Roundtable Discussion on the Sierra Nevada Bighorn Sheep February 25, 2005 Reno-Sparks Convention Center Reno, Nevada

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Sierra Nevada Bighorn Sheep Roundtable Discussion
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Dr. Hudson Glimp: I'd like to thank the Forest Service for volunteering to manage the video/audio computer presentations for hosting us in this room. And this program is also videotaped, and I'd like to thank Fred Fulstone and Marianne Leinassar for underwriting the cost of this. If you wish a copy of the audio portion, the Forest Service will provide that to you if you will leave them with a written request with your name and address on it. They're required by law to have. So if you want a copy of the audio, please make a written request with your name and address to the Humboldt Toiyabe National Forest office here in Reno. If you wish a copy of the video, I'm sure Fred would appreciate selling you some copies of this, so it could offset the huge cost he's got invested in this personally. Please see Fred Fulstone if you want a copy of the video. Thanks again for attending. I look forward to learning a lot myself, and I hope all of you do as well. And I want to turn it over to Steve at this time.

Steve Lewis: Okay, I'm just going to go over the ground rules one more time. Thank you again for being here. First ground rule: If everybody can see that, respect each other. I am aware that this issue, these topics that we're going to discuss today are fraught with emotion. We've got species recovery, we've got livelihoods at stake. We're not going to have, we're not going to complete our goal today, and our goal by the way, or objective, is to have a balanced, civil scientific discussion. Unless there is complete respect amongst us all. And so, what I mean by that is that we don't want to have any jeers, snickers, whatever, from the audience. And I know that's going to be tough to control, but unless we control that, we're not going to accomplish our objective today. Secondly, we want to respect the format. This is a meeting of respect. We're going to respect the format. And again, the format just briefly is presenters at the table present. There's going to be a round table discussion, and then there is going to be public comment. Not questions. Questions, as Hudson said, are going to be presented on the pink cards. Comments. That will be in the morning, and we're going to discuss the pneumonia complex. In the afternoon, we're going to do the same drill only genetic diversity. Presentations, round table discussion, public comment. Okay? We also want to respect time lines, and I know this is going to be particularly challenging for the presenters. We're asking that the presenters stay within the ten-minute, can you imagine? Ten-minute time period. Hudson's got a bell. I've actually got a one-minute card here that I'm going to hold up when you've got one minute, and then when your time is over, I'll stand up. And Hudson will be ringing his bell. And then, we'll come back and we'll have the round table discussion. At that time, everyone gets five minutes at the table. We'll do the same timing drill. After that, we'll have everybody in the audience or anybody that wants to comment, they get three minutes. Okay? So, we want to be respectful of each other, of our agenda, and of our time limits. And if that happens, I think we're going to have a very worthwhile and effective conference. Hudson mentioned this is going to be taped. This is also being transcribed. So the questions that you actually submit on those pink sheets will not go unheard. They will be part of the official meeting record. You will be able, when you signed in you gave some contact information. Everyone will be contacted with a letter instructing them where they can find, on a web site, I think there's going to be several web sites, that you can access the meeting transcription. I think that's it, in terms of ground rules, in terms of our

meeting objective, and I think it's time to get started. I don't think I'm going to introduce everybody all up front. I think everybody's got a program. We'll just start off with the first presentation by Dr. Keith Aune, Montana Department of Fish, Wildlife and Parks, and again, let me just mention again, for you presenters, what we want to do is address these questions: What do we know about transmission of pneumonia complex diseases based on the literature and recent field studies? What is your interpretation of the literature and recent studies? And finally, what is the risk of disease transmission to the Sierra Nevada bighorn within the context of other potential stressors such as climate, recreation, low body condition, adequacy of habitat, etcetera? If you have not prepared statements in regard to these, we got problems. Because this is what we have asked you to come prepared to discuss. So, please keep your comments limited to these particular questions. Are there any questions from the presenters? Okay. With that, Dr. Aune.

Dr. Keith Aune: Is there a controller up here, or do you? You'll do it, okay. I'm going to be fast, so sorry about that, I just, ten minutes is not much time. I think it's important since I'm visiting scientists from another state to give you a little background, so I'm going to do this in real brief fashion, but you need to understand you're not alone in this issue. There are several other states wrestling with this very same problem, including the state of Montana. As you can see from this first slide, that really, in 1913 we had very few bighorn sheep left in Montana – eleven herds, and by some intensive restoration projects, we've brought this herd number up to 49 herds. And this map kind of shows you where they are, and I'm apologizing that it might be a little blurry to you. But what I've got on here is the red hatched areas that shows where the different herds are in Montana, and then I've put a nine-mile buffer around that, just to give you the context of how much land mass we're dealing with that is affected by this issue of domestic bighorn sheep interface. And in some parts of Montana, it's huge. Entire regions of the state are embraced by this nine-mile buffer. And within that nine-mile buffer, there's a lot of private land and a lot of sheep producers that we need to be able to work with. Next slide. As far as diseases significantly impacting bighorn sheep, certainly they probably were historically. A lot of the records are not that clear. I think if you go back to the literature, you find out there's not a lot of good diagnostic link from the wild sheep epizootics and domestic sheep. There's some assumption and there's some, probably some good assumption there, but it's not that complete. And in Montana,.we've experienced that as well. You go back to the records of Glacier National Park in 1916 when there were 1,500 sheep down to 180. What are the causes of that? Well, I'm not sure it's that clear. Could domestic sheep have been a factor? They might have been. There's some significant epizootics in the Sun River in the 20s and 30s, often linked to domestic sheep. And at that time, there were a lot of domestic sheep sharing ranges with wild sheep. Currently, though, we have very little of that happening, in particular that area, and still we have some die-offs. We had some die-offs in the mid 1980s in north central Montana, with some weak diagnostic information, but some that did suggest there were some other pathogens involved in that and that it might have been an event that moved down the continental chain into the Sun River area. Now, more recently we've had some in southwestern Montana in the 1990s, and we did get more precise diagnostic information, and I'm going to present that a little bit in the context of whether

or not that we can get transmission between domestic sheep and wild sheep. Next slide. This is a classic case of a wild sheep herd, the highland sheep herd, that we were very successful in growing to a very prominent herd with trophy animals that, in the middle of its winter range, was a domestic sheep flock. So, I profile that just to keep that context in there for you. For twenty years, nothing really happened, and they were sharing this range, and there was some interaction known to occur. And so what happened is eventually, in 1994, we had a severe epizootic in that trophy herd, and we lost most of the herd, and I'll get to the factors related to that in a bit. Next slide. I think it's very important when we think about this issue that we go back to the basics of the epidemiologic triangle. There's pathogens, there's environment, there's hosts. There's a lot of things that interact to create an expression of this disease, and it's very, very difficult for us to point to one thing in most epizootic events. Next slide. Again, what tends to happen, and we've done this for many decades, and I can be at much at fault as anyone, we tend to chase the pathogen. We tend to find out why did we have this epizootic, and so we look for bacteria, we look for viruses, we look for parasites that might be implicated in this process of disease expression. And unfortunately, I think that's not the whole picture, and it's led us into a very difficult position right now of not fully understanding the expression of pneumonia in bighorn sheep. Next slide. In that chase, I can tell you, we've been trying to characterize Pasturella, that becomes the focal bacteria involved, and again, these are live capture bighorn sheep. They're healthy, we see all the T types that everybody's heard about in the old classification scheme, and nothing in there has stood out to really make me think that there was any pathogen here that was very remarkable in terms of what is normally in the bighorn sheep. Next slide. I think what's happened as we begin to learn more, I think some of the recent work done by the Caine Vet Center in Caldwell, some new taxonomy has helped us a little bit. It's still, though, is very muddy. In Montana, we've identified 22 biovariant types, 14 that are nonhemolytic, eight betahemolytic, so there's a lot of variation in Pasturella in bighorn sheep in Montana, and I'm sure you can see this in the literature, and you certainly will see it in the field studies being done here with these bighorns. Next slide. Here's kind of a breakdown of that. I can't get into the details, but certainly we could explore this later. But what it comes down to is bighorn sheep are host to Pasturella, they're host to a wide range of different bacterial strains, and I think we do recognize that. We also recognize that domestic sheep can be host to these strains as well, and how much transmission occurs, I think is highly variable, with the site, the environmental conditions, the density of animals, the interaction, and the interface itself. So, as we characterize the pathogens, I think we need to now move on to characterizing what is happening at the interface. Next slide. I want to make sure that I mention that we recognize there's other pathogens. This is a relative scale of the lungworm infection in various sheep herds. And in Montana, we have lungworm all over the place. Some herds are highly infected and high prevalence, high intensity infections, and others, not so. Next slide. Respiratory viruses, I think we're going to hear a little bit about that today, but they're out there as well. If you go looking for it, you find them. This is a slide showing some of the serologic prevalence in herds in Montana, and certainly, it's there. And what role they have I think is still a question we need to address. I can tell you that in the Anaconda die-off, which is the Lost Creek herd, prior to the

epizootic, we had a very high sero prevalence in terms of, there's a lot of challenge going on out there. When we went through the die-off, we isolated BVD extensively from the sheep that were dead. And in relation to that, we also isolated Pasturella, so we view that as a bacterial-viral combination. Next slide. I want to bring this up real quick. If we were to characterize the last four die-offs where we had some evidence of diagnostic evidence to chase, I think there's a lot of variation in terms of the factors out there. Are domestic sheep involved in all die-offs in Montana, no. Could they be involved in some? Yes. And I think, in particular, the highlands one we were convinced that there might have been some interaction that was important there. Next slide. I do want to point out that bighorn sheep in Montana exhibit a background case rate. There's always some pneumonia going on there. It may not be of an epizootic nature. And we've been exploriing that and it covers, you know, we've found in 15 different herds some cases that involve a wide range of pathogens, as you might expect. Next slide. And there are a host of other diseases that affect the bighorn sheep out there. Here's some that we've identified in Montana, and I'm certain that there's some consistency here. If you look around at bighorns or desert bighorns, you would see that some of these same pathogens might exist there. Their role, what impact they have on survival, how they affect sheep management, can vary from place to place, but they're certainly out there and we need to consider their effect. Next slide. In terms of sheep associated with domestic sheep, one of the things we've found is it's been mostly rams that have moved into and are trying to breed with domestic ewes. That's a very common story around. We've been killing and testing those rams. And again, you see a lot of variation in what pathogens they may or may not express. Certainly, we've had some that have died, and in one case, a highly variable strain of Pasturella – that bighorn ram was probably not going to make it back to any other wild sheep herd. And I want to point out we're really facing some challenges with the recent introduction of domestic sheep to control weeds. How do we deal with that? We've got a significant weed problem in parts of Montana, in particular, some of the big areas I showed you on the previous map where wild bighorns are prominent, and there are weeds that are just taking over entire valleys, the Deer Lodge, the Bitteroot, and we are struggling right now with how to address that weed problem and how we might be able to use sheep to control that situation without risking our bighorn population. Next slide. So, let me wrap it up in the last minute. Domestic sheep and bighorn sheep certainly share some of the similar pathogens, and certainly, there's probably a way that it can transmit. I don't doubt that. I think transmission is probabilistic, not certain, in field conditions, and we don't know all the factors that relate to those probabilities. Most recent epizootics in Montana were not linked to domestic sheep, and there are many other factors that we need to consider, some that are manageable, some that are difficult or perhaps even not manageable. I think we're going to look more at risk factors for bighorn epizootic events, and that they're going to be variable we know in different environments. We do need to get into a much better understanding of host immune response, distress, and to these environmental pathogens, and we need to explore a wide range of methods to mitigate this. I think that in Montana, we're exploring that extensively right now, and we would like to address it. Thank you.

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Steve Lewis: There's a little technical glitch here. Dr. Ward needed to put his presentation in another, on a disk, or an iPod, or whatever that is. Next up, Dr. Al Ward, Caine Veterinary Center, University of Idaho. Dr. Ward.

Dr. Al Ward: Thank you, and I appreciate the efforts that have been made this morning to get things transferred here so that I can present. We hope that that's going to happen here. It started out with Nevada. This is an action one, so if you go ahead and push on that, it will come up and the next one, the emeritus means that I am unemployed at this time. I'm retired, and so that also means that I come to meetings unprepared, optimally, and as we go to the next slide, I just want to comment a little bit about the background, simply to come down to the point that diagnostic experience, during the time I was overseeing cultures and conducting a lot of cultures myself, and I found that just about every animal had Pasturella. We isolated Pasturella from the mouths of mountain lions, from dogs, cats, from bites of bears and cougars, so we developed a selective media to work with some of the research interests, and that selective media has helped us to be able to isolate Pasturella from just about every animal that we have that we see. You can't hear me, okay, thank you. So we isolate Pasturella from just about any animal that has an oral cavity, and so if the samples are appropriately collected and submitted, we're going to isolate Pasturella. Next slide, please. In the Pasturella A.C. family, we see that we have actinobacillus. That is commonly associated with disease in horses, pigs, some other species. Hemolysis, we find that associated with disease in cattle and sheep. Recently, we have isolation from bighorn sheep. I have a list of publications, that, if any of you want a list of publications, I've got records of those, so that you might be able to go to the publications and find those in the literature. Pasturella, we have examples of multocida and trehalosi. As Aune mentioned a little bit ago, why there's also manheimia and this is a new species that has been adapted to replace the genus name, excuse me, for some of the Pasturellas, primarily hemolytic. Next slide, please. Going ahead, we see that the Pasturella trehalosi or obligate bacterial parasites of vertebrates, there are common commensules, which means that they are resident in the oral cavity and are not causing disease, but some of them will cause respiratory disease. I usually use the term associated with disease, because they usually do not cause the disease by themselves. There are some that will act as primary, probably in stressed animals, more than elsewhere. The majority of them cause opportunistic disease when they're associated with other organisms, such as the Pasturella, the parasites, etcetera. We have found that they are extremely diverse, as we go to the next slide, we'll look at some of this. We were presented in 1988 with a question: Do these bighorn sheep that were associated with an epizootic, a die-off, in central Idaho at that time, did they carry Pasturella, and if they did, were they from domestic sheep? That presented us a large question. And so, we've been attempting to answer that, and in the process, we've been looking at some of the literature, and where they were talking about association with disease, without a lot of background as far as scientific evidence. So we set out to culture multiple samples from various sources, then we went on to differentiation, procedures for differentiation of the Pasturella strains. From then we went on to evaluating those strains for their distribution, and as we look on, we see that we also evaluation of these organisms for their disease potential. As we go on to

the next slide, let's go ahead and locate that on down. So we were isolating from many bighorn sheep populations. We have now archived over 6,000 isolates, and as we go to the next slide, I would like to talk about the classification of these organisms as we go on down. We were dealing with a number of tests for fermentation, enzyme activity, and so on, and so, again, this is published, so if a person is really interested in that. As we go to the next slide, we see that we've differentiated the Pasturella into multiple biovariant groups. At the bottom you'll see that of the Pasturella multocida, we are seeing 32 variants. Of those in the hemolytica group, we have 184 biovariants, and the trehalosi, 45 biovariants. So we see that there's a lot of differences in those organisms, and we'll find some in different populations of bighorn sheep and some in the domestic populations as well. The biovariant typing helps us to differentiate these organisms so that we might be able to look at transmission as well as variances in geographic distribution and populations. And so, one of the things that we've been trying to do is help the wildlife biologists to determine compatibility between populations using this methodology. We recognize that as some populations will carry those organisms that are more likely to cause disease, those are not good animals to be translocated, primarily because those organisms might cause disease in the animals after they're translocated, and definitely transmit to animals in more susceptible populations. And the next slide. We went on to do DNA fingerprinting so that we could differentiate organisms within biovariant groups, and so you'll see the DNA fingerprinting in the picture to the right. You'll notice that the two on the left are quite similar, but there are some differences, and then those third and fourth lanes are quite different from the first two. So this helps us to be able to determine again if the organisms are identical or quite different. We used this methodology in following transmission from bighorn ewes to lambs that had been taken by Caesarean section, and so we know that this methodology can trace transmission. We've applied this to studies that have been conducted with cooperation of the folks here in Nevada, in the Desatoyas, the Granite Mountains and so on, and we have not found a lot of evidence of shared organisms. Let's go on to the next slide. One of the studies that was conducted involved sheep that were associated with the die-off in Hells Canyon a number of years ago. There was an organism that predominated from isolation of the lungs, and we found that that was a multocida multocida a. Those organisms have been fingerprinted, and you'll see a comparison of the organisms then here. Those two at the top right, one was isolated from a feral goat that had contacted the bighorn sheep. The next one was an isolate from one of the bighorn sheep that was in close association. Those two organisms as you'll see as I step out, down here. We can see that these organisms are very, very differently related to (incomprehensible). This is evidence that those organisms did not cause the die-off. As we go to the next slide. This is a case study conducted by Rudolph, et al. So this was in '95, '96. Dr. Rudolph was then hired by the Fish and Game Department and her director wanted her to publish on this, but in the meantime she had four children, and so last year, we went back to this and she and I have worked on a manuscript that is currently under review. You'll see that 72 sheep were removed from the Hells Canyon area. Many organisms were isolated, and different biovariants and species. In addition to the Pasturella, a microplasma was isolated. PI3 virus was isolated from the lung of one sheep. Serological evidence was there to indicate that PI3 and RSV infections were associated. DNA

profiles did not incriminate the goats, even though you may have heard through the grapevine that the goats had caused that die-off. I have recently been in contact with people back at the National Animal Disease, the National Wildlife Disease Center, to talk with them about standardizing virus culturing processes across the country, and we have been conducting microplasma cultures. We find that there are some free-ranging bighorn populations that do carry microplasma. Thank you.

Steve Lewis: Thank you, Dr. Ward. Next up is Dr. Ben Gonzalez, California Department of Fish and Game, Rancho Cordova, California. Dr. Gonzalez.

Dr. Ben Gonzalez: You know there's no shortage of controversy on this issue. There's a lot of disagreement, and I think what I'd try to do today is just more get back to a general discussion of how I understand bighorn sheep disease. First of all, let's just establish, there's a lot more than disease that happens to bighorn sheep. I think the thing that differentiates disease in my mind, is that disease can cause catastrophic losses. You might have that with habitat loss, but many of the others like predation, mountain lion predation, aren't going to cause 70, 80, 90 percent of those sheep to be lost. Go ahead. Respiratory disease complex is probably the most challenging disease that we have in bighorn sheep. Next slide. And I agree one hundred percent, it is very, very complex. I believe we do not understand this disease. When we see this disease spreading between sheep, between domestic sheep, between, you know, I just believe we don't really have a good handle on it, but the bottom line for me is that oftentimes we lose large numbers of bighorn sheep, and these are often related to environmental stressors, such as nutrition. Go ahead. So, the different species which Dr. Ward just discussed, and in my work in California, I found that they can be normal flora, they can be opportunistic pathogens, and they can be primary pathogens. And so at this point, although I really respect what Dr. Ward's lab has done, I really don't think that we're at the end point with that. We're still trying to understand it. Go ahead. What we do know is that outbreaks of respiratory disease have decimated individual populations. This is throughout the literature. Outcomes have been anywhere from 0.0% mortality, which I've seen in some of our desert mountains. We have respiratory diseases but virtually no mortality, and we've seen others where, not in California, but in, not recently, but in other states where there's been 100% adult mortality. The other thing that makes this very difficult is that you get increased lamb mortality for two to five years following an outbreak. So this really delays the population recovery. Go ahead. So there's a couple of pretty important publications: Goodson, 1982; Martin 1996, where they look at bighorn sheep outbreaks that they believe were linked to the presence of domestic sheep. There is circumstantial but substantial evidence that these outbreaks were initiated by contact with domestic sheep. I have no doubt that in some of these outbreaks, domestic sheep had nothing to do with it. The problem with these field outbreaks is that there's many potential confounding factors – you have lungworm, nutrition, you have other stressors, you have winter, you know, winterkill. In other words, some other initiating factor that could just present a normal flora to become a pathogen. Go ahead, please. And I think even though I've heard that Foreyt's 1989 paper and project is old now, I

have not seen any replacements for these studies. And when I see these replacements, then I will go with that. But Foreyt did, and one thing you need to look at is, that they did not have the technology that we have, and they made some assumptions that we would not make at this point. Anyway, he did contact studies, where he took bighorn sheep – there were five lambs born and raised in captivity – they were in captivity over one year, one wild caught lamb raised in captivity over one year. All clinically normal, all under good nutrition, and the one thing, you know, you see the flaws in the paper – he vaccinated with Pasturella and hemolytic vaccine, which at this point we know probably might have been a confounder in this. Next, please. And then in domestic sheep, he took three adult female domestic sheep two to six years from an area where a bighorn pneumonia outbreak had occurred the previous winter. Then he just went to a sale yard and got three domestic lambs. All these domestic sheep were clinically normal. Go ahead. Now you know, we know now that nasal swabs are not a very effective way to get Pasturellas. We also know that even though they didn't get Pasturella hemolytica out of that bighorn sheep, it's very possible he did have it. But, in any case, overlooking some of these details, and these domestic sheep were introduced into a two-hector pen with the bighorn. And the result is what I'm still looking at, and I still consider it valid, is that these bighorn sheep died of acute hemorrhagic pneumonia on days four through 71 post-introduction to these domestic sheep. These were healthy domestic sheep, good nutrition, at least as far as we could tell after one year of being adapted to captivity. In other words, he took a lot of the confounding factors out of the work on this one. And p. hemolytica cultures in large numbers from respiratory track tissues of all bighorn, and were they primary, were they opportunistic, what? So there's no indication of lungworm or viral involvement. Go ahead, please. And the results were that domestic sheep remained clinically normal. So here we have all the bighorn sheep died, all the domestic sheep remained normal. Whatever errors in technique or assumption he made, for me that's the bottom line, this is what happened. Three of the six of those were euthanized. They were normal. And then the Pasturella hemolytica was isolated from two out of three. Next, please. Another discussion on this, healthy domestic sheep may harbor organisms, pathogens in bighorn – there were no stress effects noted. Exposure interval four to 71 days indicates effects may be highly variable. In other words, from a management standpoint, if we have a contact between a bighorn and domestic sheep, we may not see anything for two or three months, even if it is a dangerous contact. And the Pasturella vaccine status in the bighorn had no effect. Go ahead, please. So his conclusion was that domestic sheep and bighorn sheep should not be held in proximity because of the fatal consequence in bighorns. Go ahead, please. So, wanting to take one more little confounder out of it, he went to a slaughterhouse, is the way I interpreted it, and he just got healthy domestic sheep. He isolated p. hemolytica, A2 rivotype, WSU1. He inoculated eight bighorns and seven domestic sheep, intertrachially with pure isolates, and he used rather high doses, which I've heard as a criticism of this project. Go ahead, please. So the inoculation studies, the results were the bighorn, seven of eight inoculated bighorn died from acute pneumonia within 48 hours, and one noninoculated contact bighorn, which was an animal that had contact with the inoculated bighorn, died at six days, and three control sheep, bighorn sheep, did not get sick. The domestic sheep: seven out of seven inoculated domestic sheep

remained healthy. Go ahead, please. So the authors' conclusion is a relatively nonpathogenic and common isolate of Pasturella hemolytica from healthy domestic sheep was lethal to bighorn sheep under experimental conditions. So let's just kind of take a look at what I work on. What I know is that spontaneous respiratory disease outbreaks occur in bighorn herds with no known domestic sheep contact. I also, from all the work I've done with Al and the Idaho lab and with others, is the serology virus isolation and bacterial culture surveys indicate many potential pathogens are endemic in healthy, wild, free-ranging bighorn populations without current known contact with domestic sheep.In other words, they don't need domestic sheep to get sick. Go ahead, please. We do have, I mean, I think it's still pretty compelling evidence, that we have that healthy domestic sheep can carry viral and or bacterial agents that are highly pathogenic to bighorn sheep. Go ahead, please. And I also realize that it is possible that some contacts between domestic sheep and bighorn sheep may not result in disease, so we don't really have the technology to understand which contact will be safe or not. Go ahead, and just go through the slides real quick. Go ahead. This is bighorn in the Sierra Nevada relatively unexposed. Go ahead, please. Same thing with Pasturella, mostly low risk. Go ahead, please. And what we find in the Sierra Nevada is that we don't really feel that we have a lot of diseases in the Sierra Nevada right now – body condition, evaluation, robust, healthy populations, and relatively unexposed populations. Go ahead, please. So, Martin in 1996 said, based on all these outbreaks, he said basically they are all, at least the wildlife people looking at this issue, say that domestic sheep should not occupy the same range as bighorn sheep. Go ahead, please. And then, Schomer and Woolever in 2001 said, and I'll let you read that for yourself. Thank you very much.

