RECOMMENDATIONS FOR

Domestic Sheep and Goat Management in Wild Sheep Habitat

Prepared by the
Wild Sheep Working Group

Western Association of
Fish and Wildlife Agencies

2012

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Executive Summary

Although the risk of disease transmission from domestic sheep or goats to wild sheep is widely recognized, a unified set of management recommendations for minimizing this risk has not been adopted by responsible agencies. These Western Association of Fish and Wildlife Agencies (WAFWA) recommendations were produced to help state, provincial, and territorial wild sheep managers, federal/crown land management agencies, private landowners and others take appropriate steps to eliminate range overlap, and thereby, reduce opportunities for transmission of pathogens to wild sheep.

Transmission of *Mannheimia haemolytica* from domestic sheep to bighorn sheep was irrefutably demonstrated by Lawrence et al. (2010) and provides justification sufficient for preventing range overlap and potential association of domestic sheep and goats with wild sheep. The higher the conservation value of a wild sheep population (e.g., federally or state listed, "sensitive species" status, native herds, transplant source stock, herds in areas with no history of domestic livestock presence), the more aggressive and comprehensive wild sheep and domestic sheep or goat separation management strategies should be.

Photo by: David Wetzel (Texas Bighorn Society)

Photo by:Tom Carlsen (MDFWP)

Practical solutions will be difficult, if not impossible to achieve until the risk of disease transmission from domestic sheep or goats to wild sheep is acknowledged by those responsible for wildlife and agricultural management. All parties benefit when risk is assessed and actively managed to minimize the potential for transmission of pathogens. The recommendations contained within this report are intended to help achieve that objective to benefit all sectors and are summarized as follows:

WAFWA agencies should:
(1) assess wild sheep conservation value/status and complete risk assessments of interspecies contact in a meta-population context; (2) remove wild sheep that have likely associated with domestic sheep or goats and develop a policy to promptly respond to wild sheep wandering from occupied wild sheep ranges; (3) thoroughly explore demographic consequences of translocations and conduct appropriate analyses of habitat suitability and risk of disease transfer prior to implementing any translocations; (4) coordinate with other agencies, land owners and stakeholders regarding management of domestic sheep or goats on or near ranges occupied by wild sheep; (5) fully consider the risk of disease transmission when issuing or commenting on permits/regulations associated with private lands used for domestic production; and (6) develop educational materials and outreach programs to interpret the risk of association between wild sheep and domestic sheep or goats.

Land management agencies should:
(1) reduce risk of association by eliminating overlap of domestic sheep or goat allotments or grazing permits/tenures within wild sheep habitat; (2) ensure that annual operating instructions or their equivalent include measures to minimize domestic association with wild sheep and confirm appropriate methods to remove stray domestic sheep or goats; and (3) manage wild sheep habitat to promote healthy populations in areas without domestic sheep or goats.

Wild sheep conservation organizations should:
(1) assist with educational/extension efforts to all parties; (2) negotiate alternatives and incentives for domestic sheep or goat grazers on public land to find alternatives to wild sheep habitat; and (3) advocate for and support research concerning disease and risk associated with domestic sheep and goats in proximity to wild sheep.

Domestic sheep and goat permittees/owners should:
(1) implement best management practices (BMPs) to prevent straying by domestic sheep or goats; and (2) establish protocols to respond to straying.

Private landowners should:
(1) educate themselves and work with wild sheep managers and advocates to support effective separation through a variety of site-specific mitigation measures; and (2) promptly report the potential or actual association between domestic sheep or goats and wild sheep.

Introduction

In January 2007, the Western Association of Fish and Wildlife Agencies (WAFWA), comprised of 23 state and provincial wildlife agencies from the western United States (U.S.) and western Canada, established a Wild Sheep Working Group (WSWG) to develop a report titled, "Recommendations for Domestic Sheep and Goat Management in Wild Sheep Habitat" (WAFWA 2007). Unanimously endorsed by WAFWA Directors in July 2007, that report provided recommendations to which state, provincial and federal agencies could tier their management actions. In August 2007, the report was forwarded to the heads of the U.S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, and Department of Defense. In July 2010, the report was revised (WAFWA 2010c) and has represented the official position of WAFWA on the management of domestic sheep and goats and wild sheep.

Scientific literature that has become available since July 2010 has been incorporated into this document to ensure that the recommendations contained herein remain current and robust, but the basic purpose, scope, and principles of the document remain unchanged. Additional editorial modifications are intended to improve the readability of the document. Information contained in this report is provided to assist BLM and USFS leadership with development of a unified policy addressing the grazing of domestic sheep or goats in wild sheep habitat on lands under the administration of those agencies. In addition, this document is intended to assist state, provincial, and territorial wild sheep managers, federal/crown land management agencies, private landowners and others take appropriate steps to eliminate range overlap, and thereby, reduce opportunities for transmission of pathogens to wild sheep. This revision was approved by the WAFWA Directors March 29, 2012, and supersedes all previous versions.

In this paper we do not review and synthesize all available literature or evidence pertaining to the issue of disease transmission among bighorn sheep and domestic sheep and goats. We do, however, include relevant citations, results, literature, or analyses published since completion of our previous reports (WAFWA 2007, 2010c). We provide reasonable and logical recommendations based on the best available information to help achieve effective separation between wild sheep and domestic sheep or goats. We recognize it is impossible to achieve zero risk of contact or disease transmission; however, we also recognize there are many ways to reduce the probability of association between these species and, thereby, lower the overall risk of epizootics occurring in populations of wild sheep.

Photo by: Earl Nottingham (TPWD)

Photo by: Dr. Peri Wolff (NDOW)

Photo by: David Wetzel (Texas Bighorn Society)

Photo by: Mike Pittman (TPWD)

Photo by: Brett Wiedmann (NDGFD)

Background

Throughout substantial portions of their range, bighorn sheep (*Ovis canadensis*) experience periods when populations are depressed; those episodes generally are associated with epizootics of respiratory disease (Ryder et al.1994). Diseases have contributed to the decline of bighorn sheep populations in much of western North America (Beecham et al. 2007, CAST 2008) and many native herds declined to less than 10% of historical size. According to historical accounts, such declines coincided with the advent of domestic livestock grazing on ranges occupied by bighorn sheep (Warren 1910, Grinnell 1928, Schillinger 1937, Honess and Frost 1942, CAST 2008). Epizootics among native bighorn herds were reported in various locations following European settlement and establishment of domestic livestock grazing throughout the central and southern Rocky Mountains. These observations may reflect the introduction of novel bacterial pathogens (including some strains of *Pasteurella [Mannheimia]* spp.) to naïve bighorn populations beginning in the late 1800s (Grinnell 1928, Skinner 1928, Marsh 1938, Honess and Frost 1942, Miller 2001).

