Western Association of Fish and Wildlife Agencies (WAFWA)
Wild Sheep Working Group
Initial Subcommittee
Recommendations for Domestic Sheep and Goat Management In Wild Sheep Habitat
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Introduction/Overview

The USDI Bureau of Land Management (BLM) and the USDA Forest Service (USFS), the two principal federal land management agencies in the western United States, are in the process of reviewing and updating their policies on the management of domestic sheep and goats in wild sheep habitat, with the intention of developing consistent, and potentially joint, policy. Although the risk of disease transmission from domestic sheep and goats to wild sheep is widely recognized by wildlife and land management agencies, a unified set of management guidelines for minimizing this risk has not yet been devised or adopted by responsible agencies. This report is designed to provide a foundation for BLM and USFS development of a more unified policy for management of this west-wide issue.

At the request of the BLM, guidelines for management of domestic sheep in bighorn sheep habitat were first formally developed in the late 1980s (Desert Bighorn Council 1990). These guidelines led to development and dissemination of BLM Instruction Memoranda (USDI-BLM 1992, USDI-BLM 1998), providing guidelines for BLM field offices in the western U.S. The USFS (Schommer and Woolever 2001, Schommer and

Woolever 2007) published and updated a process paper, providing agency staff with recommended direction to reduce or eliminate contact between wild sheep and domestic sheep and goats. The provinces of Alberta and British Columbia have also developed guidelines for the use of domestic sheep for vegetation management on crown lands where contact with bighorn sheep is possible.

In January 2007, the Western Association of Fish and Wildlife Agencies (WAFWA), comprised of 23 state and provincial wildlife agencies from the western U.S. and western Canada, established a Wild Sheep Working Group (WSWG). This WSWG was requested to provide a comprehensive, west-wide assessment of all facets of wild sheep management, from the desert southwest to the far north. The first task undertaken by the WSWG was to develop a framework of recommendations for state, federal, and provincial agencies to tier to, when developing management guidelines dealing with potential contact or interaction between wild sheep and domestic sheep and goats, recognizing the diversity and complexity of applying such guidelines across the wide variety of habitats and jurisdictions represented within WAFWA. The members of this initial WSWG were specifically selected based on their familiarity and knowledge of this issue, and represented a diverse mix of wildlife veterinarians, wild sheep managers, and land management agency wildlife program leaders from the U.S. and Canada.

Throughout significant portions of their range, bighorn sheep (*Ovis canadensis*) suffer from periodic population depression, largely resulting from recurrent respiratory disease epizootics. Epizootics in native bighorn herds were reported in various locations following European settlement and establishment of domestic livestock grazing throughout the central and southern Rocky Mountains. This trend may reflect historical introduction of novel pathogens (including some *Pasteurella* spp. strains) into naive bighorn populations beginning in the late 1800s (Grinnell 1928; Skinner 1928; Marsh 1938; Honess and Frost 1942; Miller 2001); the lack of similar trends in “thinhorn” sheep (*O. dalli*) that reside in habitats that have not experienced widespread domestic sheep grazing supports the notion that such epidemics are not necessarily a part of the natural history of North America’s wild sheep species.

Over the past 30 years, there has been a steadily increasing body of anecdotal and empirical evidence underscoring the potential risk of disease transmission from domestic sheep and goats to wild sheep (McQuivey 1978, Hunt 1980, Jessup 1980, Foreyt and Jessup 1982, Goodson 1982, Coggins 1982, Onderka and Wishart 1984, Jessup 1985, Festa-Bianchet 1988, Onderka and Wishart 1988, Onderka et al. 1988, Schwantje 1988, Callan et al. 1991, Coggins and Matthews 1992, Foreyt 1994, Foreyt et al. 1994, Cassirer et al. 1996, Martin et al. 1996, Coggins 2002, Rudolph et al. 2003). More recent assessments (USDA-FS 2006a, USDA-FS 2006b), workshops (UC-Davis 2007), and authors (Gross et al. 2000, Singer et al. 2000, Dubay et al. 2002, Epps et al. 2004, Jansen et al. 2006) have addressed the risk associated with contact between wild sheep and domestic sheep and goats, and many have recommended no contact be allowed between wild and domestic sheep and goats, in an effort to minimize disease transmission.

The WSWG collectively believes that effective separation (both temporal and/or spatial) between wild sheep and domestic sheep and goats should be a primary management goal of state and provincial agencies responsible for wildlife management. We acknowledge that effective separation does not necessarily require the removal of domestic sheep and goats. However, the option of removing domestic sheep and goats should be included in the array of strategies to address this issue.

We acknowledge the continuing debate between wildlife and livestock proponents regarding the credibility and scientific merit of past findings, criticisms of experimental design and rigor, limitations of drawing inferences about natural disease events versus "controlled" experiments in confined settings, and valid differences of opinion on this issue. However, we believe there is a preponderance of evidence, taken collectively from a wide variety of observations that indicates significant risk of disease transmission from domestic sheep and goats to wild sheep exists. In some cases, consequences to wild sheep have been severe enough to endanger entire populations of wild sheep. Consequently, we continue to recommend that wild sheep managers take appropriate steps to minimize, mitigate, or eliminate the opportunities for disease transmission. Practical solutions will

be difficult if not impossible to achieve until there is widespread acknowledgement that the risk of disease transmission from domestic sheep and goats to wild sheep is real. We recognize that reaching this goal is likely to require additional scientific evidence. Recognition by stakeholders that all parties benefit when this disease risk is actively managed is also critical.