Steve Lewis: Thank you, Dr. Gonzalez. Next up is Dr. Craig Beattie, University of Nevada, Reno.

Dr. Craig Beattie: Hi. Thanks very much for inviting me. It's been ten years since I gave a talk in this building. The last one was the National Cattlemen's Association in 1995. We've come full circle. I'm basically here to introduce my colleague, Dr. Anette Rink. Several years ago, as you will see, we put together a study on the incidence and prevalence of what is now known as Mannheimia hemolytica in Nevada sheep populations. This was supported by a federal grant in their rangelands initiative to the College of Agriculture, Biotechnology and Natural Resources at UNR. It had a number of groups come together. Fortunately, we're still working together to develop a series of end points. Next, please. So the purpose of the study seeks to answer two questions: What are the incidence and serotype prevalence of p. or Mannheimia hemolytica in the Nevada desert bighorn and domestic sheep populations? We hope that this study will provide a baseline for future studies that explore the question, to what extent does carryover or spillover of infectious pathogens, parasites, whatever, occur between wild and domestic sheep populations in Nevada, and we believed, at least, that it was essential that these questions be answered before we could pursue a testable hypothesis as to whether carryover or spillover pathogens between domestic and wildlife species did result in high mortality and death loss. So, we also hoped, or we believed, that samples from this study will be extremely useful in future work that

incorporates DNA-based technology to identify differences between serotypes as well as the degree of population inbreeding, determine the extent of bighorn population movement, assess the degree of genetic diversity between the California bighorn and Nevada desert bighorn sheep, and also provide a basis for standard laboratory approaches to determine the extent of potential mineral deficiency, parasite incidence and prevalence in wild sheep populations. Thank you very much. Is that under ten minutes?

Steve Lewis: Thank you, Dr. Beattie. Next up is Dr. Anette Rink, Animal Disease and Food Safety Laboratory, Nevada Department of Agriculture. Dr. Rink.

Dr. Anette Rink: As Dr. Beattie just indicated, this is a collaborative project between the Department of Agriculture, Department of Wildlife, and UNR. Next, please. I just want to quickly give you a wrapup of the experimental design. What we're trying to do is to sample 30 ewes and 30 lambs in six domestic flocks three times in a three-year period, and we're shooting for one summer, one winter, and one spring or fall sampling, because we know that the prevalence of bacteria in the upper respiratory tract varies widely within domestic animals and in wildlife depending on the climate. We have been sampling bighorn sheep that were marked by NDOW for capture and relocation, and we've been able to participate in that since 2002. We've also worked with NDOW to get access to the hunter kill sampling, because we're interested in what the hunters actually find out in the field. And 2002 was when the study was initiated. The first year, the hunter kill sampling did not go so well, and it has significantly improved over the last two years, and last year we had submissions of more than 100 samples from (transfer from tape 1 to tape 2 may have skipped something here) isolate, we do a bacteria culture, and isolate Mannheimia hemolytica, P. multocida, P. trehalosi. We prepare minus 80 stocks for future genetic analysis. We do fecal sampling. We want to check out the lungworm burden, obviously, but also other gastrointestinal parasites, because they might significantly be involved in compromising the immune system. We take a blood sample. There is, of course, serology, preferably for an O1 respiratory panel, and in Nevada, we are particularly interested in the selenium level that these animals harbor in their bodies, because Nevada is a very selenium-deficient state. Next. The hunter kill samples also involve these same samples, the blood sample, the swabs, and the fecal sample. We also ask hunters to provide us with a piece of lung tissue. We provide them with photos both of healthy lung tissue and diseased lung tissue, and we specifically ask them to submit a lesion to us, and the reason for that is that we would like to be able to detect bacterial DNA, and we use the lung as a source for sheep (incomprehensible) DNA so that we can perform population genetic studies. The reason why we both approach this on a bacteriology approach and a DNA-based approach is because we're working with lay people here, and even though we do give them precise instructions on how we would like them to transport the samples, my feeling is that if there is a choice between does the sample go back into the cooler or does the beer go back into the cooler, the sample doesn't always win. Next, please. The current status is that we have finished sampling our 660 domestic sheep, which (incomprehensible) into 330 ewes and lambs each. The Mannheimia hemolytica prevalence in

these flocks varies between 20 and 50% in ewes and ten to 70% in lambs. And the most prevalent parasite in domestic sheep in Nevada is without a doubt the different coccidia species, and they vary widely between the domestic flocks, both by location and (incomprehensible) and also by season. And they can be as low as less than five percent or almost 100%. We've been able to sample approximately 250 bighorn sheep, so far, and we were only able to isolate Mannheimia hemolytica out of 25 to 60%, but we do not have the same elaborate system that Dr. Ward has developed, so we will still have to work on that. We find that the prevalence of coccidia is very low, with less than ten percent in those bighorn sheep, and the (incomprehensible) is also very low. We do find a somewhat higher prevalence of small lungworms in our bighorn sheep compared to the domestic sheep, and roughly around 40% of them actually shed larvae. We occasionally very rarely detect a tapeworm. Next. The preliminary genetic characterization of a subset of these isolates shows that isolates from healthy bighorn sheep, and most of our isolates are from healthy bighorn sheep, more than 70% of those contained leukotoxin genes, and they mostly contain all four components of the leukotoxin genes. We haven't sequenced every single DNA piece that we've generated, but I think it might be necessary eventually to find out what exactly the situation might be there. The bacterial genotyping only started in January this year, and will probably take at least a year to do that, for all those strains. We hope to be able to complete the sampling by the end of this year, and the DNA genotyping data was available earlier this year, and we'll talk about that later today. This is just to show you what, this is the method we've chosen amplified (incomprehensible) polymorphism, and this is an image that shows you how that works or how the data is generated, and we're getting a large number of bands. We find there is a lot of individual difference within the different Pasturella species and between strains, so we should be able to come to a pretty good distinction here. It is rather time consuming, though, to do the analysis. What do we know about the Pneumonia complex? I think the most important thing that we have to keep in mind and I think we all agree on that, is that it's multifactorial, and the macronutrients, particularly energy and protein, I think are probably really significant, but also for us in Nevada, selenium deficiency is probably, as far as nutrients are concerned, very, very important. And the selenium deficiency and the nutrient level really is dependent on inclement weather, wildfires, salty agents, a lot of other factors. We definitely do see (incomprehensible) pneumonia, and because of the life cycle of these parasites, it's obvious that that is a problem that's going to be here to stay and very, very hard to control. We have probably a number of pneumonic and other exotic viruses that are circulating and we don't have a really good handle on that yet, but we hope to be able to work on that a little bit further. We certainly do see bacterial diseases and in preparing the study, and also while the study is going on, we continue to review the literature. And there's a long list of publications which represent the bigger picture. And when I talk about the bigger picture, I'm talking about those that actually acknowledge that there are multiple factors that lead to disease. And in the 90s there was a series of publications that took what I would call a "tunnel vision" approach, and I really think that that is very detrimental. These studies all revolve around Pasturella species, and specifically, I'm talking about some of the studies that Dr. Foreyt published, and you were mentioning one of them that I, and we've discussed that before. We

disagree on how we interpret that. What I really find a bit troubling in some of these studies is that the Cox postulates were not really taken into consideration here, and they're old, but they're still valid, and that means that you have to be able to show that in every animal that is suffering from that particular disease, you have to be able to isolate the pathogen, and in every healthy animal, every healthy animal that you have should be free of this particular pathogen. If that is not the case, then you're not looking at a sole source of the disease that you're studying. Next, please. To demonstrate the point in hand here about multivectoral disease, we did have, unfortunately, a significant bighorn sheep die-off here between January and July, 2004, in the Santa Rosa mountains. We first became aware of it after some domestic sheep were observed in Orovada in December, 2003. One of the domestic sheep, it's not quite clear how many actually were in there, but only one domestic was killed and sampled, and that animal was about 18 months old. We didn't find any parasites. We weren't able to isolate any Pasturella, even though the sampling protocol here was followed just like in any of the other animals. Then, on January 8, two of the very severely diseased bighorn sheep were sacrificed for diagnostic purposes, and I did the necropsy, and they were really in horrible condition. The most significant findings on necropsy were and this pathology were chronic (incomprehensible) pneumonia and an acute bacterial Mannheimia hemolytica pneumonia. They both were severely selenium deficient and they both had old lung lesions on hystopath that were indicative of a prior BRC infection and they both had low tires. And the point I'm trying to make here is that we cannot say whether actually did pass on Pasturella to the bighorn sheep, but we can say that the lung lesions caused by (incomprehensible) pneumonia definitely were not derived from that sheep because the sheep was 18 months old, whereas the two bighorn sheep were four or five years old, and the lung lesions were clearly indicative of an early infection or an infection early in their lives respectively and then an accumulation over time. Next. I think there are two different philosophies here that are really important, and one of them is the philosophy of there's only one cause, and I don't agree with that at all. And the conclusion that is often drawn is get the sheep off the range. And I don't think that does the complexity of the issue justice. And then there's the other school that basically goes out and let's see where the chips fall. So we need to admit that there is potential for disease transmission from livestock, and that needs to be investigated every time there is an implication that that might be the case. We also need to recognize that it is an endemic problem. Really comprehensive diagnostic workups need to be initiated. Results need to be interpreted in context and then the recognition of the vulnerability of completely susceptible populations is also really important. So, vaccination strategies can be developed and a management plan needs to be developed. Next. And the bottom line is, there is not zero risk obtainable here, and if every domestic sheep were to leave the range in the western United States right now, I'm not sure we would get rid of any of the disease problems, but since sheep can have beneficial effects, there might be more or less sheep available.

Steve Lewis: Thank you, Dr. Rink. Next up is Dr. Walter Boyce, University of California at Davis.

Dr. Walter Boyce: Sorry, no pretty slides, or you can say thank you, no slides. I have really just a series of short statements. Fortunately, the people who have spoken in front of me have laid out some of the studies and some of the findings, so basically, I'm going to try to address these questions from my perspective as a scientist that's worked on diseases in both domestic and bighorn sheep for about 20 years. There is substantial scientific evidence that bighorn sheep may develop fatal respiratory disease following contact with domestic sheep. There's also substantial scientific evidence that large-scale die-offs that infect entire populations of bighorn sheep may occur following contact with domestic sheep. Not every encounter between domestic sheep and bighorn sheep leads to a disease or to a die-off. Unfortunately, it only takes a single match to start a fire. And a single introduction into a bighorn sheep population that starts a die-off has an outcome that we can't predict, and indeed, if a die-off begins in the Sierra Nevada bighorn sheep population, it will not be possible to manage the outcome. The outbreak will run its course, whatever that may be, and that could mean the loss of most or all of the bighorn sheep in the Sierra Nevada mountains. Sophisticated diagnostic tools, vaccination strategies, or even genetic management of bighorn sheep will not eliminate the potential for disease transmission between domestic sheep and bighorn sheep in the foreseeable future. The best tool currently available for eliminating the risk of a bighorn sheep die-off is to eliminate potential contact with domestic sheep. Thanks.

Steve Lewis: Thank you, Dr. Boyce. And last up is Dr. Tom Stevenson, California Department of Fish and Game, Bishop, California. Dr. Stevenson.

Dr. Tom Stevenson: Thank you. I'm going to speak particularly on the subject of contact and how it might occur. I think we've heard from most of the people here, in fact, I think, almost to a person, that the potential for disease transmission is certainly possible, and that in the Sierra Nevada in particular, there is not a trivial risk of disease transmission between domestic sheep and bighorn sheep. And today, I'm going to present data on Sierra Nevada bighorn in particular collected during the last few years that addresses the potential for contact. When you look at recommendations in the literature, there are a variety of recommendations for eliminating the potential for contact. The 1998 revised BLM guidelines recommend a buffer distance separating bighorn sheep and domestic sheep of 13.5 kilometers or about nine miles. Singer, et al., published work in 2000, following some modeling work that indicated that within a contact zone of 23 kilometers, there were decreased population persistence of bighorn sheep populations. The 2001 interagency domestic sheep strategy suggested that there's an increased risk of disease transmission within ten kilometers or about six miles. A lot of the early assumptions relative to how domestic sheep management should relate to the bighorn management in the Sierras focused on straying domestic sheep, and that's certainly a possibility. I think since we've done considerably more work in the last few years, we're realizing that bighorn rams in particular exhibit a risk, and this is based on actual movement data from radio telemetry in particular. I think we also realize from these collared bighorn that we possibly had unrealistic expectations about how they would respond to natural barriers. And then finally, one of the assumptions was

that bighorn sheep remained high in the summer, domestic sheepraising was at lower elevations and that that would reduce the potential for contact. The monitoring effort for Sierra Nevada bighorn has included the capture and collaring of over 40 animals during the last three years, and this has permitted us to use radio telemetry, both VHF and GPS technology, supplemented with ground surveys to gather detailed information on movements and habitat use. And this data is being collected both through ground telemetry, aerial telemetry flights which are occurring generally on a weekly basis. We have a large number of animals with GPS collars that are giving locations that can be transmitted back to us on a regular basis, and the collars are giving locations in some cases hourly or more frequently, and then this is also combined with systematic surveys that we conduct throughout the Sierra range. The collaring, including the GPS technology, has enabled collection of enormously more data on movements and habitat use by bighorn than we had prior to several years ago, and I'm going to present some of this recent data in an effort to address assumptions and the potential for contact. Okay, just for those of you that aren't real familiar with this, with the eastern Sierra, the recovery area for Sierra bighorn runs from down around (incomprehensible) there in the south up to just west of Bridgeport. The draft recovery plan delineates 17 herd units and four recovery units, and numerous domestic sheep grazing allotments exist adjacent to primarily the northern and central recovery units. And I should point out that the black polygons are the herd units, most of which are not currently occupied. The yellow polygons are the BLM allotment screen or Forest Service. There's a couple of (incomprehensible) lands that are currently closed, and then there are some pink polygons and I'm not referring to the pink dots that are identifying cities, but the pink polygons represent private grazing, and primarily municipal, Mono County and DWP. Just to address briefly how much of an issue the national barriers are. Just in the last couple of years, we've had four instances of bighorn sheep crossing valleys, all the way from Hammill Valley in the south up to Bridgeport Valley in the north, and in many cases the crossings occurred in midsummer. One simple metric we're using is home range diameter to provide a measure of the extremes in distances traveled by bighorn and these include movements from migrations and forays. And you'll note that there's a big difference in the maximum distance we're seeing moves between ewes and rams, which is not unexpected. Okay, I'm going to focus in a little more detail on proximity to some of the allotments in the Mammoth Lakes, the Lee Vining area. The most extensive movements we've observed to date by any of our radio collared animals was by a ram who traveled greater than 33 air miles south of Lee Vining canyon to Laurel mountain during December. And he subsequently returned the following August. I'm going to provide some more examples. Go ahead. We've got one of our collared rams right now who moved up into Lundy canyon and is remaining there, and obviously, he's in close proximity to a number of domestic sheep allotments. Okay, go ahead. Another collared ram moved up there and in November, unfortunately, we lost radio contact with him for a little while, but he was hit by a car crossing the highway going from east to west in November, which is around the rutting season for bighorn sheep. And then, finally, another collared ram from Lee Vining canyon moved up north right adjacent to some of the Dunderberg allotments and spent the winter up there and then traveled back. Okay, this slide essentially illustrates the allotments that are adjacent to the central

and northern recovery units in the Sierra. When we overlay the location data that we have on bighorn sheep gathered in the last several years, you can see there's two concentrations – Wheeler Ridge on the south there is our largest population of Sierra bighorn numbering about 90 animals right now, and then up in the northern area, in the vicinity of Lee Vining and Lundy canyon are locations for our animals in the northern recovery unit. Go ahead. Okay, given the recommendations from peer review literature and data from Sierra bighorn, these polygons were generated around bighorn locations to simply illustrate the proximity between the two species. In the northern recovery unit, bighorn sheep were located immediately adjacent to active allotments during 2004. In the central recovery unit, the Wheeler Ridge herd currently supports the largest number of sheep in the Sierras, lies within less than five kilometers or a couple of miles of domestic sheep grazing allotments. Okay. The question has been raised about adequacy of habitat and it's been raised in the context of both the capacity of the northern recovery unit to sustain bighorn herds and relative to their susceptibility to disease. I think it must be noted that these are wild animals and I think we all agree that there are a lot of factors that could lead to compromise in immunity, but I want to present a little information on this subject. Preliminary habitat modeling based on data from the GPS locked collar locations illustrates that using predictive topographic variables, that areas such as Lee Vining and Lundy canyon possess winter ranges that are actually comparable to Wheeler Ridge. Just to point this out, the better winter range habitat is identified by the deeper colors of orange and red, and Wheeler Ridge is on the bottom here. You can see there's some orange, red, and yellow, but when you get up north there, Lee Vining and Lundy canyon and even further north, there's clearly adequate habitat for bighorn sheep. Go ahead. Summer range, similar, tends to be much less limiting so I'll move on past that. We're seeing lamb production up there. Every year we produce lambs up there. And then finally, there's considerable historic evidence of bighorn sheep throughout the Sierras and in the north as well.

Steve Lewis: Thank you, Dr. Stevenson. And thank you all, presenters, for keeping your comments within ten minutes, I know how challenging that must be. We're scheduled for a break, 15 minutes. We will reconvene at 10:30. See you then. And would somebody mind raising the lights back there, if they could, please. If you came in late, make sure that you sign in. For those of you that did come in late, let me repeat that by signing in legibly you will receive a letter that will give you information on the web sites that you can access the meeting transcriptions. Dr. Glimp? Okay. Now it's time for our roundtable discussion, and let me give you the play-by-play on how this is intended to work. What we're going to do is just start over here, Dr. Thain, thank you for volunteering to be first. Have we got somebody else over here that we're missing? Dr. Aune? And we're going to give each person five minutes. If you don't want to take five minutes, just say "Pass". Okay? Because it'll get back around to you. In this five minutes, you can finish your presentation. You can rebut. You can pose questions to others on the panel that we'll get to later, but everybody will be given five minutes to do whatever they want to do or pass. When you do speak, whether or not you've spoken before or not, please just introduce yourself by first and last name, so we catch that on the camera. After the five minutes, as we go

around clockwise, then we'll open it up to dialogue back and forth. So again, your task here is to complete thoughts with your presentation, rebut something you've heard, pose questions that will be answered later within this panel, or pass. Are there any questions about what we're going to accomplish in this first go-around five-minute session? Okay. Dr. Bleich, if you'd like to take five minutes, you're on. And again, name, name, yes. Yes. I'm sorry, please speak into the mike so we get a good recording of the meeting. Thank you.

Dr. Vern Bleich: I'm Vern Bleich of the California Department of Fish and Game, and at this time, I am going to yield to the next individual.