Over the past 30 years, increasing evidence has underscored the potential risk of disease transmission from domestic sheep or goats to wild sheep (McQuivey 1978, Hunt 1980, Jessup 1982, Foreyt and Jessup 1982, Goodson 1982, Onderka and Wishart 1984, Jessup 1985, Black et al.1988, Coggins 1988, 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, Foreyt and Lagerquist 1996, Martin et al. 1996, Coggins 2002, Rudolph et al. 2003, Jenkins et al. 2007, Rudolph et al. 2007, George et al. 2008, Jeffress 2008, Lawrence et al. 2010). Moreover, a number of recent risk assessments and reviews (Beecham et al. 2007, CAST 2008, Baumer et al. 2009, USAHA 2009, WAFWA 2009, Croft et al. 2010, USDA Forest Service 2010a, b; Wehausen et al. 2011), conservation management strategies or plans (Colorado Division of Wildlife 2009, Montana Department of Fish, Wildlife, and Parks 2009), modeling exercises (Clifford et al. 2009, Cahn et al. 2011), and many wildlife biologists and wildlife veterinarians (Gross et al. 2000, Singer et al. 2000, Dubay et al. 2002, Epps et al. 2004, Garde et al. 2005, Jansen et al. 2006, Foreyt et al. 2009) have focused on risks associated with contact between wild sheep and domestic sheep or goats. Many of the aforementioned investigators and participants in workshops conducted throughout the western US (California, Arizona, Utah, and Idaho),

have recommended temporal or spatial separation of domestic sheep or goats from wild sheep to reduce the potential for disease in the latter.

Disease Transmission

Although domestic animals have been selected for their ability to live at high densities and for their resilience to infectious diseases (Diamond 1997), two-way transmission of certain diseases (e.g., paratuberculosis, some enteric pathogens and parasites) between wild sheep and domestic sheep or goats in shared habitats can occur (Garde et al. 2005). However, the most important and ecologically significant transmission in this context is from domestic sheep or goats to wild sheep.

Winter 2009-2010 bighorn sheep pneumonia die-offs (totaling an estimated 880 bighorns) in Montana, Nevada, Washington, Utah, and Wyoming have reduced bighorn numbers in at least 9 herds, either through direct mortality or agency removal (i.e., "culling") of bighorn sheep exhibiting symptoms of respiratory infections (Edwards et al. 2010, WAFWA 2010b). Domestic sheep and goats were known to occur within or near occupied bighorn sheep ranges and within normal bighorn movement zones, and association between wild sheep and domestic sheep or goats is known to have preceded at least one of these die-offs, was likely in 2 others, and was possible in 4 more (WAFWA 2010b).

Die-offs of wild sheep populations and individual animals have occurred in the absence of reported association with domestic sheep or goats (Aune et al. 1998, UC-Davis 2007). However, when contact between wild sheep and domestic sheep or goats has been documented, the pattern and severity of die-off is typically greater than when otherwise is the case (Onderka and Wishart 1984, Martin et al. 1996, Aune et al. 1998, George et al. 2008).

It is generally acknowledged (Garde et al. 2005, CAST 2008) that thinhorn sheep (*Ovis dalli* spp.) in Alaska and northwestern Canada are likely naïve to exposure to many organisms commonly carried by domestic species, compared to wild sheep occurring in southern Canada and the continental U.S. Until this is confirmed and the effects of exposure to infectious organisms are clearly understood, it is essential that no association occurs between thinhorn sheep and domestic sheep or goats.

Photo by: Donny Martorello (WDFW)

Photo by: Ernie Finch

Photo by: John Kanta (SDGFP)

Photo by: Ted Borda (Borda Land & Sheep Company)

Photo by: Ted Borda (Borda Land & Sheep Company)

Effective Separation

WAFWA defines "Effective Separation" as spatial or temporal separation between wild sheep and domestic sheep or goats to minimize the potential for association and the probability of transmission of diseases between species. WAFWA advocates that effective separation should be a primary management goal of state, provincial, territorial and federal agencies responsible for the conservation of wild sheep, based on evidence that domestic sheep or goats can transfer pathogens to wild sheep. Literature (reviewed by Wehausen et al. 2011) and experimental evidence (Lawrence et al. 2010) support the goal that domestic sheep or goats should not concurrently occupy areas where conservation of wild sheep is a clearly stated management goal.

Effective separation does not necessarily require removal of domestic sheep or goats in all situations. However, the option of removing domestic sheep or goats should be included in an array of alternatives available to address this issue. In fact, some collaborative working groups (USAHA 2009) have recommended domestic goats not be allowed to graze in occupied bighorn sheep habitat because of their gregarious nature and tendency to wander. We are aware of the continuing debate and discussion (CAST 2008, USAHA 2009) between wildlife advocates and some domestic sheep or goat industry proponents and resource managers regarding the credibility or scientific merit of past findings; that debate is founded largely on criticisms of experimental design or rigor, and limitations of drawing inferences about natural disease events when compared to controlled experiments in confined settings. However, it is WAFWA's collective opinion that enough is known about potential pathogen transmission from domestic sheep or goats to wild sheep that efforts toward achieving effective separation are necessary and warranted.

Reducing risk of disease transmission on the landscape by minimizing or preventing association between wild and domestic sheep or goats is a key management strategy for WAFWA agencies (e.g., Colorado Division of Wildlife 2009, Montana Department of Fish, Wildlife and Parks 2009). Legislation in Utah (House Bill 240 Supplement, 2009), Wyoming (Senate Enrolled Act No. 30, 2009) and Idaho (Senate Bill 1232 amended, 2009) provides direction, authority and responsibilities for addressing feral or stray livestock that pose a disease transmission risk. Further, recent court rulings (e.g., U.S. District Court, Idaho Case 09-0507-BLW) have mandated separation between domestic sheep or goats and bighorn sheep, including mandatory non-use of grazing allotments where effective separation could not be assured.