Concerns about potential disease transmission between domestic livestock and wildlife, and management approaches directed at minimizing such risks, are certainly not unprecedented. An analogous situation presently exists with the disease brucellosis in the Greater Yellowstone Area (GYA): suspected transmission between wild ungulates (i.e., bison, elk) and domestic livestock (i.e., cattle) has occurred, disease transmission from elk and bison to cattle has been proven in clinical environments but has been difficult to confirm under field conditions, the economic and herd management implications are huge, and management of this disease problem has largely focused on temporal and spatial separation of livestock and wildlife to minimize risk. In the GYA, significant, and what some may consider drastic steps (e.g., lethal removal of bison) have been taken to minimize the risk of contact and possible transmission of *Brucella* organisms between wild ungulates and domestic livestock. The situation is very similar for pasteurellosis in wild sheep caused by bacteria from the *Pasteurella/Mannheimia* families (Ward et al. 1990, Ward et al. 1997, Miller 2001): there is cause for concern that is supported by logic, experience, and clinical scientific study, and a clear strategy for minimizing the risk of disease transmission by separating reservoir and susceptible species exists. Consequently, we believe there is a sufficient amount of reliable information available to move forward, seeking solutions to this issue.

The Payette National Forest Principles

At a November 2, 2006 meeting in Boise, ID, the Payette National Forest Science Panel, comprised of wildlife and domestic ungulate health experts with experience in pasteurellosis in wild and domestic sheep, working closely with a USFS facilitator, reviewed the available scientific information on bighorn-domestic sheep interactions and

developed a list of statements of principle (USDA-FS 2006b) that were discussed and debated, but then ultimately agreed on by those same experts:

> 1a) Scientific observation and field studies demonstrate that "contact" between domestic sheep and bighorn sheep is possible under range conditions. This contact increases 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.
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> 1c) Given the previous two statements, it is prudent to undertake management to prevent contact between these species.
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> 2) Not all bighorn sheep epizootic disease events can be attributed to contact with domestic sheep.
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> 3) Gregarious behavior of bighorn sheep and domestic sheep may exacerbate potential for disease introduction and transmission.
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> 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 influence bighorn sheep population viability.
>
> 6) Pasteurellaceae, other bacteria, viruses, and other agents may occur in healthy, free-ranging bighorn sheep.

Our WSWG concurs with statements developed and adopted by the interdisciplinary Payette NF Science Panel, and they form the foundation for our recommendations. Consequently, in this report, we do not intend to again review and synthesize all available literature and other evidence, both published and unpublished "gray literature" in agency files. Rather, this working group is providing what we believe are reasonable, logical recommendations, based on the best available science, that will help achieve effective separation between wild sheep and domestic sheep and goats. We recognize it is impossible to achieve zero risk of contact or disease transmission; however, we also recognize there are many ways to proactively work toward minimizing or eliminating interaction between these species that should help lower the overall risk of epizootics in wild sheep.

Concepts of Managing Risk

Two-way transmission of certain diseases (e.g., paratuberculosis, some enteric pathogens and parasites) between wild sheep and domestic sheep and goats in shared habitats can occur. However, as domestic animals have evolved and have been selected for their ability to live at high densities and for their resilience to infectious diseases, we believe the most important and ecologically significant transmission is from domestic sheep and goats to wild sheep. It is widely recognized (Garde et al. 2005), but needs to be re-emphasized, that thinhorn sheep (Dall sheep, Stone sheep) in northwestern Canada and Alaska are immunologically naïve compared to wild sheep occurring in southern Canada and the remainder of the western U.S. Additional precautions should be taken to ensure that absolutely no contact occurs between naïve thinhorn sheep and domestic sheep and goats.

It must be acknowledged that wild sheep die-offs have occurred without reported contact with domestic sheep and goats (Onderka and Wishart 1984, Aune et al. 1998, UC-Davis 2007). However, when contact between wild sheep and domestic sheep and goats has been documented, the severity of the wild sheep die-off is typically more pronounced (Aune et al. 1998, Martin et al. 1996).

Although these recommendations have been developed by a working group comprised of state and provincial wildlife agency personnel, we recognize that cooperation between state/provincial wildlife agencies, federal land management agencies, tribal/First Nation representatives, domestic sheep and goat producers and grazing permittees, agricultural industry representatives, wild sheep conservation organizations, environmental groups, academic institutions, and various interested publics is critical to deriving on-the-ground solutions. It is our hope that collaborative discussions on this topic occur in each state and province where this issue occurs.

As reflected in the Payette NF Science Panel summary, we recognize there are many human-caused (e.g, displacement/disturbance) and environmental (e.g., predation, climatic) stressors that also influence the dynamics and viability of wild sheep

populations. We acknowledge that some factors affecting wild sheep population performance can be managed; others cannot.

The guiding principle of this WSWG's effort has been "to seek effective separation." We believe that even though no "cookbook" exists for conducting risk assessments of respiratory disease transmission between wild sheep and domestic sheep or goats, comprehensive risk assessment is a critical component for managing potential disease transmission from domestic sheep and goats to wild sheep. There are thorough qualitative and quantitative risk assessments (USDA-FS 2006a, Clifford et al. 2007, Epps et al. in press) that have used both map-based and modeling approaches to assess consequences of contact and subsequent transmission risk.

Management Guidelines

The following recommendations have applicability to state/provincial wildlife agencies, federal land management agencies, wild sheep conservation organizations, domestic sheep and goat producers/permittees, and private landowners. These recommendations have been strategically assigned to a category we have judged to be most logical and reasonable. However, it is imperative that readers recognize these recommendations are typically pertinent to multiple parties, and further recognize that a multi-disciplinary approach will likely produce the best outcomes, for wild sheep and for domestic sheep and goat producers/permittees. To simplify the content of these recommendations, we have defined specific, frequently-used terms (e.g., "effective separation") in a glossary (Appendix A).

