

WILD SHEEP HERD HEALTH MONITORING RECOMMENDATIONS

Western Association of Fish & Wildlife Agencies

Wildlife Health Committee

30 June 2009

Bighorn sheep (*Ovis canadensis*) populations throughout western North America have suffered historic or recent declines. Mortality events in many bighorn populations have been associated with recurrent outbreaks of pneumonia and occasionally other diseases. Periodic disease outbreaks in bighorn populations can contribute to instability and potentially to local extinction. Although apparently spared from disease outbreaks thus far, thimhorn sheep (*O. dalli*) are susceptible to respiratory and other pathogens that cause epidemics in bighorns, and their populations also likely would be harmed by disease introductions. Consequently, preventing epidemics and minimizing their severity or impacts are universal management goals for North American wild sheep species. It follows that assessing and monitoring herd health is an essential element of wild sheep management in North America.

Wildlife management agencies are more likely to detect the presence of infectious disease when they conduct routine surveillance of wildlife populations. In wild sheep populations, early detection of infectious disease better enables management agencies to identify significant problems and adopt appropriate actions to limit or mitigate potentially deleterious effects when indicated. Evaluating overall health and monitoring for specific diseases in wild sheep populations (and within their subsidiary herd units) using standardized methods also provides wildlife managers with data that may facilitate detecting changes in population performance or health over time. Because infectious diseases influence the dynamics of most contemporary bighorn sheep populations at one time or another, health data can be used in agency processes for assessing and mitigating disease risks associated with a variety of situations and management actions in this species. In this context, long-term data sets are particularly valuable for understanding the trends and impacts and assessing the risk of disease in bighorn sheep populations.

Management regimes, methods, and strategies for wild sheep vary among state and provincial jurisdictions. Common wild sheep management goals are to support trophy hunting, wildlife viewing, and species conservation. In general, agency management objectives aim to maintain existing wild sheep populations and/or to restore populations in suitable historic habitat. Achieving these objectives may involve the manipulation of herd sizes and animal densities through various adaptive management actions. Management actions practiced include sport harvest, habitat improvement and protection, and translocations of groups of wild sheep within and among jurisdictions to start, augment or supplement herds and populations that are declining or, in some cases, as an alternative to harvest for reducing density in a herd; in addition, other actions are sometimes undertaken in the context of research and management experiments with

various goals and objectives. Observation, examination, and sampling of individuals and groups of wild sheep are routine elements of species, population, or herd management in some jurisdictions and done opportunistically in others. Regardless of approach, the resulting information (if reliable) can be used to assess some aspects of wild sheep herd health.

Monitoring the health status of individual and herds of wild sheep also contributes to broader species management efforts by improving the understanding of herd dynamics and the ecology and epidemiology of disease processes. Moreover, monitoring wild sheep herd health should help assure that infectious disease problems are not inadvertently exacerbated or expanded through translocation or other management practices.

The following document outlines principles, guidelines and minimum recommendations for key elements of wild sheep herd health monitoring and management that can be practically applied across herds and jurisdictions; however, the intent is not to prescribe a comprehensive set of actions or activities for all agencies or for use in all management situations. These recommendations are primarily directed at monitoring bighorn sheep herd health, but also may be applied to thimhorn sheep in situations where evidence suggests infectious diseases may be affecting population performance or where preventive management or research is a goal. Where there are needs and where resources are available within a jurisdiction, measures beyond those described here may be taken to acquire more detailed data (e.g., for research purposes or for comparisons over time or among herds or populations). In addition to the broad principles and recommendations outlined, the Western Association of Fish and Wildlife Association (WAFWA) Wildlife Health Committee (WHC) previously developed other documents that provide recommendations on wild sheep sampling procedures, on testing protocols for translocation of wild sheep across international boundaries, and on laboratory protocols for isolating *Pasteurella* from field samples; for convenience and reference, these also are appended (Appendix 1 & 2).