Dr. David Thain: Thank you very much. David Thain, with the Nevada Department of Agriculture. It is (incomprehensible) that have a lot of interest in domestic livestock disease and wildlife disease and have been actively involved as a regulatory individual and brucellosis eradication and TB eradication. We've seen tremendous interactions between wildlife populations and livestock over the years with a variety of diseases, and I think they're all multifactorial, and one of the things that came up is we were having an excellent presentation on contact between bighorn sheep and grazing allotments. We had the spatial arrangement there, but we were missing the time, so that we realize this disease is pretty much an obligate agent, they don't last in the environment for any length of time, and are there opportunities as we look at some of this modeling to come up with a time and spatial separation. Not dissimilar from what we're doing in the greater Yellowstone area, looking at keeping cattle away from elk during the calving season, so I pose that out there with what the opportunities are and it looks like you're getting some really excellent information to add to the pot on how far these animals move back and forth, where their ranges are, seasonal times, I think there are some more opportunities there. With that, I'd like to pass it on to Dr. Rink.

Dr. Anette Rink: I'm Anette Rink, Nevada Department of Agriculture. My comments I guess are the reason why really experienced people mostly got invited to this meeting is because we really do want to hear what you have to say, and my understanding from spending many, many nights reading all these papers is that there's a lot of scientific data that is pretty hard and pretty well documented that is already going to be enough of a base level that we can use to develop management practices. I think there's a lot that we don't know that we still need to find out, but I think that the opportunity we have today to actually figure out what it is that we know and maybe hear from the people that have been managing wildlife populations for a long time. Where are you going, where do you actually develop concrete plans, how do you go about managing a specific disease, a specific disease factor, and how can you ameliorate this? So I hope that the discussion that I hope is going to ensue after this is going to bring up a lot of these points and that you share what you're going to do, what you're planning to do with the respective bighorn sheep populations that you're currently managing.

Mr. Carl Benz: My name's Carl Benz, with the U.S. Fish and Wildlife Service. I just want to put

out two questions that hopefully can be addressed later. One is very similar to yours, Dr. Rink, and that is to Dr. Aune. You talked about the management prescriptions that you've had for bighorn sheep in Montana. In talking about the multifactoral elements that are in place with, that affect sheep, and I am curious as to how you are using best management practices to address all those aspects. You mentioned you have the nine-mile distance around the different herds, but how are you looking at matching those other issues? And to Dr. Rink, I thought I heard you say that there were benefits to having domestic sheep on the range, and I thought when we get into the discussion, you might be able to expand on that a little bit? So we can understand. Thank you.

Mr. Mike Cox: I"m Mike Cox, Big Game Staff Biologist for Nevada Department of Wildlife. And I'll just make some general comments. I'm a population ecologist. I don't consider myself really well trained in the cellular level, but I've learned a lot over the last few years working with pathologists throughout the West, many of them that are here today. It's a very complex issue. In a perfect world, as a wildlife manager, we'd like to use the best science to make the best management decisions that affect or promote good wildlife populations that are sustainable and healthy, but we don't live in a perfect world. There's lots of issues out there on the land, lots of changes that have occurred that are difficult to manage. I think within Nevada, and we're trying to use reasonable information to make some reasonable decisions on dealing with the reasonable risks. Not all risks we can control. Some things we can spend money on. We might see change or effect a difference that will be positive. In other situations, we might be dumping money down a rathole, and I think, we need to continue to dialogue. Maybe a lot of us were apprehensive to come today, but I think situations like this and opportunities like this we need to capitalize on to further our understanding of one another and our understanding of the needs that we all want to see out there or occur, whether they be livelihoods or recreational pursuits, so I hope we can all appreciate one another's situation, learn what from we've figured out to date, and try to figure out how to better understand things we don't quite have all figured out. And I don't have all the answers, and my ears are wide open, and I'm hoping that we can again continue to work together in an open forum to try to solve some of these things so we can live out there in semi-harmonious situations. So, thanks.

Dr. Al Ward: I'm Al Ward with the University of Idaho. One thing that I would comment on is, finishing up sort of on that last slide with the study that was conducted with sheep that came from Hells Canyon. And that was a study of a die-off that was in progress. And I believe that those that elected to bring out the 72 bighorn sheep, capture them and take them to a holding facility, were somewhat criticized, but it was a unique opportunity. First of all, it was to prevent continuation of the die-off, but then we tried to make the most of it and evaluate what was really going on in that population of sheep. And again, things were not done perfectly. We did not have viral cultures on a majority of the animals, we only isolated VI3 from one of nine lung samples that were cultured for viruses. But one of the things I think we should learn from that is that there had been 30, I believe, 30 augmentations into that valley, into Hells Canyon. Over 19 years,

bighorn sheep had been moved in from other locations. We know that one of those locations had microplasma, microplasma argeninii. At the time that argeninii was isolated, it was thought to be ubiquitous and not really significant in disease processes, but they didn't have really a lot of knowledge about microplasma of any type in bighorn sheep. But sheep were translocated from that area into Hells Canyon, from British Columbia, from Montana in multiple eight areas, and again and again, those sheep died out, and so management is so critical, and it's critical for us to get together to share information to prevent that kind of thing. You talk about money down a rathole. It seems as though there was extreme expense both for translocation and diagnostic workup that resulted in not very much gain. But hopefully gaining from this point on that that kind of thing will not be done again. And again, we want to facilitate sort of developing a picture of what is in a population of bighorn sheep, so that they will not be translocated into an area that is going to result in deaths. So health monitoring of populations is important, not just when they're going to be translocated, but looking at a population and finding out what is there as far as the viruses, the microplasma, and the Pasturella or other organisms that might be associated with some of these disease processes. Thank you.

Dr. Keith Aune: My name is Keith Aune, I'm with the Montana Department of Fish, Wildlife, and Parks. And first, I want to commend you all for holding this roundtable, because I think it's the start point of some very important dialogue, and I will tell you that there are some parallel approaches being done by other states on this very same issue. We just completed in our state a series of focus group meetings and we're going to conduct more. Part of the thing I want to bring up is that when you're talking about risk of disease transmission, there's one very critical element that you need to think about, and that is the human dimension. And the human dimension surrounds the issues of perceptions – perceptions that each of the different stakeholder groups have, and there's a lot of science you can build, but how people see that science is a really big hurdle sometimes to jump. And I think you've got a great start here. We, in particular, in Montana have tried to develop a dialogue where we let the producers express their views and some of their interpretations of science. We let the biologists share their views as a group. The veterinarians and agricultural health people, their groups, and the support from these other groups. And when we get back together and share those, quite often we find there's as much in common as there are difficulties and conflict. But it also helps us identify where that conflict is and how much of that is surrounding the scientific limitations, how much of it is people's perceptions, how much of it is concerns and issues of a very important human dimension. And that is people have an investment. They have invested their lives in the land, they've invested in whether it be sheep production, they've invested in saving bighorn sheep. They all have an investment that has to be recognized. So I want to commend you. I think this is a very good start for you folks in Nevada, and I think you could come together in the future and continue to explore. It's not going to be without difficulty, I'll guarantee you. I want also to come back to the idea of management and mitigation strategies, and I think sometimes, too, we get very narrow in our scope, maybe again because of our limited understanding or we have certain perceived ideas, but I think we need to broaden the discussion of mitigation. In the past, what I'm finding in our

state is the simple idea of spatial separation simply won't work. And the reason I tried to illustrate in the ten minutes on that map is that, in our state, many of our bighorn sheep herds are surrounded by private land, and as a state wildlife agency, we have no authority to tell a private landowner what he will do with his land, so we're faced with the inability to simply do spatial separation. We have to work with those landowners. We have to work with sheep producers who raise sheep near some of our herds, and we have to come up with some other ways to try to work mitigation into that and reduce risk. And I think getting back together again, talking more. We found our producers are willing to talk about this, and they have some ideas. They know a lot about their domestic sheep and we don't, that we don't know. So time and space was brought up. I think it's very important to look at it from a time and space dimension. Whether there are means to mitigate disease as it's expressed in domestic sheep is another way. There are some pretty good vaccines for Pasturella that work very well in domestic sheep, and so perhaps, working on that side of the issue might be helpful, and you might find producers willing to do that, and we've found them willing to do that. So explore ideas. Then the last thing is I think we need to think about some management experiments, and I know that's tough for those of us in the bighorn world, but we're going to have to do some kinds of experiments where we'll look at different ideas and see how they work. And we have to accept some risk in terms of doing those experiments. Certainly we're not going to experiment with a highly valued resource, but there may be some other places and other times that it can be done. Again, I congratulate you for starting this process. I encourage you to bring the other stakeholders to the table and have more discussion.

Speaker: (tape 3 begins, may have missed a portion of this discussion) ...participating in this. Mike, I'm in the same boat you're in, and I'm an animal nutritionist, a student of microbiology and a student of pathology, a student of domestic and bighorn sheep. I do have a couple of questions or concerns to this group. I put together a comprehensive bibliography on bighorn sheep. I had a graduate student do it for me. I had extreme difficulty finding references in that 1400 that documented on a scientific basis as Anette mentioned with cultures, the whole nine yards, documented bighorn (incomprehensible) you to contact with domestic sheep in the natural wild state. Yes, in captivity, but in the natural state, where there was no major stress factor involved. I'll put that qualifier on it. Nutrition, yes. Disease, other diseases, habitat loss, predators, hunting, all are stresses. The second question I have for this group. I heard this there's a lot of people wanting zero risk. There is no such thing as zero risk, I promise you. We showed the perimeters here with the desired 20-mile barrier, or 20 kilometers, I'm sorry, of barrier, hopefully a buffer zone. Larry Johnson, who I hope has a chance to comment with the public group, with the Nevada Bighorns Unlimited, and I had a conversation recently, this has been well documented – bighorn rams will migrate 50 to 100 miles. The more we allow these populations to spread, whereas our domestic sheep producers are in deep trouble if they let one stray, now how are we going to live together if we insist on zero risk, big buffers we control, and there's no control over here.

Meeting Transcription
Sierra Nevada Bighorn Sheep Roundtable Discussion
Febuary 25, 2005

Dr. Ben Gonzalez: I wanted to start and make a few comments to Dr. Rink in that, I actually think that you and I have a lot in common. We do have a lot in common. I think we understand the complexity of this issue that's not easy. I'm Ben Gonzalez, I'm a veterinarian with the California Department of Fish and Game. I want to look back at Dr. Foreyt's studies, and these are the captive studies, and they were, I'm sure in the light of the technology then, were pretty good. Now, from the technology today, we see that he made a lot of wrong assumptions. He made some oversimplifications. I think we really need to get back to, I mean, as much work as I've done in this field, I just don't understand this pneumonia. I don't really think that we can fix on Pasturella and say okay, this is it. And looking at (incomprehensible) postulates would be great, and as a matter of fact, I would support that these studies be repeated and what we are trying to do is remove a lot of these confounders that we find in the wild. And so I really think that these captive studies are valid, because if you remove the nutrition, if you remove the stresses that everybody talks about, and it still happens, then to me, that's still very significant. Okay. There's been some comments about how bighorn sheep herds are immunologically naive, and maybe we should do something about that, and I guess I have to ask, what can we do about that? If we – we have, for instance, somebody made a comment about how sheep, a group of Rocky Mountain sheep went from 1,500 to 180, and we're looking at Sierra Nevada sheep, where we think we've had or they have had tremendous success getting up to 300. Many of our bighorn sheep herds on the desert number ten or less. You know, we don't have huge numbers of bighorn sheep. And I think that that, really, means to me that we really have to be very conservative in our management of these sheep. We try to be. And then last, I'd like you to address a couple things about vaccination. Number one, is there an effective, a vaccine that's been proven effective in preventing Pasturella pneumonias in bighorn sheep? And second of all, assuming that there was a perfect vaccine, you know, in the Sierra Nevada we have worked for four years. Wheeler Ridge, for instance where there are 90 sheep, we've managed to catch 30 sheep in four years, and this is coming out to Bishop every month, working two to three days, and if we catch seven sheep in one trip, that is a fabulous success. How are we going to vaccinate these? We could use some biobullets, you know. Then, let's assume that we can vaccinate 100% of these sheep. What about all the lambs? Vaccination prevents, let's just say the perfect vaccine might prevent disease, abut it's not going to prevent infection, and then you're going to have every lamb in there coming up ill, so you're going to have to catch every lamb and vaccinate that. So it's a little more complex than what I've learned about in livestock, I mean, there's a lot of complexities to it. I have to say I really respect the work you're doing, the work Dr. Ward did for many years. I think we're going to eventually get to the point where we can predict some of these and where we can solve these problems. I just don't think that we have those answers yet, and I don't think that we can risk these small populations, like the Sierra Nevada bighorn sheep, with a lot of experimental work. You know, I don't think we can do it. So, anyway, maybe in discussion, maybe you can address some of those issues. Thank you.

Dr. Tom Stevenson: I'm Tom Stevenson. I'm a biologist with the California Department of Fish and Game. This has been interesting to me, because I had some expectations about what I was

going to hear when I came here today. One of them that I've been surprised about is that I'm still coming away from this feeling like nobody here has really said that we don't have to worry about preventing contact, that there are a lot of multifactorial factors that weigh into this disease issue, but domestic sheep is definitely one of them, and it's one of them we can't completely ignore. And I think that having said that, there's clearly a need for a conservative approach, given the status of these species and given the uncertainty about how to control disease issues. Having said that, I would like to address the buffer issue. You know, I put the polygons on the maps to illustrate the proximity of bighorn sheep to domestic sheep. And that proximity and those buffers are merely there as a guide to illustrate just how many allotments lie within the ten or twenty kilometer radii, which we use ten and 20-kilometers for a number of reasons, one, because the literature suggests, you know, in some cases, a larger buffer than that, based on the movement data we were seeing, it seemed like a reasonable buffer. And by buffer, I'm using buffer, and actually the GIS computer contacts, it doesn't necessarily mean that sheep should be excluded from that distance, but there are simply polygons to illustrate proximity. So having said that, what strikes me about one of the best ways to resolve this, is that the acceptable distance that separates these two species, if we assume there's a risk of disease transmission, is going to be a function of how closely we can monitor both species. We've got some opportunities with Sierra Nevada sheep because of their status, that we've got resources available to us that may not be open to everyone. There is so much interest in it that we may have the opportunity to pursue some creative solutions. They're not all going to be easy, and not everybody's going to be happy, but I think there's some opportunity to try to resolve this. There's going to be some tough decisions, but I think with enough persistence and creativity and follow-up, you know, we need to make it work. Just to touch on one question that Dr. Thain posed, is this question about movements, what time of year are they occurring at, and as I said in my presentation, the presumption coming into this was that bighorn sheep remain high in the summer, and domestic sheep tended, the allotments were at lower elevations. What we found was that that largely holds true for the ewes. The rams are the ones that really seem to be the problem and really pose the greatest risk of acting as a disease factor. We've seen rams at virtually every elevation available to them at any month of the year. A lot of these movements that are occurring certainly seem to be initiated during the rut, during October. Much of the domestic sheep grazing is out of there by then, but there's actually quite a bit that's still there through the month of October. But then, what we're also seeing is these animals are, these rams are presumably making forays to find ewes during the rut. They're getting to areas where they're not finding animals and they're going ahead and spending the winter and much of the spring there, and then they'll travel back in the late summer in many cases. So I don't really think we've got the information yet to really predict these ram movements very well. We're collecting as much data as we can. We're putting on as many GPS collars as we can afford, but it's complicated and I think there's a number of factors that are dictating the movements of these rams, so we can't even predict which rams are going to make these moves. And they seem to do it -- one year they'll do it, like that ram that moved 33 miles south. The first year after he was collared, he made that move, came back. The second year he remained there. So there's a lot of uncertainty about it.

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Dr. Walter Boyce: I'm Walter Boyce from the school of veterinary medicine at the University of California at Davis. I'm a real firm believer in us finding out and using the best information available to make decisions. And where I'm at on this right now is that the best information we have leaves us with some pretty unsatisfying options. We really don't understand this very well, and we've heard it over and over again. One reason for that is so much of the information available is coming from trying to describe and understand events that have already happened. An outbreak begins, we try to mobilize, get out there, get the right samples, analyze them. We collect all this and then we can kind of describe to the best extent possible what happened, but that doesn't tell us about something that we call cause and effect relationships. It doesn't say that this particular cause had this effect. The only that you can really get at cause and effect relationships is doing an experimental approach. And there's darn little experimental work available on this. The only stuff that's really out there are the Foreyt studies, which are subject to a variety of different criticisms. I think one of the best ways we can move forward is try to design experimental approaches on the management end and on the benchtop end that get at cause-effect relationships. That's where we can get facts on the table that everybody will agree with, and we won't be arguing about, well, you didn't do this, you didn't collect that sample, and you didn't do that. So it's really going to take us being proactive and designing carefully designed studies in the field, I'm afraid, is what it's going to take. Because there's a big difference between doing a laboratory study and doing things in the field, and getting to those cause-effect relationships, so that we can explore options that hopefully will be more satisfying to all of us here.

Ms. Melanie Woolever: My name is Melanie Woolever. I"m a wildlife program leader with the Rocky Mountain region of the Forest Service in Denver, and I also have the responsibility for being the national program leader for our bighorn sheep programs. In that arena, I provide guidance to our forests on how to resolve conflicts between domestic and wild sheep and how to provide for wild sheep on the national forests. And have, what Dr. Boyce referred to as the unenviable position of having to use the best information available to reach some fairly unsatisfying decisions. So, some of the documentation that has been referred to here is part of what we have done trying to help our forests make good decisions in terms of how to provide for viability of bighorn sheep on the national forests while at the same time, provide for viability in industry, for livestock producers and be sure we are able to keep them on the land. That doesn't necessarily mean both those uses are on the same acre of land, but so that's my role, and I'm here, as you all are, to gain information that the scientists doing research provide for us, so that we can do the best job we can of using that information to provide for acceptable management decisions by the Forest Service.

Mr. Steve Lewis: Okay, thank you. We did not get your name, sir. Could you please just introduce yourself?

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Dr. John Wehausen: I'm John Wehausen from the University of California, Wildlife Research Station. I'll be speaking this afternoon.

Mr. Steve Lewis: Okay, now it's time. We've expended about half of the allotted hour time for the roundtable. Now it's time to just open it up for cross discussion. Going to limit those comments to three minutes, so would anybody like to begin?

Dr. Rink: I would like to answer two questions. First the one about the (incomprehensible) of bighorn sheep habitat. I think Nevada and probably California are not quite in the same situation as it seems that some of the Rocky Mountain states are in regard to invasive weeds, but Nevada certainly has a significant invasive weeds problem, and I do not profess to be an expert on that. Dr. Glimp has done a lot of research on that, and it's turned out that domestic sheep really seem to be the only tool that you can use in an environmentally friendly way to control those weeds and to move deteriorated habitat back into a way where more nutritious (incomprehensible) and herbaceous plants are able to grow. One of the things that I came across when I was reading the recovery plan is that a major issue is that the bighorn sheep do not actually accept their winter habitat because of fear of predation. And many times, that fear of predation or the optimal predator habitat goes along with thick underbrush. That is one thing that grazing through domestic sheep actually can take away this underbrush. That was my comment with regard to domestic sheep, if grazed in a certain manner, can actually improve bighorn sheep habitat. And also, it will reduce the fire risk, and that is why sheep have been used in several parts of the world to actually graze fire breaks. So, overall the impact of sheep on the environment can be very, very positive. To get to Dr. Gonzalez' question about the vaccination, Dr. Miller in Colorado has done many studies on that and you probably know them, and he's shown that we actually need to repeatedly vaccinate an animal for it to have a pretty solid immunity. And I don't know, and he was doubtful about that, too, is the stress of putting an animal through it, even if you use a biobullet really worth it? My comment about the vaccination really was always under the assumption that if there are different interests, the risk needs to be split, so if the sheep producers agree that they will actually vaccinate their sheep against Pasturella so as to further reduce a potential risk, that is what I was specifically referring to. And if they agree to do that, so that (incomprehensible) will be eliminated or severely limited, who's going to pay for it? So is there going to be a willingness to share the risk and that would be one of the things that in field studies could be addressed in a very soon time frame to actually try that out. To do a study where you actually know, you infect your domestic sheep first then you vaccinate them, and then over a series of weeks or a month, you come back and culture them and see what their shedding level is. That is something that I had in mind when it comes to vaccination.

Mr. Steve Lewis: Response?

Dr. Ward: In the vaccine project that we did, we actually did do some culturing of domestic sheep and the bighorn sheep as well. We did not, unfortunately, find that it significantly

influenced the shedding. And so possibly, as you were mentioning, a specific strain that a person would go in with and see how that would do. That might be more productive. I believe some work in cattle, where they had followed a serotype, they found the vaccination did affect the shedding rate.

Mr. Lewis: Next comment.

Dr. John Wehausen: Yeah, John Wehausen again. I would just comment about the notion of brush control by domestic sheep in the Sierra. I think you're talking about a brush control that's not the type of brush we're dealing with in our winter ranges. We're dealing with things like mountain mahogany and even pinyon juniper forests have moved in that domestic sheep wouldn't touch. Their stature is much higher than that.
Mr. Lewis: Further discussion. Dr. Gonzalez.

Dr. Ben Gonzalez: Yes, I'd like to make one comment. I had this as a part of my presentation, but didn't have time to do it. It had to do with an outbreak of contagious eczema and infectious (incomprehensible) conjunctivitis in bighorn sheep in the Silver Bell mountains of Arizona. And in that case, they actually didn't draw a lot of their conclusions from laboratory evidence, and my point is that sometimes circumstantial evidence can be very compelling. And certainly in 1950 and 1960, they didn't have the laboratory tools that we have now, but in my mind, it does not invalidate the possibility that a lot of these outbreaks were the result of contact with domestic sheep. Now, the bottom line is that we don't know. And I don't think we had the technology back there to know about it. We didn't have the Pasturella techniques. I mean, I've heard, as recently as five years ago, people saying well, my bighorn sheep don't have Pasturella. So, I think we need to not always exclude evidence because it's circumstantial, that we're not always going to have the laboratory evidence, and that doesn't mean it didn't happen.