We recommend wild sheep managers recognize and design management strategies by prioritizing the conservation values (e.g., federal- and/or state-listed status, sensitive species status, native wild sheep herds that have never been extirpated or augmented, naïve wild sheep populations with no previous exposure to domestic sheep and goats) and importance of wild sheep populations. The higher the wild sheep conservation value, and the greater the risk of contact with domestic sheep and goats, the more aggressive and

comprehensive that wild sheep and domestic sheep and goat management strategies should be, commensurate with the level of risk of contact.

Recommendations to WAFWA Agencies

- Historic and suitable unoccupied wild sheep range should be identified, evaluated, and compared against currently-occupied wild sheep distribution for each state/province within the historic range of wild sheep, and also compared against existing and potential areas where domestic sheep and goats are, or may be, authorized.

- Risk assessments should be periodically completed (at least once per decade, more often if situations change) on all existing and potential wild sheep habitat, to specifically identify where and to what extent the wild sheep/domestic sheep and goat interface is located and to monitor changes in risk along that interface.

- Following completion of site-specific risk assessment, wild sheep transplant, augmentation, restoration, and management strategies should be designed to minimize the likelihood of contact between wild sheep and domestic sheep and goats.

- Wild sheep managers should identify, analyze, and evaluate the implications (i.e., both positive and negative) of connectivity and movement corridors between largely insular herds within a meta-population against the opportunity for increased contact with domestic sheep and goats. The benefit of genetic interchange (and implications for population viability) must be weighed against the heightened risk of possible disease transmission (Bleich et al. 1990), especially if dispersing/wandering wild sheep might travel through occupied domestic sheep and goat grazing allotments or trailing routes, or move introduced or locally endemic pathogens from an infected wild herd into a naïve herd.

- Do not transplant wild sheep where there is no reasonable likelihood of achieving effective separation between wild sheep and domestic sheep and goats, unless written agreement to the contrary has been reached between state/provincial wildlife agencies, federal land management agencies, agricultural interests, and wild sheep conservation organizations.

- As potential agricultural conflicts, landscape conditions and habitat suitability change, stocking wild sheep onto historic range, particularly on public lands, should be re-evaluated.

- Wild sheep populations should be managed to reach predetermined population levels (i.e., objectives), and maintained at appropriate densities, to minimize risk of dispersal whereby contact with domestic sheep and goats, and subsequent contact with other wild sheep, is increased. It should be recognized that wild sheep dispersal does occur at all population densities, so some risk is always present if domestic sheep and goats are within range of dispersing wild sheep.

- The higher the risk of contact with domestic sheep and goats, the more intensively that wild sheep herd(s) need to be monitored and managed. Intensity of monitoring should be commensurate with the level of risk and probability of domestic sheep and goat contact when considering “new” vs. “augmented” wild sheep populations. If there are anticipated differences in likelihood of contact with domestic sheep and goats, a site-specific transplant protocol should be spelled out for “new” vs. “augmented” wild sheep populations. For example, the percentage of transplanted wild sheep that should be radio-collared (preferably with GPS collars) should depend upon the subsequent risk of domestic sheep and goat contact. Intensive monitoring allows for documenting the proximity and frequency of interaction between wild sheep and domestic sheep and goats, and also allows for evaluation of post-release habitat use/selection and seasonal/daily movement. It should also be recognized that in some cases, monitoring will be long-term in nature. Budgets to transplant wild sheep should also be adequate to ensure long-term monitoring of transplant success and future wild sheep movements.

- Wild sheep managers should recognize that augmentation of a wild sheep herd from discrete source populations also poses a risk for moving pathogens between wild sheep. Wild sheep management agencies should only use healthy wild sheep herds as source stock for intra- and inter-jurisdictional transplant purposes. Source herds should have extensive health histories and be routinely monitored to evaluate current health conditions. Wild sheep managers should evaluate tradeoffs between genetic benefits vs. potential health consequences of mixing wild sheep from various source herds when conducting transplants or augmentations.

- If conducting a wild sheep transplant, a map of anticipated wild sheep distribution and movement should be developed prior to the transplant and compared with knowledge of domestic sheep and goat distribution. If a wild sheep transplant occurs, and contact with domestic sheep and goats is confirmed beyond an identified timeframe and/or beyond a mapped geographic area (possibly including historic, suitable wild sheep habitat), domestic sheep and goat producers should be held harmless. Domestic sheep and goat producers outside a pre-defined and mapped wild sheep restoration area, based on expected distribution following a transplant, should not be considered accountable if subsequent contact between wild sheep and domestic sheep and goats occurs or becomes likely.

- Agencies should develop, adopt, and widely distribute a written strategy to address dispersing or wandering wild sheep (British Columbia Ministry of Environment example, Appendix B; Wyoming Game and Fish Department example, Appendix C). These animals may contact domestic sheep and goats, and continue traveling, either back to their source herd, or to other wild sheep herds, with or without infectious disease. This strategy should clearly identify what and when specific actions are to be taken (e.g., kill and medically evaluate wandering wild sheep), and specify who is authorized to take those actions. Furthermore, this strategy should be openly discussed with affected stakeholders, so there is clear and widespread understanding

of subsequent management actions by state/provincial wildlife agencies. Some state/provincial wild sheep management plans have already been through considerable public input/review, where this issue has been adequately addressed.

- Agencies should develop a response protocol for confirmed contact between wild sheep and domestic sheep and goats. This strategy should include notification requirements, wildlife health intervention (if appropriate), and post-contact monitoring strategies. Furthermore, state/provincial wildlife and agriculture agencies, land management agencies, industry representatives, and wild sheep advocates should collaborate to develop an effective, efficient, and legal response protocol for errant domestic sheep and goats (e.g, feral, abandoned) for which no owner can be determined and which threaten to come in contact with wild sheep.