PRINCIPLES & RECOMMENDATIONS FOR WILD SHEEP HERD HEALTH MONITORING

Population & herd demographics

Evaluation of wild sheep population demographics or selected population characteristics such as adult or lamb survival can provide essential information about herd production, performance and health. The review of past and present herd performance is critical as the first step in assessing the health status of a wild sheep population or its subsidiary herd units. The degree of investment an agency may choose to make in monitoring individual wild sheep herds likely will depend upon the purpose or relative importance of each herd. Depending on jurisdiction and subspecies in some cases, herds may be classified using a number of terms and criteria; examples of such classifications include: endangered or threatened, sensitive, imperiled, at risk (for disease or extirpation), indigenous or core, important (for harvest or other recreational uses), expendable,

translocation source, translocation recipient, unmanaged (or unmanageable), experimental or research. Herd performance review is recommended as part of jurisdictional species management planning to help prioritize health monitoring and other management activities. For example, with respect to translocations, herd performance evaluations should be done as a part of health assessment and monitoring both for potential source herds and for potential recipient (or adjacent) herds prior to translocations. To underscore the importance of this recommendation, the requirement for such evaluations should be embedded in agency policy. In the absence of these data, herd health assessments may need to rely more heavily on other less practical approaches (e.g., extensive diagnostic sampling, quarantine).

Changes in herd size and structure over time are important elements for health assessments. Approaches for these assessments are beyond the scope of this document. Recognizing the inherent biases that may be associated with measuring population parameters in free-ranging wild sheep, managers are advised to consider the following:

Survival & recruitment

Adult & subadult survival

- Large-scale mortality events or sudden reductions in adult and subadult survival may be evidence of a recent disease event in a wild sheep herd. Such losses most often occur during early winter and rut, but can occur in other seasons. Demographic effects can vary depending on season, geographic distributions and overlap of herds and populations. Herd size and composition (or adult male and female survival) should therefore be recorded at least annually, and the cause(s) of change in herd size, composition and adult survival should be determined in herds where health monitoring is part of a management plan or strategy.

Lamb survival

- Persistent poor lamb survival (defined as lamb:ewe ratios <20 lambs:100 ewes for two or more consecutive years, measured in Nov–Mar for Rocky Mountain subspecies and in Aug–Dec for desert subspecies) can occur in the absence of adult mortality events. Depressed recruitment is commonly seen for one or several years following adult mortality events and may reflect endemic disease in a wild sheep herd or population. Lambs may die as a result of primary infectious disease(s), parasitism, predation, nutritional deficiencies or a combination of two or more of these factors, and losses can occur during gestation, shortly after birth, during the first few months of life, or after weaning. In most jurisdictions, investigations of poor lamb recruitment have shown that when the majority of losses occur in the first 3-4 months of age they are most commonly associated with pneumonia. Consequently, recruitment should be observed at least annually and, in herds with persistent poor lamb production or survival, the timing and cause(s) of poor recruitment should be determined where health monitoring is a management goal.

Evidence of clinical disease

Live animals

- Observations of physical or behavioral abnormalities by agency personnel, hunters, wildlife viewers and the public often provide the first indication of poor wild sheep health. These observations may vary in quality but are particularly beneficial when accompanied by digital photos or video clips that allow review by veterinarians or experienced wildlife biologists. Potentially important disease concerns identified in this manner should be investigated further, especially if mortality is suspected.
- Individual wild sheep or herds reported to show evidence of clinical disease should be observed by a wildlife veterinarian or a biologist trained in the recognition of important contagious or parasitic diseases.
- Observations should be recorded in a herd-specific database.
- If clinical signs of a potentially important disease are recognized, then further efforts may be warranted to determine the nature of the disease agent(s) present in the affected herd and in other nearby herds.
- Herds considered of higher priority should be observed for the presence of clinical signs associated with disease on a regular basis, preferably annually, either during spring–summer (for young lambs) or winter (for the entire population).
- Herds considered of lower priority still should be observed for the presence of clinical signs associated with disease on an opportunistic basis, or at regular intervals during critical times of the year.
- Wild sheep herds or populations considered as sources for translocation should always be observed by a wildlife veterinarian or an experienced biologist prior to translocation. Such examinations should occur prior to identifying the herd as a source and scheduling the capture, but in some situations can only be done at the time of capture.
- At the time of capture, individual wild sheep captured for translocation should be examined (preferably by a wildlife veterinarian) for signs of important contagious or parasitic diseases and animals with signs of these should not be translocated.
- Herds of wild sheep that show evidence of an active outbreak of important contagious or parasitic disease (e.g., respiratory disease, mange, paratuberculosis) should not be used as translocation sources.