Dr. Anette Rink: (tape appears to skip) .. is that since I think we all agree on the fact that there are pneumonia insulodics, maybe you could share some of your ideas about how you're actually going to control, for everybody's sake, because we, and it seems that we're all pretty helpless when it comes to an outbreak of pneumonia, and at the point when there is an outbreak, and at that point it really, in terms of managing it, there's not a huge big difference between where it originated. So if it came from a domestic sheep, or it came from a migrating ram, or it started with just the multiplication of really very (incomprehensible) strain in an animal where the individual immunity broke down, so if you have a disease outbreak with massive loss, how do you control it?

Dr. Gonzalez: I actually think that you've hit upon the whole point, is that you can't. The major point of what I think I'm trying to say is that, really there is no management. Once an outbreak occurs, it just goes on until it finishes, and that's why we really need to stress the prevention of these outbreaks. I've heard strategies like in some areas where they will go and either capture

animals and give them an injection of oxytetracycline, for instance, and I guess, you know, the comment to that is as much as we abuse antibiotics, to me, it seems counterintuitive. You might have that animal survive longer, but you're also giving it a longer time to spread the disease. And in (incomprehensible) studies, where they looked at survival of bighorn sheep populations or, they actually looked at having the very, very serious acutely pathogenic virus or pathogen would be the best, because in that case, the animals just die and they don't go wandering around for 71 days. So I wish I had an answer for you and I wish that we knew more about it, but that's the whole point – you can't control these outbreaks. We don't have the technology and that's why we have to emphasize the prevention of these outbreaks, and I think everybody at this table acknowledges that we don't need domestic sheep to have bighorn sheep epizootics. That's not even an issue to contend about.

Mr. Lewis: Yes, Dr. Bleich.

Dr. Vern Bleich: Dr. Rink raised the question, I think, of what might be done on the bighorn sheep side of things to minimize the potential for disease transfer. I am in the very challenging position of managing this project for the California Department of Fish and Game. It's not really an enviable place to be. We've put a lot of thought into this question, and pretty much have decided that should we detect contact between a wandering male mountain sheep and domestic sheep, I would make the decision to remove that male sheep using lethal methods, rather than risk it traveling back to its home herd, if you will, or worse yet, to its home herd and further south to other populations. So we are prepared to make hard decisions. There's much discussion about circumstantial evidence. There are a few experiments that have been done that have been criticized, and perhaps rightly so. Nonetheless, they are what is standing right now in terms of the experimental information. With respect to circumstantial evidence, this is all material that has arisen in the last twenty years or thirty years. Going back to 1776, Bolton, who was a chronicler of Padre Keno's expeditions from southern Arizona to the Pacific Coast, described a great pestilence that struck the wild sheep in Coyote canyon on the west side of the Santa Rosa mountains, as the Spaniards and their expedition drove their livestock through that area. Ben Tinker, who bills himself as the first game warden in Baja, California, describes a legend among Baja California indians that describes a pestilence that affected the native wild sheep when the Spaniards arrived with livestock. He doesn't specify whether they were sheep, goats, or cattle. Nonetheless, he describes this outbreak and loss of native animals that occurred. Finally, Dr. Rink, on one of the other slides, you indicated that there are two categories of people – those who are believers and those who wonder why things happen. And I think that everyone sitting around this table probably falls into the latter category. Those that might be believers, or might be behaving as believers, are doing so based on the rather tenuous status of these Sierra sheep, and prudence dictates we err on the conservative side.

Mr. Lewis: Dr. Rink and then Dr. Stevenson.

Dr. Rink: Yeah, I have no doubt that there were a significant number of pathogens introduced to the naive populations during colonization. I think that's been demonstrated in every continent that's been colonized. But, on the other hand, what I also find noteworthy in this context, because we're all about improving or increasing bighorn sheep numbers, because there's a lot habitat out there that they could potentially inhabit. And my point here is that, and I don't want to be a heretic here, but they've survived it. I mean, every population of mammals that has an immune system has undergone selection processes as they have developed. And the genetic heterogeneity that a naive population and an endemic population has is usually big enough so that it can withstand a large, the immune system can handle a large number of different pathogens. And I think we see that of all the different biotypes that are being isolated out of bighorn sheep, and if that is compared to the isolates that come out of Alaska, where there is no livestock interaction with wild sheep, there is a significant difference between the numbers and the types of Pasturella that are isolated out of bighorn sheep or wild sheep. It differs with their ability to have contact with domestic sheep. But domestic sheep 150 years ago were not managed the same way they are now. Disease losses in domestic sheep 150 years ago were significantly higher than they are now, because sheep are vaccinated, they are dewormed, and they're plain managed. So, I think that the risk and then the other thing, the current day bighorn sheep populations are not the naive populations any more than they were 150 years ago. So we have now a population that has had 150 years which breaks roughly down into 30 generations to adapt to this new environment, and has very successfully done that, plus we have the domestic sheep that right now pose a much lesser risk in terms of disease transmission.

Mr. Lewis: Dr. Stevenson.

Dr. Stevenson: In response to your comment about how well bighorn sheep have adapted, I've heard the figure that in the lower 48, there's roughly about one percent of the bighorn sheep existing today that existed in the early 1800s. More than any other ungulate in North America, they have really taken it in the shorts. The comment that I was primarily going to address is this question of stressors. And to me, there's a fundamental difference between the way wildlife managers look at stress and how animals respond to their natural environment than the way animal producers do. In animal production, there's tremendous control over many of those stressors, whether they be nutrition -- if the animals need better feed, you just pour it to them – if they need shelter, you can provide that shelter. That's not an option with wildlife. You know, it's a different system, it's a wild system, and to say that somehow those stressors, we're not considering them, I think is completely unrealistic. We're very aware of those stressors. We realize that populations are controlled by changes in climate which ultimately affect the forage base. But what we're arguing is that these wild populations on top of that, and given that there will be times when they will be faced with those high levels of stress, they can't survive the additional stress of a disease that's not native to them, that they really haven't evolved with. And to me, that's the big difference between trying to manage wildlife and trying to manage domestic livestock.

Ms. Woolever: We're a little more conservative. The numbers we use is less than ten percent of presettlement populations, so whether it's one or ten, it's still not very much, so it's a bigger issue than just exploiting available habitat. It's a recovery issue, as well, particularly for Sierra Nevadas, but for bighorn populations in general. The piece that I think is pretty missing in this conversation, or at least in maybe where it's going, is that there's an endowed chair position at Washington State University that's been recently filled, and that position is funded as it is endowed, and the focus of that position will be on disease issues in bighorn sheep exclusively, so I think as we move forward in this discussion, and there are certainly far more questions there than there are answers, that needs to be a piece of the equation, and those folks aren't here today, but I really think they need to be brought in for the benefit of all of us that are concerned about what's happening with bighorn sheep, and what might happen to the livestock industry.

Dr. Rink: When I made my comment about being adapted, I was more referring to the remarkable comeback that they've had. I am fully aware of the fact that their numbers are severely reduced as opposed to 200 years ago. But they've also undergone a bottleneck that was much more severe than they're in right now. And in terms of expanding bighorn sheep numbers, I have not been able to find a definitive number anywhere. What is the historical evidence, or what is the sequence of events in terms of disease outbreaks in the California populations? What percentage of death loss in the Sierra populations actually are due to infectious diseases? And Ben, you and I have talked about this before, and you say it's very hard to ascertain that, and I understand that. What I came across when I was reading the plan was that it's known how many are actually victims of predation, which is 54.5%, so that seems to be the biggest individual death loss that the Sierra Nevada populations currently face. It seems that less than 30% are unexplained death losses, and I would just be interested to hear from you, what is your feeling? How many of these actually died due to infectious diseases? Or is this all due to infectious diseases in your interpretation?

Dr. Wehausen: I can comment on that. I've been studying that issue for 30 years, and having compiled that table in that recovery plan. I have never, and having done a lot of work on lungworms and things like that over the years, I have never, myself, seen any evidence of disease in the Sierra bighorn. I've never seen a snotty nose, I've never seen any of those things that would be associated with Pasturella and so on. So, we have no evidence that there's been any disease problems in the last 30 years in my experience, and I'm trying to think, and I think Ben could speak to serology and so on that's been collected over quite a few years.

Dr. Gonzalez: We have been doing serologic work for years, and the pretty much across, you have to understand that the sample sizes on these sheep are very, very small, okay? There were some fairly large captures back in the 1980s, especially in the southern management area. And what I see in the serology is, and it's unfortunate, I wasn't able to tabulate that, but except for a few disease agents or potential disease agents like chlamydia, and I think EHD, there is almost

zero prevalence now, and has been for the last eight years, ten years. Now what I did notice in the southern range, in the southern management area was that there were PI3 titres down there in the southern range. You know, how you interpret that, I don't know. I mean, does that mean that there was disease down there, I don't know. The fact is, you know, that we have a lot more technology and we have a lot of animals marked now, which, when John was out there doing his work, you know, he was out there a lot, I know that for a fact. And I would think that if there had been a significant disease problem in that area, I think John Wehausen would know that. I mean, there's only so much one person can do, or two people, but based on the resources available at that time, the fact that John was out there quite a bit, I would think that he would have seen a sick sheep at one point or another. That's not really conclusive, but that's essentially what the data tells us.

Dr. Stevenson: I think that what should be added to that is John began his work in about 1970, and at that time, there were two populations left in the Sierras, and I guess there were about 300 animals at that time, then they subsequently declined. You know, and it wasn't really until the 1940s that you could really say that any work was being done on Sierra sheep. There were a couple more herds at that time, so there was clearly a substantial loss of bighorn sheep historically, prior to, based on what we know about historical levels, and so why that high percentage of sheep died off, there's not a lot of evidence out there to say one way or the other. I think there's some evidence that a scabies epidemic possibly occurred over in Sequoia National Park vicinity. So, yeah, I just wanted to add that I think relative to what caused the historical decline in the Sierras, you know, I think it's speculation at this point.

Dr. Rink: I don't mean this to be a facetious question, but on reading the recovery plan, it seems that in 25 years there's never been a confirmed disease outbreak in that region. In those 25 years, there have always been domestic sheep on that range. The biggest individual loss factor at this point seems to be predation, so when you went about to prioritize your recovery plan points, where you see your biggest need to act, how come that the disease issue, the transfer of diseases from domestic sheep to bighorn sheep became a major issue, even though it seems that in 25 years, there's not been a documented case of transmission, and it's unclear at this point how many, or how much death loss is actually attributable to the pneumonia complex?

Speaker: I think the difference is that predation in most situations and probably throughout the Sierra Nevada, does not have population level impacts. A disease epizootic associated with an outbreak of pneumonia has very, very serious ramifications for the persistence of populations. As part of my unenviable job, I get to sign death warrants on mountain lions. We have an active predator management program, and that is being addressed as part of the recovery effort. The big difference is that a disease epizootic would have very, very serious implications for the persistence of individual populations and potentially for the persistence of mountain sheep throughout the Sierra Nevada.

Mr. Lewis: Did you want to jump in, Dr. Cox?

Mr. Cox: I'm just Mister. I have a master's. No piled high deep on that one. I'd like for maybe everyone here to have Vern or John give an overview of the status of the Sierra Nevada bighorn, the draft recovery plan that responds to its endangered status, so that, maybe there are some things that are being said that don't quite make sense to a lot of us in the context of the management situation.

Mr. Lewis: Okay, we've got seven minutes left. Dr. Wehausen.

Dr. Wehausen: Let me just say something about the recovery of the population. We've actually seen remarkable recovery of the population since about 1999. At that point, we had barely over 100 sheep in the Sierra. We're probably in the area of 400 sheep today, and that's a remarkable increase, and that's happened pretty much on its own. I don't want to belittle the predator control, because predator control may have been important in some places, but the sheep are actually doing quite well. As to the recovery plan, the person next to me could talk about that, but we actually wrote that draft, finished that draft in 2001, and we were hoping to finally finalize it in the next number of months, I think.

Speaker: (tape 4 begins, missing something) ... requirements is. We still have, and as John said, we've had tremendous increases in some of our populations, but currently the majority of bighorns reside in two or three herds, and for recovery to occur, the recovery plan identified 17 possible herd units with suitable habitat, 14 of which needed to be occupied for recovery, and right now we probably have bighorn sheep in about seven of those, and as I said, with the majority of those being in about three of those herd units, so we've got increasing numbers. We still have a ways to go in terms of numbers, but as much as anything, the distribution needs to be broadened.

Dr. Boyce: Can I jump in on that for just a second? One reason we might not have seen an outbreak of pneumonia in Sierra sheep over the past several decades is that there were so few of them that the opportunities for the introduction of a pathogen were limited. It's a real conundrum or problem that as recovery succeeds, the chances for a catastrophic die-off increase. These animals are going to have to expand, they will expand into areas that they currently don't occupy and haven't occupied in the recent past, and in a sense, as we work towards recovering the population, we're increasing the risk of that population suffering a catastrophic die-off, and I think that's where it behooves us to think about all the mortality factors, predation, infectious disease, as we think about what is happening now and plan for what, indeed, may well happen in the near future.

Dr. Stevenson: To follow up on what Dr. Boyce just added about that. I was going to mention this earlier as well, that another factor that may have contributed to the lack of disease

transmission was the fact that these two remaining herd units were in the southern recovery area where there tends to be much less, you know, it's just not a suitable environment for domestic sheep grazing, and as the central and the northern areas are. It's much lower elevation at the basins and it's that extremely steep, eastern scarp of the Sierras.

Mr. Lewis: Dr. Thain.

Dr. Thain: Just a couple of comments. I think Dr. Rink's point is very valid. In your arguments against it is that we haven't seen a big die-off in 25 years, even though there have been domestic sheep there. If the recovery plan goes according to your hope and projections, we are going to see a catastrophic die-off at some point in the future, whether domestic sheep are there or not. I don't think this population is any different than a number of other populations that have been well-documented in Wyoming, Montana, and Nevada already. These events do occur through a variety of multifactorial situations, whether domestic sheep are there or not. And to hang the total hat for the recovery of this population on the total absence of domestic sheep is, I think, a little bit nearsighted.

Speaker: Sure, I'll follow up on that. There are other factors in the plan that are designed to counteract the fact that bighorn sheep die, you know. I look at bighorn sheep and they're looking to die most of the time of either a mountain lion or an infectious disease. Every sheep is going to die at some point in time. And those are the two right at the top of the list, at least in my experience. So we're going to lose sheep, in fact, we're going to lose entire populations of sheep, so in terms of managing, what we try to do is manage so we don't lose all the sheep in a given area so that that habitat can never be reoccupied unless we go back in and put sheep there. The strategy for accomplishing that is to have multiple populations that are distributed across the landscape, so that if you lose one or two or three of those populations, you haven't lost the whole game. You have other populations that can serve as a source of individuals to repopulate those areas. The plan as it was drafted a couple years ago included allowing for the establishment of multiple new subpopulations or populations, if you will, so that if you did lose one, which, indeed, you may well – it could be an avalanche, it could be all sorts of things that could cause you to lose a particular group of sheep, but you won't lose all of them. And domestic sheep are just one of several factors that could, indeed, start that sort of die-off in a local population, and the problem we have is, as Tom Stevenson was showing us, the rams can move back and forth across a tremendous distance, and once a disease epizootic gets going, it's very difficult to get in front of it and try to stop it in any way that really works.

Mr. Lewis: We have time for one final comment. If not, please help me in thanking our panelists for this discussion this morning. Okay, now it's time, and I really appreciate your patience, audience, and your continued cooperation in our meeting format. It's time now to receive comments. This is not a discussion between, necessarily, there won't be any questions or responses or interactions with this panel. The panel is here just to listen to your comments. If you

do have questions, and Hudson has the mike, if you do have specific questions that you want put in the meeting record, you can fill out one of these pink cards and these will be transcribed along with the entire meeting. So we're looking for comments right now. Just comments, and if you could, please, state your name.

Speaker: My name is Hank Vogler. I live in North Spring Valley, Nevada. I'm a sportsman and a stockman. A few short years ago, I had the opportunity to go to the Northwest Territories on the arctic circle and hunt adult sheep. There was a veterinarian in the camp that was studying adult sheep. They had die-offs. They had every problem that we've discussed today. Fifteen hundred plus miles to the nearest cow or sheep or any domestic livestock, they still had the same problems. The conclusions that they came to was low selenium. I feed my sheep selenium salt because of low selenium. I will vaccinate them for anything, and Mr. Johnson, if you need an area to put some sheep in as an experiment, you can use my range. There's enough habitat out there for all of us, and the word's out, the world's round, Columbus has landed, the wilderness has ended. We have to use management, we cannot go back to some pre-Columbian ideal. If you look at any mining camp in the Sierra Nevadas, they hunted every wild animal that there was out there for protein meat for those miners. And I have seen those pictures of stacks and stacks and stacks of bighorn sheep heads that they used for meat. And you want to hang everything on the domestic sheep. That is very disingenuous. A little predator control will go a long ways, and you cannot make a souffle unless you first break eggs.

Mr. Keil: I'm Ron Keil. I'm the Resource and Planning Staff Officer for the Inyo National Forest, and I'm also here today representing our forest supervisor, Jeff Bailey. I was also the line officer on the forest who made the decisions to cancel two domestic sheep permits and to modify several others to manage the risk of disease transmission between domestic and wild sheep. That was in 2001, I believe. First, I want to agree with Dr. Aune, that we need to continue to work together to identify potential mitigation measures in both domestic sheep management and wild sheep management to resolve this issue or to address this issue. I also want to recognize Dr. Bleich, Dr. Gonzalez, Dr. Wehausen, Carl Benz with the Fish and Wildlife Service, Terri Russi with BLM, Ryan Tillemans and Dale Schmidt with the Department of Water and Power, and the permitees, several permittees, Joey Echenique, Paco Iturria, and Ben Ansolabehere, for the work that we've done in identifying the mitigation measures, the type of work that I think Dr. Aune was talking about. And we've identified quite a range of mitigations including running pregnant ewes, changing seasonal distribution, additional counts, additional marker sheep, and these were pretty, you know, they're not easy, they're not free, they're expensive mitigations, but they kept sheep on the range and addressed the risk. It didn't take it to zero risk, but it took it to an acceptable level of risk. And lastly, I'd like to say that we need to identify some additional mitigation measures, and I'd like to just throw this out for consideration. We've got a lot of real-time information regarding bighorn sheep distribution, and we need to be able to get that information to our permittees, in a real-time way, so that they can take action, move their sheep the opposite direction, whatever. And we also need to consider take by permittees. If a wild ram

gets into a flock of ewes, domestic ewes, we need to consider allowing them to take that ram. Thank you.

Gary McCuin: My name is Gary McCuin. I'm the natural resources lead for the Nevada Department of Agriculture. Man has had a huge impact on the world and natural resources and conversely, natural resources have had a huge impact on man. Our survival as a species is inextricably linked with our natural resources, our environment. Therefore, we are in the business of management of natural resources, management of habitat. In order to do that, we must keep all of the tools that we have in our management toolbox, and that is multispecies management, using all domestic livestock, sheep, goats, cattle, etcetera. If we do that, we can optimize, or help increase the ability of our habitat to reduce the risk to all sheep, both native and wild. If we continue to go down our current path of species bigotry, as I would like to call it, or single-species management, as the ESA has forced us into, we will lose species, we'll lose our rural communities, we'll lose our way of life, so we must find a way to get around putting one species above another in managing holistically.

Dr. Barry Perryman: Dr. Barry Perryman. I'm a rangeland ecologist at the University of Nevada, Reno. I've got two quick comments. One, it seems to me, you know, I'm a habitat guy, so this is all really interesting to me, but, it seems to me that it's a reasonable assumption that the most efficient way to reduce risks of die-offs is to provide for seasonal habitats, really that provide conditions that will optimize bighorn immune system efficacy and function. It seems to me like you've got a habitat problem, you don't have a disease transmission problem. You could still have die-offs. We've already seen evidence that you could still have die-offs, even if the domestic sheep aren't anywhere around. So it's the problem is a nutritional based problem. That's where the, it seems to me, that's where the mitigation efforts need to be focused in, and not whether these things can go back and forth from one critter to another. If their immune systems are in pretty good shape, it seems to me that things aren't going to get much better than that. So that's one comment. The other comment quickly is, I've heard a number of references to, and I hear this quite often with other species as well, references to how many critters were here in 1800. And my question is what's so special about 1800? Our climatic system, climatic situation that we have now really sort of mimics what things were like 5,000 years ago more than 200 years ago. What's so special about 1800? It seems to me that we can't go back to that, and we need to quit worrying about what it was like in 1800, figure out what we have today and what we can do and make some reasonable objectives based on the habitat that we have today, so those are my comments.

Mr. Benny Romero: I'm Benny Romero with the Department of Agriculture and the grazing board for the western part of the state of Nevada. I also live right in the midst of the territory that we're talking about, the area we're talking about on the eastern Sierra. One of the comments that was brought up was you're monitoring the movements of the sheep almost on a weekly basis by either GPS or aerial monitoring. It would be very interesting to me to see what has taken place in

this particular winter. This winter is one that we can write about, and I happen to plow snow on those highways, and I'm seeing that not just the southern exposure, the southern and the northern exposures of the Sierras, are heavily covered with snow. What is happening to the bighorn sheep up there? So climatic conditions along with predation and all the other things that were brought up here today, I think we have to analyze everything on an even keel to be able to describe what's really happening to wildlife that we have very little control over. Thank you.
Speaker: I got a signal from a guy over here. I was going to volunteer him for a comment if he didn't ask to.