- State/provincial wildlife agencies should work together to develop a system (possibly internet-based) to report, record, and summarize instances of interaction between wild sheep and domestic sheep and goats, to track reported contact between wild sheep and domestic sheep and goats, and to avoid loss of anecdotal sightings/reports, Once established, the WSWG website link (http://www.wafwa.org/5.html) would be a logical place to host this incident reporting system. Furthermore, state/provincial and federal wild sheep managers should encourage prompt reporting by the public of observed interaction between wild sheep and domestic sheep and goats.

- The use of domestic sheep and goats as pack animals by hunters, anglers, and other recreational or commercial users that travel in mapped wild sheep habitat should be prohibited where legislation/regulation exists. Where legislation/regulation is not in place, an effective outreach/education program should be implemented to inform potential users of the risks associated with that activity and recommend that individuals do not use domestic sheep or goats as pack animals.

- Wild sheep managers should coordinate with local Weed & Pest Districts or other appropriate agencies/organizations involved with weed management to preclude the use of domestic sheep and goats for noxious weed control, in areas where contact between wild sheep and domestic sheep and goats is likely to occur. Agencies should provide educational information and offer assistance to Weed & Pest Districts regarding the disease risks associated with domestic sheep and goat use. Specific guidelines have been developed by, and implemented in, British Columbia (http://www.for.gov.bc.ca/hfp/publications/00006/).

- Several capture and disease-testing protocols (pre-transplant, post-dieoff) have been developed and/or drafted and are available to wild sheep managers (Foster 2004, WAFWA Wildlife Health Committee (WHC), UC-Davis 2007). Specific protocols for sampling, testing for transplant, and responding to disease outbreaks are necessary and should be standardized across state and federal jurisdictions. These protocols should be reviewed and updated if necessary by the WHC and presented to the WAFWA Directors for final endorsement. Once endorsed by the WAFWA Directors,

wild sheep management agencies should implement the existing protocols, and the WHC should lead the effort to further refine and implement said protocols.

- Wild sheep management agencies should coordinate and pool funding and resources to support laboratories and testing facilities with expertise in various facets of wild sheep disease diagnostic work. Furthermore, state and provincial wild sheep managers should support efforts on data sharing, development and use of standardized protocols for assessment of wild sheep herd health status. Inter-agency communication between wildlife disease experts should be encouraged, to synergistically accomplish more than individual agencies or organizations are capable of by themselves.

Recommendations to BLM and USFS (and other land management agencies)

- Joint federal land management agency guidelines on management of domestic sheep and goats in wild sheep habitat should be developed and included in both broad agency policy documents (e.g, USFS Manuals) and local Forest Plan/Resource Management Plans. Once guidelines have been approved, there should not be an automatic "sunset" provision or expiration date. If there is a specified longevity required by federal policy, and if appropriate and timely review cannot be completed, the existing guidelines should remain in effect, rather than becoming obsolete.

- Land management agencies responsible for domestic sheep and goat grazing allotments, trailing routes, vegetation management (e.g., weed control, enhancement of conifer regeneration), use as pack stock, or any other uses involving domestic sheep and goats should only authorize such use where mechanisms are in place to achieve effective separation with wild sheep.

- Land management agencies should require prompt notification of interaction between wild sheep and domestic sheep and goats by permittees and their herders. Notification procedures (including phone numbers/contact information for permittees, and use of satellite phones in backcountry settings) should be included in the Annual Operating Instructions for grazing allotments and trailing permits.

- Land management agencies should map active vs. inactive domestic sheep and goat grazing allotments/trailing routes, including information on dates of use and contact information for the responsible grazing/trailing permittee.

- Ensure advance written instructions (such as USFS Annual Operating Instructions) exist, addressing management, retrieval, and disposition of stray domestic sheep and goats left on public lands prior to and/or after grazing/trailing/permitted on- and off-dates.

- Collaboratively with state/provincial wildlife and agricultural interests, written agreements should be developed as to management, retrieval, and disposition of stray domestic sheep and goats occurring on public lands where there is no grazing/trailing allotment nor permitted use. Furthermore, these agreements should address feral

sheep and goats as well as other exotic breeds (e.g., aoudad, Iranian red sheep, urial, argali) that range free on public lands.

- Annual Operating Instructions should require careful management and vigilant herding, to minimize/avoid wild sheep interaction with stray domestic sheep and goats. If appropriate, a count-on, count-off inventory of domestic sheep and goats may be required as a condition of operation.

- In areas of high risk of contact, trucking should be required, since trailing may result in additional management risks. Trucking of domestic sheep and goats is preferred to trailing, since there is less chance of stray domestics, and less chance of opportunistic contact by wandering wild sheep, particularly when domestic ewes are in estrus.

- If trailing occurs, on-site compliance monitoring to minimize strays should be conducted by the permittee and/or the land management agency. In areas of highest risk, use of wild sheep advocates as volunteers to assist with compliance monitoring should be explored.

- Land Use/Resource Management Plans, where relevant, should specifically address the issue of potential domestic sheep and goat interaction with wild sheep. Land use plans should evaluate the suitability of permitting activities involving domestic sheep and goats. Plans should address this issue and identify general areas of public land where domestic sheep and goats should not be permitted for weed control, commercial grazing, recreational packing, conifer regeneration vegetation management, and other management activities.

- Land management agencies should coordinate closely with appropriate entities involved in weed control programs (e.g., local Weed & Pest Districts, University Experiment Stations, private landowners) using on domestic sheep and goats on public lands, adjoining private lands, or state/provincial wildlife habitat management areas.