Dead animals

- Wild sheep herd health programs that include health evaluations of live wild sheep can be augmented by opportunistically examining dead animals. Useful health information may be derived from wild sheep where the cause of death is unknown and needs to be determined and in some situations where the cause is already known (e.g., hunter harvest or vehicle mortality).
- Ideally, wild sheep carcasses should be examined by, in order of preference: a veterinary pathologist, a wildlife veterinarian, or an experienced biologist. However, useful information

may also be obtained by others when examinations are done systematically and documented with digital photos or video clips that allow observations to be reviewed later by an experienced individual with more training. Several jurisdictions have developed field manuals for postmortem examination of wild sheep carcasses, and electronic versions of these are available on the WAFWA Wild Sheep Working Group web site (URL below). Potentially important conditions identified through *post mortem* examinations should be investigated further to determine cause, to assess the extent of the problem and its effects on population performance.

- Hunter killed animals or found carcasses may also be an important source of tissues for health and genetic monitoring of herds (e.g., liver for trace minerals, feces for parasite levels), especially when these tissues may be difficult to access from live animal sampling.
- Although detailed discussion of *post mortem* examination and sampling is beyond the scope of this document, further information on this topic can be obtained through discussions with wildlife health professionals or at <http://www.wafwa.org/html/wswg.shtml>.

PRINCIPLES & RECOMMENDATIONS FOR LABORATORY ASSESSMENTS OF WILD SHEEP HERD HEALTH

Historically, recommendations on wild sheep herd health monitoring placed a heavy emphasis on the collection and evaluation of a variety of diagnostic samples from live animals as a basis for making assessments. Diagnostic sampling may provide data that are useful in understanding the cause(s) of health or population performance problems to inform management decisions. However, laboratory testing can be very expensive and impractical in specific geographical locations where the appropriate analytical laboratories are distant, and may not be essential for all aspects of routine wild sheep herd health monitoring. Moreover, the results obtained from improperly collected, shipped and processed samples may provide data that are misleading or simply do not clarify the health status of sampled sheep. Even in cases where samples are properly collected, shipped, processed, and analyzed the interpretation of results may be subjective or inconclusive and thus may not yield definitive insights about wild sheep “health”.

Diagnostic sampling and laboratory analysis may be most useful in situations where disease is suspected or known to be present in herds (e.g., in investigating a mortality event), or where specific agents are tracked or patterns compared to follow known disease occurrences for research or to meet other specific management goals. Selective diagnostic sampling also may contribute data that complements other aspects of wild sheep herd health monitoring, and should be considered for incorporation into an overall health assessment plan for wild sheep herds and populations where health monitoring is a management goal. Where practiced, wild sheep health sampling should follow the recommendations provided here to maximize the reliability of resulting data and minimize costs and confusion.

Laboratory evaluations of live wild sheep

- No “standard set” of diagnostic samples or tests are recommended for either routine herd health monitoring or for assuring the “health” of translocated wild sheep because of the wide variation in availability of and access to diagnostic laboratory services, the inherent delays both in submitting field samples and in obtaining results, and the subjectivity of interpreting results from available diagnostic tests when applied to wild sheep. Criteria for sampling and laboratory evaluations should be developed and modified as needed within jurisdictions based on need and test availability as well as the management priority for the herd that is to be assessed.
- Sample archiving: Some jurisdictions routinely collect blood and other biological materials (e.g., feces, hair, skin biopsy punches) from captured wild sheep (and other wildlife) at every opportunity. Frozen sera, some other tissues, and air-dried skin and hair may be stored indefinitely for retrospective use in genetic and forensic studies as well as assessment of herd exposure to pathogens; nasal and oropharyngeal swabs can be placed in brain heart infusion (BHI) broth with 10% glycerol and stored at -70 C for later culture if needed. Where feasible, jurisdictions should consider collecting tissues and blood and archiving materials opportunistically, regardless of immediate plans for laboratory screening of such samples. In some cases, jurisdictions may choose to collaborate on archiving and laboratory evaluations on a local or regional basis, but these arrangements are left to respective jurisdictions to develop.
- Interpretation of diagnostic data: Data from sampling wild sheep may help define cause(s) of health problems in wild sheep herds. However, there are two important caveats associated with interpreting and applying these data. First, not all “disease agents” are significant to wild sheep population dynamics. Some agents are capable of causing illness and mortality when present alone but other agents appear to be most pathogenic (serious) when present together. For example, parainfluenza 3 (PI-3) virus occurs widely in free-ranging wild sheep, but exposure to PI-3 virus does not appear to affect the overall health of a wild sheep herd or population unless other apparently more important respiratory pathogens are present. Second, a variety of factors can alter or confound laboratory results obtained from field samples. The interpretation of laboratory results as “negative” or “positive” or at “face value” may be misleading. For example, some strains of *Pasteurellaceae* (any of several bacteria species presently classified in the genera *Mannheimia*, *Bibersteinia*, or *Pasteurella*) survive better in transport media than others, and consequently delays in submitting or processing field samples may alter culture results obtained from those samples.
- Screening for specific pathogens and parasites:
 - o Bacteriology for *Pasteurellaceae*: Oropharyngeal swab culture data are routinely collected in some jurisdictions to document (and compare) the presence of