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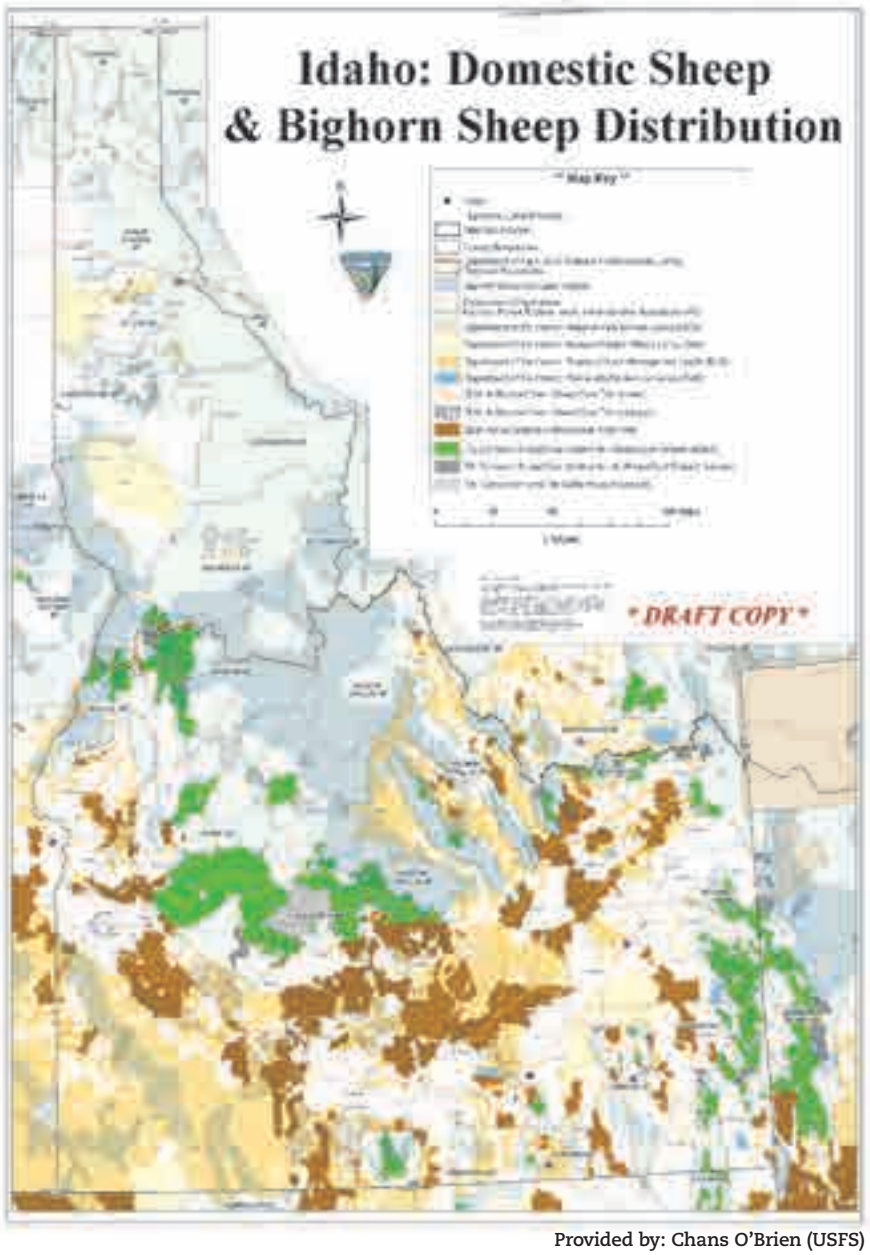
Principal federal land management agencies in the western U.S., BLM and USFS, continue to review, revise, and update policies on the management of domestic sheep or goats in wild sheep habitat (USDI BLM 1992, 1998, 2010; USDA Forest Service 2009). Additionally, several administrative units of the USFS (Northern Region, Rocky Mountain Region, Southwest Region, Intermountain Region, and the Pacific Southwest Region) have designated bighorn sheep as a "Sensitive Species," thereby mandating special management emphasis. This includes: thorough reviews and analyses of management actions that could affect populations of bighorn sheep or their habitat to ensure their viability and to preclude demographic trends that would result in the need for Federal listing.

An interagency GIS-based decision-support tool and GIS coverage maps that overlay current bighorn sheep distribution with vacant and active domestic sheep or goat grazing allotments and trailing routes were finalized for 14 western states (WAFWA 2010a). These maps identify areas where association between domestic sheep or goats and bighorn sheep could occur on, or adjacent to, lands managed by BLM or USFS, and also identify areas that could provide spatial separation. The maps further provide a context for national policy development, and help identify situations where proactive management is necessary to minimize risk of association. Although risk of disease transmission from domestic sheep or goats to wild sheep is widely acknowledged by wildlife and land management agencies, a unified set of management guidelines for minimizing this risk has not yet been adopted.

In some cases, results of contact between domestic sheep or goats and wild sheep have been severe enough to endanger entire populations of the latter. In Idaho, legislation (Senate Bill 1232 amended, May 2009) mandated collaboration between the Idaho Department of Fish and Game and domestic sheep grazing permittees that identified BMPs to achieve effective separation between domestic sheep and wild sheep on both public and private lands. In specific situations, implementation of BMPs could lead to a reduced risk of association. In particular, BMPs implemented in open, gentle terrain where domestic sheep or goats can be easily controlled and monitored can reduce risk of association (Schommer 2009). Nevertheless, BMPs that work in one situation may not work in other situations (Schommer 2009).

Consequently, we recommend that managers take appropriate steps to minimize opportunities for association and, thereby, the potential for disease transmission in all situations.

Photo by: Bighorn Institute



Provided by: Chans O'Brien (USFS)

Photo by: Rebecca Barboza (CDFG)

Photo by: Larry Kruckenberg

Management Recommendations

The recommendations that follow can be applied to state, provincial, and territorial wildlife agencies, federal/crown land management agencies, wild sheep conservation organizations, domestic sheep or goat producers or permittees, and private landowners, and have been strategically assigned to logical categories. It is imperative, however, that readers recognize these recommendations typically apply to multiple parties, and that they further recognize that a multi-disciplinary and collaborative approach will produce the best outcomes, both for wild sheep and for producers or permittees. Definitions of various terms used throughout this document are provided in Appendix A.

Although these recommendations have been developed by a working group largely comprised of wildlife agency personnel, cooperation between numerous concerned parties is critically important to deriving on-the-ground solutions (USAHA 2009, Wild Sheep Foundation 2011). Among these are state, provincial, and territorial wildlife agencies; federal/crown land management agencies; First Nation or tribal representatives; domestic sheep or goat producers or grazing permittees; agricultural industry representatives; wild sheep conservation organizations; environmental groups; academic institutions; and interested individuals. As a result of information contained herein, it is our hope that collaborative discussions will occur and that those discussions yield results in the form of innovative and collaborative site-specific delivery of programs such as the British Columbia Wild/Domestic Sheep Separation Program and the Wyoming Statewide Domestic Sheep/Bighorn Sheep Interaction Working Group.

Many anthropogenic and environmental factors (CAST 2008) influence the demographics and viability of wild sheep populations. Some factors affecting wild sheep population performance can be managed while others cannot. Nevertheless, the guiding principle of our effort has been "to seek effective separation" between wild sheep and domestic sheep or goats. There is no "one size fits all" risk assessment of respiratory disease transmission between wild sheep and domestic sheep or goats. However, a comprehensive risk assessment (qualitative and quantitative) is a critically important component for managing the potential for disease transmission.

We recommend that wild sheep managers design and implement management strategies by taking the first step of assessing and prioritizing conservation value and relative importance of wild sheep populations. The greater the conservation value and the greater the risk of association with domestic sheep or goats, the more aggressive and comprehensive a strategy to ensure effective separation should be. To ensure that is the case, we offer the following:

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Historic and suitable but currently unoccupied wild sheep range should be identified, evaluated, and compared against currently-occupied wild sheep distribution and existing or potential areas where domestic sheep or goats may occur.

Risk assessments should be completed at least once per decade (more often if warranted) for existing and potential wild sheep habitat. These assessments should specifically identify where and to what extent wild sheep could interface with domestic sheep or goats, and the level of risk within those areas.

