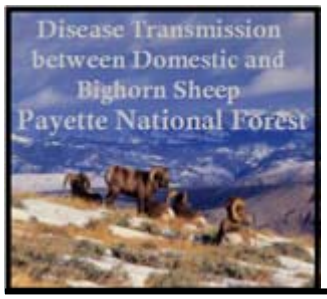


Summary of the Science Panel Discussion

November 2, 2006
USGS/Bureau of Reclamation Office
230 Collins Road, Boise, ID

Meeting Objectives

1) Clarify the science-based concerns regarding *Risk Analysis of Disease Transmission between Domestic Sheep and Bighorn Sheep on the Payette National Forest* (February 6, 2006).

2) Allow panelists to provide additional science-based information regarding disease transmission and its risk of occurring on the Payette National Forest that the Forest Supervisor should consider in conjunction with the risk analysis.

Executive Summary

Prior to the meeting, specific science-based concerns with the *Risk Analysis of Disease Transmission between Domestic Sheep and Bighorn Sheep on the Payette National Forest* (February 6, 2006) were compiled and arranged into categories for science panelists to discuss. Panelists focused on concerns in the disease/mortality category and developed statements to address these concerns:[1]

1a) Scientific observation and field studies demonstrate that "contact" between domestic sheep and bighorn sheep is possible under range conditions. This contact increases[2] risk of subsequent bighorn sheep mortality and reduced recruitment, primarily due to respiratory disease.

1b) The complete range of mechanisms/causal agents that lead to epizootic disease events cannot be conclusively proven at this point.

1c) Given the previous two statements, it is prudent to undertake management to prevent contact between these species.

2) Not all bighorn sheep epizootic disease events can be attributed to contact with domestic sheep.

3) Gregarious behavior of bighorn sheep and domestic sheep may exacerbate potential for disease introduction and transmission.

4) Dispersal, migratory, and exploratory behaviors of individual bighorn sheep traveling between populations may exacerbate potential for disease introductions and transmission.

5) There are factors (e.g., translocation, habitat improvement, harvest, weather, nutrition, fire, interspecies competition, and predation), some that can be managed and some that cannot, that can influence bighorn sheep population viability.

6) Pasteurellaceae, other bacteria, viruses, and other agents may occur in healthy, free-ranging bighorn sheep.

These statements were drafted and then revised until the group was satisfied. Throughout the discussion, the facilitator tracked suggested actions, suggested management strategies, and items to discuss further if time permitted. In addition, key literature provided by the panelists for consideration by the U.S. Forest Service was presented in two binders.

[1] References to domestic sheep also apply to domestic goats, which are not currently an issue on the Payette National Forest.
[2] Refer to the concern that this should read "can increase risk…" on page 12, 2nd paragraph under comments 38 and 40.

Meeting Opening

Patti Soucek, Forest Planner on the Payette National Forest, welcomed panelists and introduced Suzanne Rainville, Forest Supervisor. Rainville shared information about her background, including her degrees in forestry and silviculture, 28-year history with the U.S. Forest Service (USFS), and recent hiring as Forest Supervisor on the Payette National Forest.

She then summarized the process leading to this meeting—approval of the revised Payette National Forest Plan, several appeals, and directed reanalysis of bighorn sheep viability specifically related to disease transmission. Based on input from this meeting, in conjunction with the risk analysis and other information gathered, the Forest Plan will be amended. Participants for this science panel were highly recommended, and she hoped to understand the different views from the scientists by the end of the meeting. She clarified that the intent is not to redo the risk analysis but to supplement the information. Facilitator Susan Hayman, North Country Resources, talked about the two-tiered structure, with panelists at the table and observers seated around the perimeter. These observers were available to answer questions. Following the meeting, a summary document will be publicly available after panelists have reviewed the draft for accuracy. Hayman had panelists introduce themselves and then reviewed the meeting objectives and agenda (Appendix A).

Process Review

Three-Step Decision Process

Soucek described the history of the Forest Plan to date and explained the three-step decision process that the Payette National Forest is undergoing. In July 2003, the Regional Forester signed the Record of Decision for the revised Payette National Forest Plan, beginning implementation in September 2003. Once it was signed, it was open for appeal. Five appeals, covering approximately 45 issues, were received. All were affirmed except one dealing with bighorn sheep viability, availability of habitat across the "planning area" (the Forest), and the risk of disease transmission between domestic sheep and bighorn sheep. Some challenges in addressing these issues have been the requirement to use 1982 planning regulations and the overlap of bighorn sheep populations on the Payette National Forest and Hells Canyon National Recreation Area (HCNRA).

Step 1 was to conduct the risk analysis and compliance check. Jeff Waters, USFS, was hired to spend four months examining the literature and data and writing the risk analysis. Comments were solicited, and this science panel was convened to address some of those comments. Step 2 is supplementing the environmental impact statement (EIS) for the Forest Plan and adding to the Forest Plan to adequately address the disease transmission issue. Step 3, which many people are anxious to address, is to potentially adjust allotment management plans based on results of the first two steps. This step requires another environmental assessment.

Following Soucek's information, several issues were raised and discussed:

- *Definition of viability.* Under the 1982 planning regulations, viability is defined by reproducing populations, habitats to support these populations, and distribution across the planning area. In this case, the planning area is the Payette National Forest, and determining viability within that strict boundary is difficult, given used and potential habitat adjacent to the Forest. As far as Soucek knew, there are no estimations of carrying capacity for the herds, nor are there numbers on which to base

"viability." The intent is not to conduct a population viability analysis (PVA), which would require data for numerous other variables and development of a probability of persistence over a certain time frame.