- Where topography, vegetation, and other abiotic/biotic parameters are suitable, conversion from domestic sheep and goats to cattle, llamas, or other classes of domestic livestock that do not pose a disease risk to wild sheep should be carefully considered when permitting grazing allotments and pack animal outfitting.

- Land management agencies should not convert cattle grazing allotments to domestic sheep/goat grazing or permit trailing, in areas of suitable, historic wild sheep habitat. In suitable, historic wild sheep habitat not currently stocked with domestic sheep and goats, management strategies should emphasize options for restoring wild sheep populations.

- Stocking of allotments not currently under permit to domestic sheep and goats under emergency conditions (e.g., reduced forage available in permitted allotment areas due

to wildfire or drought) should only be permitted after adequate risk assessment has been completed. This assessment can be completed via project-level NEPA analysis.

- Land management agencies should incorporate state/provincial wild sheep management plans either in, or supplemental to, federal Resource or Land Use Management Plans. Land management agencies should collaborate with state/provincial wildlife agencies on comprehensive risk assessments (USDA-FS 2006a, Clifford et al. 2007) of domestic sheep and goat grazing allotments or trailing routes in wild sheep habitat, to assess risk of contact with wild sheep. Adequate training (e.g., workshops, manuals) should be provided to agency staff to conduct risk assessments.

- Where mandatory buffer zones (frequently cited as a minimum of 9 airline miles [13.5 km]) between domestic sheep and goats and wild sheep have been used to ensure effective separation, it should be recognized that buffer zones apply to herds or populations of wild sheep, rather than wandering individuals (e.g, most often sub-adult bighorn rams).

- In some cases, buffer zones have been a very effective strategy to reduce the opportunity for interaction between wild sheep and domestic sheep and goats. However, in continuous wild sheep habitat, where wild sheep movements may eventually exceed *a priori* expectations, buffer zones may not be the most effective or practical tool (Schommer and Woolever 2007).

- Topographic features or other natural or man-made barriers (e.g., fenced, interstate highways) can also be effective in minimizing the likelihood of physical contact between wild sheep and domestic sheep and goats. Site-specific risk assessments should be completed, to evaluate the efficacy using natural barriers, defined buffer zones and other preventive actions to minimize risk. Given the wide range of circumstances across jurisdictions, buffer zones may not be needed in all situations; conversely, buffer zones should not be precluded as an effective strategy to address this issue.

- Land management agencies, in collaboration with state/provincial livestock health agencies, should work with producers/permittees to prevent turnout of sick or diseased domestic sheep and goats on grazing allotments or on trailing routes, or used for weed control or pack stock. Sick or diseased animals on range should be reported to land management or wildlife agency personnel as soon as possible after recognition; after that initial notification, inter-agency coordination should promptly occur. Analogous to requirements to use certified weed-free hay on public lands, or requirements to clean logging or other heavy equipment which have been operating in other areas where noxious weed seed might be inadvertently scattered into new areas, domestic sheep and goats should be healthy before being turned out. Alberta and British Columbia (http://www.for.gov.bc.ca/hfp/publications/00006/) have developed specific health certification protocols required before domestic sheep are turned out for vegetative management in conifer reforestation efforts. The higher the risk of

contact between domestic sheep and goats with wild sheep, the higher the certainty of domestic animal health should be. It should also be recognized that "healthy-appearing" domestic sheep and goats may still carry pathogens that can be transmitted to wild sheep.

- Proportional to the risk of contact between domestic sheep and goats and wild sheep, land management agencies should work with producers/permittees, state/provincial wildlife agencies, wild sheep advocates, and others, to implement a variety of mitigation strategies (e.g., herders, dogs or other guarding animals trained to repel animals foreign to domestic sheep bands or goat flocks [such as wandering wild sheep, various predators], confinement of domestic sheep and goats at night to minimize strays, adequate fencing configurations [see Private Lands section], covenants, allotment retirements, conversion of class of livestock, trucking vs. trailing, etc.) designed to achieve the most effective separation possible.

- Land management and state/provincial wildlife agencies should cooperatively manage for healthy wild sheep habitat. Agencies should routinely monitor wild sheep habitat to detect changes in habitat quality or condition, and as needed and appropriate, conduct habitat enhancements (e.g., prescribed burning, pre-commercial thinning, salting, mineral supplements, water development, etc.) to encourage wild sheep to remain in wild sheep habitats, away from domestic sheep and goat use areas.

- In areas where contact between wild sheep and domestic sheep and goats is likely, land management agencies should post advisory signs at trailheads, campgrounds, and other popular, high-use recreational areas, to educate visitors about the issue of interaction, and to encourage prompt reporting of wild sheep contact with domestic sheep and goats. Furthermore, individuals accompanied by pets (i.e., dogs) should ensure that those dogs remain under their control, and do not disturb or scatter domestic sheep and goats in permitted areas.

- Land management agencies should clearly define the process, protocols, and timelines for short-term or emergency management actions when intervention is needed to minimize or eliminate the risk of interaction between wild sheep and domestic sheep and goats.

- Risk assessment should be conducted on an appropriate geographic scale, regardless of jurisdictional boundaries. Recognizing the limits of regulatory authority, land management agencies should consider private lands (i.e., either adjacent to, or inholdings of, federal land) contributing to that disease risk when conducting risk assessments.

- Land management agencies should closely evaluate the timing of permitted domestic sheep and goat grazing and/or trailing activities, to reduce disease transmission risk. For example, grazing domestic sheep when ewes are in estrus heightens the possibility of contact between wild sheep and domestic sheep. Effective separation should be based on temporal and spatial separation of wild sheep and domestic sheep

and goats, based on the seasonally differential vulnerability of wild sheep exposure to domestic sheep and goats.

