and Wildlife Service, and 3 by NPS. The majority of these are inhabited by resident populations of mountain sheep (Torres et al. 1994), but designation of wilderness is an opportunistic political process (Hauffer et al. 1996). The tragedy is that these wilderness areas were established largely at the insistence of special interest groups, and were delineated primarily on convenient topographic features (i.e., wilderness boundaries largely were drawn around the basal contours of isolated desert mountain ranges, or along peripheral roads). As a result, no consideration was given to the juxtaposition of those wilderness areas; the increased use *within* those areas that would result from their "protected" status (Wallace 1992, Klein 1994); the increased use *outside* of those protected areas that would occur as the public was denied motorized access to newly legislated wilderness; or, to the synergistic impact that all of the above factors would have on the potential for movement by large mammals between islands of "protected" habitat (Schwartz et al. 1986, Bleich et al. 1990, Bleich et al. 1996).

To further confound the problematic spatial arrangement of wilderness established by the Act, federal bureaucracies are moving to acquire all private or state-owned lands *within* those areas. These lands are not being purchased but, instead, are being exchanged for federal lands *outside* of designated wilderness, further complicating efforts to ensure that isolated wilderness areas are linked by intermountain corridors. Moreover, private and state-owned lands provide opportunities for habitat enhancement projects, particularly for mountain sheep, even within wilderness areas administered

by NPS (Pauli 1995). The value of these lands for habitat enhancement purposes has not been considered in the process of land acquisition. It is my contention that these exchanges ultimately will exacerbate fragmentation of mountain sheep habitat (Armentrout and Boyd 1994) by further isolating protected areas from each other (*sensu* Sarkar 1999). Of even more concern, however, is the continued fragmentation of desert *ecosystems* and resultant effects on evolutionary processes, including metapopulation dynamics (Bleich et al. 1996).

Designation of wilderness does not guarantee protection from potentially detrimental impacts (e.g., use by exotic ungulates or recreational use; Cole and Landres 1996), nor does it guarantee that such areas are “untrammeled by man” (Mitchell 1998, Bleich and Pauli *in press*). Nevertheless, recent experience has shown that wildlife conservation measures and habitat restoration is controversial and problematic in such areas (Bleich 1999). Additionally, the notion that protected areas necessarily benefit wildlife populations or enhance biodiversity can be unfounded (Berg 1991, Zika 1991, Gadgil and Guha 1995, Mace and Waller 1998, Sarkar 1999). Without consideration for landscape-level processes, wilderness areas may become islands of protected habitat (Sarkar 1999) that are subjected to more intensive human use (Klein 1994, Cole 1996a) with negative implications for conservation of wildlife or habitat, as a result of that designation (Repetto 1992).

**Summary:** The aforementioned concerns have implications for the long-term conservation of large mammals, and exemplify the lack of biological foresight inherent in the designation of wilderness in the deserts of California. The motivation for establishing those wilderness areas was founded primarily in a sociological context (*i.e.*, “solitude”, “primitiveness”), and largely lacked an ecological perspective. Indeed, Spurr (1966; cited by Haufler et al. 1996) concluded that, “Wilderness is a poetic and deep-felt concept, but is primarily sociological rather than ecological in implication...”. As a result, wildlife managers have been forced to conserve a biological wilderness

following natural laws, while the “wilderness clientele” has perceived the task as sociological, and centered largely on aesthetics (Haufler et al. 1996). Even the ability to conduct scientific investigations has been compromised by unreasonable and inflexible wilderness policies; fortunately, however, the importance of scientific investigation in wilderness is being recognized (Cole and Landres 1996).

Wilderness has value in protecting examples of natural ecosystems (Noss 1991), as baseline or reference areas to which manipulated ecosystems can be compared (Franklin 1987), and because of the psychological and sociological benefits that humans derive from the use of such places (Lucas 1973). As I noted previously, it also has value in protecting wildlife habitat. However, the lack of ecological foresight in establishing most wilderness areas has important ramifications for landscape-level processes, including animal migrations (Brower and Malcolm 1991) and metapopulation dynamics (Bleich et al. 1996); this gaffe is especially onerous in the deserts of southeastern California.

It is ironic that advocates of wilderness inevitably invoke the importance of those areas as a method to protect habitat and conserve wildlife, but that few wilderness areas contain even the year-round ranges of indigenous large mammals (Haufler et al. 1996). Bailey (1992) noted that wilderness management plans were being developed without consideration for the roles of those wilderness areas in the metapopulation dynamics of mountain sheep. Moreover, Bailey and Woolever (1992) concluded that the strict application of wilderness policies could jeopardize the existence of many populations of mountain sheep occupying small wilderness areas. It is my contention that if legislated wilderness had its foundations in wildlife conservation (as claimed by many advocates), then responsibility for administration of such areas would not be vested in persons whose primary responsibilities center on management of recreational activities.

The overzealous application of legislation, inflexi-

ble policies, pressures from special interest groups, and lack of ecological foresight in delineating wilderness areas have made wildlife conservation activities within wilderness difficult, at best. Nevertheless, the stewardship of wildlife by CDFG in the deserts of California has been facilitated by provisions of the Act (specifically Section 103[f]) that were negotiated during the legislative process. The Act ensured that management activities to maintain or restore wildlife populations and the habitats to support such populations may be carried out in wilderness, and provided for the use of motorized vehicles for those purposes. As other wilderness areas are established, similar concessions for wildlife conservation activities and for habitat enhancement or restoration will enhance the probability of maintaining viable populations of large mammals, particularly in desert ecosystems. There is concern that human actions (e.g., the restoration of mountain sheep) to enhance the "naturalness" of wilderness systems will further degrade legislated wilderness (Cole 1996b, Cole and Landres 1996) but, also, simultaneous recognition that such activities may be necessary for the maintenance of ecosystem processes outside of wilderness (Cole and Landres 1996).

I contend that the application of common sense to the interpretation of wilderness legislation, and implementation of reasonable policies, will provide greater public support for wilderness than will rigid enforcement of regulations that are deemed unreasonable by affected citizens (e.g., Hummel 1989, Klein 1994), or are inconsistent with wildlife conservation objectives (Sizer and Carr 1989; this paper). Further, consistency in the interpretation and application of wilderness policy, particularly as it relates to those areas established in 1994 by the Act, will lead to fewer disagreements between personnel in state and federal agencies, reasonable and effective wildlife conservation measures in legislated wilderness, and a greater probability of maintaining viable populations of large mammals in the deserts of California.

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#### LITERATURE CITED

Andrew, N.G. 1994. Demography and habitat use of desert-dwelling mountain sheep in the East Chocolate Mountains, Imperial County, California. M.S. Thesis, University of Rhode Island, Kingston, RI.

\_\_\_\_\_, V.C. Bleich, and P.V. August. 1999. Habitat selection by mountain sheep in the Sonoran Desert: implications for conservation in the United States and Mexico. *California Wildlife Conservation Bulletin* 12:1-30.

\_\_\_\_\_, L.M. Lesicka, and V.C. Bleich. 1997. An improved fence design to protect water sources for native ungulates. *Wildlife Society Bulletin* 25:823-825.

Armentrout, D.J., and R.J. Boyd. 1994. Consequences of habitat fragmentation on wild sheep metapopulation management within USA. *Biennial Symposium of the Northern Wild Sheep and Goat Council* 9:149-158.

Bailey, J.A. 1992. Managing bighorn habitat from a landscape perspective. *Biennial Symposium of the Northern Wild Sheep and Goat Council* 8:49-57.

\_\_\_\_\_, and M.M. Woolever. 1992. Determining the future of bighorn herds in wilderness areas. *Biennial Symposium of the Northern Wild Sheep and Goat Council* 8:121-135.

- Berg, K. 1991. Conflicts between national parks management and endangered plant protection: examples from California. Pages 374-375 in J. Edelbrock and S. Carpenter, editors. *Natural areas and Yosemite: prospects for the future*. U.S. National Park Service, Denver Service Center, Denver, CO.
- Bleich, V.C. 1999. Forum: America's wilderness. *National Geographic* 195(3):xv.
- \_\_\_\_\_, C.D. Hargis, J.D. Wehausen, and J.A. Keay. 1991. Interagency coordination and the restoration of wildlife populations. Pages 277-284 in J. Edelbrock and S. Carpenter, editors. *Natural areas and Yosemite: prospects for the future*. U.S. National Park Service, Denver Service Center, Denver, CO.
- \_\_\_\_\_, and A.M. Pauli. 1990. Mechanical evaluation of artificial watering devices built for mountain sheep in California. Pages 65-72 in G.K. Tsukamoto and S.J. Stiver, editors. *Wildlife water development*. Nevada Department of Wildlife, Reno, NV.
- \_\_\_\_\_, and A.M. Pauli. (In press). Distribution and intensity of hunting and trapping activity in the East Mojave National Scenic Area, California. *California Fish and Game*.
- \_\_\_\_\_, and B.M. Pierce. (In press). Accidental mass mortality of migratory mule deer. *Great Basin Naturalist*.
- \_\_\_\_\_, J.D. Wehausen, and S.A. Holl. 1990. Desert-dwelling mountain sheep: conservation implications of a naturally fragmented distribution. *Conservation Biology* 4:383-389.
- \_\_\_\_\_, J.D. Wehausen, R.R. Ramey II, and J.L. Rechel. 1996. Metapopulation theory and mountain sheep: implications for conservation. Pages 353-373 in D.R. McCullough, editor. *Metapopulations and wildlife conservation*. Island Press, Covelo, CA.
- Brower, L.P., and S.B. Malcolm. 1991. Animal migrations: endangered phenomena. *American Zoologist* 31:265-276.
- Clark, J.L. 1996. Round Valley deer study. *Outdoor California* 57(1):4-8.
- Cole, D.N. 1996a. Wilderness recreation in the United States - trends in use, users, and impacts. *International Journal of Wilderness* 2(3):14-18.
- \_\_\_\_\_. 1996b. Ecological manipulation in wilderness - an emerging management dilemma. *International Journal of Wilderness* 2(1):15-19.
- \_\_\_\_\_, and P.B. Landres. 1996. Threats to wilderness ecosystems: impacts and research needs. *Ecological Applications* 6:168-184.
- Countryman, C.M., and D.R. Cornelius. 1957. Some effects of fire on a perennial range type. *Journal of Range Management* 10:39-41.
- Etchberger, R.C., P.R. Krausman, and R. Mazaika. 1989. Mountain sheep habitat characteristics in the Pusch Ridge Wilderness, Arizona. *Journal of Wildlife Management* 53:902-907.
- Franklin, J.E. 1987. Scientific use of wilderness. Pages 42-46 in R.C. Lucas, editor. *Proceedings of the National Wilderness Conference: issues, state-of-knowledge, future directions*. USDA Forest Service, Intermountain Research Station General Technical Report INT-220.
- Gadgil, M., and R. Guha. 1995. *Ecology and equity: the use and abuse of nature in contemporary India*. Penguin Books India, New Delhi, India.
- Haufler, J.B., L.G. Adams, J. Bailey, R.G. Brocke, M.J. Conroy, G. Joslin, and K.G. Smith. 1996. *Wildlife management in North American wilderness*. Wildlife Society Technical Review 96-1.

- Hill, S.D., and V.C. Bleich. 1999. Monitoring wildlife water sources using low Earth orbiting satellites (LEOS). *Wildlife Society Bulletin* 27:25-27.
- Holl, S.A., and V.C. Bleich. 1983. San Gabriel mountain sheep: biological and management considerations. USDA Forest Service, San Bernardino National Forest, San Bernardino, CA.
- Hummel, M. 1989. Endangered species: the future for Canada's wilderness. Key Reporter Books, Ltd., Toronto, Ontario, Canada.
- Jones, F.L. 1954. An unusual cause of deer mortality. *Journal of Wildlife Management* 18:142.
- Klein, D.R. 1994. Wilderness: a western concept alien to Arctic cultures. *Information North* 20(3):1-6.
- Kloepfer, D., J. Watson, and P. Byrnes. 1994. The Wilderness Act handbook. 2nd ed. The Wilderness Society, Washington, D.C.
- Lucas, R.C. 1973. Wilderness: a management framework. *Journal of Soil and Water Conservation* 28:150-154.
- Mace, R.D., and J.S. Waller. 1998. Demography and population trend of grizzly bears in the Swan Mountains, Montana. *Conservation Biology* 12:1005-1016.
- Mitchell, J.G. 1998. Wilderness: America's lands apart. *National Geographic* 194(1):2-33.
- Mueggler, W.F., and J.P. Blaisdell. 1958. Effects on associated species of burning, rotobating, spraying, and railing sagebrush. *Journal of Range Management* 11:61-66.
- Noss, R.F. 1991. Sustainability and wilderness. *Conservation Biology* 5:120-122.
- Oehler, M.W. 1999. Ecology of mountain sheep: effects of precipitation and mining. M.S. Thesis, University of Alaska Fairbanks, Fairbanks, AK.
- Pauli, A.M. 1995. History, use, and management of harvestable species in the Mojave National Preserve. Unpublished report, Game Bird Heritage Program, California Department of Fish and Game, Sacramento, CA.
- Pierce, B.M. 1999. Predator-prey dynamics between mountain lions and mule deer: effects on distribution, population regulation, habitat selection, and prey selection. Ph.D. Thesis, University of Alaska Fairbanks, Fairbanks, AK.
- Repetto, R. 1992. Accounting for environmental assets. *Scientific American* 266:94-100.
- Sarkar, S. 1999. Wilderness preservation and biodiversity conservation - keeping divergent goals distinct. *Bioscience* 49(5):405-412.
- Schwartz, O.A., V.C. Bleich, and S.A. Holl. 1986. Genetics and the conservation of mountain sheep *Ovis canadensis nelsoni*. *Biological Conservation* 37:179-190.
- Sizer, B., and J. Carr. 1989. The trouble with wilderness. *Arizona Wildlife Views* 32:2-4.
- Torres, S.G., V.C. Bleich, and A.M. Pauli. 1993. An analysis of hunter harvest of mountain sheep in California, 1987-1992. *Desert Bighorn Council Transactions* 37:37-40.
- \_\_\_\_\_, \_\_\_\_\_, and J.D. Wehausen. 1994. Status of bighorn sheep in California, 1993. *Desert Bighorn Council Transactions* 38:17-28.
- United States Congress. 1964. Public Law 88-577, Wilderness Act, September 3, 1964.
- \_\_\_\_\_. 1994. Public Law 103-433, California Desert Protection Act, October 31, 1994.
- Wallace, D.R. 1992. The quetzal and the macaw: the story of Costa Rica's national parks. Sierra Club Books, San Francisco, CA.

Zika, P.F. 1991. The role of recreation in the extirpation of alpine plant species in the north-eastern United States. Pages 554-559 *in* J. Edelbrock and S. Carpenter, editors. Natural areas and Yosemite: prospects for the future. U.S. National Park Service, Denver Service Center, Denver, CO.

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## QUESTIONS, ANSWERS AND COMMENTS - VERNON C. BLEICH PRESENTATION

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**JON HANNA, ARIZONA:** Just to share an example, maybe on the other end. In some wilderness areas on Forest Service land where we have bighorn sheep, it looks like we'll have clearance to land helicopters for net-gunning and collaring sheep, and possibly also clearance for snaring lions on wilderness areas.

**VERN BLEICH:** I commend you and congratulate you on that. I think that my point is that things often must be pushed to the limit before one can make reasonable progress along the lines of implementing wildlife management activities due to the personal efforts of many people who may not agree with such activities occurring in designated wilderness areas.

**MICHELLE BOURASSA, SOUTH DAKOTA:** It seems a lot of these determinations of the acceptable activities in the wilderness areas comes down to individual managers and supervisors. I want to know if any unbiased public surveys have been completed to determine what the general public perceives as acceptable and nonacceptable activities in designated wilderness areas?

**BLEICH:** I can't respond to that question because I do not know. My point is that these wilderness areas as designated have been touted as being in the best interests of wildlife conservation. I clearly do not believe that is the case. I think that the sociologists and leisure studies people would perhaps have answers to your questions, but I would argue that if wilderness designation truly was compatible with wildlife conservation, agencies wouldn't have sociologists and recreation specialists administering wilderness areas.

**DAVE SMITH, ARIZONA:** I think you're preaching to the choir. We're the biologists who feel it's a pain to work around wilderness. I look at the inconvenience of having to walk in there to do surveys. However, at least when I go in there, somebody isn't going to be lopping the top of the mountain off for a mine. It's been Congressionally withdrawn from mineral entry, especially for the sheep metapopulations we have scattered around southeastern California. Somebody isn't going to put in an off-road competitive race track; there won't be any dirt bikes or ATVs.

**BLEICH:** Dave, I appreciate you're being part of the choir. However, I would counter that with, first of all, the raceways are not going to be occurring in the mountain ranges. They'll be occurring between the mountain ranges for lack any other place to put them. Also, where there were developable minerals or if any of these areas were of economic value, they've already been gerrymandered in or out of the wilderness areas as the case may be. Nothing went into wilderness if there was the potential for something economically to happen, that I've been able to determine.

**SMITH:** But if I want to spend a couple hundred dollars a year for recreational bulldozing, I can go anywhere I want if it's under five acres. There's a lot of that on the Quartzsite area. In the Kofa Wilderness that at least keeps the "snowbirds" from going "hobby mining". It's not the big mines. It's the hobby mines that require protection as wilderness.

**BLEICH:** You're absolutely correct. But there are ways to address those issues. The 1872 Mining Act is clearly a problem. The Taylor Grazing Act is a problem. But rather than deal with issues, we invented something really flashy, really chic. The sociologists and recreation planners have told us that we need places to go where we can get away from it all and not be exposed to the toils and troubles of daily life. Congress

called it wilderness for that reason, but didn't consider the ramifications of that for long-term conservation at a landscape level, and my concern really boils down to what's going to happen to the rest of the desert. I think we'll end up with island populations of mountain sheep in well-protected areas of suitable rocky terrain and, ultimately, with very little opportunity for emigration and immigration, and movement between those areas by mountain sheep.



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## HUNTING/HARVEST STRATEGIES

CHAIR: KEVIN HURLEY, WYOMING GAME AND FISH DEPARTMENT

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### ROB B. YOUNG - THE USE OF SILENT WITNESS LINES TO DETER WILD SHEEP POACHING

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**Abstract:** Desert bighorn sheep (*Ovis canadensis*) have high economic value to state wildlife agencies. In Arizona, sale of one bighorn sheep tag raised over \$300,000 for management activities associated with this species. Further, nonconsumptive users place a high intrinsic value on the observing of desert bighorn. Hence, management of this resource is a priority to wildlife agencies. Loss of mature rams to illegal harvest create high concern for both the consumptive and nonconsumptive users which in turn results in loss of public support to wildlife agencies. Silent Witness programs such as Arizona's Operaton Game Thief provide a unique opportunity to apprehend violators. These programs also provide substantial deterrent effects to violators. We will discuss specific cases such as the one in Arizona where an anonymous tip resulted in the arrest and conviction of the violators. In all, rewards paid for this information exceeded \$5,000. Criminal and civil assessments in this case exceeded \$17,000. Several other states have had similar successes with desert bighorn cases.

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Bighorn sheep (*Ovis canadensis*) emigrated from Eurasia to North America, crossing the Bering land bridge approximately 70,000-100,000 years ago (Kurten and Anderson 1980). They eventually spread to much of the mountainous West, extending as far south as the southern end of Baja California Sur and the northern reaches of the Sierra Madre (Brown 1989). Bighorn were successful colonizers and eventually occupied areas as far east as the Badlands of North and South Dakota, portions of Nebraska, and the Trans-Pecos region of Texas (Buechner 1960).

In Arizona, the journals of early explorers are used to develop an understanding of the pre-settlement distribution. Coues (1867) indicated that desert bighorn had an extensive range that included most of the mountain ranges in Arizona. J.O. Pattie (1833) found numerous bighorn in mountainous regions in proximity to the San Francisco River in eastern Arizona. The early naturalist E.A. Mearns (1907) found bighorn in many mountain ranges including the Peloncillos in southeastern Arizona;

the Pajarito, Atascosa, and Santa Rita mountains in southern Arizona; and in much of the Verde Valley, the Bill Williams Mountains, and the San Francisco Peaks in north-central Arizona. Presently, all bighorn populations from the mountain ranges listed have been extirpated.

This decline in desert bighorn numbers and distribution has lead to formation of several organizations dedicated to assisting state wildlife agencies improve bighorn populations. These organizations have heightened interest in bighorn sheep. Support from these organizations is essential, as maintaining or enhancing desert bighorn sheep populations requires considerable management intervention. Management activities include water development, translocations, and removal of domestic livestock in restoration efforts. In Arizona, most of these efforts are funded in cooperation with sporting groups who raise these funds via auctions or raffles of permits to harvest bighorn.

While not a direct reflection of the value people place on desert bighorn, the highest price paid for an Arizona desert bighorn tag is \$303,000. In the 15 years that these permits have been offered in Arizona, over \$3.0 million has been raised from the auction/raffle of these permits (AGFD unpublished data). Given the rarity of desert bighorn, which makes drawing a legal permit difficult, coupled with the fact that desert bighorn are highly sought after as trophies, it is likely that illegal harvest occurs throughout the range where this species is found.

Like most illegal activities, it is impossible to determine the amount of illegal desert bighorn poaching that occurs. It is important to note, though, that illegal trade in wildlife is a worldwide problem. Currently, the unlawful commercialization of wildlife is second only to drug trafficking as an illegal activity. A recent estimate indicated that up to \$4.0 billion/year is generated through the illegal trade of wildlife or wildlife parts (Clede 1993).

**Silent Witness Line Operation:** In 1978, the New Mexico Game and Fish Department initiated a program where concerned citizens who had observed wildlife crimes could contact the agency on a toll-free line to report these crimes. Arizona followed the next year with a similar program. Today, all U.S. states and Canadian provinces have a silent witness program for reporting wildlife-related crimes. These programs are known by various names including Report All Poachers (RAP), Turn In Poachers (TIP), or Operation Game Thief (OGT). The Arizona program uses the Operation Game Thief name.

Our program is in operation on a 24-hour a day, 365-day/year basis. We utilize a toll-free line that accesses the AGFD Law Enforcement Dispatch Center. All callers can remain anonymous if they request this. One of the key elements of the success of this program is that rewards are offered for information concerning various violations of Arizona law, including wounding or killing wildlife, illegal possession or transportation of wildlife or wildlife parts, selling wildlife, and in some

cases, for vandalism. Rewards are offered in cases where the information leads to an arrest (including a citation), and does not require a conviction. Rewards vary from \$50-\$1,000 depending on several factors, including the species and number of animals poached and whether the individual is a repeat offender. On occasion, private donations are solicited to increase a reward offered. In 1998, \$14,500 in rewards were paid based upon calls to the OGT line, with \$1,200 paid in desert bighorn related cases.

When a concerned citizen calls the OGT line, the dispatcher receiving the call places a priority on the call, completes a "Report of Violation" form, enters the information into a computer database, and assigns the call to a case officer. Priorities are assigned with regards to several factors, including the type of violation reported and whether the violation is in progress. Our OGT line can be accessed from the states that border Arizona (New Mexico, Utah, Colorado, and the southern half of California).

**Case Studies:** In recent years there have been several instances in Arizona where members of the general public have assisted AGFD in solving crimes related to the illegal take of desert bighorn rams. In these case studies, poaching was detected and a call received through the Operation Game Thief line that initiated law enforcement investigations. In some of these cases, without these calls, the loss of bighorn rams likely would have gone undetected.

**Arizona Sonoran Desert Museum:** On December 5, 1987, a violator illegally entered the grounds of the Arizona Sonoran Desert Museum (ASDM) after normal visitor hours and killed a mature desert bighorn ram that was on exhibit. This ram had been taken from the wild in western Arizona several years earlier. The killing was discovered by one of the caretakers the next morning. The animal had been decapitated and the head removed from the museum. Although AGFD received notification from the ASDM, a call was received from an anonymous caller who reported the crime through the OGT line. The caller re-

ported additional information that aided the investigation of the poaching. This case was eventually solved several months later when a state patrol officer in California stopped a motor home for a traffic violation. In a search of the vehicle, the horns of the poached animal were discovered and charges relating to the poaching were filed. Coincidentally, 3 days after the initial call regarding the poaching at the ASDM, a call was received on the OGT line where a report was made that indicated that an individual was trying to sell a desert bighorn skull that had been poached. Investigations revealed that the incidents were not related and the second poaching was also solved using information provided via the OGT line.

**Goat Mountain:** One of the highest visibility desert bighorn poaching cases involved the illegal take of a mature ram from the Apache Lake area in central Arizona in 1988. The desert bighorn in this area were the result of a translocation conducted by the AGFD in 1980 and 1981, whereby 32 desert bighorn were released to the area. This translocation was successful, and the population grew in both number of animals and occupied area (Cunningham et al. 1989). The area occupied by desert bighorn was close to 3 lakes used extensively for boating and fishing, and the public frequently observed desert bighorn in the area, resulting in desert bighorn being important as watchable wildlife. Two anglers on Apache Lake observed the carcass of a bighorn ram that had been shot and the head removed. They reported the crime through the OGT line, and an investigation ensued. The crime became highly publicized as both television and newspaper media made extensive coverage of the case throughout Arizona. Concerned citizens contacted the Department through the OGT line and contributed funding to increase the reward offered to a total of \$5,000. It took over 4 years of investigation, and ultimately, good information provided via the OGT line before the case was solved and arrests made. The head of the ram was still in the freezer of 1 of the 2 individuals involved. The primary individual involved was convicted and assessed more than \$17,000 in criminal and civil assessments. The second individual was convicted and assessed a

total of \$7,000 for his involvement in the poaching. Both individuals had their hunting privileges revoked for 5 years.

During its 20 years of operation, the Arizona OGT program has received calls from concerned citizens that resulted in 91 investigations involving illegal activities with bighorn sheep. In 1998 alone, 10 case investigations were initiated based upon OGT calls related to bighorn sheep poaching. One of these cases is still active and involves a suspect who lives in Alaska and supposedly flew to Las Vegas, rented a vehicle, drove to the Lake Mead area and poached a desert bighorn.

**Conclusions:** Experience suggests that poaching most frequently focuses on the maturest ram available. These are also the animals that hunters and non-consumptive users seek; thus a conflict in uses develops when prime-aged rams are lost to illegal harvest. Further, Geist (1971) reported that adult rams are essential in maintaining important social interactions in wild sheep populations. It is important that wildlife management strategic plans recognize that illegal harvest can be an important mortality source. We believe that law enforcement and use of silent witness lines can play a role in reducing illegal harvest of wild sheep. For this to become a reality though, it is essential that law enforcement and wildlife management personnel work in cooperation to promote use of silent witness wildlife lines such as Arizona's Operation Game Thief.

#### LITERATURE CITED

- Brown, D.E. 1989. Early history. *in* The desert bighorn in Arizona. R.M. Lee editor. Arizona Game and Fish Department, Phoenix, AZ.
- Buechner, H.K. 1960. The bighorn sheep in the United States; its past, present, and future. Wildlife Monograph No. 4. 174 pp.
- Clede, B. 1993. Poaching: organized crime. Law and Order Magazine.

Coues, E. 1867. The quadrupeds of Arizona. *American Naturalist*. 1:281-292, 351-363, 393-400, 531-541.

Cunningham, S.C., N. Dodd, and R. Olding. 1989. Arizona's bighorn sheep reintroduction program. *in* R.M. Lee, ed. The desert bighorn sheep in Arizona. Arizona Game and Fish Department, Phoenix, AZ.

Geist, V. 1971. Mountain sheep: a study in behavior and evolution. University of Chicago Press. Chicago, IL.

Kurten, B., and E. Anderson. 1980. Pleistocene mammals of North America. Columbia University Press, New York, NY.

Mearns, E.A. 1907. Mammals of the Mexican boundary of the United States. A descriptive catalogue of the species of mammals occurring in that region; with a general summary of the natural history, and a list of trees. *Bulletin U.S. Natural Museum*. 56:1-530.

Pattie, J.O. 1833. The personal narrative of James Ohio Pattie of Kentucky. T. Flint, ed. John H. Wood, Cincinnati, OH.

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## QUESTIONS, ANSWERS AND COMMENTS - ROB B. YOUNG PRESENTATION

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**UNIDENTIFIED SPEAKER:** I have a question about the two suspects in the Apache Lake case. Were their licenses revoked for five years?

**ROB YOUNG:** Yes, unfortunately, our laws only max at five years. Violators can do one to five. If we have a repeat offender, the price of business goes up.

**JIM BAILEY, NEW MEXICO:** What about the buyers of poached wildlife? What are the sanctions, and how often are they apprehended?

**YOUNG:** That's a big unknown. The sanctions are high. That's the biggest part of the \$4 billion cost that I alluded to earlier. The Fish and Wildlife Service needs to do a lot of work on their laws on Lacey Act violations. I'll tell you at the break what the Lacey Act is; I won't take the time now. So many of these violations go unnoticed. We almost have to depend on either infiltration, which is like the big case we showed you with all the multiple animals, which is expensive and time-consuming, or we have to rely on people turning somebody else in. So we think that probably we find out about less than five percent of the violations that occur worldwide.

**BAILEY:** That case must have involved a lot of buyers? You had a list of 50 or 60 animals.

**YOUNG:** Yes.

**BAILEY:** How many of those buyers were apprehended?

**YOUNG:** Well, only a couple of them were actually sold. One person was apprehended, like I said. That jaguar was sold to the taxidermist. He did a full body mount and sold it to our guys; our Colorado guys in New Mexico.

As you can see, there was multiple state cooperation on that particular case. We didn't find out about most of the animals until after two and a half years. Poachers have big egos, and they love to take pictures. The use of photographs, still photographs and video have been a Godsend to law enforcement, because they convict themselves with those things. That's how we made a lot of them, but we did not know who bought the poached animals. Some of the records we obtained with search warrants helped to identify them. As I recall, there were 17 people that were issued citations for one reason or another on that big case.

**GLENN LORTON, NEW MEXICO:** Why aren't higher fines levied when auction tags clearly indicate a higher value?

**YOUNG:** In Arizona we have a five person commission that sets the value of wildlife. Values have to be approved again when they're reset by our legislature. In some states, like in Utah, I don't think they have made anything in ten years off of OGT, but their fines are big-time when they catch poachers. You poach a sheep or a moose up there, and you better bring your checkbook or your toothbrush because you're going to do some time.



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## CHRIS WRIGHT AND SHANE RENO - BIGHORN SHEEP WILDLIFE LAW ENFORCEMENT IN THE MISSOURI RIVER BREAKS IN CENTRAL MONTANA

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Chris Wright, Montana Department of Fish, Wildlife and Parks, 2165 HWY 2E, Havre, MT 59501  
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**Abstract:** Relative to population dynamics, there has been little discussion with regard to illegal harvest of bighorn sheep. We do realize just how fragile isolated sheep populations are with regards to contact with humans, domestic sheep, predation, habitat variations, and variances in weather conditions. There is also the rarely mentioned factor of illegal harvesting of bighorn sheep for their trophy value. During a three year covert investigation, it was discovered that eleven bighorn sheep were illegally harvested in the Missouri River Breaks and the Little Rocky Mountains. Currently, with the existing sheep herd that falls within our districts of responsibility, there is an extensive graduate study being performed. During the course of the surveys and tracking the animals, several rams disappeared and could not be found in the study area or surrounding areas of possible migration. The theory, due to ease of accessibility, falls on the shoulders of illegal trophy harvest. To achieve proactive law enforcement goals in protecting bighorn sheep, several enforcement techniques are utilized. The most often utilized techniques are the use of routine and saturation patrols. Additional patrols may be used such as spotlight patrols in which an airplane is utilized in an attempt to locate spotlights from the air and direct ground teams to the activity. Also, the ability to develop informants becomes crucial to furthering enforcement efforts. More specialized techniques include the use of microchips placed in the rams, electronic surveillance and simulated wildlife.

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Realizing just how fragile isolated sheep populations are with regards to contact with humans, domestic sheep, predation, habitat limitations and variances in weather conditions, it becomes imperative to discuss the rarely mentioned factor of illegal harvesting bighorn sheep for their trophy value. The intent of this paper lends credence to the impact of illegal harvest. First, we will discuss known incidents of illegal harvest and then what is believed from circumstantial evidence but not confirmed. We will complete the discussion by outlining and expanding on present enforcement techniques utilized by wardens in the Missouri River Breaks and Little Rocky Mountains of Montana.

During a three year investigation, it was discovered that eleven bighorn sheep were illegally harvested in the Missouri River Breaks and the Little Rocky Mountains. A point of interest with this particular case: a member of the covert team contacted one of the perpetrators about obtaining

bighorn sheep and indicated that he would pay good money for the acquisition. The perpetrator then set up a transaction and assured the covert officer that he could find and kill a sheep anytime. When the transaction date approached, the covert officer was informed by the perpetrator that not only did he have one ram for sale but two, and was hoping the covert officer could purchase both animals. The perpetrator was expecting money in the neighborhood of \$2,000 for both rams, and although this may seem low for a bighorn it is important to note that these rams were both half-curl or less rams.

With an offshoot of the same case, wardens acted on a tip that a bighorn sheep was poached on a gold mine in the Little Rockies, and the ram was transported by an employee of the mine using a company truck. When the shooter and employee of the mine were contacted they both denied any such occurrence and the shooter was emphatic about the location of kill being on the local reservation, for

which he had a valid bighorn sheep permit. Wardens contacted the mine administrator about the incident, and the administrator offered any aid the wardens would require to further the investigation. Additionally, the mine administrator assured the wardens that if suspicions were made fact he would support the wardens and terminate the employee for utilizing company equipment in the execution of a felony. Traveling to the mine the wardens obtained permission from the mine administrator to inspect the vehicle utilized for the transportation of the illegal ram. Wardens placed the vehicle in an enclosed shop and completed a cursory inspection which revealed animal hair, which was collected and sent the lab, and blood. Wardens cleaned the unrelated debris from the box of the pickup and then covered the vehicle box with a tarp to completely darken it. Utilizing criminal science technology, wardens obtained a nite-site kit which uses a certain combination of chemicals that when sprayed on blood will react with the hemoglobin in the blood, and will then luminesce. When wardens sprayed the box of the pickup the blood began to glow and pictures were taken. This is another example of the ease with which we lose sheep to illegal activities, and a great example of an enforcement tool we utilize to further our investigations.

Currently with the existing sheep herd that falls within our districts of responsibility there has been an extensive graduate study being performed. During the course of surveys and radiotracking sheep, several rams disappeared and could not be found in the study area or surrounding areas of possible migration. The theory, due to ease of accessibility, and failure to locate any of the rams, falls on the shoulders of illegal trophy harvest. Also, as these areas inhabited by bighorn sheep are also inhabited by other huntable species like deer, elk and lions the opportunity for illegal harvest often presents itself.

Through an informant we have discovered one particular method used by poachers. When out deer, elk or lion hunting, giving the poacher an acceptable excuse, sheep are poached and left in the field to completely decompose; the animal is

then later retrieved. In Montana it is illegal for any person to pick up and possess any sheep parts, but these people are able to take these sheep for plugging to other states that do allow individuals to pick up and possess sheep. We are unclear about the number of sheep we lose each year to this method, but it is not uncommon.

Other losses of sheep have been contributed to individuals coming off the Fort Belknap Indian Reservation and illegally harvesting sheep. An important note is the reservation sheep herd has received tremendous hunting pressure, and sheep numbers have been reduced such that rams have not been able to live long enough to reach mature trophy status. The reservation, prior to 1998, auctioned one bighorn sheep license each year. As a non-tribal member, any person who hunts on the reservation must first purchase a hunting license for the desired animal, and then must obtain a guide for the hunt. We had gained information that the hunt for the auctioned license was to be conducted off the reservation. Through covert surveillance we were able to keep tabs on the guide and hunter; nearly the entire hunt was conducted outside the reservation boundaries. Here again, hunting during a time when a season for other huntable species is occurring gives people cause to be in prime, trophy ram habitat. In this particular case a sheep was not harvested.

Other losses of sheep are due to activities of tribal members who have legally purchased a bighorn sheep permit for the reservation. Their method of operation will be to purposely hunt off the reservation, as there are not any trophy class rams within reservation boundaries. When an animal has been poached the gun and run method begins. The animal is shot and loaded into the pickup, and a run for the reservation line is made. The animal is not field dressed until the poachers have reached a location on the reservation where it would be possible to harvest a bighorn. It is important to note that within the Fort Belknap and Rocky Boy Reservations, state of Montana game wardens do not have legal jurisdiction to investigate enrolled reservation members within the confines of reservation boundaries. If poachers are caught in the

act, the defense of aboriginal hunting rights becomes the excuse for them to hunt off the reservation with only reservation sanctioned licenses, and in some cases without any licenses, and not the required state licenses. An example occurred in the early 1990's in which a member of the Rocky Boy Reservation poached a sheep off the reservation and when caught, the defense of aboriginal hunting rights was used. This case was eventually taken to the Montana Supreme Court where the court ruled that aboriginal hunting rights are not viable and if an enrolled reservation members wishes to hunt outside reservation boundaries, they must obtain the correct state hunting and fishing licenses to do so.

To achieve proactive law enforcement goals in protecting bighorn sheep, several enforcement techniques are utilized. The most often utilized techniques are routine and saturation patrols. Routine patrol simply involves the day to day patrol exercised by each warden and is conducted in their area of responsibility, or assigned district. Although it is important to spend time in these sheep areas, the geographic vastness plays such a role it easily becomes a chess game trying to figure out your opponents next move. Saturation patrols are essentially identical to basic routine patrol, however, multiple wardens engage in patrolling a smaller area, which improves geographic coverage and enhances the opportunity of contact with both legal sheep hunters and possible illegal intent. During the few days preceding and following the opening day of the bighorn hunting season, several wardens will congregate in the main sheep areas and apply law enforcement practices.

Simulated wildlife, or the decoy, is another tool that may be utilized. We were able to obtain a bighorn ram decoy through donations from FNAWS, which allowed us to purchase the bighorn ram decoy and robotics. Generally the decoy is used during saturation patrols, but we may use the decoy as the need arises. Placement of the decoy depends on traffic and frequent visibility of sheep along the main traveled routes utilized by sheep hunters and other resource users. Also, placement of the decoy will depend on informant

news, which allows us to target specific areas and people. Additional patrols may be used, such as spotlight patrols, in which an airplane is utilized in an attempt to locate spotlights from the air and direct ground teams to the activity. Spotlight patrols may occur at random times or when there have been complaints for a specific area and time. Spotlight patrols are both costly and labor intensive, and we are not able to utilize this tool as often as we would like.

Additional tools relate to a need for developing informants, which becomes crucial to furthering enforcement efforts. The geographic vastness of the Missouri River Breaks and the Little Rocky Mountains makes it imperative to develop informants, as there are so few wardens and our coverage is limited at best. More specialized techniques are the use of microchips placed in rams, and electronic surveillance. Microchips are just that, a small microchip placed in a syringe from which can then be inserted under the skin of a ram. Later, a wand that detects the frequency of the microchip can be used to positively identify the possible illegal ram. An example of microchip technology occurred during the beginning stages of the earlier mentioned graduate study currently being performed in the Missouri River Breaks. At the inception of the graduate study it was important to mark, by ear tag and collaring, a specific number of sheep. A portion of those marked were smaller, non-trophy rams. These young rams had a microchip placed under the skin which will enable us, if the need arises, to properly identify that ram if the harvest technique and time of kill becomes suspect. Lastly, the use of electronic surveillance has benefits that allow us to document suspect vehicles in the area, providing us with date and times. Electronic surveillance involves the use of trail timers armed with motion detectors. When triggered, these devices either snap a still photo from a camera placed at a position to obtain full view pictures of the passing vehicle, more importantly the license plate number of the vehicle, or begin live video coverage using the same vantage points.

Although we are unclear about the exact numbers

of sheep that are lost each year to illegal harvest we believe we are headed in the right direction for improving our odds of cornering an age old market of illegal buying and selling of trophy bighorn sheep. It is important to remember all facets that affect the growth and development of a viable trophy population of bighorn sheep, and that illegal harvest may play a larger role than we believe. Through a concerted effort, we can hopefully continue the team-supported effort to effectively achieve management goals of this spectacular species of game animal.

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**QUESTIONS, ANSWERS AND COMMENTS - CHRIS WRIGHT / SHANE RENO PRESENTATION**

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**RACHELLE HUDDLESTON-LORTON, NEW MEXICO:** I was wondering if there are any legal issues in using a decoy in terms of entrapment?

**CHRIS WRIGHT:** In Montana that's been addressed through our legislature. We have a law that states that we can use these animals, and it's been determined not to be entrapment.

**HERB MEYR, IDAHO:** Do you have access to DNA techniques?

**WRIGHT:** We have access to the federal lab in Ashland, Oregon, and also to our state lab.

**MEYR:** That didn't work in this instance?

**WRIGHT:** No, it didn't. One sample wasn't large enough. The amount we got off the swabs wasn't enough. It wasn't like fresh blood that we could get a good sample from, and most of the hair we had was smashed and pretty un-recognizable. I think the lab in Ashland now has shut down part of their DNA matching. They can do some things. They can tell you the species. They can't match animal to animal and sex to sex. They have shut down that part. They're training their people and will eventually be back on track.

**KEVIN HURLEY, WYOMING:** I have a question about DNA. If you look at the "cross-pollination" we've done by transplanting sheep across the west, I wonder how much that confounds the forensic ability you have?

**SHANE RENO:** Concerning one of the sheep that was shot in the breaks, I tried to prove that it was taken on the breaks and not on the reservation. The way I tried to do that was through a soil sample in the hoof of the sheep that was taken off the reservation. There was a tiny little sliver of a certain type of soil on the reservation. It's all over the breaks as Bear Paw shale. The lab couldn't say for sure that it was not taken on the reservation. Like Chris said, there are only half curl rams on the reservation, and the rams we're losing are 180s and high 170s. They get shot when they're half-curl.



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**OPEN DISCUSSION - WHAT ARE THE BIOLOGICAL BASES FOR OUR HARVEST STRATEGIES?**

**MODERATOR: KEVIN HURLEY, WYOMING GAME AND FISH DEPARTMENT**

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**KEVIN HURLEY, WYOMING:** We would now like to move to an open discussion on harvest strategies, not so much on the strategies themselves, but to the biological basis or bases of our varying harvest strategies.

If you look at the overhead that Bill Wishart put up yesterday, states and provinces are hunting sheep in many different ways. I'll use Wyoming for an example. From the numbers in the questionnaires, it looks like Wyoming harvests more rams than any other state in the lower 48. Approximately 183 rams were harvested in 1998, and that's from a population in the mid 6,000 range (6,300 to 6,400 sheep).

Right now we have 20 hunt areas in the state, six of which are closed, one is an any sheep area, five (including the three largest in the state) are any-ram areas, and we have eight areas that are managed under a minimum three-quarter curl regulation. These are all limited entry hunts.

In terms of the biological bases, we use an any-ram strategy to reduce or eliminate abandonment of harvested sublegal rams. We use a subjective rule of thumb that for every ten rams legally harvested, there's probably one that's shot and left; we think that's a needless waste of that resource. Hunters continue to select for mature rams, even though they have the ability to take any ram. We believe the very limited harvest of  $<3/4$  curl rams is less than five percent of the total harvest. We believe this is mostly compensatory mortality for younger rams which are harvested, rather than significantly additive. We believe we are incrementally aging the ram population through time. We are not currently harvesting any females in our one any-sheep area; perhaps every other year there might be one ewe taken. We also view removal for transplant as basically a ewe harvest.

What we wanted to do next is open this up and discuss some of the other biological bases for the strategies various states and provinces and territories are using. I will start with Alberta, because I think they've been on the leading edge of ewe harvest. I'll ask Alberta to explain the biological basis for their strategies.

**JON JORGENSEN, ALBERTA:** Yes, thanks, Kevin. In Alberta we have essentially unlimited entry trophy ram harvests. Anybody that wants to hunt rams can do so, and can buy a license. But we try to limit the harvest to older mature rams through a minimal curl regulation, which currently is four-fifths curl. In a couple of areas, we just recently increased this regulation to full curl, not so much for any biological reason, but because of a demand and a concern from hunters that the quality of the rams that are coming out of Alberta now has deteriorated considerably.

Most of our rams get taken as soon as they hit that four-fifths curl. There are enough hunters out there that they seem to be pretty successful at doing that. There has been quite a bit of concern over the poor quality of rams that is in the harvest.

We've experimented with increasing minimum size to full curl in a couple of our areas to see if we can increase the age of the rams, which we will do, but the big concern is availability of trophy rams. Whether or not we'll have the impact on the availability of trophy rams by going to full curl remains to be seen. Right now, we're only into the third year. We just finished the third year of that assessment in one area. We have yet

to have any rams taken in one of the other areas. We had the first full curl ram come out of there just this past year.

As far as ewe hunting goes, our strategy is for maintaining populations at or below carrying capacity through ewe harvests; and we try to do that throughout the province wherever we can. We usually maintain a ten percent harvest rate of the population with our ewe permits.

In some areas, we're right at the ten percent. Some areas where we want to reduce the population we feel is too high, we can increase that slightly, and there are other areas where we're a little bit lower than that.

There are some areas where there are predation issues, so that harvest rate has been lowered considerably. We do that to try to keep our populations down, keep them managed at a particular level, maintain high quality herds and good growth rates, and we seem to be accomplishing that right now. We're fairly satisfied with what we're doing and what we're achieving.

**HURLEY:** The long-term data set in Alberta indicates the obvious benefits are in lamb production, lamb survival, lamb recruitment, and enhanced horn growth.

**JORGENSON:** That comes from the Ram Mountain work that essentially shows by keeping nursery herds down, we have high productivity. Essentially, all our ewes are producing lambs. We have yearlings that are breeding, and survival rates are as high as they're going to get. We have good growth rates, both in body size and in horn growth.

So, our objective is to keep our herds at as high a quality as we can. But to do that, we have to be able to regulate nursery herd size, and we do that through ewe harvest. We're not into transplants other than there has been some transplanting out of the Cardinal River coal site, mainly because we don't have an ability right now to harvest those ewes.

So we demonstrated, and we feel have pretty good evidence to support, the benefits of ewe harvests, we try to implement those throughout the province.

**JIM BAILEY, NEW MEXICO:** Your goal is to take ten percent of the ewes or the ewes and female yearlings or what?

**JORGENSON:** It works out to be ten percent of the total winter population.

**BAILEY:** Lambs and ewes?

**JORGENSON:** That's equivalent to about 18 to 20 percent of the ewes, yearlings and lamb component.

**WAYNE HEIMER, ALASKA:** The biological basis of ram management in Alaska is based on 20 years of work in the Dry Creek field study. We demonstrated to the satisfaction of the general public and the Alaska Board of Game that a significant biological benefit that came through restoring and preserving the social mechanisms of sheep dominance hierarchy, breeding and survival makes biological and economic sense to harvest full curls in Alaska's Dall sheep. We have harvested significantly more full curls in the areas where we had maximum harvest than we did earlier under 3/4 or 7/8 curl regulations.

The presently accumulating data, as Ken Whitten pointed out, are a little less certain than the earlier data because those populations have declined to half the sizes they used to be. So we're not going to be killing 130 rams out of there again until we get twice as many sheep. Some of the data that we base that biological conclusion on are inferential, and if you want to nitpick them, you can probably sleep at night thinking you aren't compelled to believe what we think. That's the way these management experiences work.

With respect to ewe harvest, we do have ewe harvests in Alaska. There are several places in the state where Alaska Fish and Game suggests there are too many sheep, and they are trying to reduce them. Harvest of ewes from those areas has probably been insignificant, in terms of an actual population reduction. But where we have ewe hunts established by regulation, we kill ewes specifically to reduce populations. The rest of the ewe hunts are of political and social origin that come out of the subsistence issues that Ken and I talked about.

These ewe hunts don't exist for biological reasons and, in fact, the rationale for those ewe hunts is that they won't cause a decrease in population. I would refer anybody that's interested in how crazy things can get in this management environment we're operating in Alaska to the soon to be available proceedings of the Northern Wild Sheep and Goat Council (1998). I have an article in there that deals with the case history of several of these ewe hunts throughout the state.

**NIKE GOODSON, UTAH:** Didn't you have a report by Lyman Nichols in Alaska where you had a ewe hunt and then the sheep moved?

**HEIMER:** Yes, that was the report. What happened was we had a management situation where Lyman Nichols was hoping to evaluate classic Alberta management techniques (which weren't classic in Alberta then). The idea was to reduce the population on one mountain, and demonstrate that there was increased lamb production and that everything would be much better, because the sheep were below nutritional carrying capacity.

Initially, they tried a number of limited-entry permit hunting regimes but eventually it evolved to an open hunt for ewes. We weren't able to get people to take ewes because they didn't want to hunt ewes.

To monitor this open ewe hunt, the Department's management staff established a check station located 300 yards off the highway in a bar. Whether or not the ewe hunters who had killed ewes wanted to go up to the bar to check out, nobody knows. The biologists didn't mind having the check station in the bar; they're the ones that moved it up there from the highway. It was originally supposed to be on the road. The result was at the end of season the ewe population was way down, and we couldn't account for the number of ewes that were missing by the check out results.

Subsequently, Lyman noticed some sheep across the highway and postulated that these animals had not been killed and taken home without checking out, but had actually moved because of disturbance. If you talk to people that were there when Lyman found those sheep, they'll tell you the sheep were there all the time and Lyman just didn't notice them until he searched that area for sheep.

I think it would have been highly unusual for sheep who are traditionally linked to home ranges to be run off by a number of ewe hunters running around. That would have been a radical finding. I frankly think people didn't want to go up to the bar or maybe the guys were not keeping good records; I don't think the sheep moved. A lot of the locals didn't think they moved. Lyman's report was the best he could do.

**KEN WHITTEN, ALASKA:** There are a few things I guess I need to point out. One is that Alaska also had ewe hunts in a few situations where Fish and Game thinks that the population can withstand it, and we have close control over that hunt through a permit system.

And then we also have a few subsistence areas, which aren't there just for politics. They were established under state law. They're being continued under state law in conjunction with federal law, sometimes only under federal law, but those harvests have been going on for decades. Nobody can demonstrate that they've had any adverse effect on sheep populations. The actual number of ewes taken in those hunts are small. They're either-sex hunts and the native people, are just like us; they're highly selective towards older rams.

We also have another area that's open to unlimited access hunting, for any sheep, by Alaskan residents. Nonresidents have to take full-curl rams in that area. The harvest is predominantly big rams. That's what our hunters want.

We don't have very much clamor from the sport hunting public for more ewe hunts. I don't think you'll find very many working biologists now who will testify that we have to have full curl rather than three-quarter curl in order to protect populations. The full curl regulation is popular among our hunters and one thing is certain with full curl hunting; you won't harm the population in any way.

As Bill Dunn from New Mexico said (to apply it to Alaska), moose, caribou and southeastern Alaska deer pays our bills. With our limited funds, when we prioritize budgets within the department, we're not going to put much money into sheep when we're being hammered day in and day out on moose and caribou issues. Consequently, with our current full curl rules applying to most of the state and other special permit areas, we feel very comfortable with a generally popular full-curl season.

Recently, public discussions resulted in some proposals coming before the Board of Game for stricter enforcement of full-curl rules because people weren't finding enough big, trophy rams. I looked at Boone and Crockett records for the 50 largest sheep taken in Alaska. Only four of those have been taken since we legally required people to take the biggest rams. Only seven of those were taken after 1970. All the rest, 43 out of the 50, were taken before 1970. Again, people were highly selective towards big rams during that period when 3/4 curl rams were legal.

I think the key to trophy management, if you want big sheep, is to limit the number of hunters. It takes several years past minimum legal size, even if it's full-curl, for a ram to reach its maximum growth potential. When you have high levels of harvest, as we do in most areas of the state, relatively few rams and usually not the potentially biggest ones, live past that age. So if you want to produce very large rams, you need to limit participation in the hunt. You need to be able to accept rams living and often dying of old age.

**HURLEY:** Thank you, Ken. Again, we need to focus these comments on the biological basis for our strategies, not necessarily a description of what we're doing.

I'm not as familiar with harvest strategies in the desert states, but am curious. Are all the desert hunts for any ram? Are there any other strategies that are used? Any of the six or seven desert states want to respond?

**VERN BLEICH, CALIFORNIA:** California has what we refer to as a mature sheep, which is three-quarter curl animal. Our regulation is identical to the Wyoming regulation in terms of horn length, unless you have changed it since we adopted it. We can harvest sheep as young as two years of age, using that regulation. That's not the intent, but that's the regulation.

**HERB MEYR, IDAHO:** I can discuss the Idaho regulations.

**HURLEY:** Again, not the strategies, but some of the reasons why, if we can.

**MEYR:** Idaho is a once-in-a-lifetime-type state so, in other words, you shoot your ram, that's it. We require three-quarter curl, but we also have a caveat in there that it has to be four years old. Biological reason is that a lot of the rams broom off the horns, they never get past half curl. Our number of permits are conservative. We only have about 62 Rocky Mountain sheep permits and 48 California bighorn sheep permits. Most of the people are going to try to find the biggest ram since it's a once-in-a-lifetime. Biologically, when I talk to a lot of our game managers, they feel it's good to be harvesting rams throughout a whole age class instead of picking on your older rams.

**JOHN McCARTHY, MONTANA:** In Montana, we do kill ewes. In Montana we've got an any-ram type season. For the most part, we're fairly conservative on the number of permits that we issue, and the permits are based on numbers of rams that fall in or above a three-quarter curl category. What we have found is that by doing this, we essentially are taking older rams out of these populations. It also allows somebody to go out and kill a two-year-old or a three-year-old, which we feel leaves an older ram out there. Biologically, we find this more easily accommodating to the hunters and we haven't had any complaints about losses of these large rams.

The biggest problem we have in trying to put these seasons in is that we get pressure from federal agencies involved. I guess they feel they have some ownership in some of these populations. They want to set the regulations as to how many permits will be issued or put out for those areas. We also get pressure from the sportsmen's groups; they've got a large degree of ownership in these populations. We've had problems in areas where we're trying to increase the number of animals being taken to reduce population sizes, but sportsmen's groups have put enough pressure on the commission that we aren't allowed to do that.

As a result of that, we have seen die-offs in some of these areas when these populations get too high.

We believe Alberta has the right idea as far as killing ewes. We feel it results in more productive populations. The numbers of animals taken or the numbers of ewes taken are based on the number of sheep that we feel we can successfully accommodate on the winter ranges. For the most part, we've got management levels set for these populations, and are trying to keep numbers at those levels.

**HURLEY:** John, in the herds that you are harvesting at whatever rate or whatever percentage, have those experienced die-offs or have you been able to preclude those?

**McCARTHY:** The die-off in sheep transplanted from Alberta affects those populations where we were taking ewes, just as much as areas where we might not be harvesting ewes, or using ewes for transplants.

**REX SOHN, UTAH:** You've been talking about the federal regulations. I'd like to hear the dates of the hunt and lengths of the hunt.

**HURLEY:** We'll get to it in a minute after Nike's comments.

**GOODSON:** I won't talk to dates of hunt or length of hunt. What I want to talk about is that the effect of removing for transplanting is similar to harvesting ewes. You're removing ewes from the population. I did a study in 1984 through 1989 on a bighorn sheep population on the west side of Rocky Mountain National Park.

It was a small subpopulation. There were 35 ewes when I started and a total of about 70 sheep in the subpopulation. About 20 ewes had been removed from it in three separate removals over the seven years before I started the study.

I looked at reproductive rates of those ewes and compared them with two other subpopulations that had not had ewes removed. In that population, the reproductive levels were pretty limited. Ewes had lambs only about every other year, and they often had extended maternal behavior where they would nurse a yearling and nurse their lamb. The survival rates of lambs were pretty moderate, and there wasn't any indication in that population of a response, as far as improved reproduction.

The subpopulation which had experienced the removals did no better; in fact, somewhat worse recruitment than subpopulations that hadn't experienced removals. We can't necessarily assume we're going to get these good responses to removals; we need to know something about the population dynamics of the individual herds, and we have to monitor populations if we are removing females, because you can have an impact. You can't count on having compensatory reproduction survival.

The herd I was studying was a high elevation herd that spent the entire year above treeline, so there was a lot of density-dependent regulation in that herd because of hard winters and a very short growing season. The herd, in our opinion, wasn't capable of a large increase in productivity in response to removals. Some of these biological factors need to be considered when you're setting up a management plan, and you also need to consider the health of the population.

Using the Ram Mountain population as a model for bighorn sheep in the United States can be problematic. The last time I talked to Bill Wishart, he admitted that the Ram Mountain population has never had a die-off, and has had no contact with domestic livestock. It doesn't show any indication that it's ever picked up any of the bugs many of our herds in the United States carry because of years of contact with domestic livestock.

We know that following a die-off, you can have depressed reproduction in a bighorn sheep herd for extended periods over five, ten years. I think you need to know quite a bit about your population, its disease status and its potential for productivity in order to implement more aggressive strategies.

**HURLEY:** In response to Rex Sohn's question in terms of dates and timing, I don't think we want a litany of when they occur, but are there rut hunts, pre-rut hunts, and post-rut hunts? I would say they're largely pre-rut hunts, at least in Wyoming and the places I'm familiar with. Does anybody conduct or offer rut type hunts or post-rut hunts? Does Montana have a hunt during the rut?

**McCARTHY:** Yes, we start as early as September 15th and run through essentially the first of December.

**HARLEY METZ, COLORADO:** I follow the sheep situation in Colorado. As for the biological basis for Colorado, they have a half-curl rule. Some of the biological strategy that CDOW communicated to me was to keep from overharvesting the older rams. Because of the very conservative approach to ram harvest, they don't take very many rams out of a lot of their populations. They do harvest ewes in at least four different units. Normally those are the units with the largest populations which seem able to sustain that. In 1988, Colorado harvested 114 rams. We also harvested the state record ram last year, but I wouldn't count him as a Colorado ram. He was from Alberta, but he was 198 plus points.

CDOW has done something I have not read about anywhere else. We have a slot limit hunt, kind of like bass fishing. In the Georgetown herd, a very popular and accessible area, archery hunters and rifle hunters are

successful. They take the old end of the population. They have a large population, and the biologists in the last three years, in order to harvest what they consider to be surplus rams, have issued a slot limit. You can harvest a ram over a half-curl, but under a three-quarter curl in order to facilitate a harvest. In the case of our small desert population, we have maintained a half-curl rule; that has been the rule and we're only harvesting five or six rams out of those populations.

**HURLEY:** We're winding down. Does anybody have a comment on the biological basis of their hunting strategy?

**BAILEY:** This is non-biology, but we're doing a lot of experiments. We're trying this on this herd and on that state and whatnot. I don't think we have a good evaluation of what we're doing. We're not finding out whether the strategy is working, in terms of the objectives we have in mind. We may think it works, but I haven't heard any data other than Ram Mountain. That's our assumption.

**HEIMER:** I think what you see, Jim, is an expression of the fact that wildlife managers are the ultimate tinkers, and they're not particularly great recorders. I think it comes back to where we started. We don't have a working hypothesis articulated for most of these strategies that relates anything to anything other than what each tinkerer thinks might be a good idea.

**BAILEY:** We provide a lot of lip service to active management, but the lack of applying that active management properly is the biggest failing in natural resource management, not just wildlife management.

**CHRIS PAPOUCHIS, CALIFORNIA:** I'm with the Animal Protection Institute. One of the things that's happening as the population becomes more urbanized, the general public is getting away from the sport hunting mentality.

One of the things I'm concerned about is something managers need to address. Up to this point in this conversation, I heard talk of keeping a healthy population and making sure there aren't die-offs. It's not clear if this is for the population's health, for its sake, or for the population to be healthy for hunters. The general public is going to keep asking very tough questions. There will be a lot of pressure on managers to make sure they can justify the biology of hunting in the best interests of the populations themselves.

I think that biologists need to address that, especially if sport hunters want to keep hunting, because unfortunately, or fortunately depending upon your viewpoint, in this country sport hunting has become more in the minority. I know I'm making this somewhat unpopular comment, but it's going to be a political reality, and I think everybody needs to think about that when they do new plans.

**BLEICH:** I would point out that this country was founded upon the rights of minorities being as important as the rights of the majority. We've seen wildlife management at the ballot box absolutely destroy any scientific options, in terms of natural resource management because of popular vote. The fact that something is unpopular shouldn't relegate it to a nonactivity.

**PAPOUCHIS:** I would agree. I think they're going to ask for the biology to show this is indeed for the health of the population and not to suit that minority. That's just a point. It's something that needs to be thought about.

**BILL DUNN, NEW MEXICO:** The purpose of hunting is consumptive activity. There should be a biological basis for how we set our hunting seasons and everything else to maintain the health of the population, but that's not why we hunt.

**PAPOUCHIS:** I understand that.

**DUNN:** I think that as long as we have a biological basis for maintaining the health of the population, we're fine.

**HURLEY:** Jim said it, Chris said it, Wayne said it, a lot of people said it. We need to do a better job of articulating what our biological reasons for hunting are. Thank you all.

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## CAPTURE AND TRANSPLANT

CHAIR: AMY FISHER, NEW MEXICO DEPARTMENT OF GAME AND FISH

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### CHRISTOPHER M. PAPOUCHIS - GUIDELINES FOR THE RESTORATION OF BIGHORN SHEEP INTO LARGE LANDSCAPES: REPORT OF RECENT FINDINGS.

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**Abstract:** With some notable exceptions, the restoration of bighorn sheep to their former range in the Intermountain west, Colorado Plateau and prairie badlands remains only partially completed. Only 41% of the 100 prior translocations into this 6-state area were rated as clearly successful (those that met the J. Berger-BLM criteria of >100 animals), a success rate far lower than for most large ungulates. In 1990, the National Park Service (NPS) enjoined with 2 other federal agencies (BLM, U.S. Forest Service) and 5 state wildlife agencies (Colorado, Utah, South Dakota, North Dakota, Nevada) to restore metapopulations of bighorn sheep to large areas in and near to 15 NPS units in a 6-state area. In order to establish guidelines, we first analyzed the factors associated with success or failure of 100 translocations, and second we assessed the suitable habitat using the Smith et al. GIS-based model for bighorn sheep for 32 of those translocations. We found that the success of translocations was associated with larger founder groups (>40 animals), when indigenous groups were used as a source stock ( $P=0.04$ ), when domestic sheep were not present in the area and no known contacts occurred ( $P=0.05$ ), when no domestic cattle grazed the same range ( $P=0.04$ ), and when the translocated herd was migratory ( $P=0.014$ , logistic regression analysis). Translocations were more successful when placed into habitat patches containing >200 km<sup>2</sup> of GIS mapped suitable habitat ( $P=0.006$ ) and when >4% of the mapped suitable habitat was lambing habitat ( $P=0.036$ ). The modified GIS procedure we used, the modified Smith model, predicted success of the translocation in 82% of cases versus the 41% success rate for all translocations. We conclude that the use of the modified GIS process for every 100 translocations, would save ~ 33 million dollars at 1999 costs for capture and moving animals (\$3,000/animal), and would save ~ 1150 wasted animals from the unsuccessful translocations ( $\pm = 28$  animals/translocation). The cost of applying the GIS process we followed was about \$1,200 - 1,500 per translocation. We applied the process to a vast area of 39,117 km<sup>2</sup>, an area the size of Vermont and Connecticut combined: 31% of that total area was rated as suitable, of which 2,687 km<sup>2</sup> was already occupied, but another 6,635 km<sup>2</sup> was unoccupied, but suitable. When fully restored and occupied, we estimate the total suitable area could potentially support as many as 7,000 - 7,500 bighorn sheep. Fifteen separate translocations were conducted in 1995-98 by the joint efforts of the 3 federal and 5 state agencies.