Pasteurellaceae bacteria. However, interpretation of culture results can be highly subjective and, as mentioned, may be influenced by transport media, storage temperature, the time interval between collection and laboratory processing, and the laboratory selected. Conflicting results may be obtained from genomic vs. phenotypic (e.g., “biogrouping”) characterization of strains; moreover, the epidemiological and management significance of various strains is not clear. Better tools are needed for detecting and identifying epidemiologically-important strains of *Pasteurellaceae*. Until such improvements are made, culture results – even those arising from established and widely-used methods – should be considered as ongoing research and interpreted with considerable caution.

- Bacteriology for *Mycoplasma* spp.: Recent research results and new diagnostic techniques suggest that this may be a previously underreported and potentially important respiratory pathogen in some wild sheep populations. Some species, particularly *M. ovipneumoniae*, are extremely difficult to culture. More consistent and reliable results may be obtained using polymerase chain reaction (PCR) tests but because PCR assays used in some laboratories may not distinguish between species of *Mycoplasma*, those resulting data are of less epidemiological and management value. Retrospective serology for *Mycoplasma* spp. may be of some value in assessing historical exposure and trends.
- Virology: Virus isolation is expensive, and attempts to isolate respiratory viruses from live sampling of apparently healthy wild sheep are rarely successful. Where available and validated, PCR techniques may be a more cost-effective alternative to screen for the presence of select viruses.
- Serology: Screening sera for evidence of exposure to viruses (and bacteria) of interest may be more informative and cost-effective than live animal sampling for culture. Interpreting results from samples at a single point in time may be confounded by the apparent duration of antibody titers for some time after exposure; consequently, lambs < 1 year old may be the best source of sera when screening a wild sheep herd for evidence of recent virus exposure. Because exposure to some viruses, particularly parainfluenza 3 (PI3) and bovine respiratory syncytial virus (BRSV), appears to be widespread among free-ranging wild sheep populations, the epidemiological and management significance of serology data may not be clear.
- Trace minerals: Deficiencies of trace minerals such as selenium and copper may reduce immune function and predispose animals to infection. Sampling and handling of specimens for the purpose of determining trace mineral levels may affect results; for example, hemolysis results in abnormally elevated levels of iron and zinc and results become impossible to interpret. In general, liver tissue samples provide much more reliable estimates of trace mineral levels than serum or plasma samples and results from the latter should be interpreted with caution. Data are needed to define the “normal” range of tissue concentrations for trace minerals of interest in wild sheep management.

- Parasites: With notable exceptions related to introduced parasites (e.g., psoroptic mange), wild sheep herd health problems related to parasitism tend to be viewed as symptomatic of more fundamental problems with animal density and habitat quality. As such, standardized monitoring approaches could perhaps provide data for flagging these broader problems or tracking responses to adaptive management actions. Because of the wide geographic variation in occurrences, priorities for monitoring specific parasites of interest seem most appropriately determined on a case-by-case basis.

Laboratory evaluations of dead wild sheep

Many of the foregoing recommendations and caveats for laboratory evaluations of live wild sheep also can be applied to evaluations of dead wild sheep and interpretation of resulting data. When properly collected (e.g., as described in the field guides referenced above) and interpreted, data from modest investments in gross necropsy and perhaps in histopathology and ancillary diagnostic testing may provide better understanding about whether one or more disease agent are influencing wild sheep population dynamics. Detailed recommendations on laboratory evaluations of dead wild sheep are beyond the scope of this document, and may best be developed and modified as needed within jurisdictions based both on need and on availability of expertise and laboratory support, as well as on the management priority for the herd that is to be assessed.