- *Focus on disease issue.* The Forest Service–Washington DC office said to focus on the disease issue, which is why the risk analysis primarily discusses the contact between bighorn and domestic sheep. In the EIS, disease transmission was identified as a "significant" issue so, under the National Environmental Policy Act (NEPA), alternatives had to be developed. The Chief of the Forest Service said that this issue wasn't adequately addressed, and viability was added as an issue because it is required under the 1982 planning regulations. Soucek acknowledged the complexities in meeting the Chief's instructions.
- *Time scale.* Forest plans have a 10- to 15-year life expectancy, but population viability considers the long term.
- *Bighorn metapopulations and connectivity.* The Payette National Forest has two metapopulations. The Hells Canyon metapopulation was extirpated by the 1940s, so current populations derive from translocations. The Salmon River metapopulation was never extirpated. There is no known interchange between the two metapopulations (based on HCNRA telemetry data, geographical barriers, and observations), although historically such interchange was likely (based on potential habitat maps and anecdotal information). Rainville commented that the Nez Perce Tribe has proposed a monitoring study and requested that the USFS buy radio collars, but the decision will be based on funding availability.

Method of Determining Risk

Waters read excerpted information from the Background section of the risk analysis report to provide the context for the discussion. The original language focused on the Hells Canyon Management Area; however, the analysis was conducted at the spatial scale of the entire Forest. The purpose of the analysis was to collect the information necessary for the Payette National Forest to address the viability of bighorn sheep relative to disease transmission. No primary research was requested.

Waters then outlined the three parts of the risk analysis—literature review, status evaluation, and expert panel assessment. The document was organized according to the three parts of the analysis.

- For the literature review, he drew from previous literature reviews and a number of management papers that focused on the issue.
- To evaluate the status of bighorn sheep populations, he reviewed all available and relevant data from the Idaho Department of Fish and Game (IDFG). Even though the analysis was at the Forest scale, he included data from just outside the Forest boundary.
- The intent of the expert panel was to obtain information about the likelihood of disease transmission for specific sheep allotments on the Payette National Forest. The approach was closely modeled on methods used to evaluate EIS alternatives on likelihood of species persistence in the Interior Columbia Basin, by Lehmkuhl et al. (1997; see the reference list in the risk analysis report). Representation relied heavily on state fish and game biologists who were knowledgeable about bighorn sheep movements and range of populations relative to domestic sheep allotments. The principal assumption stemming from the literature review and underlying the expert panel was that "[d]irect contact between domestic sheep and bighorn sheep results in a high likelihood of disease transmission to bighorn sheep and disease outbreak in local bighorn herds."

Waters pointed out that conclusions about likely impacts to population viability were included in the Discussion section of the report.

Clarifying Q&A on Processes and Procedures

Following presentations by Soucek and Waters, Hayman asked whether panelists needed clarification on processes or procedures for the risk analysis. During the ensuing discussion, several issues were raised:

- *Factors other than disease transmission.* Other factors discussed in the expert panel were habitat loss, fragmentation, fires, and human use. None were seen as causing substantive impacts, and fire can actually improve conditions by opening up habitat. The HCNRA experiences approximately 75,000 visitor days a year. The majority of use in Hells Canyon occurs during boating season: 80% of recreationists access the area in jet boats and rafts and stay along the river. A small proportion of users are hikers and hunters who access the HCNRA seasonally. Although the risk analysis recognizes these other factors, the focus is on disease transmission.
- *Lack of quantitative data regarding disease transmission.* The risk analysis was criticized for the lack of quantitative data and expert representation in the panel on disease transmission. Although information is available for the location of domestic sheep, quantifying disease transmission through contact is difficult. Dr. Dave Jessup, California Department of Fish and Game, commented that the Reed-Frost model for disease transmission has been used on much smaller projects, but data must be available to input to the model. Semiquantitative risk analyses are conducted when quantitative information is scarce, but they are subject to criticism. Rainville said that this science panel was designed to balance information in the risk analysis report. She didn't expect resolution on the issue but sought as much information as possible.
- *Locations of disease events.* Soucek and Tim Schommer, USFS National Bighorn Sheep Specialist and wildlife biologist, identified seven areas of bighorn sheep die-offs on a display map, five in the Hells Canyon area and two in the Salmon River area. These die-off events, occurring between 1983 and 2000, had above normal mortality. While Schommer indicated whether contact had occurred between bighorn sheep and domestic sheep or goats prior to these die-off events, there was no discussion among the panelists as to whether disease transmission was the primary cause:
  - In 1995, a die-off began near the confluence of the main stem Salmon and Middle Fork Salmon rivers within 10 days after contact with domestic sheep. This population has begun to rebound.
  - Another die-off occurred in the Big Creek population at about the same time.
  - A die-off along the South Fork was related to fire; this population has not rebounded yet for unknown reasons.
  - In the Sheep Creek drainage of Hells Canyon, the domestic and bighorn sheep were observed mixing in the winter of 1983–1984. All 180 bighorn sheep subsequently died.
  - In 1989, a complete die-off occurred in a new herd at Sand Creek.
  - In 1986, about 95 of 125 sheep died from the Lostine population. The McGraw herd was placed on the Oregon side, but some appeared to prefer the Idaho side. Schommer wasn't sure whether domestic and bighorn sheep populations mixed, but they were within one-eighth of a mile of each other. All 30 in the herd subsequently died by 2000.
  - In 1995–1996, a herd near Lewiston came into contact with two goats; subsequently, about 300 bighorn sheep died.

These years indicate acute mortality. [More information is available in pp. 7–9 of the risk analysis report.]