Following completion of site or herd-specific risk assessments, any translocations, population augmentations, or other restoration and management strategies for wild sheep should minimize the likelihood of association between wild sheep and domestic sheep or goats. Agencies should:

- Avoid translocations of wild sheep into areas with no reasonable likelihood of effective separation from domestic sheep or goats.
- Re-evaluate planned translocations of wild sheep to historical ranges as potential conflicts, landscape conditions, and habitat suitability change.
- Recognize that augmentation of a wild sheep herd from discrete source populations poses a risk of pathogen transfer (CAST 2008) and thus, only use source stock verified as healthy through a proper health assessment (WAFWA 2009) for translocations. Source herds should have extensive health histories and be regularly monitored to evaluate herd health. Wild sheep managers should evaluate tradeoffs between anticipated benefits such as demographic, behavioral and genetic interchange, and the potential consequences of mixing wild sheep from various source herds.
- Develop and employ mapping or modeling technology as well as ground based land use reviews prior to translocations to compare wild sheep distribution and movements with distribution of domestic sheep or goats. If a translocation is implemented and association with domestic sheep or goats occurs, or is likely to occur beyond an identified timeframe or pre-determined geographic area, domestic sheep or goat producers should be held harmless.

The higher the risk of association between wild sheep and domestic sheep or goats, the more intensively wild sheep herds should be monitored and managed. This is particularly important when considering "new" vs. "augmented" wild sheep populations.

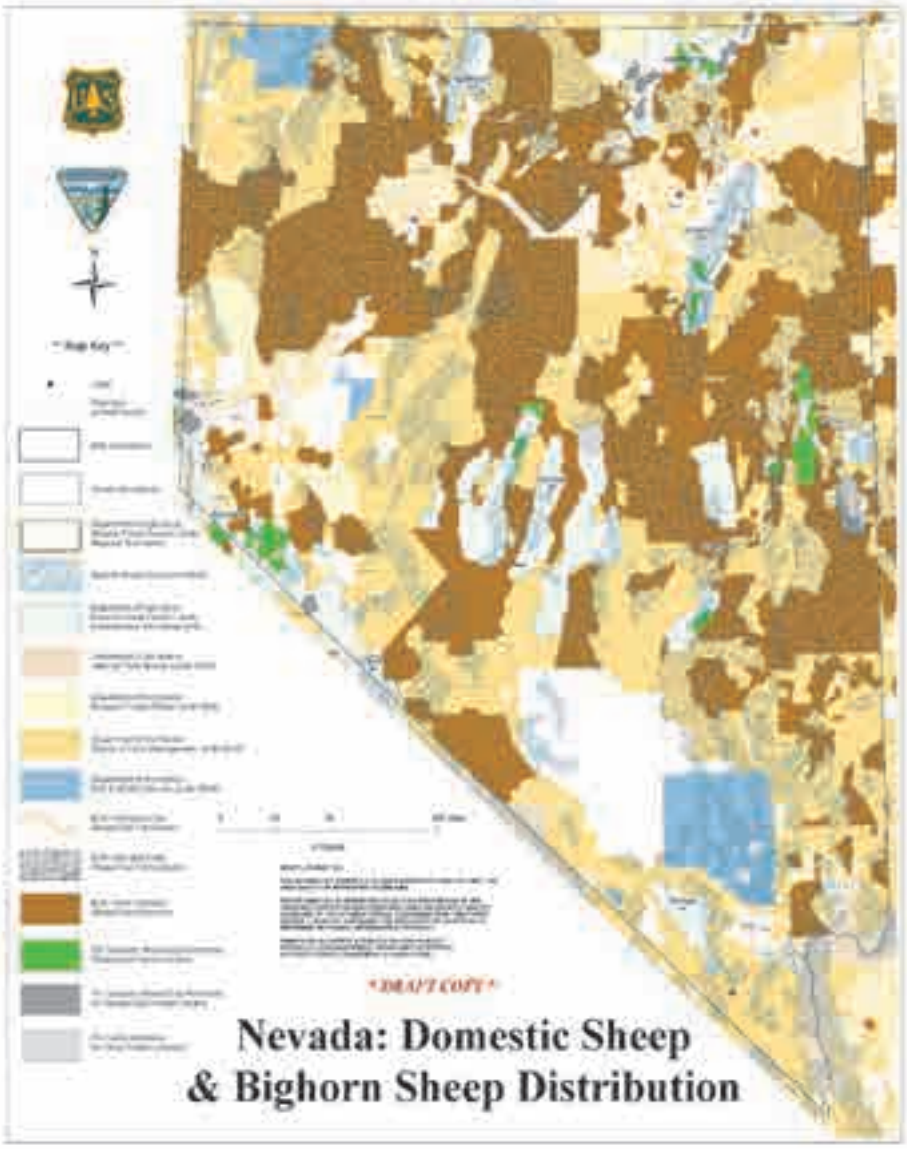
- Site-specific protocols should be developed when association with domestic sheep or goats is probable. For example, decisions concerning percentage of translocated wild sheep that must be radio-collared

Photo by: Mike Cox (NDOW)

Photo by: Chase Fountain (TPWD)

for achieving desired monitoring intensities should in part, be based upon the subsequent level of risk of association with domestic sheep or goats.
- Intensive monitoring provides a mechanism for determining proximity of wild sheep to domestic sheep or goats and for evaluating post-release habitat use and movements.
- Budgets for wild sheep translocation projects should include adequate funding for long-term monitoring.

Wild sheep managers should identify, analyze, and evaluate the implications of connectivity and movement corridors between largely insular herds comprising a meta-population against opportunities for increased association with domestic sheep or goats. Analyses should include distribution and continuity (Mack 2008) among populations of wild sheep and the anticipated frequency of movement among or within wild sheep range. In doing so, the benefits of genetic interchange and its resultant implications for population viability, must be weighed against the risks of disease transmission (Bleich et al. 1990), especially if dispersing or wandering wild sheep could travel across domestic sheep or goat grazing allotments or trailing routes, private land holdings or other areas where the potential transfer of endemic pathogens from an infected wild herd to a naïve herd could occur.



Provided by: Chans O'Brien (USFS)

Removal of wild sheep known, or suspected to have closely associated with domestic sheep or goats is considered to be an effective management tool. Atypical movements by wild sheep can heighten risk of association with domestic sheep or goats. Additional measures to achieve effective separation should be implemented if such association occurs. However, removal of wild sheep from occupied, normally-anticipated wild sheep range is not always the best management option. Continuous risk of association exists during active grazing seasons when domestic sheep or goats are grazed within normally-anticipated wild sheep range. Thus, removal of individual wild sheep is an ineffective method for maintaining separation, and has potentially negative consequences for population viability. Removal of wild sheep should occur only after critical evaluation and further implementation of measures designed to minimize association and enhance effective separation.

Wild sheep populations should have pre-determined population objectives, and should be managed at agreed-upon densities to minimize the potential for dispersal. Because some dispersal occurs regardless of population density, some risk of association is always present if domestic sheep or goats are within range of dispersing wild sheep.