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Managers consider bighorn sheep (*Ovis canadensis*) an enigmatic species. At present, some large and secure bighorn populations provide source stocks to many new herds, but most are

small, sedentary and stagnant. The species was widespread in the western U.S. until large scale declines over the past century, due to diseases contracted from domestic livestock, market hunt-

ing, overharvests, and human alterations of the landscape (Cowan 1940, Buechner 1960, Wishart 1978), eliminated the species from its historic range in 3 states and greatly reduced its presence in 4 others (Thorne et al. 1979).

Starting in the 1950s, several western states embarked on aggressive restoration programs. Some considerable successes were realized, such as in Colorado where bighorn populations approximately tripled and currently number about 6,000 animals (Bailey 1990). However, despite the successes, the restoration of bighorn sheep to large landscapes has been fraught with repeated setbacks and failures. Prior translocations suffered from a lack of detailed information and analysis of the factors relating to success, and a lack of replication and controls to test restoration techniques (Bailey 1990). Reviews of translocations in the U.S. West found only about 40% of prior translocations could be rated as clearly successful (Leslie 1980, Singer et al. 2000a). This low success rate results in waste of limited source stocks of animals and squandered dollars since the typical translocation costs about \$2,600 per animal (Bleich 1990).

Partly as a consequence of these variable restoration successes, bighorn sheep populations are generally small, isolated, and fragmented. Three separate reviews concluded roughly two-thirds of populations number less than 100 animals, and about one-third precariously number less than 50 individuals (Thorne et al. 1979, Krausman and Leopold 1986, Singer 1994). The rapid rate of extinction of many bighorn sheep populations has recently received intense scientific scrutiny (Berger 1990, 1999, Bleich et al. 1990, Krausman et al. 1993, Goodson 1994, Wehausen 1999) and has been attributed variously to disease, small population size, predation, sedentariness, poor dispersal tendencies, and inbreeding (Bailey 1986, Jessup 1985, Risenhover et al. 1988, Berger 1990, 1999, Wehausen 1996, 1999).

In 1990, the National Park Service, Intermountain Region, and the U.S. Geological Survey, Mid-continent Ecological Science Center, became involved in a long-term restoration effort of big-

horn sheep into 15 National Park Service units in a 6-state area of the Intermountain West (Singer and Gudorf 1999). The goals were to: (1) restore metapopulations of bighorn sheep into large landscapes on an interagency basis; (2) incorporate conservation biology paradigms into the review, analysis and testing of restoration procedures; and (3) to incorporate statistical probabilities, large samples and replication into the formulation of restoration protocols. This paper shares the key findings of this large, 9-year effort with managers. Many of the highlights presented here are available in greater detail in an upcoming special issue of *Restoration Ecology* (March 2000).

**KEY FINDINGS: Founder Sizes:** Success of translocations of bighorn sheep were positively associated with founder sizes. In a survey of 100 translocations, 66% of translocations with founder sizes  $\geq 40$  were highly successful, while only 35.6% of smaller founder sizes ( $\leq 29$ ) were highly successful (Singer et al. 2000a). Small founder sizes did result in some successes, but the probability of success decreased (Singer et al. 2000a, 2000b). Large founder sizes were also associated with success of translocations in a large number of mammals and birds (Griffith et al. 1989) and it is not surprising to find this same relationship holds for bighorn sheep. There are several potential benefits from large founder sizes, but it is not evident from the data which factors, alone or combined, explain the higher success in bighorn sheep. Larger founder sizes means the new population is more likely to survive unfortunate stochastic events that may occur in the first few months of the release as the animals learn about their new habitat, including early vulnerability to predators, falls from ledges, or others, leaving more animals alive at the end of the first year to breed. Finally, larger founder groups tend to have a larger amount of genetic heterozygosity, thereby introducing greater genetic heterozygosity into the new population, and giving it a better chance of persistence.

**Selection of Source Herds:** Translocations from indigenous source herds were twice as likely to be successful (48%) as translocations from previously translocated populations (24%) (Singer et al.

2000a). In particular, we do not recommend translocations come from multiply-translocated herds. Translocated populations pass through genetic bottlenecks during the process of translocation and this loss is additive in multiple translocations. Using simple calculations of the loss of initial genetic heterozygosity based on information on effective population sizes, we determined one population stemming from a prior translocation (south unit, Badlands National Park) should have lost 37% of the initial heterozygosity of the original, indigenous source herd. A second population that passed through 3 founding event bottlenecks (Beaver Creek, Colorado) was predicted to have lost 49% of the original heterozygosity. However, rapidly growing translocated populations stemming from large, indigenous herds might only lose 3-8% of original heterozygosity. These rough calculations are supported by the recent modeling of Vucetich and Waite (1999) and genetic analyses by Ramey et al. (2000) that also verified the populations had passed through large and recent bottlenecks.

The increased success of translocations utilizing multiple source stocks is generally supported by the available evidence. Bailey (1990) found some evidence for increased success of translocations in Colorado stemming from multiple source herds, but the sample sizes were small. One data set of translocated populations (n=31) indicated a positive association between success of translocations and mixing source stocks (Singer et al. 2000b), but a second, larger data set (n=100 translocations) indicated no association (Singer et al. 2000a).

This information taken as a whole, including the positive effects of larger founder size, more augmentations, and indigenous source herds, all suggest the benefits of greater genetic heterozygosity on success of translocations. Fitzsimmons et al. (1995, 1997) found greater genetic heterozygosity in indigenous versus translocated populations. The hard evidence for the benefits of higher genetic heterozygosity on fitness, or population performance, in bighorn sheep, however, is limited. There are several suggestions of such benefits. Lamb mortality was higher in inbred zoo lines of

bighorn sheep (Sausman 1982), there was some evidence for the same in wild populations (Haas 1989), and horn growth rates were associated with higher individual heterozygosity (Fitzsimmons et al. 1995). More definitive research is needed in this area, especially since the mixing of source stocks presents several dilemmas to managers. Any mixing of source stocks increases the risk of the introduction of a novel pathogen. Also, policies of some agencies, such as the National Park Service, direct that conservation of the original form, or nearest surviving genetic resource, be used in restoration (NPS 1988).

**Patch Sizes, Habitat Quality and Movements:** Success of translocations was associated with larger patch size (Zeigenfuss et al. 2000). Movements were also associated with larger patch sizes (Singer et al. 2000c). Bighorn sheep introduced into larger patches of habitat, especially those  $\geq 200$  km<sup>2</sup> of suitable habitat (i.e. just the occupiable habitat in the patch), were more likely to be successful, to migrate seasonally, to have larger home ranges, and to display higher rates of dispersal and colonization (Singer et al. 2000c, Zeigenfuss et al. 2000). Bighorns released into patches of  $\leq 40$  km<sup>2</sup> were more likely to be unsuccessful, nonmigratory, and to exhibit lower dispersal rates (Figure 1). Seasonal migrations were associated with higher growth rates, greater dispersal rates, and greater rate of success and persistence (Singer et al. 2000a, 2000b, 2000c, Zeigenfuss et al. 2000). Seasonal migrations in other ungulates has been attributed to spacing out from predators (Sinclair 1985, Bergerud and Page 1987), and to larger body mass in reproductive females compared to nonmigratory females (Albon and Langvatn 1992).

As might be expected, dispersal and colonization rates were associated with fewer water barriers, more broken terrain, fewer human developments, and less dense vegetation in the intervening habitat between patches (Singer et al. 2000b). A higher proportion of suitable habitat that was also lambing habitat ( $>10\%$  of the suitable habitat) was associated with success, but  $<4\%$  lambing habitat was associated with a lower success rate

(Zeigenfuss et al. 2000). The persistence of translocations was also associated with a lower ratio of perimeter to area (i.e. perimeter of the entire patch:area of suitable habitat), which is an index to habitat effectiveness in the patch (Singer et al. 2000c).

A number of potential benefits have been attributed to larger patch sizes. Larger patches tend to have greater habitat diversity and greater topographic diversity and thus support a greater diversity of phenological stages and forages in peak nutrition stages. Larger patches, in general, support larger populations and thus maintain greater genetic heterozygosity than do populations in smaller patches (Saunders et al. 1991). Non-persisting translocated populations reached higher effective densities on the suitable habitat within a patch, prior to their extirpation (Zeigenfuss et al. 2000), i.e. they became overcrowded *sensu* Risenhover et al. (1988) and Bailey (1986). Populations placed into larger patches were less likely to become overcrowded. The populations placed into smaller patches were more likely to be sedentary and thus the animals might have been subjected to higher parasite loads and to repeated stalking by predators (Risenhover et al. 1988).

**Presence of Domestic Livestock:** Both the presence of domestic livestock and known contacts with domestic sheep, especially the presence of domestic sheep within 6 km, were associated with a lower success of translocations (Singer et al. 2000a, 2000b, 2000c, Zeigenfuss et al. 2000). When contact between bighorn sheep and domestic sheep was observed, 45.5% of translocations failed, compared with a 23.7% failure rate when no contact was observed (Singer et al. 2000a). While a study of 100 translocated populations indicated a minimum of 16km distance to domestic sheep was necessary for greatest success of translocations (Singer et al. 2000a), another study of 32 populations recommended a distance of 23 km. (Zeigenfuss et al. 2000). Contact with domestic sheep have been implicated in twenty-eight cases of a die-off or decline in free ranging bighorn sheep herds (Jessup 1981; Blaisdell 1982; Foreyt and Jessup 1982; Onderka and Wishart

1984; Clark et al. 1988; Sandoval 1988; McCarty and Bailey 1984). While the cause and effect relationship is ambiguous, our data points clearly towards a negative impact of domestic sheep on success of bighorn sheep translocations. We therefore recommend a minimum of 16 km from domestic sheep be required before reintroducing bighorns to an area, however, whenever possible a distance of 23 km should be maintained for greatest probability of success.

We also found a negative association between the presence of domestic cattle on the same range and the success of translocations. When cattle were present, 32% of translocations failed, compared to a 6.25% failure rate when livestock were absent (Singer et al. 2000a). This was surprising since habitat and diet overlaps between the two species are minimal (Tilton and Willard 1982, Cunningham and Ohmart 1986, Dodd and Brady 1986, King and Workman 1984) and since there is little evidence for any transmission of pathogens between the two species (Mouton et al. 1991, McCarty and Bailey 1994). But several authors report there is potential for such transmissions at shared water holes (Jessup 1985, Spraker and Adrian 1990), and the role of cattle was suspected in the decline of two desert bighorn sheep herds (DeForge et al. 1981, DeForge and Scott 1982). Clearly more research is needed on bighorn sheep-cattle relations before definitive conclusions can be made.

**Minimum Viable Population Goals for Restoration:** We conclude patch size, not population size per se, was the critical minimum goal to consider in restoration of bighorn sheep into large landscapes. Population size can be an important index since ultimately, patch size and population size are correlated, but there is a high degree of circularity in references to both patch size and population size to persistence. As evidence of this circularity, there was a positive association between largest population sizes at the end of our studies and greater persistence, higher success, higher growth rates, and greater colonization rates (Singer et al. 2000b). We concluded there were two areas of potential effect of population size

alone on persistence and success. First, larger pre-epizootic population sizes increased the probability of surviving any epizootic. We investigated 41 epizootics and found only 5% of herds with <50 animals prior to the epizootic survived the disease, but 75% of herds with 51-100 animals survived, and 83% of herds of >100 survived (Singer et al. 2000c). Persistence was the highest for populations numbering >250 pre-epizootic. Not all populations are subjected to epizootics, but no population is without risk. Therefore, we suggest any errors be on the conservative side, and the largest populations feasible (i.e. >250) be planned for in restoration programs, whenever possible. Second, the threshold of group sizes for optimal vigilance and optimal foraging efficiency has been set at >10 bighorn sheep (Risenhover and Bailey 1985, Berger and Cunningham 1988). Since group sizes were positively associated with census N (Singer et al. 2000c), smaller populations might fall below this optimum average group size for predator security and foraging.

**CONCLUSIONS:** Past translocations of bighorn sheep have been of variable success partly because of a limited understanding of the factors involved. After a 9-year effort in translocating bighorn sheep into historic range, we recommend translocating large initial groups of bighorn sheep ( $\geq 40$ ) from multiple indigenous populations into large patches (especially  $>200 \text{ km}^2$ ) with no potential contact with domestic sheep or livestock and at least 16km (preferably 23km) from the nearest domestic sheep allotment. It is our hope that these guidelines will help maximize the success of future translocations of bighorn sheep.

#### LITERATURE CITED

Albon, S.D., and R. Langvatn. 1992. Plant phenology and the benefits of migration in a temperate ungulate. *Oikos* 65:502-513.

Bailey, J.A. 1986. The increase and die-off of Waterton Canyon bighorn sheep: Biology, management and dismanagement. Biennial Symposium of the Northern Wild Sheep and Goat Council 5:325-340.

\_\_\_\_\_. 1990. Management of Rocky Mountain bighorn sheep herds in Colorado. Colorado Division of Wildlife, Special Report No. 66. Ft. Collins, CO. 24 pp.

Berger, J. 1990. Persistence of different-sized populations: An empirical assessment of rapid extinction in bighorn populations. *Conservation Biology* 4:91-98.

\_\_\_\_\_. 1999. Intervention and persistence in small populations of bighorn sheep. *Conservation Biology* 13:432-435.

\_\_\_\_\_, and C. Cunningham. 1988. Size-related effects on search time in North American grassland female ungulates. *Ecology* 69:177-183.

Bergerud, A.T., and R.E. Page. 1987. Displacement and dispersion of parturient caribou at calving as an antipredator tactic. *Canadian Journal of Zoology* 65:1597-1606.

Blaisdell, J.A. 1982. Lava beds wrap-up, what did we learn? *Desert Bighorn Council Transactions* 26:3233.

Bleich, V.C. 1990. Costs of translocating mountain sheep. Pages 67-75 in Krausman, P.R. and N.S. Smith, eds., *Managing Wildlife in the Southwest*. Arizona Chapter of the Wildlife Society, Phoenix, AZ.

\_\_\_\_\_, J.D. Wehausen, and S.A. Holl. 1990. Desert-dwelling mountain sheep: Conservation implications of a naturally fragmented distribution. *Conservation Biology* 4:383-390.

Buechner, H.K. 1960. The bighorn sheep in the United States: its past, present and future. *Wildlife Monographs* No. 4. 174pp.

Cowan, I. McT. 1940. Distribution and variation in the native sheep of North America. *American Midland Naturalist* 24:505-580.

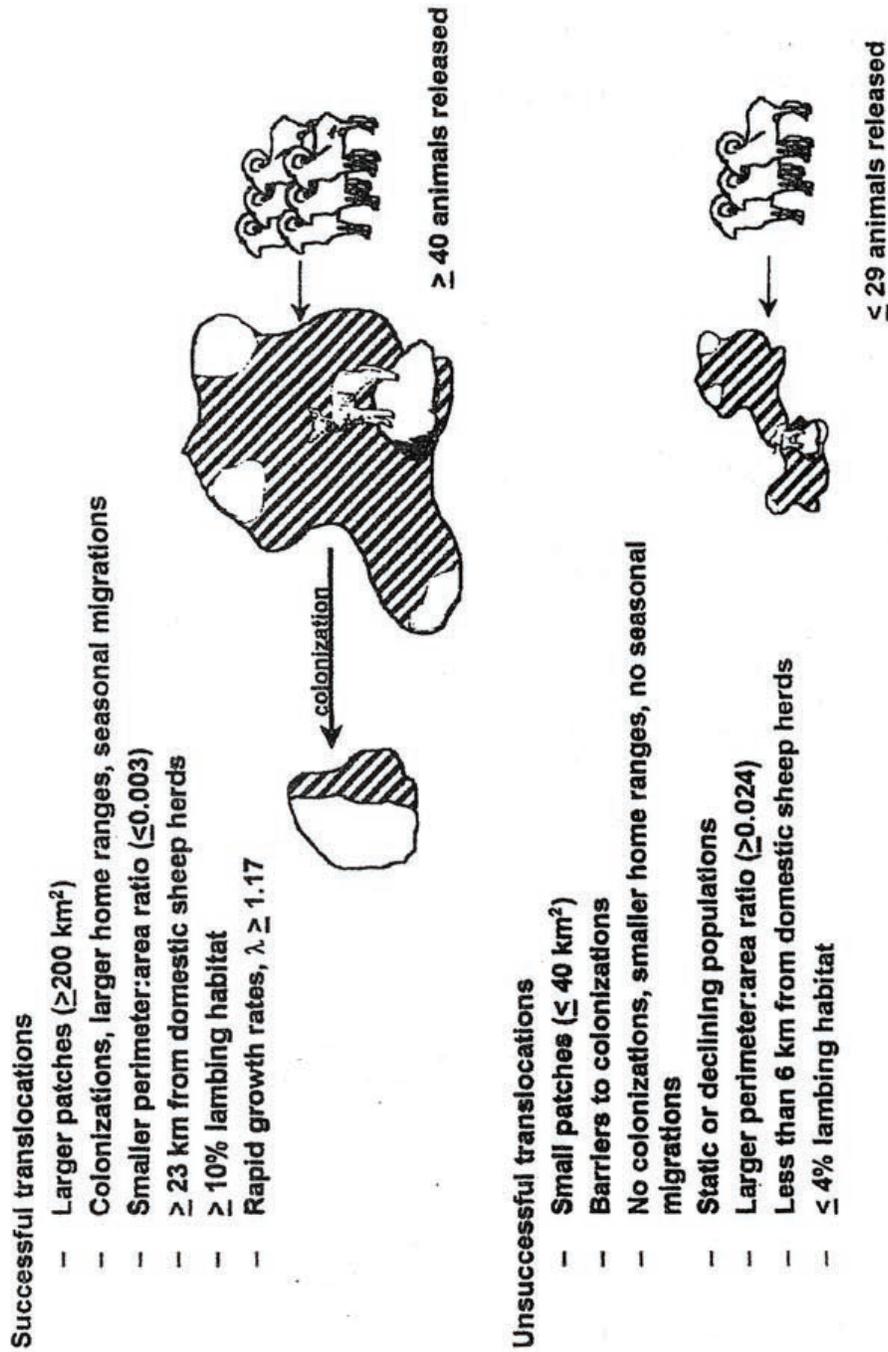
- Clark, R.K., D.A. Jessup, M.D. Kock, and R.A. Weaver. 1988. Relocation of bighorn sheep within California. *Proceedings American Association Zoo and Wildlife Veterinarians*. Pages 121-129.
- Cunningham, S.C., and R.D. Ohmart. 1986. Aspects of the ecology of desert bighorn sheep in Carrizo Canyon, California. *Desert Bighorn Council Transactions* 30:14-19.
- Deforge, J.R., J.E. Scott, G.W. Sudmeier, R.L. Graham, and S.V. Segreto. 1981. The loss of two populations of desert bighorn sheep in California. *Desert Bighorn Council Transactions* 25:36-38.
- \_\_\_\_\_, and \_\_\_\_\_. 1982. Ecological investigations into high lamb mortality. *Desert Bighorn Council Transactions* 25:36-38.
- Dodd, N.L., and W.W. Brady. 1986. Cattle grazing influences on vegetation of a sympatric desert bighorn range in Arizona. *Desert Bighorn Council Transactions* 30:12-16.
- Fitzsimmons, N.N., S.W. Buskirk, and M.H. Smith. 1995. Population history, genetic variability, and horn growth in bighorn sheep. *Conservation Biology* 9:314-323.
- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. 1997. Genetic changes in reintroduced Rocky Mountain bighorn sheep populations. *Journal of Wildlife Management* 61:863-872.
- Foreyt, W.J., and D.A. Jessup. 1982. Fatal pneumonia of bighorn sheep following association with domestic sheep. *Journal Wildlife Diseases* 18:163-167.
- Goodson, N.J. 1994. Persistence and population size in mountain sheep: Why different interpretations? *Biennial Symposium of the Northern Wild Sheep and Goat Council* 8:617-618.
- Griffith, B., J.M. Scott, J.W. Carpenter, and C. Reed. 1989. Translocation as a conservation tool: Status and strategy. *Science* 245:477-480.
- Haas, C.C. 1989. Bighorn lamb mortality: Predation, inbreeding, and population effects. *Canadian Journal of Zoology* 67:699-705.
- Jessup, D.A. 1981. Pneumonia in bighorn sheep: Effects on populations. Pages 72-78 *in* California-Nevada Wildlife Society Transactions.
- \_\_\_\_\_. 1985. Diseases of domestic livestock which threaten bighorn sheep populations. *Transactions of the Desert Bighorn Council* 29:29-33.
- King, M.M., and G.M. Workman. 1984. Cattle grazing in desert bighorn sheep habitat. *Desert Bighorn Council Transactions* 30:18-22.
- Krausman, P.R., R.E. Etchberger, and R.M. Lee. 1993. Persistence in mountain sheep. *Conservation Biology* 7:219.
- \_\_\_\_\_, and B.D. Leopold. 1986. The importance of small populations of bighorn sheep. *Transactions of the North American Wildlife and Natural Resources Conference* 51:52-61.
- Leslie, D.M. 1980. Remnant populations of desert bighorn sheep as a source for transplantation. *Desert Bighorn Council Transactions* 24:36-44.
- McCarty, C.W., and J.A. Bailey. 1994. Habitat requirements of desert bighorn sheep. *Colorado Division of Wildlife, Special Report No. 69*, Ft. Collins, CO. 27 pp.
- Mouton, R.J., R.M. Lee, and R.J. Olding. 1991. A desert bighorn sheep decline in Aravaipa Canyon, Arizona. *Desert Bighorn Council Transactions* 35:18-19.
- National Park Service. 1988. Management policies. U.S. Government Printing Office. Washington, D.C.
- Onderka, D.K., and W.D. Wishart. 1984. A major bighorn sheep die-off from pneumonia in southern Alberta. *Proceedings Northern Wild Sheep and Goat Council* 3:356-363.

- Ramey, R.R., and G. Luikart. 2000. Genetic bottlenecks resulting from restoration efforts: The case of bighorn sheep in Badlands National Park. *Restoration Ecology*. (In review).
- Risenhover, K.L., and J.A. Bailey. 1985. Foraging ecology of mountain sheep: implications for habitat management. *Journal of Wildlife Management* 49:797-804.
- \_\_\_\_\_, \_\_\_\_\_, and L.A. Wakelyn. 1988. Assessing the Rocky Mountain bighorn sheep management problem. *Wildlife Society Bulletin* 16:346-352.
- Sandoval, A. 1988. Bighorn sheep die-off following association with domestic sheep: case history. *Desert Bighorn Council Transactions* 32:36-37.
- Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: a review. *Conservation Biology* 5:18-32.
- Sausman, K.A. 1982. Survival of captive born *Ovis canadensis* in North American zoos. *Zoo Biology* 3:111-121.
- Sinclair, A.R.E. 1985. Does interspecific competition or predation shape the African ungulate community? *Journal of Animal Ecology* 54:899-918.
- Singer, F.J. 1994. Bighorn sheep in the Rocky Mountain National Parks. Pages 332-333 in *Our Living Resources – Interior West*, E.T. LaRoe, et al., eds. U.S. Department of the Interior, National Biological Service, Washington, D.C. 530 pp.
- \_\_\_\_\_, and M.A. Gudorf. 1999. Restoration of bighorn sheep metapopulations in and near 15 national parks: Conservation of a severely fragmented species. U.S. Geological Survey Open File Report 99-102, Midcontinent Ecological Science Center, Ft. Collins, Colorado. 96 pp.
- \_\_\_\_\_, C.M. Papouchis, and K.K. Symonds. 2000a. Factors contributing to the success of translocations to restore populations of a severely fragmented species, *Ovis canadensis* (bighorn sheep). *Restoration Ecology*. (In press).
- \_\_\_\_\_, M. Moses, S. Bellew, and W. Sloan. 2000b. Dispersal and colonization rates by bighorn sheep: The role of disease, corridors, and patch size. *Restoration Ecology*. (In review).
- \_\_\_\_\_, L.C. Zeigenfuss, and L. Spicer. 2000c. The rapid extinction of bighorn sheep populations can be explained by patch size, movements, and contacts with domestic livestock. *Conservation Biology*. (In review)
- Spraker, T.R., and W.J. Adrian. 1990. Problems with multiple land use dealing with bighorn sheep and domestic livestock. *Biennial Symposium of the Northern Wild Sheep and Goat Council* 7:67-75.
- Thorne, E.T., G. Butler, T. Varcalli, K. Becker, and S. Hayden-Wing. 1979. The status, mortality, and response to management of the bighorn sheep of Whiskey Mountain. Wyoming Game and Fish Department Wildlife Technical Report No. 7. 198 pp.
- Tilton, M.E., and E.E. Willard. 1982. Winter habitat selection by mountain sheep. *Journal of Wildlife Management* 46:46-359-366.
- Vucetich, J.A., and T.A. Waite. 1999. Erosion of heterozygosity in fluctuation populations. *Conservation Biology* 13:860-868.
- Wehausen, J.D. 1996. Effects of mountain lion predation on bighorn sheep in the Sierra Nevada and Granite Mountains of California. *Wildlife Society Bulletin* 24:471-479.
- \_\_\_\_\_. 1999. Rapid extinction of mountain sheep populations revisited. *Conservation Biology* 13:378-384.

Wishart, W. 1978. Bighorn sheep. Pages 161-171  
*in* J.L. Schmidt and D.L. Gilbert, eds. Big game of  
North America. Stackpole Books, Pennsylvania,  
PA. 494 pp.

Zeigenfuss, L.C., F.J. Singer, and M.A. Gudorf.  
2000. A modified habitat suitability model for  
bighorn sheep: Test in 32 populations in mountain,  
prairie, and desert habitats. *Restoration Ecology*.  
(In press).

Figure 1



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## QUESTIONS, ANSWERS AND COMMENTS - CHRISTOPHER PAPOUCHIS PRESENTATION

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**PAUL KRAUSMAN, ARIZONA:** Could you tell us what you're describing as lambing habitat?

**CHRIS PAPOUCHIS:** I'd need to refer to Tom Smith's model.

**JIM BAILEY, NEW MEXICO:** I think I can answer that.

**PAPOUCHIS:** Thank you. The question was how would I describe lambing habitat.

**BAILEY:** I'm pretty sure that in the Smith model suitable habitat had visibility constraints, but it also was something like 20 to 80 percent slope, that's suitable, and some proportion of that is at a higher slope (like 60 to 80 percent) and was defined as lambing range. It's misleading to say we need a greater proportion in lambing range because it will never be used as lambing range. We have a proportion of the better escape terrain.

**PAPOUCHIS:** I can't speak to the model. Like I said, that wasn't the work I was involved in.

**VERN BLEICH, CALIFORNIA:** Can you define migratory and nonmigratory as used in the model and its applicability to desert sheep populations in general?

**PAPOUCHIS:** What they defined as a nonmigratory population was a population that used only one area, and didn't migrate to other areas. With migratory or partially migratory populations, some of the sheep migrated, but not all of them were fully migratory. They actually used different summer and winter ranges. I don't know if I answered your question about the applicability to desert sheep areas in terms of movement between metapopulations or just within one particular range.

**BLEICH:** In my limited experience I've never really seen migratory behavior in desert sheep that you could really say were winter and summers ranges, and I was questioning the applicability of that parameter in the model.

**PAPOUCHIS:** Right. I wish Dr. Singer were here. He could answer this question better. I've been away from this data for a little bit. I would encourage anybody to ask him these questions.

**CHRISTEN LAKE, YELLOWSTONE PARK:** Why didn't winter range come up as a factor in the model?

**PAPOUCHIS:** I'm not aware of why it didn't. Again, I can leave the information and it can be discussed further. I do apologize for having limited knowledge of that aspect. I only got this information about a week and a half ago.

**NIKE GOODSON, UTAH:** Were the same data used to develop the models that were used to test the models and come up with the "success" percentages?

**PAPOUCHIS:** Are you referring to Tom Smith's original data, or the more recent data?

**GOODSON:** The new model. The original model was modified based on surveys of between 30 and 60 populations, and then there were 13 populations with habitat information.

**PAPOUCHIS:** Our model was tested on those 13 where there was specific GIS information produced by managers of those parks and of those other areas.

**GOODSON:** So the data that were used to test the model were not data that were used to modify the model? There was a different set of populations?

**PAPOUCHIS:** No, they were the same populations. The initial data used by Smith were not the same data that were used later, and Johnson and Swift made the modifications. Our study analyzed those modifications and tweaked them a little bit to hopefully improve success of defining what would really make a successful population.

**GOODSON:** I wanted to point out that if success and modification are based on the same data, then the success is not valid. You have to use independent data to come up with a success.

**PAPOUCHIS:** There are a couple of people here who can answer the question better.

**LESLIE SPICER, COLORADO:** I can help. The data I used to test against the model were new. They were not the same data originally used to produce the model.

**GOODSON:** Were they from different populations and different situations?

**SPICER:** It was partially the same population. Individual sheep weren't tagged or marked and sheep they used weren't identified. It was the same population, but the data were from different years.

**HERB MEYR, IDAHO:** Since most of the west is grazed by cattle, except for national parks, and recent studies have been done with bighorn sheep and cattle. It would be dangerous to leave here thinking we have to remove cattle so we can have bighorn sheep. I think that was a wrong conclusion that somebody came up with. The person who did the study is Elroy Taylor of BLM. There can be competition between bighorn sheep and cattle, but if you have the proper habitat, the cattle won't be in the same location.

**PAPOUCHIS:** Those were the same conclusions we reached from both of the studies, and I'm not going to backtrack from that. Obviously, there's a lot of controversy over that issue. What we found was, if you had cattle, it reduced the statistical likelihood of success of those bighorn herds. The presence of cattle was not a single determinant in affecting whether that population was successful or not. Both studies did find the presence of cattle had somewhat of a detrimental impact. Now, that may be refuted by other studies and I welcome that.

**CRAIG FOSTER, OREGON:** Were cattle grazing the same range? In a situation like Nike's down in southern Utah where you have impacts to riparian areas from cattle use, you can see it in the definition of cattle use. My sheep range is located within a cattle allotment and I've got a bunch of sheep ranges in my state where I've got a cattle allotment, but they don't use the same range. The cattle won't go on the steep ground.

**PAPOUCHIS:** As far as I know, the survey was originally set out the question of whether or not there are cattle grazing on the bighorn sheep range.



**NOTE: THIS PAPER IS PRESENTED IN THESE TRANSACTIONS AS AN ABSTRACT ONLY  
AT THE REQUEST OF THE AUTHOR**

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**RAYMOND M. LEE - ARIZONA BIG GAME TRANSPLANT PROGRAM**

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Raymond M. Lee, Arizona Game and Fish Department, 2221 W. Greenway Road, Phoenix, AZ 85023

**Abstract:** The Arizona Game and Fish Department has a long history of big game transplant activities. Beginning in 1924, big game transplants have been conducted within the state, as well as between states. Nearly all of the state's 10 big game species have been transplanted for repopulation purposes. Of most significance have been 1,840 pronghorn, 1,309 bighorn sheep, and 694 javelina. Big game transplant activities in Arizona have increased with the development of better capture techniques and equipment.

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## AMY FISHER - METHODS FOR IMPROVING BIGHORN CAPTURE SUCCESS

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Amy Fisher, formerly New Mexico Department of Game and Fish. Current address: 5 Foxtail Circle, Santa Fe, NM 87501  
Doug Humphreys, Texas Parks and Wildlife Department, 1600 West Hwy. 90, Alpine TX 79830

**Abstract:** Techniques used by the New Mexico Department of Game and Fish in capturing, processing, and transporting bighorn sheep were presented. Featured techniques included drop-netting, slinging, ground net-gunning, and processing following capture. The informal presentation emphasized methods that protect human safety and reduce mechanical injury and capture stress in bighorn sheep, developed through the capture of >500 bighorn and >2000 mule deer between 1979-1998. These methods included training personnel, preparing written capture protocols, involving wildlife veterinarians and contract capture crews in a team approach, adapting techniques and equipment to fit capture constraints and bighorn behavior, and using blood chemistry and disease exposure profiles to evaluate capture stress and herd health. We have found that monitoring vital signs, especially body temperature, is essential for monitoring capture stress and reducing handling time is the single easiest way to minimize it. Ambient temperature, sex, age, and health status are additional important factors that influence the bighorn's response to capture and restraint.

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Most of us would agree that our objective on captures is to maximize capture success. I would agree a successful capture program is safe for bighorn and for humans, and has a low sheep mortality rate following release.

Our methods have been derived from the capture, translocations and research of over 500 bighorn sheep and 2000 mule deer. Doug Humphreys was my partner and mentor for ten years and taught me a lot. I'd like to acknowledge all the department and other agency personnel that assists us on these captures. Without them, we wouldn't have the great team that we do in New Mexico.

The elements common to all of our captures include training, particularly a two-day wildlife restraint course based on a manual. I'd be happy to provide this manual (written a couple years ago by myself and colleagues), to anybody sending me their card.

The other big component of our captures is a very detailed capture protocol that is developed for each capture. It is usually about ten pages, and is the

who, what, when and where of the capture. We even have media fax sheets, and therefore, can just hand one to the media people.

Thirdly, we try to develop equipment designed specifically for the capture. I beg, borrow and steal from other states. Arizona, Oregon, and Colorado have been very helpful and generous in letting us borrow and use equipment and techniques.

Then we have our target numbers and ratios. With transplants, we do a minimum of 30 sheep, usually a ratio of one or two rams per ten ewes.

Those of you know me well know my administrative position and cleaned up look is something of the recent past. I'm more comfortable in coveralls covered with deer, bighorn and antelope hair. This is what I enjoy the most and I'm really glad that we have this session.

We've captured and removed sheep three times from the Pecos Wilderness in Northern New Mexico using drop net techniques. It's high elevation, rugged terrain, 12,000 feet. Using drop nets is basically the only technique we can use due to

wilderness restrictions.

We completed an Environmental Assessment (EA) to determine the effects of the helicopter on the wilderness. Sure enough the effect was insignificant. All the personnel packed in by horses, but luckily the 2000 pounds of equipment was slung in.

The drop nets were put up in the lamb/ewe range. As a center pole we used a fiberglass vaulting pole, a fairly new innovation, that doesn't cause harm to the sheep when it drops. The detonating system is a remote control solenoid system borrowed from Colorado Division of Wildlife. The solenoids cost a total of \$300 each, and are custom developed.

The lambs follow their mothers right in. We didn't orphan any lambs. Even if we had separated lambs from ewes, the lambs were old enough to have survived on their own.

The sheep are baited by salt. The Pecos bighorn have an intense craving for salt. Chris Haas and I demonstrated that the sheep do, in fact, have a physiological need for salt. It's not just psychological. They just keep working on salt blocks. They'll eat up to a half a pint a day if given the opportunity.

First thing after blindfolding and hobbling, you remove the sheep from underneath the net. A little top knot is used with lambs to get the blindfold tight enough.

Temperatures are taken immediately and written on the horns with indelible pen.

The sling bags are custom fabricated from Kirkhams, Salt Lake City. We got the design from Oregon Department of Fish and Wildlife. The sling bags were designed for adults and it swallowed up the lambs, but it worked just as well. Then they are carried over to the station where they will be picked up by the helicopter. They are laid out in order of temperature. The hottest sheep go first. It is essential to line out that cable system

so there are no twists. Our maximum load was 500 pounds, which was equivalent to three ewes or three ewes and a lamb. That system was also borrowed from Oregon.

We also use safety equipment, like helmets, safety vests, and ear protectors.

Craig Foster helped me develop the system, and it worked just fabulously. Understand, again, that we used a 50-foot-long line to mitigate the impact of the helicopters in the wilderness.

It was a tremendous ordeal doing this transplantation from the paper work standpoint; nine months of negotiation, EA and last-minute coordination. The rams needed to be netgunned individually. Sheep are sometimes very easy to approach closely, as long as people remain calm and are in a nonaggressive stance. The key element on the net gun capture is to have enough people.

In high altitude trapping, the sheep were cool (104°) at capture. By the time we processed them, they were 107° or 108°, even though we cooled them down with water and everything we had. It turned out that we had a whole day of torrential rain which created a 90 percent humidity. No matter how much we tried (we even put ice in the transport trailers), we just couldn't cool them down. We lost two sheep to capture myopathy, two out of 34 in high altitude is not too bad for a difficult capture. It was done again last year.

The sheep were transported in specially constructed crates put on top of vehicles. Luckily there was a road adjacent to the release site in the Wheeler Peak Wilderness, and that's how we released them from these crates. The design of the crates again came from Oregon.

Sheep never want to leave trailers now, do they? When I have more than one release, more than one transport trailer, I like to get them out quickly so the animals take off at the same time. I think that if the groups stay together, it maximizes their success in the first couple of days of the release. I like to go in and skirt them; I don't touch them, I

don't look at them, and then they go out. The only problem is, we didn't know that there was someone else helping us on the side. It doesn't help when someone tries to grab the sheep as they come out. This was a highly successful transplant.

Those 34 sheep now have grown to over 100 sheep and we're going to have the first hunt on them next fall. I guess the ultimate success of a capture is whether it results in a stable population. This was a real success story. There are factors that occur after a release that have nothing to do with how well you did the capture.

Those were alpine sheep, and now we're going to go to the desert to our Red Rock capture propagation in southern New Mexico. This is within about 1,300 fenced acres. We have over 100 sheep here and over a two-year interval, we can transplant sheep from here.

The pretrap meeting lasts four hours. It's time for last-minute coordination, especially with people who haven't been on a trap before. It's required that anyone who is going to handle the sheep attends the pretrap meeting so we don't have people who don't know what to do.

I think that's critical. This is time to coordinate with the contract pilot, the contract veterinarians, all the people who have been coordinated before the capture. This meeting assures that everybody knows what they're going to do. By the morning of the capture, there's no delay; it starts very early and the setup goes really smoothly. We've started using veterinarians, and I think they've been a really valuable addition. We have a team approach. We have enough teams to cover the sheep coming in. This capture was by Helicopter Wildlife Management. The last capture in 1998 was a giant media event. We had asked them to sling the sheep back to us right side up. My personal feeling about this is that it saves time. We should be doing it the quickest way possible and not necessarily this way. We should be taking the time to educate the public and the media as to why this is the best way.

The sheep are brought back to the processing

station and are put on stretchers. We started going to stretchers like Arizona does to avoid all that stumbling around that happens if they are carried individually. Heavy rams can weigh upwards to 300 pounds.

The sheep are brought over to a weighing system. We like to obtain the weights to track the health of the sheep. A Post-It-Note with the sheep's ID goes on the blindfold, color-coded by sex. The scale was borrowed from the California Division of Wildlife and the sheep are moved off to one of three teams that tend to the background "sick bay" area in case we have some sheep who need more attention.

We have stations set up to handle sheep within a ten-minute time frame so no sheep ever stack up. Generally we use three teams of four people each, a vet, a head person, a tail person, and someone to help with the sampling. The first thing the vet does is give it a physical exam. I wanted to mention the ear protectors put on the sheep and it really cut down on the animals' perception of noise. Whenever the animal hears the helicopters, it goes through the contortions it did when it first heard it. What we want to do on the captures is to reduce the external stimuli. That's why we put the blindfolds on and reduce noise.

I started shaving the hair by the jugular. I think it speeds up getting to that vein for people who are less experienced. We started using an IV catheter to get blood as quickly as possible. We use a butterfly catheter and in a very short period of time we can get 120 ccs of blood. We do that much blood because we do a comprehensive blood chemistry and disease exposure profile on our sheep. About \$200 per animal sounds high, but it's given us a tremendous amount of information.

Temperature is taken immediately. I think temperature is the key to monitoring stress in bighorn. We've gone to digital thermometers. It's amazing how many team members don't know how to take a temperature. We started using continuous monitoring devices on temperature. Those have been

really helpful, too.

The injections we give are now given subcutaneously, usually axillary. I think it reduces pain and increases absorption. Ivermectin is given as a prophylactic, combined with antibiotic and vitamin selenium, except for pregnant ewes. The radio collar fit is essential. I recommend everyone looks at Vern Bleich's report on that.

In cooling the sheep down, the best way is to roll it on its side; and get the thinner skin, scrotum, belly, and the horns exposed. To dissipate heat, rub water in. There's no use putting water on the top of the animals. It doesn't get absorbed very well.

We ID the sheep so we never lose track of who we have until we put them in the trailer. That's essential on our captures when we're going to three or four different areas with the particular capture.

Getting the sheep in the trailers without getting kicked too badly has always been a difficult phase. The guides came up with a system where they use a tarp with handles and they put the sheep in it. Once they take the hobbles off, they can cinch it up and avoid being kicked. We captured a lot of rams and they can be very aggressive. When you're putting one ram after another in the trailer, you don't want to put your head in that trailer for any length of time, and there is a tarp preventing that.

Despite our best efforts, the rams were heating tremendously. We caught 36 and six of those had elevated temperatures over 107° and were showing signs of capture myopathy like extreme lethargy. We took a time out and I think that's important. When you have some problem, stop the operation, talk with the vets, make an informed decision from all the information at hand.

It turned out that based on the blood chemistry, the sheep didn't have capture myopathy and my own personal feeling on this is that perhaps they were showing a psychological withdrawal. It wasn't a physiological change occurring from the process of capture myopathy itself. Perhaps some of you

also have seen this. Rams, I think, tend to get a lot more stressed out than ewes. I won't make any comparisons to humans.

The sheep are, of course, segregated by sex. We never, based on experience, put any rams with ewes. A young two-year-old ram can batter a ewe to death. We periodically check on them in the trailers, looking for alertness.

Our trailers are nothing fancy, but they work. We like to leave as soon as possible after the sheep are caught, but with a sufficient amount of daylight left at the release site for them to find bedding.

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## QUESTIONS, ANSWERS AND COMMENTS - AMY FISHER PRESENTATION

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**GLENN LORTON, NEW MEXICO:** I notice from the slides that a number of the ear tags in the Monsano Mountains cause the ear to be pulled over. Is it typically a problem? Does it cause a problem for the sheep itself?

**AMY FISHER:** I don't know. Eric, do you know what's happening there?

**ERIC ROMINGER, NEW MEXICO:** I haven't seen that, so I don't know either.

**BILL DUNN, NEW MEXICO:** I haven't noticed any problems.

**MIKE DUNBAR, OREGON:** I've been on lots of captures of sheep, and I want to compliment you and New Mexico; they are the best organized I've seen. You had problems getting temperatures down on the sheep and used cold water enemas. Enemas are a technique that will certainly get temperatures down.

Another question very quickly is, how did you determine a physiological need for salt in the sheep you were talking about?

**FISHER:** It was an analysis of the feces and the sodium excretion. I have a paper I could give you.



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## VICTOR L. COGGINS - OREGON'S CORRAL TYPE BIGHORN TRAP

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Victor L. Coggins, Oregon Department of Fish and Wildlife, Enterprise, OR 97828

**Abstract:** A total of 170 Rocky Mountain bighorns were captured and translocated using a permanent corral type trap from the Lostine, Oregon sheep herd from 1977 through 1999 with no known serious injuries. Trap design, location, attractants and handling techniques are discussed.

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**Background:** The Lostine Rocky Mountain bighorn herd was established in 1971 and increased to an estimated 70 bighorns by 1977. Since the winter range was very limited and this was Oregon's only Rocky Mountain bighorn herd, a trapping and transplanting program to establish other herds was initiated in 1977. The program continued through 1986, but was soon terminated because of a pneumonia die-off the winter of 1986-87. Herd recovery allowed trapping and transplanting to resume in 1999. In addition, sheep were captured for disease treatment and testing continued during the pneumonia outbreak and recovery period.

**Methods:** A corral trap was constructed on the Lostine Wildlife Area, Northeast Oregon to capture bighorn sheep on winter range. The trap site was accessible by vehicle on a primitive road although heavy snow during the winter frequently blocked access and made plowing snow with heavy equipment a necessity. The trap was constructed on an open grass covered ridgetop at 6,200' elevation in an area heavily used by wintering sheep.

**Baits**—A number of baits were tested including apple pumice, hay, alfalfa pellets and salt. Alfalfa pellets and salt worked the best and both were readily available locally. Acceptance of pellets by sheep as a food item takes time. Animals have to learn to eat pellets so pre-baiting time is needed. Salt is left in the trap yearlong and is heavily used by bighorns from November through May when they move on to the winter range.

**Location Of Trap**—A corral trap should be located in an area heavily used by bighorns and accessible by vehicle or other means of transportation. Materials needed for trapping and baits also require good access.

**Trap Construction**—The Lostine trap is constructed of 8x8 foot wooden panels with swinging gates in each end providing access into pens. Gates have hanging weights to speed closure. A swinging gate between the two pens allows bighorns to be sorted for handling. A variety of gate tripping mechanisms have been used including electronic blasting caps, rat traps and hand tripping.

**Handling Chute**—The handling chute is attached to the primary holding corral and has a drop gate on each end. A swinging crowder gate inside the corral aids in getting reluctant animals to enter the trap. The chute is narrow by design so adult animals can not turn around. Following capture one animal is allowed at a time into the primary corral. The crowder and chute gates are opened and when the sheep sees an escape hole it enters the chute (reluctant ones are pushed in by the crowder gate). The handler enters the chute behind the bighorn and puts a blind fold on it. The animal is then ear tagged, sampled and loaded into the transport vehicle. Never approach the bighorn from the front because occasionally they will butt the handler. Because of the width of their horns, large rams cannot enter the chute so they must be handled in a different manner.

**Results and Discussion**—From 1977 through 1999, 170 bighorns were captured, handled and

transported to release sites with no known mortalities. In addition, Lostine animals were frequently captured, sampled or treated and released on many occasions without any known serious injuries.

This is a very low cost capture technique suitable for accessible herds habituated to humans. The Lostine handling crew generally consists of four people keeping personnel costs low. The biggest expense encountered is plowing snow off the access road to get transport vehicles to the trap site. For pre-baiting and captures when animals are not moved, snow machines are used which further reduces costs.

**Summary:** Corral trapping offers a low cost method of bighorn sheep capture with a very low mortality rate. Sheep must be habituated to the trap and baits over a long period. This technique is not suitable for remote herds not habituated to humans.



Corral Type Bighorn Trap, Lostine Wildlife Area, Northeast Oregon



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## JAMES INNES - NETGUNNING WILD SHEEP: VIDEO FOLLOWED BY OPEN DISCUSSION

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James Innes, President, Helicopter Wildlife Management, 7365 South 4450 West, Box 4, West Jordan, UT 84084

**Abstract:** Techniques used by Helicopter Wildlife Management (HWM) in netgunning, restraining and transporting wild sheep be presented. James Innes, the owner of HWM, operated a fleet of helicopters in New Zealand where he captured thousands of red deer, chamois, and Himalayan thar for harvest and the ranch industry. The innovative techniques learned in New Zealand were brought to North America in 1992. Since that time, HWM has captured 2,662 wild sheep for state, provincial, and tribal agencies in Canada, the western United States and Mexico. Topics covered will include netgun used, crew configuration, shooting technique, chase time, multiple captures (more than one animal/net), use of skid mounted net, hobbling technique, transport inside helicopter, slinging upside-down, and mortality rates. An open discussion will follow the presentation.

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I think all of you know we had a terrible accident on Tiburon Island in December. In the years we've been in the business, which is about 24, I guess, and probably in excess of 100,000 hours of flight time, that was the first really serious accident we've had.

That can't be said for the industry as a whole. Our guys are as good as they are because they were trained differently. Where we come from, nobody pays to capture wildlife. If you come home with no meat or no animals, you can't afford the gas for tomorrow. You push it so hard, you kill yourself or you give up. It's a whole different training ground. The boys just really learn how to do it properly.

The other thing they learn is there's no point to the live capture business with animals that are stressed and going to die. We started in the business by capturing red deer in the mountains of New Zealand and flying them to game farms. We had seven helicopters and some crews would catch a lot of animals, but they would have a very high red deer death rate. There were guys who caught a lot of animals and they all stayed alive. It worked out financially that the guys where red deer died did not stay in the business. It was a very good training ground, made the guys develop all the skills that

we needed for what we do today.

The key to getting live animals is netting them, getting the boys out of the helicopters, and getting on to the animals really fast. It boils down to speed and experience. We talk about slinging animals upside down. We do it all the time. We had one red deer that weighed 5200 pounds. I don't know how they carried it. They must have had it on the side of a cliff and pulled it off the cliff.

Everyone in the U.S. was shocked to see us slinging everything upside down. To us it's faster and quicker. There isn't time to put animals in bags and screw around them, if we go long distances with elk, moose, or bison in the back of the helicopter.

The only reservation is when we know the animals are going to be put in small enclosures where they can't move around. Particularly with elk, bison, and moose, you've got to be careful you don't have a circulation problem. I mean an anticirculation, and problems with the tendons. If we put elk in tight captivity, we put them in the bags. Those are the only times we would waste the time putting them in a bag.

We developed a skid gun that I'm sure everybody

is aware of. Probably 20 to 30 percent of all our animals are caught with the skid gun. It increases your odds if you've got sheep on little ledges and they've got a net on them. If things don't look too good, you can put the net on the animals there, because the skid guns are under the pilots control. It gives us access to a lot of nets really quickly. With wolves and bison that get out of nets really easily, the pilot can put another net on them. It restrains them really fast with our netting system. It's as fast as the pilot can fire it and still fly the helicopter.

Our guys work out of the front seat of a helicopter. I don't know where the idea of working from the back seat came from, but all our guys only use the front seat and our techniques have been developed that way. I'm not the one that developed the techniques; it's the boys that have made a living by being paid for being efficient. They developed all these skills.

By working from the front seat, we have better communication with the pilot. We're closer to the animals, and it makes the whole operation faster. We put animals in the back seat. We also carry a lot of gear in the back seat.

We have different ways of packing nets, depending on the species we are after. All our nets are prepacked.

Occasionally we catch two animals in one shot. We don't mind doing that because the guys are smart enough to get away with it. There's no problem for handling even more animals. Once again, it's speed in handling animals. If you're slow, stupid, and don't get out of the helicopter in a hurry, they'll die. If you're really quick and you know what you're doing, you can get away with it without any trouble at all.

I'm not very impressed with the way I see sheep tied up in other situations. We use a dog collar strap and we tie back to front, front to back on either side. It completely eliminates any struggling. The idea of tying one leg at a time, in my view,

gives them far too much movement. We tie every species, except donkeys, this way. We don't tie them that way because they bite too much when you do that. Everything else, we tie up. We'll sling the rope between the two legs.

When we sling the captured animals we use the net. The net is put around their legs so that when the rope is tightened, it's the only rope here. You loop the sling rope through their legs, but we always put the net as a cushion under the legs so the rope doesn't hurt their legs.

We can bring back three, four, or five animals at a time. Generally it's one or two or three. If it takes more than three or four minutes to catch another animal, we bring them all back to base. If it's a long way, we don't carry them with slings. We do put them in the back seat.

We don't have seats in the back of our helicopters. They're all completely lined with padding and plywood. It's like putting the animals in a cage and is very efficient.

Because we work in every state in the nation in doing this kind of work, we get to know the ground crews that are really speedy and know what they're doing. If a ground crew works fast, we can bring in four animals at a time.

Target animals are often found in really steep places. We use a variety of nets depending on the terrain. We try to use 18 square foot nets. We try to net some rocks or trees, to try and stop the animals from rolling down the hills. We work in really steep terrain this way. It's not a problem with pilots that can put you in a place and shooters that know what they're doing. There are no prizes for having animals rolling down the mountain and killing themselves.

We use the same technique whether we're tying up bison, horses, sheep, goats or whatever. You hold them down and come in from behind. You get the back legs and pull the top back leg up, put it in your groin, and one guy can hold a big elk cow or

even a horse that way as long as you need to.

When we take them out of the net, we still sit in that position, none of this grabbing the head. When you grab the head, you only hurt the neck, and there's problems. On big elk, if you start at the head, by the time you get to the back end, they'll get away from you.

We had our vests specially made up. They're orange, for obvious reasons. With orange, you can find the guys on the ground. In Utah, they have nice green clothes. You fly away and you can never find them again. Vests are made with lots of pockets so you can carry ropes. We do collaring and sampling and it helps to have your ropes in the great big pockets.

What I was really trying to explain is it's all a matter of speed and having the right gear, the right equipment, and guys that are really well-skilled. We don't encourage people just to get in and out of helicopters and work with us.

For someone to use a net gun on our crews, they have to be around us for a couple of years. We work at a high speed and things can go wrong; when they go wrong, it's usually not very good for the helicopter business.

Safety is a really big issue. I'm sure some people think that with the speed we go that it's not, but it is. When you work the way we do, if safety isn't important, you'll get in trouble.

We use ordinary dog collars with straps. We run them around legs of sheep, deer, and wolves. When we do horses and bison, we use a heavier strap. We don't use straps on bigger animals. We have leather straps made in Wyoming. We get the animal's legs together, bind them back and front, and we put a loop around their legs. When you've got all your gear on, you put the straps around you twice, and hook them together.

There's no point having them when you've got a great big knot. These fit around your waist.

Regardless of what you're doing, everybody carries two or three of these.

When you catch moose or elk and something goes wrong, you can use the ropes to tie them to tree or help tie them up. We do it for sling-tying up animals. We attach and carry them using a big long chain. When they're in the steep country and 99 percent of our work is done with ropes like this.

**MARCUS NURSE:** We use the Simon gun to shoot the net over the animals. It's an Alpine gun which was designed in New Zealand. It's got these interchangeable canisters with pre-loaded nets, which we can change in a matter of seconds. We carry about seven or eight canisters in the helicopter, depending on the numbers and kinds of animals we are after. We can catch animals just as fast as we like.

We use different sorts of nets depending on the animals. We use an 18 square foot net on the larger animals (moose, elk, and buffalo) and we use the smaller, lighter nets, about 15-foot square, on the smaller animals (sheep, mule deer, and white-tailed deer).

**INNES:** As Marcus said, you can change cannisters really quickly. We don't use normal net-guns at all, because the recoil breaks too many arms in the helicopters and it could hit the jaw. These are like a bomb. When they go, you don't want to get hit. If you're clear when you have this action, you don't get hammered. Guys that get really good like Marcus get tricky, shooting out of the helicopters underneath the skids.

The Simon gun can't hurt you. These are fast and efficient. With seven cannisters in the helicopter, depending on the altitude, if you have got a weight problem, you load down. All you have to change is the bullet and away you go.

We use many different types of shells, depending on a little net or big net. The bigger the shell, the more recoil.

The key is to avoid injury to the shooter's arms and shoulders. If you get 40 to 50 animals a day, these become really sore, so you try to use as light a weight as you can to be efficient.

If you use big weights all day, you end up like my son Dan. We had a pilot who flew too high. He was real good and had 78,000 hours of flight time. He goes through about one shooter a year. He flies too high; when I say too high, he's was 10, 15, 20 feet above the animals all the time. The boys were having to use a heavier load all the time and Dan ended up having two broken arms. Many of you have been around Dan when he would tape up his wrists. He spent too much time with this pilot that wouldn't get lower. When we select pilots, they have to get real close. Otherwise, they can really ruin your arms.

Concerning blindfolds, we like these stretchy ones, because they mold to the species you are capturing. We go through hundreds and hundreds of blindfolds. The easiest ones we find, and probably the cheapest and the quickest, are the neck warmers. We buy those by the hundreds.

Another thing that is important with sheep, is not to use the same colors of blindfolds from one place to another. You may have disease problems that you could be transporting.

Another thing we did for our guys is develop a standard operating procedures manual for capturing animals. It explains in very minute detail everything we do and everything we expect our guys to do. Anybody else that wants to be around have pretty much got to meet these standards.

This reference covers right down to how we bleed animals to how to get standard proper procedures in trying to take anatomical measurements, transportation, etc. The details are all spelled out in here.

We're continuing to modify our procedures as we try new ideas. This reference is not for publication; it's our own internal manual. I know it helps agencies particularly with the scrutiny by animal

rights groups and animal welfare. If you've got copies in your possession, you'll solve a lot of problems.

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## QUESTIONS, ANSWERS AND COMMENTS - JAMES INNES PRESENTATION

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**VERN BLEICH, CALIFORNIA:** What's the operational limit of that aircraft in terms of elevation used?

**JAMES INNES:** We've done 50 collars on mountain cliffs in Colorado at 14,000 feet. I don't think it gets any higher than that, and it can be done at that altitude. We know that's pretty extreme and we used three different pilots to do that job and they're our very, very best pilots. One pilot used me as a net gunner. I'm a big, fat guy, and the pilot was a fat guy and between us we weighed 400 pounds. He also had 200 pounds of gas and three nets. He hovered with an altimeter and I put a collar on a goat at 14,000 feet. Other guys who are really, really good pilots were still struggling at that altitude. It's all the skill of pilots, but that's really extreme.

**BLEICH:** 12,000 feet would be well within your limitations, then, depending on ambient conditions?

**INNES:** I think anything up to 10,000 feet is okay. When you get over 10,000 feet, you have to make sure all systems are a go. Marcus had an experience in Colorado last year where they were working putting collars on elk at 12,000 feet. They got caught in a thunderbolt and the helicopter fell about three or four thousand feet.

**BLEICH:** You have to be careful working at high altitudes.

**AMY FISHER, NEW MEXICO:** James, one of the big problems which arose when you first came was the upside down slinging. Do you think that concern arose because the regurgitation reflexes are pretty bad when the sheep are chemically immobilized? I suspect we don't have problems with regurgitation because they're not immobilized chemically. What is the mortality that you've derived on bighorn, or in general?

**INNES:** That's true. In the early day when we were capturing red deer in New Zealand using drugs, we had to put them in the bags and pick them up. You had regurgitation. You could not sling them upside down if they were drugged. We really developed the technique once we got away from drugging, and it was all done really quick. Our death rate in New Zealand went down to about five percent when we went from drugging and putting them in the bags, to putting them in the helicopter or hanging them upside down. I'm talking five percent after the deer had been in farms about six months.

Lynn Carpenter evaluated our whole program and I think it was about two percent in sheep. Generally speaking, that ranges from where we don't get any losses at all, to where you get two percent in a disastrous day where everything goes wrong no matter what you do. You can't keep them alive and you may lose a handful of sheep. It pushes the statistics. The worst day to catch sheep is when it's windy. If it's windy, you can't handle the helicopters as well as you want to and everything gets screwed up.

I had two or three days in the U.S. with sheep where there were disasters. We lost some sheep in Oregon. It was terrible. It was a windy, snowy day. Everybody was under pressure and they had 30 guys that wanted to get it done. It was the worst thing they could have done.

In general, what we expect to get now, and we would like to think we get, is no deaths. It's not a matter of going and saying we're going to catch 50 sheep, and we'll lose ten percent or two percent. Usually we lose none. Sometimes we lose ten percent.

**FISHER:** James, could you tell us about working closely with the ground crew and what the total handling time is with regard to the sheep? You try to get the sheep to us within a few minutes, but then what happens?

**INNES:** We're really sensitive about bringing in groups of volunteers and school kids to get the job done in a fast manner. It frustrates me where we see inexperienced crews. I can understand what's going on. Everybody wants hands on. They want to be poking and shoving and pushing, but that's the worst thing that can happen. It's probably good I don't go out on those jobs. The crews are more mild mannered than I am.

It doesn't matter what species it is, the quicker you get the animals on their feet, the quicker you get them in the field the better they survive. We've had situations where, if the crews were too slow, I would say we're not going to process and we put the animals in the trailers. We did that a lot. We would hold them in the trailers and take the blood and swabs in the there, because the important thing was to get them up on their feet.

If you've had a really tricky capture situation where the animals are in rough country and have been hard to get, even though you might have a good crew, it's better to use trailers. It's more to get the animals standing on their feet. It's less stress to not have them not lying down with people poking, pushing and taking blood from them. If you get them on their feet, you're okay.

**ESTER RUBIN, CALIFORNIA:** Getting back to the theory of slinging the sheep upside down, did you evaluate the survival or the percent of losses over a long term? Not just during the day of the capture, but over a period of weeks afterwards? Was there any evaluation of that?

**INNES:** Yes, the answer to that is most of the animals that we capture are radio collared. If we were going to have a problem, people would know.

There is scrutiny in New Zealand. You're putting red deer on the farm and they are worth thousands of dollars. People care what happens. We would know quickly if we had a disaster. We find out pretty quickly here in the United States. They've got radio collars on them and any problem would be seen. It hasn't been.

**FISHER:** I might add that Ray Lee will give a paper on some of the results that Len Carpenter compiled from the captures that Helicopter Wildlife Management did where mortality rate is calculated two weeks post release. If Ray doesn't say this, I will. Slinging upside down isn't critical.

**INNES:** We can state that we caught about a thousand elk in one location and we did them by the day. One day we would sling them all and the next day we would put them in bags just to see if we had any post capture problems. We didn't have any problems at all. There was no difference. What we were really looking for were leg problems, and because our haul time was only a matter of a minute or less, it didn't make any difference. We know when we put them in bags, it slows the operation down by at least twice.

**GARY BRENNAN, WYOMING:** I've been involved in netting since about 1985. Jim was right on the speed factor. There's an alternative to slinging upside down. We have a bag that Washington has seen recently and I think Nevada can also testify to. It's probably just as fast as the sling method when you sling them by the feet. This new bag keeps them upright, so if there is a controversy with the animals being upside down, the bag supports their legs. That's one quick way. You want to support their weight, so get the new bag system. I didn't bring one, but it works quite well and it's very speedy.

One other concern I have is if you have a short flight, that's fine. You get the weight off their legs pretty quickly. If you have a longer flight, you have a slow sail on a helicopter that puts a low sling load through the

air. You stick your head out the window of the car, you notice the faster you go, the more resistance. If you have 500 pounds on the load and you go 80 miles an hour, that weight on the load is 500 pounds to 700 pounds of resistance on their bodies being drug through the air.

**FISHER:** Gary, are there any differences or any other comments that you would add to this discussion in the way that you capture or handle wildlife?