- *Recovery levels.* Recovery from a pneumonia outbreak is generally slower than for die-offs from other causes because lamb mortality is high for several years following the initial event. In addition, populations seldom recover to pre-event levels. If die-offs take enough of the population, especially ewes, herd memory of quality habitats can be lost. Ewes are not adventurous and less likely to occupy new habitat than rams. Smaller groups are also more vulnerable to predation. None of the die-offs appear to be driven by populations reaching their carrying capacity.
- *Methods of disease risk analyses.* Dr. Elena Garde, British Columbia Ministry of the Environment, had information about methods derived from translocation disease assessments that might be helpful in designing risk analyses. She commented that there were some key points missing from the current risk analysis, precluding managers from estimating the probability of a health hazard occurring. First, particular pathogens should be identified. Second, case definitions of transmission should be described. Lastly, missing from the risk analysis was the "magnitude of a negative outcome." Disease risks are generally quantified according to the probability of contact, combined with the magnitude of effect. For example, a pathogen may be at low risk of being spread through contact, but it may also have a high probability of mortality. That pathogen may be assessed differently than one with a high risk of being spread but a low probability of mortality. Likewise, it was recommended that an economic analysis be conducted simultaneously, as local economic values (agriculture, transplanted herds, native herds) need to be identified.
- *Migratory behavior in the Payette National Forest.* When asked about migratory behavior, Waters responded that migration tends to be seasonal and elevational. Lost pockets of matrilinear groups can lead to lost knowledge of migration routes, lambing areas, and summering areas. On the other hand, transplanted populations have pioneered migrations fairly quickly.

Concerns with the Risk Analysis[3]

Prior to the meeting, specific science-based concerns with the risk analysis were compiled and arranged into categories for science panelists to discuss (Appendix B). Hayman posted the disease/mortality category of concerns, which included concerns 12 through 37. She identified several subcategories. Panelists discussed these concerns and developed statements to address them. (These statements, provided in the following sections, are the work product of the science panel.)

Concerns 12 and 13

12. Disagree with the premise that domestic sheep transmit disease to bighorn sheep on the range/in the wild. Report conclusions based on circumstantial evidence, rather than in any scientifically verifiable way.
13. Disagree that the risk of disease can be evaluated in a quantitative manner when the specific mechanisms for transmitting disease have been difficult to document outside of clinical settings.

Hayman asked panelists to begin discussing concerns 12 and 13 to determine whether the underlying assumption of the risk analysis ("Direct contact between domestic sheep and bighorn sheep results in a high likelihood of disease transmission to bighorn sheep and disease outbreak in local bighorn herds") was

[3] Though the meeting minutes generally adhere to the chronological development of the meeting, information for any subject covered at different times is organized by subject matter.

faulty or accurate. Drs. Bill Foreyt, Washington State University, and Jessup shared early and separate observations indicating dire consequences to bighorn sheep of contact with domestic sheep.

Ensuing discussion covered a number of issues:

- *Desirability of scientific debate.* Vigorous debate advances science, so panelists asked that the discussion be open and unconstrained, though the panelists agreed not to engage in personal attacks.
- *Disease transmission from domestic sheep to bighorn sheep.* A question which was explicitly asked three times was whether anyone on the panel agreed with concern 12, thereby disagreeing with the premise that domestic sheep transmit disease to bighorn sheep on the range/in the wild. Despite repeated opportunities to do so, none of the panelists stated agreement with concern 12. Dr. Glen Weiser, Caine Veterinary Teaching and Research Center, stated that transmission is recognized, but hard physical data are lacking for field transmission. Dr. Alton Ward, Caine Veterinary Teaching and Research Center, also noted that proof of transmission in range conditions is lacking. Panelists offered a variety of reasons why these data are unavailable:
  - *Protocols for field epidemiology.* Foreyt said that he has asked for a protocol for studying disease transmission in the field, but so far no one has been able to offer one. During die-offs in free-ranging conditions, researchers don't have the opportunity to collect pre- and post-disease event samples. In addition, pathogens may have changed, even if a researcher were able to collect a sample for an individual that just succumbed to fibrinopurulent pneumonia. Weiser mentioned a study in Montana, with help from Colorado, during which over 1,000 samples were collected. If a die-off does occur, it may be possible to go back to the archived samples and trace the source.
  - *Failures in observations or in tools.* Some people assume that, because contact between domestic sheep and bighorn sheep was observed or suspected prior to an outbreak, epizootic was "caused" by the contact. This assumption may be faulty. Likewise, a lack of physical evidence could result from faulty lab analysis: inconsistency among technicians in processing samples, focus on certain pathogens at the expense of others, and limits in technology. There was discussion about phenotypic and genotypic bases for studying pathogens and whether the tools being used could adequately answer the questions.
  - *Standards of "proof."* One question was raised repeatedly: What would constitute sufficient proof? Although disease transmission from domestic to bighorn sheep under field conditions has not been unequivocally demonstrated by a controlled experimental study, this phenomenon also has not been disproved by experimental study. A panelist stated that the burden of proof lay with both parties. If research is published in a peer-reviewed journal and has not been duplicated and shown to have different results, then it generally stands. If another researcher disagrees with the findings, that researcher generally designs a different study and publishes the results. According to several panelists, when assessing transmission of disease in other species or human, this amount of circumstantial evidence is considered sufficient to make management decisions. They agreed that more research is needed but that basic preventive actions are warranted. Dr. Mark Drew, Idaho Department of Agriculture/Idaho Department of Fish and Game, also commented that not all research is published. In Oregon, there were two well-documented cases where animals were tested prior to mixing. After mixing, those bighorns died. A manuscript was drafted, but it was never published. Dr. Sri Srikumanan, Washington State University, read an excerpt from Ward et al. (1997, pp. 555–556; see Appendix C of this document) stating that nose-to-nose contact has resulted in transmission of *Pasteurella haemolytica* from domestic to bighorn sheep, based on findings reported by D.L. Hunter and A.C.S. Ward (unpublished).

– *Proper diagnostic focus.* In the field, many opportunities may have been missed to analyze the cause of pneumonia because people assumed that the pneumonia resulted from contact. In addition, opportunities may have been missed in the lab where analyzes have focused on certain organisms. These analyses cannot rule out that organisms are shared by both species, only that the organisms assessed were not shared. Stress has been mentioned as a potential factor, but a study by Miller showed no relationship between cortisol levels and death from pneumonia.

Based on what she heard during the discussion, Hayman drafted four statements and asked panelists to assess them for accuracy and agreement. She reminded panelists that consensus was not required. It was important that Rainville understood areas of agreement, areas of disagreement, and information supporting each. Panelists revised the statements as follows. The strikethrough typeface indicates verbiage that was removed, while underlined information was added to the original statement during subsequent discussion.