Agencies should develop a written protocol to be implemented when association between wild sheep and domestic sheep or goats is confirmed. Notification requirements, appropriate response and post-contact monitoring options for both domestic sheep and goats and dispersing or wandering wild sheep should be included. Moreover, wildlife agencies should collaborate with agricultural agencies, land management agencies, producers and permittees, grazing industry representatives,

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and wild sheep advocates to develop an effective, efficient, and legal protocol to be implemented when feral or abandoned domestic sheep or goats threaten to associate with wild sheep but for which no owner can be identified. Written protocol examples are provided in Appendix B (British Columbia Fish, Wildlife and Habitat Management Branch) and Appendix C (Wyoming Game and Fish Department).

Wildlife agencies should develop databases as a system to report, record, and summarize association between wild sheep and domestic sheep or goats and its outcome; the WAFWA WSWG website (http://www.wafwa.org/html/wswg.shtml) would be a logical host. Further, wildlife managers and federal/crown land managers should encourage prompt reporting by the public of observed proximity between wild sheep and domestic sheep or goats.

Wild sheep managers should coordinate with local weed or pest management districts, or other applicable agencies or organizations involved with weed or vegetation management, to preclude the use of domestic sheep or goats for noxious weed or vegetation control in areas where association with wild sheep is likely to occur. Agencies should provide educational information and offer assistance to such districts regarding disease risks associated with domestic sheep or goats. Specific guidelines (Pybus et al. 1994) have already been developed and implemented in British Columbia, and are available at: http://www.for.gov.bc.ca/hfp/publications/00006/.

Specific protocols for sampling, testing prior to translocation, and responding to disease outbreaks should be developed and standardized to the extent practical across state and federal jurisdictions. Several capture and disease-testing protocols have been developed and are available to wild sheep managers (Foster 2004, UC-Davis 2007, WAFWA 2009). Protocols should be reviewed and updated as necessary by the WAFWA Wildlife Health Committee (WHC) and presented to WAFWA Directors for endorsement. Once endorsed, agencies should implement the protocols, and the WHC should lead an effort to further refine and ensure implementation of said protocols.

Agencies should coordinate and pool resources to support the ongoing laboratory detection and interpretation of important diseases of wild sheep. Furthermore, wild sheep managers should support data sharing and development and use of standardized protocols (WAFWA 2009). Interagency communication between wildlife disease experts such as the WAFWA Wildlife Health Committee (WHC) should be encouraged to enhance strategies for monitoring, managing and improving health of wild sheep populations through cooperative efforts.

Wild sheep management agencies should develop educational materials and outreach programs to identify and interpret the risk of association between wild sheep and domestic sheep or goats for producer groups, owners of small and large farm flocks, animals used for packing and 4-H animals. In some cases, regulation may be necessary to maintain separation.

RECOMMENDATIONS TO BLM, USFS, PARKS, PROTECTED AREAS AND OTHER APPLICABLE LAND MANAGEMENT AGENCIES

Joint federal land management agency guidelines on management of domestic sheep or goats in wild sheep habitat should be developed and included in broad agency policy documents. Guidelines should be based on the need to minimize risk of association and provide effective separation between domestic sheep or goats and wild sheep.

Photo by: Todd Nordeen (NGPC)

Photo by: Debra Hamilton (CDFG)

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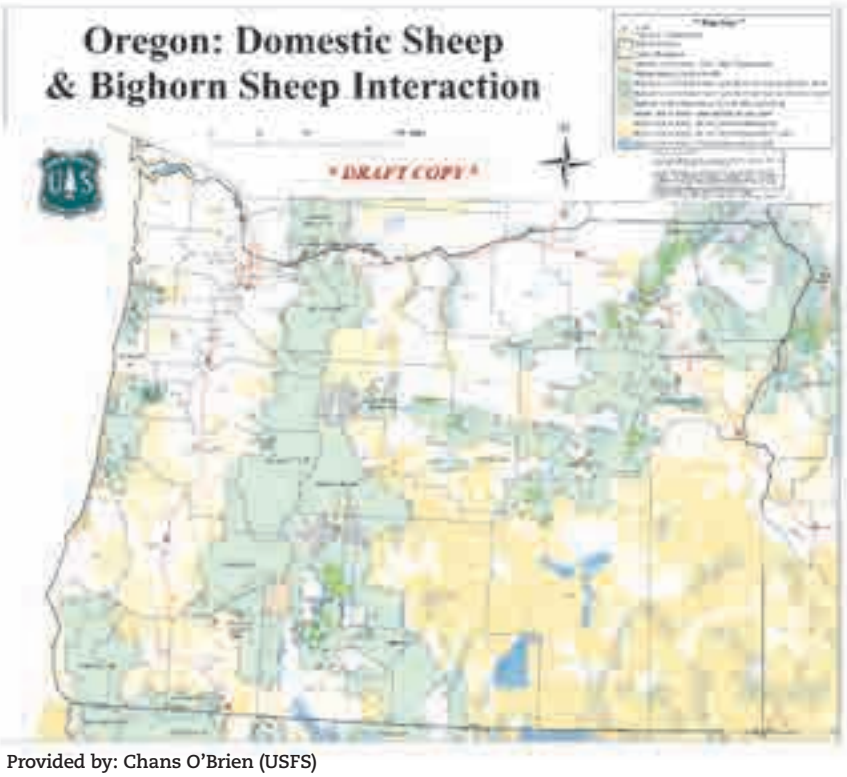
Approved guidelines should not include an automatic "sunset" provision or expiration date but, if there is a maximum longevity (i.e., a "sunset clause") specified by federal policy and if appropriate and timely review cannot be completed, guidelines should remain in effect, rather than becoming obsolete, until any mandated review can be completed.

The use of domestic sheep or goats as pack animals by persons that travel in identified wild sheep habitat should be prohibited by the appropriate management agency (e.g., USDA Forest Service 2011). Where legislation or regulations are not already in place, an outreach program to inform potential users of the risks associated with that activity should be implemented to discourage use of domestic sheep or goats as pack animals.

Photo by: Ted Borda (Borda Land & Sheep Company)



Provided by: Chans O'Brien (USFS)

Land management agencies that regulate or are responsible for domestic sheep or goat grazing allotments, trailing routes, vegetation management, use as pack stock, or any other uses involving domestic sheep or goats should only authorize such use(s) outside of occupied wild sheep range.

Land management agencies should require immediate notification by permittees and their herders of association between wild sheep and domestic sheep or goats and in no case should it be more than within 24 hours of any such event. Notification procedures, including phone numbers and contact information for permittees and use of satellite phones in backcountry settings, should be outlined in Annual Operating Instructions for grazing allotments and trailing permits, and should include consequences for failure to report.

Land management agencies should map active and inactive domestic sheep or goat grazing allotments and trailing routes, including information on dates of use and contact information for responsible grazing or trailing permittees.

Land management agencies must ensure that advance written instructions (such as USFS Annual Operating Instructions) exist, and that they address management, retrieval, and disposition of domestic sheep or goats present on public lands prior to or after permitted grazing or trailing dates.