Mr. Larry Johnson: I'm Larry Johnson, Nevada Bighorns Unlimited here in Reno. We got involved in bighorn sheep reintroduction only about 20 years ago and have been very, very successful in funding and reintroduction around the state. I think, Mike, we've got about 60 new mountain ranges transplanted I think to date bighorn sheep in Nevada largely almost extirpated by the turn of the century, once our most numerous big game animal. Rockies became extinct in the northeast, California is extinct in the northwest, desert is extinct through most of their range, and we've come a long ways in putting those animals back, but we've got a long ways to go. Do we believe domestic sheep and wild sheep interaction results in a disease problem? You betcha. Okay. To ignore that would be as naive as saying the white man didn't bring disease to the American Indian. Okay. Is domestic sheep interaction necessary for every die-off? Of course not. Any time we have high densities, we risk natural die-offs of animals. For that reason, the Department of Wildlife identifies areas, mountain ranges with high densities. We use those for capture and transplant elsewhere. We control those densities with hunting and capture and transplant elsewhere. Does every interaction with wild sheep and domestic sheep result in a die-off? Of course not. We know our rams are very social animals and they're big travelers. We have a really nice population in Pershing county that pioneered out across several mountain ranges. Just take up a new population in a new mountain range all by themselves. It happens. For that reason, we recognize we are at risk here. Our wild sheep populations are at risk. We try, wherever possible, to transplant in mountain ranges that have no domestic sheep populations. Okay. Twenty years ago there was a big fear between sheep advocates and domestic sheep growers statewide. We tried to put that to rest to the best of our ability by working with everybody. We developed, we lobbied into our state agency. The state, which is now our state policy, in order to look for cancelling a grazing allotment to make room for domestic sheep. We're never going to ask for a reduction of AUMs to make room for domestic sheep. We realize that we're at risk. We assume that risk. We fund the program. We put the volunteer man hours on the ground to make this happen. Every public hearing, every time I've ever been interviewed on radio, television or in public hearings, I'm very clear to say woolgrowers, sheepmen, ranchers, belong out there every bit as much as we do. We need to find ways to work together.

Mr. Lewis: Thank you, Larry.

Floyd Rathbun: I'm Floyd Rathbun. I live in Fallon. I'm a ranch consultant and my primary work

is for one of the sheep ranches, one of the sheep permittees in this area. I apologize for my voice, I think I'm rapidly losing it. I just got back from the East Coast a couple of days ago and I'm listening to these veterinarians, and I understand now that I'm showing some of these Pasturella symptoms. I think I've got a fever from traveling too much. So my comments are, I've written them out, I'll try to keep them in the same time. On the other, explain that some of the comments on the recovery plan, I wrote my first issue to be raised is that the recovery plan gives a history of the bighorns in the Sierras, which nearly disappeared in the 1800s, were protected from hunting, and recovered to well over 300 bighorns in the mid 1900s and almost disappeared again, corresponding with the protection of predators, especially mountain lions by the state of California. The recovery plan, as we just heard, has 25, well actually Dr. Wehausen said, 30 years of observations with no observed transmission of disease from domestic to bighorn sheep. So there's an absence of connection, an absence of correlation, between what the fear of disease transmission is and the actual observation of the disease. The recovery plan itself, somebody else just mentioned, fails to identify the need to do habitat restoration and real specific habitat management. The recovery plan does identify it that there's a the lack of seasonal habitats, especially winter range in the northern part of the recovery area. This winter, as Benny said, this winter's a good illustration that bighorn sheep simply aren't going to survive north of Lee Vining creek. The presentations this morning include quite a few factual presentations with lots of data and the observation by several people that empirical evidence is simply lacking. I would like to point out that the recovery plan and the efforts so far have been tremendously expensive. They have cost communities the wealth that comes from the production of domestic sheep, and they haven't solved the problem of providing more bighorn sheep. I would like very much for the agency supervisors especially to take the actions that are necessary, including a national leadership to take the actions that are necessary to stop wasting the time, resources, and money that are being spent on this specific bighorn sheep effort and many of the other ones, and look for solutions, look for what the real problems are and find real solutions that work. Thank you.

Mr. Vogler. Hank Vogler again. We were talking about all these historical preferences. In 1950 in this country we had 60 million head of sheep and now we have seven. In the state of Nevada, we had 3 million head of sheep and now we have sixty thousand. That's about a 98 percent reduction and we're still hanging the Nevada and the California sheep industries out to dry over this? There has got to be a little more probative evidence pointing to something else like the same things that we face with our domestic animals, i.e., predation, predation, lack of selenium. All of these things have a far more profound effect on these animals. I mean, if it was domestic sheep that were causing all the problem, there should have been the biggest recovery in the history of the world in wild sheep, because we have absolutely removed them all from the United States.

Mr. Don Bowman: My name is Don Bowman, and I'm a Nevada rancher, and I just have a question. It seems like some of the people think selenium deficiency and some of those things really contribute to the disease. How much trouble is it to put out some selenium blocks?

Mr. Lewis: We're not doing that, sorry, Larry.

Mr. Larry Johnson: Larry Johnson, Nevada Bighorns again. Yeah, we're doing so. We airlift selenium blocks into and identify with area biologists commonly used saddles, places that concentrate wild sheep. We airlift selenium blocks in and there's an ongoing program to do so.

Mr. Louie Test: My name's Louie Test, and I've been involved in this project for some period of time, and from the information that I've gleaned from this roundtable discussion is this definitely isn't perfect science. I mean, we can talk about best science, legal science, and so forth, but everything I've heard is that this is not the best science and it's not a perfect science. There's possibilities and there's potentials. We know that Freddy is going to get up in a minute and explain that we know one cause is the climatic situations that have been affecting these bighorn sheep, and there's been a number of die-offs even on the Sierra bighorn sheep because of the climatic situations. But, you know, the whole reason I think we're here, at least I know the reason that Freddy's here and I think a lot of the other producers is, we don't want to turn this into a them and us type situation. We want to turn this into a we situation so that we can work together and come up with some solutions to this because we don't have the best science or, I don't want to use that word because it's a legal word, we don't have a perfect science, okay, in regards to this. One of the things that you guys mentioned up here was perceptions. I would hope that the people in this group go back to their constituents and say hey, every die-off is not caused because domestic sheep come in contact with bighorn sheep, and I'm tired of reading that in the newspapers and articles. That's the first line that always comes out. By perceptions that people get there, it's going to make it a lot harder for us to become we, rather than them or us, when misperceptions are taken out because people have biases. So if anything comes out of this meeting, let's try and drop our biases, look at what is best for everybody, and get a management plan that we can all live with. There's enough room in this country for bighorn sheep and allotments, too, and we can find a way to do it if we work together, put aside our biases, and come up with plans that are going to take care of everybody's needs. That's what has made this country great is compromise. And they may have to give up some of the areas in regards to the interaction between the bighorn sheep and the domestic sheep, and we may have to give up some of our areas in regard to how we manage our sheep, maybe go in earlier, do things along these lines. But what I hope comes out of this meeting, and I would ask this of everybody at this table is drop your biases. Open your minds and come up with a plan so it could be we, rather than them and us.

Mr. Lewis: Further comment.

Dr. Glimp: It's amazing. We're ahead of schedule here. I want to make one comment. Just what Louie said and what Larry said awhile ago. Wyoming state government, sheep producers, wildlife biologists, veterinarians, spent two years putting together a teamwork plan. Now I've got

20 copies of the summary of that plan, so I'd have to beg you to let me distribute it to a few people who could get it to other people. And what I've got is a 17-page summary. The whole plan is 640 pages long, and ranchers and wildlife biologists and veterinarians came up with this plan, and it's a buy-in. And maybe one of the things we need to be thinking about the rest of this day and discussing it at the end is can we get together, like we've been asked to, and do this in Nevada and California together, or Nevada do it, and California do it. I don't know what the answer to that is. Sorry, I'm hogging the mike here, and I've got another public comment.

Ms. Judy Mendagia: My name is Judy Mendagia. I'm married to a Basque sheepherder that spent 45 years out in the desert and the forest with his sheep and in his case, he didn't go home to town, he was out there day and night, all day long, every day. And the biggest concern we had as commercial producers, it was evident, that it was the predator loss that took our numbers down. And I understand that some of the questions have been brought up about predators, but nobody's really gone into detail about exactly what are you doing to mitigate the loss for the bighorn. In the 1970s there was a study done on Mount Rose. My husband was involved in his capacity as a producer with the government agencies, determining the impact on the deer population there by predators. The study went on for a number of years, and the conclusions were that over 80% of the fawns were taken by predators. As time went on, and I became involved, I had asked the government agencies if we could get a copy of that study, and I'm not sure, but I think some of the people here might have been at that table when I asked, and they kind of looked at each other and said, well, what happened to that study? Well, I don't know, where did it get filed? I don't know. They never did come up with the study, so my concern is are you really studying the impact of the predators on the bighorn sheep problem. Because living there for 45 years with his animals, every year he saw a deep loss to predators. And so I have the concern that this is an issue which is not politically correct to address, because any time the public hears you're trying to control predators, I know they come down hard on you, but I would appreciate a little more information on what you're doing to control the predators. Thank you.

Mr. Lewis: Further comment. Seeing none, I think it's time for lunch.

Dr. Glimp: We're getting out early. How about if we start 15 minutes earlier than what we say on there? At 1:15 instead of 1:30.

Mr. Lewis: We will reconvene at 1:15. There are some food options. There's the Liberty Bell right over here. There's a snack bar somewhere in this facility, back to the east, I guess, and we'll reconvene at 1:15 and talk about genetic diversity. Thank you all very much.

Mr. Lewis: Okay, I'd like to welcome you all back. For those of you that may be just getting here, please sign in at the registration table back there, for it's that information that's going to allow you to receive a letter indicating where you can find the web sites you can access in order to get a transcription of today's proceedings. So be sure you register and register legibly. Okay.

Meeting Transcription
Sierra Nevada Bighorn Sheep Roundtable Discussion
Febuary 25, 2005

This afternoon, the topic is genetic diversity. You all have a good idea we're going to run this portion of the program the same way as we did this morning's, but we asked these researchers to address these four questions in regard to genetic diversity. First off, what genetic information indicates that Sierra Nevada Bighorn Sheep are a genetically unique species? Secondly, has the genetic difference of Sierra Nevada Bighorn from other bighorn been adequately documented to justify its listing as a distinct population segment? Thirdly, is there sufficient genetic diversity to sustain this population segment? And lastly, how can the scientists work together to share data, genetic samples and other information? We've got four researchers to give presentations today. Our first is Vern Bleich, and Vern has asked if he can yield some of his time to John Wehausen, and that would be fine. So let's start off with Vern Bleich.

Dr. Vern Bleich: Good afternoon. Liberty Bell was a great suggestion. Thank you. I would like to first of all, emphasize the fact that I'm not a population geneticist. The best course I ever took in college was population genetics. It was a real eye-opener, but I am not a geneticist. I want to take my time to discuss a little bit about the taxonomy, the taxonomic history of Sierra Nevada bighorn sheep, and how we got to where we are with some of the information that will be presented to you a little bit later, and in particular, touch on item four, how can the scientists work together? Sierra sheep were classified as a unique taxa in 1912 by Joseph Cornell. He classified them as Ovis Serena sierraeii. In 1940, Ian McTaggart Cowan revised the taxonomy of north American wild sheep, and he synonymized Ovis serena sierraeii, that is the Sierra sheep, with Ovis Canadensis californiena, sheep in the northwestern part of the continental United States and western Canada. In 1970, the California Fish and Game Commission classified Ovis Canadensis californiena in the Sierra Nevada as being a rare species, later changed to threatened. In 1994, Rob Ramey presented evidence that Sierra Nevada bighorn sheep were genetically unique, but in fact were more closely allied with sheep from the desert areas to the south and east of the Sierra Nevada than to mountain sheep dwelling in the north, currently classified as Ovis Canadensis californiena. In 2000, John Wehausen and Rob Ramey revised the taxonomy of north American wild sheep based on some very recent morphometric work that they had completed. And they essentially synonymized Ovis Canadensis californiena in areas outside of California with Rocky Mountain bighorn sheep, but retained that classification for mountain sheep in the Sierra Nevada. That is, as of 2000, they were still considered to be Ovis Canadensis californiena, but were the only group representing that taxa. Subsequently, the name of Sierra Nevada bighorn sheep has been changed or will be changed in a forthcoming paper that is in press, to Ovis Canadensis sierraeii, consistent with the rules of zoological nomenclature. They are a distinct taxa. When Sierra Nevada bighorn sheep were listed as endangered as a distinct population segment, the Department of Fish and Game was asked to take a lead role in the recovery program. Substantial funding for that purpose became available. The department immediately recognized the need or the importance of genetic diversity to the question of the future viability of these animals. There were very few of them and genetic issues were of a paramount concern. Simultaneously, we recognized the desirability of further understanding the phylogenetic significance of these sheep to the overall question of bighorn sheep in north America. As a result

of these concerns, we initiated a contract with the University of California and research on the genetics of these animals has been ongoing since 1999. One major result of that effort has been the development of methodologies of obtaining DNA that has substantially enhanced sample sizes. No longer are we dependent on blood or tissue for obtaining DNA. As per item four, how can we work together? Dr. Rink had contacted me sometime this spring perhaps, six to twelve months ago, requesting an opportunity to work with us, or actually requesting some samples of Sierra sheep DNA, and at the time, and in fact currently, I was not able to just dish out this material. We have a contractual arrangement through the University of California, and I think that there were breach of contract issues, and I explained this to you, that it complicated that request. It also, in my mind, could have involved breaches of professional ethics. It doesn't mean that we don't want other people to be using this material, it simply means that right now, other people have the right to pursue their work with respect to the samples that are available. And I would point out that work on this topic has been truly collaborative, because it is involving researchers from two separate campuses of the University of California as well as the Denver Museum of Natural History, so we're not trying to keep other people from having it, it's just that we initiated this work six years ago and it's ongoing. So, Fred, we did provide that sample through Cecilia Panedo or to Cecilia Panedo at the University of California at Davis and Dr. Rink has confirmed, and in fact, will present some of the work that she did with that sample. Thank you.

Mr. Lewis: Thank you, Dr. Bleich. Next up, Dr. John Wehausen. Dr. Wehausen is with the Sierra Nevada Recovery Plan Team in Bishop, California.

Dr. John Wehausen: My actual affiliation is the University of California. I'm a research scientist at the University of California at San Diego. I'd like to first acknowledge a couple of very important collaborators in this work. In the front there is Dr. Rob Ramey, with whom I've worked for many years closely and has been very much involved in morphometrics and the genetics work I'm going to talk about and behind him is Clint Epps, a graduate student at Berkeley who came in to start working with us probably about 2001, and has generated a large amount of excellent genetics data to put into this question. Vern mentioned Cowen's work. I want to emphasize here, we're not talking about species as a unique species, we're talking about subspecies, and this is the subspecies classification that Cowen proposed in 1940. Here is the California bighorn that Vern mentioned, considered to be distinct from the Rocky Mountain sheep and distinct from the desert form here, the Nelson bighorn. When Rob and I started to address the question of taxonomy, we recognized that there were three critical elements we needed to bring into this in order to have a sound scientific basis for what we were doing. The first of which was that we needed a subspecies definition to work from. The problem with a lot of the past taxonomy is there was no definition. People could call it anything they wanted of subspecies. Second, we needed well-defined falsifiable hypotheses to test and we needed discriminating test criteria from those to separate things as to subspecies or not. Relative to the question of definition, fortunately, that was provided to us by some literature that was recent at

the time. We did that, and I'll read it to you: Some species represent major subdivisions of the gene pool diversity within species; where such subdivisions mean phylogenetic distinguishability that could be supported by concordant patterns of multiple genetically based traits. I want to emphasize that we're talking about major subdivisions in the gene pool diversity. I want to emphasize the concept of distinguishability as a criterion and that we're looking at concordant patterns of genetically based traits, not just one, but more than one. Relative to hypotheses, Cowen, fortunately, provided us our hypothesis. The hypotheses were the proposed subspecies definitions he had, and more specifically, subspecies should be distinguishable from each other if they are valid subspecies, and conversely, within the subspecies we should not be able to find separate groups that are distinguishable if they are valid subspecies. And relative to tests, we've worked on creating morphometrics work and genetic analyses. The important thing in the morphometrics work is that we needed to look at shape differences versus size. Size is potentially ecophenotypic differences, but if we wanted genetic basis, we needed shape to the extent possible. That's a multivariant question. And we used a multivariant analysis known as linear discriminate analysis which specifically is designed to separate groups and to classify specimens into groups by the equations. And we chose a very stringent criterion within discriminate analysis that more than at least 90% of the specimens would be correctly classified at jackknife posterior probabilities of at least .95. And I emphasize the importance of jackknife, because that removes the bias inherent in discriminate analysis. Otherwise, again, that's a very stringent criterion, but we wanted a strong filter here, in order to have balanced subspecies, and I want to also emphasize that we removed age effects from our sample sizes by actually looking at the influence of age on variables and only using the specimens that were in the older age classes, where there was no longer an age effect. In genetic analyses, the mitochondrial DNA, we actually borrowed a criterion from the concept of evolutionary significant units that Morritz had proposed about ten years ago, and that was the concept of reciprocal monofiling, and that means that there's no shared variation across some division that you're talking about, and that has been debated since then as being too stringent, and Morritz himself has backed off on that, and that's why I put near would be the criterion, but I would say that at least 90% or something like that. So to go back to Cowen and that quickly, in terms of our tests, that means we should find distinguishability between sheep in this northern part of the California bighorn and Rocky Mountain sheep. I need to note that there are no surviving populations between British Columbia and the southern Sierra Nevada. And likewise we should not be able to distinguish those sheep from the north there from the sheep in the southern Sierra Nevada. We should be able to separate Sierra sheep from desert sheep to the east, and we should be able to separate desert sheep from Rocky Mountain sheep. So, as in Rob's dissertation work, the first thing he did is he got hold of all the measurements from Cowen that he used in his 1940 paper, and he subjected them to a modern statistical analysis, and what he found was that the only thing that Cowen's own data could support statistically was a separation between Rocky Mountain sheep and desert sheep, and then he developed some data on mitochrondial DNA variation using RLP data, which we saw earlier as a concept. It's basically a partial sampling of the sequence within the group he's looking at, and what he found is a clear separation between desert sheep and Rocky Mountain

sheep, but what he found was that the so-called California bighorn and British Columbia were not separable from Rocky Mountain sheep, but were very separable from those in the Sierra Nevada, which is right here. Those in the Sierra Nevada were actually separable from the desert in the reciprocal monofiling, although they seemed to be related to desert sheep. So, we followed that up with morphometric work, we measured some 1,200 skulls in North America at this point in time. This work is not actually finished yet. We've been working on it for more than ten years. And we found basically the same patterns. The sheep in British Columbia and Washington were not distinguishable from those in the Rocky Mountains. Those from British Columbia and Washington were quite separable from those in the Sierra. They were so separable that it took only two variables to separate them, cranial height and cranial length, with a bivariant plot, separates these two from each other. This is a classic example of shape variations opposed to size variations in just plotting two variables like this. It's equivalent to taking a ratio of the two. Sierra sheep were clearly distinguishable from those in the desert to the east, and Rocky Mountain sheep were very clearly distinguishable from those in the desert. So, and I don't have time to talk about all the other work we've done on other subspecies, but to make a long story short, what's come out of this work is a greatly changed map of subspecies in North America of bighorn sheep. We have a fairly large Rocky Mountain subspecies, we have a desert subspecies that goes all the way up into Oregon. This Rocky Mountain one actually includes Washington, that was once the California bighorn, and strangely, we have this little subspecies here in the southern Sierra. This stand out, has always stood out like a sore thumb to us. We never could think of a good reason why that should be there, and we were actually surprised to see it hold up to our tests. So, I made one more run at it recently, and actually last fall I sequenced, developed 85 complete sequences of that mitochrondrial control region that Rob had looked at with RLP data, and rather evenly distributed among five populations in the eastern Sierra – one in the Sierra Nevada, the Inyo Mountains, Hunter Mountain, Last Chance range and the White Mountains to the east of the Sierra Nevada. And the haplotypes you're going to see, these are designated as ES. And, in addition, Clint Epps has developed 394 sequences of the same region across the Mojave Desert and 25 mountain ranges, and those will be designated MD haplotypes. Just to show you where we're talking about, Clint Epps' work covered this region across here, like this, up through there, up to Clark Mountain there, and across and all the way down to the San Gabriels and like that, so that was the region all the samples came from. Here is the Sierra Nevada populations, right there, immediately to their east are the Inyo Mountains. Here is Hunter Mountain right there. Here is the Last Chance range right there, and finally, here are the White Mountains right up there that I've sampled. What we found across that entire region is 32 different haplotypes. I was able to reduce that to 15 haplotypes by removing the haplotypes that were very closely related to each other. They were one, two or three bases different, but what stood out among those haplotypes was that there were three that were very notably different from all the rest, very notably different. One from the Sierra, which incorporated every sample in the Sierra, one from the Inyo Mountains, and one from Hunter Mountain. And not only were they very different from all the desert, I put in one Rocky Mountain sequence to be an outgroup in this, and they ended up being at least as different from the Rocky Mountain one as they were

from the desert ones. So this is a tree that comes out of this analysis. You have desert sheep here, you have this Rocky Mountain one, and surprisingly, this group that included the Sierra ended up coming out looking more different from desert sheep than Rocky Mountain sheep did. I'd like to point out that Sierra sheep exhibited reciprocal monofiling. There was no shared variation across the Owens Valley. These others are mixed. We have a couple other Hunter mountain habilotypes of the desert type, and we have another Inyo mountain one up here somewhere, too, right there. So, what we seem to be looking at here are the remnants, the remains of a very old image of sheep that has persisted here and down in the southern Sierra, and perhaps the reason that the Sierra sheep remain morphometrically distinct is because gene flow has not gotten to the Sierra as much as it might have gotten to these other places to have them pretty much mix with the other sheep. What this history is we don't know. I want to point out also that there's very strong bootstrap support for this group. It varies from 95 to 98% depending on how you run the analyses. In fact, you can run many different types of analysis, develop various types of trees, I've run a lot of them, and no matter what you do, this group always comes out as a distinct group, even though for instance, Rocky Mountain sheep may not be distinguishable from desert sheep sometimes and even dull sheep not from desert sheep sometimes, I'll show you those in a minute. This group always comes out as a distinct group. Here's another tree developed out of those same data. Things get rearranged a little bit in the desert, but otherwise it stays the same. I threw in a snow sheep from Siberia, which is the closest Old World relative to North American sheep and a dull sheep sequence to see what would happen, and under this analysis, you can see Sierra fit in still again between them and the Rocky Mountains. On a different analysis, we find dull sheep running in with Rocky Mountain sheep. How about nuclear DNA? We've developed a huge amount of data on microsatellites. Between us, we've developed data on over 700 individuals, including 250 in the Sierra alone. And what you can do with those data is do a bottleneck test, and see what the if the evidence of these sheep being (incomprehensible). There's no question that Sierra sheep are going to show a clear signal bottlenecking. That's what these low probabilities mean here, compared to these right up here for east of the Sierra. That's not at all surprising, given their population histories, and we can look at genetic diversity, and what you would expect indeed is genetic diversity would be lowered in the Sierra, and you see that here there at the low end of the whole spectrum. I've not had a chance to put Clint Epps' data into this. This is a different study that I put some comparative data in with. But the whole question of genetic diversity, I want to point out. Could I have the last slide? A quick summary here. Well, actually, we'll discuss genetic diversity later.