1) Scientific observation and field studies demonstrate that "contact" between domestic and sheep and bighorn sheep is possible under range conditions. This contact ~~creates a~~ increases risk of subsequent bighorn sheep mortality and reduced recruitment, due primarily to respiratory disease. [later renumbered as 1a.]

2) The complete range of mechanisms/causal agents that lead to epizootic disease events cannot be conclusively proven at this point. [later renumbered as 1b.]

3) Given the previous two statements, it is prudent to undertake management ~~that minimizes~~ to prevent contact between these species. [later renumbered as 1c.]

4) Not all bighorn sheep epizootic disease events can be attributed to contact with domestic sheep. [later renumbered as 2.]

Concerns 14 and 15

14. Failure to address significance of bighorn behavior and social patterns that contributes to their natural susceptibility to disease.

15. Failure to evaluate the potential for disease transmission through inter-population movements of bighorns when assessing risk for allotments on the east side of the Forest.

Concern 14 confused two issues—behavior and genetic susceptibility to disease. Statement 4 was mentioned as possibly addressing this issue. It was noted that groups of ewes tend to be insular, while rams move more widely across the landscape. Rather than determining whether this concern was addressed implicitly in one of the four existing statements, panelists decided to draft an explicit statement about bighorn sheep behavior. Their efforts resulted in the following two statements. Because the first addressed aggregation and the second about dispersal, panelists believed that both were necessary.

5) Gregarious behavior of bighorn sheep and domestic sheep may exacerbate potential for disease introduction and transmission. [later renumbered as 3.]

6) Dispersal, migratory, and exploratory behaviors of individual bighorn sheep traveling between populations may exacerbate potential for disease introductions and transmission. [later renumbered as 4.]

Panelists commented that concern 15 went into a level of detail on allotments that was inappropriate for them to discuss at this time. It did, however, point out the need for more data (VHF and GPS, daytime and nighttime) on movements and locations of bighorn and domestic sheep, especially on the east side of the

Forest. This need was recorded on a flip chart of suggested actions (see Appendix D for all flip chart notes).

Concerns 26 through 29

26. Failure to address how the factors of transplantation, human contacts, and sedation for transport may be precursors to disease problems.
27. Failure to address how the effects of fire may be precursors to disease problems.
28. Failure to address how excessive or unseasonable rains and snows, and extremes of heat and cold may be precursors to disease problems.

Panelists decided that other factors needed to be addressed but not spotlighted. Some felt that statement 4 addressed the concerns, but others felt that this concern also warranted an explicit statement. The main concern in drafting the statement was articulating whether factors could be controlled or managed. In some cases, such as fire, resource managers might want to manage a factor in some situations but not in others. Those management decisions had to be left to the discretion of the Forest. Panelists agreed to the following statement:

7) There are factors (e.g., translocation, habitat improvement, harvest, weather, nutrition, fire, interspecies competition, and predation), some that can be managed ~~(e.g., translocation, habitat improvement, harvest)~~ and some that cannot, that ~~to~~ influence bighorn sheep population viability. ~~There are other factors (e.g., fire, nutrition, weather) that cannot be readily managed that also influence bighorn sheep population viability.~~ [later renumbered as 5.]

Concern 24

24. Question whether the bighorns could be carriers of disease, and that transplanting introduces new pathogens into their own herds.

This concern was adequately addressed by statement 4.

Concern 25

25 Failure to address whether bighorn sheep could be carrying disease to domestic sheep herds.

This concern was deemed as outside the scope of the Chief's request, somewhat addressed by statement 2, and irrelevant to the viability of bighorn sheep populations.

Concern 16 through 19

16. Failure to include references that the same viral and bacterial pathogens in bighorn sheep are also commonly found in domestic sheep bands.
17. Failure to acknowledge a Pasteurella strain unique to bighorn sheep.
18. Failure to include references that bacteria in the family Pasteurellaceae have been found in bighorn sheep herds regardless of no known, or suspected, contact with domestic sheep.
19. Underestimates risk of disease in bighorns because it is limited to projections based solely on direct contact with domestics in 23 allotments.

Concerns 17 and 19 were addressed in statement 4. Panelists discussed the uncertainty of whether *Mannheimia haemolytica* is a result or trigger. It was also mentioned that some pathogens can be both primary and secondary when the immune response is reduced. Uncertainty also exists about stressors such as marginal nutrition, weather, dust, and others. Rainville commented that a statement specifically mentioning Pasteurella would be helpful since that is what lay people hear about. Panelists drafted statement 8 to meet that suggestion.

8) Pasteurellaceae, other bacteria, viruses, and other agents may occur in ~~the normal flora of~~ healthy, free-ranging bighorn sheep. [later renumbered as 6.]

Concern 35

35. Failure to address the effects of predation on bighorn sheep.

Panelists believed that the issue of predation was related to population viability but not disease transmission. Given the percentage of losses to predation, this factor has more impact than some of the other factors. On the other hand, predation may be a cause of death for individuals weakened by other factors. The issue can be complex. Collar data may help fill a gap in information about the impacts of predation to these populations. Panelists decided to add predation as a factor in statement 7 (above).

Concerns 33 and 34

33. Failure to draw more extensively from studies by Garde et al.
34. Failure to cite studies from the University of Idaho Caine Veterinary Research and Teaching Center.

Hayman provided copied and bound literature recommended by panelists (including Garde, Ward and Weiser, among many others). The USFS will retain two of three binders, and Hayman will retain the last copy in case people request copies of specific articles later. A bibliography will be made available for anyone interested in what this panel thought was the relevant literature (see Appendix C).

Concern 30

30. Question about factors related to the success and failure of translocations, other than proximity to domestic sheep, which were considered and measured in the analysis.

Dr. Kim Keating, U.S. Geological Survey wildlife ecologist, summarized other factors affecting the success of translocations, as reported by Frank Singer. Other factors were assessed during the study and could be discussed in the risk analysis report. However, those factors had not been highlighted, given the disease transmission focus on the risk analysis.