Land management agencies should work collaboratively with state, provincial, and territorial wildlife and agricultural interests to develop written agreements that address management, retrieval, and disposition of domestic sheep or goats occupying public lands where there is no permitted use. Such agreements should also address the presence of feral sheep or goats and other exotic ungulates, especially ovines such as aoudad, red sheep, urial, or argali that are detected on public lands.

Land management agencies should review domestic sheep allotment boundaries or other use areas, such as trailing routes, and reconfigure boundaries or routes to avoid or minimize overlap with occupied wild sheep habitat. Techniques available to accomplish this include the use of geographic or topographic

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barriers that enhance species separation, and temporal or spatial separation resulting from implementation of novel domestic sheep or goat grazing management strategies.

Land management agencies should undertake habitat enhancements that improve wild sheep habitat outside allotment boundaries in an effort to attract wild sheep away from domestic sheep allotments.

Land management agencies should undertake water developments to divert wild sheep away from domestic sheep allotments or domestic sheep or goats away from areas used by wild sheep.

Land management agencies should ensure that Annual Operating Instructions require careful management and vigilant herding to minimize potential association between wild sheep and stray domestic sheep or goats. A count-on, count-off inventory of domestic sheep or goats must be required as a condition of operation with follow-up provisions to account for missing livestock.

In areas of high risk of association, trucking should be required to minimize risks associated with trailing. Trucking of domestic sheep or goats is preferred to trailing because there is less chance of straying and, thereby, less likelihood of association with wild sheep, particularly when domestic sheep are in estrus.

Land management agencies should require marking of all permitted domestic sheep and goats to provide for rapid ownership identification of stray animals.

In the event of trailing, on-site compliance monitoring to minimize strays must be conducted by the permittee or the land management agency.

Land use or resource management plans should explicitly address the potential for domestic sheep or goats to associate with wild sheep. Land use plans should evaluate the suitability of permitting activities involving domestic sheep or goats, and determine the best course of action with respect to wild sheep conservation. Plans should also identify general areas of public land where domestic sheep or goats cannot be permitted for weed control, commercial grazing, recreational packing, vegetation management, or other uses.

Land management agencies should coordinate with appropriate entities involved in weed control programs that use domestic sheep or goats on public or Crown lands (Pybus et al. 1994), adjoining private lands, or state, provincial, and territorial wildlife habitat management areas to minimize risk of association between domestic sheep or goats and wild sheep.

Within occupied or suitable wild sheep habitat, where topography, vegetation, and other parameters allow, conversions of allotments from domestic sheep or goats to types of domestic livestock that pose a lower risk of disease transmission to wild sheep should be implemented.

Within suitable, historic wild sheep habitat not currently occupied by wild sheep, agencies should not convert cattle grazing allotments to domestic sheep or goat grazing, or allow trailing if restoration of wild sheep populations is an agency goal.

Photo by: AZGFD

Photo by: Justin Binfet (WGFD)

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Under emergency conditions, stocking of allotments not currently under permit to domestic sheep or goats should be permitted only after an adequate risk assessment has been completed. Any such assessment must include appropriate documentation and the conclusion that effective separation can be assured, and can be accomplished via project-level NEPA analysis.

Land management agencies should incorporate state, provincial, or territorial wild sheep management plans either in, or as supplements to, federal resource or land use management plans, and collaborate with wildlife agencies to ensure comprehensive risk assessments (Clifford et al. 2009, USDA Forest Service 2010a, b) of domestic sheep or goat grazing allotments or trailing routes in wild sheep habitat are thorough and complete. To accomplish this objective, training adequate to allow the preparation of such assessments must be provided.

Photo by: Mike Cox (NDOW)

Photo by: Todd Nordeen (NGPC)

Where mandatory buffer zones (frequently cited as a minimum of 9 airline miles [14.5 km]) between domestic sheep or goats and wild sheep have been used to minimize association, it should be recognized that buffer zones apply to herds or populations of wild sheep, rather than individual wandering wild sheep. In some cases, buffer zones have been effective in reducing association between wild sheep and domestic sheep or goats. However, in contiguous wild sheep habitat where movements by wild sheep have the potential to exceed *a priori* expectations, buffer zones may not be effective or practical (Schommer and Woolever 2001).

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

Land management agencies, in collaboration with jurisdictional domestic sheep or goat health agencies, should work with producers and permittees to prevent turnout or use of sick or diseased domestic sheep or goats on grazing allotments and trailing routes. Sick or diseased domestic sheep or goats can increase risk of association with wild sheep because they likely are less able to keep up with their bands and are more prone to straying. Sick or diseased animals observed on the range should be reported to land management agency personnel immediately, and inter-agency coordination to address the situation should promptly occur. Further, responsible agencies must require that domestic sheep or goats are in good health before being turned out. For example, Alberta and British Columbia have developed health certification protocols (Pybus et al. 1994) that must be complied with before domestic sheep are turned out for vegetation management in conifer regeneration efforts (available at: http://www.for.gov.bc.ca/hfp/publications/00006/). We emphasize that the higher the risk of association between domestic sheep or goats with wild sheep, the higher the certainty of domestic animal health should be. Further, it must be recognized that even clinically healthy domestic sheep or goats can still carry pathogens that are transmissible to wild sheep, and thus, pose a significant risk to wild sheep.

Management Recommendations

Proportional to risk of association between domestic sheep or goats and wild sheep, land management agencies should work with stakeholders to implement a variety of management practices. Examples include: herders, dogs or other guarding animals trained to repel animals foreign to domestic sheep bands or goat flocks (wandering wild sheep or various predators), regular counts, removal of sick animals, confinement of domestic sheep or goats at night, adequate fencing configurations, covenants, allotment retirements, conversion of class of livestock, trucking versus trailing, and others. Effectiveness of management practices designed to reduce risk of association are not proven (Baumer et al. 2009, Schommer 2009) and therefore should not be solely relied upon to achieve effective separation. Such practices could however, help achieve separation when applied outside of occupied wild sheep range or connected and potentially mitigate impacts associated with straying domestic sheep or goats, or wandering wild sheep.

Land management agencies and wildlife agencies should cooperatively manage for quality wild sheep habitat and routinely monitor habitat to detect changes in condition.

In areas where association between wild sheep and domestic sheep or goats is likely, land management agencies should post advisory signs at trailheads, campgrounds, and other high-use areas that are designed to educate visitors about the issue of interaction and to encourage prompt reporting of association of wild sheep with domestic sheep or goats. Agencies should also ensure that individuals keep dogs under immediate voice control or on leash to prevent scattering of domestic sheep or goats in permitted areas, or disturbances to wild sheep.

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

Land management agencies should develop programs to foster and recognize the benefits of compliance, cooperation, and cost-sharing in efforts to prevent commingling of wild sheep and domestic sheep or goats on shared ranges.

In collaboration with wild sheep management agencies, land management agencies should investigate and implement an option to allow the permittee or producer, or appropriate agency representatives, to remove commingling wild sheep and, where not already established, develop or clarify legal authority for removing stray domestic sheep from public lands by lethal means.

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 in-holdings and adjacent private lands when conducting risk assessments.