Mr. Lewis: Okay, next up is Anette Rink. Dr. Rink is Animal Disease and Food Safety Laboratory, Nevada Department of Agriculture. Dr. Rink.

Dr. Anette Rink: With regard to the first question, what genetic information indicates that Sierra Nevada Bighorn Sheep are a genetically unique species or population segment? When I read the recovery plan, my impression was that mostly mitochondrial DNA studies were used to classify it at such, particularly two papers published by Drs. Ramey and Wehausen in '93 and '95. What I

would like to point out with regard to using mitochondrial DNA as a target to evaluate genetic related genetic distances is that mitochondrial DNA is only maternally inherited. It also mutates much faster than nuclear DNA, creating mitochondrial DNA (incomprehensible) which are dissociated from the nuclear genome. The term for that is cytonuclear genomic dissociation. What that means is that there is not a single haplotype off the mitochondrial DNA that is associated with any phenotypic trait in any livestock or wildlife species. There are only mitochondrial related diseases described in human so far. The nuclear genome alone is responsible for the phenotype, and the marker of choice for population studies right now are microsatellite markers because they have a low mutation, there is no selection pressure on them unless they are linked to a trait, and they're highly polymorphic, so that is the one way where you get a maximum amount of information with a relatively small amount of input of money and resources. Based on population dynamics and structure in bighorn sheep populations, rams have a much higher influence on a breeding unit or herd, or a population, and if you do mitochondrial DNA studies, they are not taken into consideration at all. It really pains me to tell you this, but, ladies, the bigger picture in population genetics, we don't play a role. And evolutionary anthropologists and ecologists have abandoned this concept. There are different schools of thought, but several have abandoned this concept because it can create this artificial result, of separate populations, and we can discuss that in detail. Second question, does it justify listing as a distinct population segment, and I really want to tell you that I'm very grateful that you shared this one sample with me, and this analysis is based on 100 bighorn sheep that were harvested in the state of Nevada, plus one bighorn sheep from the Sierra Nevada bighorn sheep population, so this analysis should be taken with a lot of caution. It is preliminary, at best. But what I found by using microsatellite markers which in this case are selection neutral. There is one in there that is not. These microsatellite markers are used in studies of wild ungulates worldwide, and they've been around a long time. They were developed using sheep, goat, and cattle DNA, and then they're tested for transferability to a new species. So this is a very, very robust technique. And my personal impression is that microsatellite genotyping should have been performed prior to actually getting the listing done, since only the nuclear genome tells the whole story, and Dr. Boyce has published a very good paper in 1994, where he looked at 14 different populations of desert bighorn sheep in the western United States using several microsatellites and MHC related markers. Additional electronic sequences can help reconstruct population history, and if you want to look at the biparentally inherited markers, you can use some in the X chromosome. If you only want to look at the paternally inherited segment, you would use electronic sequences from the Y chromosome. Additionally, in the population, where, in this particular population, where it seems that disease is a major factor that controls the population and controls genetic shift, it would be very important to actually look at MHC haplotypes, since the MHC is the major histocompatibility complex actually enables the animal to form a (incomprehensible) immune response. And this is, well, it's moved a little bit, but this is basically where in my analysis at this point the Sierra Nevada bighorn sheep ran false in groups closely to some other desert bighorn sheep from the state of Nevada. I used UPGMA for this particular tree, but I've also used (incomprehensible) minimum evolution and the 100 samples that I have in total to

compare against, if I use those the tree changes somewhat. And there's a poster in the back for those who can't read the small print, but it basically shows the analysis including 101 sheep. One of the major things that you look at in these markers, the first thing is does it contain any private alleles? That is, a private allele is an allele that is significant or is distinct in one population. I did not find one that was distinct to that particular ram. Then the next thing is you look at the combination of the alleles at a locus if you have a unique allele combination. This particular ram did not have one. And, as I said, if you use the 22 markers, the overall data said it clusters with 14 or 15 depending on which kind of algorithm you use. This is a list of the markers that were used and then the possible alleles that were observed, the alleles that were observed, alleles that are possible, and then the size range of the alleles that were found in this population of 101. It shows what particular genotype this particular ram, this Sierra Nevada bighorn ram had. Allele A is one copy, which could be either maternal or paternal. Allele B is the other copy which is also maternal or paternal – I don't know that. And then I have a list of the rarest allele that I found in this population of 101, and all these markers have some rare alleles circulating in the population in Nevada. What you can see here is 22 microsatellites have been used for typing, 21 of them have two genomic copies, only one of them is X-linked, so since it is a male animal, there is only one of those. So if you look at the heterozygosity at any particular locus, the ram is homozygous at 62% of its loci and heterozygous at 38% of its loci. Whether that is sufficient genetic diversity to support – there is an indication that this animal is a little bit inbred, whether that is going to be significant, I can't tell you. I have never been able to find a specific threshold level anywhere that describes at what point of loss of heterozygosity a population becomes vulnerable, because that is really dependent on the environment they live in. If they are mollycoddled along, you probably can inbreed them to the nth degree. If they have a variety of challenges to deal with, they need a lot of heterozygosity in a population to be able to survive. And I think that's my last slide. Oh, no. Last question – how can scientists work together? Dr. Boyce has started the, and I don't know if that's the exact term, but it's North American Wild Sheep DNA Repository, that's what I've been, that's how people have referred to it, and we're more than happy to contribute to that repository from all the 100 kill samples that we get here in the state of Nevada. I would strongly suggest that we all use the same data or the same markers when we genotype our populations, because only that makes them directly comparable. I would also strongly support the exchange of genotypic data to obtain larger data sets and identify the best source of populations for relocation and increase of heterozygosity in those populations where a loss of heterozygosity has been identified and could potentially lead to a problem. The other thing I think we're falling short in is we don't really have good physiological standards for any of the reference values for bighorn sheep. We always used domestic sheep for reference, and I don't know how well that is going to work. So, whenever we do diagnostic workups or even population studies, just a screen in serology, I think we should share this data and compile it in some way. And I understand that California has been collecting information on disease outbreaks since '79, so we're not there yet, and I'd be interested to know if you'd be willing to share what exactly and in what format you actually collect this data, so that, you know, if there's a common standard, if you've already nuked all the problems in your data collection approach, we don't

have to reinvent the wheel so we'd be more than happy to see if we could maybe collect our data by the same method. Thank you.

Mr. Lewis: Thank you, Dr. Rink. Next up is Dr. Walter Boyce, University of California at Davis.

Dr. Boyce: Hope all of you are enjoying this genetics primer. A couple of caveats – Dr. Bleich mentioned that genetic studies are ongoing on Sierra Nevada sheep at the University of California. I'm from the University of California, but I'm not doing those studies. He's primarily referring to the ones that John Wehausen and perhaps the other one was Clint Epps from Berkeley. And with regard to the DNA repository, I got interested in bighorn sheep DNA and bighorn sheep genetics in the early 1990s, and began to try to collect samples whenever possible. So working with wildlife biologists across western North America, we set up a system whereby if they would send us a blood sample, or in some cases, a tissue sample, but it's typically been a blood sample, we would extract DNA and bank that DNA so that it would be available for subsequent analysis. At this point we have about 1,500 samples in that DNA bank. They are Rocky Mountain bighorn sheep, California bighorn sheep, and a lot of desert sheep. I do not have any of the Sierra Nevada sheep samples. So, a few comments, again, these are fairly simple. I say that, I guess that's up to you to decide. So, let's speak about bighorn sheep. They exist in populations, or groups of populations called metapopulations. What can we use genetics for? Well, genetics can basically give us useful information about the recent and in some cases, the past history of those populations relative to each other. It's telling us something about animal movements, and the movements of the genes within those animals, so the more isolated populations are, the less genetically similar they should be. So it's really, genetics is a way to get this view of how these populations relate to each other. To take that a step farther, we attach labels to named species and subspecies, and, from my perspective, subspecies labels are relatively subjective and arbitrary. You'll find that they shift over time. Different people come up with different opinions and new data becomes available. We heard John talk about it today. We get better tools that allow us to either take what used to be several subspecies and lump them together, or we split them apart – the term that you sometimes hear in biology is you're either a lumper or a splitter, you like to put everything together or you like to tear it apart. And in a certain sense, those labels are artificial, and I think they're also artificial from a conservation perspective in terms of what we need to be thinking about with Sierra Nevada bighorn sheep. When you have small populations that are at risk of extinction, it really doesn't matter what subspecies they are. What matters is this unit that we've identified for management purposes or for conservation purposes. So far, I think it's still unclear just how different Sierra Nevada bighorn sheep are from other nearby bighorn sheep populations. Regardless, the Sierra sheep population is small and isolated, and it's at higher risk for extinction than larger, less isolated populations. What you've heard a little bit of, and these arguments can go on for months and years, you know, about who's right, who's wrong, what marker tells us what – the fullest answer, or the best view of what's going on is to use multiple different genetic systems and combine those with other types of evidence, morphologic evidence, like John was talking about, horn

measurements or body measurements. When you look at this entire body of information and you can see that there is agreement between different markers – mitochondrial DNA agrees with microsatellites agrees with morphologic data – then you can begin to have a high degree of confidence that you actually have a clearer picture of what's going on, and that you can attach the correct label to whatever it is you're talking about. Going into something that we haven't talked too much about yet, I don't believe that our current genetic diversity measures are very useful for predicting resistance or susceptibility to respiratory disease in bighorn sheep. In other words, the tools that we have out there right now we can't use them. The tools for telling us about the genetic background of these animals, they are not very useful at present for predicting who is going to be resistant or susceptible. And just to give you an example, you've heard heterozygosity, which basically means that at every genetic loci, we have two copies of a gene, and if they're the same, you're homozygous and if they're different, then that individual is heterozygous, so heterozygosity is a measurement of genetic diversity. The Santa Rose bighorn population here in northern Nevada, when we examined it relative to several other desert populations, and indeed, some putative California populations up in Oregon, was very diverse when we used that measure of heterozygosity. But what happened in the Santa Rosa population in 2004? You had a significant disease die-off. We can't use just simply heterozygosity to tell us who's going to live and who's going to die. It's helpful for us to begin to unravel some of this, but we can't go out right now and use that as a tool and say well, this sheep out of this population is a survivor, let's move this one and leave the others behind. And that goes to my last point. I think that genetic management of bighorn sheep for resistance to disease is currently a concept, rather than a tool. Genetic management doesn't offer us a quick fix right now to disease issues between domestic sheep and bighorn sheep. Thanks.

Mr. Lewis: Thank you, Dr. Boyce. That concludes the panel presentations, and now it's time for the roundtable discussion. And as we went through this morning, we'll do it the same way. We'll give you five minutes and we'll go around the table, and you may either comment, pose questions or pass, whatever is your pleasure. So, Dr. Bleich, would you like to start, please?

Dr. Bleich: As was the case this morning, I'll pass.

Dr. Thain: David Thain, with the Nevada Department of Ag. It's been an interesting discussion here about what is unique. We described as a subspecies a species or now a new term, as a native population, and I guess one of the questions I have for my colleague at the Fish and Wildlife Service, since they're the ones who are saddled with the issue of the endangered species, is what exactly becomes a unique qualified endangered species under the Endangered Species Act? Just for some clarification on my part as to when qualifies. The next question I have is for my colleagues with the California Game and Fish is when will this genetic data become available so that we have a better idea that we could link it with our data in Nevada to see if we are truly looking at a unique subspecies or if this one sample would suggest, with this limited analysis, say that it sure doesn't look like a subspecies to me. And then, finally, you know, as a state livestock

health official, I get involved in politics quite often. There becomes the political question, and I just pose it to the group here and to the audience, if the Sierra bighorns are not a unique species, how does that affect the funding for recovery of this unique species as it now stands. And then the final answer is, you know, unfortunately, a lot of this has gone on for years and years and it's compromised grazing allotments for a number of individuals, and it's currently impacting one family's ability to have a good business, and probably this will all get sorted out in the wash, but how many years is it going to take to sort out, and that's more of a philosophical question than anything else.

(New tape begins, maybe something missing)

Speaker: ... out there.

Dr. Rink: I did not imply that MHC alleles are useful for population management. What I'm trying to say here, and I basically all my career, for whatever that's worth, I've looked at the immune system, the immune response, how it's mounted, how it's based in the host, and how it influences the pathogen and maybe the genome of the pathogen. And all I can say, you know, in all the papers that I've read, there is a distinct line of thought in there. If you lose heterozygosity at the MHC level, a population becomes incredibly susceptible to disease. There are a couple of association studies, I will gladly admit that, but MHC loss of heterozygosity often goes along with a loss of heterozygosity genome-wide. And there's more to the genome, there are so many pieces of the genome that actually facilitate immune response, and if you lose heterozygosity overall, you basically compromise the population or the species. They won't be able to survive in the long term. But as I said, I don't know at what level of heterzygosity there is a true danger involved, and I don't know – have no studies been done what (incomprehensible) alleals confer resistance to Pasturella. It's not quite that easy. I do understand that. But what I do find important to remember is that microsatellites, and they are very widely used markers, I mean, every paternity test is based on microsatellite markers. They have a great ability to differentiate individuals and populations. They show difference and commonalities, and unlike mitochondrial DNA, they are responsible for the phenotype, and for the layperson, what you want to preserve is the phenotype of a specific sheep. It has absolutely zero correlation with any haplotype of any mitochondrial sequence. And that has been used – mitochondrial sequences are very accessible – it's a small genome, it's only 16,000 based pairs, if you have to look at 16,000 based pairs – where if you're looking at 3 billion, which is the nuclear genome, obviously it's a lot more accessible. But depending on what species you look at, it mutates roughly 16 times faster than the nuclear genome. And if you look within the mitochondrial genome, if you look at the control region, which is the preferred region for mitochondrial study, that in itself mutates six times faster than several other genes that are coded in the mitochondrial genome. So obviously, if you do look for differences, that's where you find them. There's absolutely no surprise. But does it actually mean anything? There are so many studies out there that describe how mitochondrial DNA differences and this probably pretty artificial claim that was identified, how that was used

to manage populations, and one very good example for that is the Benobo (incomprehensible) in Central Africa, where the people have identified three different (incomprehensible), population structure and behavior is similar to bighorn sheep, females are true to location, males migrate. Eventually, due to loss of habitat, they were put so close together that it took a lot of effort to actually keep those populations separate from each other, then somebody did a nuclear genomic DNA study and they found that there was absolutely no difference, because males, for generations, had spread their genes all the way around, and this is a very, very often observed situation. It's been observed for forest and savannah elephants, it's been observed in whales and sable antelopes. You look at the literature, there are hundreds of examples that were published where nuclear DNA and mitochondrial DNA study did not confirm each other, they contradicted each other. And the reason for that is the so-called cytonuclear dissociation. And I really don't think that in this particular context, that can be ignored.

Dr. Craig Beattie: Hi, this is Craig Beattie. I just had a couple of questions, probably based on total ignorance, but, you know, I'm kind of a heterozygote myself, coming from a Scots Hungarian background. You can't get much more heterozygous that that combination, any that I know of. You know, it's a funny thing, we heard that highly heterozygous populations like humans still get sick. They sure do. They can get hurt real bad, and I know that if I had a mountain lion chasing me, I think my level of heterozygosity would make very little difference to the mountain lion, probably not to my future either since I don't run very fast. The other thing that I was curious about is if you simply have a small population and it happens to be on a number of occasions been shown to be different phenotypically from similar-looking animals, we should take care of it. Well, fair enough. But if that population is shown to be similar genetically, not different than most of what else is out there, then what is the value of not simply putting it someplace else out there with its brother? And the third point is the traveling male. And while I can appreciate Dr. Rink's comments as to the loss of female influence in that particular situation, cheer up, in a million years, there won't be a Y chromosome, so there you have it.

Mr. Carl Benz: Carl Benz of the Fish and Wildlife Service. I'll pass at this time and wait for discussion to address the question I will put forward.

Dr. John Wehausen: I guess I'd have to take issue with some of the things Anette said just now. She noted that microsatellites are very good at distinguishing individuals and populations. They're good for paternity and paternity analysis and so on, but in fact, there are no criteria for using them for phylogenetic questions relative to taxonomy. And that's the problem, they don't seem to have any sort of an historical signal of any sort in them, and they actually have very high mutation rates, and that's why they're used the way they are, they're called hypervariable because they have so much variation in them. And contrary to that, people have used mitochondrial DNA for a very long time for these phylogenetic questions relative to taxonomy. I'd like to finish just a little of what I was saying up there about genetic diversity. The Sierra sheep fall on the low end of genetic diversity. What's been measured in the southwest, it doesn't

mean that it's a problem at this point time, and as noted, we don't know what those criteria are, whether it's going to be a problem. Large mammals in general show indications that low genetic diversity doesn't seem to be much of a problem (incomprehensible) is a good example in California, elephant seals, and so on. Animals with very low genetic diversities have shown very good recoveries in their populations, and I would say in the Sierra we've seen sort of maximal population increases at this point in time, which suggests, at least from a demographic standpoint in that regard, we have no limitations there. I'd point out that a population in the Mojave Desert, which actually was very close in genetic diversity to our Mount Baxter population in the Sierra, has been one of our most productive populations in the desert California, a source of over 200 sheep move translocations. So again, genetic diversity, there's no indication that genetic diversity is a problem at this point with these animals. I want to emphasize also that what I presented a short while ago is a work in progress. We are just in the process of merging data sets. I'm about to develop another 48 sequences relative to that question and someone, we'll probably expand our sampling as a result of those most recent results. And I guess I would just emphasize what Walter mentioned, I wanted to point out that we have found concordance consistently between the morphometric data and the mitochondrial DNA data. We've seen that all across North America, and so we actually have concordant data sets that suggest some uniqueness there. I think in terms of nuclear DNA, we need to look at something other than microsatellites. We need to sequence a good nuclear marker that will have some kind of a deep historical signal. And I think I'll pass this on.

Mr. Cox: Mike Cox. From a management standpoint, I don't think we really care what subspecies names are given to the animal. We've always seen that the more populations you have as part of a large metapopulation, the more sustainability those populations together will be. So, they're all important to me, they're all important to my agency, and our constituents, and so, regardless of what you want to call the critter, we want to give every opportunity to maintain and sustain those separate populations. We are certainly interested in, (incomprehensible) of increasing heterozygosity in bighorn sheep populations. As said today, there's still no criteria or guideline or value that states that if it gets to a certain level of heterozygosity, they're going to be superior animals. I'd like to see that, but we are certainly interested in learning more of whether our efforts as a management agency can be done in various ways to increase the sustainability of these populations, and if heterozygosity is one way to do that, then we certainly would be interested.

Speaker: Pass.

Speaker: I pass, too.

Dr. Glimp: I have a question. I don't know which one of you is best qualified to answer it, but what is your best estimate of the total population of this unique or distinct segment or subspecies, or whatever of the Sierra Nevada bighorn? Yeah, what is your estimate of the number?

Speaker: 350.

Dr. Glimp: Well, my only comments regarding that. I have, and I'm not a geneticist, so I consult geneticists quite frequently. I do have a distinct population segment of sheep in the United States, domestic sheep. I've got the largest population of Australian merinos outside of Australia. I've got a thousand head, and the geneticists keep telling me, you'd better keep feeding some new blood into this or you're going to wind up in trouble, even with going with non (incomprehensible) matings, if I brought in no more rams, I'd be in trouble in 50 years, and I got a thousand head.

Speaker: I'll pass.

Speaker: Pass.

Speaker: If I'm frustrating you, I apologize, 'cause I'm frustrating myself. I'm a frustrated individual today. I started off trying, in my academic career, trying to figure out genetic resistance among different breeds of domestic sheep. My training is a Ph.D. in parasitology, and for my Master's degree, I looked at (incomprehensible) and a few other what we'll call tropical breeds of domestic sheep to see if we could identify factors that would allow these animals to be raised in the subtropics and tropical areas, because there are parasites that they succumb to if you try to raise them there. Basically, the (incomprehensible) nematodes and liver flukes. If you try to raise domestic sheep in certain areas, they die. And so we were trying to figure out, and people are still trying to figure out the genetic basis or a genetic tool that would allow you to put these sheep in a place that they hadn't evolved with those parasites over time. And it's a really tough battle. I failed at that, and that's part of my frustration. And here I am. Anette, I wasn't intending to attack you or anything about the MHC. I've looked at MHC quite a bit and have found it unrewarding. It seems like I'm going to change jobs, and find something rewarding to do. But the genetics, I was really hoping that genetics would be a tool for helping us figure out how to solve some of these disease issues where you have bighorn sheep that want to die and domestic sheep that don't. But we just don't seem to have the knowledge yet to be able to do that. We have a theoretical basis for thinking it make sense. You all are absolutely right, inbreeding will cause problems. Enough brother-sister matings, you're in trouble. And that holds true for people and for sheep, etcetera. Our wildlife populations have some other inbreeding avoidance mechanisms that are ecological and social, that tend to minimize that even when the populations are really small. They're really good, actually, at figuring out who they want to mate with. So I don't disagree that heterozygosity is an important component to fitness or resistance, it's just not one that we can reach out and grab right now and use from a management perspective.