- In areas with high risk of contact between wild sheep and domestic sheep and goats, agencies and permittees should pursue enhanced monitoring of domestic sheep and goat grazing and/or trailing patterns via use of high-tech Global Positioning System collars or other technology that would provide detailed data on movements and grazing patterns of domestic sheep and goats.

Recommendations to Wild Sheep (and Other) Conservation Organizations

- Recognize and support efforts of wild sheep management agencies implementing different strategies where wild sheep are federally- and/or state-listed, hold sensitive species status, are native wild sheep herds that have never been extirpated or augmented, are naïve wild sheep populations with no previous exposure to domestic sheep and goats, or have unique conservation values.

- Assist state/provincial wild sheep and federal land management agencies with education efforts to inform hunters, anglers, and other recreational users, who might enter or utilize wild sheep habitat, that those individuals should not use domestic sheep or goats as pack animals, as they travel in, and through, wild sheep habitat. If use of domestic pack goats is authorized, close control and night-penning to reduce strays should be encouraged. Encourage prompt reporting of potential or observed interaction between wild sheep and domestic sheep and goats.

- Encourage prompt reporting of observed interactions between wild sheep and domestic sheep and goats. Help agencies in promoting a reporting system for monitoring potential or actual contact between wild sheep and domestic sheep and goats.

- Maintain or establish open lines of communication with domestic sheep and goat producers and industry organizations (e.g., woolgrowers associations), to reduce polarization on this issue. Jointly organized and cooperatively-funded workshops on risk assessment, identification of practical strategies to achieve effective separation between wild sheep and domestic sheep and goats, development/distribution of pamphlets/brochures, and public speaking opportunities on this topic are tangible examples of a collaborative, multi-disciplinary approach to address the issue of interaction and potential disease transmission.

- Continue to negotiate alternatives or incentives for domestic sheep and goat permittees to shift or trade to grazing allotments outside occupied wild sheep habitat, convert to a different class of livestock where suitable, or waive permitted domestic sheep and goat permits in areas where risk assessment indicates high potential for contact with wild sheep. All federal grazing permit-related actions must be carefully coordinated with the appropriate land management agency to ensure that policies and permit requirements are fully met and that appropriate NEPA or other analyses and decisions support proposed/recommended changes.

- Assist agencies during periods (e.g., trailing of domestic sheep and goats) or in geographic areas where close monitoring is needed to reduce the risk of contact.

- Encourage and support the development and funding of cooperative research on this issue. Encourage state, provincial, and federal agencies and other conservation groups to commit appropriate resources to maintain wild sheep resources.

Suggested Management Practices for Domestic Sheep and Goat Permittees

- Support multi-lingual education and the need for prompt, accurate reporting of contact for foreign herders working domestic sheep and goat grazing allotments where interaction between wild sheep and domestic sheep and goats is possible.

- Commensurate with the level of risk of interaction between wild sheep and domestic sheep and goats, and recognizing the differential seasonal likelihood of wandering wild sheep, provide an adequate number of herders and guard animals, and employ other methods (e.g., volunteers, hazing of approaching wild sheep) to monitor potential contact and minimize opportunity for contact between wild sheep and domestic sheep and goats. Depending on band/flock size, consider confining domestic sheep and goats at night where feasible, rather than loose herding/bedding, to minimize possible strays.

- Where feasible, provide cell or satellite phone or other communication tools to herders to ensure prompt communication to the livestock producer/permittee if interaction occurs between wild sheep and domestic sheep and goats. The producer/ permittee should then notify the state/provincial wildlife agency of this contact.

- Producers/permittees should take appropriate measures to prevent turnout of sick or diseased domestic sheep and goats on grazing allotments, on trailing routes, or in weed control or pack-stock situations. Sick or diseased animals should be removed or otherwise eliminated as soon as possible after their recognition.

Suggested Management Practices on Private Lands

- Recognize that domestic sheep and goat husbandry on private lands may influence wild sheep population viability on adjacent public lands. Voluntarily participate in comprehensive risk assessments with state and federal agencies when private land/farm flocks adjoin public land with wild sheep resources.

- Any observed interaction between wild sheep and domestic sheep and goats on or near private land should be promptly reported to the state/provincial wildlife agency.

- Participate in cooperative educational efforts to enhance stakeholder understanding of the issues of disease transmission between domestic sheep and goats and wild sheep.

- Do not release or leave unattended domestic sheep or goats in areas where they may seek out, or be sought out by, wild sheep.

- Cooperate with the public, state/provincial/federal government agencies, agricultural organizations, producer associations, wild sheep conservation organizations, and other interested stakeholders to develop effective, comprehensive risk management approaches to ensure effective separation between wild sheep and domestic sheep and goats, while recognizing private property rights in and near wild sheep habitat. Approaches may include but are not limited to changing species/class of livestock, buyouts of land and/or livestock, use of methods to ensure physical separation (e.g, fencing strategies, use of guarding animals), conservation-based resolutions, bylaws, covenants or legislation.

- Cooperate with agencies and wild sheep non-governmental organizations to investigate and develop adequate conservation incentives for effective risk management by private producers on privately-owned land.

- Consider alternative domestic livestock management strategies if they can reduce risk of disease transmission without causing economic hardship or reducing profitability.

- Consider partnerships with non-governmental organizations and wild sheep advocate groups for cost sharing in fencing or other domestic sheep and goat management that reduces risk of disease transmission from private flocks to public wild sheep.