**BRENNAN:** What James said is exactly right. You see a lot of organizations that don't have the experience and don't know how to handle the animals quickly. That's the key thing to the whole thing. There are probably 30 alternative methods. I caught quite a bit of flak from the news media. People are not used to seeing that technique. I'm not a scientist. I don't know that part of the thing, how it affects the animal, but I know how it affects the public and there are repercussions. I wouldn't want to be slung around by my feet upside down. I'd much rather be supported. For a short distance, I don't think it hurts. Like he said, if they go longer distances, they do different things.

As far as transport systems, I think there are only two ways, upside down by the feet or the bag system. Any other systems you have out there are way too slow and you don't gain anything from them.

**INNES:** We put the majority of our sheep and goats and anything that will fit in the helicopters. If you put them in right, you can put four or five sheep. We've done work in Utah where they were moving sheep from one location to another. It's just as quick to get four or five, stick them in the bag, whatever the distance (40, 50, 100 miles) and drop them off. We've done quite a bit of that.

**REX SOHN, UTAH:** I don't know about Gary's bag system. I have a concern about the body bag system especially in antelope where you experience hyperthermia problems. It's like you running a hundred yard dash and then somebody wrapping a safety blanket around you and you can't get rid of that excess body heat. I think we should investigate looking into a bag system that has a fine mesh to it that allows the actual flight through the air being a cooling down of the animals.

**INNES:** We made bags like that for that very reason. We used them so little, we gave them away. You can count the days we use bags in one hand.

**FISHER:** Our bags are made out of a mesh. They're in the back and take a look at them. As they're being slung through the air, if you have to do it that way, it has a cooling effect on the animal.

**DAVE SMITH, ARIZONA:** I was wondering, maybe for everybody, is this methodology been accepted by the animal rights groups or has any group threatened to shut down a capture because of the concern?

**INNES:** We had that problem when we first came here and I think the worst example was when we were in Oregon. Some of those guys probably remember when we got shut down and the animal rights guys had a bit of a field day.

After that happened, I spent quite a lot of time traveling back to Washington and wherever those guys were and I got to know the people and PETA and the Humane Society. I personally got to know all those guys for that very reason. Since I got to know them we developed this standard operating procedures manual together, and that was a large part of our reasoning for putting together this manual. I regularly, for no other better reason, keep in touch with those guys and we haven't had any trouble since that Oregon deal. We potentially got into trouble three or four more times.

I used to ring one of the big honchos in Washington and tell them to you get off my back, you know we did a good job. Everything went away, and there haven't been any problems since.

I think what happened when we came here was that we probably put the catcher business in a higher profile that it may have been before, with TV crews following us everywhere. We've got the media following us around. We had to nip it in the bud, because there were too many people. I would suggest two, three, four times a year. I ring this one individual who is a powerful guy and if I smell any problems, he shuts them down really fast.

**CRAIG FOSTER, OREGON:** We cannot measure a difference between slinging them upside down as opposed to the bags. I looked through our capture records on probably a thousand California bighorns in Oregon. We don't, as a state, accept sheep slung under the helicopter by their legs. One reason is PETA showed up at one of the captures and turned it into a significant wreck. I'm like Gary, I don't like to be slung upside down. The only animals I see slung upside down for a period of time are dead.

As a state, if they're going to be come in slung by their hobbles, we won't accept those animals. They have to come into us some other way. We don't see a significant increase in the time of handling if you've got a good crew that knows what they're doing. Putting them in a bag and hanging them under the ship versus wrapping the net under their feet and wrapping them in the hobbles, is a bone of contention and I know there are people on each side. That's how Oregon does it and that's how it works.

**INNES:** Particularly in our deal when we were using bags, and I've seen it here in the United States too, you can have just as many problems with animals throttling themselves. What Rick said before is a very real case. We've been doing sheep in hot climates putting them in bags. They are not better in the bags, but if you don't put them in the bags in the helicopters, they tend to piss all over the helicopter. But we try to get away from it.

I think when you say it doesn't slow the operation down, just like anything, it depends on what your standards are. What your expectations are. If you're used to the time it takes to do it, that's okay. We just flat out don't want to take the time delay. I've caught too many animals and I've monitored too many animals. What I'm worrying about is the body temperature. I know how to keep it down and when we screw with bags, I know it will come back up.

**FOSTER:** I have a question for the veterinarians in the group. Rex brought up the temperature problem. Our bags allow air to flow through pretty quickly and cool animals slung upside down. Are their respiratory systems compromised with the weight against the lungs, as opposed to being upright to exchange the air for temperature?

**DAVE HUNTER, MONTANA:** When we talk about temperature in bighorn, remember they do not sweat. The reason that we pour water on them is we're using their skin as an evaporative organ of the body. The fact is that as they would hang on those bags, the animals dissipate or get rid of heat by respiration. Anything you do to compromise that respiration is hard on the animal.

One of the criteria for Idaho was not slinging them upside down. Looking at moose, elk, and bighorn sheep, my concern was respiration. The trip back can bring up the body temperature. If they're breathing, they're getting rid of heat while flying around at 80 miles an hour, even with mesh on the bags. I would rather see a bag that supports the animal so it's not hanging by its neck or folded up in such a way that it's pushed the

diaphragm up. If they're sitting like a dog, that rope is pushing on the diaphragm, which is the main organ of respiration, and they have to pant because they can't get that diaphragm up.

I agree with Gary and James with hanging them upside down and watching their respiration. Esthetically, I find it distasteful. As far as going through all the records and trying to find areas where we had problems, I have not seen them. I think that with the way these animals are hobbled and hung up there, the diaphragm is allowed to move as they're moving back to base camp.

If you put them in the bags, those can be killers, too. Watch the way they're supported. A little animal has a big back, if you put the head out, the butt is not hitting the bottom of the bag. He's hobbled up there and he's hanging by his neck. Shove them all the way down in the bag. If those bags have an opening, close it all the way and sling him so he has a chance to use his respiratory system. I'll get off the soap box now.

**INNES:** We had a ram that we transported last year that died for that reason. He was a big ram and really heavy, the bag was only two or three inches too long. His butt didn't hang heavily, and his lights went out. That was the first ram of a major big transplant that died that way.

**NOTE: THE FOLLOWING ABSTRACT IS INCLUDED FOR THE SAKE OF COMPLETENESS IN THIS CAPTURE AND HANDLING SECTION. THE PAPER CAN BE FOUND IN THE SEVENTH BIENNIAL PROCEEDINGS OF THE NORTHERN WILD SHEEP AND GOAT COUNCIL, PAGES 171-175.**

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**COMPARISON OF HELICOPTER-SUPPORTED CHEMICAL IMMOBILIZATION AND SKID-MOUNTED PROJECTILE NET CAPTURE OF DALL SHEEP IN ALASKA**

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**Abstract:** Helicopter-supported darting to capture Dall sheep in Alaska has frequently failed. Because of serious wounding by drug delivery systems, unstandardized drug doses, long induction times in hazardous terrain, and stressful chases, reported mortalities associated with Dall sheep capture in Alaska have averaged 22%. Physical capture through use of projectile nets appears more promising. We experimented with a skid-mounted projectile net for capture of Dall sheep, and found it to have advantages over helicopter-supported chemical immobilization. Fiscal costs appear to be somewhat lower, and benefits to sheep considerably greater. We think this system also has human safety advantages compared with shoulder fired projectile nets.

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**NOTE: THIS ABSTRACT HAS BEEN INCLUDED IN THE CAPTURE SESSION FOR THE SAKE OF COMPLETENESS. THE PAPER CAN BE FOUND IN THE SECOND BIENNIAL NORTHERN WILD SHEEP AND GOAT COUNCIL PROCEEDINGS, PAGES 601-614.**

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**A COMPARISON OF ROCKET NETTING WITH OTHER METHODS OF CAPTURING DALL SHEEP**

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**Abstract:** Rocket netting was the most efficient method we tested for capturing wild Dall sheep (*Ovis dalli*) at a natural mineral lick in Interior Alaska. Other methods included drop netting, cannon netting, snaring, and chemical immobilization. Age comparisons of sheep caught in rocket and drop nets suggested mature wild sheep avoid drop net traps for up to two years. Younger sheep, lifetime-habituated to the drop net, which presents a formidable visual barrier, were equally susceptible to capture by drop net or rocket net. This may indicate habituation to foreign objects by Dall sheep is a long-term process.

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**NOTE: THIS PAPER IS PRESENTED IN THESE TRANSACTIONS AS AN ABSTRACT ONLY AT THE REQUEST OF THE AUTHORS.**

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**DEIRDRE S. MERWIN - IMMOBILIZATION OF FREE-RANGING ROCKY MOUNTAIN BIGHORN EWES WITH TELAZOL® AND XYLAZINE HYDROCHLORIDE**

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**Abstract:** We determined the efficacy of immobilizing human-habituated, free-ranging Rocky Mountain bighorn ewes (*Ovis canadensis canadensis*) with Telazol® and xylazine hydrochloride (HCl) in summer and winter. Telazol® is a 1:1 combination of tiletamine HCl and zolazepam HCl. Eleven sheep were readily approached from the ground and darted with 1 of 3 drug combinations. Mean induction time was 20.1 min. (Range=42 to 140). Sheep that fled after being darted had significantly longer induction times. Sheep that received greater doses of xylazine HCl had significant increases in the duration of immobilization. When used in combination with Telazol®, the xylazine HCl dose required for effective immobilization in this study was less than reported in similar studies where xylazine HCl was used alone or in combination with ketamine. In this study, 250 mg of Telazol® (4.2 mg/kg) and 30 mg of xylazine HCl (0.5 mg/kg) in winter and 370 mg of Telazol® (6.2 mg/kg) and 30 mg of xylazine HCl (0.5 mg/kg) in summer provided effective and safe immobilization in human-habituated, free ranging bighorn sheep with minimal side effects.

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## DAVID HUNTER - CHEMICAL IMMOBILIZATION OF WILD SHEEP - HISTORY AND CAUTIONS

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**Abstract:** Immobilization of free-ranging bighorn sheep has long been an acceptable method of collaring, sampling and relocating animals. With adequate knowledge and training there are effective drugs and drug combinations that can be used to safely immobilize bighorn sheep. The most effective and safest agents for field immobilizations are the narcotic agents (Schedule II drugs). Many thousands of animals have been handled using these drugs from helicopters and ground darting operations. These drugs are extremely potent and human exposure to these drugs must be avoided. Special handling and safety precautions are mandatory. Other non-narcotic drug combinations have also been used successfully. During the post-capture (post-immobilization) event, critical care must be taken by the individual or team to assure a successful capture event. Immobilization drugs discussed will include: etorphine, carfentanil, ketamine, Telazol®, xylazine and valium. Reversal agents and other drugs include: naltrexone, yohimbine, antaginalol, tolazoline and Dopram V®.

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As one gets involved with bighorn sheep, there is one thing you must understand. Bighorn sheep are addicting. There is not a person here that doesn't love these animals. There is a lot of expertise in this room today. Any biologist starting a project on BHS should avail themselves of this published and unpublished treasure.

**Immobilization of Bighorn sheep:** The capture operation is more than just putting drug into the animal. I would suggest that any researcher working with BHS attend a restraint and handling course before you go into the field. There are several good courses throughout the nation. Veterinarians can not legally issue you drugs unless you are certified by a "drug course" for using these drugs. The biggest mistake people make in the field is under dosing the drug. There is nothing that will complicate an immobilization more than a half-drugged animal. This is true from the ground or from a helicopter. When you are in the process of immobilizing a BHS you must also be cognizant of your responsibility for the drugs you use and how you dispense them. As a point of fact, what is your responsibility if the animal you drug today is poached and consumed tomorrow?

Your greatest resources are the people in this room that have had to answer these questions in the past.

There is nothing you can do legally that can replace good records. The excellent records biologists keep on the animals are a work of art. That is what you do the best. That same detail should easily transfer to the drug records that you must keep. The Drug Enforcement Agency and the Food and Drug Administration are not easy people to deal with should questions arise. Do not put yourself into a position that will put your careers or credibility on the line. **Keep Good Records.**

**Succinylcholine:** Over the years this drug has gained a bad reputation from veterinarians and biologists. This drug is a curare like drug that causes paralysis of the muscles. This is not a tranquilizer, analgesic or sedative. It only inactivates the animal by paralyzing the major muscle groups. Remember the dreams you had as children when you were being chased but could not run? That is the action of this drug. Is this more traumatic than being chased by a helicopter and having a human fire a net over your body and then running up and manhandling a BHS?

The other reason the drug has had a bad reputation is the narrow safety margin when used to immobilize an animal. In certain species the amount of drug need for immobilization is dangerously close to the amount that will kill the animal. Good animal management and understanding CPR can save these animals. Paralysis of the diaphragm is the reason for concern. If you can rescue breath the animal, the drug will metabolize and the animal will fully recover. The drug is quick acting and totally metabolized 20-25 minutes after darting. It could have a place in your drug kit only if you use it in the presence of a person who has successfully used the drug on the species before. Many biologists have used the drug for years without mortality, while others have lost most of the animals they have darted with succinylcholine. The drug is extremely safe for humans.

**Diazepam or Valium:** The most important factor to remember about Valium is that it is a potent anti-convulsant or anti-seizure drug. Valium can be used on BHS and is a mild tranquilizer. It is slowly absorbed when that given intramuscularly but has a long duration of action. When given intravenously, it must be given slowly. It can cause a problem if given in a bolus. It is a good drug to have in your drug kits. Valium can be used in conjunction with any other drug used for BHS immobilization. There is no need to reverse Valium when used as a tranquilizer.

**Acepromazine:** This tranquilizer has been used in wildlife for many decades. You will find doses for acepromazine listed in the literature in conjunction with most immobilization drugs. It is not reversible. It is an excellent tranquilizer. This drug will smooth out the harsh effects of other immobilization agents and can be used during transport of animals to curtail aggressive or destructive behaviors. It is a bottle you should have in your drug kits.

**Xylazine (Rompum), Detomidine and Medetomidine:** These drugs are alpha-adrenergic agonists. The drugs work on a specific portion of the brain. They can be used as tranquilizers/sedatives in low doses and immobiliza-

tion agents at higher doses. Xylazine is the weakest of the drugs and has been used for years in combination with ketamine, telazol and narcotics. This drug is reversible with yohimbine, tolazoline, and antagonil. The effect of having an alpha-adrenergic agonist with other narcotic and non-narcotic agents is that it does have analgesic properties. Therefore, procedures that produce pain require analgesia. You should all address the aspect of pain in your care and use protocols for handling animals. Used by themselves as immobilization agents can be unrewarding since adrenaline can override the drug. If the animals are stimulated they may jump up and continue to avoid capture. You must be careful in that if you do not find an animal that has had a large dose of xylazine, it may hide and, as the drug takes effect, the animal may place itself in a body position that will cause harm or death. These drugs are strong respiratory depressants and monitoring when using these agents is critical. Xylazine comes in two strengths; 20mg/ml and 100 mg/ml. Make sure you know the concentration when ordering this Xylazine.

**Ketamine and Telazol:** The drugs are non-narcotic disassociative analeptics. That is a term used to describe the effect of the drug on an animal. Many of the older biologists used phencyclidine as an immobilization agent in the past. Phencyclidine on the streets was called angel dust. Ketamine and Telazol are in the same category in their mode of action. These drugs keep the heart rate and respiration high so monitoring the animals is not as critical. These drugs are under a heavy scrutiny as having a potential for human abuse. Keep good records when using any drug. Ketamine and Telazol with Xylazine or Medetomidine can be used to immobilize any wildlife species in North America. Together they can produce a smooth immobilization and the alpha agonists can be reversed.

**Etorphine and Carfentanil:** The narcotic drugs have a reputation for being extremely dangerous to use in the field. These drugs do require respect. That respect, and a good certification class, should give biologists the confidence to use these drugs. In the ungulate species narcotic drugs are the safest

drugs to use. They are completely reversible and the literature to draw on is immense. No one should be given these drugs to use in the field until they have successfully completed a certification course and is current on CPR. That should be mandatory for all state and federal biologists. Working in pairs with another person certified and current in CPR again should be a mandatory requirement.

**Drug Doses:** You should have a good reference guide. Calculating drug dosages, drug combinations, equipment to deliver the drugs, restraint equipment and emergency equipment and medications are areas that are covered in Terry Kreeger's book, "Handbook of Wildlife Chemical Immobilization". There are several other authors that have printed reference books.

**Monitoring:** Respiration, body temperature, heart rate, oxygenation and depth of immobilization are all areas that must be assessed frequently during a drugging event. Training in these areas should also be included in any certification class.

**Euthanasia:** Drugging events are an art form. Sometimes animals are critically injured and a biologist must address how to humanely euthanize the animal. There are several drugs on the market for this purpose. Many of these solutions can not be used unless the animal is removed from the wild. Residues from the euthanasia drugs can be deadly to carrion harvesters. That may include threatened or endangered bald eagles, condors, wolves, ferrets or bears. You must check the label before leaving a euthanized animal in the wild. The American Veterinary Medical Association has adopted guidelines for wildlife species.

**Alternative Capture Methods:** Net-gunning, drive netting, drop netting and corral trapping have all been used successfully for capturing BHS. They all have good and bad points. The stress on the sheep can produce bad results two to three weeks post capture. You should take responsibility for the animal you dart, relocate or otherwise handle for three weeks. If you have interfered with that animal's life, you may have predisposed that

animal to disease or predation. There is a lot of expertise in this room. We are all here to assist you in your quest for handling BHS. Do not expect to become a BHS capture specialist by reading books and literature.

**Conclusion:** Be trained, keep good records, listen to your peers, and ask questions if you don't understand a protocol or procedure. Anyone in this room can put drug in a dart and potentially stick that dart in a BHS. The professionals know what to do for that animal to keep it alive after the dart is removed.

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## QUESTIONS, ANSWERS AND COMMENTS - DAVE HUNTER PRESENTATION

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**COREY HEATH, OREGON:** You touched on it briefly, but with new drugs like telazol, xylazine, dexamethazone, and antibiotics, what is the recommended metabolism time period prior to human consumption? What will hold up in court and what won't?

**DAVE HUNTER:** Have we put together anything that talks about withdrawal times of drugs before humans can consume those drugs? Yes, we plagiarized some documentation out of Alaska. Terry Kreiger has copies and Idaho Fish and Game has copies, where we talk about withdrawal times. Basically, other than narcotics, we got it down to seven days. As far as drug companies, nobody will spend the money on withdrawal times. Seven days is what all the wildlife veterinarians use.

**HEATH:** That includes antibiotics?

**HUNTER:** It includes antibiotics, other than the long-acting penicillins and such. It's according to label. It might be 30 days with liquimiacin.

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## RAYMOND M. LEE - POST-CAPTURE SURVIVAL ESTIMATES FOR BIGHORN SHEEP

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**Abstract:** Bighorn (*Ovis canadensis*) populations declined through much of their range in North America because of introduction of livestock diseases and parasites where the bighorn were naïve to these organisms, unregulated harvest, competition with livestock, habitat fragmentation, and other lessor causes. Early efforts to re-establish populations were limited by lack of suitable capture methods. From the 1970s to the present, considerable research has been conducted to develop capture methods that had low capture-related mortality. Three methods are currently used to capture bighorn; darting with chemical compounds, drop netting, and aerial net gunning. We estimated survival rates from 306 bighorn captured by Helicopter Wildlife Management (HWM) and a total of 405 bighorn captured by Arizona Game and Fish Department (AGFD) with known post-capture fates. Survival estimates ranged from 0.942 for aerial net gunning to 0.983 for aerial darting. Survival estimates were significantly different only between aerial net-gunning and aerial darting.

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Bighorn entered North America by crossing the Bering land bridge approximately 70,000 to 10,000 years ago (Kurten and Anderson 1980) and populations became widespread in much of western North America (Brown 1989). Buechner (1960) suggested that bighorn occupied most mountainous areas as far east as North Dakota, Nebraska, the Trans-Pecos region of Texas, and as far as northern Mexico and much of the Baja peninsula. Although Seton's (1929) estimates are probably high, he did document widespread bighorn presence in the New World.

Most researchers and naturalists who investigated population densities between 1900 and 1960 (Mearns 1907, Seton 1929, Russo 1956, Buechner 1960) documented widespread declines with many local extirpations due to the introduction of pathogenic diseases and parasites, unregulated harvest, competition with livestock, habitat fragmentation, and other lessor causes. Like many other hunted species that had undergone considerable population declines, public concern with the decline of bighorn prompted wildlife management agencies to begin management programs to repopulate

historic habitat. At the heart of these recovery efforts were capture and relocation programs.

Although some bighorn capture efforts date to the early 1920s (Yoakum 1963), it was not until the 1950s that many bighorn relocation programs were initiated. Early efforts relied on physical restraint applied at areas where bighorn concentrated such as salt licks or water sites. It is often difficult to determine mortality rates from early reports, however, where mortality rates are reported, they are often high. Further limiting the success of some of these efforts (Weaver 1973) was the high commitment of human resources to accomplish a few captures. Over a 2-summer period (1956-1957), over 2,000 person-hours were expended to capture 17 bighorn on the Kofa Game Range, with 6 mortalities and only 5 animals being capable of release.

Because of high mortality rates and labor commitments required to capture bighorn, most capture efforts after about 1970 eliminated mechanical restraint and used chemical immobilizers (Weaver 1973). Research efforts to develop new capture methods that provided a high level of human

safety, high survival rates, and afforded the opportunity to efficiently capture large numbers of bighorn continued. Eventually, aerial darting with Etorphine<sup>®</sup> (deVos and Remington 1981), drop nets (Schmidt et al. 1978, Fuller 1984), and net gunning (Remington and Fuller 1989, Krausman et al. 1985) have become the standard methods for capturing bighorn.

To evaluate if these methods achieved the goal of high bighorn survival, post-capture, we compiled data from captures for each of these methods and used these databases to estimate survival rates for each method.

**METHODS:** We compiled data from 2 sources; captures using net gun captures completed by HWM and captures using net guns, aerial darting, and drop netting completed by the AGFD. The HWM database consisted of 306 bighorn from 20 separate captures. The AGFD database consisted of 405 bighorn with 107 captured by drop nets, 115 by aerial darting, and 183 by net guns. We did not compare the HWM database to the AGFD database because of differences in how the data were collected. The HWM database monitored survival for 10 days where the AGFD included all animals that died within 30 days of capture.

Survival rate estimates were calculated using the computer software MICROMORT (Heisey and Fuller 1985). We tested for significance among the 3 capture methods represented by the AGFD database using Z-testing as recommended by Nelson and Mech (1986). Differences were deemed significant when  $P < 0.05$ .

**RESULTS:** Data from the HWM captures indicate that 21 of 306 bighorn died during or within 10 days post capture for a survival rate of 0.932. Of this total, 9 died during capture (mortality rate = 2.9%), with 12 (mortality rate = 3.9%) being found dead within 10 days of capture.

The estimated post-capture survival rate was highest for aerial darting (2 of 115; 0.98), intermediate for drop netting (4 of 107; 0.962), and lowest for net gunning (10 of 183; 0.942) (Table 1).

When analyzing for differences between the capture types, the only significant differences among the 3 methods was between aerial darting and helicopter net-gunning ( $Z = 2.015$ ;  $P < 0.03$ ).

**DISCUSSION:** Public scrutiny of wildlife management programs has increased recently. Practices that result in high mortality have been deemed unacceptable and in some cases have resulted in public initiatives to prohibit some agency practices (deVos et al. 1999). Further, high mortality can adversely affect the success of project objectives as study animals are lost. Therefore, wildlife managers need to select capture methods that optimize bighorn survival.

We have evaluated survival rates for the 3 methods currently used in bighorn management programs and found that all methods have high survival rates. In our experience, each of these techniques has advantages and limitations. The selection of a capture technique should be based on project objectives, terrain, and personnel training. It is also important to recognize that each of these techniques do not work in all situations. Other consideration to be used to select a capture method would be targeted sex and age ratios and the need for genetic diversity. Aerial capture methods allow selection of specific age and sex ratios, where drop netting captures large numbers a bighorn at 1 time and sex and age ratios are determined by the bighorn that come under the net. Aerial captures may also optimize genetic diversity. Bighorn can be captured from several areas, minimizing the level of genetic relatedness.

We conclude that the methods we evaluated provide safe and effective bighorn captures. Given the high probability of bighorn survival after being captured, restoration efforts should continue to be successful in building bighorn populations in vacant historic habitat.

#### LITERATURE CITED

Brown, D.E. 1989. Early history. in *The desert bighorn in Arizona*, R.M. Lee, Editor. Arizona Game and Fish Department, Phoenix, AZ.

- Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present, and future. *Wildlife Monograph No. 4*. 174 pp.
- deVos, J., and R. Remington. 1981. A summary of capture efforts in Arizona since 1977. *Desert Bighorn Council Trans.* 25:57-59.
- deVos, Jr., J.C., D.L. Shroufe, and T. Supplee. 1999. Managing wildlife by ballot initiative: the Arizona experience. *Journal of Human Dimensions*. (In press).
- Fuller, A. 1984. Drop-net capture of bighorn in Arizona. *Desert Bighorn Council Transactions* 39-40.
- Heisey, D.M., and T.K. Fuller. 1985. Evaluation of survival and cause-specific mortality rate using telemetry data. *Journal of Wildlife Management*. 49:668-674.
- Krausman, P.R., J.J. Hervert, and L.L. Ordway. 1985. Capturing deer and mountain sheep with a net-gun. *Wildlife Society Bulletin*. 13(1):71-73.
- Kurten, B., and E. Anderson. 1980. *Pleistocene mammals of North America*. Columbia University Press. New York, NY.
- Mearns, E.A. 1907. *Mammals of the Mexican boundary of the United States, Part 1*. U.S. Natural History Museum Bulletin 56.
- Nelson, M.E., and L.D. Mech. 1986. Mortality of white-tailed deer in northeastern Minnesota. *Journal of Wildlife Management*. 50:691-698.
- Remington, R., and A. Fuller. 1989. Capture and transplant techniques. in: *The desert bighorn in Arizona*, R.M. Lee, Editor. Arizona Game and Fish Department, Phoenix, AZ.
- Russo, J.P. 1956. *The desert bighorn sheep in Arizona: a research and management study*. Arizona Game and Fish Department, Phoenix, AZ.
- Schmidt, R.L., W.H. Rutherford, and F.M. Doderstam. 1978. Colorado bighorn capture techniques. *Wildlife Society Bulletin*. 6:159-163.
- Seton, E.T. 1929. *Lives of big game animals*. Doubleday, Page, and Company. New York, NY.
- Weaver, R.K. 1973. Bighorn sheep stocking. Arizona big game investigations, Project W-53-R, WP 652. Arizona Game and Fish Department, Phoenix, AZ.
- Yoakum, J. 1963. Re-establishing native bighorn ranges. *Desert Bighorn Council Transactions*. 122-125.

Table 1. Survival estimates for bighorn captured using aerial darting, drop-netting, and aerial net gunning. Data were compiled from capture records maintained from clients of Helicopter Wildlife Management (HWM) and from Arizona Game and Fish Department (AGFD) records where survival status was known.

<b>Data Source</b>	<b>Capture Method</b>	<b>Number Captured</b>	<b>Number Dead</b>	<b>Survival Rate<sup>1</sup></b>
HWM	Aerial net-gunning	306	21	0.932
AGFD	Aerial darting	115	2	0.983
AGFD	Drop-netting	107	4	0.963
AGFD	Aerial net-gunning	183	10	0.942

<sup>1</sup> Survival rate estimates for HWM data are based on a 10-day period post-capture. The AGFD survival rates are based on a 30-day period post-capture.

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## QUESTIONS, ANSWERS AND COMMENTS - RAY LEE PRESENTATION

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**WALT VAN DYKE, OREGON:** How big a population do you have to have before you need to avoid transplanting out, and how many sheep do you take?

**RAY LEE:** We've been fairly fortunate to have is relatively high populations, the Kofa approaches 1,000 and fluctuates between 900 and 1,000. The Black Mountains population is probably between 1,000 and 1,500. Those are probable source stocks. We did a transport from a source of 300, and as far as I'm concerned, that's as low as we want to go for the source population. We try not to remove more than five percent of the population, and five percent means five percent of the females.

**VAN DYKE:** What's the transplant size you're looking for?

**LEE:** Typically, we're looking at 30 animals on the upside.

**STACEY OSTERMANN, CALIFORNIA:** Under what circumstances do you give fluids?

**LEE:** We find during the drop net captures the animals are not stressed to the point that we give fluids at all. We have them available. If we have an animal, we're taking its rectal temperature. If the rectal temperature goes up above 105°, we'll start watching them closely. If it goes up above 106°, we'll start giving them fluids.

We find on our net gun captures, the animals almost always come in with a slightly elevated rectal temperature. At that point, we always watch for temperature rise. It will rise up to a point, we start fluid treatments, and it starts coming down at that point. Fluids we give are lactated ringers solution.

**NIKE GOODSON, UTAH:** In the last presentation, they said they had a recommendation of a limiting amount of 371 square kilometers in desert habitat for predicting successful transplants. I wondered if, from your experience, that number makes sense to you?

**LEE:** I think as I read the slide that it's the southern Colorado deserts that he had 371 kilometers. To me that's the uppermost range of the desert bighorn. I'll go ahead and address it in that fashion.

If we can come with 200 contiguous square miles, however close that is to 371, that's what we're looking for.

Only two of our transplants totally failed. We feel they failed due to there not being enough habitat for them, not being enough escape terrain, and not being quite enough contiguous habitat. When we scored the two areas, they were great, absolutely fantastic. They weren't big enough and really what we in Arizona consider to be the most important factor for bighorn sheep reintroductions is contiguous habitat.



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## WAYNE HEIMER - HUMAN MORTALITY IN WILD SHEEP MANAGEMENT

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**Abstract:** Modern sheep biologists have come to rely heavily on aircraft for research and management. Although aircraft facilitate census, capture, and relocation of wild mountain sheep, the human mortality cost of mountain flying is significant. Aircraft-associated mortalities are the leading cause of job-related deaths among wildlife biologists. The documented mortality rate for humans working in wild sheep and mountain goat management is one death for every 14.6 months over the last 28 years. The nature of mountain sheep and the terrain which they inhabit require operation of most aircraft at the upper margins of their design limits. Operating any machine at (or frequently beyond) its design limits leads to increased risk of failure. Nevertheless, the most common cause assigned to aircraft-associated mortalities among humans flying in mountainous habitats is not mechanical failure, but human mistakes. Typically these mistakes are characterized as "pilot error." Because most pilots are flying under the charter or direction of biologists, "pilot error" should be correctly understood as the proximate cause of death; the ultimate cause is "biologist error." Possible sources of "biologist error" will be defined in the hope that familiarization with the mortality statistics and sources of "biologist error" will eventually reduce sheep-associated aircraft mortalities among humans.

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I'd much prefer talking about Dall sheep trapping to discussing human mortalities associated with mountain flying. However, I think this is an important issue for us to address. I do not hold this opinion specifically because of the recent Tiburon Island tragedy we share, but for a more compelling reason: our collective losses over the years. I doubt there is anyone in this room who hasn't either had a close call or been personally touched by an aircraft-related mortality resulting from sheep, goat, or wildlife management. The bad news is that if you haven't been involved in such a tragedy, you will be if we continue to use aircraft to the extent we have in the past. If we continue to develop "new applications" for aircraft to our work needs, this time will be shortened rather than lengthened.

**PERSONAL EXPERIENCE:** My initial experience with aircraft-related human mortality among sheep and goat biologists involved Jim Erickson's death. Jim was a pioneer in North American wild sheep research and management. By chance, I had met Jim and his family when I was a callow brown fat fanatic at the University of Alaska. Jim was the

Alaska Department of Fish and Game's Dall sheep biologist in Fairbanks, and neighbor to some close friends. For reasons which must have seemed justifiable at the time, Jim and his pilot went to count sheep in the Hulahula River drainage on north side of the Brooks Range. Several mistakes contributed to their deaths. They were surveying sheep in the mountains using a Super Cub on floats, the only practical way to access that area at the time. Additionally, Jim's pilot, although experienced in other aircraft, was not highly experienced with the Super Cub. Apparently, they 'spun in' and burned. Jim was a young man with a young wife and young children. Whatever the justification for taking the risks to gather Dall sheep population data in the remote Brooks Range might have been in 1970, it has been long forgotten. The data were never retrieved. By all accounts, Jim Erickson was an uncommonly good biologist, and had he lived, would probably have become one of the giants of our business.

Prior to my hire as sheep biologist for the Department of Fish and Game, I was warned about the high mortality among wildlife biologists. When word "leaked out" to the faculty of physiology I

had applied for the sheep biologist job (having found the allure of working with Dall sheep at a higher level of biological organization irresistible after years of working my way up from molecules through enzymes, cells, tissues, organs and intact mice), my academic advisor, who was not known as a compassionate man, said, "You don't want to do that, you'll soon die in a plane crash." At that time, I was young, considered myself immortal, and paid little attention to his advice; I got the job. Because of the circumstances, I was hired into the shadow of an unusually impressive human being, and living in Jim's shadow certainly impacted my career and the approach I brought to the work.

Not only did I inherit Jim's programs, which were unusually visionary for the late 1960s, I also inherited a palpable appreciation of the fact that the time any of us has to contribute may be short. This may explain why I have perhaps appeared "pushy" over the years, and why I can't abide the notion that I might know something important that you don't. After all, I could be gone soon. I appreciate the tolerance you, my colleagues, have generally shown in this regard over the last quarter of a century, and I hope you will be as kind to me in the future as you have been in the past.

Within a year of my hire, my partner, Tony Smith had crashed with a pilot named Bart Cox while on a sheep survey. The cause was mechanical failure, and both escaped with minor injuries. Within another year and a half, a close friend and colleague from the Fairbanks office, Spencer Linderman, and his pilot were killed counting mountain goats on the Kenai Peninsula. Like Jim Erickson, Spencer was a young man who left a young wife. Spencer's was my first Departmental funeral. The Department was quite shaken and disturbed as we wondered, "Is it worth it?" and "What could we do to prevent this sort of thing?" Being coldly analytical based on the events of Spencer's funeral and the funerals of others since, I have calculated this introspective period in the Alaska Department of Fish and Game lasts about three weeks. At the end of the three-week introspective period, it's back to business as usual. Mountain goat management was

unaffected by the loss of the data Spencer had set out to gather.

Spencer's funeral didn't seem to change anything in the Department except me. Living as I did in Jim Erickson's shadow, and influenced by Spencer's death, I made a personal commitment to reduce the flight risks associated with sheep biology. For me, this was obviously a personally adaptive decision. I hoped it might also serve future sheep biologists. Still, it didn't spare me from my own 'biologist error.' Within a year, I also crashed in an overloaded helicopter. By the grace of God, both the pilot and I walked away physically unscathed.

Criteria affecting my decision, when to fly or not, established as a result of these brushes with death included this basic litmus test: *if the data I was gathering held promise for making a difference in sheep management or increased safety for future sheep biologists, I would go...if not, I wouldn't.* This litmus test, along with scarcely having enough money for minimal aircraft charter, led to our discovery of the predictive value of what I call "internal population dynamics" which require detailed composition data which can't be gathered from aircraft (Heimer 1994). As a result of limiting flying to the necessary minimum and maximizing inexpensive ground-based observation techniques, my friends and I found that accurate ground-based recruitment and mortality assessments have predictive value which far exceeds the applicability of aerial survey data for Dall sheep management. The mathematics aren't as impressive, but the program was cheaper in terms of operating budget, and the data tracked population trends and sizes with amazing accuracy.

**METHODS:** In the course of writing that paper (Heimer 1994), I attempted to "cost out" the expenses and benefits of "ground-based" biology compared with "aircraft-based" biology. Clearly such an analysis involves the cost of flight time vs. on-ground field time. At the end of that analysis, I included a paragraph on the human mortality costs involved with sheep and goat management.

I compiled those data by going through the proceedings of the Northern Council as far back as the 1970 meeting dedicated to Jim Erickson's memory. I simply totaled the number of humans memorialized in those proceedings and divided by the 23 years which had elapsed in the interim. For purposes of this calculation, I included all human mortalities. This approach could have inflated the death rate because I included a Canadian incident in which a plane of searchers looking for a lost biologist went down and all on board were killed. Still, it was mountain flying related to sheep management.

**RESULT:** The average resultant mortality rate for humans involved in wild mountain sheep and goat research was at least one human death every 14 months. In the years between 1994 and 1998 the mortality rate declined slightly, but with the Tiburon Island tragedy, it now averages one human death every 14.6 months over the last 28 years.

**DISCUSSION:** When Heimer (1994) was being internally reviewed by the Alaska Department of Fish and Game, one reviewer objected to the paragraph on human mortality costs because, he said, "This paragraph is a red herring! Flying can be done safely." During the time that passed between the "red herring" comment and my retirement, four more Alaskan biologists lost their lives in work-related aircraft accidents. These accidents were related to moose surveys.

I think we are perhaps more "safety conscious" than biologists used to be, but at the same time, we've increased dependence on aircraft for sheep work. This leads me to ask the philosophical question, "Why?" Put more practically the question becomes, "What causes the 'biologist error' which, too often, results in aircraft-related human death?"

I think the most basic cause is simple denial of risk. Clearly the "red herring reviewer" just cited above was in denial of the risks associated with aerial survey (just as I was when I dismissed the advice of my old major professor and embarked

on the adventures of sheep biology and management). Denial of risk comes from two sources, biologists and supervisors. The biologists who do the work are mostly younger people who are no more closely in touch with their own mortality than was I. Youth has always believed itself invincible. Even cautious biologists will eventually be caught up in the work, and take some unreasonable risks to save money or labor so they can attain their research or management objectives. Supervisory denial may stem from the same desire to meet established goals, but is more complex. Perhaps both supervisors and biologists are unaware of the risks. I reject this possibility, and note tacit supervisory support for aerial work appears unfailingly present. I suggest this is because the supervisors probably took similar risks (and survived) as field biologists before they became supervisors. I've never heard a supervisor say, "No, the potential management or research yields associated with the athletic flying you're proposing aren't worth the risk." However, during my career, I had two supervisors suggest, and even demand that I engage in extreme high-risk flying as the basis of research and management programs. If both biologists and supervisors are actually aware of the manifest risks of mountain flying, yet continue to fly as a matter of course, I can only presume they are in denial of these risks. They must simply assume "It won't happen to me...or to my employee."

A more chilling possibility exists where supervisors are concerned. If supervisors are aware of the risks of mountain flying and still approve (or even, demand) high-risk flights or programs based on high-risk aircraft use, we may infer a supervisory mentality that parallels that of military combat commanders. In this case, leaders understand there will be casualties, but consider obtaining the objective worth risking the mortality costs.

Alternately, biologists and supervisors could be operating under the assumptions of fatalistic philosophy. If both believe that "when your number is up, it's your time," the willingness to take risks not commonly considered prudent may be rationalized.

Finally, I suggest a certain machismo accompanying flying and adventurous field work contributes to increased human mortality. High risk flying, capturing animals from helicopters, and “hanging it all out” are exciting. Many of my colleagues consider these activities exhilarating and fun. How many times have we lingered in bars telling and hearing ‘near-miss’ stories? In my case, too many; I hope not in yours. For too many biologists, the ‘adventure rush’ of doing of field works seems more the point than the management progress which should justify the ‘doing.’ The too-frequent result is that biologists who do not relish the risks are frequently considered by their more macho colleagues as lacking “the right stuff.” This results in a “peer pressure” to fly in spite of the risks.

As an example I cite the story of a friend and colleague in the Alaska Department of Fish and Game who paid the social price for declining to “relish the risks” after a serious helicopter crash. He was engaged in wolf shooting from a helicopter piloted by the same fellow who had crashed with me. As they made a downwind approach on a wolf pack, a gust from behind them overrode the lift by “zeroing out” the helicopter’s airspeed, and they fell to the earth. Fortunately both scrambled out of the helicopter with minor physical injuries moments before it caught fire and burned to a small pile of ashes. When my friend told his supervisor that he didn’t want to fly anymore, his supervisor honored his wish. However, other staff members surreptitiously and disparagingly whispered that he’d lost his nerve. This is a difficult story to tell, but I fear the machismo root of ‘biologist error’ is among the more common causes of human mortalities. Shamefully, it is also the least rational.

Although I think we’re more safety conscious than biologists used to be, I am less than encouraged by the lack of creativity we show with respect to decreasing risks associated with flying for research and management. I may be overly pessimistic, but a recent exchange of correspondence may illustrate this point. Kevin Hurley (who continually looks for employment for me) forwarded a recruitment notice for an Alaska sheep biologist position to me. Within it, I noted the following job duty:

Flying in small aircraft for extended periods in mountainous terrain during turbulent or cold weather while radiotracking, capturing wildlife, or conducting aerial surveys.

When I wrote the project supervisor (a colleague whom I like and respect) inquiring about the risks of mountain flying in turbulent weather, I was reassured that:

I don’t take the risks associated with this project or any other lightly. For 15 years, I have run research projects here in Alaska that require substantial flying and have done so without incident, largely because I fully recognize those risks and don’t have my ego all tied up with getting the job done. I am notorious for being very picky about which pilots I’ll work with. Further my staff and I never second-guess or pressure a pilot to do anything, a trait that is surprisingly rare from what I hear from pilots.

I think you need to be cautious about over-interpreting that sentence in the job announcement. I purposely put in the verbiage about turbulence and mountain flying so that prospective applicants would know that we are not running a flightseeing operation and to weed out folks prone to motion-sickness. I fully discuss the flying aspects of the job with every person that calls me regarding the job and this will be a major portion of any upcoming interviews of candidates. The reference to [flying in extreme] cold must be taken in context. You stated a  $-30^{\circ}\text{F}$  cutoff in you letter, which is highly reasonable and the industry standard up here, but to many people seeing this announcement  $-30^{\circ}\text{F}$  is extreme cold that they have never experienced!

While I endorse and respect the supervisor’s approach to safer flying, I found the announcement chilling, and wondered what survivor’s benefits

would be associated with the position. I also wondered if the goals of the project were worth "dying for." I doubt they are, but chances are that if safety guidelines are followed, there will be no human mortalities associated with the project. I also doubt sheep management will be changed by what is learned for the risks taken.

**RECOMMENDATIONS:** I fully realize that this presentation will have minimal effects on those of you who fly. Still, I shall offer this advice:

First, be creative in finding ways to gather better data with less flying. Technical progress doesn't consist of thinking up more innovative applications of aircraft to field situations that create high risk. Nevertheless, such applications are often represented and recognized as technical advances. As an example, I offer the following analysis of a recent "techniques paper" from Alaska (Scotten and Pletscher 1998). This paper reports on the successful use of the Robinson R-22 helicopter (an inexpensive, two-place piston-powered ship) for neonatal Dall lamb capture, and recommends it for expanded application as a research and management tool. I suggest this recommendation may amount to 'biologist error.'

In researching the Robinson R-22 I corresponded with the New Zealand CAA (equivalent to the USA's Federal Aviation) because I'd heard of high accident rates for this machine in the venison trade in New Zealand. In response to my inquiry regarding piston powered and turbine powered helicopter reliability and safety, a CAA supervisor said there is a "... significant difference between the turbine powered and piston powered groups in terms of engine failure type accidents." (P. Nadler N.Z. CAA supervisor pers. commun.). With respect to suitability of the Robinson R-22 for "in close" work at 3,000 to 4,000 feet of elevation (where Dall ewes lamb), the N.Z. CAA had this to say:

Like all helicopters, the Robinson needs to be flown with an adequate margin of power available vers the power required for any given manoeuvre. The problem with the Robinson [model R-22] is that it

can be difficult to judge when this margin exists. This problem almost certainly accounts for more accidents than any other cause. Why is this such a problem for the Robinson? I guess the answer is simple, it's a small helicopter designed to carry two people and some fuel. If the helicopter is asked to carry more than this the design limits can be very easily exceeded (P. Nadler, N.Z. CAA supervisor pers. commun.).

With these comments from the New Zealand CAA, I suggest following the recommendations of Scotten and Pletscher (expanded use of the Robinson R-22 for Dall sheep work in Alaska, let alone for other mountain sheep living at higher altitudes) will lead to unacceptable risk levels. It would certainly have been appropriate for these authors to report the results of the lamb mortality study where the little helicopter was used. I don't think it was responsible to represent use of the R-22 as a technical advance or recommend this marginally-powered ship for athletic, "in-close" mountain flying. I think focusing on the management relevance of the data they gathered and simply stating they "got away with" using the R-22 would have been more responsible. True technical advancement will limit dangerous activities while improving data quality. Too often techniques papers confuse the two. If you can find any other way to get the work done, avoid flying in the mountains.

[Author's late note: While this conference was underway, a Robinson R-22 chartered by the Alaska Department of Fish and Game crashed because of inadequate power for the task to which it had been applied. Fortunately, neither the pilot nor the biologist was injured. WH]

Second, if you must fly, fly as little as possible. Don't fly unless you are convinced the data you're going to collect are worth risking your life. In the last analysis, this means that you consider the results worth "dying for."

Third, when you fly, be careful. Never push yourself, your pilot (or his machine), or people under

your supervision. Don't ever fly with a pilot you don't know to be experienced, competent, cautious, and independent enough to tell you "No!"

Fourth, when possible, hire a professional to do unusually athletic flying and capture work. You may think this is fun, but the professionals are probably better at it than you are, and their risk of failure, while unacceptably high by some standards, is considerably lower than yours.

Finally, if you must fly, negotiate for just compensation for the risks you take. In Alaska, the death rate among biologists is clearly higher than that for police and firefighters. During an unusually enlightened period (following Jim Erickson's death) field personnel in the Alaska Department of Fish and Game were included in the police and fire retirement program. Under that program, if you could "cheat the grim reaper" for 20 years, you could retire with full benefits. Unfortunately, recognition of the grim actuarial statistics associated with job-related death was withdrawn several years ago because of its apparent cost. Biologists in Alaska are, at this time, inadequately compensated for the risks they take. My advice? Get involved with your union or collective bargaining unit and negotiate inclusion in your state's "police and fire" retirement system. You're worth it!

**EPILOGUE:** We should never forget that deaths affect those who remain alive. Jim Erickson's children are now grown. Still, as adults they developed an interest in knowing about their biological father. Consequently, their mother, Alexandra Coy, who had remarried more than 20 years ago, contacted me to see what I might be able to offer. I was able to supply her with a copy of the memorial page from the Northern Wild Sheep Council proceedings dedicated to Jim's memory as well as the acknowledgement sections of various papers I had written crediting Jim with work he had started, and upon which our further work had been based. Eventually she called me with thanks for what I had been able to provide, and asked if Fish and Game was still doing the same amount of flying. Unfortunately, I had to tell her that despite my efforts to make sheep field

work safer, the Department was more dependent on aircraft than ever before. Alexandra didn't understand. Neither do I.

#### LITERATURE CITED

Heimer, W.E. 1994. Aerial survey and Dall sheep population size: Comparative usefulness of external and internal population dynamics for management purposes. Proc. Bienn. Symp. North. Wild Sheep and Goat Council. 9:43-50.

Scotten, B.D., and D.H. Pletscher. 1998. Evaluation of a capture technique for neonatal Dall sheep. Wild. Soc. Bull. 26(3):578-583.

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## DISEASE

CHAIR: KEVIN HURLEY, WYOMING GAME AND FISH DEPARTMENT

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NOTE: THIS PAPER IS PRESENTED IN THESE TRANSACTIONS AS AN ABSTRACT ONLY AT THE REQUEST OF THE AUTHORS.

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### RYAN J. MONELLO - A RANGE-WIDE EVALUATION OF THE POPULATION DYNAMICS AND ECOLOGICAL FACTORS ASSOCIATED WITH BIGHORN SHEEP DIEOFFS

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**Abstract:** Many bighorn sheep (*Ovis canadensis*) populations throughout much of western North America are characterized by periods of rapid growth followed by drastic declines. The proximate cause of most bighorn mortalities during population dieoffs is the pathogen *Pasteurella* spp., which can cause pneumonia and death in infected animals. We examined factors potentially predisposing bighorn sheep to pneumonia-related population declines by assessing the correlation between bighorn population trends and environmental and biological factors. We collected information on composition and demography, precipitation, and temperature data for 174 sheep populations ranging from the southwestern U.S. to Alaska. The majority of pneumonia outbreaks were found in Rocky Mountain (*Ovis canadensis canadensis*) as opposed to Desert (*Ovis canadensis nelsoni*) or California bighorn sheep (*Ovis canadensis californiana*). Of these, 88% of the dieoffs occurred at or within three years of peak herd numbers. Lambs experienced significantly higher mortality rates (66% in year of dieoff), but mortality rates were similar among rams (35%) and ewes (42%). No significant differences in herd growth rates were found between non-dieoff and pneumonia dieoff populations prior to dieoff, although herds that experience a dieoff due to pneumonia and non-pneumonia factors tended to have lower growth rates. All herds tended to grow exponentially or linearly prior to a peak or dieoff, irrespective of their disease status. Our analyses of monthly/annual precipitation and temperature data from areas close to bighorn herds failed to detect differences between non-dieoff or pneumonia dieoff populations. However, we detected a qualitative relationship between pneumonia epizootics and harsh weather conditions, where summer/fall outbreaks tended to occur in years of lower than average precipitation and higher than average temperatures. Herds which experienced a pneumonia dieoff were located significantly closer to domestic sheep allotments than either non-dieoff or non-pneumonia dieoff herds. This information, combined with the finding that herds grow rapidly immediately prior dieoff, implies that herds are likely more vulnerable to pneumonia due to an increased probability of contact with domestic sheep. Accordingly, we reject the hypothesis that density-dependent effects of food limitation on disease immunity and stress cause a pneumonia dieoff. Our results suggest that appropriate management options for the control or mitigation of pneumonia dieoffs in bighorn sheep may include the need to keep populations at low numbers via increased ewe and ram harvest rates and, where applicable, termination of predator control programs.

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**OPEN DISCUSSION - ARE WE EFFECTIVELY REDUCING INTERACTION BETWEEN DOMESTIC AND WILD SHEEP?**

**MODERATOR: KEVIN HURLEY, WYOMING GAME AND FISH DEPARTMENT**

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**KEVIN HURLEY:** I'm uncomfortable trying to moderate a discussion on disease sitting in front of people that know far more about this topic than I. I won't attempt to interject anything but will start this discussion.

As a starting point, we've asked a question. Are we effectively reducing the interaction between wild and domestic sheep? There are a number of efforts underway. The BLM has established a set of guidelines. The Forest Service is developing a white paper or strategy which, according to Tim Schommer, is about to be signed off at the upper echelons in the Forest Service.

Keeping in mind our management focus for this conference, we wanted to pose that question and hear people's experiences and opinions. Are we effectively reducing that interaction?

**VIC COGGINS, OREGON:** In Oregon, we have really changed the picture on potential problems with domestics, because most of the domestic sheep bands are now gone from Hell's Canyon. A lot of the problems were just economics. When we first started with wild sheep transplants in the 1970's, we were making a lot of mistakes. We were putting bighorns in on domestic allotments and we didn't have much success with them. The allotments are virtually gone due to buy-outs and court cases and such. I'd say we're a whole lot better off than we were. We have the brochure out that FNAWS has sponsored. Not that we couldn't have a problem because you always have to be vigilant, but we're much safer now as far as domestic sheep.

**JON JORGENSEN, ALBERTA:** We don't have a big problem with domestic sheep in Alberta. It's not a big industry in our province. But recently we have run up against a situation where domestic sheep are being used for range enhancement and range improvement in certain circumstances, and are also being used for weed and brush control in reforestation efforts. We've had to deal with these issues because we've had proposals for using domestic sheep in these types of situations where they're getting pretty close to our bighorn ranges.

What we've done is work with the Public Lands and Agriculture group, to develop a set of guidelines similar to what you folks have done here in the states, and we've had pretty good "buy-in," although it hasn't been signed off yet. We've had the "buy-in" and the agreement with the local folks, but it's kind of stalled right now and we're hoping that it will get signed off on.

It essentially identifies a "no domestic sheep buffer zone" between our easternmost extent of bighorn ranges. Outside of that, there's another area that has been identified where domestic sheep could be used in certain situations under a prescribed set of protocol to try and reduce the potential interactions that might occur.

**HURLEY:** Jon, in the "no domestic sheep buffer zone," what miles or kilometers are you using?

**JORGENSEN:** We're trying for about nine miles. We ended up settling for something in the five to seven mile range. Not quite as much as we would have liked, but that's what we've ended up settling on.

**HURLEY:** Helen, I know you're really involved in British Columbia with using domestic sheep on these reforested areas to allow conifers to come back. What luck have you had, or how is the "buy-in" there in BC?

**HELEN SCHWANTJE, BRITISH COLUMBIA:** Basically the biologists doing the Environmental Assessment reviews of the proposals from the forestry companies or Forest Service have been given a guideline of something in the neighborhood of ten kilometers, or some barrier dividing wild sheep and goat populations from the domestic sheep used for vegetation management. Generally speaking, most places where vegetation management using domestic sheep is economical are nowhere near a wild sheep and goat range.

There are a few places where there's been a bit of slip up and most of those cases have been where there's traditional use of domestic sheep on private property nearby anyway. Probably one of our biggest problems is what do you do with the small farmers and the people that are using that range, because it belongs to them.

That's where the educational effort comes in. I heard recently about one area in the southern interior where wild sheep seemed to have disappeared and the rumor I've heard is there's a farmer who purposely got domestic sheep to get rid of the wild sheep. I don't know whether that's true or not, but we'll be looking at that this summer.

**HURLEY:** We've been threatened with that a couple of times. You've mentioned the educational effort. I'm curious what other states and provinces have done with that issue on private lands? How are you dealing with that? How are you trying to get that word out to the private landholders?

**CRAIG FOSTER, OREGON:** I guess I'll jump in here and talk about California bighorns. Vic has the Rocky Mountain bighorns and the rest of us have California bighorns. From the educational standpoint, one of the things that all our biologists do not do is put wild sheep any place where we think there may be a conflict with domestics. We have a distance of 10 miles or so.

On the education side, any time I might have a conflict because I've got a farm flock, I go to the landowner, talk about the problem and hand them the FNAWS pamphlet. If they see one of my wild bighorns near their domestic sheep, I want it dead. Shoot the bighorn before it goes home.

**HURLEY:** You're giving them permission?

**FOSTER:** I'm telling them to call me. If they cannot find me, kill it and then call me. It gets a little racy, but we're dealing with small farm flock situations here. We don't have a lot of open range issues. I guess our agency's feeling is we'd rather have one dead bighorn than take the risk of an all-age die-off.

**HERB MEYR, IDAHO:** We're using the brochure that FNAWS came out with also. We're also working on buying out sheep allotments on both Forest Service and BLM lands so we can transplant sheep.

In a lot of cases they're converting to cattle instead of sheep and reducing the AUMs. I personally have held public meetings at the county courthouse to talk about a possible transplant of bighorn sheep in the area and the effect of domestic sheep. A few weeks ago we also had a meeting with the County Commissioners and people from the local press that put the article in the paper, on the concerns about interactions.

A buffered zone of ten miles might be good in some areas, but not if it's contiguous habitat like a long mountain range; if it's not adequate and the sheep can move all the way down, you need natural barriers. Last

year at the conference in Whitefish, somebody had a paper on a collared young ram that was going 25 miles out and cruising around. I think they can cover a lot of area if it's contiguous habitat.

With these farm flocks, ranches are getting divided and people are getting ten sheep or whatever in there. On our field tour last year, we were looking at bighorn sheep at the Canadian border. Below the bighorns on the ridge line was a farm flock. There was a lot of talk about fencing for the private land. I don't know if people have done double fencing or something, so there isn't any interaction.

When I drove home, all the way down the Bitterroot Valley and through Idaho, there were farm flocks all the way from Challis down to Salmon. We've lost our bighorn sheep herds in those areas and this winter the bighorns are coming down and interacting with the domestic sheep. We have a problem with that. I think we've learned a lot about allotments and we're not making the mistakes we did 15 or 20 years ago.

**SCHWANTJE:** At one point in time we had 40,000 domestic sheep on our forestry lands "doing vegetation management" and it snow-balled on us. We didn't have a lot of control.

The idea of domestic sheep getting out in the wild, affecting other species as well as wild sheep, was a concern to us. One of our focuses, besides developing these guidelines for wild sheep, was to try to encourage the domestic industry to improve the health of domestic sheep. We worked with the domestic industry and other provinces as well as British Columbia. We have healthier domestic sheep now. I don't know if it raised awareness in domestic sheep ranchers.

**AMY FISHER, NEW MEXICO:** That's a really interesting point, Helen. I wanted to jump to what Herb was saying about the farm flocks. We're seeing an increase of those in New Mexico. I'm thinking perhaps we're missing the bet by going to the owners of these flocks after they get them and their kids are really involved in raising these little guys through 4-H. Maybe we need to go to the organizations like 4-H and slowly and persistently, perhaps, change the emphasis on domestic sheep.

You know, maybe there's a new sexy domestic that we can get these kids to love. Pot belly pigs were big at one time. Llamas might be a concern. There was a little bit of a scare with Johne's disease. Maybe we can put our heads together and identify some domestic that kids can get just excited about that won't cause harm to wild sheep.

**DAVE HACKER, NEW MEXICO:** I'd like to pick up on something that Amy said. If you look at agricultural commodities in general (in the southwest, anyway), the number of livestock on the range is down from what it has been. A lot of these guys are tired of taking a beating in the market right now. Maybe this is a good opportunity to take advantage of it, based on economics.

**HARLEY METZ, COLORADO:** I'm with the Colorado BLM, a 4-H leader and a sheep hunter. A situation we're dealing with right now in Colorado, is that BLM can use our buffer systems and our guidelines to help with this, and we are retiring allotments. We've got a number of livestock operators that we have worked with in our sheep areas to voluntarily retire their sheep privileges. We have worked closely with them to convert to cattle. If the area was suitable for cattle, we've actually even got guidelines to keep the cattle out of the riparian areas as well.

Our land pattern in Colorado puts us in a position where we cannot control what's going on with private land other than through education. What's happening nationwide is all these small farm flocks are coming in. From a 4-H leader standpoint, our problem is cattle. They'll make it to the county and state fairs, but are just too big

for kids to pick up. They're not going to be very competitive. Pigs are another problem. They're just not as sexy. Lambs are relatively competitive. They're cheap, pretty easy to take care of, and pretty docile.

My recommendation would be maybe rabbits or chickens. I don't know how to do it other than look at proper fencing. When we wrote our latest plan with the Colorado Division of Wildlife, we got all of the landowners together and tried to educate them as best we could.

Part of the plan is that the Division of Wildlife said they would immediately respond to any sightings of sheep in those areas. We looked at beefing up the fences where we could also. We did not allow anybody to shoot bighorns on sight, because if that would be the case, I think they'd be buying a lot more sheep and opening the gate.

**HURLEY:** I would like to raise a question. Lee Howard from Utah FNAWS and Jim Karpowitz from Utah Department of Wildlife Resources, are my heroes. These guys have taken the lead on allotment buy-outs and I commend them for their efforts. A lot of places are following suit. Wyoming just completed our first one. Jim, what are you doing on private lands in Utah?

**JIM KARPOWITZ, UTAH:** I want to say something about that because our Utah chapter of FNAWS has been really aggressive in doing a lot to help us reduce the problem with domestic sheep. I was just counting in my head; I think they've done 12 buy-outs of domestic sheep operators or conversions to cattle from sheep, and they've spent hundreds of thousands of dollars.

Lee Howard can tell you how many hundreds of thousands of dollars, but they've raised a lot of money and they've done a lot of good. But we still have a lot of problems with domestic sheep allotments near bighorn sheep populations, and I'm quite frustrated with the inability of the federal agencies, both the Forest Service and the BLM, to be able to do something about that.

There's now a tendency to rely on FNAWS to solve those problems for them. It's not because there aren't good people in the BLM and Forest Service that have tried. There's just not much progress being made within those agencies and it still is the single most limiting factor to expansion of our sheep populations and security for our existing populations.

Without FNAWS and what they have done, we would have real problems in Utah. They've done a lot of good and we appreciate it. They'll do a lot more because they're raising a lot more money. I can also see, in terms of this private land situation, them offering incentives to private people to do something other than raise domestic sheep, and I fully expect them to be involved in that, too. They're also doing some private land purchases to eliminate that.

**HURLEY:** You raise a good question, Jim, and I'll ask Tim Schommer and Melanie Woolever from the Forest Service to respond to that.

**MELANIE WOOLEVER, COLORADO:** The Forest Service talked about it last year at the meeting in Montana, and is putting together the paper you've mentioned. It's going to help our district and forest biologists address this issue. There's been a lot of resistance by the leadership of our agency to address it. The livestock industry has traditional power within our agency and in the Legislatures in the states in the West. They're very effective and it's been one of those things that has been pushed aside unless the situation was critical.

Tim and I have been working on a white paper, a process paper, to help our folks start addressing that issue. It's a collaborative process to bring all the players together and start working on workable solutions. We're not wanting to put the livestock industry out of business. They own base property that we'd rather see in their hands than condos or 5 - 40 acre ranchettes.

We're trying to figure out ways to keep them on the landscape, but keep wild sheep healthy. The paper mentions a lot of things including buffers and topographic barriers. There are all kinds of other things such as time and duration of use, and changing class of livestock. We have lots of vacant allotments because the wool subsidy went away and the sheep industry is struggling. There's opportunity to move wild sheep around.

The problem is we're pretty short-funded on the range and you have to do NEPA analysis. Whenever you restock the allotments, there are some financial challenges. We've been working very closely with the range people in our agency and they have an understanding of the problem, and by and large, are willing to help.

We still have state wool growers associations. Utah has one of them. As a matter of fact, they're the only one that when we send in a draft document for review, they send back a stack of documents this high. "There really isn't a problem, all old literature, we haven't been able to demonstrate that there is a conflict or a problem in the loss of bighorn sheep." Tim and I are planning to go meet with them and see if we can help them understand the problem and help them want to work with us.

But I think you're going to see some aggressive moves. There are some challenges that we're starting to address. I think you'll see some progress and if you don't, you need to let Tim and me know. If you have any places where you need help and you're not getting enough response, let us know and we'll see what we can do to be part of the solution.

The other thing that's happening in the Forest Service is that we're undertaking our second round of forest plans. Those forest plans are supposed to be revised every ten years, and we're on the brink of revising them. In that process, we have guidelines on some kinds of things you might want to insert in the plans on standards and guidelines, such as standard procedures when sheep allotments become vacant, and how to address them if it's an urgent enough situation to move animals.

I think we're taking some pro-active steps. If we're not moving fast enough in areas where you've got trouble, you need to alter things and get them addressed. The people pushing the hardest to get issues addressed are the timber people and the livestock people.

**HURLEY:** My follow-up is directed to Tim, but really to everybody. Call on these two for help. We had some difficulty consummating this first deal in Wyoming, and Tim and Melanie and some other people in the Forest Service really leveraged the local folks to get that off dead center.