INTERPRETATION & APPLICATIONS OF WILD SHEEP HERD HEALTH MONITORING DATA

General considerations

For wild sheep populations in which population dynamics or recruitment data suggest that disease may be a problem, identifying the responsible pathogen(s) through live and dead animal sampling in collaboration with a laboratory experienced with wild sheep diseases should be attempted whenever feasible in order to inform future management decisions. A herd health assessment as recommended above to address the risks and relative importance of disease agents present to the herd and to other wild sheep populations may assist in understanding options to manage the herd or specific individuals, and in identifying immediate proximate causes. Potentially important conditions identified through live animal or *post mortem* examinations should alert managers to determine cause(s), and to assess the extent of the problem and its effects on population performance.

Translocation herds

For wild sheep herds that are considered as source or recipient herds for translocations, the following are recommended:

- An overview of herd dynamics (e.g., population structure and recruitment estimates) should be completed for each herd considered as a translocation source or recipient herd. In the

absence of regular herd or population performance data, live and dead animals should be sampled to determine the baseline health status of the herd and detect potentially important pathogens prior to animal capture and, where feasible or required, a risk assessment completed.

- Wild sheep herds with lamb:ewe ratios <20 lambs:100 ewes should not be used as a source for translocation and should not be supplemented until the cause(s) of poor lamb survival has been determined. If the cause of lamb mortality in a herd or population is determined to be pneumonia or another contagious disease, the herd should not be used as a translocation source unless such translocations are part of a designed management experiments (e.g., assessing the effects of density reduction on occurrence of lamb pneumonia). Supplementing such herds with wild sheep from other sources is not recommended.
- Wild sheep herds or populations intended for use as a translocation source should be observed by a wildlife veterinarian or an experienced biologist, preferably prior to scheduling capture but minimally at the time of capture. Individual wild sheep captured for translocation should be examined for signs of important contagious or parasitic diseases and apparently unhealthy individuals should not be translocated. Wild sheep herds showing evidence of an active outbreak of important contagious or parasitic diseases should not be used as translocation source.
- Translocations involving interstate, interprovincial, or international movements of wild sheep may be predicated on meeting specific testing requirements. Where feasible, establishing the herd health or “disease freedom” status of a source herd or population prior to (most likely within a year before) the time of actual capture for translocation is recommended. State and provincial authorities should be consulted to determine health testing requirements and to ensure that samples may be shipped and stored appropriately and tested effectively to provide useable data from which to base assessments on health status. (See appendices for an example of health and testing protocols for international translocation of wild sheep.)

PROPHYLACTIC TREATMENTS TO IMPROVE HEALTH & WELFARE OF TRANSLOCATED WILD SHEEP

In general, wildlife managers have had limited success using traditional veterinary approaches (e.g., antibiotics, antiparasitics, vaccines) to improve the long-term health of free-ranging wild sheep populations. However, the management of wild sheep during translocation captures generally includes the prophylactic use of medications in an attempt to reduce the incidence of capture and transport-related illness; in additions, precautions should be taken to assure pathogens (e.g., contagious ecthyma virus) are not transferred between populations via contaminated equipment, clothing, or bait. During handling, a variety of treatments may be used for captured wild sheep to control identified or potential health problems including stress-induced respiratory diseases, mange (“scabies”) and conjunctivitis (“pink eye”). Prophylactic treatment should be based on clinical signs and history of diseases in the herd and should only be

developed and preferably applied under the direction of a wildlife veterinarian; moreover, such treatments should not be viewed or used as a substitute for conducting proper herd health evaluations prior to translocation as recommended above.