Land management agencies should closely evaluate timing of permitted domestic sheep or goat grazing or trailing activities to reduce risk of disease transmission. For example, grazing estrous domestic females heightens

Photo by: Robin Fehlau (BLM)


Photo by: Stephanie Steinhoff (CPW)

attraction and increases the probability of association between wild sheep and domestic sheep, and should be eliminated where benefits can be accrued.

In areas of high risk of association between wild sheep and domestic sheep or goats, agencies and permittees should ensure enhanced monitoring of grazing and trailing patterns using global positioning system (GPS) collars or other technology that provide detailed data on movements and grazing patterns. While enhanced monitoring will not reduce risk of association, it is vital for development of meaningful risk assessments and to ensure appropriate management recommendations are taken to achieve effective separation.

Photo by: Mike Cox (NDOW)

Photo by: Helen Schwantje (BC FLNRO)

RECOMMENDATIONS TO WILD SHEEP AND OTHER CONSERVATION ORGANIZATIONS

Recognize and support efforts of wild sheep management agencies and industry leaders in maintaining effective separation.

Assist wildlife and land management agencies with development of informational brochures and other materials that identify and explain risk of association between wild sheep and domestic sheep or goats.

Assist wildlife and land management agencies with educational efforts regarding risks associated with the use of domestic sheep or goats as pack animals in wild sheep habitat. If use is authorized, encourage participants to closely control, tether, and night-pen their pack stock. Encourage prompt reporting of association between wild sheep and domestic sheep or goats, and promote a reporting system for monitoring association between wild sheep and domestic sheep or goats.

Maintain or establish open lines of communication with domestic sheep or goat producers and industry organizations to reduce polarization. Jointly organized and cooperatively-funded workshops on risk assessment, identification of practical strategies to achieve effective separation, development and distribution of pamphlets or brochures, and public speaking opportunities are tangible examples of collaborative, multi-disciplinary approaches to address potential disease transmission.

Continue to negotiate alternatives or incentives for domestic sheep or goat permittees to shift their operations to grazing allotments outside of wild sheep habitat. Advocate that permittees convert to a different class of livestock with lower risk of disease transmission or waive permitted domestic sheep or goat use in areas where risk assessment indicates high potential for association with wild sheep.

Encourage and support development and funding of cooperative research, and encourage agencies and conservation groups to commit resources necessary to maintain wild sheep populations.

SUGGESTED MANAGEMENT PRACTICES FOR DOMESTIC SHEEP AND GOAT PERMITTEES

The following suggestions are based largely on recommendations provided by CAST (2008), Baumer et al. (2009), or USAHA (2009), and are intended to provide a responsible and common-sense approach for reducing risk of association. However, there is no science-based evidence or evaluation that assesses the effectiveness of these actions to reduce risk or enhance separation (Schommer 2009).

Management Recommendations

Implement the following reporting and record keeping procedures or use an existing standard such as the BC (Appendix B) or Wyoming (Appendix C) models:

- Require prompt, accurate reporting by herders working on domestic sheep or goat grazing allotments where association of wild sheep with domestic sheep or goats is possible.
- Support fluency in English or translators for foreign herders in order to facilitate accurate reporting.
- Require sheepherders to use cellular or satellite phones or two-way radios, and location equipment such as GPS receivers to report and record grazing movements and encounters with wild sheep. Seek cost-sharing partnerships for providing communications equipment when an operator changes grazing management practices for the sole purpose of minimizing domestic sheep association with wild sheep. Partnerships could include wildlife management agencies, federal land managers, or private organizations.
- Require herders to record GPS locations, counts, losses and other information in a log book.

Place only experienced, informed and responsible sheepherders on allotments located near wild sheep habitat.

Ensure that all domestics are individually marked and traceable to source flocks.

Conduct full counts when trailing, immediately any time scattering occurs and regularly during general grazing.

Develop agreements between permittees and wildlife agencies that provide for locating and reacquiring all stray domestic sheep, either dead or alive. In the event of missing domestic sheep, a comprehensive search should be initiated immediately and the land manager and state wildlife agency must be notified of missing and subsequent recovery of animals.

Develop a detection and response protocol that includes:

- Reporting of wild sheep and domestic sheep associations (animal counts and GPS location) to the appropriate wildlife agency.
- Reporting of stray or missing domestic sheep to the land management agency who will, in turn, report that information to the wildlife agency.
- Removal of stray domestic sheep by the permittee, land manager or wildlife agency personnel.
- Removal of individual commingling wild sheep by wildlife agency personnel.
- Collection of standardized diagnostic samples from stray domestic sheep or commingling wild sheep.

Utilize the following trailing procedures:

- Conduct full counts when moving on and off each allotment/grazing site.
- Truck domestic sheep through "driveway" areas that pass through occupied wild sheep habitat.
- Truck in water (if needed) to reduce straying.
- Immediately remove animals unable to stay with the flock/herd and move them to a base property.
- Avoid trailing more than 5 miles per day and stop trailing when sheep or lambs show signs of fatigue. Provide for a "babysitter" or removal of lagging sheep when trailing.
- In the event that all animals cannot be accounted for, the permittee must advise the responsible agency and initiate efforts to locate missing animals and implement removal protocol as necessary.

Sick domestic sheep should be removed from allotments immediately and must never be abandoned.

Photo by: Mike Pittman (TPWD)

Photo by: Aaron Reid (BC FLNRO)

Management Recommendations

Select herder's camp, nighttime bedding ground, and midday bedding ground locations that maintain communication between guard dogs and herding dogs by smell, sound (barking) and sight, and to take advantage of differences in the sleep cycles of guard dog and herding dogs. Place mature and effective guard dogs and herding dogs with domestic sheep (at least 2 of each per 1000 animals) and do not use female dogs in heat.

If grazing on federal lands, comply with established "bed ground" standards. Where conditions permit, construct temporary electric or boundary fences to ensure that domestic sheep remain within selected bedding grounds.

SUGGESTED MANAGEMENT PRACTICES ON PRIVATE LANDS

Recognize that domestic sheep or goat farming on private lands can influence wild sheep population viability on adjacent public or other private lands.

Report any observed association between wild sheep and domestic sheep or goats on or near private land to the appropriate wildlife conservation agency.

Cooperate with wildlife agencies in reporting and removing feral sheep or goats and other exotic bovine ungulates such as aoudad, red sheep, urial, or argali that are detected within or near wild sheep habitat.

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

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

Cooperate with appropriate agencies, agricultural and producer associations, conservation organizations, and other interested stakeholders to develop effective, comprehensive risk management approaches to help ensure effective separation between wild sheep and domestic sheep or goats, consistent with private property rights in and near wild sheep habitat.

- Possible approaches include, but are not limited to, changing species or class of livestock, purchase of land or the domestic sheep or goats, use of methods to ensure physical separation, or development of conservation incentives, bylaws, covenants, or legislation.

Consider partnerships with non-governmental organizations and wild sheep advocate groups for cost sharing on risk management/mitigation strategies such as fencing, or other domestic sheep or goat management actions that reduce risk of disease transmission from private flocks to wild sheep.