**DICK WEAVER, NEW MEXICO:** This will change the subject. A tip from experience. You can save yourself a lot of grief on spreading contagious ecthyma accidentally if you know where you bought your alfalfa. We gave a herd of sheep contagious ecthyma by buying alfalfa from a field that had been pastured by domestic sheep.

**TIM SCHOMMER, OREGON:** I work for the Forest Service in Oregon and Idaho, and I also work at the national level. I look at the incompatibility problem from a historical standpoint. If you look at the 1970's, we, as a group, put reintroduced bighorn sheep in a lot of areas right on top of domestic sheep. In general, the problem was most of us didn't have a clue what we were doing.

In the 1980's, Nike Goodson came out with a paper that she was beat up pretty good on, concerning the incompatibility between the two species. A lot of people challenged her and it proved out through the 1980's that she was right. I spent a tremendous amount of my personal career trying to get the acknowledgment of the disease problem to people all over the West. It's not just this group that needs to be educated. There's still a lot of people that are in denial, mainly the permittees and a lot of the land managers that I have to deal with. That was really elevated in the early 1990's by the DNA fingerprinting that a lot of people in here were involved in. I think we've got most of the people convinced that it's a problem and we need to keep domestic and wild sheep separated. That's been a huge undertaking especially with our land managers.

That's really some tremendous progress. In my opinion, we're starting to understand how to develop or reduce risk of disease transmission in site specific situations on national forests.

The paper we're coming out with is going to help do that. I personally went out to a lot of forests in the West and tried to help them with acknowledgment of the problem, to develop collaborative approaches, and then site specific solutions. That's what we tried to put in this paper.

What it boils down to is each situation is different on the ground. You've got to develop solutions that match that piece of ground, and I spend a lot of my time trying to do that on national forests. I guess, Jim, I'd just like to say if you've got an area that needs some help, we'd be glad to talk to you or anybody else. I feel really good about where we're going and I think in the 21st Century we'll do a lot more effective separation of the two species, get buyouts, and feel good about it.

**HURLEY:** Cal McCluskey from BLM.

**CAL McCLUSKEY, IDAHO:** Let me touch on a couple of items here. Melanie mentioned the Forest Service is going through their planning process again. We've been through this at numerous levels and pretty much covered our agency with land use plans. Many of those have decisions already in them that provide opportunities when allotments are vacated, we will revisit whether or not we will allow that class of animal to be changed in there or even purchased. We've had a number of allotments where we have eliminated domestic livestock raising because of the conflicts with wild sheep.

You need to work with the local field office managers to know where those areas are, making sure they're on your radar screen, and try to take advantage of opportunities that come along.

We're not in the business of putting the livestock industry out of business, so our basic policies are always going to be that we're going to deal with willing sellers and individual ranchers or permittees that want to voluntarily change their class of livestock. We have, in a few instances, cancelled permits or required permits to change class of animals due to conflicts. Those are usually minor situations and they usually involve protracted legal fights that can take years to resolve.

The idea of buying out lands has been mentioned a couple of times. We've worked with just about every nonprofit organization you can think of in doing that. You've heard about a few of the examples this week with the number of the earlier discussions with FNAWS and some of the other organizations.

However, one of the things that we're always under scrutiny about from Congress, particularly the western delegation, is that they don't particularly like to see more land in federal ownership out west. So what we're generally looking for are opportunities that don't really expand federal ownership, but to have that ownership

be in a conservation easement in the hands of either a nonprofit organization or conservation-minded ranchers like Ted Turner.

I want to mention BLM has state level Memorandums of Understanding between the state wildlife agencies in every state in the West. There are certain kinds of mandatory things that we ask our states to ensure in those. We've also recently asked that we revisit every one of those MOUs because a number of them are getting quite dated.

This is a perfect opportunity for those of you with the state wildlife agencies to raise these issues specifically and to develop mechanisms and procedures to work with BLM at the local level. Where there are issues that involve wild sheep, we have those in place. I just wanted to remind people to take advantage of that.

We also have another process going on right now. Due to some litigation that was settled a little over a year ago, we're in the process of going through a review of all of the ten-year grazing permits that come up for renewal.

They now have to be evaluated using an interdisciplinary process and NEPA procedures have to be completed on each of those. We're looking at over 4,500 permits that need to be revisited and reauthorized, or at least looked at for reauthorization over the next two years. I think there are about 22,000 permits on BLM lands. There again, this is another good opportunity to get your input into that process, because part of the objectives of this whole thing is to look at conflicts between wildlife and other resources on public lands and the livestock grazing that's going on. So don't miss that window of opportunity. It will only come along once every ten years.

In addition to the BLM guidelines, however, I wanted to mention a couple of other things. We've had very little controversy with those, particularly from the sheep industry. I think one of the reasons was the manner in which we approached developing them. We invited industry to the table to participate in that process. Some might say that watered them down and it probably did. At the same time, we've had virtually only one or two instances that I'm aware of where we actually had some complaints from state sheep industry organizations. When they found out that their national organization was at the table that basically muted any concerns that they had. So I consider it a success.

The other thing we did though, in addition to just writing the guidelines and issuing them, was to ask the states to do a number of things to implement them. We gave them about nine months to do a number of follow-up actions that we hadn't done the first time we developed guidelines in 1992. Those actions included such things as making sure that every range conservationist that was employed was aware of the guidelines, and that each permittee that grazed domestic sheep in the vicinity of wild sheep, received a copy from the field office. Of course, the state wildlife agencies at the local level received copies.

Recreational specialists within BLM had some concerns related to domestic goats, pack goats, that sort of thing. We also make sure that they received copies of the FNAWS brochure that you all are aware of.

This past year, I got a phone call from a gentleman who grazes sheep at Mile Post 158 in British Columbia. He somehow or another got my name off the Internet. Actually what he was interested in was our guidelines. He had gotten a copy of the FNAWS brochure. He was one of these gentlemen that grazed sheep in a forest area for forest management, and he said that there was a wild sheep herd in the vicinity. He was very concerned and he wanted to learn more about this issue. So I thought we're making progress.

**DUNCAN GILCHRIST, MONTANA:** British Columbia pays the cost of printing those brochures. They had no idea how much it would cost. Brown McMillen donated the paper. The Wild Sheep Society in BC paid for the printing, which I think was \$25,000.

**JIM BAILEY, NEW MEXICO:** I've got a question for the Forest Service people. Maybe Melanie can answer it. When an organization purchases the base property with the intention of retiring an allotment or changing the classification from sheep to cattle or whatever, what is the legal basis for the permanence of that retirement? Do we have a binding contract or do we in fact really have a promise that might go challenged in court someday?

**WOOLEVER:** Just getting wild sheep established would solve all this. It depends on how the allotment was retired or if it's retired. Let's say that you bought the sheep and you bought the base property and have a grazing permit on National Forest Service lands. You get the permit and, let's say, you want to sell the livestock and you don't want the permit. You can take up to three years non-use. If you keep it, you have to keep livestock during the time or you can take three years non-use. After that time, you have to use it or waive it back to the government. In that time, there needs to be some sort of agreement made on the part of the agency on what they'll do with the allotment.

If it's in the forest plan that there's conflict and if it becomes vacant, that solves your problem. That's where we're heading to get those stipulations and guidelines in the forest plan. If it's a forest allotment, it will be analyzed and evaluated for closure. If you're in that situation, it's good. If you're not covered, then you've got to get commitment from the line officers that they'll keep it vacant at least for the time. If it's held vacant, it will move to the bottom of the priorities and somebody will come in and ask for it and they'll say, yeah, when we get to it NEPA workwise, we can do it.

Bonnie Pritchard is our resident legal agent, she'll correct anything I said.

**BONNIE PRITCHARD, CALIFORNIA:** Melanie was pretty accurate. However, when a purchaser of base property comes into the Forest Service, the seller of that property waives the property back to the government. It's at the government's discretion whether to reissue that permit again. It doesn't necessarily go over to them.

What we've done in California with so-called buy-outs is the Forest Service itself doesn't recognize the value placed on a permit. What we've been doing, working with private foundations with dollars, is to make agreements with that permittee who wants to receive those dollars. They then write a letter or waive the permit back to the government by stating that they no longer have a need for it.

Once the government is again in possession of that permit, they can, as Melanie said, put it to the bottom of the list, leaving it in a vacant status. What we did to translocate bighorn sheep in the Inyo Mountains was to write a NEPA document in which the decision is a "no grazing decision" and active pursuit of bighorn sheep habitat.

**HURLEY:** Bonnie obviously implied that FNAWS recognized the value even though the agencies can't say there's value here or the permittee has a right, et cetera.

**PRITCHARD:** Just to respond to Jim's comment. Currently within the grazing administration portion of the U.S. Forest Service, there is no inherent structure that would remove grazing privileges for the reason of bighorn sheep being nearby. What Melanie and Tim are working on is a pretty progressive paper which would

establish a set of guidelines in which actions could be taken within the administrative guidelines of the Forest Service without necessarily having to go to court to win a solution.

Another comment to FNAWS is I think the relationship that we've had with FNAWS is outstanding. I know you don't like to depend on them to solve the problems, but they do solve them and we appreciate that. The fact that willing sellers do have a place to go and the Forest Service can get solutions quicker and we can get domestic sheep out of there faster has resulted in a tremendous amount of progress for us with the bighorn sheep we have in California.

**DAVE BYINGTON, NEVADA:** I thought it might be worth mentioning there are some differences between Forest Service and BLM in terms of regulation and policy.

In the BLM, we've gone through our Interior Board of Land Appeals on property buy-out of a livestock operation in Arizona where The Nature Conservancy has basically bought the privileges. After those privileges were basically retired by agreement or whatever, another individual from the livestock industry came in and applied for them. They were denied and that was brought before the Interior Board of Land Appeals because those grazing privileges were not withdrawn in the land use plan. The guy won his appeal and we had to address his application, not just deny it.

We are closing grazing in 85 percent of the Mojave Desert in Nevada through land use plans and we're doing that with the cooperation of Clark County. In Clark County you have to have a conservation plan. Groups are buying out these ranches, but they're not making final payment to the ranchers until the BLM has officially closed the allotment through writing an amendment to our land use plan. It's permanent closure. It's withdrawn from the grazing regulations at that point and all we need to say to anybody that would come to apply for that grazing is no, it is just closed. There are no recourses. It's basically closed.

**HURLEY:** I guess we covered that one, but it's a hot button issue for a lot of people, on all sides.

**DAVE SMITH, ARIZONA:** Is there any definite impact regarding domestic goats? We see the hobby goat herds showing up in Dolan Springs Field and places close to the Black Mountains. They're on private land. I guess this is out to the veterinarians in the group. Has there been work done that tells us how concerned we should be with domestic goats?

**BILL FOREYT, WASHINGTON:** We did two studies with domestic goats. We thought there might be a problem. We put domestic goats in the same pen with bighorn sheep on two separate occasions and the bighorn sheep made it. We also took bacteria from domestic goats and put them in domestic sheep and nothing happened. We put domestic sheep in with domestic goats and put the goats with bighorn sheep, and nothing happened. These are very limited data. So far we have not seen a problem. A lot of you think domestic goats are a problem, and there might be chromatid evidence in Hells Canyon. There are so many different types of bacteria, but the probability is much less than with domestic sheep.

**HURLEY:** Dave, you were involved with the pack goat industry before you left Idaho for greener pastures.

**DAVE HUNTER, MONTANA:** There was a goat involved in the scenario of the Hells Canyon die-off. Whether goats can carry organisms from domestic sheep and spread them to bighorn sheep is a big issue. Based upon Bill's work and work we've done, I would say, the jury is still out on this. To chastise an industry, especially the pack goat industry, would be a little overkill, particularly at this point in time.

I think we need to keep watching it. In the BLM guidelines, didn't we address pack goats and the pack goat issue in bighorn sheep territory? If the animals are tethered and hobbled overnight and aren't allowed to interact with bighorn sheep, and if interaction is suspected or seen, then the local Fish and Game is notified immediately.

We turn too many people against us without a good information background. If we're trying to stop goats because they're goats, if we're trying to use disease as a criteria, we might be gypping ourselves when it comes to llamas, alpacas, horses, and cattle. We haven't mentioned much about cattle. Cattle carry some major killer diseases and I think the reason we don't see more problems is because they don't go nose to nose with wild sheep.

I think we need to make sure that people understand the potential is there with goats and be responsible for their animals, period. I think we can make that work as far as goats, until we have more information.

**HURLEY:** Are we effectively reducing the interaction between the wild and domestic sheep? Obviously, a lot has been accomplished and a lot more needs to happen.

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## PREDATION

CHAIR: TOM RYDER, WYOMING GAME AND FISH DEPARTMENT

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### ERIC M. ROMINGER - BIOLOGICAL EXTINCTION AND A TEST OF THE "CONSPICUOUS INDIVIDUAL HYPOTHESIS" IN THE SAN ANDRES MOUNTAINS, NEW MEXICO.

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**Abstract:** The desert bighorn sheep (*Ovis canadensis mexicana*) population in the San Andres Mountains (SAM) was once the largest herd of desert bighorn in the Chihuahuan desert ecosystem. This herd has apparently declined from an estimate of >200 individuals in 1978, to a single known ewe. The decline occurred in 2 distinct phases separated by 18 years. The initial decline to <40 bighorn occurred between 1978 and 1980, and was associated with a psoroptic mite (*Psoroptes ovis*) epizootic and a series of capture and treatment operations. Between 1996 and 1997, the herd declined from a minimum known population of 25 to a minimum known population of 1 ewe. During a 15-month period, 90% (9 of 10) of the radiocollared bighorn died and 6 were killed by mountain lions (*Puma concolor*). Associated with this increased lion predation was an extended drought, continued infestation of bighorn by psoroptic mites, and a rapid decrease in the number of mule deer (*Odocoileus hemionus crooki*), the principal prey of mountain lions in the SAM. Despite intensive search effort, no uncollared bighorn sheep have been documented since 1997. Our inability to document any uncollared bighorn suggests that the mortality rate of this portion of the population was at least equivalent to that of radiocollared bighorn. These data are a single, within-population-scale test of the hypothesis that higher mortality occurs on radiocollared ungulates because they are "conspicuous individuals." We also present data that suggest this hypothesis is untrue at a multi-population scale. Additionally, we review high mountain lion predation in other New Mexico desert bighorn sheep herds unaffected by scabies.

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In New Mexico, all native bighorn sheep (*Ovis canadensis*), with the exception of two remnant populations in the San Andres and Big Hatchet Mountains, were extirpated by 1955 (NMDGF 1995). However, the exact causes of extirpation in >20 other herds known to occur were never documented. These extirpations were largely attributed to factors that are thought to have caused declines of bighorn sheep throughout western North America including disease, market hunting, and competition with large numbers of domestic livestock (Buechner 1960).

Desert bighorn (*O. c. mexicana*) in New Mexico were state-listed as an endangered species in 1980

(NMDGF 1995). The statewide population estimate, excluding the SAM, has increased from <15 in 1979 (Watts 1979) to 220 in 1998 (Rominger 1999). The desert bighorn sheep herd in the SAM was, until 1978, the largest herd in New Mexico and the largest in the Chihuahuan desert ecosystem (Sandoval 1979). The highest number of bighorn observed in the SAM was 119 in 1976 (Sandoval 1979) and the largest population estimates, although conjecture, were 200-400 (Buechner 1960).

The SAM population declined from an estimated 200 bighorn to <40 subsequent to a virulent

scabies epizootic in 1978 (Sandoval 1980) and a series of treatment operations from 1979-1983 (Lange et al. 1980, Sandoval 1981, Wright et al. 1981, Kinzer et al. 1983). Hoban (1990) reviewed the initial phase of this decline. Although the population remained relatively stable for 15 years following the decline, a sudden increase in adult mortality beginning in the winter of 1996 apparently has resulted in the biological extinction of this herd.

Predator/prey theory suggests that large populations of ungulates are relatively unaffected by predation, even in ecosystems with a full complement of predators (Mech 1970). However, small or isolated populations of ungulates can be vulnerable to predation resulting in population decline or extinction (Murie 1944, Bergerud 1971, Mech and Karns 1977, Seip 1992, Wehausen 1996, Hurd and Bunnell 1999, Harrington et al. 1999). This phenomenon is more common where predators are able to switch to alternate ungulate species as numbers of the more rare species decline (Seip 1992, Hurd and Bunnell 1999, Harrington et al. 1999). This has been documented in numerous predator/prey systems including the caribou (*Rangifer tarandus*)-moose (*Alces alces*)-wolf (*Canis lupus*) system in British Columbia (Seip 1992), the moose-elk (*Cervus elaphus*)-wolf system in Alberta (Hurd and Bunnell 1999), the roan antelope (*Hippotragus equinus*)-zebra (*Equus zebra*)/wildebeest (*Connochaetes taurinus*)-lion (*Panthera leo*) system in South Africa (Harrington et al. 1999) and the bighorn sheep-mule deer-mountain lion system in California (Wehausen pers. commun.). Recent research suggests that individual mountain lions may have impacts on bighorn populations that are independent of mountain lion population density (Hoban 1990, Chow 1991, Logan et al. 1996, Ross et al. 1997).

Small populations of bighorn sheep have higher probabilities of extinction due to greater influences of inbreeding and stochastic events including predation, disease, weather, and variable nutrition (Berger 1990, Wehausen 1999, Berger 1999). These data, for the SAM desert bighorn sheep population, document a rare instance where cause

of mortality was determined for ~40% of the population during the extinction phase.

It is hypothesized that radiocollared bighorn sheep are subject to higher rates of mortality, particularly predation, because they are "conspicuous individuals" (*sensu* Curio 1976:117) and therefore more visible. Without intensive monitoring of all predators, to determine the presence or absence of radiocollars on all animals that are preyed upon, or comparison of mortality rates on animals with inconspicuous radio-devices to those on radiocollared animals (*sensu* Garrott et al. 1985) this is nearly an untestable hypothesis. However, the extinction, or in this case the apparent biological extinction, of a bighorn population with a proportion of radiocollared animals enables a comparison of mortality rates between radiocollared and uncollared animals. The apparent biological extinction in the SAM is a single population-scale test of the "conspicuous individual" hypothesis. In addition, population trend data from annual helicopter surveys in desert bighorn herds where a high percentage of the population was radiocollared are compared to trends in populations with few or no radiocollars as a multi-population-scale test of this hypothesis.

The objectives of this manuscript are to (1) document the extinction phase of the SAM desert bighorn population and (2) compare mortality rates of bighorn sheep with radiocollars to apparent mortality rates of bighorn without radiocollars within the SAM population and population trends of desert bighorn herds with different percentages of radiocollared individuals in New Mexico.

**Study Area:** The SAM, in southcentral New Mexico, are 130 km in length and the largest contiguous bighorn sheep habitat in New Mexico. Elevations range from 1,280 m at the base of the mountains in the Jornada del Muerto to 2,733 m at Salinas Peak. The SAM lie entirely within White Sands Missile Range (WSMR) which is managed by the U.S. Army. Within the SAM is the 232 km<sup>2</sup> San Andres National Wildlife Refuge (SANWR) managed by the U.S. Fish and Wildlife Service

(USFWS). Plant communities are dominated by grass-shrublands at lower elevations and pinyon pine (*Pinus edulis*) and juniper (*Juniperus monosperma*) at higher elevations (USFWS 1998).

Population trends for desert bighorn sheep herds in the Peloncillo and Hatchet mountains in southwest New Mexico, the Ladron Mountains 70 km southwest of Albuquerque, and Fra Cristobal Mountains in central New Mexico are also reported during 1996-1997.

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**Methods:** In 1993, 11 bighorn sheep (3 males and 8 females) were captured and radiocollared (Telonics, Mesa, AZ) using a helicopter and net-gun. In April 1997, the only 2 known bighorn in the SAM were recaptured using a helicopter and net-gun and fitted with new radiocollars to maintain telemetric contact.

For 1995-1997, population estimates for SAM bighorn sheep were derived from annual helicopter and ground surveys. In 1996, 3 helicopters were used simultaneously to survey the entire mountain range from San Agustin Pass north to Capitol Peak. Helicopter surveys were initially flown without the use of telemetry and then re-flown using telemetry to attempt to obtain a visual observation of radiocollared bighorn and any associated bighorn. Observation rates of bighorn sheep are based on the number of bighorn observed/hr of search time without telemetry. Numbers of mule deer were recorded during bighorn surveys and are reported as deer/hr as an

index of deer numbers seen in bighorn sheep habitat.

Remote census 8 mm video cameras were placed at 3 water sources most likely to be visited by bighorn sheep during summer (Upper Ash Spring, Five Rams Spring, and an unnamed spring on Bennett Mountain). Since the apparent decline of the SAM population to 1 ewe, visual monitoring of this radiocollared ewe was conducted in an attempt to document the presence of a lamb or associated bighorn sheep.

Monitoring of radiocollared desert bighorn sheep in the SAM was conducted at least weekly and mortalities were investigated between 2 and 4 weeks after death. In the other mountain ranges, radiocollars were monitored in monthly fixed wing flights, annual helicopter surveys, and at least weekly in the Peloncillo Mountains. A combination of methods or observations were used to determine lion kills and included: lion tracks scrapes and/or scat at the cache site, multiple cache sites, sticks and rocks covering the carcass, drag marks, canine punctures on the radiocollar, neck/throat or head, the size of lion dental arcades, uneaten rumen, rumen removed from the carcass, blood patterns indicative of arterial pressure at time of death, cracked brain cases in ewes, and the rostrum eaten >10 cm. We recognize that the possibility of a lion scavenging on a dead bighorn would have resulted in some of the above listed variables.

The mortality rate documented for radiocollared bighorn was compared with the assumed mortality in the uncollared portion of the population as a single within-population test of the hypothesis that radiocollared bighorn are subjected to higher rates of mortality than are uncollared bighorn. A multi-population-scale test of this hypothesis was conducted by monitoring population trends in other bighorn populations with different proportions of radiocollared bighorn sheep. These include bighorn in the Ladron and Fra Cristobal mountains, where 100% of transplanted bighorn were radio-collared (n=60) or collared with

neckbands (n=8), and the Peloncillo (n=2) and Hatchet mountains (n=0) where <5% and 0% of bighorn, respectively, were radiocollared during 1996-1997.

**Results - San Andres Herd:** Desert bighorn sheep numbers in the SAM were at historic highs between 1960 and 1978, prior to declining to fewer than 40 individuals as a result of the psoroptic scabies epizootic and subsequent salvage operation (Fig. 1). From 1980-1995, the causes of mortalities of 52 radiocollared bighorn were determined (Fig. 2), and although mountain lion predation was the principal mortality factor the bighorn population remained relatively stable.

During the second phase of this apparent biological extinction (1996-1997), an increase in mountain lion predation resulted in at least 6 of 9 radiocollared bighorn sheep mortalities in a 15 month period (Fig 3). The remaining radiocollared ewe is the only bighorn sheep known in the SAM since August 1997. Four bighorn sheep kills occurred within the potential home-range of 1 mountain lion and the other 2 kills were within the potential home-range of a second mountain lion. However, because of the relatively high degree of home range overlap by mountain lions in the San Andres Mountains (Logan et al. 1996) more than 2 lions may have killed these bighorn sheep.

As of April 1999, the 3 remote video cameras had not recorded any bighorn sheep, nor has the ewe been observed with other bighorn or a lamb through 3 lambing seasons (1997-1999). Observation rates of bighorn sheep during helicopter censuses have declined from 70.1/hr (Sandoval 1979) prior to the scabies epizootic, to <0.2/hr in 1997.

Other factors that may have influenced the rapid extinction of this herd include 3 years (1994-1996) with below average precipitation (Fig. 4). In addition, there is evidence that the mule deer population also decreased substantially during this period of drought. The observation rate of deer during bighorn helicopter surveys declined from 17.0/hr in 1995 to 2.7/hr in 1997 (Fig. 5). In the

1982 (15.6 hrs count time) and 1996 (15.0 hrs count time) the entire SAM was censused for desert bighorn by helicopter. Deer observation rates were 8.7/hr in 1982 and 3.2 /hr in 1996 (NMDGF, files). Other recent contributors to the overall population decline of desert bighorn have been a small, senescent population, the ongoing effects of the scabies epizootic, and poor reproduction. There was no known recruitment into the SAM bighorn population from 1995-1999. Radiocollared bighorn comprised approximately 42% (11/25) of the estimated population in 1995.

During the 15-month period of rapid decline between 1996-1997, 90% of the radiocollared bighorn sheep died. Because no uncollared bighorn sheep have been observed in more than 3 years using multiple means of detection, i.e., helicopter surveys, remote video cameras, and observation of the extant ewe, it is assumed that 100% mortality has occurred on the uncollared portion of the population. Mean age of the last 9 bighorn sheep that died was 9.9 years (SD=2.7) and the mean age of lion killed bighorn was 8.8 years (SD=2.0).

**Mortality in other herds:** All bighorn sheep transplanted to the Fra Cristobal Mountains (n=37) were radiocollared and 23 of 31 (74%) bighorn transplanted to the Ladron Mountains were radiocollared, with the other 8 fitted with neckbands (Fig. 6). Between 1996 and 1997 the number of adults decreased slightly in both populations (Fig. 6). In the Peloncillo Mountains population, with 2 radiocollared bighorn, and the Hatchet Mountains population with no radiocollared bighorn (Fig. 6), the estimated number of adults also declined slightly.

All New Mexico populations with radiocollared desert bighorn have been affected by mountain lion predation. Between 1992 and 1997, 106 radiocollared bighorn sheep were transplanted from the Red Rock breeding facility into 4 populations. As of June 1999, the fates of 101 of these 106 bighorn sheep were known. Of 49 known mortalities, 36 (74%) have been due to mountain lion predation (Fig. 7). In addition, 3 of

8 mortalities in the 'unknown cause of death' category are suspected to be mountain lion predation because of the location of radiocollars within areas of high lion predation, or reanalysis of mortality reports. Lion predation accounts for 88% of the known-cause mortality of these transplanted desert bighorn sheep. Eight of 12 ewes transplanted in November 1997, in an attempt to extend range use into unoccupied habitat in the southern Peloncillo Mountains, were killed by mountain lions in <18 months, despite successful efforts to take the offending lion at the carcass of 3 of these ewes. In addition, no lambs born to these transplanted ewes in 1998 were recruited and at least 1 was killed by a mountain lion. Mean age of the 36 bighorn sheep killed by lions has been 6.0 years (2.6 SD).

**Discussion:** Evidence from video footage, helicopter surveys, visual observation of the sole remaining ewe, including no observation of a lamb, combined with the mathematical prediction based on the 90% mortality rate on radiocollared bighorn suggest that our conclusion of a biological extinction is probable. It is assumed that the remaining ewe continues to ovulate and therefore if a ram or rams were present in the SAM it is likely that they would have encountered her. However, we cannot be sure that there are no other bighorn because of the vastness of this habitat and the difficulty in surveying all areas.

This apparent biological extinction of the SAM population is a partial test of the hypothesis that collared animals suffer higher mortality rates particularly due to predation because they are "conspicuous individuals." Although the cause of mortality is unknown for any uncollared bighorn sheep in the SAM, it appears that an equal or greater rate of mortality has occurred than on the radiocollared portion of the SAM population. Survival rates of mule deer fawns with radiocollars did not differ from those with smaller eartag radio devices (Garrott et al. 1985) nor did adult mortality of mountain goats (*Oreamnos americanus*) differ due to radiocollaring (Cote et al. 1998). Population trends in other desert bighorn sheep herds in New Mexico with high and

low percentages of radiocollared individuals are virtually identical, with mountain lion predation being the principal cause of adult mortality on radiocollared bighorn sheep. Neither the within-population test nor the multi-population test supports the hypothesis that mountain lions select for "conspicuous individuals"; i.e., radiocollared bighorn sheep.

During the period 1985-95 a mountain lion study on the SAM documented a mean annual mortality rate of 5% on adult radiocollared bighorn sheep (Logan et al. 1996). This moderate rate of adult mortality was not determined to be a factor limiting population growth. No correlation between mountain lion density and kill rates on desert bighorn sheep was found (Logan et al. 1996). However, the Logan et al. (1996) study was completed just as the final phase of this biological extinction event began and the conclusions presumably would have been different if the study had continued throughout the extinction phase of the bighorn sheep decline. The removal of a mountain lion that had killed 3 radiocollared bighorn in 11.5 weeks in 1989 (Hoban 1990) may have biased the measure of lion predation on desert bighorn in the SAM (Logan et al. 1996). The removal of a mountain lion in 1981 after it killed 5 radiocollared bighorn sheep is evidence that the predicted extinction may have been delayed by the selective removal of individual mountain lions that developed a predilection for killing bighorn (Hoban 1990). These data and the work of others (Chow 1991, Ross et al. 1997) suggest that individual behavior of predators can influence population dynamics of prey and are independent of predator density.

The potential for misidentifying a mountain lion kill for a scavenging event existed in both the SAM and other mountain ranges. However, at the 9% rate of scavenging documented by Logan et al. (1996) it is unlikely that even 1 of the 6 mountain kills was a scavenged animal. Additionally, all 6 bighorn determined to have been killed by mountain lions had multiple indicators of having been preyed upon by mountain lions rather than scavenged. Because no other New Mexico desert

bighorn herds have mortalities associated with scabies, a lower probability of scavenging is predicted. The rate is likely to be more similar to the 2.4% observed on mule deer in the SAM (Logan et al. 1996) and therefore it is unlikely that even 1 bighorn outside the SAM was scavenged. A complex of ecological factors have combined to result in this apparent biological extinction and mountain lion predation is perhaps only the proximate cause of the final phase of extinction. The ultimate cause may be related to changes in the landscape induced by succession of overstory canopy cover (Stelfox 1976, Etchberger et al. 1989, Etchberger et al. 1990, Archer 1994), particularly pinyon-juniper trees and shrubs, which make bighorn sheep more vulnerable to predation by ambush predators due to decreased visibility (Risenhoover and Bailey 1985, Wakelyn 1987). For more than 50 years prior to the establishment of WSMR in 1952, the SAM were heavily grazed, resulting in the reduction of the fine fuels required to carry fire. During the latter half of this century, the SAM were managed with a strong fire suppression regime. The USFWS began a prescribed burning program in 1999 to restore desert bighorn sheep habitat on the SANWR. Psoroptic mites may have affected the vulnerability of bighorn sheep due to induced deafness (Norrix et al. 1995) and other decreases in fitness of individual bighorn sheep. Additionally, the drought that may have affected population levels of both bighorn sheep and mule deer, may have influenced the necessity for greater hunting effort by mountain lions resulting in more chance encounters with bighorn sheep which occur at low density due to the small population size.

#### LITERATURE CITED

- Archer, S. 1994. Woody plant encroachment into southwestern grasslands and savannas: rates, patterns and proximate causes. Pages 13-68 in M. Vavra, W.A. Laycock, and R.D. Pieper, editors. Ecological implications of livestock herbivory in the west. Society for Range Management, Denver, CO.
- Berger, J. 1990. Persistence of different sized populations: an empirical assessment of rapid extinctions in bighorn sheep. *Conservation Biology* 4:91-98.
- \_\_\_\_\_. 1999. Intervention and persistence in small population of bighorn sheep. *Conservation Biology* 13:432-435.
- Bergerud, A.T. 1971. The population dynamics of Newfoundland caribou. *Wildlife Monographs* No. 25. 55 pp.
- Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present, and future. *Wildlife Monographs*. No. 4. 174 pp.
- Chow, L.S. 1991. Population dynamics and movement patterns of bighorn sheep reintroduced to the Sierra Nevada, California. M.S. Thesis. University of California, Berkeley, CA. 158 pp.
- Cote, S.D., M. Festa-Bianchet, and F. Fournier. 1998. Life-history effects of chemical immobilization and radiocollars on mountain goats. *Journal of Wildlife Management* 62:745-752.
- Curio, E. 1976. The ethology of predation. *Zoophysiology and ecology* 7. Springer-Verlag, Berlin, Germany. New York, NY. 250 pp.
- Etchberger, R.C., P.R. Krausman, and R. Mazaika. 1989. Mountain sheep habitat characteristics in the Pusch Ridge Wilderness, Arizona. *Journal of Wildlife Management* 53(4):902-907.
- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. 1990. Effects of fire on desert bighorn sheep habitat. Pages 53-57 in P.R. Krausman and N.S. Smith, eds. *Managing wildlife in the southwest*. Arizona Chapter, The Wildlife Society, Phoenix, AZ.
- Garrott, R.A., R.M. Bartmann, and Gary C. White. 1985. Comparison of radio-transmitter packages relative to deer fawn mortality. *Journal of Wildlife Management* 49:758-759.

- Harrington, R., N. Owen-Smith, P.C. Viljoen, H.C. Biggs, D.R. Mason, and P. Funston. 1999. Establishing the causes of the roan antelope decline in the Kruger National Park, South Africa. *Biological Conservation* 90:69-78.
- Hoban, P.A. 1990. A review of desert bighorn sheep in the San Andres Mountains, New Mexico. *Desert Bighorn Council Transactions* 34:14-22.
- Hurd, T.E., and F.L. Bunnell. 1999. Factors limiting moose numbers and their interaction with elk and wolves in the Central Rocky Mountains, Canada. Presented at the Symposium on Ecology and Management of Ungulates. Nelson, BC.
- Kinzer, H.G., W.P. Meleney, R.E. Lange, and W.I. Houghton. 1983. *Psoroptes ovis* research with bighorn sheep in New Mexico. *Desert Bighorn Council Transactions* 27:6-8.
- Lange, R.E., A.V. Sandoval, and W.P. Meleney. 1980. Psoroptic scabies in bighorn sheep (*Ovis canadensis mexicana*) in New Mexico. *Journal of Wildlife Diseases* 16:77-82.
- Logan, K.A., L.L. Sweanor, T.K. Ruth, and M.G. Hornocker. 1996. Cougars of the San Andres Mountains, New Mexico. Final Report, Project W-128-R. New Mexico Department of Game and Fish, Santa Fe, NM. 280 pp.
- Mech, L.D. 1970. The wolf: the ecology and behavior of an endangered species. Doubleday and Co., NY. 384 pp.
- \_\_\_\_\_, and P.D. Karns. 1977. Role of the wolf in a deer decline in the Superior National Forest. USDA Forest Service Research Paper NC-148. 23 pp.
- Murie, A. 1944. The wolves of Mount McKinley. U.S. National Park Service, Fauna Series No. 5. 238 pp.
- New Mexico Department of Game and Fish. 1995. New Mexico's long-range plan for desert bighorn sheep management, 1995-2002. Final Report, Federal Aid in Wildlife Restoration Project W-127-R10, Job 1. New Mexico Department of Game and Fish, Santa Fe, NM. 40 pp.
- Norrix, L.W., D.W. DeYoung, P.R. Krausman, R.C. Etchberger, and T.J. Glatke. 1995. Conductive hearing loss in bighorn sheep. *Journal of Wildlife Diseases* 31:223-227.
- Risenhoover, K.L., and J.A. Bailey. 1985. Foraging ecology of mountain sheep: implications for habitat management. *Journal of Wildlife Management* 49:797-804.
- Rominger, E.M. 1999. Status of desert bighorn sheep in New Mexico 1998. North American Wild Sheep Conference. (In press).
- Ross, P.I., M.G. Jalkotzy, and M. Festa-Bianchet. 1997. Cougar predation on bighorn sheep in southwestern Alberta during winter. *Canadian Journal of Zoology* 74:771-775.
- Sandoval, A.V. 1979. Preferred habitat of desert bighorn sheep in the San Andres Mountains, New Mexico. M.S. Thesis, Colorado State University, Ft. Collins, CO. 314 pp.
- Sandoval, A.V. 1980. Management of a psoroptic scabies epizootic in bighorn sheep (*Ovis canadensis mexicana*) in New Mexico. *Desert Bighorn Council Transactions* 24:21-28.
- \_\_\_\_\_. 1981. New Mexico bighorn sheep status report. *Desert Bighorn Council Transactions* 25:66-68.
- Seip, D.R. 1992. Factors limiting woodland caribou populations and their interrelationships with wolves and moose in southeastern British Columbia. *Canadian Journal of Zoology* 70:1494-1503.

Stelfox, J.H. 1976. Range ecology of Rocky Mountain bighorn sheep in Canadian national parks. Canadian Wildlife Services Report Series 39. 49 pp.

U.S. Fish and Wildlife Service. 1998. Comprehensive conservation plan and environmental assessment: San Andres National Wildlife Refuge. 38 pp.

Wakelyn, L.A. 1987. Changing habitat conditions on bighorn sheep ranges in Colorado. *Journal of Wildlife Management* 51:904-912.

Watts, T.J. 1979. Status of the Big Hatchet desert sheep population, New Mexico. *Desert Bighorn Council Transactions* 23:92-94.

Wehausen, J.D. 1996. Effect of mountain lion predation on bighorn in the Sierra Nevada and Granite Mountains of California. *Wildlife Society Bulletin* 24:471-479.

\_\_\_\_\_. 1999. Rapid extinctions of mountain sheep populations revisited. *Conservation Biology* 13:378-384.

Wright, F.C., F.S. Guillot, and W.P. Meleney. 1981. Transmission of psoroptic mites from bighorn sheep (*Ovis canadensis mexicana*) to domestic sheep, cattle, and rabbits. *Journal of Wildlife Diseases* 17:381-385.

Figure 1. Observed and estimated numbers of desert bighorn sheep in the San Andres Mountains, 1941-1999.

### San Andres Mountains Bighorn Numbers Observed vs. Estimated, 1941-1999

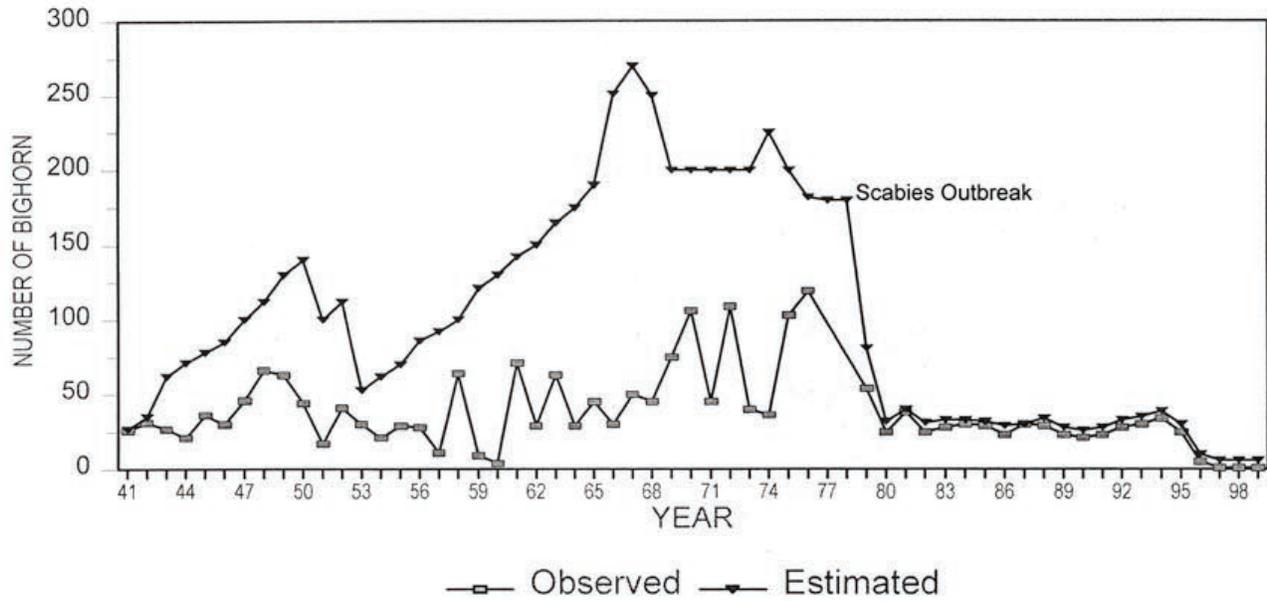


Figure 2. Causes of mortality in radio-collared desert bighorn sheep in the San Andres Mountains, 1980-1995.

## Desert Bighorn Mortalities, 1980-1995 San Andres Mountains, NM (n=53)

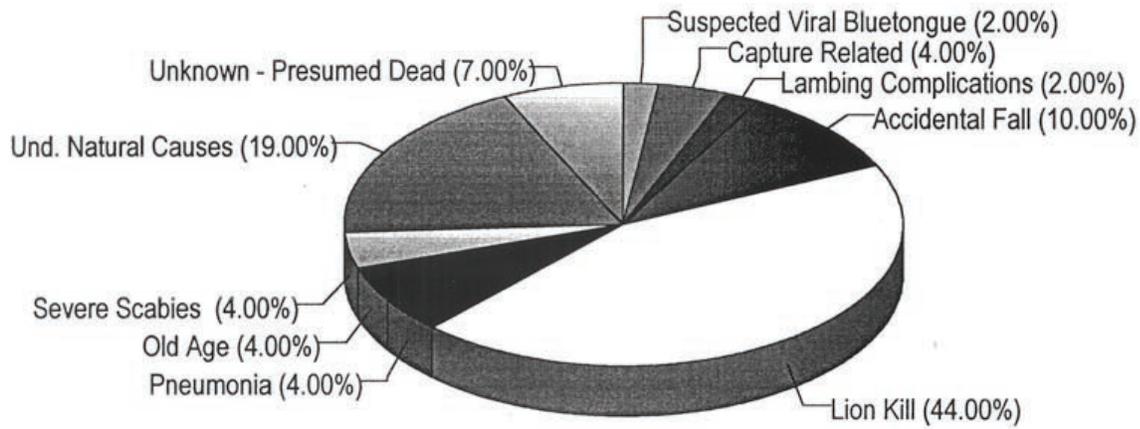


Figure 3. Cause of mortality for last 9 radio-collared mortalities of desert bighorn sheep in the San Andres Mountains 1996-1997.

# Desert Bighorn Mortalities, 1996-1997

San Andres Mountains, New Mexico (n=9)

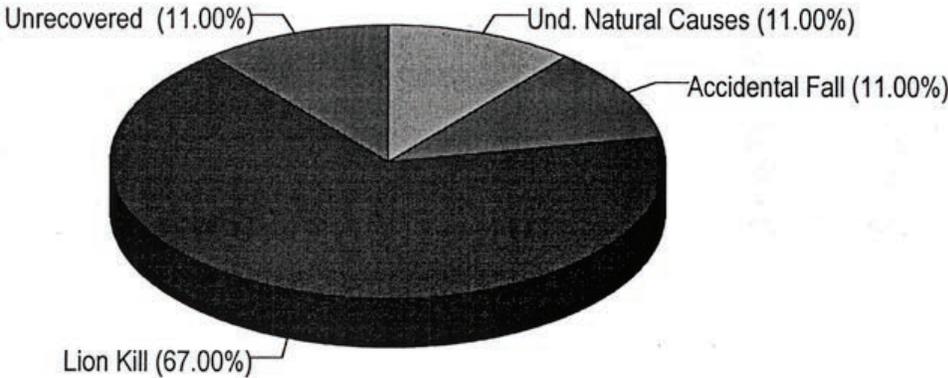


Figure 4. Amount of precipitation recorded in the San Andres Mountains from 1990-1998. Horizontal red line is the long term average.

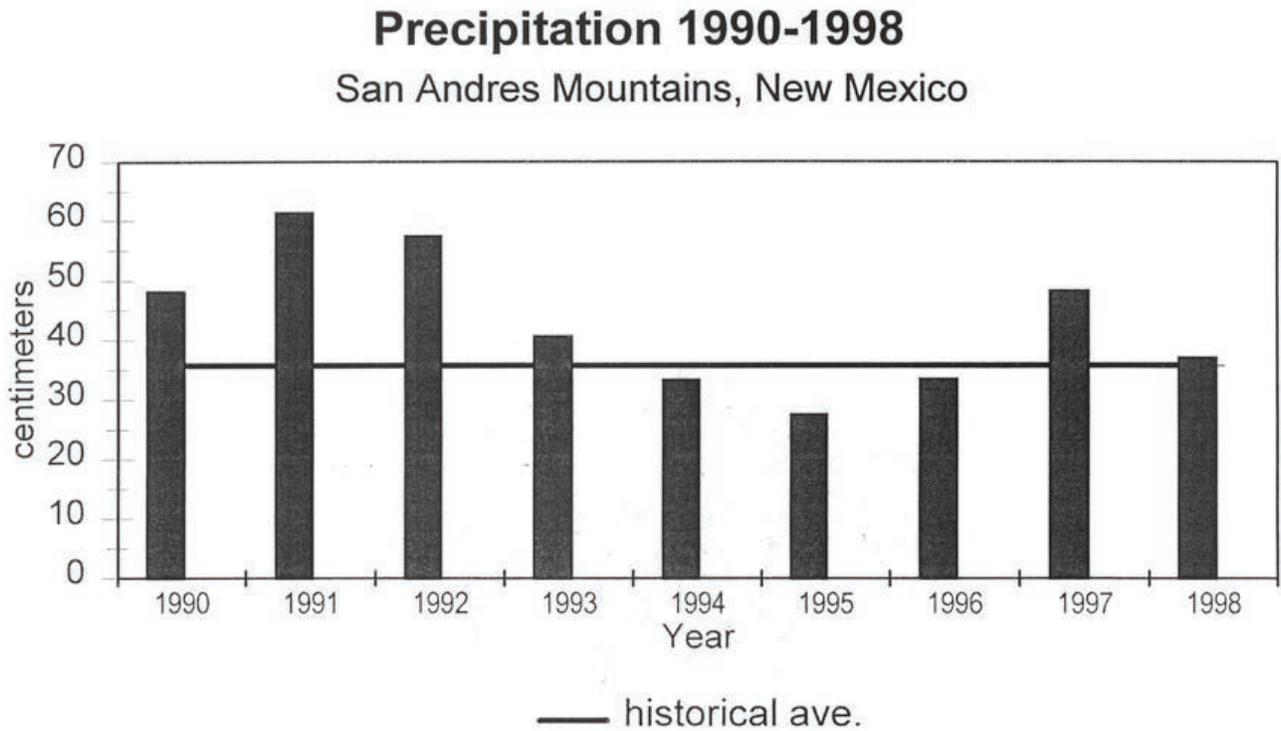


Figure 5. Observation rate of mule deer in the San Andres Mountains seen during bighorn sheep helicopter surveys, 1995-1997.

### Number of Deer Observed Per Hour in Aerial Surveys, San Andres NWR

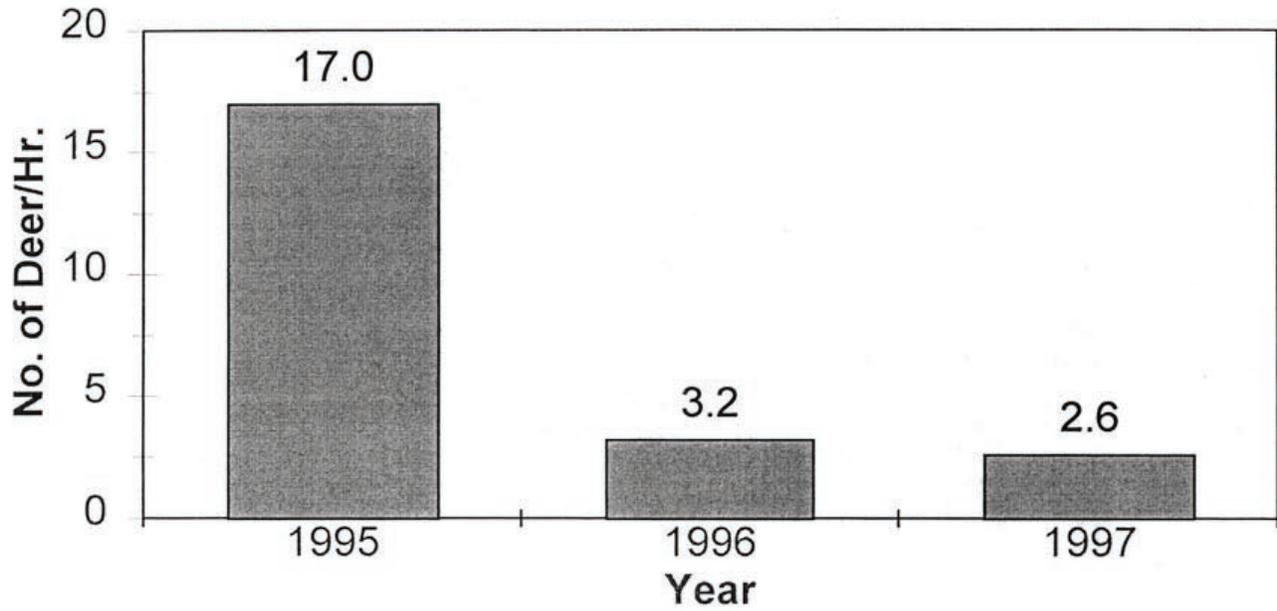


Figure 6. Proportion of radio-collared bighorn sheep and estimated numbers of bighorn sheep in 4 herds in New Mexico. Mountain ranges are described as LA = Ladron, FC = Fra Cristobal, PE = Peloncillo, and HA = Hatchet.

## Radio-collared and estimated numbers of adult bighorn in 4 New Mexico herds

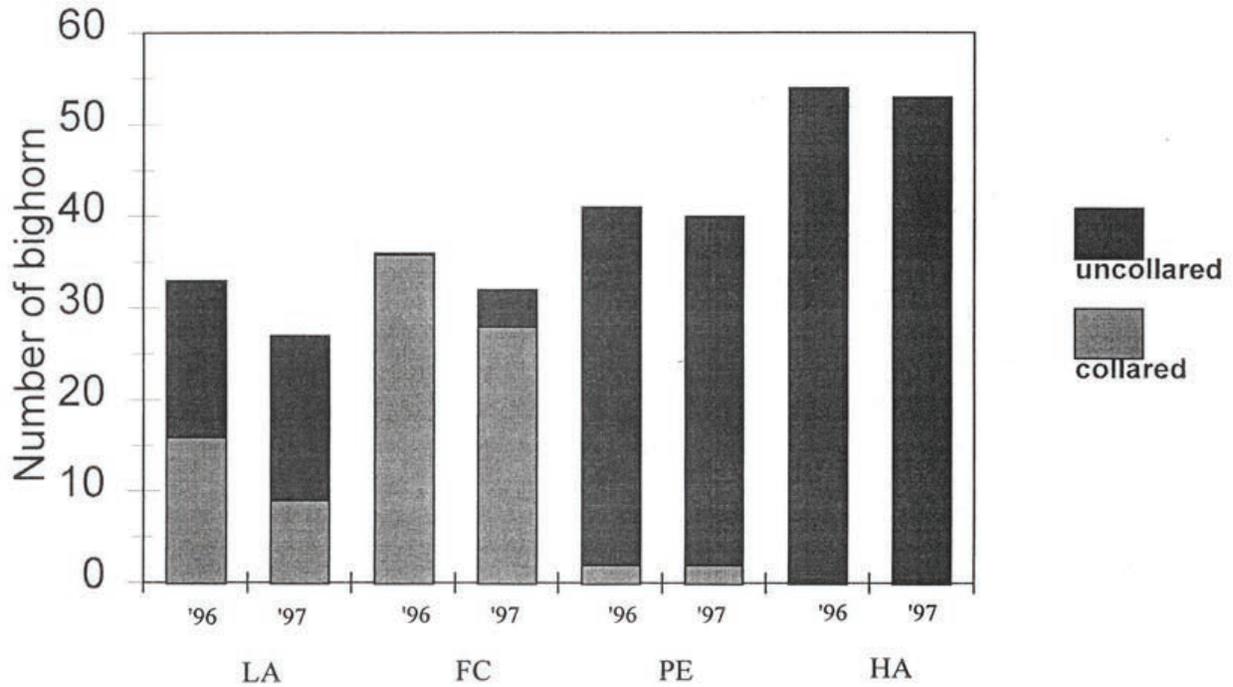
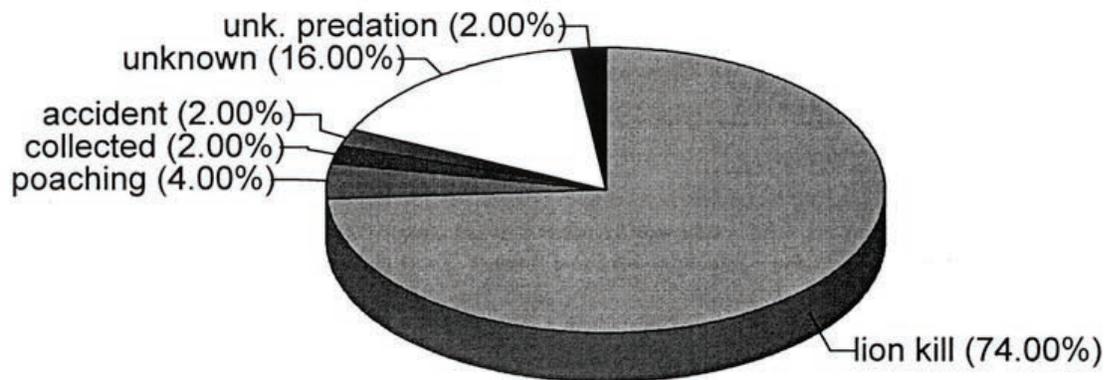


Figure 7. Cause of death for 49 radio-collared desert bighorn sheep transplanted (n=106) from the Red Rock captive breeding facility, 1992-1997.

### Cause of death for 49 radio-collared bighorn transplanted from Red Rock captive breeding facility, 1992-1997



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## QUESTIONS, ANSWERS AND COMMENTS - ERIC ROMINGER PRESENTATION

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**JON HANNA, ARIZONA:** Just to get more of a clarification, you mentioned that mountain lions were the principal cause of the decline or extermination of the sheep herd there. I wanted a little clarification on your reasons or thoughts on decline of the sheep herd. From what you presented, I would say your herd declined from scabies. I did not know if you were interpreting the decline of the herd to be from lion predation?

**ERIC ROMINGER:** No, I don't. The initial phase of decline in that population of 40 was certainly scabies. But when you lose six of nine radio-collared sheep due to mountain lion predation, we would say the eventual biological extinction, or at least 66.6 percent of it, was attributed to lion predation.

**HANNA:** By the time you get to less than 40 sheep, you are pretty much going to lose your population. If you could touch on Kenney Logan's ten-year study from his management recommendations, he felt that removal of lions or management of lions was inconsequential as to any effect on the bighorn sheep population. Do you have any thoughts on that?

**ROMINGER:** We always hope for long-term data sets. In the case of the Logan study, I think 10 years wasn't quite long enough. If it had had been an 11 1/2 year study, I think the conclusions would have been completely different. We removed a lion in 1989. I believe that was the department's decision; that if a lion was preying heavily on bighorn sheep that lion would be removed. If that individual hadn't been removed, you probably would have seen the extinction or a drastic decline while Logan was in the field. That's an unfortunate imposition on the data. We've seen the raw data from Alberta, and some of the Wehausen data suggesting individual lions may be responsible for significant predation on bighorns.

Of the six mortalities, four would have been easily within the home range of one lion. The other two mortalities would have been in the home range of another lion. We weren't able to fingerprint those, but it looks like it could have well been the work of perhaps just two individual lions.

**VERN BLEICH, CALIFORNIA:** We've been involved in reasonably intensive work for about nine years in the eastern Sierra Nevada, and have in fact marked 1,480 deer with telemetry collars and reported 450 lions. The deer had declined from 6,000 down to 950, then recovered to 2,400. Long-term studies truly are important, and like you say, Kenney might have come to a different conclusion had it been an 11 1/2 year study.

One thing that has come out of this, with reference to your statement about tom lions killing rams. I think you said something like 42 percent of the animals go for males and 48 percent go for females. Do you think female lions kill big rams?

**ROMINGER:** We've got a big tom in the Fra Cristobal Mountains that we feel has been responsible for the vast majority of rams killed in this mountain range.

**BLEICH:** One of the things that has come out of our work is the importance of understanding the demography of the predator population as well as the prey population.

We were able to demonstrate that females traveling with kittens select heavily upon younger mule deer,

actually fawns. Neither lone females or males were selective in what they killed. That's just another thought to put in your back pocket if you're looking at long-term work in the future.

**ROMINGER:** We're hoping that with this operation on the Fra Cristobal, we'll have all the lions collared, and get a better picture on deer and bighorn sheep predation.



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## WAYNE HEIMER - WOLF MANAGEMENT IN ALASKA'S INTACT ECOSYSTEMS: AN OBSERVER'S REVIEW, CRITIQUE, AND FUNCTIONAL PRESCRIPTION

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**Abstract:** Once early humans realized their survival was affected by competition with other predators, human mental capacity was applied to the competition. Consequently, technology advanced, man became dominant, and predator populations declined. As human and cultural evolution progressed they resulted in the eventual establishment of varying centralized governments in Alaska. Attitudes toward, technologies employed, and participation in predator management varied greatly with the governmental system. Under Federal Territorial administration, predators were considered pests, and subjected to wholesale extermination attempts by federal pest control agents. At statehood, federal power was limited, and the new State of Alaska raised the public status of predators to allow their management as integral parts of intact ecosystems. Because of their high fecundity, wolves soon recovered from the overuse of federal territorial days. Reduced human benefits from populations that were prey for both wolves and humans soon followed. This prompted the State to propose wolf population control to re-establish human benefits. Owing to development of sociopolitical resistance to wolf management, based on romantic interpretations of wolf biology, this enterprise became difficult. State managers went to extraordinary lengths to assure opponents that wolf management, including population control designed to increase human benefits, would not result in extirpation of wolves. When two modern control programs were finally completed, one was successful in restoring moose populations; the other failed. The fact that wolf control was not invariably and demonstrably linked to increased prey abundance was politically exploited by opponents of wolf management. Withdrawal of federal, Pittman-Robertson, funding from use in wolf population control (a federal decision) also interfered with state wolf management success. In an effort to cope with the sociopolitical environment, the Alaska Department of Fish and Game invested heavily in the planning process and adapting multiple equilibrium theory to mammalian predator/prey systems. This model of predator/prey interaction predicts that prey abundance requires only occasional wolf population control. Increased levels of human benefit have not been consistently sustained as predicted by this model. As a result of these seemingly divergent factors, State-sponsored wolf population control to produce human benefits has ceased in Alaska; and many prey populations are in decline or exist at low levels. Here, I suggest managers simplify their predation model, defining predation as an additive component of overall environmental resistance which must be lowered if prey populations are to increase. If a mathematical model is necessary, Ohm's law of electrical resistance expressed as  $I=V/R$ , should serve practically and with sufficient eloquence as both a conceptual and functional predation model. It empirically assures consistent regulation of predator populations, the most significant management-alterable component of environmental resistance, will result in increased prey population growth.

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I'm not a wolf biologist, and I'm not a predator-prey specialist. This being the case, perhaps I should suggest some reasons why you should take the time to read what I have to say about predator management in Alaska. For one thing, I paid close attention to what was happening with predator management during the turbulent quarter of a century I worked as a wildlife biologist at the Alaska

Department of Fish and Game (ADF&G). For most of this time, I shared an office with my friend, Bob Stephenson, as he was developing a world reputation that eventually landed him on the International Union for the Conservation of Nature wolf team. Because Bob was up to his ears in wolf biology and management during the most recent resurgence (and perhaps the swan song) of man-

aged wolf populations, I had an unusual opportunity for an "inside look" at the interface of biology with politics without being personally involved.

Wildlife management in general has a powerful political component, but wolf management in the last quarter of the 20th century may represent the zenith of political influence on biological wildlife management. Because of the time in which I served with the ADF&G, I had the unique opportunity to be present through periods characterized by open aerial wolf hunting and raising wolf status to the level where advocating wolf management became equated with political suicide. I was present when the last great wolf control programs were argued and begun. My colleague, Mel Buchholtz, pressed me into service to help take the first wolves of the "modern wolf control era." Being otherwise external to the process, I suggest I've maintained a sufficiently objective distance to evaluate the scope of changes in biological and administrative thinking and the introduction of theoretical modeling of predator/prey biology, which has become a discipline unto itself. In short, you might find what I have to say interesting because, I have been an "inside" but uninvolved observer. Borrowing from the late outdoor and firearms writer's autobiography, I can say with Elmer Keith (1979), "*Hell, I Was There!*"

**REVIEW: ANCIENT HISTORY:** I wasn't actually there from the beginning, but archeological and fossil records indicate that as long as man has been identifiable as a species, he has competed with wolves for prey. In the balance of physical adaptations, wolves are clearly better equipped to catch and kill prey than men are. Wolves can run longer and faster than men. Additionally, they are better adapted for killing, and stand cold exposure better than men. In truth, about all men have going for them is intellectual capacity.

We may hypothesize that early man didn't see wolves as competitors until his brain developed to the point of linking cause with effect. Prior to understanding wolves as a predator, it seems a safe assumption that man lived a precarious and wretched existence during the time when his

ability to compete with wolves for food was virtually nonexistent. However, once the brain developed to the point that man realized he was in competition with wolves, and put his mind to developing ways of competing more effectively, the balance changed radically. Development of biological understanding and technology allowed humans to aggressively escalate their competition with predators.

In Alaska these technical breakthroughs produced aboriginal "denning," the practice of killing wolf pups at dens to reduce populations, the evolution of trapping, primarily through snaring and deadfalls, and the clever invention of what we might call mechanical poisons. I judge the most ingenious of these to have been a small piece of whale baleen coiled inside a frozen piece of fat. Once ingested, the fat would be digested, the baleen fragment uncoiled, and the digestive system of the unfortunate wolf who had taken the bait lacerated, thus eliminating that wolf from the competition for prey items.

More effective human competition with wolves and other predators resulted from the interaction of aboriginal Alaskan cultures with immigrants from Russia and Western Europe. Perhaps the most important advance introduced by the more recent immigrants was metal. Early whalers and Russian trappers introduced firearms and steel traps as human adaptations in the competition with wolves. The developing technologies introduced by this wave of Alaskan immigrants eventually improved everyone's ability to get around the country as machines eventually supplanted travel by foot and dog sled. This second wave of immigrants eventually augmented the mechanical poisons developed by the earlier Asian/Siberian immigrants with metabolic poisons, and accelerated the use of firearms in the competition with wolves. Eventually, these technical innovations melded to the point that metabolic poisons were delivered by aircraft which were also used to deploy steel traps and wire snares, and as shooting platforms for killing wolves.

**RECENT HISTORY:** Of course political evolution

accompanied technological development of more effective competitive mechanisms for use against wolves and other predators. Alaska was "claimed" by Russia, and subsequently "sold" to the United States, becoming the Alaska Territory. Gold rushes and other human developments followed and the competition with wolves escalated. The competition between predators and men reached its most extreme expression at the end of Alaska's territorial period. At that time, there was "wholesale war" on predators under the auspices of the U.S. Biological Survey (which eventually became the U.S. Fish and Wildlife Service). Originally, this wolf suppression effort was implemented to protect domestic reindeer herds in Northwestern Alaska, but the practice of "pest control" spread to other parts of the state to increase human benefits from wildlife by limiting wolf predation (Rearden 1999).