- Support "effective separation" fencing standards whenever feasible, including the options of electric outrigger fences or double fencing methods to reduce transmission of respiratory disease agents. The goal of separation fencing is the physical prevention of nose-to-nose contact, and an adequate physical distance to prevent aerosol transmission. Outriggers of electric wire 2 feet from page- (woven) wire fencing or double fencing consisting of two page-wire fences with a minimum spacing of at least 10 feet are considered effective. A combination of fencing methods may be most effective to ensure that wild sheep do not come into contact with domestic sheep and goats on private land.

- Participate in cooperative research ventures to enhance understanding of this issue and test mitigation protocols for disease risk management.

- Investigate opportunities to graze domestic sheep and goats on public land allotments/landscapes where no potential contact with wild sheep exists, in exchange for grazing "cattle-only" on private lands where wild sheep and domestic sheep and goats might come into contact.

- Carefully consider the use of domestic sheep and goats for weed control on private land areas where wild sheep contact may occur. Work with agencies to consider alternative weed management strategies to reduce risk of contact while adequately managing weed problems.

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Appendix A.
Glossary of Terms

Allotment: A portion of a landscape where livestock grazing of a plant community is prescribed according to a specific land use plan or legally defined regulatory authority.

Annual Operating Instructions: Specific language included in a term grazing or trailing permit file; reviewed each year with the permittee, prior to turnout of livestock on a grazing allotment or trailing route.

Augment: An intentional introduction of wild sheep from one or more a source populations into another existing wild sheep population, to enhance the recipient population demographically or genetically.

Buffer Zone: A defined and delineated space on a landscape established by wildlife managers to prevent contact and disease transmission between wild and domestic sheep and goats across that geographic space

Bighorn Sheep: A member of the species *Ovis canadensis* found throughout the mountains of western North America. They occur from the Peace River in Canada to northern Mexico and east to the Badlands of the Dakotas. Eight races are reported if one counts the extinct Audubon's bighorn.

Contact: Direct contact or close proximity between body parts of two animals during which a disease might be transmitted from one to another. In this document, "contact" typically refers to nose-to-nose or face-to-face interaction that may lead to the transmission of respiratory disease via secretions or aerosols. Synonymous with "Interaction".

Close Management: A specific management prescription that requires intensive monitoring of animals in a population whose long-term persistence is at risk.

Connectivity: Creating or maintaining networks of habitat that connect fragmented habitats, thus linking population segments of wildlife. Connectivity allows gene flow and enhances long-term species survival.

Conservation Incentives: Incentive-based conservation is in direct contrast to regulation-based conservation. Incentive-based conservation provides economic, management or esthetic benefits to individuals or corporations to encourage them to conduct management activities that have positive conservation consequence to wildlife or wildlife habitat. Examples are: private land conservation easements, direct lease agreements for grazing rights for conservation purposes, or a trade/exchange of equal value grazing rights among various partners to minimize wildlife-domestic livestock conflict.

Die-off: A large-scale mortality event that impacts many animals from a population and may have significant demographic consequence to the long-term persistence of that

population. In this report, such mortality events are usually caused by respiratory disease epidemics involving bacterial and/or other pathogens alone or in various combinations.

Disease: The word disease means literally “free of ease”. Disease is any impairment that modifies or interferes with normal functions of an animal, including responses to environmental factors such as nutrition, toxicants, and climate. Typically, disease involves transmission of, and exposure to, some infectious agent but it may involve non-infectious causes such as congenital defects.

Dispersal: The process where individuals leave one habitat or landscape to seek another habitat or landscape in which to live.

Double Fencing: Two fences running parallel around a landscape or pasture to prevent contact between animals across the fence line, designed to inhibit disease transmission.

Effective Separation: Spatial and/or temporal separation between wild sheep and domestic sheep and goats resulting in minimal to no risk of contact and subsequent transmission of respiratory disease between animal groups.

Feral: An animal of a domestic species that resides in a non-domestic setting and is not presently owned or controlled.

Historic habitat: Landscape that at one time (most often at the time of European settlement) provided all necessary habitat requirements to sustain a wild sheep population through time.

Interaction: Direct contact or close proximity between body parts of two animals during which a disease might be transmitted from one to another. In this document, “interaction” typically refers to nose-to-nose or face-to-face interaction that may lead to the transmission of respiratory disease via secretions or aerosols. Synonymous with “Contact”.

Meta-population: An assemblage of populations, or a system of local populations (demes) connected by movement of individuals (dispersal) among various population segments.

Migration or migratory: A term used to refer to the movement of individuals or genes (gene flow) across a landscape; typically refers to movements from one seasonal habitat to another, or between breeding and non-breeding habitats.

Movement corridor: Routes that facilitate movement of animals between habitat fragments.

Occupied habitat: Suitable habitat in which a wild sheep population currently exists (ca. 2007).

Preferred: A specific management action that *should* be chosen over another, whenever possible:

Radio Collars: Transmitters fitted on neckband material to monitor animal locations.

> Global Positioning System (GPS): A radio transmitter fitted on neckband material linked with orbiting satellites; animal locations can be precisely triangulated from space, with the location data then electronically stored in a memory chip or transmitted from a satellite system for data retrieval.
>
> Very High Frequency (VHF): Radio instrument fitted to neckband material transmitting in the Very High Frequency range that can be located from the ground and/or aircraft, using a telemetry receiver.

Removal of sheep: Physical extraction of domestic sheep and goats or wild sheep to eliminate (permanently or temporarily) occupancy of that range or habitat.

Required: A specific management action that ***must*** be chosen over another.