Support “effective separation” fencing standards that are designed to prevent nose-to-nose contact and aerosol transmission through adequate physical distance, in order to reduce transmission of respiratory disease agents. Examples include: electric outrigger fences (2 feet from page (woven) wire fencing) and double fencing (two page-wire fences with a minimum spacing of at least 10 feet). A combination of fencing methods with or without the use of effective livestock guardian dogs may be most effective to ensure that wild sheep do not physically contact domestic sheep or goats on private land.

Participate in or support cooperative research to enhance understanding and test mitigation protocols for disease risk management.

Carefully consider the consequences of using domestic sheep or goats for weed control on private lands where association with wild sheep could occur. Work with agencies to develop alternative weed management strategies to reduce risk of association, while adequately managing weed problems.

Photo by: David Wetzel (Texas Bighorn Society)

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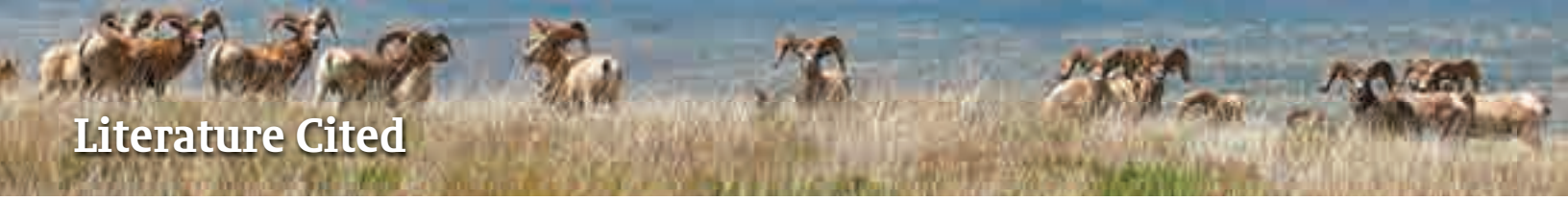

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Appendix A

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.

Association: Close proximity between wild sheep and domestic sheep or goats, potentially leading to direct physical contact and potential disease transmission.

Augment: To intentionally introduce wild sheep from one or more 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 reduce association and the potential for disease transmission between wild and domestic sheep or goats across that geographic space.

Bighorn sheep: A member of the species *Ovis canadensis* found throughout the mountains of western North America from the Peace River in Canada to northern Mexico and east to the Badlands of the Dakotas.

Contact: Direct contact 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 interactions that may lead to the transmission of respiratory disease via secretions or aerosols. Synonymous with "Interaction."

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: 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 for the long-term persistence of that population. In this report, such mortality events are usually caused by respiratory disease epidemics involving bacterial 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 whereby 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 or temporal separation between wild sheep and domestic sheep or goats, resulting in minimal risk of contact and subsequent transmission of respiratory disease between animal groups.

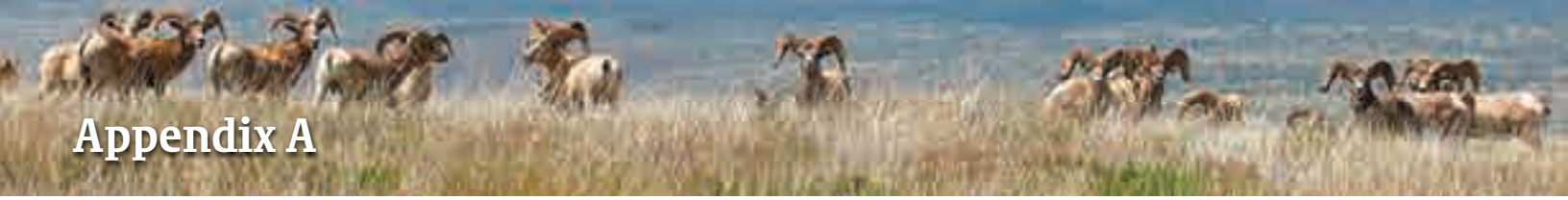
Feral: An animal of a domestic species that resides in a non-domestic setting and is not presently owned or controlled.

Historic habitat: Based on historic records, landscape that was previously occupied by bighorn sheep and thought to have provided necessary requirements to sustain a wild sheep population through time.

Interaction: Direct contact between body parts of two animals during which a pathogen 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".

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

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



Appendix A

Occupied habitat/range: Suitable habitat in which a wild sheep population currently exists.

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 by various methods for data retrieval.

Very High Frequency (VHF): A radio transmitter fitted to neckband material transmitting in the Very High Frequency range that can be located from the ground or aircraft using a telemetry receiver.

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

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 separated from its 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 association, such that they may occupy the same physical space but at different times.

Thinhorn sheep: A member of the species *Ovis dalli* occurring in Alaska, Yukon Territory, 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 or goats across a landscape or within a corridor to reach a destination where grazing or use will be allowed.

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

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

Wandering Wild Sheep: Wild sheep, primarily but not always young, sexually-mature rams, occasionally traveling outside of normally anticipated or expected wild sheep range and adjacent habitat. Removal of wandering wild sheep typically does not have population-level implications for wild sheep. Conversely, failure to respond to wandering wild sheep may result in significant, adverse population-level impacts.

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):

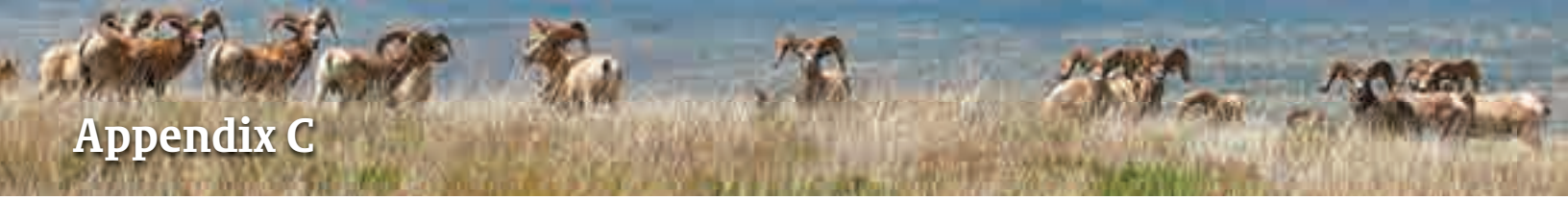
- Contact reported to Regional office.
- Assessment of situation by sheep biologist and COS, in consultation with wildlife veterinarian
- If close contact is confirmed and is considered a high risk situation, consider the following options:
    a. Kill bighorn and save carcass – sample bighorn and/or 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:
    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.



Appendix C

WYOMING GAME AND FISH DEPARTMENT
5400 Bishop Blvd. Cheyenne, WY 82006
Phone: (307) 777-4600 Fax: (307) 777-4610
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KERRY POWERS

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.

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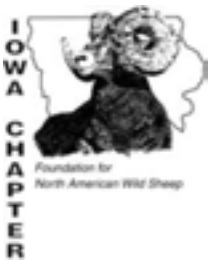

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