In its fledgling days, the State of Alaska continued with wolf control programs for a time, but soon decided to "upgrade" wolves and other predators from the antique federal "pest and varmint" classification, recognizing them as important and integral components of what were envisioned as managed Alaskan ecosystems. Following closely upon the State of Alaska's raising the status of wolves and other predators, emerging wolf-protection advocates began a vigorous crusade to prevent harvest of wolves by humans. The national electronic and print media played major roles in this program. At the outset, victories for wolf-protectionists were relatively easy because there was minimal interest in wolf population control. The effectiveness of federal and early state wolf population control had lowered wolf populations in many areas of the state to the point that wolves were not an effective check on prey population growth. Ungulate prey was abundant.

Where wolf populations were considered "too high" by human users, privately subsidized wolf reduction efforts and public aerial hunting (see Heimer, working hypothesis paper this proceedings) suppressed wolf population recovery somewhat through the 1960s. After this period of non-governmental wolf suppression, aerial wolf shoot-

ing was banned because of public sentiment mobilized against the practice. This pressure was most effective because it came during the tenure of an Alaska Fish and Game Commissioner with a deep personal bias against aerial hunting. Once poisoning was banned and aerial shooting was disallowed, wolf populations rapidly recovered.

*CONTEMPORARY HISTORY:* Since man had effectively withdrawn from the historic competition with wolves because of altruistic ideology, it wasn't long until the competitive advantage shifted back to the better-adapted wolves. When this happened, prey-dependent human populations began to demand re-invigoration of the historic competition of humans with wolves. The proposed mechanism for this competition was allowing public aerial hunting once again. This pressure was basically ignored, coming as it did during the tenure of the above-mentioned Commissioner who was stridently against aerial hunting, especially by private individuals. Still, the clamor for more prey animals for humans continued. The resulting compromise, once a new Commissioner was appointed by a new Governor, was a proposal for the Alaska Department of Fish and Game to do predator control using aerial shooting as the major technique.

This initial proposal was vigorously opposed by wolf-protection interests, and animal rights activists who had joined the battle. Every subsequent wolf population control program has been vigorously opposed by this powerful axis. These interests found sympathetic supporters in national media outlets, primarily network newscasters looking for sensational news items. In one instance where I was present, Jack Perkins, then a field correspondent for the NBC Nightly News, lied to me about the use to which NBC News would put film of a wolf pack running through broken snow we had just taken from a helicopter. During our return to Fairbanks, I reminded Mr. Perkins that ADF&G had cooperated in helping him get the footage, and that we were all near death (because we were in a helicopter). After these grave reminders, I asked, "You aren't going to use this film to screw us, are you?" That's when Mr. Perkins lied.

He said, "No! We only report the news, we don't slant it!" However, in the end, Mr. Perkins filed a story in which the film footage we had taken was heavily edited to simulate an aerial wolf hunt which had not taken place. The NBC News editing included eliminating the helicopter rotor noise, dubbing in fixed wing airplane engine sounds, dubbing in a shotgun blast, and "freezing the frame" when the wolf being photographed stumbled in the broken snow. "*Hell, I Was There!*" (ibid).

Sensational "news" reports such as this on the national media generated tremendous revenue for those opposed to wolf management by population reduction. They also served to sensitize viewers and generate intense negative public reaction toward the State of Alaska from throughout the nation and world for such allegedly barbarous acts. The funds raised as a result of this outrage allowed wolf protection and animal rights interests to pursue their agenda in court.

Following this "raising of consciousness" by the national news media, the typical course of resistance to predator population management involved legal filings by those opposed to the process. In these early cases, opponents of wolf control would obtain a court injunction against the program pending hearings or trial. The universal result, once hearings and trials were held, arguments heard, and any administrative procedural mistakes rectified, was lifting of the restraining order and implementation of the program. In this environment, wolf population reduction was extremely difficult to implement. The early history of this era has been documented in detail by Harbo and Dean (1983).

In spite of these constraints, two major wolf reduction programs were undertaken. One, in the Tanana Flats south of Fairbanks, was highly successful in restoring moose and caribou abundance, and halting a Dall sheep population decline (Gasaway et al. 1983, Heimer and Stephenson 1982). The other, in the Nelchina Basin had little positive effect on the moose population there. Later work would show grizzly bears were heavily

involved in the moose population declines in the Nelchina Basin. Hence wolf removal didn't reverse the downward trend in moose numbers (Ballard et al. 1991). Three major changes in Alaskan wolf management history resulted from the legal strife associated with these modern wolf control programs.

*The first long-term effect* resulted from legal wrangling over the Nelchina Basin wolf control program. As a result of public pressure from outside of Alaska, the U.S. Fish and Wildlife Service arbitrarily precluded use of federal aid to wildlife restoration funding (Pittman-Robertson dollars) in wolf control programs by righteously, and simplistically stating words to the effect that 'We don't restore wildlife by killing it.' Withdrawal of federal funding did not directly impact the Nelchina Basin program because it was carried out using State of Alaska general funds while the federal aid dollars were diverted to other programs and projects deemed socially "acceptable" by federal aid administrators. In retrospect, the federal aid administrators appear highly inconsistent when they allow use of federal aid money for other habitat improvements for wildlife (which lower environmental resistance through the deaths of millions of plants and tiny animals in controlled or natural wildfire) but preclude the deaths of a few charismatic predators. The legality of this capricious choice by the U.S. Fish and Wildlife Service has never been questioned.

The importance of withdrawing P-R funding for wolf population management was that it meant only State of Alaska general funds could be used for wolf population control. This didn't seem particularly significant at the time, but would become a major factor eliminating man from competition with wolves for prey in the longer-term future. Unlike private aerial hunting or private wolf control programs, court-approved, state-sponsored predator population reduction requires large amounts of public money. When that money is limited to state funds, Alaska's Governor can effectively block any or all wolf control in the state by refusing to budget funds for it. As a result, it is no longer necessary for wolf preservation/animal

rights interests to defeat a more resilient public process which has money available (P-R dollars) to undertake unpopular programs in the interests of the human consumptive users who generate the funds. With federal aid money out of the picture, all that is necessary to stop wolf control is to convince one person, the Governor of Alaska, that wolf populations should not be managed. This is the present circumstance in Alaska. The present Governor doesn't like it, so it doesn't happen.

*[Author's note: As I write this final draft, a story of unprecedented micro-management is unfolding. The Governor is trying to force the Alaska Board of Game to pass regulations which would ban wolf trapping and hunting on half a million acres of state land to prevent the harvest of about one wolf per year from two well publicized wolf packs which have a territories near the northern border of Denali National Park. En masse resignations of State Fish and Game Advisory Committees are presently occurring as a result of the Governor's blatant attempt to control actions of the Board of Game. The end result is not yet apparent.]*

Second, management authority was effectively transferred from the Commissioner of Fish and Game to the Alaska Board of Game, i.e., from a professional wildlife manager to a board of politically appointed "laymen/women." The Alaska Constitution and the state laws which implement it vest management authority in the Commissioner of Fish and Game. The Commissioner has legal authority to hire folks to help him with this impossibly large task, hence the Department of Fish and Game. Under this system, the Commissioner had sole authority to implement or stop wolf control. However, when legal challenges to modern wolf control programs were being argued, wolf preservation interests asserted the issue involved allocation of wildlife harvests, which is the role of the Alaska Board of Game. Acknowledging the apparent "anti-wolf control" mood of the public, and some confusing language in the Board of Game's enabling legislation, the Department's attorneys conceded this point, thus effectively abdicating the Commissioner's management authority to the Board of Game. This meant the Commissioner

could not institute a wolf control program, even if done exclusively by Departmental biologists, unless harvest of the involved wolves had been "allocated" to the control effort. That is, the Board of Game had to approve wolf control plans and implementation programs before any recognizable wolf control program could be undertaken.

Through this uncontested "out of court" settlement by the Department's attorneys, the management authority of the Commissioner, who is Constitutionally directed to manage for production of wildlife for human food on the sustained yield basis, was subtly transferred to the Board of Game. This action re-enforced the relatively new, 'modern' notion that the public could not be involved in wolf control...only Departmental biologists. It also strengthened the hand of the Governor in predator management. Now, not only can the Governor appoint the Commissioner (who occasionally turned out to be an intractable wildlife professional who had to be "fired" if a meddlesome Governor demanded his obedience and couldn't get it), the Governor can also appoint members to the Alaska Board of Game. It was this Board which was given the authority over wolf control when the Department's lawyer conceded wolf control was an allocation issue.

The third longer-term result from the Nelchina Basin wolf control "failure" was introduction and establishment of scientific credibility for the now-politically correct notion that although predators kill prey, lowering predator populations has no predictable relationship to prey abundance. As stated above, the present Governor opposes wolf control to benefit human consumptive users. Many, perhaps most, rural Alaskans (which represent a traditional power base for the Governor's political party) differ with the Governor on this point. Hence, the Governor must justify his position if he (and his party) are to remain politically viable in rural Alaska. To meet this end, the Governor seized on the "failure" in the Nelchina Basin to assert the obvious fact that wolf control didn't produce an obvious increase in prey for humans when bears were the limiting predator. Almost 20 years later, on the advice wolf protectionists who

understood the workings of the National Academy of Sciences, the Governor contracted with the National Research Council (the review arm of the National Academy of Sciences) to evaluate the "scientific correctness" of the Alaska Department of Fish and Game analyses of the effectiveness of wolf control in producing human benefits. In spite of the fact that both the best (the Tanana Flats) and worst (the Nelchina Basin) of these experiences had already been documented in review articles published (primarily as monographs in the peer-reviewed *Journal of Wildlife Management*), the Governor and his advisors sought a "second opinion."

The National Research Council doesn't work for free, so to fund his review contract, the Governor used a third of a million dollars available to him through sales of Alaska hunting licenses and matching federal (Pittman-Robertson) funds. This review took more than two years, but the Governor got satisfactory results for his political agenda. An additional political benefit for the Governor was that, owing to the lengthy review period, he was able to replace some staunch wolf control advocates on the Alaska Board of Game (which now must approve or disapprove wolf control programs) with appointees he considered likely to share his opinion on matters of wolf management.

I consider it ironic that the very humans who wanted to compete with wolves for prey animals had paid (through their license fees and taxes on guns and ammunition) for the National Research Council to determine that not all wolf control programs will produce predictable and statistically significant positive prey population responses. This was, of course, not in dispute before the National Research Council review (because of the Nelchina Basin "failure"). Additionally, the review found that many Alaskans and others opposed wolf control, and that it did cost a lot of money. These findings have served the Governor's agenda well. He now has a prestigious report (National Research Council 1997) which allows him to delay any proposed wolf control program because it is expensive, and lacks broad public support (i.e., is opposed by urban Alaskans and out-of-state wolf

protection and animal rights interests). However, his most powerful reason to refuse wolf control is that it is "not based on sound science." In the end, the National Research Council review allows the "scientifically validated" conclusion that although wolves kill prey, they should not necessarily be considered a component of environmental resistance to prey population growth.

**CRITIQUE: FALLOUT FROM SOCIAL AND POLITICAL FACTORS RELATING TO WOLF CONTROL:**

The "sound science" conundrum was compounded by the natural human tendency among upper level Department of Fish and Game administrators to minimize the distraction and discomfort associated with controversial predator management. The stress of what had become the "wolf management cycle" took its toll on the human resources of the Department of Fish and Game. Department leadership grew weary of responding to public demands for restored prey abundance by documenting prey shortage or downward trend, determining whether it was likely wolves were the primary cause of prey declines (with a level of confidence which could be defended in court), preparing subsequent wolf population reduction plans to increase prey abundance, taking these plans to the Board of Game, defending the plans, the Department, and themselves against constant vitriolic criticism (which always makes good "news" copy), being enjoined by the courts from proceeding, then going to hearings or trial, being vindicated by the court, and then either implementing the program or having it stopped or rendered ineffective by political constraints. Leadership began to express its feeling that other Departmental functions, not to mention staff morale and particularly not to mention their morale, were being negatively impacted by the constant, minimally productive wolf management efforts. Naturally, they began to look for relief.

The adaptive response of Department leadership was two-pronged. Leaders embraced public planning processes and multiple equilibrium theory in their search for relief.

**Public Planning Process:** The Department con-

tracted with consultants who had developed a highly successful program which enabled public agencies to succeed in implementing controversial public works projects. The program was called "Citizen's Participation," and attained success by effectively neutralizing project opposition. Neutralizing opposition was accomplished by getting opposing activists to participate in the planning phases of controversial projects. Along the way, the agency strategy centered on gaining the known opposition's incremental "informed, albeit grudging, consent" by neutralizing their effectiveness during the planning process. The thinking was that if opponents could be induced to "buy into" a project bit by bit, they couldn't credibly veto it at the end. The program had been highly successful in many controversial urban public works projects, and most Department personnel were sent to "Citizen's Participation" training. However, the Alaska Department of Fish and Game was insufficiently committed to implementing wolf control to use this apparently manipulative process to "sell wolf control" to the public by what many considered devious means "*Hell, I was there!*"(ibid).

Instead, Department leadership adapted two of the program's concepts, inviting all interested parties (especially opposition activists) to participate equally in the public planning process, and use of neutral, non-agency facilitators to run the planning meetings. Borrowing these two concepts, the Department pioneered its own course. "Affected interests," also called "stakeholders" were invited to sit down with wildlife biologists and planners to produce a statewide wolf plan.

This effort had the effect of involving the Alaskan public, for the first time, in developing management policy. Until this time, setting management policy had been the exclusive province of Department of Fish and Game leadership. The policy which emerged, with what was hailed as success, from this process, prescribed differing levels of wolf management (i.e., levels of human/wolf competition) based on land ownership and human demand for prey on those lands. For example, wolf management would simply not be an option within Alaska's vast National Parks (where harvest

by humans was generally precluded). On other federal lands which supported significant historic harvest by humans, a moderate level of wolf population management was to be a potential option, and on state-owned lands, which had been historically important sources of prey for humans, it was agreed that humans could enter heartily into the ancestral competition with wolves without organized opposition from those interests involved in the planning process.

This plan took about two years to develop as incremental informed consent emerged from confrontation. Still, some interests which had grudgingly consented to the plan didn't like it at all. Apparently, they had been 'lurking in the shadows' awaiting an opportunity to destroy the process. Eventually these interests, through unlikely but orchestrated deceptive 'support' for the plans of arch wolf-control advocates, succeeded in blowing up the process at the last minute before implementation. Here's how it happened.

With the plan basically finished, and requiring only final formal approval by the planning team, opponents of any wolf control, some of which had been appointed to the Alaska Board of Game, orchestrated the demise of the plan (S. Castle, member, Alaska Board of Game pers. commun.). Realizing "hard liners" in the Departmental leadership were anxious to implement the plan on state lands scheduled for maximum competition between humans and wolves, the "anti" influences on the Alaska Board of Game supported approval of Departmental wolf-control plans which basically "ran ahead of" the planning process (remember the plan had not yet received formal approval by the planning team). When wolf control regulations "outran" final formal approval, wolf protection interests "bailed out" of the planning team, righteously asserting that the Department had not operated in good faith.

In the resulting controversy, the Director of Wildlife Conservation unintentionally involved the Alaska Division of Tourism. In justifying the need for predator reductions to benefit the Fortymile caribou herd (which will be important later), the

Director argued that tourists, as well as hunters, benefit from wolf control because they like to see large numbers of animals. In making this argument, the Director colorfully referred to "Mom and Pop from Syracuse," and suggested that, with wolf control in the Fortymile, Alaska could become, "the Serengeti of the North." The good news was that these colorful statements expressed the potential viewing opportunity in appealing language. The bad news was that the Director had not discussed wildlife viewing by tourists as a justification for wolf control with the state's Alaska Division of Tourism. As everyone soon learned, the Division of Tourism is extremely territorial and assiduously dedicated to husbanding the "appropriate marketing" image for maximizing the state's economic benefit from tourism. These standards, based on the perception of "untouched wilderness" conflict with the concepts of managed ecosystems. The results have been that the Division of Tourism dictates how wildlife for viewing is to be provided. The Division of Tourism was highly offended by the Director of Wildlife Conservation, and made it clear that wolf control to provide animals for viewing was not considered appropriate from its agency point of view.

In an effort to salvage the progress which had been made (and the work which had been expended) the Department agreed to organize (with protectionist and animal rights advocates) a "wolf summit," where all viewpoints would be presented in a public forum. At this conference, protectionists mobilized the ecotourism segment of the generally offended Tourist lobby. Ecotourism business were clearly terrified by the specter of a tourism boycott threatened by wolf protectionists if any wolf control took place in the state. The then-Governor of Alaska, had made his fortune in the hotel/tourism business, and was particularly susceptible to the influence of the tourism lobby. In the resulting compromise, the ecotourism/wolf protectionist axis got the Governor's administrative ban on aerial wolf control to prevent the threatened tourism boycott, and those humans demanding competition with wolves for food got a wolf control program. The "catch" was that the program could not involve aerial shooting (the

bottom line for avoiding the threatened tourism boycott). Details of this adventure in planning have been reported elsewhere (Stephenson et al. 1995).

*[Author's note: This success in using "tourism" to derail wolf control programs has been effectively exploited by wolf protectionists ever since. In March 2,000, testimony to the Alaska Board of Game, tourism was frequently cited as justification for creating a half-million acre buffer zone around Denali National Park on the premise loss of 14 "park" wolves over 17 years to trapping outside the park would harm the tourism industry. Interests advocating for a "broader view" of wildlife management (read wolf protection interests) now frequently cite the value of tourist viewing of wolves as a justification to prohibit wolf management involving control of population size (Keeler 2000).]*

Prior to this ground-based wolf control program, it was generally held that a wolf population could not be effectively reduced if methods were limited to conventional trapping techniques. Nevertheless, the Alaska Department of Fish and Game set out to do exactly that to benefit depressed caribou populations and the humans who hunted them immediately south of Fairbanks. Trapping was unconventional in that it was done by locating wolf-killed prey animals from the air, landing on them with helicopters, and setting snares for wolves around the kill sites. The harvest of wolves by this trapping effort was surprisingly effective the first year, although the catch was primarily young wolves, which were more readily trapped than adults.

Still, all was not well. The Fund for Animals, a wolf protectionist group, had retained a sympathetic biologist to demonstrate the ugliness and inhumane nature of this trapping program. This biologist proclaimed himself the Department's "watchdog." Meaning no disrespect, I shall refer to him as such. The "watchdog's" flight budget was sufficiently large that he could fly the area almost as extensively as the Fish and Game biologists doing the trapping. Additionally, he had obtained (through earlier court action) the frequencies of

radio-collared wolves (many packs in the area were radio-collared) and located them often. Hence, it seemed only a matter of time until he found a live wolf in a trap. Still, the fact that the “watchdog” had been trying to catch the Department for years, and that Department biologists knew the “watchdog” was flying with a pilot who lacked expertise in aerial wolf tracking (pilots with well-developed tracking expertise initially refused to fly the “watchdog”) led to a false sense of security and perhaps arrogance on the part of the Department. It made no plans for when it would eventually be caught on ‘candid camera.’

The “watchdog’s” relationship with his inexperienced wolf tracker-pilot eventually failed, and he finally found an experienced wolf-tracking pilot willing to take his money. Consequently, he became more effective at finding kills and wolves. The “watchdog” continued to wait for the Department to make a mistake. Eventually, it did.

The Department’s biologist/trapper decided to “set” a conspicuous moose carcass in the the “watchdog’s” area of special interest. More experienced field biologists recommended against “setting” that particular moose carcass, noting the “watchdog” was certain to find it. Their recommendations were overridden by the biologist/trapper’s supervisor, who agreed with the biologist/trapper that they shouldn’t “let ‘the watchdog’ tell the department where to trap.” As predicted by the more experienced field personnel, the “watchdog” found the set with a live wolf in a snare.

Rather than dispatching the wolf, or contacting the Department to end its suffering, the “watchdog” kept knowledge of the live wolf in a trap to himself, returned to Fairbanks, contacted an Anchorage television station, and made plans to join a videotape crew and reporters who would helicopter up from Anchorage to record the suffering of the trapped wolf the next day. When the “watchdog” and his crew arrived at the trap site the next day, more wolves had been caught. While the crew was taping the “watchdog’s” narration about the inhumanity of trapping and wolf control to benefit hunters, the Department’s biologist/trapper arrived

by helicopter. His first concern was apparently for the trapped wolf. Hastily trying to humanely dispatch the most critical trapped wolf, the biologist/trapper allowed himself to be taped in a grisly, inefficient attempt to put the wolf “out of its misery.” Later investigation would reveal he had hastily chosen the wrong ammunition for the gun he was using. This choice along with cold weather resulted in a low-powered load inadequate to kill the wolf, which he shot repeatedly at close range with non-lethal effects. The next day, the incident was nationally televised. The resultant public outrage was predictable, but involvement of Alaska’s almost-new, and now-present, Governor was not.

At this time, Alaska was waiting on final counting of rural and absentee ballots in a gubernatorial election. The front runner (by only a few votes), who had allegedly never purchased a hunting, trapping, or fishing license in Alaska, immediately released a statement to the media detailing his disgust with and personal revulsion at the incompetence of the Department of Fish and Game over the incident. He stated that if he were the election winner, the program would be stopped, and fully investigated. He was, and so was it.

The new Governor turned investigation of the incident and audit of the biological program over to his newly appointed Commissioner of Public Safety and the Alaska State Troopers. The forensic evidence clearly indicated the biologist/trapper had selected the wrong ammunition (shooting a .22LR in a .22 Magnum revolver), and that in the -30°F temperature the load developed insufficient energy to dispatch the poor suffering wolf. This was found to be an error in judgment by the biologist/trapper.

With respect to audit of the trapping program, the first report released by the Governor’s office stated the trapping program had been grossly mismanaged as well. This finding was inconsistent with the actual data regarding the program audit by the Alaska State Troopers. Subsequent investigative reporting by local newspapers revealed that the Troopers’ report on the audit had been “heavily

edited” to put the program in a factually incorrect light. After the original “ghost copy” of the report was retrieved from the Troopers’ computer, the “mistake” was rectified, and the audit finding was that the program (save the mistake in ammunition selection by the biologist/trapper) had been well-managed, and was completely within the guidelines established by the Board of Game and administrative process. Nevertheless, the program was terminated. Although the Governor’s Chief of Staff apologized telephonically to a group of Department of Fish and Game employees threatening a grievance over the Governor’s blanket insults of their work and ethics, the Governor has never been fully called to account on this matter.

Termination of this program and the questions about the Governor’s political interference with day-to-day management of fish and game inflamed those to whom competition with wolves for caribou to eat remained an important issue. They persisted in petitioning the Alaska Board of Game to allow human competition with wolves for caribou. It was perhaps to get these folks “off his back” that the new Governor contracted with the National Academy of Sciences (National Research Council) as discussed earlier.

There is *one more “planning story”* associated with the contemporary history of wolf population control in Alaska. As just mentioned, humans committed to competing with wolves for food were not happy with the Governor’s intrusive micromanagement-by-arbitrary-exclusion-of-humans from the competition with predators. Among the most distressed were lower-level biologists committed to traditional wildlife management as called for in the Alaska Constitution. As a rule, these ADF&G employees tend to be less “politically mature” than the ADF&G leadership. Consequently, they are more likely to take action. This planning story appears to be one such example.

In an effort find some way to establish wolf control to benefit the Fortymile caribou herd and its users, someone, allegedly the local area biologist, convened a planning team of would-be Canadian

users of the Fortymile caribou herd and a local advisory group from the Tok, Alaska, area. The apparent thinking was that this international “grass roots” effort would produce some positive results for the Fortymile caribou herd, a traditionally important food source for those involved. This once-huge herd had dwindled to where it was producing vanishingly small human benefits compared with the recent past. The localized, independent planning effort functioned briefly at the “grass roots level,” but was soon co-opted by the more politically mature planning specialists in the Department’s Fairbanks regional office. Following the procedure established in its statewide wolf policy near-miss, the Department’s regional planners expanded the local group by inviting all “potentially affected interests” to participate.

Here, there is some disagreement in the story. The trappers claim they were not invited. The planners say they were. Whatever the cause, trappers were not formally represented on the planning team. Other “potentially affected interests” included representatives of regional fish and game advisory committees, Canadian Native hunters, anti-hunters, animal welfare advocates, environmentalists, and representatives from the Alaska Division of Tourism and the Department of Fish and Game. An external facilitator was hired as well. The major difference between this group and the earlier statewide wolf policy group was that management for a particular herd was the issue rather than policy development.

The planning team worked long and hard, apparently thinking they were actually planning to restore the Fortymile caribou herd. However, based on observations of the process over time and the eventual outcome, I suggest the group’s original focus, restoration of the Fortymile caribou herd to provide human benefits, soon became secondary to each represented special interest’s larger agenda. It wasn’t long before each involved special interest appeared to be using the planning team to establish some advantage for its position, which might be exploited once the issue of wolf management policy (as had been the statewide planning focus)

was revisited. For any interest or organization desiring to control the future of wolf management, this was simply adaptive behavior. Whatever might come of a small, specific population management plan is secondary. Control results from influence on policy.

The result was a planning team which eventually reached a consensus where “everyone got something.” The final plan had two phases. “Phase One” called for reductions in biologically insignificant human harvest (demanded by animal protectionists and would-be Canadian hunters), and encouraging trappers to reduce the number of wolves by conventional trapping practices. “Phase Two,” scheduled for implementation if conventional trapping ever reduced the resident wolf populations sufficiently, called for Alaska Department of Fish and Game biologists to capture, neuter, and mark the alpha pair of wolves in each pack to see if the neutered wolves would hold their territories and keep fertile wolves from repopulating the area. “Phase Two” also called for Fish and Game to capture fertile subordinate wolves and transplant them to other areas.

When viewed in the cold (and perhaps cynical) light of practicality, the Fortymile plan appears less a caribou herd management plan than a “smorgasbord of gotcha’s” for competing ideologies. Hunting interests swapped constitutionally mandated maximum sustainable human benefits for an on-the-record (and they thought precedent setting) admission by anti-hunters that wolf predation was the main factor limiting Fortymile caribou herd growth. Wolf protectionists negotiated away total protection of wolves to establish (what they saw as precedent-setting) acceptance of “non-lethal” wolf control by wildlife managers.

A look at the economics of trapping suggests neither side could have realistically anticipated it would ever really be faced with a decision on implementing “Phase Two” of the plan. After all, “Phase Two,” sterilization of alpha wolves and translocation of fertile subordinates (euphemistically designated as non-lethal wolf control), was not to be undertaken until traditional trapping had

lowered the wolf population enough that sterilization of dominant pairs and deportation of their fertile subordinates became logistically and economically feasible for the Department of Fish and Game’s research biologists. Viewed from outside of the planning team, this seemed a remote prospect for two reasons.

First, it was considered (in spite of the Department’s early success in lowering the Tanana Flats wolf population using lavishly funded, helicopter-supported trapping prior to the TV scandal) axiomatic that trapping of wolves by traditional methods wouldn’t reduce wolf numbers to the point the sterilization experiment would be feasible. Second, wolf pelt prices were so low that wolf trapping was certain to be a money-losing venture for any conventional trapper. In spite of these apparent obstacles to plan implementation, the planning team appeared positive about its compromise solution.

As mentioned earlier, everyone got something they wanted to influence future policy (on-the-record admission of the validity of its arguments from its opponents), and nobody had to give up anything critical to survival of their specific interest. Even the Canadians were happy because Alaska hunters had cut their harvest (a biologically insignificant quota) from 450 to 150 bulls in a symbolic gesture of international cooperation. The role of Canadians in this issue should not be overlooked.

In times past, the Fortymile caribou herd (numbering about half a million animals) migrated from Alaskan calving and summer ranges (located between Fairbanks and the U.S./Canada border north to the Yukon River) to winter ranges in the Yukon Territory. When these migrations took place almost 60 years ago, the herd was almost 20 times larger than when the plan was finalized. It has not followed the international migration pattern for decades. Nevertheless, the Canadians wish it would, and the planning team clearly *assumes* it will once again, if it gets large enough (the population goal is half a million caribou). In the spirit of consensus, Canadian Native “First Nations” exchanged their promise of compliance with the

plan's restrictive harvest provisions for the team's formal apology to "our mother the earth" for past mismanagement of the caribou herd.

The expected period of relative inactivity in implementing the plan (because "Phase One" would be long-in-coming, if ever achievable) was short-lived because the only affected interest group which had not participated in the planning process, the trappers (whose semantically disputable assertion is they were not asked), took action. Reminiscent of the days of lively competition between wolves and man, the Alaska Trappers Association arranged, through funding by private citizens and hunting interests, a competition incentive for trapping wolves. In what was called the "Fortymile Caribou Calf Protection Program" these "Competes-With-Wolves" Alaskans provided, through a local Fairbanks fur-buyer, for a supplemental price subsidy of an additional \$200 for the pelt of any wolf legally taken in the Fortymile caribou herd's range. Although Dall sheep were only marginally present in the Fortymile Caribou herd's range, this economic incentive program was largely funded by grants from the Foundation for North American Wild Sheep. The Foundation reasoned that if wolf populations could be controlled through conventional trapping, the program might be moved to where greater sheep benefits would follow.

The economic incentive brought the trapper's yield per wolf pelt to \$400, and changed trapping wolves in the Fortymile from a certain-loss to a profit-making enterprise for skillful trappers. The result was intense trapping pressure in the area. Within two years, the wolf population had been reduced to the point that the Department of Fish and Game had to face implementing "Phase Two" of the Fortymile Caribou Herd Recovery Plan. Implementing "Phase Two" was controversial. Nobody but the planning team and the Department of Fish and Game liked the idea, and many considered it unnecessary for herd recovery.

Coincident with the removal of wolves by trappers, the Fortymile caribou herd began to increase noticeably. By the time the Department was faced with the decision to begin "Phase Two," the

population increase rates specified in the Fortymile Caribou Herd Recovery Plan had already been obtained. The "Competes-With-Wolves" folks were ecstatic, but ADF&G officials appeared uncertain of their course. After all, admission that wolf control by trapping (particularly using a system which looked suspiciously like a "bounty" on wolves) could lead to demands for application of this approach to other areas where wolves appeared to be getting the best of men (who had been forced, by regulation to abandon effective competition with wolves for food) and the humans weren't liking the results. As a result, the Department produced official biological rationalizations that suggested, at their most inclusive extent, that trapping *might* have augmented caribou population growth, which resulted primarily from good weather and good luck. The Department's most credible assertion was that the subsidized harvest of wolves had not been focused in the core calving area.

From the trapper's perspective, these *post hoc* rationalizations were sufficiently assailable, and the Department's perceived zest for experimenting with wolf sterilization sufficiently apparent, that relations between the trappers and the Department were strained to the breaking point. This situation aggravated an existing tension between the trappers and the Department generated by the Department's blatantly negative reaction to the trappers' announcement of their plan "to help" accelerate herd recovery by lowering wolf populations numbers. I suspect the Department's negative reactions resulted from legitimate nervousness concerning longer-term anti-trapping sentiments coupled with institutional 'unease' associated with resurrecting the "bounty concept" where wolf management was concerned. Remember, Departmental leadership embraced the citizen's planning group concept to limit controversy. Hence, being "immediately" faced with implementing "Phase Two" appeared to be an unwelcome and unexpected opportunity.

The situation worsened because the trappers, having been rebuffed by the Department for doing what they considered the "right thing," also stood

to lose income if "Phase Two" were implemented. It seemed certain that if the Department were to experiment with "non-lethal" wolf control by sterilization and transplant of wolves from the area, the opportunity to make money through subsidized wolf trapping would vanish. Trappers argued in vain that they had been responsible for the increase in caribou herd growth, that they could assure future herd growth through trapping if it remained economically viable for them, and that the Department shouldn't "mess with Mother Nature" by sterilizing wolves. In this last argument, the trappers were aligned with their long-term arch-foes, the wolf protectionists. Neither thought sterilizing wolves was the thing to do.

When the Department, after months of withholding its plans, finally revealed it would undertake "Phase Two" on November 18, 1997, the Commissioner, Department leadership, and the planning team held a joint press conference. In the glow of the moment, the Commissioner announced that the Fortymile Caribou Planning Team would now become the Fortymile Caribou Management Team. The trappers withdrew their efforts from the Fortymile area.

*[Author's note: The Commissioner's promotion of the Fortymile Caribou Planning Team to the Fortymile Management Team appears to have foreshadowed the Governor's plans to further distance wildlife management from the Department and Alaska Board of Game. If the Governor is able to coerce the Board into protecting the two wolf packs on the northern border of Denali National Park, he has said he will appoint "adaptive management groups" [teams?] to oversee management of predators and prey in other critical areas. These groups would have the effect of further removing management from professionals (the Department) and paraprofessionals (the Alaska Board of Game), by placing management more directly in the hands of those sympathetic to the Governor's agenda. The Governor would play the pivotal role in appointing the members of these "adaptive management teams." WH]*

"Phase Two" has now been operative for almost

three years. Numbers of wolves, approaching 100, have been transplanted to compete with other wolves and other humans for food in other areas around Alaska. The caribou herd has continued to grow, and sterilized wolves have apparently held their territories. However, immigration of other wolves into the area has been high. It is uncertain whether or not the Department's deportation program has kept up with immigration. Controversy over the program has not abated.

Recall if you will, our friend, the "watchdog," from the TV videotape scandal in the Tanana Flats. The "watchdog" also monitored the non-lethal program in the Fortymile. This time, his techniques included flying high above the Department's biologists and contract pilots as they trapped, sterilized, and deported wolves. The "watchdog" also recorded conversations among these persons. In spring of 1999, the "watchdog" released these recordings for public airplay in Alaska. The tapes appeared to document that the Department and its contract pilots were engaged in unethical behavior, were negligent of the welfare of captured wolves, and guilty of technical violations of administrative rules established for the program. While there was a brief flurry of interest, no ethics complaints or charges have been filed by the "watchdog," and the entire incident appears to have dropped from public consciousness. It may be that the "watchdog" had "cried wolf" so many times in the past, his credibility, even with apparently irrefutable evidence, was sufficiently low that he could no longer be effective in his task. Alternatively, the "watchdog" may have longer-term strategies up his sleeve. The future may not be satisfactory, but at least it will be interesting with respect to planning and science.

**Multiple Equilibrium Theory:** Interesting science relating to competition of humans with predators for food has not been limited to the sociobiology of Departmental wolf control. Please recall my earlier hypothesis, that the stresses of the "wolf control management cycle" (public demand, department planning, Board approval, litigation, legal vindication, and administrative override) drove Alaska Department of Fish and Game

leaders to pursue two adaptive courses. The first was large-scale planning program and its eventual fallout just discussed. The other was apparent commitment to a multiple equilibrium theory of predator/prey population dynamics.

Multiple equilibrium theory is a conceptually simple but mathematically elegant model originally derived to study the dynamics of forests where insects prey on spruce tree buds. Conceptually, it predicts that when predator numbers (insect larvae in the seminal work) are high relative to prey numbers (originally spruce buds), predation will have a greater influence on the productivity of the forest than when there are relatively fewer insect predators. This much seems intuitively obvious.

However, interactions of the basic assumptions (from catastrophe theory) and the elegant mathematics describing the dynamic changes in predator and prey populations as the ratios of predators to prey change predict two "stable" or "equilibrium states." One is predicted at relatively high predator densities relative to prey. The other at relatively lower predator densities with respect to prey population sizes. By inference, at the "low-density equilibrium" prey populations subject to high predation can never grow sufficiently to overcome the environmental resistance due to predation. In this case, predators are capable, because of their relative high density, of killing all the young produced.

This model was particularly attractive to Department biologists and leaders for several reasons. *First*, it was conceptually simple and made intuitive sense.

*Second*, the multiple equilibrium model appears robust, particularly for "macro" systems. It has predicted well in forest and reservoir management situations (R. Demarchi pers. commun. this conference, and J. Bailey--see discussion at end of paper).

*Third*, the "low-density equilibrium" lent itself to an attractively alliterative appellation affected by

its biological aficionados, the term "predator pit." "Predator pit," conveyed almost everything wolf-control advocates needed to implant in the mind of a public which didn't seem to appreciate the need for predator reduction if man were to have access to prey animals. It subtly communicated, in almost Madison Avenue fashion, the desperate plight of prey populations under the unrelenting suppression of predators. Use of the term (which is also fun to say) readily explained why, without any actual elucidation necessary, it was important to curtail human harvests when predators had the upper hand in competition with man. It clearly conveyed the notion, "Things are serious!"

*Fourth*, it seemed intuitively apparent that if predators and prey are in balance at "high-density equilibrium," there should be enough prey that wolves wouldn't be in serious competition with humans. Surely, it seemed, man could harvest prey animals without having a measurable effect if there were lots of them. Further application of this casual intuition, apart from the complex semantic limitations of the term, *equilibrium*, and the mathematical constructs of the theory, were interpreted as showing that *wolf control is necessary only occasionally*, to "release prey animals from the predator pit." That is, intuitive reaction to the apparent notions derived from multiple equilibrium theory, without getting involved in its basic assumptions and bothersome mathematical details, seems to suggest that wolf control need not be an ongoing effort, but practiced only in periodic emergency situations where prey have been driven into the predator pit.

The prospect that wolf control would be required only occasionally (and not on a sustained basis) was bound to be highly attractive to Department leaders interested in escaping from the pressures of the "wolf control management cycle" detailed earlier. This being the case, it is not surprising that the Departmental leadership embraced the theory with apparent wholeheartedness. Had they been aware that our old friend, the "watchdog," was among the first proponents of applying this theory to predator prey systems in Alaska (G. Haber pers. commun., Walters et al. 1981), they might have

been a bit more cautious.

Experience with wolf reduction programs throughout Alaska over the last 25 years has shown simplistic application of multiple equilibrium theory just doesn't work in practice. Of the various applications of radical wolf reduction throughout Alaska (National Research Council 1997), only those areas with significant and consistent trapping or wolf hunting pressure (the Tanana and Minto flats) seem to fit the model for any extended length of time. Please remember this fact because I shall bring it up again in suggesting a functional prescription.

The primary reason application of an overly simplistic conceptualization of multiple equilibrium theory doesn't predict accurately for wolves, men, and prey in Alaska is that the semantic and mathematical constraints of the theory have been ignored. Analysis of the semantic difficulties, primarily misunderstanding the equilibrium concept (best illustrated in chemical terms), will serve to illustrate this problem. I can't do the complex math, so I shall be forced to deal with the semantics inferred from the, perhaps inappropriate term, equilibrium.

If the balance between predators and prey at low density were a true equilibrium, there could be, by definition, no change in either predator or prey population sizes. Only a decrease in predation rate, occasioned by a relative decrease in predator population size or predator efficiency, could disturb the equilibrium and allow the prey population to increase. Alternately, if predators take more than the annual productivity of the prey population at low-density equilibrium, the equilibrium will be disturbed, and the trend will result in eventual prey extirpation. Subtraction of any prey animals from a system at equilibrium, all else (particularly predator efficiency) remaining constant, will lead to nothing but predators remaining alive in the pit...until they eat each other and starve.

Likewise, by definition of the term equilibrium, the population sizes of predators and prey, prey productivity, and predation rate at high-density

equilibrium cannot change any more than allowable at low-density equilibrium. High-density equilibrium remains conceptually the same as low-density equilibrium, there are just more predators eating more prey. If high-density equilibrium truly exists, and man is unwilling to compete with predators for prey animals, no human harvest is allowable because any additional mortality will (by definition of the term, equilibrium) be additive and result in decreased prey abundance as prey populations are forced back into the pit.

*[Author's note: The National Research Council (1997 p84) discussed application of this model to pulsed wolf control. That report stated, in the context of applying multiple equilibrium theory to predator/prey management, that "In this context, equilibrium does not mean constant predator and prey densities, but that densities tend to return to the vicinity of the equilibrium if they are caused to deviate substantially from it." This prediction appears to stem from the basic assumptions driving the model. I consider this lack of accountability to the definition of equilibrium, indicative of a semantic mushiness which approaches my mathematical ineptitude. Imprecise language is of minimal utility in dealing with the semantic misunderstanding of equilibrium which drove Departmental leaders to embrace the concept as the model for predator/prey relationships. Furthermore, imprecise or altered language leads to sustaining rather than solving problems. If we can't communicate, we have no hope. WHJ]*

If one accepts a semantically rigorous definition of equilibrium, it follows that the management possibilities for increasing human use of prey arise only when equilibria (be they low-density or high-density) have been disturbed by lessening the overall effectiveness of predation.

This can be done by increasing prey production (while limiting wolf population growth) or by decreasing predation (by decreasing predator population sizes). Only when prey population increases are allowable because of decreased environmental resistance is a sustainable harvestable surplus for human uses even a theoretical

possibility. The assumption that there will be enough prey for “everyone” at high-density equilibrium is a mistake based on faulty semantics applied to the equilibrium concept. At “high-density equilibrium,” there may appear to be no additive effect of harvest by humans (or predators), but that perception most likely results from the lack of sufficient resolution in population monitoring complicated by limited understanding of the equilibrium state. In plain words, we can’t count predator and prey animals with sufficient accuracy that the data will force us to re-examine the accepted, muddled thinking about sustainability of harvest by humans where wolves and prey may exist at “high-density equilibrium.”

**FUNCTIONAL PRESCRIPTION:** In this review, I have concluded the Alaska Department of Fish and Game bought into a flawed understanding of multiple equilibrium theory. My conclusion is based on two things. The first is Departmental preoccupation with “predator pit” semantics compounded by the logic of language as discussed above. The second is the frequent Departmental assertion that wolf-control is a temporary necessity or emergency measure employed simply to liberate prey from the “predator pit” and shift dynamics to the high-density equilibrium. This deceptively simplistic language suggests the high-density equilibrium state is a sort of golden pathway to “peaceful consumptive coexistence” between wolves and man. It doesn’t work that way in theory (already discussed), and hasn’t worked that way in practice.

There have been numerous modern wolf-control programs in Alaska. Results from only two (the Tanana and Minto Flats) areas are even suggestive that light moose harvests by humans are sustainable without pushing prey populations back into the “predator pit.” In the Tanana Flats, which have supported significant human harvest pressure on wolves from traditional trapping and incidental wolf harvests by human hunters (as well as the ADF&G trapping program terminated by the “watchdog’s” TV escapade), modest harvests of bull moose have been sustained for approximately 20 years. However, the Department is now moving

to reduce the human harvest of bull moose because of low bull to cow ratios. Hence, it appears that even in the Tanana Flats, the level of sustained wolf harvests by man has been insufficient to keep wolves from “getting on top of” the Tanana Flats moose population. In the Minto Flats, consistent harvest of wolves by trappers has prolonged the positive results of wolf population reductions.

If the multiple equilibrium theory were generally applicable to Alaskan predator/prey systems, the need for recurrent human harvest limitations or subsequent wolf control efforts (such as has been historic in the Fortymile River country over time) should be absent. They aren’t. Hence, I conclude the Department’s pulsed wolf reduction programs ultimately fail because of flawed biological understanding about the nature of predator/prey dynamics. The flaws lie not in multiple equilibrium theory, but in faulty application of the inferences drawn from multiple equilibrium theory.

If my conclusion is correct, the first requirement for successful predator/prey management in Alaska is Departmental reassessment of its assumptions about predator/prey population dynamics. Investment in “predator pit theory” has driven the Department to embrace the concept (inferred from its behavior) that the only successful way to control wolves is a pulsed, high-volume wolf killing program.

If a paradigm shift away from this mind set is to occur, I suggest it will require the Department look more toward long-term experience and evolutionary competition models than strained application of mathematically complex models which don’t produce the predicted results. Alternatively, it would be productive for the Department to consider models from disciplines outside of the specialized area of predator/prey dynamics as it has defined itself. Several less complex thought systems more satisfactorily explain predator/prey relationships.

As previously suggested (Heimer 1996), a simplified model from basic enzyme kinetics predicts more simply and is conceptually more accurately

than the Departmental interpretation of multiple equilibrium.

Similarly, a model from electrical physics predicts more simply and shows more accurate description of long-term trends than the multiple equilibrium model. It is Ohm's law of electrical resistance ( $V=IR$ ). Manipulated algebraically Ohm's law becomes,  $I=V/R$ . Please recall that current flow is inversely proportional to resistance in electrical circuits. If we were to simplify predator/prey dynamics by looking at it from a broader perspective, we could consider predation a simple component of overall environmental resistance to prey population increase. This simply predicts that lowering environmental resistance ("R" in the manipulated equation) will result in increased population growth ("I" in Ohm's equation) if the force ("V" the driving "pressure" of voltage where Ohm was concerned) remains constant. I suggest "V" is analogous to the biological reproductive capacity of prey populations, and remains fairly constant. The prediction is that lowering environmental resistance will allow greater realization of biological reproductive capacity and result in prey population increase.

This simplification would demystify predator/prey biology. Instead of a complex non-linear function requiring advanced mathematics, we would be left with a simple relationship which predicts that incremental lowering of environmental resistance will result in an increase in prey population growth.

Here, it may be worth noting that this simple approach to population dynamics is closely related to the well-accepted basis of nutritional carrying capacity theory. The major difference is that nutritional carrying capacity theory operates on prey productivity rather than prey mortality. To work, both must operate in the "linear" portion of the curve. The problems inherent in management application are also similar for both theories. Harvests of predators (in this instance) or prey (where nutritional carrying capacity is a concern) must be effectively applied before populations have stabilized at asymptotic levels (in these cases,

nutritional carrying capacity of habitats--whether the food species be plants or ungulates).

Finally, the human social choices between predator and prey might be explained by borrowing a concept from the field of economics. Initially, readers may find this strained, however, the definition of economics is most simply stated as the study of allocating scarce resources to supply the demands of competing factions. With respect to predators and prey in today's social environment, this application could represent a significant step forward. In economic terms, limited resources demand maximization, maintenance, and determination of some balance between competing users. This approach realizes (like the Department's failed statewide wolf policy/plan) that not everyone's wants will be supplied to their full extent.

From an economist's perspective, understanding this balance requires consideration of "income" (the analog of biological recruitment), "levels of competition" (the analog predation), and the role of "market forces" (hunter/trapper pressure as well as government intervention through biological control programs). As in complex economic systems, the predator/prey issue can be conceptually reduced to "supply and demand." While this reduction of predator/prey theory to a model from the "social sciences" probably won't appeal to some who prefer nouveau chic mathematical models, its simplicity and social relevance should be obvious. Simply stated, the model simply represents how a resource can be allocated to competing demand interests. Inputs are finite and limited, and therefore output must necessarily be limited as well. In this "economic" case, biological productivity is the input and allocation of outputs can be equated to the traditional "guns and butter" of basic introductory economics (K. Martin-Gordon, Alaska Dept. Nat. Resources, pers. commun.).

Both guns and butter are necessary to society; the interesting question becomes, who decides how many units of guns and butter are produced. The choices to satisfy demand are as follows: produce all guns, produce all butter, or produce a mixture

of guns and butter. Obviously, the first two choices are not logical if society needs both, but rather a compromise must be reached which will provide both guns and butter to the economy. The refined problem then becomes how to allocate scarce resources to maximize market satisfaction. For every unit of guns produced correspondingly fewer units of butter can be created.

Likewise, with the "economic choices between" predator and prey populations, an analogous inverse relationship exists. Add more wolves, get less moose (or caribou or Dall sheep). Subtract wolves (effectively decreasing the demand for ungulate prey); get more moose (or caribou or Dall sheep). Hence, the question becomes not how much input (money or prey) we have, but how we decide to alter the balance between guns and butter (wolves and ungulates), and what biological/harvest balancing methods will be used to achieve those levels. While this model isn't rocket science, it rather simply states the relationship between predator and prey populations in basic, but practical, economic (allocation of scarce resource) terms.

Without realizing it, the Department-sponsored statewide planning effort came close to applying this model. Unfortunately, when that effort collapsed, Departmental leadership reacted by more tightly embracing its limited understanding of the multiple equilibrium model and the *planning process* rather than choosing a more productive "guns and butter" model. In short, the Department retreated to the esoteric science of predator/prey biology rather than pursuing the more relevant socio-economic approach to solving the predator/prey problem.

Considering predation from any or all of these three perspectives (enzyme kinetics, electrical physics, and economics) should lead to the hypothesis that sustained, appropriate levels of wolf harvest will be more biologically effective in producing prey for human uses than the major, pulsed high-volume wolf killing efforts inferred as effective from questionable application of multiple equilibrium theory.

History suggests the attractiveness of this approach. When Alaskans used to harvest wolves more aggressively in the days of less restrained competition, prey abundance was generally higher because environmental resistance was generally lower. This generality is in concurrence with predictions of the Department's better contemporary iterative models (see McNay 1998). Additionally, a stable, long-term wolf harvest program, once established by liberalizing wolf harvest methods and means, would not draw the attention of non-competition advocates geared to respond to the "specific crises" associated with large, pulsed Departmental wolf-control programs.

Consideration of Ohm's law (of predation), enzyme kinetic models or the economics of "guns and butter" would simplify management, but might take much of the fun and mystique from predator/prey biology. There is great intellectual satisfaction to be gained from understanding processes at their most basic level. I hypothesize this intellectual gratification drives much modern predator/prey research. At present interest in the "micro-dynamics" of predation (as represented, by the National Research Council's approach to reviewing individual predator control programs) have become the research norm. Unfortunately, even if these micro-dynamics are knowable, their relevance to the larger picture is too-easily overlooked. It's become a sort of "forest for the trees" situation, which I shall illustrate with a final chemical analogy.

We all know that putting a teaspoon of sugar in a beaker of water and stirring it will sweeten the water as the sugar dissolves. We also know that the more sugar we add, the sweeter the water will become. However, in the mechanics of stirring, the stirring rod generates and sheds vortices as it moves through the water. Some of these "mini-tornados" will be more effective at sweetening than others because they will pick up more crystalline sugar from the bottom of the beaker and whirl it into solution. We can't characterize the exact dynamics of sugar dissolution in each vortex. Some might contain lots of sugar, some virtually none (depending on the localized circumstances).

If we would study the sweetening effect of sugar in water by trying to assess the dynamics of each individual vortex, we would become greatly frustrated by the variation between vortices. Given enough time and sufficiently sophisticated technology coupled with descriptive mathematics, we could eventually build a model which could sum the effects of all vortices, thus predicting with statistical assurance that water will eventually be uniformly sweetened. However, our confusion resulting from vortex variability will in no way change the fact that the entire contents of the beaker will be sweetened. Neither will it change the fact that the water will be sweetened in direct proportion to the amount of sugar added, up to the saturation point.

In predator/prey biology, we seem to have become so interested in individual vortices that we've overlooked the proportional nature of sweetening. In summary, my suggested prescription is:

First, the people of Alaska should decide whether arbitrary human withdrawal from competition with wolves is acceptable when driven by the ideology of one individual, Alaska's Governor. In truth, that's the Alaskan situation at this time. Certainly the Governor is driven by factors which he sees as maximizing his inclusive fitness, but the decision will rest with the Governor, as long as he/she controls the function of the Commissioner and the Alaska Boards of Fish and Game. The Governor appoints both.

Second, the Department should reexamine its assumptions about predator/prey relationships, particularly those which seem to be driven by casual analysis of multiple equilibrium theory and where the "logic of language" associated with "multiple equilibrium" jargon has taken it.

Third, the Department should simplify its models from the very complex (such as multiple equilibrium) to any of the number of simple models which better describe the overall predictable effects of predation on prey abundance.

Fourth, the Department should revisit and recap-

ture the diversity of prey uses based on land ownership which was virtually within the grasp of all users when "winner take all" wolf protectionists "blew it up" prior to the threatened ecotourism boycott. Care should be taken to separate the "functional economics" of this model from its "public process."

Fifth, the Department should invest in informing the Alaskan public about the basic thinking and political expediencies driving predator/prey research and management.

Finally, the Department should embrace increasing consistent, lower-level mortality on predator populations where more prey are desirable for human use, and step away from pulsed Departmental mega-kills of wolves. These pulsed wolf removals are of questionable utility in the long run, very expensive, difficult to administer, dangerous to biologists, and easily defeated by folks who don't consider the historic competition for prey animals between wolves and men appropriate for ideological reasons.

#### LITERATURE CITED

- Ballard, W.B., J.S. Whitman, and D.J. Reed. 1991. Population dynamics of moose in South-Central Alaska. *Wildl. Monogr.* 114: 49pp
- Harbo, S.J., and F.C. Dean Jr. 1983. Historical and current perspectives on wolf management in Alaska. *In Wolves in Canada and Alaska; Their status biology and management*, Ed. L.N. Carbyn, pp 51-64. Canadian Wildlife Service report series #45, Ottawa.
- Gasaway, W.C., R.O. Stephenson, J.L. Davis, P.E.K. Shepherd, and O.E. Burris. 1983. Interrelationships of wolves, prey, and man in Interior Alaska. *Wildl. Monogr.* 84. 50pp.
- Heimer, W.E. 1996. A new look at predator-prey interactions using a simple enzyme kinetic model. *Proc. Bienn. Symp. North. Wild Sheep and Goat Counc.* 10:14-19.

\_\_\_\_\_, and R.O. Stephenson. 1982. Responses of Dall sheep populations to wolf control in Interior Alaska. *Proc. Bienn. Symp. North. Wild Sheep and Goat Council.* 3:320-329

Keith, E. 1979. *Hell, I was there!: Elmer Keith, his life story.* Petersen Pub. Co. Los Angeles, CA.

Keeler, L. 2000. Listen to All. Guest Opinion, Fairbanks Daily News-Miner. March 4, page A-4.

McNay, M. 1998. PredPrey model. Fed. Aid in Wildl. Rest. Final Rep. Grants W-24-1 and W-24-5 (July 1992-1997) Alaska Dept. Fish and Game. Juneau, AK. Compact Disk.

National Research Council. 1997. *Wolves, bears, and the prey in Alaska.* National Academy Press. Washington, DC. 207pp.

Rearden, J. 1999. *Alaska's wolf man, the 1915-1955 wilderness adventures of Frank Glaser.* Pictorial Histories Publishing Co. Missoula, MT. 330 pp.

Stephenson, R.O., Ballard, W.B., Smith, C.A., and Richardson, K. 1995. Wolf biology and management in Alaska, 1981-1992. Pages 43-54 in L.N. Carbyn, S.H. Fritts, and D.R. Seip *Eds.*, *Ecology and conservation of wolves in a changing world.* Canadian Circumpolar Institute, Edmonton, Alta. Can.

Walters, C.J., M. Stocker, and G.C. Haber. 1981. Simulation and optimization models for a wolf-ungulate system. Pages 317-338 in Chas. W. Fowler and Tim D. Smith *eds.* *Dynamics of large mammal populations.* J. Wiley and Sons. New York, NY. 447pp.

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## QUESTIONS, ANSWERS, AND COMMENTS-WAYNE HEIMER PRESENTATION

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**GLENN LORTON, NEW MEXICO:** What part do Natives play in predator control?

**WAYNE HEIMER:** It's difficult to categorize Alaska Natives because the inclusive term "Native" includes so many diverse groups. Some groups, depending on culture and village experience have a greater interest in wolves and taking wolves than others. Some villages have very active histories, for others there is little documentation. Throughout Alaska as a whole in recent history, I would say the impact of Alaska Natives on wolf populations has not been significant. Hunting and trapping wolves is not the priority it used to be. Fur market forces and changing traditions are factors. Would either of you other Alaska Fish and Game guys like to offer comments on that question?

**KEN WHITTEN, ALASKA:** Basically that's true, except that for wolf control almost all is done by urban whites.

**HEIMER:** He said predator control is an issue for urban whites. To which I would add, with a cultural history involving relationships with wolves. However, there are political aspects of the issue which greatly concern Alaska Natives. These political issues involve ballot initiatives to protect wolves from harvest.

The first of these ballot initiatives was to prohibit harvest of wolves on the same day a hunter had been airborne. It was placed on the ballot by wolf protection interests primarily financed by sources outside of Alaska. There was no organized opposition to the initiative, and a well financed campaign in favor of its passage. This campaign presented false advertising about aerial hunting which was calculated to capitalize on the emotions of urban women predicted by campaign researchers to be the critical block of votes (D. Pope, initiative organizer interview with Anchorage Daily News). This initiative passed. Those interested in competing with wolves, including Alaska Natives took note.

The second ballot initiative grew out of the economic wolf-trapping incentive (largely financed by FNAWS) which resulted from the planning effort to recover the Fortymile caribou herd mentioned earlier. The primary tool of the effective trappers involved in reducing wolf populations (to the point the Department could experiment with sterilizing alpha pairs) in the Fortymile was snaring. Buoyed by their success in the previous election, wolf protectionists again placed a wolf protection initiative (banning of snares to trap wolves) on the ballot. This issue galvanized Alaska Natives on the predation control issue. The Alaska Trappers Association approached Alaska Natives and formed a coalition with them to oppose this initiative.

In this election campaign, Alaska Natives and trappers out fund-raised and out campaigned the wolf protection interests. The campaign strategy to defeat the anti-snaring initiative focused on preserving the Alaska Native life-style of trapping. In reality, data showing intense dependence on snaring by Alaska Natives weren't there. This didn't stop initiative opponents from exploiting pro-Native public sentiment to defeat the initiative to ban use of snares by a large margin. This empowering action established Alaska Natives as a major player in harvest and trapping issues.

*[Author's note: As of March, 2000, predator control is not an "urban white issue." In the time since aircraft*

*supported harvest of wolves was banned through the initiative process, wolf populations surrounding several important Native villages on the Yukon and Kuskokwim Rivers have apparently increased. Reports of wolves coming into villages to capture and eat sled dogs on their chains have become commonplace, and moose populations critical to the human food supply in these villages have been depleted. In the eleven months which have passed since this conference, Alaska Natives living in these villages have petitioned the Alaska Board of Game for predator control in their areas. The Board of Game has passed enabling regulations, but the Governor has blocked their implementation. Alaska Natives in these villages are now demanding, not only that predator control be done in their areas, but that they be the ones to do it. At least two villages with leaderships involved in resisting the snaring initiative have instituted economic incentives apparently inspired by the Fortymile Caribou Calf Protection Program-pioneered trapping subsidy discussed earlier. Hence, during the eleven months since this conference was held, the situation has changed radically. Additionally, the Alaska Legislature eased restrictions on aerial wolf hunting somewhat after the two year prohibition on amending a voter's initiative ended, and appears to be "on track" to allow remove wildlife issues from ballot initiative modification. Much of the impetus for these changes is driven by rural Alaska Native dissatisfaction with the Governor's present wolf management policy. "Wolf control, it's not just for 'urban whites' any more." WHJ*

**WHITTEN:** Alaska presently has wolf trapping seasons with very liberal (unlimited in many areas) bag limits, (wolf harvest seasons are much longer than prey harvest seasons in general), and still we don't actually limit wolf populations. As a matter of practicality, I don't think there's enough public interest and participation in harvesting wolves to manage wolf populations in Alaska. I doubt that Alaskans will ever harvest the 15 to 20 percent of wolves Wayne suggests would be required for humans to compete effectively with wolves for prey.

**HEIMER:** What's the estimated sustainable harvest level from Alaska wolf populations?

**WHITTEN:** It's the same as harvesting sheep; it depends on the population. If you have a vigorous wolf population with a high prey base, you can harvest over 50 percent [of a wolf population on a sustained basis]. Harvest by hunters or trappers is not allowed until recruitment of pups is pretty much assured. If you have a wolf population on a less abundant prey base you can't support that much harvest. The estimated 20 percent harvest rate that we take across most areas of the state isn't affecting wolf populations, but there are some accessible areas around the river centers where wolves are depressed at times by harvest.

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**OPEN DISCUSSION ON PREDATION ISSUES**

**MODERATOR: TOM RYDER, WYOMING GAME AND FISH DEPARTMENT**

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**RACHELLE HUDDLESTON-LORTON, NEW MEXICO:** I have a question for the biologist in California with regards to the mountain lion initiative and removal of mountain lions from management in the State of California. I'm wondering if you see any hope for a change in that situation in the near future?

**VERN BLEICH, CALIFORNIA:** No. There is a bill currently pending that would alter the status of lions. As written, it is not supportable by our department or most publics. The way it is worded, or is being interpreted, will essentially restore the game animal status for lions. If it's going to be successful, it will have to specifically eliminate that possibility, and speak to those instances where mountain lion control or management by the agency could be implemented. There are hearings next week. We're not optimistic, either.

**DICK WEAVER, NEW MEXICO:** Vern, to change Proposition 117 which passed in 1990, takes a three-quarters vote in the Legislature. They can't get a simple majority on most bills.

**BLEICH:** You've got that straight. It's a very political thing that has nothing to do with conservation or wildlife issues, whatsoever.

**DUNCAN GILCHRIST, MONTANA:** I'm speaking on behalf of FNAWS. I know some of you don't think predators are a problem, but most of you do.

The mission of FNAWS is to put more wild sheep on the mountain. We hear talks like Eric Rominger's, we get discouraged. Many of you have seen these reports, and I pass them on to the board, and we see these tragic numbers. Not just sheep, but antelope and deer and wolves and mountain lions and coyotes.

So what we would like from this group is some policy statement of what you folks believe, because you're the sheep managers in North America. We need something to hang our hat on, so we can head in the right direction. We don't want to keep spending money in putting sheep on the mountain only to have them eaten.

**TOM RYDER, WYOMING:** This leads to a point I was hoping to make to the group during the discussion period. It's obvious even to me, a person that doesn't work with large predators very much, that they kill prey species. Mountain lions kill bighorns and coyotes kill them on occasion. My initial statement to that is, so what if predators are killing those species? Predation on bighorn sheep, in most instances, does have a measureable population effect.

If predation is a form of mortality and not additive, I don't see predation as a big issue. However, if predation is additive, then humans have to make a choice as to how we're going to allow sheep to be allocated.

In other words, do we allow predators to have an additive effect and just reduce human harvest or do we reduce predators to keep human harvest up? This is the bottom line in putting together this session. It became obvious that there are not a lot of data specifically addressing the issue of predation on bighorn sheep populations.

There's some work going on now. Eric's work, certainly. John Wehausen's work in California sure appears to be that way, and Ian Ross' work in Alberta. But I think there's a real lack of good, solid data that shows interactions between sheep populations and predator populations. With that, I'd throw it out to you all again, especially the researchers and managers in the room that have feelings or data concerning this topic.

**RAY DEMARCHI, BRITISH COLUMBIA:** I said it before and I'll say it again. I just concluded a couple of status reports and did some work on Stone's sheep in the Northern Rockies, and I tried to sort out this whole predator/prey thing. I wrote some stuff earlier on predators and have a little bit of experience working with the wolf recovery program down into Montana.

I'm as confused now as I ever was. The title of my talk is "Man as part of nature." Game management works. If you want more ungulates, there's ways to do it; improve the habitat, reduce competition for forage, reduce predation, all of the above. If you don't have the habitat and you have predators, you're going to have problems.