Concern 31

31. Disagree with finding that removal, rather than separation, is the only remedy to reduce risk of disease transmission on the Payette National Forest.

This concern is addressed in statement 3. Rainville requested that the panel brainstorm management strategies for preventing contact, if time permitted.

Concern 32

32. Failure to discuss how the separated populations of domestic and bighorn sheep populations have helped the health of bighorn populations in the long term.

Dr. Michael Miller, Colorado Division of Wildlife, said that a paper in press may provide a framework on these kinds of analysis (measuring the effects of preventive actions). It will be published in December in *Ecological Applications*, and he will provide the information to Rainville. Connor et al. also provides an example of how one might go about evaluating preventative actions. The Singer paper (see the reference list in the risk analysis report) showed that translocations are 50% more likely to fail if domestic sheep are in the area. Any fish and game agency that translocates bighorn sheep in the vicinity of allotments needs to assess the wisdom of this action.

Panelists also discussed the amount of time and number of replicates necessary to evaluate actions. Changes in the populations may not be seen for some time since recruitment is affected for several years by a disease event. Rainville commented that population viability is the larger issue but disease transmission is the surrogate for addressing it. She asked for any literature talking about long-term responses (or lack thereof). Panelists were encouraged to provide her with any literature about rates of recovery.

Concern 19

19. Underestimates risk of disease in bighorns because it is limited to projects based solely on direct contact with domestics in 23 allotments.

This issue was related to viability since the planning unit is the Forest itself. Forest staff have coordinated with surrounding National Forests on the issue. Panelists agreed that statements 5 and 6 about movement might stimulate consideration of a broader scope.

Concern 20

20. Failure to completely highlight the various levels of a “more limited contact,” i.e., traces of just-trailed domestics, use of domestic goats for weed control, propensity of some bighorns to wander widely, etc.

When asked about information provided to the expert panel, Waters said that Pete Grinde, Payette National Forest, had presented an overview of grazing practices and management of domestic sheep on Payette National Forest allotments and been available throughout the day to answer questions about livestock management on these allotments. This information could be added to the risk analysis report. Panelists agree that management needs to be monitored and enforced, especially if management actions are implemented. Otherwise, the success/failure of these actions is impossible to evaluate. Regarding current permittees, Grinde commented that three of the four are outstanding. To guard against wolves, these permittees have two people per band and use guard and herding dogs. Grinde said there were two separate instances, totaling about 150 head, of lost or missing sheep separated from the rest of the permitted bands at some point during their time on the Payette National Forest allotments. Sheep that stray likely don’t last long due to predation. If Wildlife Services are notified immediately upon finding a kill, they can determine the cause of death.

Concern 21

21. Failure to address concerns over driveways in risk ratings.

It was mentioned that the statements didn't address domestic goats. Although no goats are under permit for weed control on the Forest, goats are occasionally used for packing by recreationists. Panelists decided to note that references to domestic sheep also include domestic goats. The statements should also note that goats are not currently an issue on the Payette National Forest. Foreyt reported that mountain goats and bighorn sheep have been penned together with no trouble. On the range, they avoid each other.

Concern 23

23. Failure to acknowledge that there are many documented cases of die-offs in bighorn sheep that have no reported contact with domestic sheep.

This concern was addressed in statement 4.

Concern 22

22. Disagree with characterization of die-offs—believe that the record shows frequent, significant losses of lambs that should be characterized as die-offs.

The phrase "and reduced recruitment" was added to statement 1 to address this issue.

Concern 37

37. Disagree with assertion that there is no data on disease transmission from Salmon River Mountains.

Drew reported that the IDFG has considerable information, but many of the health assessments were conducted farther upriver. Others interpreted the concern as being about the lack of data in the risk analysis. Waters responded that the report did include documentation, mostly from the IDFG. Nowhere in the document was it asserted that data were lacking.

Concern 8 (in Population Subcategory)

8. Disagree with finding that Salmon River meta-populations are not at risk from domestic sheep.

This issue was viewed as being similar to concern 37. The Salmon River metapopulation was addressed in the risk analysis. Panelists did wonder about the movement of bighorn sheep (especially rams) between the two metapopulations, given the continuous availability of habitat. They talked about potential barriers, but little was known. Schommer showed on the map where, with greater numbers, the two metapopulations could and would likely connect and interact. This discussion further emphasized the need for telemetry data. Dr. Ben Gonzales, California Department of Fish and Game, believed that the risk to metapopulations in Hells Canyon and in the Salmon River mountains was understated in the report. According to the scale of the maps provided and the distances traveled by GPS-collared rams, it is possible, if not probable, that rams could expose the different ewe groups throughout the range. Resources aside, if there are limited objective data on ram movements, management of bighorn/domestic interactions should be conservative. Likewise, Schommer believed there was probably more movement and connection than indicated in the document.

Concern 5 (in Habitat Subcategory)

5. Failure to address the effects of high elk numbers grazing in bighorn winter range in the Payette National Forest on bighorn sheep.

Panelists decided to add interspecies competition as a factor to statement 7. Schommer mentioned that the Oregon Department of Fish and Wildlife monitors elk in Hells Canyon. The numbers are about 70% to 75% of the agency's management objectives. Radio-collar studies on elk numbers show a huge impact of cougars on calf survival. He didn't see much overlap in wintering habitat.

Concern 38 and 40 (in Livestock Management Subcategory)

38. Question accuracy of the statement that bighorn sheep come into contact with the domestic sheep herds on the Payette (believe contact is unlikely and preventable due to herding)
40. Failure to include in the risk assessment that ewes are bred on the Curren Hill and Victor-Look allotments during late summer/early fall.

Panelists were asked whether they agreed that contact between bighorn sheep and domestic sheep occurs under range or other conditions (concern 38). With no voiced disagreement that contact can occur, the ensuing discussion focused on management to minimize contact between the two species and development of management practices to do so. Panelists agreed that management to minimize contact was possible, but it would require help from sheepherders as well. Garde reiterated that other factors of contact were less important than the magnitude of the consequence. She sought information on what was required before domestic sheep were placed on allotments and when they were out there.