Risk/Risk Assessment/Risk Management: In this context, evaluation of the probability that a wild sheep population could experience a disease event with subsequent demographic impacts. Identification of what factors might contribute to the probability of a disease event. Management actions taken to reduce the probability of exposure and/or infection among, or between, animals. Examples of risk management include separation of infected and non-infected animals, treatment of infected individuals, vaccination, manipulations of the host environment, or manipulations of the host population.

> Qualitative Risk Assessment: Interpretation and analysis of factors that cannot necessarily be measured.
>
> Quantitative Risk Assessment: Use of tangible data and measurements.

Spatial separation: A defined physical distance between animal populations.

Stray: A domestic sheep or goat physically or temporally separated from its associated flock or band.

Stressor: A specific action or condition that causes an animal to experience stress and the subsequent physiological results of that stress.

Suitable habitat: Landscape that has all necessary habitat requirements to sustain a wild sheep population through time.

Temporal separation: Segregating animal populations over time to prevent contact, such that they may occupy the same physical space but at different times.

Thinhorn sheep: A member of the species *Ovis dalli* ranging from Alaska, the Yukon, Northwest Territories, and northern British Columbia.

Transmission: The physical transfer (direct or indirect mechanisms) of a disease agent from one animal to another, either within an animal population or between animal populations. In some instances, transmission can lead to full expression of disease in individuals or populations.

Transplant: An intentional movement of wild sheep from a source population to other suitable wild sheep habitat, either currently occupied or not. (Also called "translocation" in some documents.)

Trailing: The planned ambulatory movement of domestic sheep and goats across a landscape or within a corridor to reach a destination where grazing or use will be allowed.

Unoccupied habitat: Suitable habitat in which a wild sheep population does not currently exist.

Unsuitable habitat: Landscape that does not provide all necessary habitat requirements to sustain a wild sheep population through time.

Viability: The demographic and genetic status of an animal population whereby long-term persistence is likely.

Appendix B.

British Columbia Domestic-Wild Sheep Separation Project Contact Protocol

The following protocols outline **the steps to be taken when reports of wild sheep contact with domestic sheep are received by the Ministry of Environment** in one of several ways:

1. **Regular report from public to regional office (Conservation Officer Service or Wildlife Section):**
   - Contact reported to Regional office.
   - Assessment of situation by sheep biologist and COS, in consultation with wildlife veterinarian
   - If close contact is confirmed and is considered a high risk situation, consider the following options:
     a. Kill bighorn and save carcass - sample bighorn and/or domestics in consultation with wildlife veterinarian
     b. Continue to monitor bighorn herd in area – observe and record general signs of health
     c. Do nothing – but keep records
   - If contact is unsubstantiated/considered low risk, continue to monitor bighorn herd in area, alert and encourage mitigation measures with domestic producers in area to ensure separation.

2. **Regular report from public to Call Line.**
   - Contact reported to Call Line; Call Line staff forwards to regional COS.
   - Assessment of situation by COS and sheep biologist, in consultation with wildlife veterinarian
   - If close contact is confirmed and is considered a high risk situation, consider the following options:
     a. Kill bighorn and save carcass - sample bighorn and/or domestics in consultation with wildlife veterinarian
     b. Continue to monitor bighorn herd in area – observe and record general signs of health
     c. Do nothing – but keep records
   - If contact is unsubstantiated/considered low risk, continue to monitor bighorn herd in area, alert and encourage mitigation measures with domestic producers in area to ensure separation.

3. **Out of hours call from public to Call Line.**
   - Contact reported to Call Line; Call Line staff forwards to regional COS officer-on-call.
   - Assessment of situation by COS officer-on-call - contacts sheep biologist and wildlife veterinarian, if possible for consultation
   - **If sheep biologist and wildlife veterinarian cannot be contacted, biologist and veterinarian will support COS decision and action. COS will inform sheep biologist and wildlife veterinarian by email of the situation and action taken.**
     - If close contact is confirmed and is considered a high risk situation, consider the following options:
     - Kill bighorn and save carcass - sample bighorn and/or domestics in consultation with wildlife veterinarian
     - Continue to monitor bighorn herd in area – observe and record general signs of health
     - Do nothing – but keep records
     - If contact is unsubstantiated/considered low risk, continue to monitor bighorn herd in area, alert and encourage mitigation measures with domestic producers in area to ensure separation.

Appendix C.

WYOMING GAME AND FISH DEPARTMENT

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April 5, 2006

MEMORANDUM

TO: Wildlife Division Employees

FROM: Jay Lawson, Chief, Wildlife Division

COPY TO: Terry Cleveland, Gregg Arthur, File

SUBJECT: **PROTOCOL FOR HANDLING THE COMMINGLING OF BIGHORN SHEEP AND DOMESTIC SHEEP/GOATS**

Due to the threat of disease transmission and subsequent bighorn sheep die-offs, the following protocol should be followed.

Wandering Bighorn Sheep:
Where there is known, suspected, or likely contact by a wandering bighorn sheep with domestic sheep/goats:

- If possible, that bighorn(s) should be live-captured and transported (one-way) to our Sybille Research Unit.
- If that bighorn(s) cannot be live-captured, that bighorn(s) should be lethally removed (per authority of Chapter 56) and, if possible, transported (either whole or samples) to our Sybille Unit or our WGFD Lab in Laramie.

Stray Domestic Sheep/Goat:
Where there is known, suspected, or likely contact by a stray domestic sheep/goat with bighorn sheep:

- The owner of such livestock should be notified and asked to remove the stray sheep/goat to eliminate the threat of disease transmission; however, it will be the owner's prerogative to determine what course of action should be taken.

Reporting:
All documented commingling and any actions taken must be reported to the employee's immediate supervisor, Wildlife Administration as well as the Bighorn Sheep Working Group Chairman, presently Kevin Hurley.

"Conserving Wildlife - Serving People"