Speaker: Pass.

Dr. Rink: I would like to respond to that, if I may. With regard to, yes they are hypervariable markers, their mutation rate in sheep is considered to be ten to the power of minus five. That goes through the germ line and so we're looking at roughly ten to 100,000 generations for a microsatellite to actually show a new mutation. So for paleontological studies, I totally agree, they might not be the best markers because you're looking at millions of years, so there will be new alleles that will ensue in the meantime. But, and I want to get away from what does the DNA tell us about whether the animal is going to get sick or not. I think one of the crucial questions here is if it is a distinct population segment, who founded it? The founder effect is, if you have a distinct founder or a first generation in a population that is separated long enough, so that you actually accumulate mutations in there, you would have to see that. Obviously, there wasn't enough time for microsatellites to mutate within the last thousand years or so. Or, between the settlement history of the western United States and today. But what I'm really trying to say here, and I know that 22 markers are not a lot, but what they represent is the segment of the genome, and the segment of this particular genome indicates that it comes from the same origin as the segment of the sheep next door. So at what point do we decide that this is such a different population segment that it actually is worth conserving as a different population segment. And I also don't have a doubt that some of the haplotypes coincide spatially with certain characteristics, but I want to stress again that the mitochondrial haplotype has nothing to do with the phenotype of an animal unless you actually have a metabolic disease. And in humans, I think, now there are five metabolic diseases that are mitochondrially inherited that are described, but in livestock that has never been shown.

Mr. Lewis: I'd like to extend the offer for anyone that passed, if they'd like to take their five minutes at this time.

Speaker: I would like to comment more about mitochondrial DNA, because in fact, that is exactly what has been used to develop phylogenies on a global scale, for instance. That's what's been used to separate sheep in the world into two lineages, and so on. It has a very good historical signal and that's why it's been used continually. So I don't agree, even though it in itself has nothing to do with phenotype, it doesn't mean it doesn't have a signal that tells us something about divisions phylogenetically at some distant time, and that's why it's so good. We don't have any evidence of that in microsatellites. And that's the problem. People are starting to use microsatellites, but probably mostly because they're convenient, not because there's any evidence that they actually give you a signal for phylogenetic analysis.

Dr. Rink: What has happened in elephant populations is that the mitochondrial genome has become completely dissociated from the nuclear genome, and that is why I am saying that I think that this is something that needs to be looked at in this particular case. In the number of generations that might have elapsed between populations getting cut off due to habitat used by settlers, the mitochondrial DNA definitely had enough time to accumulate a couple of mutations in that time, but the mitochondrial DNA, because it is maternally inherited, can be a standalone

item, and the nuclear DNA can have completely changed, based on the influence of rams that might well, until today, be migrating in from Nevada and might be mating with those ewes. And that is my point, I think that is why it's so important to not only look at the mitochondrial DNA and not only look at the microsatellite DNA, but also maybe look at a couple of the electronic sequences on the X chromosome and a couple of electronic sequences on the Y chromosome, so that we can actually figure out what the picture really is like. Did the nuclear genome evolve along with the mitochondrial genome or is there complete dissociation?

Dr. Wehausen: I actually agree with what you just said. That's exactly what we need to do. I would like to point out one other thing. People tend to minimize the importance of morphometrics, because there's uncertainty of how much is ecophenotypic variation versus genetic variation, but when you look at morphometrics in a really good way, looking at shape differences, we may be looking at the influence of many genes on shape differences. So morphometrics may actually in the long run tell us more than any of these single genes we look at genetically. And that's just – we don't know, that's the trouble.

Dr. Rink: Yeah, I'm personally a skeptic when it comes to morphometric studies, so I guess we differ there.

Mr. Lewis: Other comments?

Dr. Boyce: One of the issues we're talking about here will probably never be resolved by scientists talking because it's ultimately a political question, and so, Carl Benz should not get away without answering the question that was asked of him earlier, about the Endangered Species Act. And one way to look at this is you can have mitochondrial DNA that tells you quite a bit about an animal's more distant past. Microsatellite information can tell you more about their recent movements. So if we're talking about sheep in the Sierra Nevadas, they can be very unique in terms of their mitochondrial DNA, because perhaps no females have mated out of the Sierra Nevada and established that lineage of mitochondrial DNA in surrounding mountain ranges. You could have males move out of the Sierra Nevada and mate with females who have very different mitochondrial DNA in some of those surrounding mountain ranges so that you have gene flow, and your microsatellite data can reveal that gene flow, so then we're stuck with this issue. Okay, Sierra Nevada sheep have a different mitochondrial DNA, but they're actually sharing genes with sheep in other populations. What does that mean in terms of conservation, and what does it mean in terms of this political thing we have, the Endangered Species Act? Well, I think we have a number of managers here, and basically, managers manage populations. They don't manage these kind of amorphous things that aren't real entities out in the field, they manage populations that oftentimes correspond to mountain ranges, but what I think we really need a good answer or some clarification to is maybe from Carl or someone else about what the law tells us in its current form about what this genetic and taxonomic information means?
Mr. Benz: Thank you. I believe the question was what are the standards or the factors that the

service bases to list endangered species? And the service uses the best available information it has, and we use that information to consider it, and then applies a five-factor analysis to that. The five-factor analysis includes these points: We look at the present and the threat of destruction or modification of habitat or its range; we look at overutilization, and that could be overutilization for recreational purposes, scientific purposes, education, things like that; we look at disease; we look at predation. The fourth factor is inadequacy of existing regulatory mechanisms, and then the fifth factor is sort of a collect-all, where we look at other natural or manmade factors that are affecting that species. The service looks at the taxonomic unit for anything from a species or a larger unit, subspecies or with (incomprehensible) populations we can look at distinct population segments. The process that we go through is that we do that analysis internally. We're charged by Congress to do that. We put that out to the public for review and comment. We go to the extent of inviting peer reviewers to comment on that because we're trying to get the best available information in making this decision before we make a determination. And then based on the comments made by the public and peer reviewers, then we make a determination, and decide whether or not that species is at risk or not and if at risk, how close is that risk of extinction. If it's in the foreseeable future, then we will list that as endangered and if it's likely to become endangered in the foreseeable future, then we identify it as threatened. I hope that answers your question.

Mr. Lewis: Let's go to Dr. Glimp and then Dr. Thain.

Dr. Glimp: I wanted to shift gears a little bit.

Mr. Lewis: Well, hold on then. If you want to shift gears, Dr. Thain.

Dr. Thain: If I may get a clarification on that, so I can appreciate that if we have species A and species B, but if we have a population subset of a species, that genetically isn't diverse, but it is a unique population, i.e., the Sierra bighorns, does it truly qualify under the Endangered Species Act for protection?

Mr. Benz: The service has a policy that it pursues in looking at units less than the subspecific level, looking at the state population segments, and that is applied only to vertebrates. And in that policy, we look at factors of discreteness, as well as the significance of that unit to the larger species to which it's attributed, and then we go in and apply whether it needs any conservation measures or the protection of the Act

Mr. Lewis: Along that line, any other further comment? Yes, Dr. Boyce.

Dr. Boyce: Just one. I have no doubt that it can be shown that Sierra Nevada bighorn sheep are genetically unique. I think we could take any population of bighorn sheep and with the advance in genetic tools that we get, at some point we're going to be able to show that they are different

from other populations of sheep, so it becomes this, at what point do you draw the line? And this is going to be more and more of a problem as we develop more genetic tools down the road. At some point, every individual in here is unique, but if we use crude tools we all get lumped together. And that's really where we are with sheep. And that's the problem I have with using genetics to answer or to drive our conservation goals. And so that's what I'd like us to think about – this distinct population segment, for example, where you have a discrete population. In the Sierra Nevada mountains, this range that stands alone, it has a metapopulation of bighorn sheep. It's small in number. There are a number of factors that put it at risk. And yes, we can prove that it's genetically distinct, or at this point we could argue pretty heartily that it might not be genetically distinct enough, but it doesn't change the fact that it's still at risk as a distinct population segment for extinction.

Dr. Rink: If I could make just one short comment. Yeah, it's going to be a little philosophical, but also a practical discussion, how many microsatellites do you actually have to type before you can find differences? Just one number, 11. Eleven is the microsatellite set that every forensic laboratory in the United States and worldwide uses to test for paternity or exclude paternity and to investigate the gene pool and to identify an individual from a crime scene. So 11 microsatellites have the power to actually differentiate between every single individual that is right now on this planet. So 22 microsatellites, I think, give a pretty good idea of how related or how different an individual is from any other individual or from any other population. So that's why I'm saying I think we need to use the same data set, and 22 seems to be a good sample, or a subset thereof, and then let's look at it again, if there's more genetic data available from more individuals.

Speaker: I'm sorry, I've got to say one thing. I agree and I disagree with you there. It's not completely fair to compare human forensics with bighorn sheep because humans are incredibly diverse at these microsatellite loci, and for a bighorn sheep population, we might have six or eight different versions of a given gene. Humans, it can be 20, 30, 40, 50 different versions of a human gene. It's an apples and oranges sort of comparison. The other part of it is having a reference set to compare to. So many different people have been genotyped that you've gotten into these match probabilities, and you can do things more accurately with people than with sheep. The more important part of this is I completely agree with you that we ought to be working together on this. It's really difficult to draw comparisons between different genetic studies if you use different markers or if you don't have access to the samples. This is one of those things where all the data ought to be out on the table for everybody to see and we ought to be using the same methods, so that we're not arguing about methodology, we're actually talking about results.

Dr. Rink: Well, I've spent years of my life cloning more genes than anyone else that I personally know, but I'm still a big fan of microsatellites, and just to give a couple more numbers, yeah, human microsatellites, to actually make it into the forensic panel, you have to have a minimum

of 12 different alleles. The microsatellites that were used for this particular study, on average have eight alleles. So that is a pretty good number, actually, and most of the ungulate studies, and there's always a problem, because you have a species transfer here. These microsatellite markers were developed in cattle, sheep, and goats. So if you transfer a marker across a species, you often lose that. So I went back and looked for these particular markers that come all out of the sheep genome, and actually it's 7.8 alleles on average in the bighorn sheep and it's 8.4 alleles on average in the domestic sheep population, so (incomprehensible) Peneda did a fabulous job at picking markers. There's no ascertainment bias in this marker set. And then another comment is that a lot of other wild ungulates have been microsatellite typed and it's been shown that for microsatellite markers the allealic richness can be less than two and is never more than six alleals on average per individual marker. So I think the bighorn sheep are actually in a pretty good spot when it comes to genetic markers.

Mr. Lewis: Okay, Hudson, are we ready to...?

Dr. Glimp: I've go one very important question that the hosts of this conference requested that we put up there to answer or help answer. And I think the decision makers are sitting at the table. How can scientists work together to share data, genetic samples and other information? Please answer that one if you can. The people at this table are the ones that control that, I think.

Mr. Lewis: Would anybody like to jump in on that one?

Speaker: I will. At forums like this is how it happens. This is the first time several of us have ever met face-to-face, and working together, it's a, people work with people that they know and get to understand, and you have to develop a level of trust, and especially when there's a lot on the table, when there's a lot at stake, and so the way you end up working with people is first, you have to talk to them. It's really hard to work with people when mainly they're talking to you through newspaper headlines, and you have to reply through your own newspaper headline. So I think this is an excellent start. There's a number of us here that have been working together and sharing samples and data for many years. I think the audience is that group that is working together, is in large sum today, so I'm actually optimistic about that happening. I don't think that there is active resistance on the part of any person here to us working together.

Mr. Lewis: Other comments?

Dr. Rink: Yeah, I agree. I guess that's why the invitations were extended, and somebody had to make the first step, and really I think this is what it boiled down to, and I think and I personally hope that this is not going to be the last, but this is going to be the first scientific roundtable discussion between California and Nevada.

Mr. Cox: I was curious – Was Dr. Bill Foreyt invited here today?

Dr. Rink: No. We decided to invite one person who had done a lot on the bacteriology, and we decided to invite Dr. Ward. There's a long list of people that have done a lot of research on infections and Pasturella specifically in wildlife, and we only had a limited amount of money, and so we invited for this session, we invited the people that are here. But for any future sessions, we're open to suggestions who should and could participate in this.

Speaker: I'd like to chime in as well on this, and I think that to just expand that question, how can the scientists get together and work together, I think that at both this morning's session and this afternoon session, I'm really pleased to have seen this group come together and with the limited time we did have, start to make sure this information is getting out there – all perspectives, all different views. And as Walter said, I think the first step is sitting at this table, and hearing what people have to say, trying to understand their perspective, because that's the beginning point of working together, the beginning point of starting to learn to trust one another and see that there are common grounds that we could all work from and there are other things that we are going to have to work to get closer to, and I'm really looking forward to going beyond this meeting, and I think that this meeting here is going to be the place that we can really expand from where we've been.

Dr. Ward: I've appreciated the opportunity to meet with the group today, and to hear the discussions, and at this point in my career, obviously, retired, my interest is to facilitate what can be done by cooperation. And so I mentioned before, and I'll mention again, that I'm very interested in facilitating, getting samples into one central area for processing, looking for additional pathogens, because, as we've discussed today, Pasturella is not the end. It's one of the agents, one of the factors, but certainly not the end. We're also looking for microplasmas, as I mentioned earlier today. And so, if we could standardize collection and processing of samples of any type from bighorn sheep particularly, I think it would really help the industry or the concerns regarding the augmentation of these populations.

Mr. Lewis: Yes, Dr. Boyce.

Dr. Boyce: If I could just make a plug again for us working together to do experiments. I honestly think that the only way we're going to come up with real answers here are to devise experiments that tell us about cause and effect relationships, in terms of disease between domestic and bighorn sheep, and there's a lot of folks here from both sides of that fence that have access to the resources, whether they be domestic sheep or bighorn sheep, and we've got a partial collection of the scientific minds that could contribute to this. There are others that could, but I think there is some much-needed experimental work that could get rid of some of the ambiguity and doubt that we have now about what might work or what might not work, and I would encourage us to work together on those types of activities. I think we'll all learn from it.

Mr. Lewis: Any more on genetic diversity? Okay, seeing none, we'll take a fifteen minute break and be back here at ten minutes to 3. Let's give the panel a big hand. Again, public comment period is designed to make comments. If you do have specific questions, please make sure to fill out one of those blue cards and get it into us. We're going to do something a little bit different, since we have time this afternoon. After we finish with the public comment period, we're going to ask the panelists, and this is the first time some of the panelists have heard this, we're going to ask the panelists if they wouldn't mind responding to what they just heard from the audience.

Dr. Glimp: In other words, open up the dialogue between the panel and the audience.

Mr. Lewis: No, that's not exactly what I said, Hudson. What we're going to do is we're going to end public comment and then we're going to have the panelists respond. Okay. So, at this time, we're open for public comment.

Mr. Rathbun: I'm Floyd Rathbun. This afternoon's discussion was pretty overwhelming to most of us. It was over most of our heads, but I think I sorted through parts of it, and as I understand the discussion specifically on the separation of these bighorn sheep populations taxonomically, in the recovery plan, the basis for listing a distinct population segment is to make sure that meeting that test of discreteness and significance that the gentleman down there mentioned is to make sure that if the Sierra Nevada bighorn sheep becomes extinct, that will cause a gap in genetic material available for California bighorn sheep which at that time went through British Columbia, and that the California bighorn sheep that had that naming was also under consideration for being renamed as a different taxonomy, as Dr. Wehausen has expressed. And so the whole issue of discreteness and the whole issue of distinct population segment is based on a taxonomy that's changing, so all the discreteness and significance arguments don't seem like they apply to the way this is now being handled taxonomically. So I'll be real interested in reading through the transcripts and seeing how the comparison between Dr. Rink and Dr. Wehausen's presentation on these DNA analyses of these species works out. This morning, I started to make several comments, and one thing that didn't get clearly said that really bothers me. I deal with management of, and my apologies to Dr. Rink, but I have to identify an organism based on what I can see. I don't get to do a laboratory analysis of it, so the morphological features are important. So that's the basis for management decisions. And that aside, that doesn't separate the two fields of study for being important to each other. In our society, and by the way, this distinction between the bighorns based on the discussion of disease transmission this morning, doesn't seem to have any real connection with our issue of bighorn sheep and domestic sheep. Bighorn sheep taxonomy exists all by itself, separate from our concerns about domestic sheep issues and domestic sheep grazing. If our society decides that we really want to have bighorn sheep to the exclusion of domestic sheep, society can do that, and that's why we've got forest rangers running around with guns. That's the way that works. But when we do that, we don't get to do it for free. When we eliminate domestic grazing, we eliminate the major segment of local economies, and this has huge ramifications for the local communities. Anyway, we don't

get to do it for free, it's expensive. Thanks.

Mr. Lewis: More comment?

Speaker: Having no branches on my family tree, I certainly can understand if you listen to Anette's side of this argument, that what she said may satisfy everything, and so therefore we should all get to go home. If you listen to the folks that had this argument over here, there's obviously a heck of a lot more time that should be spent sharing this material beyond one sample before we could even begin to come up with a conclusion unless we're dealing with political science rather than science science. So at the end of the day, Mr. Fulstone and his family after 100 years of being in the sheep business, it's their head that's on the chopping block for something that seems rather arbitrary and capricious. And it doesn't seem fair, as a species of our own, as homo sapiens, and to destroy part of our subspecies, homo sapiens agriculturus shepherdaris, there is a rare and endangered species.

Ms. Lisa Eidman: My name is Lisa Eidman. I'm the Executive Director for the California Woolgrowers Association, which represents the California sheep industry. And with that, California is the second largest sheep producing state in the country, and so our industry is extremely important on the national level, because without the California production, our national industry is going to be hurt. And with that, our industry in California relies on the need and use of public lands for grazing, and so, with the elimination of these leases, it's been talked, and when you talk to the different harvesting and processing facilities of lamb, that it could have the effect of nearly two weeks of production, which in turn puts a huge economic impact on our industry and the communities that lie within that area. And I know that we're here talking about the science, but it's also important to look at the economic impacts that this is having on our producers, but then also, just within communities that are being affected with that. So, that's just one thing that I did want to bring forth. And as we've learned, I mean, we are by no means wanting to extinct any population of any type of species, and so we want to work with the different agencies in any way that we can because we rely, and we want to be good stewards of the land and we are good stewards of the land because we need the land in order for our production. And so it's those different issues that we need to discuss and look at further and so when there are the different things that are being looked at and said that there's the possibility of disease transmission and there's the what -ifs this happens, but at the same time, these what-ifs and these probabilities are having a severe impact on our industry, and it's difficult for producers which rely on the livelihood through production agriculture that it's being threatened by these what-ifs. And so, it's just these different things that we want to work with everyone on, but at the same time, it's different issues that just need to be completely analyzed and just talked about. So, thank you and I think this is a great opportunity and I think we're making the right steps in the directions, but at the same time, there's many other issues that need to be addressed.

Mr. Lewis: More comment?

Mr. Doug Busselman: My name is Doug Busselman. I'm the Executive Vice President of the Nevada Farm Bureau. Having sat through today's discussions on the scientific level, I think that it is a beginning point in a conversation that needs to carry out. It seems to me that as an observer, the real issue of the day has been discussion of whether or not the subspecies that have been labeled as the Sierra bighorns justify the ESA listing that's been given them. And a lot of the debate and the questions seem to go back and forth, whether or not the management prescriptions as an endangered species apply. I would hope that down the road we could somehow plan to come together in a more collaborative fashion to discuss how we might be able to live together and manage and conserve this species as well as the livelihoods of the agricultural producers who are threatened by the management prescriptions that have been discussed. At some point in time, there is going to be a desire by those who currently have the ability to use the Endangered Species Act to accomplish their objectives, to want to expand beyond where they have already established their toehold, and at that point in time, it will be very difficult, I would think, to get who's left to go along with reception of the expansion of those populations into their neighborhood, because they've seen, based on the victims that have been left behind, that it's not a very good long-term strategy to allow for the kind of expansion that probably some of you might want to look at. So I would hope that down the road, we might be able to come up with a solution of how we can adequately deal with the Endangered Species Act and conservation, while at the same time preserving those who are in business.

Mr. Jim Linebaugh: My name is Jim Linebaugh. I work part-time for the Nevada State Grazing Board. I'm a range management person for many years. And one thing I've done over these years is work a lot in collaborative processes. I won't say a lot because Doug almost said it for me. We need to work through this in a collaborative fashion, whether it's what we call coordinated resource management or some other approach, and that needs to be done early on, before we have species listed, if possible. And maybe it's not even too late afterwards, to get together and resolve some of these issues, get all the players at the table at the same time, rather than preparing recovery plans in a vacuum and then tossing them out to the agencies to implement. We need to keep that in mind in general, I think.

Speaker: It's not important who I am, but what Jim said, there is a group in existence, it's called the Executive CRM Committee in Nevada, and all the heads of the agencies, Fish and Wildlife, etcetera, are in that setting. They've been meeting regularly, and they can implement what Jim just talked about.

Mr. Lewis: Further comment?