The phrases "is possible" and "under range conditions" were added to statement 1. This statement was also broken into two sentences. Panelists discussed whether to change "increases risk" to "can increase risk." Most panelists believed that "increases risk" was accurate: the risk may be very small but it is not zero. Dr. Anette Rink, Nevada Department of Agriculture, dissented and preferred "can increase risk" because it didn't imply that any contact will result in disease transmission. Panelists also determined that the first three statements were related and should be renumbered as 1a, 1b, and 1c.

Suggested Management Strategies

Hayman reminded panelists that an item raised to discuss further if time permitted was possible management strategies to prevent contact between domestic and bighorn sheep. Garde had mentioned some strategies earlier in the day, so Hayman asked her to reiterate management actions regarding domestic sheep in British Columbia.

Garde said that, before any sheep are allowed on the range, the Ministry of the Environment considers the risks and mitigates for those to promote high-health flocks. Based on identified risks, such actions include inspecting for hoof rot, other foot problems, abscesses, parasites, blue tongue (location dependent), and body condition. In addition, sheep are vaccinated, lambs are weaned, and all are identified and subject to an isolation protocol. There are also regulations pertaining to the ratio of herders, guard dogs, and herding dogs to sheep. Once on the range, sheep must be penned at night. These protocols are applicable province-wide, not just in bighorn sheep habitat. Costs are borne by the producers, without government subsidies, but producers buy in because the protocols protect their own sheep since these are mixed flocks being used for clear-cut management on public lands. One panelist noted that die-offs have occurred in captivity after bighorn sheep were penned with apparently healthy domestic sheep. Therefore, these actions to ensure the health of domestic sheep may not eliminate pneumonia die-offs in bighorn sheep. It

was also noted that, although these measures are appropriate for BC flocks, a state-specific protocol should be developed that identifies local management strategies (flock health practices, closed vs. open flocks, etc.) and mitigation for diseases of local concern.

Several other management actions were also suggested:

- Not allowing breeding or lambing on the range
- Trucking rather than trailing in some situations
- Timing turn-in and turn-out to avoid overlap with known, occupied bighorn sheep ranges (an action requiring an understanding of wild sheep movements)
- Managing at night (through penning or other measures)
- Removing wild sheep in contact with domestic sheep (an action requiring rapid response from management agencies and herders)
- Removing/eliminating stragglers to prevent their grouping up with bighorn sheep (an action requiring a higher ratio of herders and dogs to sheep as well as a regular account of sheep and their movements)
- Marking sheep with bells or markings

Meeting Evaluation

Panelists were given the opportunity to evaluate the effectiveness of the meeting and make final remarks. Overall, panels were pleased with the interchange of ideas. They felt that the discussion during the meeting paved the way for a more collaborative approach. Although the meeting was held primarily to serve Rainville's immediate purpose, participants felt that it served a broader context. Several panelists hoped that the open and frank discussion could lead to a new direction in research. Specific research needs mentioned during the evaluation included not just looking at Pasteurella but also at other bacteria, viruses, and agents, assessing techniques used in domestic animal research, and adapting them for use on this issue. Laboratory scientists were also encouraged to let field scientists know what more they needed. Hayman was commended for processing the information in advance and focusing the meeting. Rink encouraged people to read the Wyoming management plan, which she thought could be adapted to other states. She added that all states with a lot of or mostly federally managed lands conduct the conflict with more adversity than Wyoming did due to that state's approach with private property rights. Keating mentioned the importance of continuing to study population structure and how bighorn sheep behave on the landscape. Management is important and cannot wait for epidemiological answers.

Closing Remarks

Rainville made several closing remarks. She was impressed with the open and honest exchange of information. She felt that the panel had met the objectives of the meeting, and she and the Payette National Forest now had excellent ideas on how to address the issues. She thanked panelists for the additional information that they provided. A key outcome was the eight statements that addressed the concerns and issues that came from the 67 comments from diverse interests. Rainville had not anticipated that outcome but greatly appreciated it. She hoped that the forum was also useful for the panelists.

Rainville emphasized that the USFS is methodical and has a process to follow. The risk analysis was the first step, and it is too early to begin making decisions regarding allotments. She understands that litigation is possible, but she'd like to show progress to avoid such litigation. She is interested in the Wyoming plan, and in exploring this with Idaho Fish and Game.

Rainville expressed her concern about panelists changing their minds about the statements, especially given that the meeting summary will be a public document and panelists are representatives of their agencies and organizations.

Hayman thanked the panelists and observers and adjourned the meeting.

Attendees

Meeting Administration

Suzanne Rainville, U.S. Forest Service, Payette National Forest, Forest Supervisor
Susan Hayman, North Country Resources, Inc.
Natalie Chavez, Chavez Writing & Editing, Inc.

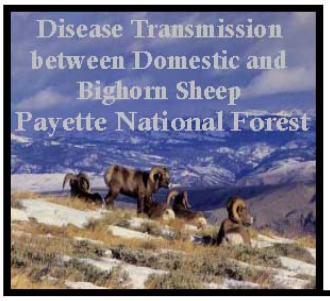
Science Panelists

Dr. Mark Drew, Idaho Department of Agriculture/Idaho Department of Fish and Game
Dr. Bill Foreyt, Washington State University, Department of Veterinary Microbiology and Pathology
Dr. Elena Garde, Ministry of the Environment–British Columbia
Dr. Ben Gonzalez, California Department of Fish and Game
Dr. Dave Jessup, California Department of Fish and Game
Dr. Kim Keating, U.S. Geological Survey, Northern Rocky Mountain Science Center
Dr. Michael Miller, Colorado Division of Wildlife
Dr. Anette Rink, Nevada Department of Agriculture
Dr. Sri Srikumanan, Washington State University, Department of Veterinary Microbiology and Pathology
Dr. Al Ward, University of Idaho, Caine Veterinary Teaching and Research Center
Dr. Glen Weiser, University of Idaho, Caine Veterinary Teaching and Research Center