- Vaccines: To date, commercial vaccines have been of limited value and only killed virus (and killed bacteria) vaccines, where indicated by previous data or experience with the population, are recommended for use in wild sheep and other wildlife species unless the vaccine has been developed for and tested in the target species.
- Antibiotics: Broad spectrum, long acting injectable antibiotics such as tulathromycin (e.g., “Draxxin”), long-acting oxytetracycline (e.g., “LA200”) or ceftiofur (e.g., “Excede”) may be useful for the transient control of bacterial pathogens including *Pasteurellaceae* and *Mycoplasma* spp. These drugs are not indicated for routine or therapeutic use and they should not be used in animals intended for human consumption within established withdrawal periods.
- Antiparasitics: Injectable anthelmintics such as ivermectin, doramectin, or moxidectin may reduce or temporarily eliminate infections from lungworms, mange mites, and some other parasites of potential concern. As with antibiotics, these drugs must not be used in animals intended for human consumption within established withdrawal periods.
- Other pharmaceuticals: If animals are being translocated, a long acting neuroleptic such as azaperone (alone, or in combination with haloperidol) may reduce handling and shipping stress as well as the stress associated with novel environments. Dosing should be determined under the direction of a veterinarian, because overdose with these drugs may cause treated individuals to be less able to deal with predators or suppress eating and drinking behaviors.

Nonsteroidal antiinflammatory drugs and fluid replacement also are sometimes used to treat or prevent capture myopathy in translocated wild sheep.

- Vitamin E & selenium: These drugs are commonly used to prevent or treat capture myopathy in ungulates; however, their efficacy is unproven for wild sheep. Present forms of vitamin E can help stabilize muscle membranes, but most selenium preparations are oil based and not quickly absorbed for systemic distribution. Selenium supplementation may be beneficial in wild sheep captured in habitats where deficiency has been identified or suspected previously in the course of herd health monitoring.

Based on considerable collective experience, attempts to “rescue” individual or groups of wild sheep by capturing and/or treating them after the onset of an epidemic are rarely successful. Consequently, the emphasis in wild sheep herd health management should be placed on measures to prevent the introduction of novel pathogens and minimize other conditions that might foster epidemic disease.

APPENDICES

The WAFWA Western Wildlife Health Committee previously has developed various recommendations on sampling procedures and other topics related to wild sheep health. Those previous recommendations are appended as a source of reference material for jurisdictions that may have interest in or need for such information.

APPENDIX 1

WAFWA WHC BHS sampling guidelines. (Note: Source is the Western Association of Fish and Wildlife Agencies, not “Western Association of Wildlife Agencies”.)

Protocol for Movement of Bighorn Sheep from Canada to the United States

**Western Wildlife Health Committee
Western Association of Wildlife Agencies
March 16, 2001**

Extensive disease testing of free-ranging bighorn sheep, *Ovis montanus*, in the United States and Canada has been done by most wildlife management agencies that participate in the Western Association of Wildlife Agencies. There are no known endemic diseases in free-ranging bighorn sheep from Canadian populations that present a risk to United States livestock. To date, infectious diseases of concern in wild bighorn sheep in Canada are limited to gastro-intestinal and pulmonary helminthes and some biotypes of *Pasteurella* spp.; while in the United States infectious diseases of concern are limited to *Psoroptes* spp., gastro-intestinal and pulmonary helminthes, and some biotypes of *Pasteurella* spp. In general, these infectious diseases are not widespread throughout free-ranging bighorn populations. With reference to diseases of regulatory concern, brucellosis of any type is not an endemic disease in free-ranging bighorn sheep in either Canada or the United States.

The Western Wildlife Health Committee (WWHC) provides an advisory role for the Western Association of Wildlife Agencies on wildlife health issues. The Western Wildlife Health Committee endorses the following testing requirements for free-ranging bighorn sheep transported from Canada to the United States for reintroduction purposes into appropriate habitats.

Disease testing of the herds of origin and release should be done prior to the capture and transport of free-ranging bighorn sheep. At a minimum, 10 individuals, or 10% of the population in the herds of origin and release should be tested if there is no pre-existing health information available. This testing should follow the testing protocol for bighorn sheep approved by the Western Wildlife Health Committee (Attachment 1).

The WWHC recommends that all animals that are captured and transported into the United States be sampled for disease testing at the time of capture according to the WWHC protocol (Attachment 1). The WWHC recommends that treatment for gastro-intestinal and respiratory helminthes and *Psoroptes* spp. be administered at the time of capture to all bighorn sheep that are to be transported into the United States.

Testing requirements for international movement should be minimal if data is available from the herds of origin and release. If data from the herds of origin and release are not available, testing of individual bighorn per WWHC recommendations (Attachment 1) should be used to determine health status of animals to be included in the shipment. If possible, test results should be known before bighorn sheep are released so that individual sheep can be retained if necessary. However bighorn sheep could be released before final test results are known at the discretion of the attending veterinarian.