I came to a region where I spent 28 years managing 11 species of ungulates and 8 species of animals that eat meat every day. I kept reminding people they didn't eat corn flakes. They ate meat.

We came on the heels of some of the biggest fires we had in the 1930's, but the forests are coming back in. I'm hearing stories about sheep herds that are disappearing up north.

There are herds that are gone. They didn't die this time from *Pasteurella*. They died off from predators and people are blaming the predators.

I look at the habitat and I look at what's happened. As forests move in, the advantage goes to the predator. What happened with the elk and the black bears way back when, it's happening with moose and wolves, it's happening with caribou and cougar, it's happening all over. In some cases, opening up the habitat makes more access for wolves and black-tailed deer. It depends on the situation; every situation is different.

I think that in some places in my beloved province, people are practicing wolf control. I don't know who is doing it but somebody is doing it. It's unfortunate that this has been done behind the scenes, because it's probably not being done right, if there is a right way of doing that kind of stuff.

Still it's a very complex issue. Just sitting here listening to the conversations and the session today, I think I have to go back and rewrite a couple of things that I wrote. One guy is saying coyotes are hard on sheep and lambs and other people say that wolves are hard on Stone's sheep. Why would the wolves be different? Maybe they are, or maybe they aren't. I think the jury is still out.

**KEN WHITTEN, ALASKA:** I think Ray hit on it and other people have too; predation can be a problem. It's not always a problem and I think often where we get caught up in these political wars is by thinking that the animal rights people are on one extreme, so we'll fight them by going to the other extreme. We don't need to kill wolves everywhere in Alaska in order to reduce problems in the few places where we have them. You don't need to kill mountain lions throughout California to save the Sierra Nevada bighorns. You have to look at these things on a case-by-case basis.

Another point I'd like to make is there can be innovative solutions to predator control. We have, I think, adequate predator control programs on the books. The problem is ballot initiatives basically overrode four of

them. The ballot initiative pretty much closed all loopholes of public taking of wolves with airplanes.

As far as the department goes, we can't do lethal predator control with aircraft and there's a few other conditions on it. The one program we sometimes have going involves capturing wolf packs basically catching the entire pack, sterilizing the adult males, taking the juveniles out, transplanting them to other areas of the state. It's very expensive. Costs much more than shooting them from helicopters would be. The problem is, politically we haven't been able to shoot wolves from helicopters and we are now doing this. It looks like it's working, and it's been successful in that the sterilized males are maintaining their territories.

Transplanted pups, with very few exceptions, are not coming back. We take them far enough away, and they can't find their way home. We've been specifically able to target packs on the feeding ground.

**WAYNE HEIMER, ALASKA:** There are alternate interpretations of what went on. On this groundbreaking sterilization program, what you end up with when you want to do the research, you want to know which lion it is that's killing the sheep, and you want to know which wolf is the problem.

I think, in trying to express it, you're basically attacking an analog question looking for a digital answer. This also happens with the disturbance studies and some of the other things we do. We look under the microscope at this thing or that thing and it works or doesn't work. Our governor doesn't want to do any wolf control. He doesn't control the Board of Fish and Game which makes the regulations. A number of powerful native communities wanted wolf control because the wolves were eating all the moose they wanted to eat.

Our governor took a third of a million sportsmen dollars to contract with the National Resources Council, to have them review the published work of the Department of Fish and Game to see if it's scientifically valid.

As I understand the report, by the time they had looked at the successful wolf control programs, and those that hadn't been quite so successful, and those that were halfway in between, they basically said, you can't really be sure what you're going to get. Wolf control is like a box of chocolates; you never know what you're going to get.

If I may be allowed a homey analogy from your chemistry lab days. If you take a 250 cc beaker, fill it with water and put 20 grams of sugar in there and take a round stirring rod, and you begin to stir, what happens as you drag the stirring rod through that aqueous environment? You set up little vortices that come off of those and there's a little turbulence at each place. We cannot predict what's going to happen in any individual vortex that comes off the stirring rod. If you stir it, and you taste, it's all going to taste sweet. It's pretty homey and it's to suggest that we use Ohm's law as a management model.

But the point is, you can look at what has happened out there in our 40 mile country and, I'll suggest to you from the planning documents and what I know of the situation, we would never have had few enough wolves that we could approach the sterilization program had not crazed red-necks put a bounty on wolves. They did and the department can go ahead and try that thing. Some folks told you it's working, some folks don't think it is working. I don't know whether it's working or not.

But by the time you take a little snapshot of a vortex in your beaker here and another one over here, and you find them consistent, but you say you don't know what's going to happen, you're asking me to believe that when you stir up the sugar, it isn't going to taste sweet. I have a difficult time chasing those things through the absurd extreme, and they don't seem logical to me.

To say we need a bunch of research looking at individual vortices to see if the beaker will eventually be sweetened I find is strange. I think environmental resistance, as Ray said, comes from a number of components. Some of them we can manage, some of them we can't.

If it's the priority of society to have more game for people, we know how to do that. It isn't that hard if society's priority is more game. If this isn't society's priority, there will be a struggle and it will go the other way.

**JEFF DENTON, ALASKA:** What I'm interested in, in Alaska where our sheep are, does climate affect those populations, trimming off the old periodically? Do you consider wolves a problem in Alaska within relatively stable situations?

**HEIMER:** As long as everything is going great, which includes not just a lot of sheep, but includes a lot of caribou and moose, and includes favorable weather. As long as everything is going good, I don't think that wolves are going to beat up on sheep particularly.

They're going to kill them all the time and my observations are probably they will kill adults and not lambs. When caribou go down the tube or moose go down the tube, sheep are going to support those wolves.

Dave Mech's work in Denali Park at one point suggested the major factor associated with successful whelping in wolves in Denali Park was how many sheep they ate. Is that because sheep are an aphrodisiac of some kind? What was probably going on in the park at that time was that moose had been eaten and the caribou were pretty well on the way to being eaten, and wolves that were eating sheep would be okay. When things aren't good with alternate prey, if you want to have sheep, you have to decide whether you want to have an unmanaged ecosystem or whether you want to have sheep.

**JEAN CAREY, YUKON:** What's happening next door is we just completed a five-year wolf reduction program to enhance a caribou herd. Wolf numbers were reduced by 70 percent over 5 years. Moose populations increased and caribou populations increased, but sheep didn't.

As a follow-up and part of the legal control, we also are doing non-lethal control sterilization. To date, we have six packs that are sterilized. None of the pairs produced pups. They've all maintained their territories, and we feel we're extending the benefits for moose and caribou of wolf control through nonlethal measures.

In addition, a master's thesis done in Yukon suggested that wolves with only sheep to eat were having no pups at all. Wolves surviving on sheep alone seem to be in desperate conditions.

**HEIMER:** The research option is: which "vortex" do you want to study? (See thinhorn working hypothesis predator section for more detailed review of wolf/sheep studies in U.S. and Canada.)

*(Note: During the June 2000 meeting of the Northern Wild Sheep and Goat Council in Whitehorse, Yukon, I had the opportunity to interview R. Hayes (Yukon Territory wolf specialist) about final impacts of the wolf control program on Dall sheep. In discussion of the overall impact, Hayes reiterated no statistically significant changes in lamb: 100 ewes or yearling:100 ewes ratios had been seen. However, he stated the investigators had always suspected their wolf-project sheep count area used to measure the effects of wolf control on sheep was too small. When they finally secured funding to census the entire area affected by wolf control (after the project had ended), they found the number of adult Dall sheep had increased by 35 percent*

*when compared with the pre-wolf control total count. This finding supports the conclusion that wolf predation focuses on adults, and that assessment of lamb or yearling ratios is an inadequate methodology for assessing wolf control impacts on Dall sheep populations. The finding was too late to include in the monograph reporting on the Yukon project. It had already been accepted for publication.)*

**RYDER:** Just to switch gears slightly to try to accommodate all the various portions of the country represented here today. I'm curious, we've been talking the last ten minutes or so about the large contiguous blocks of habitat in the northern part of the continent. How about the Rocky Mountain or desert states? When we're dealing with sheep populations that are fragmented, most folks I talk to say lion predation is increasing across the western U.S.

What do you folks see in your various states concerning sheep population dynamics and predator populations? Even if you don't have any solid, hard core telemetry data, just feelings and observations you make in the country, please share these.

**WALT VAN DYKE, OREGON:** We have some bighorn populations in southeast Oregon that were doing quite well up until the winter of 1992-93 which was a very tough winter. It knocked our mule deer populations down by 50 percent. Most of our sheep coinhabit areas with mule deer. We know we've got an increasing lion population. We've not seen any rebound in bighorn sheep since that tough winter. We get lamb production, but we don't get lamb survival. In some cases, we do get good lamb crops, but the adult mortality appears quite high.

We've had 20 percent annual mortality of radio collared ewes in our transplants. In some real good desert habitat that also has sheep in it, we have 20 percent annual mortality of adult mule deer. I think we've got some problems.

We came from a period of drought prior to that tough winter. Drought had a lot to do with the impact of that winter on both mule deer and bighorn sheep, but now we've had five wet summers and mild winters and looking at logically, we expect that things should have really rebounded. We had better recruitment in mule deer and bighorn sheep during the years of drought than we've got now.

There's been some talk about density dependency. When you cut your mule deer population in half, especially going into five wet years, you should see a tremendous response in mule deer production.

Where we've got both species in the habitat and there's the argument that ecologically we've moved towards climax, and we no longer have habitats that can support mule deer, I can buy that. But that means that habitat should be better for bighorn, but there's nothing to suggest this is true. We've got a problem somewhere.

**RYDER:** Another thing that seems to be concurrent in Wyoming, I observed the same thing in 1992-93; a big decline in our mule deer populations. There were several sheep die-offs at roughly the same time, yet little recovery has occurred in some of those sheep herds. Deer populations generally are also still depressed. With that, we've seen an eruption in our elk herds statewide. That may not be as much of a factor with depressed mule deer numbers, although there may be some competition going on there. If elk increases are occurring in your states, how have they affected your sheep herds?

**VAN DYKE:** There are no elk here. We can't blame this on elk. Antelope are not doing well at the same time.

**VIC COGGINS, OREGON:** In our case in Hell's Canyon, as far as transplanted sheep, we have small herds that we think have been held at pretty low levels by predation, but it's an opinion. We don't really have any kind of solid information.

As far as our elk herds, that's another story. We have sheep herds that have been devastated, in my opinion, by predation. We have some at 20 percent of their management objectives, and of course the sheep that are there were involved in the die-off. We have not seen much predation on them, at least at this point, but I don't think any of our problems are related to high elk numbers.

**JIM BAILEY, NEW MEXICO:** I would like to say you didn't do very good justice by saying that it's based all on spruce budworms. There's evidence to support the two stable states model. Some of it comes from epidemiology (May and Anderson). A lot of it comes from predation and the model really has a lot of concepts in it. One of them is predator/prey relationships are important and it's been around at least since Doug Peinlock and Dave Mech's first book.

Another issue is functional and numerical responses. The concept of territorial among predators is biological information that supports the model.

**HEIMER:** Can you explain what that is for me?

**BAILEY:** Well, the rate of predation per wolf varies with the prey, and the number of prey out there also varies, but the plateaus in both cases vary with prey density.

Those are concepts in part of the model. Messier worked on that in eastern Canada with respect to wolves, and lots of other things with species that have shown the same thing. I think it's a good model. I'm not going to base my management on it so much as I'm going to use it as a really valuable thinking tool.

The issue of habitat was brought up here, too, because that alters and puts limits on the functional responses of killing rates of predators and prey. It's a good teaching model. It allows us to put a lot of complexities together and see how it relates; I don't think you did justice to it.

**HEIMER:** I'm sorry if I didn't do justice to it. I do think of it as a teaching model, a theoretical model, fine, but you have focused the entire responsibility for predator manipulation in the government sector, where it's so readily politicized. My suggestion is that while it may be a wonderful model, it isn't serving us well in management.

**BAILEY:** It's a good hypothesis of where we are. Where we are with small populations, populations that have been brought into the break point, into the predator pit, where we are today down here in the south, with really small populations. We're in the pit, and we can't get out. We don't have habitat.

**HEIMER:** Or we've got too many predators. You can take your pick.

**BAILEY:** The amount of predators is related to the amount of prey. Supporting the predators is the issue. That can be built into the model.

**DALE TOWEILL, IDAHO:** This is one of those issues that it's really, really critical that we understand

exactly what we're talking about.

When we're talking about the individual, all mortality is additive. It's only nailed once. Predators may switch off prey, going back to the concept of compensatory mortality. It's been generalized but that's the basis of it. Basically, if the prey species of interest produces more young than the habitat will support, other animals will knock them off, with no net effect on the subsequent birth pulse.

Compensatory mortality is time dependent, area dependent, and species dependent. Predators switch off. So while it's a convenient learning tool and we were all taught it, don't let it disintegrate into jargon. Be very specific about your area, your population, your alternate prey, your production and the predators of interest.

**RYDER:** Thanks, Dale. I want to thank you all for your input and to thank Wayne and Eric for their presentations.



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## **WILD SHEEP MANAGEMENT WORKSHOP**

**MODERATOR/EDITOR: Kevin Hurley, Executive Director, Northern Wild Sheep and Goat Council**

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Friday April 9, 1999 was the final day of the 2ND North American Wild Sheep Conference. We asked conference attendees to participate in a day-long workshop designed to identify specific recommendations for wild sheep management; 60 sheep biologists, managers, researchers, students, and advocates participated. At the minimum, we wanted to develop an outline with specific, succinct recommendations, to help guide wild sheep management in North America for the next 25 years.

After introductory remarks and instructions, we provided each participant with a simple, matrix-format table (Table 1) listing Dall, Stone, California, Rocky Mountain and desert sheep on the X-axis, and wild sheep management challenges and issues discussed the previous 3 days on the Y-axis. Conference organizers prioritized the issues in this matrix; the first seven matched individual sessions at the conference. We asked people to identify and develop distilled, "bullet" recommendations for the intersecting cells, based on their personal wild sheep management experience and knowledge. For example, under the first intersecting cell of advocacy groups and Dall sheep, we wanted specific recommendations on what could be done by or with advocacy groups to benefit Dall sheep management. We asked participants to develop recommendations based on what they knew, rather than what they thought they knew. We asked participants to work individually for 90 minutes, developing their recommendations. We then reassembled participants in thornhorn, California, Rocky Mountain, and desert sheep subgroups. For two hours, subgroup participants briefly discussed and recorded their recommendations on flip charts, sorted by management challenge/issue. In this round-robin format, every participant had the opportunity to list their recommendations, without argument from their peers, until all recommendations were exhausted. Then, subgroups were assembled into a large-group format, and subgroup recorders individually described each recommendation, again sorted by management challenge/issue. Additional recommendations were then offered by the entire group and recorded. After all four subgroups had presented their recommendations, without argument from their peers, a short general discussion was held and the workshop was adjourned.

It is important to understand that conference and program co-chairs were not seeking a finished or polished product from this one-day workshop. Rather, we wanted to, at a minimum, develop an outline which could be expanded upon in our publication. Also, we did not expect, nor are we claiming, that this sorted list would include every legitimate recommendation for wild sheep management. We were not looking to "reinvent" but to "update" the wheel. The 1971 wild sheep meeting in Fort Collins, Colorado, the 1974 wild sheep conference in Missoula, Montana, the 1980 Desert Bighorn Council guidelines, and numerous other publications provide extremely useful templates for comparing and evaluating where we are with wild sheep management at present. We were not looking for unanimity in recommendations; in fact, we encourage skepticism and healthy debate on wild sheep management, with arguments grounded in science, data, and knowledge. We expect and encourage each reader to question the recommendations included here, and decide for themselves which are most appropriate.

Using workshop notes, a transcript from a court reporter/stenographer, comments on the matrix-table sheets submitted or subsequently mailed by individual workshop participants, and subgroup flip charts, the following pages represent the "raw", bullet-like recommendations identified. These have been further edited for brevity,

but content has not been altered. Following this section and drawing on these “raw” recommendations and available literature, a synthesized compilation of management recommendations for wild sheep in North America is included.

**Table 1. Workshop matrix, 2ND North American Wild Sheep Conference, Reno, NV, April 9, 1999.**

Management Challenge/Issue	Dall	Stone	California	Rocky Mountain	Desert
Advocacy Groups (political action, fund-raising, network of support)					
Habitat Fragmentation/Human Disturbance (urban sprawl, subdivisions, planning/zoning, land ownership/acquisitions/easements/ consolidation, highways, fences, dams, industrial activities, ORV use, military, recreational), human dimensions					
Habitat Management (buffer zones, mineral/salt licks, water development, prescribed and natural fire, noxious weeds, logging, reclamation, mapping techniques, GIS modeling)					
State/Federal Relationships (formal wilderness designation/restrictions on needed management activities, forest plans, resource management plans)					
Hunting/Harvest (subsistence, trophy, ewe harvest, hunter orientation, mandatory horn registration/plugging, waiting periods)					
Capture/Transplant (minimum transplant sizes, source herds, herd health histories, techniques, evaluation of long-term transplant success)					
Disease (documentation, diagnosis, cooperative response, treatment options)					
Predation (documentation, management options and strategies)					
Population Management (density-dependent effects)					
Livestock (cattle, sheep, feral horses and burros)					
Genetics/Taxonomy (DNA databases/confounded by transplants, forensics)					
“Inter-Connectedness”/Corridors/Migration Routes/Metapopulation approach					
Threatened & Endangered Status/Listing					
Law Enforcement (poaching, pickup heads, record book entries/fair chase, forensics)					
Exotics					
Native Ungulates					
Information and Education/“Watchable Wildlife” strategies					
Other					

## **Desert Bighorn Sheep**

### **Advocacy Groups**

- Expand vision toward long-term conservation of wild sheep.
- Educate groups about wild sheep habitat needs and reality of land-use planning and NEPA.
- Recognize contribution of and cultivate financial support from these groups.
- Contribute information and articles to advocacy group publications.
- Expand advocacy groups to include conservation groups, and increase their involvement as interested parties.
- Help groups with diverse objectives realize their commonality.
- Expand upon funding needs.
- Explain potential limitations of short-term research findings; obtain funding for longer-term research.
- Help groups better evaluate funding requests.
- Continue working with groups in retiring and/or purchasing domestic sheep grazing permits.

### **Habitat Fragmentation and Human Disturbance**

- Recognize importance of inter-mountain corridors for conservation of metapopulations which travel across intervening desert valleys.
- Consider all lands used by desert bighorn sheep as important.
- Explain how population persistence declines as populations become more isolated.
- Unfragmented habitat in good condition which includes corridors must receive high management priority.
- Involve biologists in land exchanges, which must be evaluated for their impact on sheep habitat.
- Recognize that recreational use also fragments habitat.
- Restore movement corridors with vegetative treatments, especially where tamarisk has encroached.
- Restoration of movement corridors includes decreasing recreation, acquiring land through easements, restrictions on use by hikers, and decreasing vegetation to improve visibility through burning, chemical treatment, and logging.
- Evaluate human impacts to determine their adversity on desert sheep and their habitats.

### **Habitat Management**

- Continue to use existing BLM guidelines for fencing in bighorn sheep habitats.
- Document and evaluate benefits of artificial water development.
- Restore natural waters rather than just concentrating on artificial water development.
- Support natural fire, restore natural fire frequency; implement prescribed burns to improve habitat.
- Develop a database to demonstrate how we're losing habitat by vegetative encroachment.
- Provide adequate protection, buffer zones, and seasonal restrictions for oil, gas, mining, and other extractive commodity practices near suitable mountain sheep habitat.

### **State/Federal Relationships**

- Wilderness legislation should include a description of the minimum tools which can be used.
- Include stipulation to continue use of current management practices in wilderness and wilderness study areas (WSAs), as they become designated wilderness areas.
- Encourage better communication between state/federal agencies on wilderness management goals.
- Hold annual meetings involving upper management to discuss current issues and problems.
- Encourage more education and information sharing among resource specialists.

- In land-use plans, important, occupied bighorn habitat needs to be identified and assigned management priority, to establish a legal basis for actions to benefit bighorn sheep. This may include amending existing land-use plans to eliminate domestic sheep allotments as they become vacant.
- In land-use plans, recognize options to reallocate forage for wildlife as livestock grazing permits are retired or relinquished.
- Involve state agencies in the scoping process for land-use/ecosystem plans, and throughout process.
- Land management agencies should prohibit or closely manage packing with domestic goats in wild sheep habitat.
- Encourage more cooperative management between the U.S. and Mexico for shared bighorn herds.

#### **Hunting and Harvest Strategies**

- Encourage hunter orientation programs in states where desert bighorn sheep are hunted.
- Develop predictable, reliable information and survey methodology on which to allocate sheep permits, and develop consistency in those. Standardize between and within states.

#### **Law Enforcement**

- Reduce poaching by making the sale or barter of pickup sheep heads illegal.
- Discontinue pinning pickup heads, which makes them basically legal.
- Collect and store horn samples as part of the pinning requirement for legal heads.
- Develop a DNA or mineral database to assist law enforcement.
- During capture and transplant operations, pin or somehow mark transplanted rams, for future identification.
- Emphasize potential DNA analyses to identify populations for research and law enforcement.

#### **Capture and Transplant**

- Generally support the 1973 DBC guidelines, with one specific exception. Remove the recommendation to utilize enclosures following transplant.
- Historical sheep distribution information should be used in determining suitable transplant areas.
- Evaluate cause of initial sheep decline. Determine whether that cause has been effectively eliminated.
- Do not transplant new sheep into sites where prior transplants failed, without attempting to determine and rectify problems that occurred with the original transplant.
- Recognize different transplant objectives, including establishment of new populations, expanding the range of existing populations, or creation of migratory behavior.
- Evaluate predation potential before the transplant and the need to consider predator control. Transplant populations are especially vulnerable to predation.
- Examine disease potential and status of source herds, and consider what diseases may be carried with transplanted sheep.
- Minimize diseases that transplanted sheep carry, and consider possible disease effects on augmented herds.
- Do not transplant large numbers of animals from small herds, to minimize impact on source herd.
- Develop and establish updated protocol for capture and reestablishment of bighorn sheep herds.
- Use transplants to create linked male populations.
- Use transplants to expand distribution and habitat use of existing populations.
- Avoid establishing isolated populations which are likely going to struggle. Use transplants to create linked populations, create metapopulations, or expand existing metapopulations.

- Develop guidelines for the best possible management of bighorn sheep captive facilities.

#### **Disease**

- Support research regarding effects of llamas, domestic goats, and cattle on bighorn sheep.
- Assess health of source bighorn herds. When capturing animals, develop a database on the diseases herds have been exposed to, particularly if transplanted sheep will contact other wild sheep.
- Bighorn and domestic sheep must be separated, to minimize potential disease transmission.

#### **Predation**

- Evaluate transplants of sheep into densely occupied deer habitat, which often have abundant mountain lion populations.
- Conduct research on predation impacts on lamb production and survivorship.
- Support ability of managers to remove mountain lions where they are a documented problem, especially with struggling bighorn herds.
- Improve habitat visibility to reduce vulnerability of bighorns to predation.
- Design artificial water developments so that predation at water sources is reduced or eliminated.

#### **Population Management**

- Do not assume density-dependent responses in bighorn sheep populations. Responses of bighorn sheep to population reductions are complex, and dissimilar to other ungulates (e.g., white-tailed deer).

#### **Livestock**

- Discourage habitat degradation by cattle and minimize habitat overlap between cattle and bighorn sheep. Anticipate more overlap with yearling cattle than with cow-calf pairs.
- Prohibit recreational goat packing in bighorn habitat, since we don't know what disease implications there might be, and also because escapee goats can survive very well in bighorn habitat.
- Manage burros within established appropriate management level (AML) guidelines.
- At water sources, bighorn sheep need to be separated from domestic stock and other feral animals, because bighorns tend to be displaced or outcompeted.

#### **Genetics and Taxonomy**

- Support Captive Breeding Specialist Group (CBSG) workshops to obtain more information on impacts of inbreeding. Establish an adequate information base to manage inbreeding effects.

#### **Endangered and Threatened Status**

- When justified, designation as T&E status should be pursued. Once sheep are designated, federal land management agencies then have legal requirements (e.g., reduction in direct take, killing, harassment) they must follow. Use T&E status to help obtain needed funds. Indirect take requires consultation on any habitat loss or negative impacts.
- Investigate alternatives (e.g., conservation plan) to listing for declining populations.

#### **Exotics**

- Do not introduce exotic mammals and/or plants to bighorn sheep range.
- Attempt to eliminate existing exotic plants and/or mammals from bighorn sheep range.

- Reduce potential for colonization of exotic plants on bighorn range by requiring use of certified hay and controlling or eliminating off-road vehicles.

#### **Education**

- Watchable wildlife programs should not increase disturbance on bighorn sheep ranges. Biological input into these programs is needed. Programs should emphasize ethical viewing of wildlife, especially by photographers.
- Use Project Wild to disseminate information about bighorn sheep.

## **Rocky Mountain Bighorn Sheep**

#### **Advocacy Groups**

- Expand the FNAWS network in states and provinces that don't currently have chapters/affiliates.
- Review the FNAWS grant-in-aid process and offer suggestions to improve that process.
- Improve coordination between the FNAWS network and states/provinces in the political arena.
- Seek increased funding for sheep management from the general public and non-consumptive NGOs.
- Expand outreach to include nonhunters. Recognize nonhunted populations as potential source herds.
- Be aware of expectations and conditions associated with funding (i.e., *quid pro quo*).
- Reinforce that advocacy groups are advisory while agencies retain responsibility and decisionmaking.
- Invite advocacy groups to meetings where they traditionally are not invited.
- Ensure that money from auctioned complimentary sheep licenses goes back into sheep management.
- Advocacy groups should get more involved in public and private land-use planning.
- Encourage and improve youth education in sheep projects.
- Advocacy groups should be strong proponents of hunter ethics.

#### **Habitat Fragmentation and Human Disturbance**

- Continue human disturbance studies and develop specific recommendations for specific herds.
- Use technology (e.g., Internet) to distribute herd-specific information on human disturbance studies.
- Integrate existing information between groups on how human disturbance is affecting bighorn sheep.
- Minimize human disturbance during critical times of year for bighorn sheep.
- Assess risk and map vulnerability (e.g., GIS) of herds on a five-year basis.
- Map cumulative effects of human disturbance and model future impacts, depending on land uses.
- Synthesize what is known about, and recommend further human disturbance research topics.
- Constrain time and location of recreational activities to enhance bighorn sheep habitat security.
- Work with metropolitan planners and local/state/private organizations to reduce human disturbance.
- Discourage habitat fragmentation and require mitigation of impacts.
- Work with public/private partners to expand/facilitate land exchanges, easements and acquisitions.
- Develop interpretive signs, brochures, pamphlets about ethical viewing of sheep.

### **Habitat Management**

- Implement habitat improvements on a large scale.
- For pinyon/juniper burning, implement a 50-year-or-less fire frequency, and reseed with grass and forbs. For sagebrush-dominated habitats, that fire frequency should be 25 years or less.
- Synthesize and share knowledge about necessary fire frequency and fire management practices for different vegetative communities which comprise sheep habitat.
- Aggressively pursue or create options to improve habitat within wilderness areas.
- Include habitat management techniques in wilderness planning, implementation, and legislation.
- Seek consistency from land managers on what habitat management practices are allowed in wildlife management areas, wilderness areas, or wilderness study areas (WSAs).
- Recognize wild sheep as a primary wilderness component.
- Assess, evaluate, and monitor wildlife habitat treatments and manipulation.
- Aggressively pursue chemical, mechanical, and biological control of noxious weeds in sheep habitat.
- States and provinces need written goals or plans for sheep restoration and distribution.
- Produce current and historic maps of known or suspected bighorn sheep habitat.
- Standardize terminology for sheep seasonal habitats.
- Standardize mapping scales and integrate mapping techniques
- Analyze and evaluate habitats prior to transplants, to ensure suitability before moving sheep.

### **State/Federal Relationships**

- Better coordinate state and federal planning for domestic sheep grazing in wild sheep habitat.
- Amend BLM and USFS land-use plans to recognize importance of wild sheep habitats. Describe specific management actions to achieve recognition of important wild sheep habitats.
- Modify existing MOU's to clearly establish state wildlife agency jurisdiction over wild sheep transplants, perhaps through the Western Association of Fish and Wildlife Agencies (WAFWA).
- Improve communication between states and National Park Service on bighorn sheep management.
- Develop bighorn sheep management plans where absent, particularly in the National Park Service.

### **Hunting and Harvest Strategies**

- Coordinate with tribal managers on shared herds.
- Manage herd population size and density with ewe removal strategies.
- Articulate biological basis for why we hunt these sheep herds.
- Management should be adaptive and based on management experiments.
- Publish results from management experiments (e.g., any-ram hunting), to build on that research.
- Standardize regulations between states.

### **Law Enforcement**

- Standardize legality of pickup heads and associated regulations on pinning and sale of pickup heads.
- Support stiffer penalties and fines for illegal harvest of bighorn sheep, perhaps to felony level.
- Enforce existing regulations and laws on wildlife violations and human-related disturbances (e.g., ORVs, dogs, planes). Elevate poaching of bighorn sheep to felony status.
- Work with advocacy (e.g., FNAWS network) and wildlife law enforcement groups (e.g., North American Wildlife Enforcement Officers Association) to promote, fund, and expand existing law enforcement relative to wild sheep.
- Support efforts to restrict or eliminate game farming.

- Support efforts to restrict or eliminate trafficking of wildlife parts.
- Improve coordination with tribal law enforcement officials.

### **Capture and Transplant**

- Optimize transplant stock between states and provinces.
- Improve communication on the need for, and availability of, different transplant stocks.
- Evaluate compatibility of transplant stocks to new habitats.
- Maintain database on transplant histories.
- Continue to use transplants to return sheep to historic ranges.
- Perform rigorous suitability evaluation of potential transplant areas.
- Evaluate success/failure of transplants, and publish that information.
- Transplant at least 30 sheep initially, then transplant additional animals via multiple releases, to increase the likelihood of a successful transplant.
- Formalize transplant guidelines in states and provinces.
- Perform disease testing on transplanted sheep, and include results in accessible transplant database.
- Establish minimum requirements and protocols for handling transplanted sheep.
- Where lacking, develop capture and transplant manuals.
- Determine individual mortalities two weeks post-transplant, to evaluate success of the transplant.
- Develop health and DNA histories for source herds, including linkage to prior transplants.
- Synthesize knowledge about appropriate interval between a die-off and reintroduction of sheep.
- Evaluate deer density and numbers, and the cougar situation, in potential transplant sites.
- Develop management strategies for metapopulations (i.e., sheep population size > 500).
- When transplanting sheep, radiocollar as many mature animals as possible to facilitate monitoring, while recognizing watchable wildlife viewing issues.
- No equipment should be used between herds unless properly sanitized, to decrease disease transmission.

### **Disease**

- Develop and share detailed health assessments of source herds.
- Promptly remove wild sheep after known interaction with domestic sheep.
- Share data on bighorn sheep disease, perhaps through the Western Wildlife Health Cooperative.
- Work with livestock industry and interested publics on the concerns of using domestic sheep for vegetation management (i.e., weed control) in bighorn sheep habitats.
- Continue to acknowledge fatal pneumonia transmission from domestic to wild sheep.
- Summarize and share available knowledge on effectiveness of treatments for diseases.
- Assess risk of potential interaction with domestic sheep and reduce this risk where possible.
- Synthesize information on risk of disease transmission from other livestock and wildlife species.

### **Predation**

- Encourage research that examines prey and predator populations simultaneously.
- Synthesize existing information on predation and its effect on bighorn sheep.
- Determine not only if predation is occurring, but if there is a population-level effect from predation.
- Recognize the complexity of predation.
- Monitor and evaluate effectiveness of predator control/management actions

### **Population Management**

- Status and trend of sheep herds should be monitored by taxonomic units and bioregions, not just state and provincial political units.
- Develop population management plans for wild sheep herds.
- Stress importance of high quality habitat coupled with appropriate density of sheep (i.e., “more sheep is not always better”).
- Acknowledge the potential for different limiting factors on males and females in the population.
- Monitor specific population parameters to determine status relative to carrying capacity, and make data-based management decisions.

### **Livestock**

- Partitioning of forage resources should be based on best available knowledge, including temporal, spatial, and dietary overlap.
- Recognize bighorn sheep habitat needs when allocating forage.
- Increase enforcement of trespass livestock.
- Encourage federal land managers to manage feral horses to appropriate management levels (AMLs).
- Research and recommend fence designs compatible with wild sheep daily or seasonal movement.
- Eliminate or modify net wire fences in wild sheep habitat, to facilitate passage by bighorn lambs.

### **Genetics and Taxonomy**

- Collect, analyze, store and share DNA information (e.g., blood, tissue, hair) on wild sheep.
- Develop and publicize an accessible database where this information is stored.
- Minimize loss of genetic diversity in our herds.
- Repopulate historic ranges with native subspecies when possible; if not, use closest ecotype available.
- Develop guidelines for mixing California and Rocky Mountain bighorn sheep via transplants.
- Determine and use most appropriate genetic stock for transplants.

### **Metapopulations**

- Recognize importance of corridors between populations. Be aware of potential disease transmission.
- Develop metapopulation strategy for Rocky Mountain bighorn sheep that addresses genetic diversity and potential disease transmission.
- Maintain metapopulations and genetic linkage for Rocky Mountain bighorns.

### **Exotics**

- Remove free ranging exotic ungulates. Seek effective and prompt responses for game farm escapees.

## **California Bighorn Sheep**

### **Advocacy Groups**

- Foster education, develop and improve communications and dialogue, provide information and data, and cooperate with those groups who seek information.
- Inform advocacy group about their opportunities for input into wild sheep management.
- Promote cooperation with other groups, including ranchers and forests products industry.

### **Habitat Fragmentation and Human Disturbance**

- Produce a seamless habitat map at 1:250,000 scale, identifying historic, occupied, and potential habitats of all wild sheep species/subspecies. Focus on U.S./British Columbia/Alberta by 2005; Alaska/Yukon/NW Territories by 2010.
- Identify problems with urban sprawl, animal damage, and developed areas where wild sheep may become a nuisance.
- Include wild sheep goals in range management and forest plans, and planning and zoning documents, listing specific objectives for wild sheep management, at the earliest opportunity.
- Develop, retrieve, and share existing guidelines on forestry and roads in British Columbia.
- Recommend distance from roads to fences be at least one-half mile, so sheep harassed off a highway/road do not immediately encounter a fence barrier.
- Develop guidelines on ORVs, military overflights, air space use, recreation, to minimize disturbance.

### **Habitat Management**

- Utilize adequate buffer zones for separation between domestic and wild sheep.
- Evaluate management practice of placing salt on bighorn ranges. Determine physiological demand for salt of California bighorns. Recognize the utility in treating some diseases and the potential for increased disease transmission (e.g., contagious ecthyma) with salt.
- Prescribed burning and fire management for California bighorns can be used to control juniper and conifer encroachment, but site-specific fire management planning should be done in advance.
- In general, fires should be avoided if they result in shrub loss in California bighorn habitat, but prescribed fire may promote desirable forage, enhance visibility, or decrease noxious weeds.
- Leafy spurge and other noxious weeds in bighorn habitat should be controlled chemically, rather than by use of domestic sheep.
- Provide forest and mining industry guidelines to maintain and enhance bighorn sheep habitat.
- Standardize terminology used in bighorn sheep management (e.g., defining habitat effectiveness).

### **State/Federal Relationships**

- Stress the importance for federal land management agencies to manage vegetation in designated wilderness and wilderness study areas (WSAs). Noxious weed control and prescribed burning to attain vegetation objectives for bighorn sheep are necessary.
- Stress the importance of being allowed to develop and maintain water sources in WSAs.
- Cooperatively identify time periods for sheep management activities in WSAs, to minimize overlap with heavy recreational use season(s).
- Cooperatively determine timing and frequency of helicopter use and landings in wilderness for sheep management practices.
- Recommend mitigation measures to address Department of Defense use of air space over WSAs and other seasonally important bighorn habitat.
- Identify and seek federal land agency approval for various habitat management activities in WSAs.

### **Hunting and Harvest Strategies**

- Develop a biological framework for harvest recommendations. Identify alternative harvest strategies to attain the same management objective.
- Trap/transplant surplus sheep to fill potential habitats prior to implementing limited ewe harvest.
- Recognize that hunting is a valid and legitimate population control method for California bighorns.

- Explain the importance of biological data collection relative to status, trend, and impact of hunting.
- Discourage the unethical practice of using aircraft for scouting by hunters.
- Minimize survey/inventory flights to minimize disturbance and displacement of bighorn sheep.
- Support mandatory horn plugging/pinning of legally harvested rams. In states where private possession of pickup heads is legal, pickup heads should also be pinned.
- Require permit for private possession of sheep heads, but disallow sale, to reduce illegal commerce.
- Subsistence harvest by native peoples should be monitored and reported.
- All harvest for herds shared by state/provincial/tribal jurisdictions should be recorded and shared.
- For California bighorn sheep, limited entry hunting rather than over-the-counter, general license hunting is preferred. If limited entry licenses are set appropriately, minimum horn curl regulations are not necessary.

#### **Law Enforcement**

- Seek consistency between and among states, provinces, and tribes on legality of pickup sheep heads.
- Eliminate the potential for private ownership of native species of wild sheep.
- Oppose game farming, private ownership, sale, trade, or interstate transfer of wild sheep except between government agencies and tribal governments.

#### **Capture and Transplant**

- Develop a standardized capture procedure.
- Develop and document herd health histories.
- Pretest source herds, especially for interstate or international transplants.
- Be extremely cautious about mixing stocks from different sources.
- Transplant of California bighorns outside traditional range should be allowed if they are the best adapted or most appropriate stock to fill available habitat if, and only if, separation from other wild sheep is assured.
- Standardize protocols for release sites, including a prerelease evaluation of each site.
- Identify preferable family group units when capturing stock for transplants.
- Use caution in transplanting sheep into marginal sites. Many states are nearing completion of transplants into their most preferred sites. To continue their program, they may be transplanting sheep into marginal sites. It may be better to leave those as buffer areas without sheep, or allow the core population to expand into those areas, rather than risk compromising the entire area with the possibility of introducing disease.

#### **Predation**

- States should establish protocols for predator management and maintain opportunities to utilize all tools necessary for predator management. Predator control or management may increase the success or decrease the risk of new transplant herds or herds in decline.

#### **Population Management**

- Urge formal application of a modified metapopulation model, defining a metapopulation as an area of distinct herds or subgroups where periodic interchange may occur, bounded by topographic or mechanical barriers that preclude all but rare movement across those barriers.
- Consider weather and climate as explicit variables, along with topographic, vegetative and nutritive factors in determining habitat suitability and herd performance.

- Improve the ability to monitor herd performance.
- Further delineate and seek to understand mortality and risk factors in population management.

#### **Livestock**

- Cattle grazing may be compatible with wild sheep, but managers should minimize the potential for direct contact and forage competition, wherever possible.
- Wild horses should be managed to appropriate levels, to minimize impacts to wild sheep (e.g., water holes, habitat destruction and/or modification, range condition).
- States and provinces should prevent interaction between mouflon sheep and California bighorn sheep. The presence of mouflon sheep precludes opportunities for establishing new bighorn herds.
- Managers should strive to encourage blood testing and serum banking of California bighorn sheep, to develop species-specific standards, as opposed to cattle standards now used for disease exposure.

#### **Inter-Connectedness and Corridors**

- Identify, map, secure, and/or recover corridors for dispersal and seasonal movement between distinct herds and segments of herd. Once corridors are identified, identify potential blockages to movement.
- Identify private lands critical to wild sheep conservation.

#### **Genetics and Taxonomy**

- Retain existing nomenclatures until evidence can be clearly established and independently validated that new taxonomy merits acceptance by all parties concerned.
- Recognize that species are more than their genetics. Maintain unique ecotypes.
- Identify how much genetic diversity exists. Discuss how much diversity is being lost because small populations are experiencing genetic drift, with some populations being extirpated or in decline.

#### **Endangered and Threatened Species**

- Threatened or endangered status for British Columbia-derived populations of California bighorn sheep is unnecessary.

#### **Exotics**

- Urge federal land management agencies to be more restrictive with mouflon sheep on public lands.

#### **Records Book Listing**

- Support records book listing for California bighorn sheep if entered heads are plugged/pinned and supported by a valid hunting license. No pickup heads should be allowed in records book listings.

## **Thinhorn Sheep**

#### **Advocacy Groups**

- Enhance and maintain existing alliances.
- Initiate new, less traditional alliances, being particularly attentive to learning and teaching in developing and maintaining those relationships.

**Habitat Fragmentation and Human Disturbance**

- Enthusiastically participate in land management planning and review.
- Firmly educate involved publics concerning probable negative impacts to wild sheep.
- Monitor impacts and increase certainty of recommendations for future management of wild sheep.
- Anticipate problems and proactively plan for specific wild sheep management.
- Teach the public that sheep populations can support many managed uses, and that parks meet needs for special nonconsumptive uses.
- Recognize wild sheep habitat needs when analyzing land tenure adjustments and large-scale land exchanges.

**Habitat Management**

- Protect basically pristine thinhorn habitats from degradation. Habitat degradation of pristine habitats will be negative for thinhorn sheep.
- Managers should not rush to “improve” pristine habitats.

**State/Provincial/Territorial/Federal Relationships (Intergovernmental Relationships)**

- Work locally with other governmental agencies, advocating a return to or establishment of a functional management system.

**Hunting and Harvest Strategies**

- Harvest of only mature rams has minimal effect on thinhorn populations and can be sustained with minimum population monitoring or management action.
- Harvest of ewes or immature rams may adversely affect population size, productivity, and trend, and is not universally appropriate. It must be closely monitored where it occurs.

**Law Enforcement**

- Inform and educate the public on the rationale for existing regulations, in an effort to minimize violations because people understand and comprehend those regulations.
- Support law enforcement and aggressively support fines equal to the established market value of poached animals, when convictions have been obtained.

**Capture and Transplant**

- Capture only as necessary. Use the best data available to select the most appropriate capture method.
- Oppose transplants in thinhorn ranges.

**Disease**

- Aggressively pursue legislation and regulations assuring no domestic sheep, goats or cattle interact with thinhorn sheep.
- Establish baseline studies to examine the health and disease status across thinhorn sheep range.

**Predation**

- Retain predator control as a management option, apply it with great care, and make sure you identify why, how and what your thresholds are for application.
- Predation is seldom an important limiting factor in Dall sheep populations. In isolated cases where predation may be a problem, the biology of the situation should be carefully documented and demonstrated, and then appropriate action taken.

- Additional research and documentation on situations where predation can have an effect are needed. If predator control/management is undertaken, the program should be thoroughly documented and evaluated.
- Where consistent with applicable constitutional mandates and legal constraints, managers should support implementation of predator management to facilitate attainment of defined population size and human use objectives.

#### **Population Management**

- Thinhorn populations are not subject to density dependent effects. Rather, they are held below carrying capacity by other factors, such as weather.
- Managers should take no management action which may reduce population size without clear and consistent data indicating a density-dependent limitation exists.

#### **Genetics and Taxonomy**

- Examine the issue of the Fannin subrace of Stone and Dall sheep.
- Genetics is an academic rather than a management concern for thinhorns.
- Maintain pristine ecosystems and let natural systems operate.

#### **Endangered and Threatened Species**

- View thinhorn sheep as subspecies, not jurisdictional groups.
- Do not let thinhorn populations become endangered.

#### **Exotics**

- No introduction of exotics in thinhorn habitat.

#### **Native Ungulates**

- Manage total predator/prey systems, not single species management. To target management for one species often can be detrimental to other species. Management should be designed at the landscape scale.
- Maintain intact ecosystems.

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## **MANAGEMENT OF WILD SHEEP IN NORTH AMERICA**

**COMPILED BY JAMES A. BAILEY**  
**EDITED BY KEVIN P. HURLEY**

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A workshop was convened at the 2ND North American Wild Sheep Conference to develop guidelines for managing wild sheep in North America. Participants included wild sheep biologists and managers from state, provincial, territorial, tribal, and federal agencies, universities, and research organizations, law-enforcement officers, and members of the public representing organizations that support conservation and management of wild sheep. Much of the experience and knowledge concerning the biology and management of wild sheep in North America was represented.

Working groups for desert bighorn, Rocky Mountain bighorn, California bighorn, and thornhorn sheep developed separate recommendations. These were discussed by the entire workshop and recorded for developing guidelines. Management topics were not wholly prioritized because the most critical management needs will vary among locations and times. Some literature citations have been added to increase utility of the guidelines. However, this is far from a complete review of the literature on wild sheep management. Previous useful literature reviews and management guidelines are found in: Bureau of Land Management (1995a), Trefethen (1975), Monson and Sumner (1980), Wilson et al. (1980), Van Dyke et al. (1983), Krausman et al. (1984), McCarty and Bailey (1994), Bureau of Land Management (1995b) and Valdez and Krausman (1999).

This list of guidelines is long and ambitious. It will tax the resources of many management agencies and organizations. However, it is the goal we must strive to achieve if we are to maintain the benefits of North American wild sheep for ourselves and future generations.

### **MANAGING WILD SHEEP ENVIRONMENTS**

We may be certain that, if civilization continues its attrition of the remaining tracts of primitive country, all of our scientific knowledge and its specialized techniques may come to nothing. Not only the bighorn's existence, but much of his intrinsic value to man as well, depends upon the preservation of his habitat. It is more than likely that a hunter's memory of his stately ram is at least equaled by remembrances of mountain peaks, glittering lakes and green, untrampled meadows. (Smith 1954:104-105).

#### **Habitat Loss and Fragmentation**

1. Establish, restore, maintain and protect complete wild sheep ranges, including seasonal ranges and movement corridors for populations and metapopulations.
2. Protect all pristine wild sheep environments where they persist.
3. Provide buffer zones and seasonal activity restrictions to mitigate impacts of oil and gas developments, mining, other industrial activities, and tourism-related impacts upon wild sheep ranges. Promote zoning regulations to minimize subdivision expansion into important foothill and canyon wild sheep habitats.

### **Habitat Management and Acquisition**

1. Where necessary, use easements, land exchanges and acquisitions to establish, restore and protect complete year-round ranges, including movement corridors, for wild sheep populations.
2. Habitat analysis should precede habitat management for wild sheep so that management is directed at limiting factors within sheep ranges, including movement corridors. Limiting factors may differ between ram ranges and ewe-juvenile ranges, and among years with differing weather. Access to a diversity of forage resources and foraging sites with different elevations, aspects and forage types will provide the most stable, year-round nutrition for wild sheep. Management efforts should include evaluation of the effectiveness of habitat manipulation in achieving stated goals for sheep populations and distributions.
3. In many areas, wild sheep habitats are being lost due to encroachment by trees and tall shrubs that restrict visibility (Risenhoover et al. 1988). Managers should be aggressive in developing site-specific prescriptions for treating deteriorated habitats with fire, chemical, or mechanical means (Greenwood et al. 1999, Smith et al. 1999). Repeated treatments of large areas may be necessary. Landscape-level habitat manipulation should be addressed, to avoid small, "patch" treatments that may artificially and adversely concentrate wild sheep. However, caution is advised where California bighorn use open shrub habitats, and pristine thinhorn sheep ranges probably do not require vegetation manipulation.
4. Within wild sheep ranges, reseed disturbed areas with native grasses, forbs and shrubs known to be valuable to local sheep populations.
5. Control introduction of exotic plants on wild sheep ranges by requiring use of certified hay. Educate off-road vehicle users about their potential to inadvertently transport exotic weeds on vehicle undercarriages. Seek to control established exotic plants with chemical, mechanical or biological methods.
6. Where bighorn sheep use natural or artificial waters, restrict access to those waters by livestock and feral burros. Artificial waters should be placed in secure habitats with escape terrain and good visibility. Remove visibility-obstructing vegetation surrounding water sources.
7. Follow Bureau of Land Management fencing guidelines (BLM Manual Handbook H-1741-1-Fencing, Release 1-1572, 12/6/89) on wild sheep ranges and in movement corridors. Remove or modify net wire fences, where possible, in sheep ranges.
8. Seek to place highway right-of-way fences as far from roads as possible, so as not to create a barrier that may keep animals on the roadway.

### **Human Disturbance**

1. With public outreach and interagency coordination, including local governments where appropriate, develop site- and herd-specific regulations for eliminating or mitigating impacts of human disturbance on wild sheep. Where necessary, seasonally restrict recreational use of critical wild sheep habitats and movement corridors. Prohibit hiking with dogs in critical habitats. Agencies should enforce their regulations intended to control wildlife harassment.

2. Identify areas where wild sheep may become attracted to human developments or become a nuisance/hazard (e.g., roadside barrow ditches feeding on exotic grasses, golf courses). Develop habitats to attract sheep away from these areas.

### **Disease Threats and Management**

1. Due to the frequent transfer of *Pasteurella* spp. bacteria, domestic sheep allotments in or near the ranges of wild sheep are a serious threat to the health of wild sheep (McCarty and Bailey 1994:15, Martin et al. 1996). These allotments should be eliminated or, if suitable, converted to cattle.
2. Domestic sheep should be kept at least 13.5 km (9 miles) from desert sheep ranges (Desert Bighorn Council, Tech. Staff 1990; BLM Instruction Memorandum No. 98-140). Greater isolation distances, up to 20 km (12.4 miles) (Singer et al. 2000) or more (Schommer and Woolever 2000) are necessary where there are no effective barriers to wild sheep movements. Movement patterns of wild sheep should be determined for any herd in the vicinity of an existing or proposed domestic sheep pasture. Where possible, maintain dense forest cover as a barrier between domestic and wild sheep. Continue education and outreach with the domestic sheep industry and small "farm flock" operators regarding risks to wild sheep associated with domestic sheep. Use an inter-agency approach, involving domestic sheep permittees and Woolgrower Associations, to analyze risks and potential for interaction and to develop site-specific solutions (Schommer and Woolever 2000).
3. Permanently remove any wild sheep that has interacted with domestic sheep.
4. Do not use domestic sheep or goats for exotic weed control in or near wild sheep range.
5. Remove any feral goats from wild sheep ranges. Discourage recreational pack goats. If used, ensure they are closely tended, are tethered or penned at night, and will not contact wild sheep. Pack goats should not have been in recent contact with domestic sheep. In areas where wild sheep are exceptionally tame and prone to approach humans and pack animals, prohibit recreational pack goats.
6. Prevent, and seek legislation to preclude, the introduction of any domestic sheep, goats or cattle into the pristine ranges of thinhorn sheep, or into the ranges of any bighorn sheep populations that may have persisted without previous contact by livestock.
7. Consider the risks of disease transmission in developing strategies for metapopulations. In some cases, the viabilities of two smaller metapopulations will have to be weighed against the risk of epizootic in a larger metapopulation.
8. Use all opportunities to obtain samples for assessing the health status of wild sheep herds. This is especially important prior to transplanting animals. Maintain a database of herd health and disease-exposure for each herd. All cases of sickness or natural death of wild sheep should be presented to a wildlife disease expert or veterinary diagnostic laboratory for accurate diagnosis. Each state, province, and territory should have a protocol for responding to reports of sick wild sheep, including where to obtain veterinary assistance, tests to be performed and subsequent population monitoring.
9. States, provinces, territories, and tribes should share data on disease exposures and health parameters of wild sheep, possibly through the Western Wildlife Health Cooperative.

10. Develop an internet site or other effective, timely communication for disseminating current knowledge of disease outbreaks and science-based management actions.

#### **Competition from Livestock, Exotic and Native Ungulates**

1. No exotic ungulates or domestic livestock should be allowed on pristine thorn sheep ranges. Exotic ungulates should be discouraged on all other wild sheep ranges.
2. Manage wild horses and burros on wild sheep ranges within established guidelines. Eliminate other exotic ungulates, especially mouflon sheep, where they have no legally mandated presence.
3. Where cattle graze wild sheep ranges, use management strategies to minimize overlap of range use, especially during critical seasons. Cow/calf pairs are preferred to yearlings, which are more prone to use steep terrain. Partition forage resources between cattle and wild sheep using the best available local knowledge, including food habits and spatial and temporal overlap for both ram and female groups of sheep. Allocate sufficient amounts and kinds of forages to wild sheep to maintain a viable herd of healthy animals.
4. Promptly remove trespass livestock from wild sheep ranges. Monitor allotments for conformance to agreed-upon stocking rates and seasons.
5. Wild sheep are generally subordinate to other ungulates at water sources. Where access to water is a limiting factor, provide separate watering access for sheep by fencing out livestock, horses and burros from at least a part of the water source. Otherwise, provide wild sheep waters in such steep terrain that other ungulates cannot access the sites and/or develop other water sources to draw competing ungulates away from waters developed specifically for wild sheep.
6. Oppose game ranching in which exotic ungulates may unintentionally become established on wild sheep ranges. Where game ranches exist, promptly remove any escaping animals. Require game ranches to provide bonds that will assure removal of escapees. Regular monitoring and maintenance of game ranch fences should be required and there should be penalties for inadequate fence maintenance.
7. Discourage vegetation change, from disturbance or succession, that will create or increase competition from other native ungulates on wild sheep ranges.

#### **Predation**

The impacts of predation upon wild sheep populations will depend mostly upon (1) the vulnerability of sheep to predation, as determined by the health of sheep and by habitat security factors (escape terrain proximal to foraging areas, and visibility); (2) predator abundance; and (3) the size of the wild sheep population as it determines whether predation rates are density- dependent, or inversely density-dependent (Solomon 1958). In a multiple-prey system, the predator/wild sheep ratio and the proportion of the sheep herd lost annually to predation may increase as the sheep population declines, even to extirpation. Predator-prey relations are often complex and highly dynamic, and therefore vary among times and places.

1. Predator control is a valid management option, especially for small or newly transplanted wild sheep herds. Predator management strategies should be flexible, adapting to local and temporal conditions,

and should be implemented in ways that allow reliable evaluations of their effects upon wild sheep populations.

2. Many wild sheep habitats need management, particularly removal of tall, dense vegetation, to improve visibility and reduce vulnerability of sheep herds to predation. State and provincial wildlife agencies should be more proactive in encouraging and facilitating habitat management, including wild sheep transplant or population augmentation sites.
3. Water sources in wild sheep ranges should be designed and located, or vegetation near waters should be treated, to decrease vulnerability of sheep to predation by providing escape terrain and good visibility.
4. New transplants of wild sheep are especially vulnerable to predation because there are relatively few sheep and they are placed in unfamiliar territory. Transplant sites should be selected to minimize vulnerability to predation. It is desirable to evaluate predator abundance in proposed transplant sites, and to consider if pre-transplant predator control should be implemented.

### **Wilderness Management**

1. Improved state-federal communications on wilderness management is needed. Federal agencies should assign biologists, as well as recreation specialists, to coordinate with state agencies and wild sheep advocacy groups on wilderness issues. Domestic sheep in wilderness areas with potential or occupied bighorn sheep habitat should be eliminated.
2. If wild sheep are to contribute fully to wilderness values, wilderness management plans must recognize and provide for the natural processes expected in wild sheep populations. Where wild sheep occur in wilderness areas, their populations should be designated as primary wilderness components (Bailey and Woolever 1992). Wild sheep should be reintroduced into all suitable, vacant historic ranges within wilderness areas.
3. Some management intervention will often be necessary in order to maintain the wilderness values of wild sheep populations, especially in the preponderant small wilderness areas. These values include seasonal and metapopulation movements that are necessary for population viability and maintenance of genetic resources. Interventions such as ignition of prescribed fires, monitoring of populations, and the capture and movement of animals are justified to retain these values. Reducing conifer encroachment in prime bighorn range inside designated wilderness should be emphasized.
4. Clear policy guidance should be developed for management of habitats and wildlife populations in wilderness areas and wilderness study areas. Policies should be applied consistently among areas and periods.
5. Based on input from state wildlife management agencies, wilderness management plans should identify time windows when management activities for maintaining wild sheep values, including survey flights, will cause minimal impacts to other wilderness uses and wilderness values.

### Research Needs

1. The effects of developing artificial water sources upon the distribution, productivity and survival of wild sheep requires further study. Experimental research, with treatment and control groups, is recommended. In hot climates, artificial waters should be tested periodically for the presence of dangerous *Clostridia* bacteria.
2. Studies of predator-wild sheep dynamics, including systems with multiple prey species, are needed. Wild sheep demographics, including lamb survival and recruitment, should be determined at various combinations of predator and prey population sizes. Experiments should be designed to manipulate predator or prey population sizes, and should include both favorable and unfavorable weather periods for wild sheep.
3. Experiments are needed to determine the minimum fence necessary to hold cattle while allowing safe passage for all sex-age classes of wild sheep.
4. Continue research on the infectious diseases and parasites of llamas, domestic goats and cattle, and their threats to wild sheep.
5. A standardized disease and nutrition sampling and testing protocol should be developed for wild sheep, possibly through the Western Wildlife Health Cooperative. Routine collection and sharing of blood and fecal samples may be used to establish baseline values of nutritional and health parameters for each subspecies and species of wild sheep. Baseline values may then be used to assess herd health, trend of ecological density, and success of habitat management.
6. Conduct experimental as well as observational research on the effects of human disturbance upon wild sheep. Demographic as well as behavioral and physiological impacts should be determined. There is a need for a review and synthesis of existing information on this topic.
7. Review and synthesize information on fire frequencies needed to maintain open wild sheep habitats in many ecosystems. Develop protocols for conducting prescribed fires in wild sheep habitats.
8. Review and synthesize information on effects of aircraft (fixed wing, helicopter and hang gliders) upon wild sheep behavior. Develop guidelines for management.

### **MANAGING WILD SHEEP POPULATIONS**

“The objective of conservation of mountain sheep is to safeguard the future of the species. As a minimum it means the preservation of a diverse gene pool in interaction with a natural ecosystem..... A reserve system would contain representative populations, not only of each subspecies of mountain sheep, but also of different ecotypes within a subspecies..... Such a system would be the backbone of our efforts to conserve mountain sheep and insure the availability of animals and knowledge for present and future management needs.” (Geist 1975:84).

### Harvests and Population Reductions

1. Obtain reliable survey information as a basis for allocating wild sheep harvest permits. For large thornhorn populations, conservative harvests can be sustained with minimum population monitoring.

Elsewhere, monitor population trend, abundance, recruitment and ram age structure, at least. Monitor forage conditions in critical habitats. Additional data on sex-age specific mortality rates will enhance understanding of herd dynamics and enhance population modeling efforts (McCarty and Miller 1998). Use long-term data to assess the role of weather in determining herd performance.

2. For large, productive wild sheep herds living in open, continuous habitat, conservative harvest of mature rams has little, if any, population effect (Geist 1975:92). If the number of ram licenses is limited and conservative, horn curl regulations are unnecessary.
3. Removal of ewes may be beneficial in herds that are near forage carrying capacity and are exhibiting symptoms of density-dependent declines in recruitment and animal quality. Symptoms of density-dependence may include lack of yearling breeding and reduced reproduction by 2-4 year old ewes, extended lactation, increased average age of adults, reduced horn annuli growth in rams over the first 3 years of life, and reduced body size of yearling ewes. Density-related changes in herd dynamics should be verified, not assumed. Many herds are controlled primarily by density independent factors, and carrying capacities may vary greatly among years, depending upon weather. If ewes are to be removed, translocation is preferred unless all suitable ranges have viable wild sheep herds. Impacts of ewe removals should be measured with pre- and post-treatment data, or with another experimental design including control and treated populations.
4. All harvests, including state, provincial, territorial, tribal or subsistence harvests, should be reported and recorded in a common database for each metapopulation.
5. Hunter orientation programs are encouraged. These may include identification of legal sheep, regulations and hunter ethics, care of meat and trophies, and biological rationales for harvest levels and methods.
6. Use public outreach to explain the rationales and the economic, cultural, recreational and biological bases for hunting of wild sheep. Do not promote a biological basis (herd management) where none exists (herds below forage carrying capacity; harvest of older rams only).
7. The California bighorn working group supported record-book listings for California bighorn, but only for registered and plugged trophies taken by fair chase, not for pickup heads.

#### **Capture, Handling and Transplants**

1. Wild sheep should be reestablished in all vacant historic ranges that still provide suitable habitat.
2. Transplants may be used to establish new herds, augment existing herds, expand existing ranges or create migratory behavior. Transplant strategies should be related to plans for metapopulations of wild sheep. Establishing isolated populations in habitats that do not have the potential to support at least 100 wild sheep is discouraged.
3. Potential transplant sites should be thoroughly evaluated. For historic ranges, consider the possible causes for extirpation and determine that these problems have been rectified. If evaluation indicates potential habitat problems, improve habitat prior to releasing sheep. Evaluate predator abundance, especially where there may be moderate to large deer and cougar populations. If determined appropriate, implement pre-transplant and temporary post-transplant predator control to assist in

establishing new wild sheep populations. Eliminate or mitigate livestock or other large ungulate conflicts prior to release of wild sheep.

4. For each transplant, use the native subspecies where possible, otherwise the most nearly similar ecotype (i.e., similar food habits, similar habitat selection patterns, similar seasonal and daily movement patterns). Cooperation among states, provinces and tribes may be necessary to provide the most appropriate transplant stock.
5. Move at least 30 sheep for any initial transplant. Higher numbers, through multiple transplants, will likely enhance success. Translocation of family or social groups is preferred over the use of individuals captured separately, but genetic concerns from transplanting small numbers of potentially-related sheep should be recognized. Recognize that smaller transplants (N=10 head) to supplement existing small bighorn herds are a viable management technique. Also, transplanted sheep may be released at multiple locations within a project area.
6. Do not remove large numbers of sheep from small source herds. Such removals may cause range contraction and inversely density-dependent predation rates.
7. Test source herds for diseases. Minimize potential for transferring diseases among wild sheep ranges. Do not transplant sheep from herds with recent histories of pneumonia. In multiple-source transplants and augmentations, aim to avoid mixing animals with dissimilar disease exposures. If necessary, test for incompatible diseases by exposing a few animals under controlled conditions. Sanitize all handling equipment between capture and transplant operations.
8. Obtain adequate samples for genetics analysis from each group of transplanted sheep.
9. Monitor transplanted sheep for at least a year, most intensively during the first 6 months. Use mortality sensing radio collars, and collar as many animals as possible, with exceptions where wildlife viewing is the primary management objective.
10. Each state, province, and territory should maintain a database of transplant histories, including genetics and disease information.
11. If propagation pens are used to maintain a source herd and provide transplant stock, maintain numbers of sheep with supplemental feed *ad libitum*, if food quantity or quality is suspected to be limiting. Maintain a 1:5 ram:ewe ratio, primarily by removing young rams. Isolate ewes during the lambing season. Periodically obtain samples to monitor genetic diversity of the captive population. Rotate breeding rams to maintain genetic diversity while recognizing potential disease concerns. Periodically supplement the female breeding stock with ewes from external sources. Remove competing ungulate species from the pen. Minimize predation losses with effective fences and predator control, as needed (New Mexico Dept. Game and Fish/Conservation Breeding Specialist Group, 1999:83).
12. Each state, province, and territory should have written protocols for capturing, handling and transplanting wild sheep. There should also be a standard protocol for evaluating animal health. Health and safety of wild sheep must be stressed in all capture and handling operations. Capture teams should include veterinarians. Guidelines of the Desert Bighorn Council Technical Staff (1982) are recommended with one exception: soft release of transplanted sheep, using a temporary enclosure, is not recommended.