Observers

Rick Forsman, U.S. Forest Service, Payette National Forest
Pete Grinde, U.S. Forest Service, Payette National Forest
Mark Hilliard, Bureau of Land Management
Clint McCarthy, U.S. Forest Service, Payette National Forest
Tim Schommer, U.S. Forest Service
Patti Soucek, U.S. Forest Service, Payette National Forest, Forest Planner
Jeff Waters, U.S. Forest Service

Appendix A—Agenda



Science Panel Discussion
November 2, 2006
USGS/Bureau of Reclamation Office
230 Collins Road, Boise ID

Meeting Objectives:

1) Clarify the science-based concerns regarding the *Risk Analysis of Disease Transmission between Domestic Sheep and Bighorn Sheep on the Payette National Forest (February 6, 2006).*

2) Allow panelists to provide additional science-based information regarding disease transmission and its risk of occurring on the Payette National Forest that the Forest Supervisor should consider in conjunction with the *Risk Analysis*.

Meeting Prework:

1) Read the *Risk Analysis* and note any ***specific*** areas of concern for discussion.

2) Review, and be prepared to discuss, the abstract of the science-based comments received during the comment period for the *Risk Analysis*.

3) Provide one copy each of up to five separate scientific documents that you personally feel are critical to the analysis and discussion. **Please provide this to the facilitator by October 20, 2006**.

4) Provide a bibliography of other key literature that you think the Forest Supervisor should consider in conjunction with the *Risk Analysis*.

Agenda

Time	Topic	Process / Product
8:30 a.m.	Opening ▪ Welcome and introductions – Pattie Soucek, Payette Forest Planner ▪ Meeting purpose and outcomes – Suzanne Rainville, Payette Forest Supervisor ▪ Meeting overview – Susan Hayman, Facilitator	Information
9:00 a.m.	Process review ▪ Overview of the 3-step decision process – Pattie Soucek ▪ Method of determining risk – Jeff Waters, Forest Service Wildlife Biologist ▪ Clarifying Q&A on processes and procedures – Panelists	Information, Facilitated Discussion
9:30 a.m. *(A 15-minute break will be taken during this segment)*	Specific science-based concerns with the *Risk Analysis* ▪ Concerns identified during the comment period ▪ Concerns brought forward by the meeting participants ▪ Discussion of the compelling scientific literature related to specific concerns	Information, Facilitated Discussion
11:30 a.m.	LUNCH (to be brought in)	
12:30 p.m. *(A 15-minute break will be taken during this segment)*	Specific concerns with the Risk Analysis (cont'd)	Information, Facilitated Discussion *Product: Complete list of specific science-based concerns and related key scientific findings*
4:00 p.m.	Next steps, closing remarks – Suzanne Rainville	
4:30 p.m.	Adjourn	

Appendix B—Comments to Address

Synthesized from the "Abstract of Comments," and grouped by topic areas

Habitat

1. Failure to document the extent of high quality, unoccupied habitat and historical bighorn range within the Hells Canyon Area.
2. Disagree with potential bighorn habitat listed in Figure 1, page 37 of the report.
3. Report underestimates the extent of the area affected by the Smith Mountain Sheep Allotment.
4. Failure to provide information on the quality of bighorn sheep habitat in the area.
5. Failure to address the effects of high elk numbers grazing in bighorn winter range in the Payette National Forest on bighorn sheep.

Population

6. Critical of the lack of documentation of "abundant" populations of bighorn sheep prior to the commencement of domestic grazing in the 1800's.
7. The population status evaluation is flawed.
8. Disagree with finding that Salmon River meta-populations are not at risk from domestic sheep.
9. Inaccurately describes the amount of bighorn sheep habitat contained within the five allotments associated with the Shirts Brothers.
10. The positive annual growth numbers for bighorn sheep in Hells Canyon do not take into account the large number of bighorn reintroductions that have taken place.
11. Failure to discuss why it is necessary to adopt any management changes when the Hells Canyon meta-population has increased over the last 30+ years.

Disease/Mortality

12. Disagree with the premise that domestic sheep transmit disease to bighorn sheep on the range/in the wild. Report conclusions based on circumstantial evidence, rather than in any scientifically verifiable way.
13. Disagree that the risk of disease can be evaluated in a quantitative manner when the specific mechanisms for transmitting disease have been difficult to document outside of clinical settings.
14. Failure to address significance of bighorn behavior and social patterns that contributes to their natural susceptibility to disease.
15. Failure to evaluate the potential for disease transmission through inter-population movements of bighorns when assessing risk for allotments on the east side of the Forest.
16. Failure to include references that the same viral and bacterial pathogens in bighorn sheep are also commonly found in domestic sheep bands.
17. Failure to acknowledge a Pasteurella strain unique to bighorn sheep.