Animal Identification

Age

Sex

Subspecies

Body condition score (1-5) (sheep in poor or fair condition [BCS 1-2], are not suitable for release)

Identification (ear tags, radiocollar frequency)
Capture location
Capture date
Method of capture

Recommended tests

Ear swab for identification of *Psoroptes* spp.

Feces

Flotation for parasite ova
Baermann for parasite larvae

Pharyngeal swab for bacterial culture and identification, especially *Pasteurella* spp.

Swabs must be refrigerated and arrive at the laboratory within 48 hours after collection

Blood

Serology (Red top or serum separator tube)

Infectious bovine rhinotracheitis
Bovine virus diarrhea
Bovine respiratory syncytial virus
Parainfluenza 3
Brucella ovis
Leptospirosis
Epizootic hemorrhagic disease
Bluetongue
Anaplasmosis

Serum banking (red top or serum separator tube)

Trace minerals (purple top and royal blue top tubes)

Selenium
Copper
Molybdenum
Iron
Manganese
Zinc

Optional tests

Hair sample for genetic analysis

Nasal swab for virus isolation

Blood

Hematology (purple top tube)

CBC

Clinical biochemistry (red top or serum separator tube)

Chemistry panel with electrolytes

Genetic analysis (green top or purple top tubes)

APPENDIX 2

WESTERN WILDLIFE HEALTH COMMITTEE ASSOCIATION OF WESTERN FISH AND WILDLIFE AGENCIES

RECOMMENDATIONS FOR ISOLATION OF *Pasteurella* spp. AND *Mycoplasma* spp. FROM BIGHORN SHEEP

Mark L. Drew, DVM, Idaho Department of Fish and Game, Caldwell, Idaho
Colin Gilin, DVM, Oregon Department of Fish and Wildlife, Corvallis, Oregon
Glen Weiser, Caine Veterinary Teaching Laboratory, University of Idaho, Caldwell, Idaho

Background

The WWHC has developed health testing protocols for interstate and international movement of bighorn sheep. Within these protocols, an oropharyngeal swab is highly recommended for culture of *Pasteurella* spp. and *Mannheimia haemolytica* as these bacteria are part of the respiratory disease complex in bighorn sheep.

Although it is recognized that *Pasteurella* spp. and *Mannheimia haemolytica* may not always be the primary or exclusive agent involved in the respiratory disease complex of bighorn sheep, information gathered to date from numerous animals, herds, and locations has shown the importance of some strains of these bacteria for disease in bighorn sheep. Although numerous recommendations for sampling and processing of samples from bighorn sheep are available, most western fish and wildlife agencies send oropharyngeal swabs from bighorn sheep to the Caine Veterinary Teaching Center, University of Idaho in Caldwell, Idaho for culture and identification of *Pasteurella* spp. and *Mannheimia haemolytica*. Standardization of methods and techniques for isolation of *Pasteurella* spp. and *Mannheimia haemolytica* with a multi-level approach to identification and assessment of virulence of the bacteria isolated from bighorn sheep have been developed at the Caine Veterinary Center. However, confusion in the interpretation of laboratory results, health assessment of bighorn sheep, and comparisons with data from previous years or other locations may develop if different techniques are used by other laboratories that provide bacteriological services.

The purpose of these recommendations is to provide standardization of methods and techniques for the collection, isolation and identification of *Pasteurella* spp., *Mannheimia haemolytic*, and *Mycoplasma* spp. from oropharyngeal swabs in bighorn sheep so that results will be comparable, no matter which laboratory will receive and process the samples.

Sample collection

1. Use a clean oral speculum or mouth gag to allow the swab to reach the oropharyngeal area.
 - a. The oral speculum or mouth gag should be cleaned with soapy water and sterilized with 70% ethanol between animals.
2. Use Dacron swabs with a plastic shaft.
 - a. Wood and cotton may leach some bacterial and *Mycoplasma* spp. growth inhibitors and may interfere with identification techniques like PCR.
3. Use a forceps or hemostat, clamp the end of the swab and insert it through the oral speculum to the oropharyngeal area and aggressively swab the pharyngeal mucosa.
 - a. Do not touch the swab to the sides of the speculum or the oral cavity.