13. Transplants are not needed in thornhorn sheep populations.

#### **Taxonomy, Genetics, Ecotypic Variation**

1. Although the existing taxonomy of wild sheep is questioned, it should be retained until thorough and extensive genetic analyses have been completed and withstood peer review.
2. States, provinces, and territories should cooperate to monitor the status and trends of wild sheep according to political units, taxonomic units, and bioregions (major ecotypes of wild sheep).
3. The wild sheep of North America have undoubtedly lost much of their original genetic diversity due to extirpations and population declines resulting in genetic drift. Genes interact with environments to determine the genetics of future populations and also the diverse anatomical, physiological and behavioral results of ontogenies. If the remaining genetic diversity of wild sheep is to be preserved, and if its full value is to be realized, wild sheep must persist in a diversity of environments. Therefore, the preservation of ecotypic diversity is equally important as the preservation of taxonomic diversity (Geist 1975:84).
4. In pristine North America, subspecies of wild sheep did not frequently occur as isolated populations. As more historic ranges of wild sheep are being repopulated, genetic exchange between subspecies is again expected. The Desert Bighorn Council and the Northern Wild Sheep and Goat Council should develop guidelines for managing clines between subspecies, and provide suggestions for recognizing categories of wild sheep in hunting-related record books.
5. Genetic studies are needed, not only to refine the taxonomy of wild sheep, but also to determine the genetic diversity that can be retained within subspecies. Biologists should collect, label and store samples for genetic analyses at almost every opportunity. A small number of central storage repositories for these samples is desirable. Samples should be available to qualified geneticists. Protection of samples for individual professional ambitions should not impede comprehensive analyses using a variety of methods.

#### **Threatened and Endangered Classifications**

1. Federal funding should be adequate for the recovery of listed subspecies. Prohibitions of the Endangered Species Act against direct take and against indirect take (i.e., habitat destruction) should be enforced.
2. Conservation strategies should be developed and implemented to avoid the necessity for listing imperiled subspecies or distinct populations of wild sheep. These strategies must contain clear commitments to conserve sheep and their habitats, if they are to reduce a need for protection under the Endangered Species Act.
3. Stocks of California bighorn sheep derived from British Columbia do not warrant listing as threatened or endangered at this time.

### **Management of Metapopulations**

1. Metapopulation management plans should weigh the values of demographic support and genetic interchange against the risks of disease transmission among populations.
2. It is imperative to maintain corridors with appropriate habitat qualities (e.g., foraging areas, water sources, security) for unimpeded movement of wild sheep among populations within metapopulations. Likely corridors are areas with steep or broken terrain. Vegetation in these corridors should be managed to maintain visibility. Barriers caused by roads, especially interstate highways, and by canals, fences, and human occupations should be minimized and mitigated.
3. Agency rewards and incentives should not favor the funding and implementation of isolated management projects at the expense of developing and implementing comprehensive metapopulation plans (Bailey 1992).

### **Research Needs**

1. Experimental research on the impacts of inbreeding in wild sheep is needed. There are opportunities for this research whenever a small wild sheep herd is augmented with a novel genetic stock. Pre- and post-transplant reproduction and survival may be compared. Or, if a novel genetic stock of only ewes is introduced, the reproductive successes of native inbred and translocated outbred ewes may be compared within the post-transplant period.
2. Historic records should be used to evaluate the effects of moving transplant stocks into novel vegetation types.
3. Determine the persistence of diseases following dieoffs and the appropriate quarantine period necessary before the affected herd or habitat may be restocked with wild sheep. Evaluate management activities that may reduce this quarantine period.
4. Much research is needed on the population dynamics of wild sheep in single- and multiple-prey predator-prey systems. Opportunities to manipulate the abundance of wild sheep, the abundance of alternative prey, or the abundance of predators should be used in management experiments.
5. The values and disease risks for wild sheep, particularly of contagious ecthyma, from providing baits or salt blocks, including antibiotic, anthelmintic (Miller et al. 2000) or trace-mineral blocks, should be determined.
6. The characteristics of "Fannin" thinhorn sheep should be investigated to clarify their taxonomic, genetic and ecotypic status.
7. Information on the interrelationships of mountain goats and wild sheep should be summarized and the need for further research evaluated.

### **ADAPTIVE MANAGEMENT**

"It is a common pastime in many organizations to collect vast quantities of data on a routine basis . . . with the vague intentions of submitting them to analysis one day. The piles of useful stuff in the files get more

comprehensive, and out of date, as the years go by. Pious intentions to analyze them some day are of little value. If data are not worth analysis at a suitable near date they are rarely worth collection. Data should be collected with a clear purpose in mind. Not only a clear purpose, but a clear idea as to the precise way in which they will be analyzed so as to yield the desired information." M.J. Moroney, source unknown.

1. Management of wild sheep and their habitats should be adaptive, building upon reliable knowledge that is generated by testing management hypotheses with rigorously designed management experiments (MacNab 1983). Designing these experiments is the responsibility of both management biologists and research biologists. To the extent practicable, experimental management should include designated controls, random assignment of treatments, replications, and a commitment to measuring and reporting results.
2. Confounding of multiple experiments on one wild sheep herd or habitat must be avoided if the effects of individual management practices are to be evaluated.
3. Results of management experiments should be analyzed and published in accessible journals, symposia or proceedings.

#### **THE HUMAN ELEMENT IN WILD SHEEP MANAGEMENT**

"Perhaps the greatest need of all is for an informed general public willing to accept the responsibility of seeing to it that good conservation practices and a continued program of research are carried out." (Buechner 1960).

#### **Advocacy Groups**

1. Wild sheep advocacy groups have important advisory and fund-raising roles. However, management agencies have ultimate decision-making responsibilities.
2. Advocacy groups should be expanded to include a broad range of both hunting and non-hunting publics and organizations.
3. Chapters of the Foundation for North American Wild Sheep, or organizations affiliated with the Foundation, should be established in all states and provinces that have wild sheep. Chapters are also encouraged in states and provinces that do not have wild sheep.
4. Professional biologists should encourage advocacy groups by maintaining regular communications, by providing clear biological rationales and critiques for management options, and by carefully considering and responding to the concerns and needs of advocacy groups.
5. Advocacy groups should be invited to participate in interagency management meetings, especially for land-use planning that impacts wild sheep habitat.
6. In dealing with advocacy groups, biologists should emphasize the commonality of goals among otherwise diverse groups. Attention should be focused upon the maintenance of complete wild sheep habitats and healthy, viable populations and metapopulations.

7. Professional wild sheep biologists should be used to assist in evaluating proposals for project funding by advocacy groups. Each funding organization should develop a comprehensive format to be used for submitting all proposals.
8. Advocacy groups should be strong proponents of hunter ethics.

### **Fund Raising**

1. Continued private funding of many types of projects for wild sheep is needed. These include population management, improvement and acquisition of habitat, education, short- and long-term research, and law enforcement.
2. Funding of wild sheep management by a broad range of advocacy groups and by the general public is appropriate and needed. Hunters have accepted a disproportionate share of the costs of wild sheep management, while the benefits of wild sheep populations are realized by all.
3. Cooperative federal funding of wild sheep management is especially appropriate for unhunted populations on federal lands, such as National Parks. Relying primarily upon hunter/advocacy groups to fund this management is not appropriate.
4. Professional biologists should communicate regularly with advocacy groups, not just when funding of management projects is being requested.
5. When an advocacy group is funding a management or other wild sheep project, there should be a clear, written understanding of the project objectives, including the expectations of the funding organization. Funding recipients are obligated to report management efforts, research findings and management implications from funded projects to their funding organizations.
6. Funds from special sales or auctions of hunting licenses for wild sheep should be used solely for wild sheep enhancement and should not be diverted to other uses (Northern Wild Sheep and Goat Council 1988).

### **Political Action**

1. Political activities for protecting wild sheep and their habitats should be coordinated among advocacy groups and across state, provincial, territorial, First Nation, Native Corporation/Organization, and international boundaries.
2. In order to reduce the threat of pneumonia epidemics in wild sheep, political (e.g., legislative) support from advocacy groups is especially needed to facilitate the retirement or purchase of domestic sheep grazing allotments within or near wild sheep habitats, or to preclude introduction of domestic sheep or goats into pristine wild sheep habitats. Support is also needed for transplants of wild sheep when they are opposed by other special interest groups, and for protection of wild sheep habitats in land use planning.

### **Education and Outreach**

1. Public education programs should emphasize the values of both huntable and nonhuntable populations of wild sheep, the habitat needs of wild sheep and the impacts of land uses upon wild

sheep habitats, including corridors that allow sheep to move within and between sheep ranges. The public should be better informed of the values of genetic diversity within subspecies of wild sheep.

2. Education and outreach programs should be expanded to reach more of the non-hunting public.
3. Watchable wildlife programs should not increase disturbance on wild sheep ranges. Viewing sites should be carefully planned to avoid disturbance, especially during critical seasons of the year. Viewing sites are best located below the sheep and behind a barrier such as a river. Where viewers frequently walk among sheep, restriction of viewers to designated trails is desirable.
4. Public education programs should emphasize the ethics of viewing wildlife.
5. Opportunities to involve youth in wild sheep management projects should be utilized.
6. Biologists should encourage publications on wild sheep for the public by suggesting topics, providing information and providing texts and photos.
7. Advocacy groups should assist in disseminating accurate and timely information on wild sheep management to the broadest possible public.

#### **Law Enforcement**

1. Sale or barter of picked up heads should be illegal because poached sheep may be represented as "pickups". Ownership of all wild sheep heads should be by permit only, and all heads should be registered and permanently marked (i.e., plugged, pinned) for future identification. The North American Wildlife Enforcement Officers Association could assist in developing uniform laws and regulations among state, provincial, territorial, and tribal jurisdictions.
2. Biologists should use all opportunities to photograph, PIT-tag and record characteristics of valuable wild sheep heads, as this information may be used for identification in law enforcement. Horn cores from the plugging process and other available samples should be saved for DNA and mineral analyses.
3. Penalties for illegal taking of wild sheep, including fines, should be consistent with the market values of the illegal products and the public values of illegally-taken sheep.
4. Private ownership, sale, trade or transport of native wild sheep should be illegal (Northern Wild Sheep and Goat Council 1990).
5. There is a need for public education regarding rationales and needs for strict regulations and controls on ownership of wild sheep, trophies, or body parts. Threats to wild sheep populations, loss of genetic potential, and loss of public values should be emphasized.
6. Law enforcement activities should be coordinated among federal, state, provincial, territorial, and tribal enforcement agencies.
7. Law enforcement efforts should be expanded, based upon adequate agency funding. Funding of special law enforcement efforts and programs by advocacy groups is also appropriate.

8. Management biologists should assist and support law enforcement activities.

#### Interagency Cooperation and Coordination

1. Better interagency communications are needed for the management of wild sheep and their habitats. Annual status reviews, including agency administrators, are desirable. Local projects should be developed using inputs from the variety of resource specialists needed to address the local issues - biologists including wildlife pathologists, sociologists, and physical scientists.
2. Interagency coordination of projects for wild sheep, especially state-federal and province-federal coordination, should be facilitated by having written agreements that facilitate cooperation, cost-sharing and timely exchange of funds to accomplish mutually agreed upon goals.
3. State, provincial, and territorial wildlife agencies should have written, long range plans including goals for the distribution and abundance of wild sheep, and addressing the restorations, land acquisitions or easements necessary to achieve these goals. Plans must be developed with input from land management agencies and interested publics.
4. Historic, current and potential wild sheep ranges, including movement corridors, should be mapped for use in land-use planning. Critical and vulnerable habitats should be identified.
5. Management biologists should work with local, state and tribal governments and nongovernment organizations to assist in planning for the needs of wild sheep in all land use decisions. State, provincial, and territorial wildlife agencies should be involved early in the scoping processes of land use planning. Using agencies merely to review already drafted plans greatly limits their abilities to protect wild sheep habitats. Biologists should monitor implementation of plans to assure that approved protections for wild sheep are not neglected.
6. Biologists should analyze and interpret appropriate data in their files, providing this information for land use planning. Historic and current populations should be compared for evaluating the impacts of past changes in land uses, and as evidence for discouraging continued habitat degradations.
7. Too many wild sheep management plans are restricted to individual populations or are constrained by political boundaries. Metapopulation management and planning are needed (Bleich et al. 1990, Bailey 1992, Armentrout and Boyd 1994). Interagency coordination will be necessary where metapopulations extend across international, state, provincial, tribal, or other administrative boundaries.
8. The needs of wild sheep should be considered in all agency land exchanges.
9. Where necessary, plans of the Bureau of Land Management, Forest Service, Park Service and other land management agencies should be amended to adequately recognize the importance of wild sheep habitats. Threats to these habitats should be identified and mitigation measures should be developed and implemented.
10. Use easements, exchanges and acquisitions of land to develop and maintain complete wild sheep ranges, including movement corridors within and among populations.

11. Biologists should be conservative and proactive in protecting wild sheep habitats, and should anticipate impacts of land uses.
12. Federal grazing and other land use plans should allocate needed amounts, kinds and distributions of forages to meet the year-round needs of wild sheep, in both normal and abnormal years.
13. State and federal agencies should coordinate to address National Environmental Policy Act (NEPA) requirements for wild sheep habitat and transplant projects. For some projects, the state wildlife department, as the project proponent, may be more effective as the lead agency for NEPA activities. Projects covered in prior NEPA documents, such as Habitat Management Plans or other land use plans, may not need additional NEPA analysis. Management decisions should be based upon legal mandates of the agencies, supported by accurate biological and social information developed under NEPA. The NEPA process is not intended to be a "popularity contest." Management decisions should not be directed by special interests that use the NEPA process to publicize and develop support for their personal goals.

Assistance, review, and helpful comments on this recommendation section were received from Rick Brigham, Vic Coggins, Ray Demarchi, Jeff Denton, Michael Dunbar, Craig Foster, Wayne Heimer, Kevin Hurley, Harley Metz, Tim Schommer, Helen Schwantje, Dale Toweill, and Alasdair Veitch.

#### LITERATURE CITED

- Armentrout, D.J., and R.J. Boyd. 1994. Consequences of habitat fragmentation on wild sheep metapopulation management within the USA. *Bienn. Symp. North. Wild Sheep and Goat Council*. 9:149-158.
- Bailey, J.A. 1992. Managing bighorn habitat from a landscape perspective. *Bienn. Symp. North. Wild Sheep and Goat Council*. 8:49-57.
- \_\_\_\_\_, and M.M. Woolever. 1992. Determining the future of bighorn herds in wilderness areas. *Bienn. Symp. North. Wild Sheep and Goat Council*. 8:121-135.
- Bleich, V.C., J.D. Wehausen and S.A. Holl. 1990. Desert-dwelling mountain sheep: conservation implications of a naturally fragmented distribution. *Conservation Biol.* 4:383-390.
- Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present, and future. *Wildlife Monograph No. 4*. 174 pp.
- Bureau of Land Management. 1995a. Rangewide plan for managing habitat of desert bighorn sheep on public lands. USDI, BLM, Washington, DC. 41 pp.
- Bureau of Land Management. 1995b. Mountain sheep ecosystem management strategy in the 11 western states and Alaska. USDI, BLM, Washington, DC. 79 pp.
- Desert Bighorn Council, Tech. Staff. 1982. Revised procedures for capturing and re-establishing desert bighorn. *Desert Bighorn Council Trans.* 26:1-7.
- \_\_\_\_\_, \_\_\_\_\_. 1990. Guidelines for management of domestic sheep in the vicinity of desert bighorn habitat. *Desert Bighorn Council Trans.* 34:33-35.

Geist, V. 1975. On the management of mountain sheep: theoretical considerations. Pages 77-98 in Trefethen, J.B. (Ed.) *The wild sheep in modern North America*. Winchester Press, N.Y. 302 pp.

Greenwood, C.L., S. Goodrich and J. Lytle. 1999. Responses of bighorn sheep to pinyon-juniper burning along the Green River Corridor, Dagget County, Utah. Pages 205-209 in: Monsen, S.E. and R. Stevens (Eds.). *Ecology and management of pinyon-juniper communities within the interior west*. USDA Forest Service Proceedings. RMRS-P-9. Ogden UT. 411 pp.

Krausman, P.R., J.R. Morgart and M. Chilelli. 1984. Annotated bibliography of desert bighorn sheep literature, 1897-1983. *Southwest Natural History Assn.*, Phoenix, AZ. 204 pp.

MacNab, J. 1983. Wildlife management as scientific experimentation. *Wildl. Soc. Bull.* 11:397-401.

Martin, K.D., T. Schommer and V.L. Coggins. 1996. Literature review regarding the compatibility between bighorn and domestic sheep. *Bienn. Symp. North. Wild Sheep and Goat Council.* 10:72-77.

McCarty, C.W., and J.A. Bailey. 1994. Habitat requirements of desert bighorn sheep. *Spec. Rept.* 69. Colorado Div. of Wildlife, Denver, CO. 27 pp.

\_\_\_\_\_ and M.W. Miller. 1998. Modeling the population dynamics of bighorn sheep: a synthesis of literature. *Spec. Rept.* 73. Colorado Div. of Wildlife, Denver, CO. 35 pp.

Miller, M.W., J.E. Vayhinger, D.C. Bowden, S.P. Roush, T.E. Verry, A.N. Torres and V.D. Jurgens. 2000. Drug treatment for lungworm in bighorn sheep: Reevaluation of a 20-year-old management prescription. *J. Wildl. Manage.* 64:505-512.

Monson, G., and L. Sumner (Eds.). 1980. *The desert bighorn, its life history, ecology and management*. Univ. of Arizona Press, Tucson, AZ. 370 pp.

New Mexico Department of Game and Fish/Conservation Breeding Specialist Group. 1999. Population and habitat viability assessment for the desert bighorn sheep of New Mexico. NM Dept. of Game and Fish, Santa Fe, NM. 135 pp.

Northern Wild Sheep and Goat Council. 1988. Recommendations of the Northern Wild Sheep and Goat Council regarding the use of special big game (Governor's) permits for funding wildlife programs. *Bienn. Symp. North. Wild Sheep and Goat Council.* 6:54-56.

\_\_\_\_\_. 1990. Recommendation of the Northern Wild Sheep and Goat Council regarding privatization/ownership of wild sheep and goats in North America. *Bienn. Symp. North. Wild Sheep and Goat Council.* 7:1-2.

Risenhoover, K.L., J.A. Bailey and L.A. Wakelyn. 1988. Assessing the bighorn sheep management problem. *Wildl. Soc. Bull.* 16:346-352.

Schommer, T., and M. Woolever. 2000. A process for finding management solutions to the incompatibility between domestic and bighorn sheep. USDA, Forest Service, Lakewood, CO. (Draft management guideline).

- Singer, F.J., C.M. Papouchis and K.K. Symonds. 2000. Translocation as a tool for restoring populations of bighorn sheep, *Ovis canadensis*. Restoration Ecology (accepted for publication).
- Smith, D.R. 1954. The bighorn sheep in Idaho. Idaho Dept. of Game and Fish, Boise, ID. 154 pp.
- Smith, T.S., P.J. Hardin and J.T. Flinders. 1999. Response of bighorn sheep to clear-cut logging and prescribed burning. Wildl. Soc. Bull. 27:840-845.
- Solomon, M.E. 1958. Meaning of density-dependence and related terms in population dynamics. Nature 181:1778-1780.
- Trefethen, J.B. (Ed.). 1975. The wild sheep in modern North America. The Winchester Press, NY. 302 pp.
- Valdez, R., and P.R. Krausman. 1999. Mountain sheep of North America. Univ. Arizona Press, Tucson, AZ. 353 pp.
- Van Dyke, W.A., A. Sands, J. Yoakum, A. Polenz and J. Blaisdell. 1983. Bighorn sheep. In Wildlife habitat in managed rangelands – the Great Basin of southeastern Oregon. Gen. Tech. Rept. PNW-159. USDA Forest and Range Expt. Sta., Portland, OR. 37pp.
- Wilson, L.O., J. Blaisdell, G. Welsh, R. Weaver, R. Brigham, W. Kelly, J. Yoakum, M. Hinks, J. Turner and J. DeForge. 1980. Desert bighorn habitat requirements and management recommendations. Desert Bighorn Counc. Trans. 24:1-7.



## APPENDIX A

### WILD SHEEP STATUS QUESTIONNAIRES Prepared for 2ND North American Wild Sheep Conference

#### **The Thinhorn Sheep: Dall's Sheep and Stone's Sheep**

Alaska - Steven M. Arthur  
British Columbia (Dall's) - Ian Hatter  
British Columbia (Stone's) - Ian Hatter  
Northwest Territories - Alasdair Veitch & John Nagy  
Yukon Territory - Jean Carey

#### **Rocky Mountain Bighorn Sheep**

Alberta - Jon T. Jorgenson  
Arizona - Raymond Lee  
British Columbia - Ian Hatter  
Colorado - John Ellenberger  
Idaho - John Beecham  
Montana - John J. McCarthy  
Nebraska - Gary Schlichtemeier  
Nevada - Larry T. Gilbertson  
New Mexico - Bill Dunn  
Oregon - Don Whittaker  
South Dakota - Ted A. Benzon  
Utah - Jim Karpowitz  
Washington - George Tsukamoto  
Wyoming - Kevin Hurley

#### **California Bighorn Sheep**

British Columbia - Ian Hatter  
California - Steven G. Torres  
Idaho - John Beecham  
Nevada - Craig Mortimore  
North Dakota - Mike Oehler  
Oregon - Don Whittaker  
Utah - Jim Karpowitz  
Washington - George Tsukamoto

#### **Desert Bighorn Sheep**

Arizona - Raymond Lee  
California - Steven G. Torres  
Colorado - John Ellenberger  
Nevada - Patrick Cummings & Craig Stevenson  
New Mexico - Eric Rominger  
Texas - Doug Humphreys  
Utah - Jim Karpowitz



WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **ALASKA**

Subspecies (1 questionnaire/subspecies): Dall's  Stone's  CABS  RMBS  Desert

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1. ESTIMATED POPULATION size: 1988 >65,000 1998 50,000-65,000

2. HARVEST

Permits were not limited, except in specific areas. These data are numbers of hunters reporting that they hunted sheep each year. Totals include hunters that did not report residency. Data for 1998 are preliminary.

Resident permits	1988 <u>2,278</u>	1998 <u>2,427</u>
Non-Resident permits	1988 <u>580</u>	1998 <u>571</u>
Total Permits	1988 <u>3,169</u>	1998 <u>3,059</u>
No. Killed	1988 <u>1,377</u>	1998 <u>967</u>

Record B&C Score and year killed: 189 6/8; 1961

What is the dominant harvest strategy in your state/province for hunting wild sheep?

For most areas: provide maximum opportunity to harvest full-curl rams.

3. PREDATION. What impact does predation have on your sheep populations?

Statewide, predators are not generally viewed as a significant problem, however, predation may be important to some subpopulations at some times.

Do you control predators to benefit sheep? If so, how?

No.

4. DISEASE. Have you had a disease die-off in the last 5 years? No  Yes

Last 25 years? No  Yes

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Record hunter reports of diseased sheep, and investigate these to the extent possible (analyze samples provided by the hunter, solicit reports from other hunters, biologists, etc. that may be active in the area).

5. **STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Conflicting mandates pertaining to allocation of subsistence resources among users.
- B. Political debate may supercede biological considerations.
- C. Decision-making process is still evolving, thus, changes may take managers by surprise.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Little effect on management activities or sheep populations. However, in some instances, sport hunting opportunities have been reduced.

6. **CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation

25 years ago (1975) with estimated mortality rate (%)

- A. Drop nets. No data on mortality.

Last 5 years, with estimated mortality rate (%)

- A. Net guns. So far, negligible mortality.
- B. Tranquilizer darts fired from helicopters. Not used often, very little mortality.

7. **SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Adverse winter weather.
- B. Hunting pressure in accessible areas may limit the number of mature rams (although generally this does not limit the success of the population).
- C. Population-scale effects of predation are largely unknown, but may limit some subpopulations at some times.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **BRITISH COLUMBIA**

Subspecies (1 questionnaire/subspecies): **Dall's**  Stone's  CABS RMBS  Desert

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1. **ESTIMATED POPULATION** size: 1988 400-600 1998 400-600

Range is in the extreme NW corner of BC, i.e., the Haines Triangle west of Bennett Lake. Tatshenshini Provincial Park protects the majority of the Dall's sheep in BC.

2. **HARVEST** (AAH = Annual Allowable Harvest)

Resident permits	1988 <u>30</u>	1998 <u>62</u>
Non-Resident permits	1988 _____	1998 <u>~ 20% of the AAH is allocated to Non-Res</u>
Total Permits	1988 _____	1998 _____
No. Killed	1988 <u>2</u>	1998 <u>8</u>
Record B&C Score and year killed:	_____	

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)  
A limited entry hunting (full-curl rams) season is offered in the Tatshenshini area of MU 6-28 and 6-29.

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate. No studies have been done.

Do you control predators to benefit sheep? If so, how? No current control outside of liberal hunting and trapping seasons for predators, which in this area is likely not effective.

4. **DISEASE.** Have you had a disease die-off. None known.

Last 5 years? No  Yes \_\_\_\_\_

Cause and herd name:

Last 25 years? No  Yes \_\_\_\_\_

Cause and herd name:

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?  
No action on this to date.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

This is not directly applicable as British Columbia has jurisdiction over its land and natural resources and 94.5% of the Province is Provincial Crown Land.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

British Columbia is nearing the end of a ten year process to double the amount of provincial Protected Areas from 6% to 12% of the land base. Protection of wilderness areas and control of access is seen as a positive effect, providing that increased use by the recreating public is managed within the limits of acceptable change and does not negatively impact mountain sheep populations. The creation of the Tatshenshini-Atsek Park prevented significant access into sheep (Dall’s) range.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture Dall’s sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)? None done to date.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. The greatest potential source of mortality is predation and severe weather
- B. Increased access and human activities (mining, forestry, etc.) can affect Dall’s sheep. An effective environmental assessment and mitigation process related to natural resource development would help to reduce development impacts.
- C. Unregulated First Nations harvest is a potential concern. There are no regulations for First Nations and they currently do not have to report harvests.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **BRITISH COLUMBIA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's  x  CABS RMBS \_\_\_\_\_ Desert \_\_\_\_\_

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1. **ESTIMATED POPULATION** size: 1988  11,000-12,000  1998  11,000-12,000

2. **HARVEST** (AAH = Annual Allowable Harvest)

Resident permits	1988 _____	1998 <u> 197 </u>
Non-Resident permits	1988 _____	1998 <u> ~ 20% of the AAH is allocated to Non-Res </u>
Total Permits	1988 _____	1998 _____
No. Killed	1988 <u> 359 </u>	1998 <u> 407 </u>

Record B&C Score and year killed: \_\_\_\_\_

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Primarily general open seasons for full-curl rams (over the bridge of the nose) are offered. There are some limited entry hunting (full-curl rams) seasons offered in Spatsizi, Mount Edziza, and Atlin areas of northwestern BC.

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Most of the work available on the impact of predation on Stone's sheep in BC comes from north-eastern British Columbia (Bergerud, AT and JP Elliott. 1997. Wolf predation in a multiple-ungulate system in northern British Columbia. *Can. J. Zool.* 76:1551-1569). Following a reduction in wolf numbers, there was approximately a 2-fold increase in lambs (9 mths of age)/100 ewes. This study also indicated that wolf numbers, not the severity of the winter (in either the first or second winter), explained the continued decline in recruitment of sheep from 9 to 21 months of age. Generally, populations in the Kechika area increased ( $\lambda = 1.08$ ) when large recruitments were added after wolf reductions and decreased ( $\lambda = 0.93$ ) when smaller additions followed no wolf reductions.

Do you control predators to benefit sheep? If so, how?

No current control outside of liberal hunting and trapping seasons for predators. Wolf removal experiments were undertaken during the mid-1980's in the Kechika and Muskwa areas of northeastern BC.

**4. DISEASE.** Have you had a disease die-off?

We obtained the head of a 6 year ram that died at Toad River this past spring, and several other rams from the Toad River area have been reported. They apparently were very emaciated, retained last winter's hair, and were wheezing and subsequently were not seen again (believed dead). Obviously there are many possibilities and without bodies and necropsy confirmation of cause of death, little can be concluded. This area has had, however, non-commercial llama use from Fort Nelson, leaving open a possible cause-effect connection. A controversy continues over the access of camelids, especially into northern wilderness areas of BC, most particularly where we have little information on existing health status of wild sheep.

We have initiated a project to evaluate the health status of a population of Stone sheep on winter range following reports of possible heavy tick infestations. Preliminary results confirm that some animals in this herd do carry significant numbers of *Dermacentor albipictus* and lost significant amounts of hair coat during the winter. Parasitological and serological testing is in progress and expansion of the project is planned.

Last 5 years? No  Yes \_\_\_\_\_

Cause and herd name:

Last 25 years? No  Yes \_\_\_\_\_

Cause and herd name:

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?  
All radio-collared mortalities are necropsied by wildlife veterinarian when possible.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

This is not directly applicable as British Columbia has jurisdiction over its land and natural resources and 94.5% of the Province is Provincial Crown Land.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

British Columbia is nearing the end of a ten year process to double the amount of provincial Protected Areas from 6% to 12% of the land base. Protection of wilderness areas and control of access is seen as a positive effect, providing that increased use by the recreating public is managed within the limits of acceptable change and does not negatively impact mountain sheep populations.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture Stone's sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%) no records available.

Last 5 years, with estimated mortality rate (%) During a sheep transplant in the Atlin area, there were 2 capture related mortalities among the 26 animals that were handled (i.e. 8% mortality). One was believed to be an acute neck injury, the second was likely capture myopathy.

- A. Net-Gun
- B. Drive-Net

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. The greatest potential source of mortality is predation and severe winter.
- B. Access management including access associated with mining and oil/gas exploration.
- C. Fire suppression and forest encroachment resulting in reduction of range quality.
- D. Disease introduction from domestic animals is a potential concern.

**WILD SHEEP STATUS QUESTIONNAIRE**  
2nd North American Wild Sheep Conference, Reno, Nevada,  
6-9 April 1999

State, Province, or Territory: **NORTHWEST TERRITORIES, CANADA**

Subspecies: Dall's  X  Stone's      CABS      RMBS      Desert    

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**1. ESTIMATED POPULATION size:**

*Richardson Mountains:* 1983  500  1991  1510  (note years of surveys)

These estimates from aerial surveys.

*Mackenzie Mountains:* 1988  6500\*  1998  14,000 - 26,000\*\*

\* Estimate from a model based on age structure of harvested rams (1984) combined with life tables developed for Kluane National Park, Yukon.

\*\* Estimate from average density estimates from 10 aerial and ground surveys done across the Mackenzie Mountains (1966-98) applied over 140,000 km<sup>2</sup> of the total mountain range.

For the 1996-1998 hunting seasons we collected the horn plug cores from all rams harvested across the Mackenzie Mountains by non-resident hunters (appx. 200/year) and sent the samples to Dr. Curt Strobeck, University of Alberta for DNA analysis. One of the objectives of this research is to determine if there are recognizable 'herds' within the range of Dall's sheep in the Mackenzie Mountains, NWT.

## 2. HARVEST

A) *Richardson Mountains*

Resident permits	1988	<u>0</u>	1998	<u>0</u>
Non-Resident permits	1988	<u>0</u>	1998	<u>0</u>
Total Permits	1988	<u>0</u>	1998	<u>0</u>
No. Killed	1988	<u>0</u>	1998	<u>0</u>

Record B&C Score and year killed:  ?

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Closed, other than for subsistence use. Subsistence harvest typically 10-20 sheep/year.

B) *Mackenzie Mountains*

Resident tags*	1988	<u>71</u>	1998	<u>64</u> (note: data for 1996)
Non-Resident tags*	1988	<u>?</u>	1998	<u>246</u>
Total tags	1988	<u>?</u>	1998	<u>310</u>
No. Killed**	1988	<u>194</u>	1998	<u>222</u>

\* There is no draw system for tags; each hunter is allowed to purchase 1 tag per year for a male sheep with horns at least  $\frac{3}{4}$  curl.

\*\* Does not include subsistence harvest, which is typically 10-30 sheep/year.

Record B&C Score and year killed: #1- 177 1/8 (1973); #2 - 176 4/8 (1973)

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Trophy ram and subsistence.

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

*Richardson Mountains* – impact unknown, but not thought to be a problem.

*Mackenzie Mountains* – impact unknown, but not thought to be a problem.

Do you control predators to benefit sheep? If so, how?

*Richardson Mountains* - no

*Mackenzie Mountains* - no

## 4. DISEASE.

*Richardson Mountains*

Have you had a disease die-off in the last 5 years? No  X  Yes \_\_\_\_\_

Last 25 years? No  X  Yes \_\_\_\_\_

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Collect fecal samples and lung samples from harvested animals.

*Mackenzie Mountains*

Have you had a disease die-off in the last 5 years? No  X  Yes \_\_\_\_\_

Last 25 years? No  X  Yes \_\_\_\_\_

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Collect fecal samples during the course of ground-based population monitoring surveys at 4 separate study sites and lung samples from harvested animals. In 1997-1998 we began a detailed investigation of parasites and diseases of Dall's sheep in the Mackenzie Mountains with the University of Saskatchewan and will be expanded to include a project with Montana State University. These projects will be done at least from 1999 through 2001.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

*Richardson Mountains* – no challenges.

*Mackenzie Mountains* – no challenges.

NOTE: for the Richardson Mountains, NWT and the northern half of the Mackenzie Mountains, NWT - primary responsibility for wildlife management now falls under the mandate of wildlife co-management boards that were set up as a result of three settled land claim agreements between the Government of Canada, the Government of the Northwest Territories, and the Gwich'in, Inuvialuit, and Sahtu Dene and Metis. These co-management boards are public boards with members nominated by local land claim organizations and the governments of Canada and the Northwest Territories.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

*Richardson Mountains* – no. Resident and non-resident hunting of Dall's sheep is not permitted. Range is essentially undeveloped wilderness, although there has been no official designation.

*Mackenzie Mountains* – were designated as a Game Preserve 1938 to 1953. Game Preserve status removed in 1953 and opened to sheep hunting by Resident Hunters. Non-resident hunting for Dall's sheep allowed since 1965, except within Nahanni National Park in the south Mackenzie Mountains (appx. 4770 km<sup>2</sup>). Sheep management within NNP is the responsibility of Heritage and Parks Canada. Currently, the Mackenzie Mountains are primarily undeveloped wilderness, although there has been no official designation, except for NNP.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

*Richardson Mountains* – no captures/transplants ever done.

*Mackenzie Mountains*

25 years ago (1975) with estimated mortality rate (%)

No captures/transplants in last 25 years. However, a log-net corral trap at two mineral lick sites in the central Mackenzie Mountains was used by Norm Simmons, Canadian Wildlife Service to catch 106 Dall's sheep for research from 1969 to 1973; mortality rate unknown (in our files there are records of at least one ewe and lamb that died as a result of handling).

Last 5 years (1995), with estimated mortality rate (%)

No captures/transplants in last 5 years.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

*Richardson Mountains* – currently appear to be no limiting factors. Population growing.

*Mackenzie Mountains* – unknown, but assumed to be some combination of climate, predation, harvest, and disease. Population trend unknown.

## WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **YUKON**

Subspecies (1 questionnaire/subspecies): Dall's  Stone's  CABS  RMBS  Desert

While the Yukon has both Dall and Stone sheep, we do not manage them differently, and harvest is not tracked separately.

Contact Person: Jean Carey

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Whitehorse, Y.T. Y1A 2C6

Phone: (867) 667-5849; Fax: (867) 393-6263 e-mail: jean.carey@gov.yk.ca

### 1. ESTIMATED POPULATION size:

1988 22,000

1998 22,000 (18,000 white Dall's sheep; 2,500 "Fannin" and 1,500 Stone)

### 2. HARVEST

Permits are required only in a small portion of the territory that is open to resident hunters only. The numbers presented here are for the number of seals sold (\$10). In addition to purchasing a seal non-resident hunters must also retain the services of a licensed outfitter. Seals are only a very crude way of measuring hunter interest and can't be used to calculate hunter success because many seal holders do not hunt.

Resident permits	1988 <u>625</u>	1998 <u>682</u>
Non-Resident permits	1988 <u>364</u>	1998 <u>334</u>
Total Permits	1988 <u>989</u>	1998 <u>1016</u>
No. Killed	1988 <u>321</u>	1998 <u>274</u>

Record B&C Score and year killed: Dall's Sheep: 183 4/8; Stone's Sheep: 177 7/8

The horn growth measurements taken by Renewable Resources are not equivalent to a B&C score.

### What is the dominant harvest strategy in your state/province for hunting wild sheep?

We believe that a conservative harvest focussed on older-aged (full curl) rams will have the least impact on sheep populations while at the same time providing recreational opportunities, both consumptive and non-consumptive. First Nations people are not required to obtain a hunting licence to hunt within their traditional territory and have the right to hunt sheep of either sex and any age at any time. Limited entry permits are required in a small area; for the most part harvest is open to general hunting by seal holders.

### 3. PREDATION. What impact does predation have on your sheep populations

Yukon sheep populations are, for the most part, naturally regulated. Predation is an important part of this natural system, but does not seem to drive annual variation in population size. Predation may, however, play a more important role during the decline phase of the snowshoe hare cycle when coyotes may switch prey.

**Do you control predators to benefit sheep? If so, how?**

Wolf control programs have been carried out in sheep range to benefit caribou and mosse; we have detected no response in the sheep populations.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No  Yes \_\_\_\_\_

Last 25 years? No  Yes \_\_\_\_\_

**What do you do to detect, manage and/or prevent disease**

There is no systematic disease testing, but hunters and others occasionally submit tissue samples for examination.

5. **STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. Neither the territorial nor federal agencies have large budgets with which to work.

**Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?** n/a

6. **CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

There were no capture programs 25 years ago. We captured some animals in 1985 and 1990 A.

Last 5 years, with estimated mortality rate (%)

There have been no sheep captures in the last 5 years.

7. **SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. stochastic events e.g. weather

B. predation

C. localized subsistence harvest of either sex, any age sheep

## WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **ALBERTA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_ Stone's \_\_\_\_ CABS \_\_\_\_ **RMBS** **X** Desert \_\_\_\_

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1. **ESTIMATED POPULATION** size: 1988 10,000 1998 10,000

Province wide our sheep population is similar to what it was in 1988. There have, however, been local changes in some populations.

### 2. HARVEST

Resident permits 1988 2412(male)\*, 491 (non-trophy)\*\* 1998 1793(male)\*, 328(non-trophy)\*\*

Non-Resident permits 1988 91 1998 86

Total Permits 1988 2994 1998 2207

No. Killed 1988 229(male), 132(non-trophy) 1998 167 (male), 122(non-trophy)

\* unlimited entry for trophy males

\*\* non-trophy are ewes and lambs

Record B&C Score and year killed: 208 1/8, 1911

What is the dominant harvest strategy in your state/province for hunting wild sheep?

(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

To maximize recreational opportunity, rams are hunted on an unlimited entry basis in most areas (except two that are on a draw) with a minimum curl size defined as 4/5<sup>th</sup> curl. In 3 areas, the minimum curl size is defined as full curl. Non-trophy sheep (ewes and lambs) are hunted in most areas on a permit system.

3. **PREDATION.** What impact does predation have on your sheep populations?

We have very little documented information on the role of predators in limiting sheep populations. In northern Alberta, predation (wolves, cougar) is thought to remove a portion of the available surplus of non-trophy animals that would otherwise be available for harvest but is not considered the predominant limiting factor. In the rest of the province, predators are thought to be of minor consequence except in very specific instances (Ram Mtn, Sheep River) where an individual predator (primarily an individual cougar) has become a specialist preying on sheep in which case they have shown an ability to limit a population.

Do you control predators to benefit sheep? If so, how?  
 We do not control predators for the benefit of sheep

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No  Yes \_\_\_\_\_

Last 25 years? No \_\_\_\_\_ Yes

Cause and herd name: Sheep River, 1978, pneumonia

Cause and herd name: Waterton-Westcastle, 1981-82, pneumonia

Cause and herd name: Sheep River, 1985-86, pneumonia

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

- nothing for detecting
- if sick sheep are reported, an immediate assessment is made and any sick animals with clinical signs of pneumonia will be culled from the herd and necropsied
- any sheep captured are visually examined for contagious ecthyma. Any sheep for transplant are treated with ivermectin and often nasal swabs will be taken for bacterial culture.
- Alberta has developed guidelines with the agricultural sector to exclude opportunities for domestic sheep/goat - bighorn sheep interactions.

5. **STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. In Alberta, management of sheep by federal authorities applies only within the National Park system. Cooperation is often needed to inventory populations that interchange across boundaries as well as enforcement along boundaries during hunting seasons. Currently, cooperation is very good.

B. National Parks currently have an excellent program of habitat enhancement through prescribed fire for sheep range that benefits both jurisdictions

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Designation of wilderness areas has not had a great effect on management activities other than the exclusion of hunting opportunities and an inability to manage the size of nursery herds. This has led to some sheep populations that are above carrying capacity and of relatively low quality in terms of productivity, survival, and growth.

6. **CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

A. Drop nets (<1%)

B. Corral traps (<1%)

C. Chemical immobilization (3-5%)

Last 5 years, with estimated mortality rate (%)

A. Drop nets (<1%)

B. Corral traps, box traps (<1%)

C. Chemical immobilization (2%)

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. Lack of suitable winter range

B. Encroachment on some winter ranges of conifer and deciduous tree cover.

C. Longterm effective fire suppression policies have led to a reduction in high quality range. Although the situation has improved considerably, we are still severely limited through finite resources in implementing habitat enhancement projects.

D. Other potential limiting factors could include competition with livestock in certain areas, industrial and recreational activities, and disease related issues. Unfortunately, our understanding of these factors is poorly understood due to a lack of research.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **ARIZONA**

Subspecies (1 questionnaire/subspecies): **RMBS X**

Contact Person: Raymond Lee

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**1. ESTIMATED POPULATION size:** 1988 - 250    1998 - 600

**2. HARVEST**

Resident permits	1988 - 4	1998 - 9
Non-Resident permits	1988 - 0	1998 - 4*
Total Permits	1988 - 4	1998 - 9
No. Killed	1988 - 4	1998 - 9

Record B&C Score and year killed: 188 3/8 (1995)

\*All permits are available to residents - no more than 10% of the total permits are available to non-residents, nor more than 50% in any one hunt.

What is the dominant harvest strategy in your state/province for hunting wild sheep?

Provide hunter recreation that stresses the quality of the hunting experience and harvest of older age class rams. The legal animal is any ram.

**3. PREDATION.** What impact does predation have on your sheep populations?

Predation is not usually a causitive factor in ungulate population levels, with the very small number of animals in a typical release, predation can adversely impact the success of a transplant.

Do you control predators to benefit sheep? If so, how?

The Arizona Game & Fish Department does not control predators to benefit bighorn sheep. In 1999, the Department will initiate a management action in a select area to remove mountain lions and determine the subsequent effect upon a bighorn sheep population.

**4. DISEASE.** Have you had a disease die-off in the last 5 years? No X

Last 25 years? No X

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Bighorn sheep populations are tested during capture projects to determine titers to common livestock diseases.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. US Forest Service burn policies and grazing policies.
- B. USFWS endangered species recovery plans (e.g. wolf reintroductions).
- C. US Forest Service grazing allotments.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Not applicable to this subspecies in Arizona.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation?

25 years ago (1975) with estimated mortality rate (%)

- A. None transplanted at that time.

Last 5 years, with estimated mortality rate (%)

- A. Drop-net (<5%)

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Lack of habitat.
- B. Lack of contiguous habitat.
- C. Human disturbance.
- D. Predation on a small population.

## WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **BRITISH COLUMBIA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ **RMBS** x Desert \_\_\_

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e-mail: ihatter@fwhdept.env.gov.bc.ca

1. **ESTIMATED POPULATION** size: 1988 2500-3000 1998 2500-3000

2. **HARVEST** (AAH = Annual Allowable Harvest)

Resident permits	1988 <u>888</u>	1998 <u>728</u>
Non-Resident permits	1988 <u>73</u>	1998 <u>64</u>
Total Permits	1988 <u>961</u>	1998 <u>792</u>
No. Killed	1988 <u>200</u>	1998 <u>99</u>

Record B&C Score and year killed: \_\_\_\_\_

What is the dominant harvest strategy in your state/province for hunting wild sheep?

(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Both general open (full-curl) and some limited entry hunting (full curl and ewe or lamb) seasons are offered.

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Predation is a possible limiting factor for some bighorn populations, but there is little information available for BC. Alberta has identified "sheep specialist" cougar's as being significant predators on sheep herds in an adjacent area to BC herds. Anecdotal information has identified coyotes as also being significant in some herds in the East Kootenays.

Do you control predators to benefit sheep? If so, how? No real control outside of liberal hunting and trapping seasons for predators.

4. **DISEASE.** Have you had a disease die-off.

Yes, although it does not fit a classic "die-off" scenario. Chronic pneumonia has resulted in likely less than a dozen deaths over a number of months in the fall of 1998 in one group of sheep. These were all very chronic bacterial pneumonias with mostly *Actinomyces pyogenes* bacteria isolated. Pathology suggested a primary pathogen such as a respiratory virus or *Mycoplasma* acting as an initiating factor. Other factors such as hot, dry and dusty conditions may have also played a role in this disease episode.

Last 5 years? No \_\_\_\_\_ Yes  x

Cause and herd name: Some coughing sheep initially observed in Elk Valley (near the Line Creek mine) (southeastern BC) in July 1998 and a few mortalities reported, starting in August. Six necropsies were performed. Coughing is presumed to have been associated with a respiratory infection with moderate morbidity, but low mortality, followed by secondary bacterial infection. One animal from outside this population has been destroyed with similar pathology results. It was a mature ram after the rut and may have come from/been associated with this herd.

Last 25 years? No \_\_\_\_\_ Yes  x

Cause and herd name: "Classic" die-offs in 1920s, 1941, 1964, and 1981 in the East Kootenay - initially reported to begin at Radium, Bull River and McGuire Creek herds respectively.

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?  
Observations from staff and a contractor to monitor as well as to coordinate assistance from the interested public to report on status of the sheep herds in the area for the winter of 1998-9.

The majority of live captured animals are bled to archive samples. Any animals captured for relocations are sampled according to the WWHC protocol.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

This is not directly applicable as British Columbia has jurisdiction over its land and natural resources and 94.5% of the Province is Provincial Crown Land.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations? British Columbia is nearing the end of a ten year process to double the amount of provincial Protected Areas from 6% to 12% of the land base. Protection of wilderness areas and control of access is seen as a positive effect, providing that increased use by the recreating public is managed within the limits of acceptable change and does not negatively impact mountain sheep populations.

25 years ago (1975) with estimated mortality rate (%), Likely much higher then, but no solid records available.

A. Drive-net

B. Drop-net

Last 5 years, with estimated mortality rate (%) 0 to 4 %, depending on project, ave. probably 1-2 %

A. Net-gun

B. Drop-net

C. Drive-net

7. **SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Habitat Alienation (residential developments, access and highway developments, industrial developments, agricultural developments and recreational developments and activities).
- B. Fire suppression and conifer forest encroachment on grassland ranges.
- C. Potential disease transmission from domestic sheep
- D. Competition for forage on critical winter ranges with domestic livestock; mainly cattle on Provincial Crown lands and horses on Indian Reservations.
- E. Unmanaged predator populations which fluctuate widely over the long term.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **COLORADO**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ CABS \_\_\_\_\_ **RMBS**  Desert \_\_\_\_\_

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1. **ESTIMATED POPULATION** size: 1988 ~6000 1998 7250

2. **HARVEST**

Resident permits 1988 305 ram, 45 ewe 1998 241 rams, 82 ewes

Non-Resident permits 1988 35 ram, 5 ewe 1998 28 rams, 8 ewes

Total Permits 1988 340 ram, 50 ewe 1998 269 rams, 90 ewes

No. Killed 1988 114 rams, 20 ewes 1998 114 rams, 36 ewes

Record B&C Score and year killed: 198 & 3/4 1998 (green score)

What is the dominant harvest strategy in your state/province for hunting wild sheep?

(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Limited harvest of 1/2 curl or better rams in all units with limited ewe hunting in some units.

3. **PREDATION.** What impact does predation have on your sheep populations?

Predation (by mountain lion) occurs in many herds but is usually not a significant limiting factor.

Do you control predators to benefit sheep? If so, how?

Colorado uses a harvest quota system for sport harvest of mountain lions. APHIS or ADC is not used to harvest lions in addition to sport harvest.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No \_\_\_\_\_ Yes

Cause and herd name: Big Thompson Herd, Pasteurella pneumonia most likely cause

Cause and herd name: Tarryall Herd, Pasteurella pneumonia most likely cause

Last 25 years? No \_\_\_\_\_ Yes

Cause and herd name: Trickle Mountain, Pasteurella pneumonia most likely cause

Cause and herd name: Alamosa Canyon, Pasteurella pneumonia most likely cause

Cause and herd name: Almont/Taylor River, Pasteurella pneumonia

Cause and herd name: Upper Lake Fork/Pole Mt., Pasteurella pneumonia

Cause and herd name: Dillon Pinnacles, Pasteurella pneumonia/heavy winter

Cause and herd name: San Louis Peak/Lagurita, Pasteurella pneumonia

Cause and herd name: Rock Creek/Cebolla, Pasteurella pneumonia

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Our most frequent attempt at disease control is baiting and treating sheep with Fenbendazole in apple

## COLORADO

pulp. We also treat all sheep captured for translocation with Ivermectin and a broad spectrum antibiotic. Sheep that are found dead are necropsied (if carcasses are fresh) to determine cause of death and disease agent if possible. Blood samples and nasal/throat swabs are taken at trapping and translocation projects to determine disease status of sheep.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

In general, conflicts between state and federal agencies have been minimal. Preserving and maintaining sheep populations and their habitats is a high priority for all agencies in the state.

- A. Habitat improvement projects such as prescribed burns and range fertilization on public lands can be cumbersome to plan and implement due to agencies' internal regulations and guidelines.
- B. Outdoor recreation plans and projects (ski area expansion and helicopter skiing have caused problems in some areas but is not a state-wide problem.
- C. We are beginning cooperative management of domestic sheep allotments in proximity to bighorn herds. This project is in the early stages and will probably face some opposition from land management agencies as well as livestock operators.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Wilderness area designation has caused some problems for trap and translocation projects. However, we have been able to work with individual forest supervisors and district rangers to acquire temporary exemptions for limited use of helicopters in wilderness areas to allow CDOW to conduct net-gunning operations or the use of helicopters to transport sheep to remote locations for release.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. Drop nets (<5%)

Last 5 years, with estimated mortality rate (%)

- A. Drop nets (<5%)
- B. Net-gunning (<5%)

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Human population growth and related development (housing, roads, etc.) that occurs as a result of

## **COLORADO**

increasing human populations.

B. Increased human activity on sheep ranges (both wilderness areas and non-wilderness areas) as human population growth results in increased demands for outdoor recreation (both developed and undeveloped).

C. Disease management: We need to work with land management agencies, livestock organizations and the general public to make them aware of the need to keep bighorn sheep and domestic sheep segregated to decrease the potential for transmission of disease.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: IDAHO

Subspecies (one questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ CABS  RMBS  Desert \_\_\_\_\_

Fax:

Contact Person:

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Phone:

e-mail:

1. ESTIMATED POPULATION size: 1988 \_\_\_\_\_ ? \_\_\_\_\_ 1998 \_\_\_\_\_ ? \_\_\_\_\_ (No data given)

2. HARVEST

Resident permits	1988 <u>46(RM) - 22(CA)</u>	1998 <u>51(RM) - 38(CA)</u>
Non-Resident permits	1988 <u>22(RM) - 0(CA)</u>	1998 <u>13(RM) - 7(CA)</u>
Total Permits	1988 <u>168(RM) - 22(CA)</u>	1998 <u>64(RM) - 45(CA)</u>
No. Killed	1988 <u>62(RM) - 14(CA)</u>	1998 <u>36(RM) - 30(CA)</u>
Record B&C Score and year killed:	<u>RM - 197-7/8 (1996) CA - 174-4/8 (1997)</u>	

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Trophy - 3/4 curl or 4 + years of age

3. PREDATION. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

None known or suspected of being a problem

Do you control predators to benefit sheep? If so, how?

No

4. DISEASE. Have you had a disease die-off in the last 5 years? No  Yes \_\_\_\_\_  
No all-age die-off, lamb die-off only.

Cause and herd name:

Last 25 years? No \_\_\_\_\_ Yes

Cause and Herd Name: All pneumonia caused die-offs: Upper Hells Canyon 1983, 1991; Panther Creek, Morgan Creek, East Fork, Lost River Range, and west Middle Fork, Camas Creek.

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Monitor herd population characteristics and size

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Regulation of domestic sheep allotments
- B. Grazing by domestic livestock
- C. Helicopter use in Wilderness areas

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. Darting - 10-15%
- B. Drop-net - <1%
- C. Net gun - <1%

Last 5 years, with estimated mortality rate (%)

- A. Drop net - <1%
- B. Net gun - <1%

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Management program
- B. Disease/ Dieoffs
- C. Availability of habitat
- D. Availability of transplant stock

# WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **MONTANA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ RMBS X

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e-mail: jomccarthy@state.mt.us

1. ESTIMATED POPULATION size: 1988 4600 1998 4900 (42 populations)

## 2. HARVEST

Resident permits	1988 <u>447</u>	1998 <u>520</u>
Non-Resident permits	1988 <u>61</u>	1998 <u>77</u>
Total Permits	1988 <u>508</u>	1998 <u>597</u>
No. Killed	1988 <u>206 (125 M; 81 F)</u>	1998 <u>202 (157 M; 95 F)</u>
Record B&C Score and year killed:	<u>204-7/8</u>	

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Any ram, ewe hunting

3. PREDATION. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.  
There is some indication that wolves and lions have reduced some population in the Sun River Area.

Do you control predators to benefit sheep? If so, how?  
NO

4. DISEASE. Have you had a disease die-off in the last 5 years? No \_\_\_ Yes X  
Cause and herd name: Pneumonia: Highlands; Anaconda: Taylor / Hilgard  
Cause and herd name:

Last 25 years? No \_\_\_ Yes X

Cause and herd name: In addition to the above: Sun river, Beartooth, tendoy. Lost Cr. Ear Mtn. Black Leaf, Gardner, Taylor / Hilgards

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?  
Detection has been done by field personnel. Once detected nothing can really be done but to record the effects and results. We have utilized medicated salt block in the Highlands and inoculation with capture equipment in the Taylor Hilgard with no or limited success.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Fire Suppression
- B. Over grazing
- C. Road construction

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

NO

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. Corral Trap – 5%
- B. Cannon net – 5%
- C. Darting – 1-2%

Last 5 years, with estimated mortality rate (%)

- A. Net gun – 1%
- B. Drivenet – 1-2%
- C. Darting – 1-2%

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Disease
- B. Loss of habitat to forest encroachment
- C. Habitat fragmentation

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **NEBRASKA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ RMBS  Desert \_\_\_

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1. ESTIMATED POPULATION size: 1988 21 1998 70

2. HARVEST

Resident permits	1988 <u>          </u>	1998 <u>1</u>
Non-Resident permits	1988 <u>          </u>	1998 <u>1</u>
Total Permits	1988 <u>          </u>	1998 <u>2</u>
No. Killed	1988 <u>          </u>	1998 <u>2</u>
Record B&C Score and year killed:	<u>1998 - 185<sup>7</sup>/<sub>8</sub></u>	

What is the dominant harvest strategy in your state/province for hunting wild sheep?

Removal of surplus rams, legal bag one ram with one horn  $\frac{3}{4}$  curl or greater. Provide recreational opportunity and funding for future sheep management projects.

3. PREDATION. What impact does predation have on your sheep populations?

No apparent impact observed. More data is needed.

Do you control predators to benefit sheep? No.

4. DISEASE. Have you had a disease die-off in the last 5 years? No  Yes           

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Observations and in past years wormed annually using fenbendazole in a feed mixture.

5. STATE-FEDERAL RELATIONSHIPS. What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

Nebraska is 97% private land. Cooperation with the Forest Service on sheep projects is good.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations? No.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

No capture or transplants accomplished to date. A study was recently completed using satellite remote sensing to determine suitable habitat for transplanting sheep in Nebraska's pine ridge region.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations?

We are in the process of developing a five year management plan that will address issues including transplants, habitat needs, behavior, disease, genetics, social interactions, predation, movement and other factors.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **NEVADA**

Subspecies (one questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ CABS \_\_\_\_\_ **RMBS**  Desert \_\_\_\_\_

Fax: 775-738-2485

Contact Person: Larry T. Gilbertson

Full Address: Nevada Division of Wildlife, 1375 Mtn. City Hwy., Elko, NV 89801

Phone: 775-738-6036

e-mail:

1. **ESTIMATED POPULATION** size: 1988 150 1998 250

2. **HARVEST**

Resident permits            1988 2                            1998 5

Non-Resident permits    1988 0                            1998 0

Total Permits                1988 2                            1998 5

No. Killed                    1988 1                            1998 5

Record B&C Score and year killed: 182-6/8 Ruby Mtns.

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Any ram with season including the months of September and October

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Lion predation has been documented on all released populations except for the Ruby Mtns., and may be one of the major factors (other than disease) limiting transplant success.

Do you control predators to benefit sheep? If so, how?

No

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No \_\_\_\_\_ Yes X

Cause and herd name: Pneumonia - Ruby Mtns.

Cause and herd name:

Last 25 years? No \_\_\_\_\_ Yes X

Cause and herd name: Unknown - possible disease and/or predation in the N. Snake Range, S. Snake Range, Pilot Peak, and Mt. Grafton releases.

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Detection - conduct intensive helicopter surveys. Investigate reports of disease. Collect and analyze blood samples during capture operations.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Domestic sheep management in allotments adjacent to bighorn areas
- B. Red tape in Wilderness areas and WSA's related to capture and water development
- C.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Wilderness has resulted in more red tape negatively impacting sheep management  
Wilderness may have attracted more visitor use into sheep habitat

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. No Rocky Mtn. Bighorn were trapped in Nevada 25 years ago

Last 5 years, with estimated mortality rate (%)

- A. Net gunning with a 8% mortality rate

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Domestic sheep in allotments adjacent to wild sheep populations
- B. Low numbers of bighorn sheep available for transplants
- C. Possibly lion predation in populations <50

# WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **NEW MEXICO**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ **RMBS** **X** Desert \_\_\_

Contact Person: Bill Dunn

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Fax: 505-827-7915

e-mail: [wcdunn@state.nm.us](mailto:wcdunn@state.nm.us)

1. **ESTIMATED POPULATION** size: 1988 \_\_\_ 575 \_\_\_ 1998 \_\_\_ 560 \_\_\_

## 2. HARVEST

Resident permits	1988 ___	1998 ___
Non-Resident permits	1988 ___	1998 ___
Total Permits *	1988 <u>11</u>	1998 <u>9</u>
No. Killed	1988 <u>8</u>	1998 <u>9</u>

Record B&C Score and year killed: 192 6/8, 1996

\* Residents and non-residents are drawn from the same pool.

**What is the dominant harvest strategy in your state/province for hunting wild sheep?**

Trophy Ram

## 3. PREDATION. What impact does predation have on your sheep populations?

Predation seems to be more of a factor with low-elevation populations that share ranges with deer. We have had predation documented on the Manzano, San Francisco River and Turkey Creek herds. The data are sparse, but the impact of predation seems to be moderate.

**Do you control predators to benefit sheep? If so, how?** Yes. If we document a predator kill, we can issue a take permit to have the offending lion removed.

4. **DISEASE. Have you had a disease die-off in the last 5 years?** No \_\_\_ Yes **X** (Maybe)  
Cause and herd name: San Francisco River. We suspect that disease may have played a significant role in the recent decline.

Last 25 years? No \_\_\_ Yes **X**

Cause and herd name: Latir Wilderness, 1981. Pneumonia from domestic sheep

**What do you do to detect, manage and/or prevent disease?**

At each capture, we do a complete external examination, take ear swabs, collect ticks, mites and fecal samples, and draw blood. These biological samples are analyzed by Dr. Walter Boyce at UC Davis. Eleven different titers are measured from the blood including BTV, CE, and PI3.

## NEW MEXICO-RMBS

**5. STATE-FEDERAL RELATIONSHIPS. What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?**

- A. Proper management of livestock allotments.
- B. Wilderness regulations/restrictions
- C. National Wildlife Refuge policy

**Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?**

Negative in that capture for transplants requires a lot of extra steps and we are limited in the number of people we can have on the capture crew.

Positive in that wilderness herds aren't affected by heavy livestock grazing, roads, and as much human disturbance.

**6. CAPTURE-TRANSPLANT TECHNIQUES. What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?**

25 years ago (1975) with estimated mortality rate (%)

- A. Dropnet: <15%
- B. Chemical Immobilization: >30%

Last 5 years, with estimated mortality rate (%)

- A. Dropnet: 0% n=28
- B. Netgun: 0% n=28
- C. Chemical Immobilization (on 1 occasion): 57% (4 OF 7)

**7. SIGNIFICANT LIMITING FACTORS. What are the most significant factors that limit the success of your sheep populations?**

- A. Vegetation encroachment in low elevation habitats.
- B. Roads and human disturbance
- C. Predation from lions, coyotes, and feral dogs.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **NORTH DAKOTA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ **RMBS X** Desert \_\_\_

Contact Person: Ted A. Benzon

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Fax: 605-394-1793

e-mail: benzon@gfrc1.state.sd.us

1. **ESTIMATED POPULATION** size: 1988 300 1998 375

2. **HARVEST**

Resident permits	1988 <u>2</u>	1998 <u>4</u>
Non-Resident permits	1988 <u>      </u>	1998 <u>      </u>
Total Permits	1988 <u>4</u>	1998 <u>4</u>
No. Killed	1988 <u>2</u>	1998 <u>4</u>

Record B&C Score and year killed:

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Any ram.

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Unknown at present time.

Do you control predators to benefit sheep? If so, how?