18. Failure to include references that bacteria in the family Pasteurellaceae have been found in bighorn sheep herds regardless of no known, or suspected, contact with domestic sheep.
19. Underestimates risk of disease in bighorns because it is limited to projections based solely on direct contact with domestics in 23 allotments.
20. Failure to completely highlight the various levels of a "more limited contact," i.e. traces of just-trailed domestics, use of domestic goats for weed control, propensity of some bighorns to wander widely, etc.
21. Failure to address concerns over driveways in risk ratings.
22. Disagree with characterization of die-offs – believe that the record shows frequent, significant losses of lambs that should be characterized as die-offs.
23. Failure to acknowledge that there are many documented cases of die-offs in bighorn sheep that have no reported contact with domestic sheep.
24. Question whether the bighorns could be carriers of disease, and that transplanting introduces new pathogens into their own herds.
25. Failure to address whether bighorn sheep could be carrying disease to domestic sheep herds.
26. Failure to address how the factors of transplantation, human contacts, and sedation for transport may be precursors to disease problems.
27. Failure to address how the effects of fire may be precursors to disease problems.
28. Failure to address how excessive or unseasonable rains and snows, and extremes of heat and cold may be precursors to disease problems.
29. Failure to address how nutritional shortages may be precursors to disease problems.
30. Question about factors related to the success and failure of translocations, other than proximity to domestic sheep, which were considered and measured in the analysis.
31. Disagree with finding that removal, rather than separation, is the only remedy to reduce risk of disease transmission on the Payette National Forest.
32. Failure to discuss how the separated populations of domestic and bighorn sheep populations have helped the health of bighorn populations in the long term.
33. Failure to draw more extensively from studies by Garde et al.
34. Failure to cite studies from the University of Idaho Caine Veterinary Research and Teaching Center.
35. Failure to address the effects of predation on bighorn sheep.
36. Failure to discuss the relationship between the reintroduction of wolves and the resultant change in bighorn sheep behavior, keeping the bighorn sheep at higher elevations and, effectively, keeping domestic and bighorn sheep apart.
37. Disagree with assertion that there is no data on disease transmission from Salmon River Mountains.

Livestock Management

38. Question accuracy of the statement that bighorn sheep come into contact with the domestic sheep herds on the Payette (believe contact is unlikely and preventable due to herding)

39. Failure to adequately evaluate the risk of contact between domestic and bighorn sheep for allotments on the east side of the Payette National Forest
40. Failure to include in the risk assessment that ewes are bred on the Curren Hill and Victor-Look allotments during late summer/early fall.

Viability Analysis

41. Failure to define population viability for bighorn sheep.
42. Disagree with conclusion that domestic sheep grazing in the Smith Mountain and Curren Mountain allotments would not threaten the viability of bighorn populations north of Hells Canyon.
43. Disagree with all findings on "viability" due to the inadequacy on analyzing for viability in the report. The report cannot reach conclusions about long-term viability without performing a viability analysis.

Risk Analysis Process

44. No qualified veterinarian with knowledge of domestic sheep included on the expert panel.
45. No rangeland professionals were included on the expert panel.
46. No one knowledgeable in domestic sheep behavior or management was included on the expert panel.
47. Failure to provide expert panel with information regarding livestock rotations or herding practices on the allotments in question.
48. Disagree with the Forest Service conducting a risk analysis rather than a viability analysis as directed in the appeal decision, and lack of information in the report to document why this was done.
49. Believe analysis was really an analysis of the "risk of contact" rather than a "risk of disease transmission."
50. Failure to conduct a risk assessment for the Surdam allotment.

Appendix C—Panelists' Key Literature References, Compiled October 30, 2006

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Appendix D—Flip Charts

Risk Analysis:
3 Components

1) Literature review
2) Review and analysis of information on known bighorn sheep populations (including those adjacent to Forest)
3) risk of disease transmission (expert panel)

1) Scientific observation and field studies demonstrate that "contact" between domestic and sheep and bighorn sheep is possible under range conditions. This contact ~~creates a~~ increases risk of subsequent bighorn sheep mortality and reduced recruitment, due primarily to respiratory disease.
2) The complete range of mechanisms/causal agents that lead to epizootic disease events cannot be conclusively proven at this point.
3) Given the previous two statements, it is prudent to undertake management ~~that minimizes~~ to prevent contact between these species.
4) Not all bighorn sheep epizootic disease events can be attributed to contact with domestic sheep.
5) Gregarious behavior of bighorn sheep and domestic sheep may exacerbate potential for disease introduction and transmission.
6) Dispersal, migratory, and exploratory behaviors of individual bighorn sheep traveling between populations may exacerbate potential for disease introductions and transmission.
7) There are factors (e.g., translocation, habitat improvement, harvest, weather, nutrition, fire, interspecies competition, and predation), some that can be managed ~~(e.g., translocation, habitat improvement, harvest)~~ and some that cannot, that ~~to~~ influence bighorn sheep population viability. ~~There are other factors (e.g., fire, nutrition, weather) that cannot be readily managed that also influence bighorn sheep population viability.~~
8) Pasteurellacae, other bacteria, viruses, and other agents may occur in ~~the normal flora of~~ healthy, free-ranging bighorn sheep.

Bin

1) Can viability be determined on a Forest-wide basis?
2) Suggest management strategies for preventing contact

   —monitoring of management
3) Literature regarding rate of recovery

Missing [from Risk Analysis]

- Other pathogens
- Case definitions for contact
- Magnitude of the negative outcome (level of consequence)
- Check out other models for risk assessment (Elena)

Suggested Actions

1) Telemetry data on Salmon River metapopulations, especially at potential interface of Hells Canyon/Salmon River populations
2) Note: There may be additional factors beyond disease transmission affecting bighorn sheep populations.
3) More robust assessment of risk of contact (lack of quantitative information)
4) Check out other methodologies for assessment from Elena
5) Need data on domestic and bighorn sheep movements (telemetry VHF/GPS; day/night)
6) Encourage evaluation/monitoring of before/after data in future bighorn sheep management (#32) (Mike Miller to provide Connor et al. article on how you might do this)

   —long-term, takes awhile for positive change/recovery

   survival, recruitment, as well as lamb ratios
7) Include current management of domestic livestock in analysis information (provided, but not included in report)

Suggestions: Management Strategies

1) Provisions/protocols for what needs to occur before domestic sheep are put on the range

   —with adaptive management

   —risk analysis specific

   —(see Elena's paper)
2) Don't breed or lamb on range
3) Trucking instead of trailing in some circumstances
4) Timing of turning sheep in/out on allotment so that not an overlap with bighorn sheep
5) Night-time management (e.g., penning)
6) Removing wild sheep in contact with domestic sheep (quickly)
7) Remove/eliminate straggling domestic sheep from range
8) Regular accounting of sheep/movements
9) Requirements for herding experience, ratio of herders to sheep, guard dogs to sheep, herding dogs to sheep, etc.
10) Mark sheep with markers/bells