Dr. Barry Perryman: Barry Perryman again, rangelands ecologist, UNR. I find all this genetic stuff's really been fascinating. It's really been a neat little discussion that I've seen this afternoon, but it all comes back to mind with me that regardless of what the species is or the

subspecies is called or whether, what it is, there's a danger from within the bighorn herds and from without of the bighorn herds for disease transmission, for the origin of the disease. And I still, I think it's been overlooked, in many cases, and in other species as well, but particularly with this one, if there's not enough critical habitat, and in this case it's in the winter ranges, if there's not enough habitat that provides the nutritional quantity and quality that these critters need to make sure that their immune system is where it needs to be, they're going to get sick in the winter and die. It doesn't make any difference whether the disease comes from within the herd or from outside the herd, it's a habitat problem, it's not a disease transmission problem. It's fascinating, but from a management standpoint on the ground, I think the group needs to start looking more at the habitat. And when you look at the habitat, in order to maintain winter range, you have two tools, and this is kind of an odd thing here, but there are two big tools that you have – you have fire and you have domestic sheep at your disposal to improve bighorn habitat winter range. Those are your two big options, and we're trying to completely eliminate one and we don't like the other, and yet we expect the habitat to remain the same quality and quantity over the next 50 or 60 years without doing any implementation of the management tools. So that's something that I think needs to be discussed at great length in any of this recovery planning discussions that are going on. So I just wanted to mention that one last time.

Mr. Bob Williams: I'm Bob Williams, and I'm the field supervisor for the U.S. Fish and Wildlife Service here in Nevada. And I guess I feel like I'd be a little remiss if I didn't stand up. I want to thank the Forest Service and Fred Fulstone and his family for holding this conference, forum, whatever, opportunity to share information. I guess there are only a couple of things I wanted to say. One, I think the debate about genetics has been very good. I think it would probably do us all well to go back to a listing of the species, read within the Federal Register. Genetics may have been, you know, a part of why we listed it in terms of a distinct population segment, but there were other factors, biological and ecological factors that we believed separated this subspecies out, and I think going back and reading it would help. What Carlos said is absolutely true, we are here to basically listen and to learn. I am willing to basically sit down with whoever and work through what I believe to be a win-win situation for the sheep grazers in moving their needs forward, working with the Forest Service, but also keeping in mind the conservation needs of the species, so I guess that's all I really wanted to say, and I'd like to thank Bob (incomprehensible) for putting this together and the UNR folks.

Dr. Glimp: Thank you. Mr. Fulstone.

Mr. Fred Fulstone: Fred Fulstone, and I just want to emphasize the impacts on our outfit. We have lost three allotments. It's cost us close to a million dollars, and furthermore, I wanted to thank Hudson and everybody that's here. Communication is what we need. We need that. I need to communicate more with Vern and more with Carl. If we can get together, I think we can solve this thing, and then we must learn to manage these sheep. We can have all the science in the world, but if you don't manage those sheep right, you're going to lose them. Just like us, we

provided big bucks, we put in our herd, we get poor sheepherders and we don't manage them right, we go down. You've got to watch those sheep. We've lost too many sheep in Lee Vining Canyon. They've lost them there. They haven't lost those sheep from bacteria, they've lost them from the snows, mostly, and predators, and it's just not a good environment there to do that. Four times that's collapsed, that area. You've got it in your recovery plan. And you keep pushing them down towards us. I think if you push them back the other way you've got 3,000 square miles to run your bighorn. We have about 50 square miles, and you could leave them down there. You've got all kinds of room. You could work out something there. And now the next thing is – you need us. If you're going with your bighorn, you need us. You need the domestic sheep to cultivate your winter ranges. Right now, some of your winter ranges, and I've been down there, have been so rank that those bighorn are not making it too good. You need those sheep in to cultivate, clean that out a little bit and get some fresh feed going. You can't go without us. You forgot that. I see so many people – get off those, we don't need those domestic sheep – Nevada's just about taken over everything here. And what was the next one I had? If they keep going, on this thing, it'll amount to about 120,000 sheep, and that's going to affect our national economy. It'll affect two weeks on our kills – Superior Pack in California, talk to them. And we can't let that happen. So we've got to, we can't just let everything go to the bighorn. We've got to work here. You've got to help us get in business. The way this works, I think we could change it. What happens if Fish and Game sees a bighorn? They call U.S. Fish and Wildlife, Bob Williams. Bob Williams then in turn calls the Forest Service – well, they saw a bighorn, tell Fred to get his sheep out of there, we've got to move. Those are unexpected situations that are hard to put up with. I just want you all to realize what we're going through. We're losing our hope. My family's been in business since 1858, and as far as going back to how long these bighorn have been here. Our domestic sheep have been here 500 years. To John Wehausen, I was running those mountains up there around Lee Vining before you was born.

Mr. Lewis: More comment. Right there, Hudson.

Ms. Marianne Leinassar: I wanted to thank everybody for coming and participating in this meeting, and seeing all these faces I've talked to for years on the phone to. I want to express that I'm in it for the long haul. You know, everybody sees the next generation coming up, but I'm in it for the long haul. I want this operation to continue, and I am so lucky my two kids want to walk into this business with me. And if there is any way possible, we can work, we can negotiate, we can keep feeding these ranges, and keep this bighorn project going. I've been here since 1980 when it started down on our (incomprehensible) and allotment, and we had a young man says, or I asked him, "How much of a buffer zone do you want?" And he says, "I want the whole range." Well, he got it, and we don't have that range anymore. But we will work with you. We have never said we won't work with you. We will always work with you. So please take into consideration my family still wants to stay in this business and hopefully we can come up with a resolution. Thank you, everybody. Thank you, UNR.

Mr. Lewis: More comment?

Speaker: Dr. Glimp, you asked a question at the very beginning, and I don't think we received a response from it, and that was, are there any scientific studies that have gone through peer review that have actually shown where there is a transmission of the Pasturella between the domestic sheep and the bighorn sheep? And I don't know if any, you know, that was a question that you asked at the beginning, and I don't know if – die-off, and on the ground in the natural habitat. Okay. So nobody found you at least after lunch or before lunch. Okay, thank you.

Mr. Lewis: More comment? Okay, seeing none, what we'll do is we'll open it back up to the panel to respond to any of the public comment that you just heard. Would anybody like to jump right in? Yes, Dr. Ward.

Dr. Bleich: Yes, as I said it's challenging and frustrating at times. Marianne, I really appreciate what you had to say. Anette again earlier had alluded to or made mention of the believers and those who wonder why things happen as being two distinct groups, and I want to emphasize again that I believe that sitting around this table are everyone who are members of that latter group. Those who are wondering why, how things work, why they work the way they do, and looking for answers. I don't think there's anyone here who is saying, by God, this is how it always is and I believe that is how it will always be. The gentleman from the University, I didn't catch your name, you talked about habitat issues, though. Many of the things that you are proposing are just, by law, are just flat illegal. We or management agencies don't have the authority to manipulate habitat in big ways on public lands anymore. The Wilderness Act took care of a lot of that. I just did a 37-year review of the population history of mountain sheep in the San Gabriel mountains. We've got three wilderness areas down there. There hasn't been a fire burn since they were established. The mountain sheep population has tanked. Big fires occurred last October, and the cycle begins again, but we just don't have some of the tools available to us. These are well-intentioned pieces of legislation, just as is the ESA, just as was the Wild Horse and Burro Act. We cannot manipulate habitat for wildlife in wilderness areas, but donkeys and horses are considered integral parts of the natural system in those areas. Some of these laws are illogical. They are passed at the behest of special interest groups. I have a paper coming out in the Wildlife Society Bulletin this spring, and the title is "Politics, Promises, and Illogical Legislation Compromise Wildlife Conservation." That will probably be the last thing I ever write in my current position, but we need to bring some common sense to the whole issue of the way things get done, in my opinion, the way things get done in Washington. And that may be the last thing I say in my current position. Nonetheless, I do have to leave. I have an appointment in Sacramento at six o'clock that I have to be at. I wanted to take the opportunity, though, to make those thoughts known, to say that I really appreciate the opportunity to be here, and the effort that went into organizing this. Fred, you and I can talk any time. And finally, this was alluded to as the first roundtable or square table discussion that occurred. I think Al Ward probably remembers the one about 20 years ago here in Reno. It was pre-Walter Boyce. I think Johnny

does. So this is really the second one in 20 years. Let's let the third one not be 20 years from now. Fred, this is solvable. We can work together, but it's not going to be solved in the absence of a lot of influence from higher levels.

Mr. Lewis: Okay, as you probably noticed, and thank you, Dr. Bleich, and I'm sorry that you have to leave. We've already lost two panelists, Dr. Boyce and Dr. Beattie to other commitments, and they didn't realize that they were going to be asked to participate in this extemporaneous or at the last moment added to the agenda little program here. Further comments from the panelists in response to the public comment. Dr. Stevenson.

Dr. Stevenson: Yeah, I'll address a couple of comments, some of which were just reiterated, but also from this morning. The same gentleman over here from the University, I didn't catch his name, brought up a number of issues, including selenium, I believe. I think a couple of people brought that up. We are looking at selenium levels, and currently, based on the blood analysis and what we're seeing in selenium levels, we're not seeing selenium deficiencies in the Sierra Nevada. We were very interested in that as a possibility, because there has been work, particularly in deer, that has shown selenium deficiencies in the Sierras, but we're not seeing that yet. The recovery program is a lot bigger and the issues it addresses is a lot bigger than what we've focused on here today. This meeting was set up to focus on disease and to focus on genetics, and so along those lines, just so everybody's aware of it, we have a substantial predator management effort. It's a big part of the recovery program, and we do have the authority to take lions, and we do take lions, particularly if they're taking bighorn sheep, so I don't want everybody to feel like we're putting all our efforts into the disease management, because that's definitely not the case. In addition, we're also, Vern touched on the habitat issues a little bit, we are trying to work with the Forest Service. There are a few areas that could definitely benefit from some burns, and then in a lot of the other areas, we are actively trying to quantify the carrying capacity of those ranges, and that's a very big job when you're working with a recovery area as large as the eastern Sierra Nevada, however, I think we're making strides in understanding how many sheep these various ranges can support, and we have no interest in putting or continuing to maintain bighorn sheep in areas where the habitat is not available and they can't be supported. But there's clearly the areas we're focusing the recovery efforts on can support sheep, do support sheep, and have supported sheep in the past, and sheep being specifically bighorn sheep.

Mr. Lewis: Thank you. Other comments in response to public comment?

Dr. Wehausen: Yeah, I'd like to follow up a little on what Tom just said. There was some concern here about us working together on solving these problems, and I'd like to point out a couple of things. After this animal was listed as an endangered species, there was an interdisciplinary group that dealt with the domestic sheep issue, and we worked very hard on trying to find solutions to keep allotments there in various places, and to the extent of double

fencings, countings, all these different things, and it wasn't actually this program that caused a number of those allotments to go away. It was the Department of Water and Power just suddenly decided to get rid of them, and so, after we had actually come up with solutions that might have been acceptable to keep some of those. And, along the same line, we never had any intention of moving sheep north, knowing there would be a major conflict with domestic sheep. That's something that might have happened in 30 years if it was possible or something. It happened on its own, and this issue came up unexpectedly to us and unfortunately to us, because we did not want to get into this situation at all, so we've all suddenly gotten stuck in this situation, in a sense. And regarding again the gentleman on the question of winter range habitat, I'd like to point out that the populations have been growing at maximal rates. There's not a nutritional problem at this point, there's not a nutritional problem at all. That doesn't mean that we couldn't use fire in some places we have used fire. The Forest Service has done some burns in some areas and greatly improved some winter ranges, but there is plenty of nutrition in most cases. What's limiting the nutrition is rainfall, and I don't think we can do a whole lot about that.

Mr. Lewis: Further panel comment? Dr. Gonzalez.

Dr. Gonzalez: I just wanted to support what John just said. We really don't have a problem with nutrition. When we handle these animals, Tom does ultrasound, looks at body fat, muscle thickness, etcetera. These animals are in good body condition, so we're not having a problem with nutrition. Let me just touch on that vein a little bit more. Having said that we don't have a nutritional problem right now, as John indicated, it's completely climate driven. If we enter into another drought, we could be in bad shape again, so, and I think that needs to be kept in mind, especially given what I've alluded to earlier, that this is a wild species, and we don't have control over some of these issues. In a very worst case scenario, if the population was completely tanking, we might, there might be some opportunity to actually use supplemental feeding, but even if we wanted to do that, there's downsides to it and logistically it would be extremely difficult in some of the populations. But I guess that's, you know, I just wanted to clarify that even though we're in good shape nutritionally right now, that could change, and I think until we in particular are able to expand the distribution of these populations, given that we've got so few, that it wouldn't take, we've had a rapid increase over the last several years, but we could just as easily experience a rapid decrease.

Mr. Lewis: Further comment from the panelists? Okay, seeing none, I think what we'll do is we'll get started on the last 15 minutes. Oh, I'm sorry, Dr. Thain.

Dr. Thain: Just a few brief thoughts. I would encourage UNR, the Forest Service, BLM, Fish and Wildlife Service, California Game and Fish, NDOW, our agency, to continue to try and have an annual forum like this, whether it be here in Reno or travel down to the Bridgeport Bishop area for a similar conversation on an annual basis to one, continue to put the faces with the folks we deal with via e-mails and phone calls, and continue this dialogue, and I would encourage UNR to

continue a leadership role to try to keep the majority of this on a science-based discussion. We'll continue and we will always have political decisions in here because of the rule-making process and complex regulations and laws that we have to deal with, but if we keep a lot of the science on the table so that our discussions will always be about science, and if we make decisions based on science versus supposition, I think it makes our working together as a group much easier to do. And thank you again for taking the time to come to Reno, and I look forward to future meetings along these same lines.

Mr. Lewis: Well, thank you Dr. Thain. Actually, that leads right into our last 15 minutes, and that is to discuss what the value of today's discussion was, and then also, where do we go from here? How should we continue? And I just recorded here one of your ideas and that is to hold an annual forum on the science. So, let's start over here with the value of today's discussion.

Speaker: I'll add a couple things as an outsider, just observing, and that is, I think you've identified some really significant common ground. We need to build on that. Don't lose that, and I would encourage you to continue to meet even outside of your annual meetings on the science with your stakeholder groups. I can't say that enough. I don't know what the right forum for you is, but I would encourage that you do that. I think it's real important that you develop trust and respect each other, and that's going to be accomplished by these routine meetings and some kind of forum.

Speaker: We've got a variety of perspectives on the science, the two discussion items out on the table, and through those discussions, we identified some important information or data needs.

Mr. Lewis: The value of today's discussion.

Speaker: Cooperation is essential for success.

Mr. Lewis: Cooperation is essential for success. Over here. Should we talk about what goes on from this point on? And as Dr. Thain suggested, hold an annual forum and focus on the science. What else would you suggest?

Speaker: Could I suggest one other thing you might consider, and that is these types of natural resource problems, especially the livestock wildlife interface, are actually fairly common, and I think that if you were to reach out and look at other models of how people have addressed these types of problems, you might pick up some tips on how to proceed. I had either the good fortune or misfortune to be involved in bison and brucellosis for 20 years, and I'm not sure that's a good model, but we certainly can share with you some of the mistakes we've made. And so I really think that this is real important, and I know that there's lots of challenging wildlife disease interface issues, Michigan TB and some others, and you might look to those models and see how they wrestled with it and how they built some kind of process for solutions.

Speaker: I think something that Dr. Boyce indicated. I think the scientific community will have to try and get together and come up with standards that everybody follows, because I'm hearing different standards (incomprehensible) scientific research, and I think it's important for the scientists to try and get together to come up with standards that they all feel are real standards that the rest of us can refer to.

Dr. Glimp: I heard David Thain, I heard Mike Cox from the Nevada Division of Wildlife, I've heard Marianne as a producer, I've heard other scientists, and I'll tell you for sure that, and I heard the Department of Agriculture say that we need to get together, we need to work together to solve these problems, and I think we can, I believe we can, and I know that the Forest Service and Bob, I think I can speak for you, you would certainly be willing to work with this, and the University will certainly be willing to facilitate in any way we can. Gary.

Speaker: (incomprehensible – speaker too faint, not near the mike)

Dr. Glimp: I do have a few more copies of that Wyoming plan that was collaboratively developed if some of you would specifically like to have one after we finish.

Speaker: Would it be possible for those who have registered to receive a copy of the draft recovery plan to find out what opportunities they might have to (incomprehensible) public input into the discussion? Where are we at in the recovery process?

Dr. Glimp: I'm sure there's a process for getting that. Would one of you all like to comment on that?

Mr. Benz: Carl Benz, I'd be happy to. Yeah, if they want to get the mailling list to me, I can make sure that we could send, if people, I think on that list we put down our e-mail address, we could mail electronic copies to everybody of the draft and with that I could attach our proposed schedule for moving forward, from going from a draft to a final version.

Dr. Wehausen: I felt like, just among the agency folks that the communication hasn't been as complete and nearly as timely as it could have been, and I think all of the major agencies involved are guilty for this not occurring. Now that the ball's rolling a little bit more, I'd like to see us in communication and see us in communication with the permittees on a more regular basis, and really, I was serious about trying to pursue some of these creative solutions. I think the last thing any of us wants to see is a big die-off anywhere, and I think if it happens, it's going to be bad for both sides, and I think there's a lot of things that could be done, and some of them probably aren't that difficult if we can just work together and communicate and just make sure we know what's going on with the bighorn sheep, what's going on with the domestic sheep, a little bit more. You know, from my perspective, I'd like to learn a little bit more about how some

of the operations work, and you know, maybe that's going to alleviate some of my concerns, but there may also be aspects of that that we might be able to help out with some of the monitoring and what not to make sure that contact does not occur. Thanks.

Speaker: (incomprehensible – speaker too far from the mike)

Speaker: Well, let me preface it by first saying that the perception is always that there are a lot more lions out there than there really are, and I think, in part, that's because lions have such large home ranges. Right now, in the entire eastern Sierra, we've probably got, and we tend to average having, and by the eastern Sierra, I'm essentially talking from Lone Pine up to Lee Vining, probably. But we typically have somewhere in the neighborhood of 17 lions on the air, and by on the air I mean that we have caught and radio-collared. We have two full-time houndsmen that are very capable and qualified and do an extremely good job of determining when new lions move into the area. You know, I'll often get, you know, people are convinced that Round Valley alone just west of Bishop has 70 lions living in it. That's not the facts. Having said that, in the last three or four years, we've probably taken about five lions. The reason why, and we do have the authority to take lions. The reason why we don't take every lion that sets foot in the eastern Sierra, and a lot of people have heartburn about this, is that you have to understand that the vast majority of the lions' diet is mule deer in that range. They're not having a significant impact on mule deer populations right now. Mule deer populations are going up, just like sheep populations, and that's largely because of rainfall and forage quality. Having said that, we would rather have lions living adjacent to sheep ranges that eat mule deer and not bighorn sheep. And when we have lions that move in and start eating bighorn sheep, we take that lion promptly. We get hit from both sides – half the state doesn't want to see a lion, the other half couldn't have enough lions. So it's a no-win situation from our standpoint. So, relative to your lion control question, hopefully I've answered it. On the subject of coyotes, we are interested in the possible impacts that coyotes may have. So far, we really don't see any evidence that coyotes are having a substantial impact on population growth as we've talked about, and we have very extensive population monitoring of all of our bighorn herds. Right now, we're seeing very high lamb production and recruitment. That's why the population is growing so fast. So right now, we don't have any indication that coyotes are a problem. If we did, we're certainly in a position to deal with that.

Dr. Glimp: I'd like to make one comment on that. I'd like to thank you, your team, and NDOW, for decisions to take lions to protect wildlife. I'm on the east Walker River, and prior to your taking lions for protecting the bighorns and other wildlife, we were taking out an average of 12 lions a year on our ranch alone. The ADC people were. Now it's about one a year. Thank you.

Speaker: (incomprehensible – microphone not turned on)

Mr. Lewis: Keeping with that idea, Bob, who would you suggest? Carl, who would you suggest?

Meeting Transcription
Sierra Nevada Bighorn Sheep Roundtable Discussion
Febuary 25, 2005

Speaker: (incomprehensible – microphone not turned on)

Dr. Glimp: And I would reiterate, our (incomprehensible)

Mr. Lewis: We're calling this the momentum team. Who else would like to serve on the momentum team? We've got Bob and Carl. Yes, Melanie. Is that on?

Ms. Woolever: Yes, now it is. A couple of us in the Forest Service put out a paper a few years ago addressing these same sorts of challenges with bighorn sheep and domestic sheep. It's a process paper addressing kinds of alternatives and encouraging people to work together and to find collaborative solutions. That document kind of outlines how we have found that to work best, and so I would tell you that what we found is that all interested stakeholders need to be at the table, and so, even though you're developing a list here, I suspect that there are going to be those that are not here that want to be involved. And for it truly to be successful, we found that truly all of them need to be involved. You can either have them at the table, no matter whether you like their ideas and opinions or not, and work through that together as a team, or they'll be sniping at you from the outside, so you might as well just invite them to the table. If you'll do that, even though that's difficult and it's not fast. The challenge with that, like all collaborative processes, is they're slow. So, if you will indeed get all the interested stakeholders at the table and start working through this, I think you will find that you have far more in common than you do differences, and I can speak from being the granddaughter of a rancher, who learned all her values for wild places and wild things from that livestock person. So, I know full well that livestock people are just as interested in wildlife, and by and large, the wildlife people are just as interested in keeping the livestock people on the land as well. So, it's those similarities that then you start carving out how you're going to address some of the challenges that face us that are contentious and difficult, there's no doubt. So, please get everyone at the table, I think you'll be better served that way.

Mr. Lewis: Jim?

Speaker: (incomprehensible – speaker not at active mike)

Mr. Lewis: Thank you. Other ideas on how we continue?

Dr. Stevenson: They were looking for participants. I'll certainly volunteer myself, since I'm the one who's pushing for it, and Vern may want to participate as well, although he's not a big fan of meetings, so I figure I might as well go ahead and volunteer myself, because that's what he'd probably do for me, but, Tom Stevenson.

Dr. Glimp: Gary.

Meeting Transcription
Sierra Nevada Bighorn Sheep Roundtable Discussion
Febuary 25, 2005

Speaker: (incomprehensible – speaker not at active mike)

Dr. Glimp: Judy, have you got that list of registrants? Grab it before somebody runs off with it.

Speaker: (incomprehensible – speaker not at active mike)

Mr. Lewis: Okay. I think that we're going to call this a wrap. We had some great discussion.