No.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No \_\_\_ Yes x

Cause and herd name: unknown, Badlands National Park

Cause and herd name:

Last 25 years? No x Yes       

Cause and herd name:

Cause and herd name:

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Disease screening at capture.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Habitat improvement
- B. Maintaining present habitat
- C.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)  
No captures done 25 years ago.

Last 5 years, with estimated mortality rate (%)

- A. Drop net with 0% mortality
- B. Net gun with approximately 5% mortality

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Habitat quality
- B. Habitat quantity

WILD SHEEP STATUS QUESTIONNAIRE

2<sup>nd</sup> North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **OREGON - RMBS**

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Portland, OR 97207  
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don.whittaker@state.or.us

1. ESTIMATED POPULATION:

1988	<u>285</u>	1998	<u>560</u>
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2. HARVEST

Resident permits	1988	<u>3</u>	1998	<u>9</u>
Non-Resident permits	1988	<u>1</u>	1998	<u>2</u>
Total Permits	1988	<u>4</u>	1998	<u>11</u>
No. Killed	1988	<u>4</u>	1998	<u>11</u>
Record B&C Score and year killed	<u>200 6/8 in 1989</u>			

What is the dominant harvest strategy in your state/province for hunting wild sheep?

Conservative management for quality experience, using limited entry controlled hunts and any ram bag limit.

3. PREDATION. What impact does predation have on your sheep populations?

Mountain lion predation is suspected of causing some local population declines and may be depressing growth rates in other local populations.

Do you control predators to benefit sheep? If so, how?

No active predator control but hunters are encouraged to hunt mountain lions with liberal seasons and reduced tag fees.

4. DISEASE. Have you had a disease die-off in the last 5 years? YES

*Pasteurella* in Lower Hells Canyon, Upper Joseph Canyon, and Wenaha herds during winter 1995-1996. Herds in Washington and Idaho were also impacted.

Last 25 Years? YES

*Pasteurella*, Lostine herd in 1986-87.

*Pasteurella*, Upper Hells Canyon herd, 1984.

What do you do to detect, manage and/or prevent disease?

- Disease screening when animals are captured for any reason.
- All animals handled vaccinated with anthelmintics and broad spectrum antibiotic.
- Medicated salt blocks.
- Regular aerial population surveys with frequent ground observation to monitor health.

5. STATE-FEDERAL RELATIONSHIPS. What are the 3 biggest challenges?
- Ten years ago the approval process for bighorn sheep transplant was too detailed and expensive. The process has since been streamlined and is now much more effective.

Has the designation of wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Wilderness classifications have resulted in preserving some large blocks of bighorn habitat. However, some management practices (e.g. use of helicopters for capture) have become difficult to use in such areas.

6. CAPTURE-TRANSPLANT TECHNIQUES. What are the 3 primary techniques used?

25 Years ago with estimated mortality rate?

- Corral trap, 0% mortality.
- Darting from ground, 0% mortality.

Last 5 years?

- Corral trap, 0% mortality
- Helicopter netgun, 0% mortality.
- Dropnet, 3% mortality.
- Helicopter darting, 100% mortality.

7. SIGNIFICANT LIMITING FACTORS. What are the most significant factors limiting sheep populations?

- Diseases associated with domestic livestock (*Pasteurella* and domestic sheep).
- Fragmented land ownership patterns and the relationship with domestic livestock.
- Predators, at least locally.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **SOUTH DAKOTA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ CABS \_\_\_\_\_ **RMBS** X Desert \_\_\_\_\_

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1. **ESTIMATED POPULATION** size: 1988 300 1998 375

2. **HARVEST**

Resident permits	1988 <u>2</u>	1998 <u>4</u>
Non-Resident permits	1988 _____	1998 _____
Total Permits	1988 <u>4</u>	1998 <u>4</u>
No. Killed	1988 <u>2</u>	1998 <u>4</u>

Record B&C Score and year killed:

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Any ram.

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Unknown at present time.

Do you control predators to benefit sheep? If so, how?

No.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No \_\_\_\_\_ Yes x

Cause and herd name: unknown, Badlands National Park

Cause and herd name:

Last 25 years? No x Yes \_\_\_\_\_

Cause and herd name:

Cause and herd name:

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Disease screening at capture.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Habitat improvement
- B. Maintaining present habitat
- C.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

No captures done 25 years ago.

Last 5 years, with estimated mortality rate (%)

- A. Drop net with 0% mortality
- B. Net gun with approximately 5% mortality

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Habitat quality
- B. Habitat quantity

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **UTAH**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ **RMBS** **X** Desert \_\_\_

Contact Person: Jim Karpowitz

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1. **ESTIMATED POPULATION** size: 1988 300 1998 800

2. **HARVEST**

Resident permits	1988 <u>0</u>	1998 <u>4</u>
Non-Resident permits	1988 <u>0</u>	1998 <u>1</u>
Total Permits	1988 <u>0</u>	1998 <u>5</u>
No. Killed	1988 <u>0</u>	1998 <u>5</u>

Record B&C Score and year killed: A ram scoring just over 184 was killed in 1992.

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Provide a high quality hunting experience with a reasonable opportunity to harvest an older age class ram. Current regulations allow the harvest of any ram.

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Predation by mountain lions and coyotes has been observed in bighorn populations. The total impact of predation is unknown. However, predation appears to be a significant mortality factor in some areas. It is believed to be a principle cause of the failure of the Nebo and Deep Creek transplants.

Do you control predators to benefit sheep? If so, how?

Yes. Specific areas are targeted in predator management plans to remove coyotes and mountain lions through sport harvest and with removal by Wildlife Services and Division of Wildlife Resource personnel.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No \_\_\_ Yes X  
Cause and herd name: Lung worm related pneumonia - Sheep Creek herd near Flaming Gorge

Last 25 years? No Other than above Yes \_\_\_

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Regular census of bighorn populations by helicopter is the principle method used to detect disease. Changes in population trends and productivity are used as possible disease indicators. Bighorn populations are also periodically blood tested during capture projects to detect changes in disease exposure. Fecal analysis is conducted in areas of suspected lung worm.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Grazing by domestic sheep near some bighorn populations.
- B. Habitat degradation due to vegetation changes and human disturbance.
- C. Loss of habitat due to increased development.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Population management such as capture and survey work has continued in wilderness study areas. Habitat improvement especially water developments have been limited in some WSAs. Potential designation of millions of acres as wilderness areas may impact sheep populations if management practices are not allowed to continue.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

Very few Rocky Mountain bighorns existed in Utah 25 years ago.

Last 5 years, with estimated mortality rate (%)

A net gun fired from a helicopter is the main method currently used to capture bighorns. Mortality rate is less than 5%. Darting with immobilizing drugs is occasionally used with minimal mortality.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Disease
- B. Predation
- C. Human disturbance
- D. Loss of habitat

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **WASHINGTON**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ **RMBS** \_\_\_ **X** Desert \_\_\_

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1. ESTIMATED POPULATION size: 1988 235 1998 200

2. HARVEST

Resident permits	1988 <u>2</u>	1998 <u>0</u>
Non-Resident permits	1988 <u>0</u>	1998 <u>0</u>
Total Permits	1988 <u>2</u>	1998 <u>0</u>
No. Killed	1988 <u>1</u>	1998 <u>0</u>
Record B&C Score and year killed:	<u>198 pts.</u>	<u>1989</u>

What is the dominant harvest strategy in your state/province for hunting wild sheep?

We have limited permits (none for rocky mountain bighorns currently) but any ram harvest strategy when permits are available.

3. PREDATION. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Predation impacts vary by herd. Most of our bighorn herds are limited to small populations that could be impacted by the loss of just a few individuals to predation. We do not have scientific studies documenting predation impacts but anecdotal reports. Biologist in the Hall Mountain area report cougar predation is likely limiting population size.

Do you control predators to benefit sheep? If so, how?

We do not control predators to benefit any ungulate population.

4. DISEASE. Have you had a disease die-off in the last 5 years? No \_\_\_ Yes X

Cause and herd name: Pasturella - Black Butte (1995-96)

Cause and herd name: Pasturella - Wenaha-Tucannon (1995-96)

Cause and herd name: Pasturella - Mt. View (1995-96)

Last 25 years? No  0  Yes \_\_\_\_\_

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

We have an annual herd health testing program at Hall Mountain. Dr. Bill Foreyt and his veterinarian students have been monitoring herd health of this population every December for about 20 years. We also do disease screening when animals are captured for transplant or when sick or freshly killed animals are made available.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. Domestic sheep grazing on public lands.

B. Noxious weed control

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations? NO

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

A. Drop Net                      mortality ?

Last 5 years, with estimated mortality rate (%)

A. Drop Net                      mortality less than 5%.

B. Net Gun                        mortality less than 5%.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. Adequate escape terrain

B. Domestic sheep

C. Severe winter weather

D. Predation

# WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **WYOMING**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ CABS \_\_\_\_\_ RMBS X Desert \_\_\_\_\_

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e-mail: khurley@trib.com

1. **ESTIMATED POPULATION size:** (post-season) 1988 6,800 1998 6,700  
(includes Yellowstone National Park) \_\_\_\_\_

## 2. HARVEST

Resident permits	1988 <u>273</u>	1998 <u>186</u>	
Non-Resident permits	1988 <u>91*</u>	1998 <u>66*</u>	(Includes 5 governor's licenses)
Total Permits	1988 <u>364*</u>	1998 <u>252*</u>	(Includes 5 governor's licenses)
No. Killed	1988 <u>218*</u>	1998 <u>183*</u>	(Includes governor's license harvest) _____

Record B&C Score and year killed: 200-0/8 in 1883 \_\_\_\_\_

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

--8 hunt areas with  $\geq 3/4$ -curl ram regulation

--5 hunt areas (including 3 largest hunt areas in state) with any ram regulation; increasing use of this strategy

--1 hunt area with any sheep regulation

--6 hunt areas currently closed

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

--predation documented in almost every herd, but effect of predation not well established

--mountain lion predation (especially on lambs) suggested as one factor in keeping herds from building after transplant (e.g., Shell Canyon, Laramie Peak) or rebounding after dieoff (e.g., Whiskey Basin herd still depressed after winter 1990-91 pneumonia dieoff); most problematic where vegetative encroachment has affected high-visibility habitats, primarily due to fire suppression

--wolf expansion around Yellowstone National Park may directly affect large herds in Absaroka, Teton, Wind River, Gros Ventre Mountains, with most likely effect being reduced bighorn use of currently-utilized habitats furthest away from escape terrain

Do you control predators to benefit sheep? If so, how?

--generally no; prophylactic predator control work has been used in the past and is anticipated in advance of planned transplants (e.g., Sweetwater Rocks); contracted with APHIS/Wildlife Services

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No \_\_\_\_\_ Yes  X

Cause and herd name: winter 1990-91 pneumonia dieoff continues to affect Whiskey Basin herd

Last 25 years? No \_\_\_\_\_ Yes  X

Cause and herd name: winter 1990-91 pneumonia dieoff; ~1/3 (N=400) of Whiskey Basin herd died

Cause and herd name: winter 1981-82 *Chlamydia* (pinkeye) dieoff in northern Yellowstone NP

Cause and herd name: scabies, lungworm, other disease problems in various herds around state

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

--necropsy all recovered sheep mortalities at the Wyoming State Veterinary Laboratory

--blood drawn for serum bank/various analyses done at WGFD and Wyoming State Vet Labs

--ear swabs for scabies (*Psoroptes* spp.) mites

--tonsillar/pharyngeal swabs for *Pasteurella*

--occasionally, vaginal swabs taken for *Campylobacter* (none found)

5. **STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. differential ability to implement needed habitat improvement treatments (e.g., prescribed fire) on federal lands in various parts of the state; especially problematic in designated wilderness areas; situation is improving, though

B. proposed transplants/augmentation/reintroductions have been hindered due to federal agency involvement and adverse public reaction to that involvement; transplants should be unilateral responsibility of state wildlife agency; federal agency(ies) should be in a support role but not decision-making role on transplant actions

C. bighorn sheep viewed as high-priority species by state wildlife agency, but not as high priority for federal agencies; federal budgets/staffing don't allow emphasis on bighorn sheep

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

--positive in terms of limiting development/activities (e.g., snowmachines, oil/gas exploration, housing/subdivisions)

--somewhat negative in terms of localized, heavy recreational activity (e.g., Grand Teton National Park, Wind River Mountains) attracted to designated wilderness areas

--negative in terms of implementing needed habitat treatments (e.g., prescribed fire, noxious weed control) in designated wilderness; situation improving, though; many spring/summer/fall habitats inside designated wilderness, with corresponding winter ranges often outside

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

A. since 1975, drop-net exclusively used at Whiskey Basin winter range (source herd for in- and out-of-state transplants); ~1,900 sheep trapped since 1949; mortality averages <1%

Last 5 years, with estimated mortality rate (%)

A. drop-net used at Whiskey Basin, although trapping has only occurred once (i.e., 1995) in past 5 years due to depressed population status following 1990-91 dieoff; mortality <1%

B. net-gun has been technique of choice in past 10+ years everywhere else in state where sheep have been captured; mortality <5%

C. chemical immobilization still occasionally occurs, depending on circumstances and project needs; mortality ~5%

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. conifer encroachment and decreasing visibility in many low-elevation and subalpine habitats, primarily due to historic fire suppression on national forest lands

B. in many transplanted herds, a combination of poor habitat conditions, varying inability to implement needed habitat treatments, known/suspected interaction with domestic sheep, and starting with too few sheep all contribute to poor transplant success

C. depressed population status at Whiskey Basin (which has been the source herd in Wyoming for in-state transplants/augmentations) has limited our ability to supplement struggling herds; another possible source herd (i.e., South Fork Shoshone River) has had scabies present in 1/4 to 1/3 of herd over the past 15+ years

D. unknown effect of predation (e.g., mountain lion) on lamb survival in native (e.g., Whiskey Basin), transplanted (e.g., Shell Canyon, Laramie Peak), and proposed (e.g., Sweetwater Rocks) herds; wolf expansion around YNP may affect habitat selection/use in large, native herds in NW Wyoming

## WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **BRITISH COLUMBIA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ **CABS**  RMBS \_\_\_\_\_ Desert \_\_\_\_\_

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1. **ESTIMATED POPULATION** size: 1988 3200-3500 1998 4500-5000

2. **HARVEST** (AAH = Annual Allowable Harvest)

Resident permits	1988 <u>84</u>	1998 <u>165</u>	
Non-Resident permits	1988 _____	1998 _____	~ 20% of the AAH is allocated to Non-Res
Total Permits	1988 _____	1998 _____	
No. Killed	1988 <u>105</u>	1998 <u>49</u>	

Record B&C Score and year killed: \_\_\_\_\_

What is the dominant harvest strategy in your state/province for hunting wild sheep?

(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Both general open (full-curl) and limited entry hunting (any ram, at least  $\frac{3}{4}$  curl and ewe or lamb) seasons are offered.

3. **PREDATION**. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Hebert and Harrison (1998) studying CABS in the Junction herd concluded that coyote predation and range condition, nutrition, stress, parasites, disease or climate resulted in a significant loss of lambs as reflected in a decline in the seasonal lamb:ewe ratios from the late 1970s. Harrison and Hebert (1988) determined that cougar predation and not habitat condition or illegal hunting reduced the number and proportion of mature rams in the Junction herd. Evidence was obtained which supported the hypothesis that scavenging of cougar kills by coyotes increased the frequency of predation by cougar.

Do you control predators to benefit sheep? If so, how? No real control outside of liberal hunting and trapping seasons for predators.

4. **DISEASE**. Have you had a disease die-off.

There are no records of an all-age die-off of California bighorn sheep ever having occurred in BC. However, reductions of over all numbers and ewe:lamb ratios have occurred in the past in some populations, without reports of sick animals. Markedly increased summer lamb mortality/poor lamb survival has been noted over the past several years in specific sheep herds. Investigations have identified heavy lungworm loads in 6 - 8 week old lambs as well as bacterial pneumonia in some. Lamb losses appear to be less in the 1998 season.

Last 5 years? No \_\_\_\_\_ Yes  x

Cause and herd name: pneumonia in lambs: Junction, Churn and West Fraser herds

Last 25 years? No \_\_\_\_\_ Yes  x

Cause and herd name:

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?  
All radio-collared mortalities are necropsied by wildlife veterinarian when possible. Over past two years helicopter census work has identified time of lamb losses and weak or sick lambs at that time were killed for necropsies. This work is still in preliminary stages.

All live captured sheep are bled to archive serum and genetic samples. Any animals captured for relocations are sampled according to WWHC protocol.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

This is not directly applicable as British Columbia has jurisdiction over its land and natural resources and 94.5% of the Province is Provincial Crown Land.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

British Columbia is nearing the end of a ten year process to double the amount of provincial Protected Areas from 6% to 12% of the land base. Protection of wilderness areas and control of access is seen as a positive effect, providing that increased use by the recreating public is managed within the limits of acceptable change and does not negatively impact mountain sheep populations.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%), Likely much higher then, but no solid records available.

- A. Drive-net
- B. Drop-net

Last 5 years, with estimated mortality rate (%) 0 to 4 %, depending on project, ave. probably 1 -2 %

- A. Net-gun
- B. Drop-net
- C. Drive-net

7. **SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Habitat Alienation (residential developments, access and highway developments, industrial developments, agricultural developments and recreational developments and activities).
- B. Fire suppression and conifer forest encroachment on grassland ranges.
- C. Potential disease transmission from domestic sheep
- D. Competition for forage on critical winter ranges with domestic livestock; mainly cattle on Provincial Crown lands and horses on Indian Reservations.
- E. Unmanaged predator populations which fluctuate widely over the long term.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **CALIFORNIA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS X\* RMBS \_\_\_ Desert X

\*Note that CABS in California (Sierra Nevada) have been found to unique (Genetically and morphometrically) from CABS in BC. While they are distinct and may merit their own subspecies designation, they are more closely aligned with the desert races of bighorn sheep. Therefore, their status will be included in this status report of desert bighorn sheep.

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1. ESTIMATED POPULATION size: 1988 4700 1998 3500

2. HARVEST

Resident permits	1988 <u>8</u>	1998 <u>9</u>
Non-Resident permits	1988 <u>0</u>	1998 <u>0</u>
Fundraising permits	1988 <u>1</u>	1998 <u>1</u>
Total Permits	1988 <u>9</u>	1998 <u>10</u>
No. Killed	1988 <u>7</u>	1998 <u>9</u>

\*Non-resident applicants are entered into the drawing with resident applicants. However, state law specifies that no more than 15% of the tags awarded may go to non-residents. Less than 5% of those that apply for drawing are non-residents.

Record B&C Score and year killed: 182 0/8 - this is the official CDFG score w/ deductions

What is the dominant harvest strategy in your state/province for hunting wild sheep?

Hunting Desert (Nelson) bighorn sheep began in 1987 with only two hunt zones (Marble Mountains and Old Dad Peak/Kelso Mountains) in San Bernardino County open for hunting. Currently, California has five zones open for hunting desert bighorn sheep. These are the Marble Mountains (Zone 1), Old Dad Peak/Kelso Mountains (Zone 2), the Clark/Kingston/Mesquite Mountain Ranges (Zone 3) of San Bernardino County, and the Orocopia Mountains (Zone 4) and San Gorgonio Wilderness (Zone 5) of Riverside County. One to two fund-raising tags, that are valid in any hunt zone (open zone tag), are auctioned each year to fund bighorn sheep conservation efforts.

The current strategy is trophy ram hunting. A legal ram is defined as having at least one horn, the tip of which extends beyond in a straight line beginning at the front (anterior) edge of the horn base, and extending downward through the rear (posterior) edge of the visible portion of the eye and continuing

downward through the horn. These reference points are based on viewing the ram directly from a 90 degree angle from which the head is facing.

State law specifies that ram tags cannot exceed more than 15% of the number of adult rams estimated to be available in the population. Generally, we determine these tags as 15% of adult rams seen during helicopter surevys to ensure that we are in compliance with this law. This allocation usually results in tags being allocated for 3 to 8% of the adult rams estimated to be in the respective population.

Hunter success has been 88% overall (since 1988).

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Predation varies tremendously in desert sheep populations. Specifically, mountain lion predation appears to be very effective at limiting the recovery of small populations, including reintroductions. Mountain lion activity in California has increased dramatically since a moratorium on mountain lion hunting was established in 1972. Lion activity increased most dramatically in the late 1980's and peaked in 1995, and was defined by historically high reports of depredation (lions killing livestock or pets), human attacks, and predation (bighorn sheep and deer) problems. During this time, there are several circumstances where traditional theory of predator/prey relationships have come into question, with some scientists suggesting that mountain lion predation may be much more capable of influencing prey population trends than previously believed. Reestablishing bighorn sheep populations in areas where deer and mountain lions are present is problematic.

Populations that appear to have declined significantly under high levels of predation include:

Native:

- 1)San Gabriel sheep population (Nelson)
- 2)Peninsular Ranges sheep population (Peninsular)
- 3)Bighorn sheep in the Sierra Nevada - 2 herds (California)
- 4)Granite Mountains (Nelson)
- 5)San Gorgonio Mountains (Nelson)

Transplants that failed, most likely due to high mountain lion predation:

- 1)San Rafael Peak (Nelson)
- 2)Prarie Fork (Nelson)

Transplant that almost failed, but was recovered by selective mountain lion control (prior to 1990 mountain lion initiative):

- 1)Lee Vining Canyon

Do you control predators to benefit sheep? If so, how?

No. Since 1990 the California Department of Fish and Game does not have the authority to remove mountain lions to protect sensitive wildlife populations. This was the result of a ballot initiative (Proposition 117) that limited the Departments authority to manage mountain lions.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No  Yes \_\_\_\_\_

Last 25 years? No \_\_\_\_\_ Yes

Cause and herd name: Pneumonia after contact with domestic sheep. Complete die-off of captive herd. Lava Beds National Monument. 1980

Cause and herd name: Pneumonia after contact with domestic sheep. Complete die-off of population. Warner Mountains. 1988

Cause and herd name: Pneumonia type disease. Dramatic population decline in the Peninsular Ranges desert sheep metapopulation. Late 1970's

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

The Department screens for exposure to various pathogens by collecting a blood samples from all captured animals. These samples are submitted for a serological panel of tests. The blood samples and results are stored at the Departments Wildlife Investigations Laboratory in Rancho Cordova.

5. **STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. Interagency cooperation for the recovery of bighorn sheep in the Peninsular Ranges. Currently the Department is cooperating with the USFWS, BLM, US Forest Service, California State Parks, the University of California (Riverside and Davis), and Bighorn Institute in the completion of a metapopulation recovery plan. This bighorn sheep metapopulation is federally listed as endangered. Development pressures in the northern part of the Peninsular Ranges threaten bighorn sheep habitat.

B. Interagency cooperation for the recovery of bighorn sheep in the Sierra Nevada. Currently the Department is cooperating with the USFWS, National Park Service, US Forest Service, BLM, University of California White Mountain Research Station, and the Sierra Nevada Bighorn Sheep Foundation in the implementation of a recovery strategy. These bighorn sheep have been state up-listed to endangered, and are being federally listed as endangered under an emergency provision of USFWS. Mountain lion predation appears to have singularly limited population increases in the 5 remaining herds, and as few as 100 adult animals remain. Plans are being made to establish a captive herd in 2000.

C. In 1994 the California Desert Protection Act designated most of California's deserts as wilderness. This lead to conflict between the Department and the National Park Service and BLM in issues related to access for conservation and research projects, and jeopardized the Department's ability to monitor important bighorn sheep populations. Additionally, the maintenance, development, and restoration of

water sites was inhibited by access restrictions. Traditional volunteer organizations in California such as the Society for the Conservation of Bighorn Sheep and Desert Wildlife Unlimited were frustrated with lack of land agency support, and this ultimately threatened volunteer assistance. Recently, the California Department of Fish and Game and BLM have developed and signed an MOU that attempts to address the issues of access, and guzzler maintenance and development. This agreement will hopefully lessen misunderstandings related to wildlife management projects on designated wilderness lands.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

See C. above. Likely to result in negative impacts on sheep populations.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

A. Drive net and dart gun - 5 to 10% mortality

Last 5 years, with estimated mortality rate (%)

A. Net gun - less than 2% mortality

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. Climatic conditions influencing forage conditions and water availability

B. Mountain lion predation

C. Habitat loss and associated human activity (northern Peninsular Ranges)

D. Lack of wildfires in bighorn sheep habitat (particularly San Gabriel herd)

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **IDAHO**

Subspecies (one questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ **CABS**  **RMBS**  Desert \_\_\_\_\_

Fax:

Contact Person:

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Phone:

e-mail:

1. **ESTIMATED POPULATION size:** 1988 \_\_\_\_\_ ? \_\_\_\_\_ 1998 \_\_\_\_\_ ? \_\_\_\_\_ (No data given)

2. **HARVEST**

Resident permits	1988 <u>46(RM) - 22(CA)</u>	1998 <u>51(RM) - 38(CA)</u>
Non-Resident permits	1988 <u>22(RM) - 0(CA)</u>	1998 <u>13(RM) - 7(CA)</u>
Total Permits	1988 <u>168(RM) - 22(CA)</u>	1998 <u>64(RM) - 45(CA)</u>
No. Killed	1988 <u>62(RM) - 14(CA)</u>	1998 <u>36(RM) - 30(CA)</u>
Record B&C Score and year killed:	<u>RM - 197-7/8 (1996) CA - 174-4/8 (1997)</u>	

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Trophy - 3/4 curl or 4 + years of age

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

None known or suspected of being a problem

Do you control predators to benefit sheep? If so, how?

No

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No  Yes \_\_\_\_\_  
No all-age die-off, lamb die-off only.

Cause and herd name:

Last 25 years? No \_\_\_\_\_ Yes

Cause and Herd Name: All pneumonia caused die-offs: Upper Hells Canyon 1983, 1991; Panther Creek, Morgan Creek, East Fork, Lost River Range, and west Middle Fork, Camas Creek.

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Monitor herd population characteristics and size

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Regulation of domestic sheep allotments
- B. Grazing by domestic livestock
- C. Helicopter use in Wilderness areas

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. Darting - 10-15%
- B. Drop-net - <1%
- C. Net gun - <1%

Last 5 years, with estimated mortality rate (%)

- A. Drop net - <1%
- B. Net gun - <1%

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Management program
- B. Disease/ Dieoffs
- C. Availability of habitat
- D. Availability of transplant stock

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **NEVADA**

Subspecies (one questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ **CABS**  **RMBS** \_\_\_\_\_ Desert \_\_\_\_\_

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1. ESTIMATED POPULATION size: 1988 564 1998 1248

2. HARVEST

Resident permits	1988 <u>4</u>	1998 <u>37 + 1 Partners in Wildlife</u>
Non-Resident permits	1988 <u>0</u>	1998 <u>3</u>
Total Permits	1988 <u>4</u>	1998 <u>41</u>
No. Killed	1988 <u>3 (100%)</u>	1998 <u>33 (80.5%)</u>
Record B&C Score and year killed:	<u>175-2/8 in 1997</u>	

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Harvest: 8% of rams 1 year old+, based upon population models.  
No age or size restrictions

3. PREDATION. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

No impact, although one herd has changed distribution

Do you control predators to benefit sheep? If so, how? NO

4. DISEASE. Have you had a disease die-off in the last 5 years? No  Yes \_\_\_\_\_

Cause and herd name:

Cause and herd name:

Last 25 years? No  Yes \_\_\_\_\_

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Animals are briefly examined during annual composition surveys for obvious physical signs of disease. All captured animals are examined for physical evidence of disease and provided w/a panel of prophylactic drugs. Throat and nasal swabs used to be taken; however, our arrangement w/Dr. Hunter ended.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

NDOW has good relationships with USFS, USFWS, and BLM

A. Commission policy prevents NDOW from releasing any bighorns onto Mtn. Ranges that have active domestic sheep permits

B. Domestic sheep trailing

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Not California BHS

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

A. Drop net (< 5%)

B. Linear entanglement net (< 5%)

Last 5 years, with estimated mortality rate (%)

A. Net gun exclusively ( 5%)

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. Some type conversions due to wildfire

B. Public desire for limited harvest of mature rams (the "quality" experience) limits the harvest potential that individual herds have.

C. We have concerns about increasing densities becoming vulnerable to environmental factors. Our response has been to reduce densities through translocation; however, we are coming close to full re-establishment on a geographical scale.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **NORTH DAKOTA**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ **CABS**  **RMBS** \_\_\_\_\_ Desert \_\_\_\_\_

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e-mail: [moehler@state.nd.us](mailto:moehler@state.nd.us)

1. ESTIMATED POPULATION size: 1988 200 1998 150

2. HARVEST

Resident permits	1988 <u>7<sup>^</sup></u>	1998 <u>7</u>
Non-Resident permits	1988 <u>0</u>	1998 <u>0</u>
Total Permits	1988 <u>8</u>	1998 <u>8</u>
No. Killed	1988 <u>8</u>	1998 <u>7</u>

<sup>^</sup>An additional permit was auctioned at FNAWS (total of 8 both years).

Record B&C Score and year killed: 166 5/8 - 1987

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Maximizing hunter opportunity (current regulations allow harvest of any ram).

3. PREDATION. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

The effects of predation on mountain sheep in ND has not specifically been evaluated. There have been incidental observations of sheep/coyote interactions by researchers doing other sheep research; however, predation was not the focal topic of their study. When discussing this matter with other biologists (i.e., Bill Jensen and Roger Johnson), there is a consensus among ourselves that predation is likely a problem for our sheep herds, and that it is an issue we would like to address in the future. In the past, we have had a pretty healthy coyote population in our sheep range (evidenced by the relatively high rate of sheep/coyote interactions), and it is likely that predation has affected recruitment in our herds. Recently, however, coyotes have declined in much of North Dakota as a result of mange, thus, the potential exists for sheep populations to experience higher rates of recruitment until coyote populations rebuild. I would like to reiterate that the effects of predation on sheep have not been evaluated in ND, nor has the current status of coyotes in habitats inhabited by sheep.

Do you control predators to benefit sheep? If so, how?

NDGF does not control coyotes for the benefit of bighorn sheep; however, Animal Damage Control does have an active predator control program that is aimed at reducing predation on livestock (based on complaints from ranchers). Because most of our sheep herds exist in areas that also are ranches, it is likely that sheep experience reduced predation as a result of the efforts of ADC. Again, population dynamics of coyotes in our sheep ranges are not known, and I have not seen data from ADC regarding coyote harvest from those areas inhabited by sheep.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No \_\_\_\_\_ Yes  X   
Cause and herd name:

We just recently (between January 1998 and January 1999) lost ca. 30 sheep from the South Bullion herd (South of Medora, ND). Skeletal remains are all that were discovered in the area, thus, cause of death is unknown at this time.

Cause and herd name:

Last 25 years? No \_\_\_\_\_ Yes  X

Cause and herd name: Lone Butte herd, cause unknown (all-age die-off).

Cause and herd name:

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

When mountain sheep are handled, every attempt is made to sample blood for serology. From 1980 to 1995, the Department treated bighorn sheep with fendbendazole (mixed with apple pulp) at various sites within sheep range; the efficacy of that treatment regimen is being evaluated. Additionally, sheep that have been trapped for transplant to other areas in the Badlands have been given intramuscular injections of Ivermectin (lungworm), vitamin E and selenium (capture-related stress), and longicil (infections). In addition to monitoring health of our herds during captures and other related activities, our herds also are monitored by a field technician during autumn months.

5. **STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. In the past, EISs have not been completed in a timely manner, thus, our ability to re-establish new herds in suitable habitats, in a timely manner, has been greatly hindered.

B. Much to our chagrin, there are federal agencies who continue to consider using domestic sheep and goats as a method for controlling noxious weeds in areas in and around our sheep herds.

C. Policies regulating use of federal lands (e.g., grazing, mineral extraction, etc.).

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Presently, we have no designated wilderness areas in our sheep range. If we did, however, I don't

think they would adversely affect our sheep herds. In fact, wilderness areas would likely limit activities such as grazing and mineral development (which would reduce disturbance, etc....), and consequently, would probably benefit our herds. To be designated as a wilderness area usually requires that a tract of land be quite large; unfortunately, as I pointed out earlier, much of our range is quite fragmented. Therefore, it is unlikely that wilderness areas within mountain sheep range will ever be a reality.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. Drop-net: handled ca. 150 sheep with about 5 % mortality.
- B. Net-gun: 20-25 animals, with 4 animals dying from capture myopathy.
- C. Drive-net: 4 animals handled, 100% mortality.

Last 5 years, with estimated mortality rate (%)

- A. Drop-net: 28 sheep handled, no mortality.
- B. Net-gun: not used.
- C. Drive-net: not used.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. Recruitment of lambs into the adult population is probably the most important factor limiting our populations (go figure, huh). This is probably a result of several factors; however, the scarcity of good lambing habitat and escape terrain is likely the ultimate cause. The habitat is quite fragmented to begin with (i.e., there are no large contiguous blocks of land that have not been impacted by man - grazing oil development, etc.), and as such, the remaining sheep habitat consists of small "islands" that are not well connected. The range of sheep in ND is a mosaic of land ownership (private, USFS, ND school lands, and some BLM), so it can prove challenging to reduce further fragmentation of sheep habitats. I probably listed more than three limiting factors there, but I think most of the problems with any sheep population that is considered "unsuccessful" (or any population for that matter) is recruitment. I want to reiterate that point because most limiting factors ultimately can be reduced to that single HUGE factor; when recruitment is poor, sheep populations do poorly (be it trophy ram production, viewing pleasure, etc.).

B. Disease is a problem that we have to monitor more closely, as is evidenced by our recent loss of a herd of sheep.

C. As I stated in an earlier answer, I think predation could be important, and it too needs to be addressed with further study.

D. Pick one from my long and lengthy "first" answer.

WILD SHEEP STATUS QUESTIONNAIRE

2<sup>nd</sup> North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **OREGON - CABS**  
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1. ESTIMATED POPULATION:

1988 >1200 1998 2544

2. HARVEST

Resident permits	1988	<u>37</u>	1998	<u>52</u>
Non-Resident permits	1988	<u>3</u>	1998	<u>3</u>
Total Permits	1988	<u>40</u>	1998	<u>42</u>
No. Killed	1988	<u>41</u>	1998	<u>55</u>
Record B&C Score and year killed	<u>184 7.8 in 1997</u>			

What is the dominant harvest strategy in your state/province for hunting wild sheep?

Conservative management for quality experience, using limited entry controlled hunts and any ram bag limit.

3. PREDATION. What impact does predation have on your sheep populations?

Mountain lion predation is suspected of causing some local population declines and may be depressing growth rates in other local populations.

Do you control predators to benefit sheep? If so, how?

No active predator control but hunters are encouraged to hunt mountain lions with liberal seasons and reduced tag fees.

4. DISEASE. Have you had a disease die-off in the last 5 years? NO

Last 25 Years? YES

*Pasteurella*, Aldrich herd, 1991

Suspected *Pasteurella*, Canyon Mountains herd, 1984.

What do you do to detect, manage and/or prevent disease?

- Disease screening when animals are captured for any reason.
- All animals handled vaccinated with anthelmintics and broad spectrum antibiotic.
- Medicated salt blocks.
- Regular aerial population surveys with frequent ground observation to monitor health.
- Cooperative domestic livestock management, avoid domestic sheep.

5. **STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges?

- a. Regulatory processes for re-introductions and water development.
- b. Domestic sheep allotment management.

Has the designation of wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Not a significant factor in Oregon's California bighorn ranges.

6. **CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used?

25 Years ago with estimated mortality rate?

- a. Corral trap, up to 10% mortality.
- b. Drive nets, no estimate of mortality.

Last 5 years?

- a. Helicopter netgun, 3% mortality.

7. **SIGNIFICANT LIMITING FACTORS.** What are the most significant factors limiting sheep populations?

- a. Habitat availability.
- b. Domestic and exotic sheep management.
- c. Fragmented land ownership patterns and the relationship with domestic livestock.
- d. Predators, at least locally.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **UTAH**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ **CABS**  **RMBS** \_\_\_\_\_ Desert \_\_\_\_\_

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1. **ESTIMATED POPULATION size:** 1988   0   1998   45  

2. **HARVEST**

Resident permits	1988 <u>  0  </u>	1998 <u>  0  </u>
Non-Resident permits	1988 <u>  0  </u>	1998 <u>  0  </u>
Total Permits	1988 <u>  0  </u>	1998 <u>  0  </u>
No. Killed	1988 <u>  0  </u>	1998 <u>  0  </u>

Record B&C Score and year killed: \_\_\_\_\_

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

California bighorns are not currently hunted in Utah

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Predation is an unknown factor in Utah's only California bighorn population on Antelope Island.

Do you control predators to benefit sheep? If so, how?

No

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No  Yes \_\_\_\_\_

Last 25 years? No  Yes \_\_\_\_\_

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Regular census of bighorn populations is the principle method used to detect disease. Changes in population trends and productivity are used as possible disease indicators. Bighorn populations are also periodically blood tested during capture projects to detect changes in disease exposure. Fecal analysis is conducted in areas of suspected lung worm.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

California bighorn sheep are currently found only on Antelope Island which is a state owned park. There is a good working relationship with the Utah Division of Parks and Recreation.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Wilderness is not an issue on Antelope Island. It may become an issue in future transplant sites.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

California bighorns did not exist in Utah 25 years ago.

Last 5 years, with estimated mortality rate (%)

A net gun fired from a helicopter is the main method currently used to capture California bighorns. Mortality rate is less than 5%.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Quantity and quality of habitat
- B. Human disturbance
- C. Possible predation
- D. Possible disease

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **WASHINGTON**

Subspecies: (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ **CABS**  RMBS \_\_\_\_\_ Desert \_\_\_\_\_

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1. ESTIMATED POPULATION size: 1988 460 1998 730

2. HARVEST

Resident permits	1988 <u>9</u>	1998 <u>12 (includes raffle &amp; auction)</u>
Non-Resident permits	1988 <u>0</u>	1998 <u>1</u>
Total Permits	1988 <u>9</u>	1998 <u>0</u>
No. Killed	1988 <u>8</u>	1998 <u>13</u>
Record B&C Score and year killed:	<u>No records kept</u>	

What is the dominant harvest strategy in your state/province for hunting wild sheep?

We have limited permits for any ram harvest strategy.

3. PREDATION. What impact does predation have on your sheep populations?

Predation impacts vary by herd. Most of our bighorn herds are limited to small populations that could be impacted by the loss of just a few individuals to predation. We do not have scientific studies documenting predation impacts but anecdotal reports. In the Tucannon area we had very high coyote populations in lambing areas. Lamb survival plummeted to near zero. A coyote control program was initiated in the lambing areas and lamb survival went to 100% the following year. A few years later, lamb survival dropped again. Cougar have been seen in the lambing area and our local biologist believes cougar are impacting lamb survival.

Do you control predators to benefit sheep? If so, how?

We do not now control predators.

4. DISEASE. Have you had a disease die-off in the last 5 years? No  Yes

Last 25 years? No \_\_\_\_\_ Yes

Cause and herd name: Scabies - Cottonwood creek 60% die-off

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

We do disease screening when animals are captured for transplant or when sick or freshly killed animals are made available. We also collect fecal pellets from bighorn herds suspected of parasite disease problems.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Domestic sheep grazing on public lands.
- B. Noxious weed control
- C. Tribal hunting of bighorns

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations? NO

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. Corral trap            10% mortality
- B. Drop Net             10% mortality

Last 5 years, with estimated mortality rate (%)

- A. Drop Net             mortality less than 5%.
- B. Net Gun              mortality less than 5%.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Adequate escape terrain and winter range with quality forage.
- B. Domestic sheep
- C. Severe winter weather
- D. Predation

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **ARIZONA**

Subspecies (1 questionnaire/subspecies): **Desert X**

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1. **ESTIMATED POPULATION size:** 1988 - 4500    1998 - 6500

2. **HARVEST**

Resident permits	1988 - 71	1998 - 99
Non-Resident permits	1988 - 7	1998 - 10
Total Permits	1988 - 78*	1998 - 109*
No. Killed	1988 - 75	1998 - 98

Record B&C Score and year killed: 197 1/8 (1988)

\*All permits are available to residents - no more than 10% of the total permits are available to non-residents.

What is the dominant harvest strategy in your state/province for hunting wild sheep?

Provide hunter recreation that stresses the quality of the hunting experience and harvest of older age class rams. The legal animal is any ram.

3. **PREDATION.** What impact does predation have on your sheep populations?

Predation has been blamed for the failure of three transplants (Black Mountain, Lion Mountain and the Superstitions). While predation is not usually a causitive factor in the decline of ungulate population levels in the Southwest, with the very small number of animals in a typical release, predation can adversely impact the success of a transplant.

Do you control predators to benefit sheep?

The Arizona Game & Fish Department does not control predators to benefit bighorn sheep. In 1999, the Department will initiate a management action in a select area to remove mountain lions and determine the subsequent effect upon a bighorn sheep population.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No X

Last 25 years? No X

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Bighorn sheep populations are tested during capture projects to determine titers to common livestock diseases.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. Joint jurisdictional differences of opinion, particularly on military ranges and USFW National Wildlife Refuges.

B. Non-compatible domestic sheep grazing practices on BLM and USFS lands.

C. Designated wilderness areas affect management and utilization activities.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Designation of wilderness areas has required altering routine management activities.  
Wilderness areas, over the long term, will probably have positive impacts on sheep populations.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

A. Helicopter/ground drug darting (20%)

Last 5 years, with estimated mortality rate (%)

A. Drop-net (<1%)

B. Net-gun (<2%)

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. Loss of habitat.

B. Fragmentation of habitat.

C. Human disturbance.

D. Adverse climatic conditions.

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: CALIFORNIA

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS X\* RMBS \_\_\_ Desert X

\*Note that CABS in California (Sierra Nevada) have been found to unique (Genetically and morphometrically) from CABS in BC. While they are distinct and may merit their own subspecies designation, they are more closely aligned with the desert races of bighorn sheep. Therefore, their status will be included in this status report of desert bighorn sheep.

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1. ESTIMATED POPULATION size: 1988 4700 1998 3500

2. HARVEST

Resident permits	1988 <u>8</u>	1998 <u>9</u>
Non-Resident permits	1988 <u>0</u>	1998 <u>0</u>
Fundraising permits	1988 <u>1</u>	1998 <u>1</u>
Total Permits	1988 <u>9</u>	1998 <u>10</u>
No. Killed	1988 <u>7</u>	1998 <u>9</u>

\*Non-resident applicants are entered into the drawing with resident applicants. However, state law specifies that no more than 15% of the tags awarded may go to non-residents. Less than 5% of those that apply for drawing are non-residents.

Record B&C Score and year killed: 182 0/8 - this is the official CDFG score w/ deductions

What is the dominant harvest strategy in your state/province for hunting wild sheep?

Hunting Desert (Nelson) bighorn sheep began in 1987 with only two hunt zones (Marble Mountains and Old Dad Peak/Kelso Mountains) in San Bernardino County open for hunting. Currently, California has five zones open for hunting desert bighorn sheep. These are the Marble Mountains (Zone 1), Old Dad Peak/Kelso Mountains (Zone 2), the Clark/Kingston/Mesquite Mountain Ranges (Zone 3) of San Bernardino County, and the Orocopia Mountains (Zone 4) and San Gorgonio Wilderness (Zone 5) of Riverside County. One to two fund-raising tags, that are valid in any hunt zone (open zone tag), are auctioned each year to fund bighorn sheep conservation efforts.

The current strategy is trophy ram hunting. A legal ram is defined as having at least one horn, the tip of which extends beyond in a straight line beginning at the front (anterior) edge of the horn base, and extending downward through the rear (posterior) edge of the visible portion of the eye and continuing

downward through the horn. These reference points are based on viewing the ram directly from a 90 degree angle from which the head is facing.

State law specifies that ram tags cannot exceed more than 15% of the number of adult rams estimated to be available in the population. Generally, we determine these tags as 15% of adult rams seen during helicopter surevys to ensure that we are in compliance with this law. This allocation usually results in tags being allocated for 3 to 8% of the adult rams estimated to be in the respective population.

Hunter success has been 88% overall (since 1988).

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Predation varies tremendously in desert sheep populations. Specifically, mountain lion predation appears to be very effective at limiting the recovery of small populations, including reintroductions. Mountain lion activity in California has increased dramatically since a moratorium on mountain lion hunting was established in 1972. Lion activity increased most dramatically in the late 1980's and peaked in 1995, and was defined by historically high reports of depredation (lions killing livestock or pets), human attacks, and predation (bighorn sheep and deer) problems. During this time, there are several circumstances where traditional theory of predator/prey relationships have come into question, with some scientists suggesting that mountain lion predation may be much more capable of influencing prey population trends than previously believed. Reestablishing bighorn sheep populations in areas where deer and mountain lions are present is problematic.

Populations that appear to have declined significantly under high levels of predation include:

Native:

- 1)San Gabriel sheep population (Nelson)
- 2)Peninsular Ranges sheep population (Peninsular)
- 3)Bighorn sheep in the Sierra Nevada - 2 herds (California)
- 4)Granite Mountains (Nelson)
- 5)San Gorgonio Mountains (Nelson)

Transplants that failed, most likely due to high mountain lion predation:

- 1)San Rafael Peak (Nelson)
- 2)Prarie Fork (Nelson)

Transplant that almost failed, but was recovered by selective mountain lion control (prior to 1990 mountain lion initiative):

- 1)Lee Vining Canyon

Do you control predators to benefit sheep? If so, how?

No. Since 1990 the California Department of Fish and Game does not have the authority to remove mountain lions to protect sensitive wildlife populations. This was the result of a ballot initiative (Proposition 117) that limited the Departments authority to manage mountain lions.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No  Yes \_\_\_\_\_

Last 25 years? No \_\_\_\_\_ Yes

Cause and herd name: Pneumonia after contact with domestic sheep. Complete die-off of captive herd. Lava Beds National Monument. 1980

Cause and herd name: Pneumonia after contact with domestic sheep. Complete die-off of population. Warner Mountains. 1988

Cause and herd name: Pneumonia type disease. Dramatic population decline in the Peninsular Ranges desert sheep metapopulation. Late 1970's

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

The Department screens for exposure to various pathogens by collecting a blood samples from all captured animals. These samples are submitted for a serological panel of tests. The blood samples and results are stored at the Departments Wildlife Investigations Laboratory in Rancho Cordova.

5. **STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. Interagency cooperation for the recovery of bighorn sheep in the Peninsular Ranges. Currently the Department is cooperating with the USFWS, BLM, US Forest Service, California State Parks, the University of California (Riverside and Davis), and Bighorn Institute in the completion of a metapopulation recovery plan. This bighorn sheep metapopulation is federally listed as endangered. Development pressures in the northern part of the Peninsular Ranges threaten bighorn sheep habitat.

B. Interagency cooperation for the recovery of bighorn sheep in the Sierra Nevada. Currently the Department is cooperating with the USFWS, National Park Service, US Forest Service, BLM, University of California White Mountain Research Station, and the Sierra Nevada Bighorn Sheep Foundation in the implementation of a recovery strategy. These bighorn sheep have been state up-listed to endangered, and are being federally listed as endangered under an emergency provision of USFWS. Mountain lion predation appears to have singularly limited population increases in the 5 remaining herds, and as few as 100 adult animals remain. Plans are being made to establish a captive herd in 2000.

C. In 1994 the California Desert Protection Act designated most of California's deserts as wilderness. This lead to conflict between the Department and the National Park Service and BLM in issues related to access for conservation and research projects, and jeopardized the Department's ability to monitor important bighorn sheep populations. Additionally, the maintenance, development, and restoration of

water sites was inhibited by access restrictions. Traditional volunteer organizations in California such as the Society for the Conservation of Bighorn Sheep and Desert Wildlife Unlimited were frustrated with lack of land agency support, and this ultimately threatened volunteer assistance. Recently, the California Department of Fish and Game and BLM have developed and signed an MOU that attempts to address the issues of access, and guzzler maintenance and development. This agreement will hopefully lessen misunderstandings related to wildlife management projects on designated wilderness lands.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

See C. above. Likely to result in negative impacts on sheep populations.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

A. Drive net and dart gun - 5 to 10% mortality

Last 5 years, with estimated mortality rate (%)

A. Net gun - less than 2% mortality

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. Climatic conditions influencing forage conditions and water availability

B. Mountain lion predation

C. Habitat loss and associated human activity (northern Peninsular Ranges)

D. Lack of wildfires in bighorn sheep habitat (particularly San Gabriel herd)

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **COLORADO**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ RMBS \_\_\_ Desert X

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1. ESTIMATED POPULATION size: 1988 ~250 1998 460

2. HARVEST

Resident permits	1988 <u>2</u>	1998 <u>6</u>
Non-Resident permits	1988 <u>0</u>	1998 <u>0</u>
Total Permits	1988 <u>2</u>	1998 <u>6</u>
No. Killed	1988 <u>2</u>	1998 <u>6</u>
Record B&C Score and year killed:	<u>NA</u>	

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)  
trophy ram with a half-curl or larger regulation

3. PREDATION. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.  
Mountain lions have been having an impact on some of our desert bighorn herds. One in particular, the Black Ridge herd seems to be suffering substantial mortality due to mountain lions.

Do you control predators to benefit sheep? If so, how?

We have been attempting to control predators with sport hunting. We haven't attempted to use APHIS or ADC to do additional control work to benefit sheep populations.

4. DISEASE. Have you had a disease die-off in the last 5 years? No X Yes \_\_\_\_\_

Cause and herd name:

Cause and herd name:

Last 25 years? No X Yes \_\_\_\_\_

Cause and herd name:

Cause and herd name:

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?  
The only thing we are doing for desert sheep at this time is conducting necropsies on all fresh carcasses to determine cause of death and disease agent if disease was cause of death.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. We are working with BLM to try and control human recreation in desert bighorn ranges. Currently mountain biking is very popular in the area and increased demand for more bike trails and riding opportunities is a potential problem for desert bighorn sheep management.

B. Disease management in the form of establishing and maintaining segregation of domestic sheep from desert bighorn sheep.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Designation of some areas as wilderness curtails some of our management activities, but we have been able to get waivers for management activities (helicopter use for net-gunning or translocation of sheep).

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

A. Desert bighorn sheep were first released in Colorado in 1979.

Last 5 years, with estimated mortality rate (%)

A. Net-gunning (<5%)

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. CDOW has designated a portion of western Colorado as desert bighorn sheep habitat. Any sheep translocated in this area will be the desert sub-species. As a result, we are limited by the small number of sites that can hold sheep in the area designated as desert sheep range.

B. Human population growth. As the states human population grows there are impacts on sheep habitat due to road building, housing development and outdoor recreation.

C. Controlling human outdoor recreation activities in areas that are important habitats or seasonal ranges for desert bighorn sheep.

# WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **NEVADA**

Subspecies (one questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ RMBS \_\_\_ Desert **X**

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1. ESTIMATED POPULATION size: 1988 5,700 1998 5,300

## 2. HARVEST

Resident permits	1988 <u>123</u>	1998 <u>100</u>
Non-Resident permits	1988 <u>13</u>	1998 <u>10</u>
Total Permits	1988 <u>138*</u>	1998 <u>115**</u>
No. Killed	1988 <u>114</u>	1998 <u>95</u>

\* includes auction tags

\*\*includes PIW tags and auction tags

Record B&C Score and year killed: 187 2/8 1982

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

The regulation which addresses harvest strategy stipulates any ram may be taken. The any-ram regulation has been the dominant harvest strategy in the last three seasons (1996-98). Previously, a trophy ram requirement corresponded to slightly more than half the hunt areas while an any-ram regulation applied to the remaining hunt areas.

3. PREDATION. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

The extent to which predation has influenced sheep population dynamics is not well understood. Empirical data from which conclusions may be drawn relative to impacts of predation on sheep populations and transplants are lacking.

Do you control predators to benefit sheep? If so, how?

No.

4. DISEASE. Have you had a disease die-off in the last 5 years? No \_\_\_ Yes \_\_\_

Last 25 years? No \_\_\_\_\_ Yes X

Cause and herd name: Respiratory bacterial infection - Mormon Mountains, Lincoln County

Cause and herd name: Respiratory bacterial infection - Tobin Range, Pershing County

Cause and herd name: Respiratory bacterial infection - East Range, Pershing County

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

It is difficult to link a die-off to a disease event. Moreover, in instances marked by precipitous population declines, no conclusive evidence exists which would demonstrate disease transmissions between domestic and bighorn sheep occurred and bighorn sheep mortality resulted. Given that, in the absence of indisputable evidence, it has been suspected two additional bighorn populations experienced disease induced die-offs: Pancake Range (late 1990's), Nye County and Virgin Mountains (early 1990's), Clark County.

In the southern portion of the state, collection of biologic samples may occur during capture and translocation operations, and is considered incidental to the overall effort. Further north, in Churchill, Pershing and Lander counties, active domestic sheep allotments are more prevalent, and in instances where intermingling may have occurred between the species, bighorn have been captured for disease testing.

The policy regarding translocations stipulates priority will be afforded to those areas where no domestic sheep are present and adjacent to the proposed habitat area and introduction site. In the event domestic sheep are found to occupy adjacent habitats the degree of risk will be evaluated, and the appropriate land management agency(s) as well as concerned publics will be consulted to determine the overall long-term implications of a bighorn release with consideration of other multiple uses and potential recreational and scientific values.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Federal land management agencies tend to have many conflicting objectives and plans. The schizophrenic nature of multiple use agencies is often the root of unnecessary delays relative to obtaining required clearances and permits for wild sheep projects.
- B. Wildlife programs and concerns within federal land management agencies ordinarily do not extend much beyond feral horses and burros, and species which are federally listed as threatened and endangered. Consequently, the welfare of wild sheep populations and management of wild sheep habitat often receives little consideration. Moreover, management actions within the scope of feral horses and burros, and threatened and endangered species usually have profound impacts on bighorn sheep habitat, distribution and movements.

- C. The high turn-over rate of personnel from Washington to the field ensures many federal employees lack background knowledge on critical issues, and lack intimate knowledge of resources under their responsibility. In short, brief tenure breeds unfamiliarity on many levels, and ultimately serves to delay issuance of essential clearances and permits for desert bighorn sheep projects and activities.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

In Nevada, as a wilderness bill has yet to be enacted, the area designation of concern would be Wilderness Study Area (WSA). And indeed, the designation of WSAs has impacted management activities. The very qualities of remoteness, rugged terrain, and limited access, which qualified areas for wilderness consideration, constitute key habitat for desert bighorn sheep. Thus, the wilderness designation and attendant restrictions have been and continue to be an entanglement which the Division of Wildlife must maneuver through to achieve management objectives.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. Drop-net: 1,037 trapped - 14 capture related mortalities (1.4%)
- B. Net-gun: 815 trapped - 18 capture related mortalities (2.2%)
- C. Drive-net: 32 trapped - 2 capture related mortalities (6.3%)

Last 5 years, with estimated mortality rate (%)

- A. Drop-net: 6 trapped - 1 capture related mortality (1.7%)
- B. Net-gun: 415 trapped - 9 capture related mortalities (2.2%)
- C. Drive-net: 0 trapped

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Habitat fragmentation
- B. Habitat loss and degradation as a consequence of increasing human population and public land disposals
- C. Protracted drought conditions
- D. Lack of knowledge (health status of herds and impacts of predation)

## WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **NEW MEXICO**

Subspecies (one questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ CABS \_\_\_\_\_ RMBS \_\_\_\_\_ Desert X

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1. ESTIMATED POPULATION size: 1988 159 1998 230

### 2. HARVEST

Resident permits	1988 <u>0</u>	1998 _____
Non-Resident permits	1988 <u>0</u>	1998 _____
Total Permits	1988 <u>0</u>	1998 <u>2*</u>
No. Killed	1988 <u>0</u>	1998 <u>1</u>

\*One permit is auctioned at FNAWS convention

Record B&C Score and year killed: 181-4/8 in 1995

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Trophy ram

3. PREDATION. What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

All herds are thought to be stable or declining with lion predation as a principal cause of adult mortality and hypothesized to be limiting recruitment also.

Do you control predators to benefit sheep? If so, how?

Special permits issued to harvest specific lions on a case-by-case basis.

4. DISEASE. Have you had a disease die-off in the last 5 years? No X Yes \_\_\_\_\_

Cause and herd name:

Cause and herd name:

Last 25 years? No \_\_\_\_\_ Yes X

Cause and herd name: Pneumonia

Peloncillo Mountains

Cause and herd name: Blurtongue/Contagious Ecthyma

Red Rock herd

Cause and herd name: Psoroptic scabies/Contagious Ecthyma

San Andres

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

- 1) Disease screening at capture; 2) No mixing of bighorn from other states

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Federal wilderness capture and transplants
- B. Cooperation on livestock allotment management plans
- C. Implementing fire management to restore bighorn habitat

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Yes. Hampered capture and transplant programs negatively.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

- A. Drive net (3%)
- B. Chemical immobilization by darting (10-20%)
- C.

Last 5 years, with estimated mortality rate (%)

- A. Net gun--n=111(<1%)

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Low juvenile recruitment due to ???
- B. High adult mortality due primarily to lion predation
- C. Reduction in habitat due to vegetation changes

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **UTAH**

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_\_\_ Stone's \_\_\_\_\_ CABS \_\_\_\_\_ RMBS \_\_\_\_\_ **Desert x**

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1. **ESTIMATED POPULATION** size: 1988 1500 1998 2600

2. **HARVEST**

Resident permits            1988 13                            1998 28

Non-Resident permits    1988 2                                1998 3

Total Permits                1988 15                            1998 31

No. Killed                    1988 12                            1998 31

Record B&C Score and year killed: A ram scoring just over 168 was killed in 1997.

What is the dominant harvest strategy in your state/province for hunting wild sheep?  
(e.g., closed, subsistence, any-ram, trophy ram, ewe hunting, maximum recreational opportunity)

Provide a high quality hunting experience with a reasonable opportunity to harvest an older age class ram. Current regulations allow the harvest of any ram.

3. **PREDATION.** What impact does predation have on your sheep populations? (e.g., has predation caused populations to decline or transplants to fail?). Specify herd name if appropriate.

Predation by mountain lions, coyotes and golden eagles has been observed in several bighorn populations. The total impact of predation is unknown. However, predation appears to be a significant mortality factor in some areas. It is believed to be a principle cause of the failure of the Westwater Canyon transplant.

Do you control predators to benefit sheep? If so, how?

Yes. Specific areas are targeted in predator management plans to remove coyotes and mountain lions through sport harvest and with removal by Wildlife Services and Division of Wildlife Resource personnel.

4. **DISEASE.** Have you had a disease die-off in the last 5 years? No X Yes \_\_\_\_\_

Last 25 years? No \_\_\_\_\_ Yes X

Cause and herd name: Suspected die off of North San Juan herd by Pasteurella pneumonia.

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Regular census of bighorn populations by helicopter is the principle method used to detect disease. Changes in population trends and productivity are used as possible disease indicators. Bighorn populations are also periodically blood tested during capture projects to detect changes in disease exposure.

**5. STATE-FEDERAL RELATIONSHIPS.** What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

- A. Grazing by domestic sheep near some bighorn populations.
- B. Habitat degradation due to human disturbance including unregulated outdoor recreation and off road vehicle use.
- C. Loss of habitat due to increased development.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

Population management such as capture and survey work has continued in wilderness study areas. Habitat improvement especially water developments have been limited in some WSAs. Potential designation of millions of acres as wilderness areas may impact sheep populations if management practices are not allowed to continue.

**6. CAPTURE-TRANSPLANT TECHNIQUES.** What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

25 years ago (1975) with estimated mortality rate (%)

Helicopter darting with immobilizing drugs was the only method 25 years ago. Mortality rate 20-40%

Last 5 years, with estimated mortality rate (%)

A net gun fired from a helicopter is the only method currently used to capture desert bighorns. Mortality rate is less than 5%.

**7. SIGNIFICANT LIMITING FACTORS.** What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

- A. Disease
- B. Predation
- C. Human disturbance
- D. Loss of habitat

WILD SHEEP STATUS QUESTIONNAIRE

2nd North American Wild Sheep Conference, Reno, Nevada, 6-9 April 1999

State or Province: **TEXAS** 98% Privately Owned

Subspecies (1 questionnaire/subspecies): Dall's \_\_\_ Stone's \_\_\_ CABS \_\_\_ RMBS \_\_\_ Desert X

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1. ESTIMATED POPULATION size: 1988 < 90 1998 284 Observed

2. HARVEST

Resident permits	1988 <u>1</u>	1998 <u>2</u>
Non-Resident permits	1988 <u>1</u>	1998 <u>1</u>
Total Permits	1988 <u>2</u>	1998 <u>3</u>
No. Killed	1988 <u>0</u>	1998 <u>1</u>

Record B&C Score and year killed: 176 1/8 1997

What is the dominant harvest strategy in your state/province for hunting wild sheep?

Trophy Ram

3. PREDATION. What impact does predation have on your sheep populations?

Predation retards growth of transplanted populations i.e. Van Horn Mountains, 25 bighorns transplanted in late 1980's has remained stable at 10 for 5 years. Black Gap Wildlife Management Area 60 bighorns transplanted 1994-1997, 16 mortalities caused by mountain lions.

Do you control predators to benefit sheep? If so, how?

Predators are removed prior to transplant, during restoration, and specific depredating animals removed after bighorn population established.

4. DISEASE. Have you had a disease die-off in the last 5 years? No X Yes \_\_\_\_\_

Last 25 years? No X Yes \_\_\_\_\_

What do you do to detect, manage and/or prevent disease (e.g., disease screening at capture)?

Obtain disease exposure profile at capture, and screen for exposure during subsequent captures.

5. STATE-FEDERAL RELATIONSHIPS. What are the 3 biggest challenges in your state/province regarding state/federal relationships and management of wild sheep?

A. Federal Endangered Species Act has limited the State's ability to work with private land owners as they perceive that by keeping State employees off their property they are protecting their interest.

Has the designation of areas as wilderness impacted management activities or caused negative or positive impacts on sheep populations?

This is not applicable to Texas as there are no wilderness areas designated.

6. CAPTURE-TRANSPLANT TECHNIQUES. What are the 3 primary techniques used to capture bighorn sheep for research and/or translocation (e.g., drop-net, net-gun, drive-net)?

Use of the drop-net and net-gun are used exclusively for capturing bighorns in Texas.

25 years ago (1975) with estimated mortality rate (%)

A. Unknown

Last 5 years, with estimated mortality rate (%)

A. Fifteen bighorns have been captured using net-gun in Texas the past 5 years with no mortalities.

7. SIGNIFICANT LIMITING FACTORS. What are the most significant factors that limit the success of your sheep populations? These may repeat answers to previous questions.

A. Predation (mountain lion)

B. Fragmented habitat

C. Exotics, feral sheep and goats

D. Lack of bighorns to support transplanting within the State

## APPENDIX B

### ATTENDEES AT THE 1999 2ND NORTH AMERICAN WILD SHEEP CONFERENCE (LIST COURTESY OF DARREN DIVINE)

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