Outline of Concerns relating to the perception of disease transmission issues at the Livestock/Wildlife interface in the Western United States

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Abstract:
The following document is a synopsis of opinions and data derived from the current literature addressing the risk domestic sheep represent concerning pneumonia of big horn sheep. The summary below acknowledges that domestic sheep have been shown, in some situations, including experimental mixing to share certain pathogens. What is not known is the true risk domestic sheep present to big horn sheep or the contributions of a multitude of other risk factors such as carrier big horns, other wildlife, other domestic animals and big horn sheep genetics, especially immunogenetics.

Introduction:
The issue is not whether the current literature provides data pointing to domestic sheep as one potential risk factor to big horn sheep under experimental conditions; the issue is that of the actual risk which domestic sheep present to big horn sheep under natural-range conditions. As is summarized below, *Pasteurella* spp. require physical contact for efficient transmission and the threshold (infectious dose and other factors) for transmission of Pasteurella under natural conditions of range are not known. Furthermore the risk of disease transmission from other animals such as wild cervids, bison, cattle, and other wildlife to big horn sheep health is present but not yet defined. Also, the contributions of big horn genetics in terms of their susceptibility to disease and or carrier status of pathogens are also not known. The current outcome of enforcing buffers between domestic and wild sheep populations is based on limited surveillance of a multitude of potential risk factors with the focus and current recommendations intended to minimize an unknown degree of risk presented by domestic sheep to bighorn sheep. These recommendations have not taken into account well-established knowledge concerning the need for extreme close contact between an infected and naïve animal for effective transmission of *Pasteurella* spp. under natural range conditions. Neither do they take into account the numerous management techniques which are applied by range sheep operations to prevent contact between domestic sheep and wildlife.

Historically there are numerous examples where conclusions, based on limited data and personal bias, have been drawn concerning causal infectious disease relationships. Decisions were made and press releases issued which had significant economic and/or emotional impact only to find years later that the information used to make these decisions was incomplete and the conclusions reached did not hold up to the test of time and research. Examples include:

- the conclusion that scrapie was the cause of BSE;
- canine distemper virus was the cause of multiple sclerosis;

- domestic sheep were the source of scabies (mites) in big horn die-offs, and
- adenovirus was the primary cause of deaths in Arabian foals.

All attempts to reproduce BSE in cattle with scrapie from domestic sheep have failed; canine distemper virus and the measles virus of humans are closely related and able to induce cross reactive antibodies (which led to the initial conclusion and confusion), however careful molecular studies have shown the presence of measles virus components in patients with multiple sclerosis, but components of canine distemper virus have not been found; attempts to transmit scabies (*Psoroptes* spp.) mites among different species have failed to show domestic sheep were the source for big horn sheep, and the true underlying cause of the susceptibility of Arabian foals to adenovirus was shown to be a genetic deficiency in immune response. Analysis of each of these examples show historical economic and/or emotional loss and pain which could have been avoided by careful examination of the basic principles of causation in infectious diseases and transmission.

The literature (some peer reviewed and some not) regarding management concerns of big horn sheep populations in the Western United States is voluminous. There are many opinions as to the cause(s) of the inability of big horn sheep to thrive in some locations. Whether a group or individual believes that domestic sheep are part of the decline experienced by some big horn sheep populations or not, a survey of the literature allows one to find a statement or statements in support of their bias. There is general agreement as summarized by the Desert Bighorn Council that the difficulties big horn sheep apparently face in enhancing their populations fall into the following areas. (1) Comparatively lower tolerance to poor range conditions; (2) Interspecific competition (competition between two or more species for limited resources); (3) Excessive hunting; (4) loss of habitat, and (5) enhanced susceptibility to diseases, especially pneumonia, relative to domestic sheep and to other wildlife species in the Bovidae family.

There is no disagreement that infectious causes of pneumonia, in particular bacteria such as *Pasteurella haemolytica* (recently renamed to *Mannheimia haemolytica*) and other bacteria such as *Pasteurella multocida* and *Pasteurella trehalosi* are isolated from diseased big horn sheep. Recent discussions call into question the frequency or epidemiological importance of *Mannheimia haemolytica*. Often left out of the discussions is that these bacteria don't form spores and are extremely labile (easily broken down or rendered non-infectious) in the environment and therefore require close contact both in terms of distance and time for transmission. In fact in Foreyt, et. al. the authors state "*Pasteurella haemolytica* is a relatively labile bacterium and generally requires direct physical contact between animals for transmission".

- ❖ While it is known that this bacterium and some related strains can be isolated from domestic sheep, the role of the domestic sheep, if any, under natural range conditions in the transmission of these bacteria to big horn sheep is not known. The importance of this point can not be over emphasized. Important to this point as quoted in references by Martin and Ward "Evaluation of samples from Idaho and Alaska bighorn sheep has conclusively demonstrated that free roaming

bighorn sheep which have not had contact with domestic sheep are not free of *P. Haemolytica*". To date only one report has been published which found that BHS and domestic sheep shared the same *Pasteurella* isolates (Ward et al., 1997), all animals sampled in this study were healthy. In the Hell's Canyon BHS disease outbreak in 1995-6 a domestic goat was initially implicated because she shared a *Pasteurella* isolate with several BHS. This die-off involved BHS herds in 3 states and a variety of different Pasteurella were subsequently isolated, none corresponding to the very localized, goat associated Pasteurella strain. Not one single report from any disease investigation has established a direct link to domestic sheep as the origin of the pathogen, be that viral, bacterial or parasitic.

- Secondly, and of equal importance the possibility of other animal sources, including big horn sheep, of these bacteria or other infectious diseases for transmission to big horn sheep under natural range conditions is also not known. Research published by D. K. Onderka and colleagues in 1988 within the Canadian Journal of Veterinary Research shows this point clearly. Bighorn sheep were inoculated with *Pasteurella haemolytica* unique to wild bighorns, with *Pasteurella haemolytica* isolated from clinically normal domestic sheep or with *P. haemolytica* through a cattle vaccine. All three inoculations caused bronchopneumonia within the bighorn sheep; even the cattle vaccine.

Summary:
In summary it is premature and inappropriate based upon the complete body of literature and current research investigations to allow domestic sheep to be the focus as a major cause of Big Horn disease and herd decline. Critical to the point are the other parameters found in multiple documents which indicate that there are bighorn sheep die-offs due to pneumonia that have occurred without any association with domestic sheep (quoted in Martin et. al.) and other factors with potential involvement are the presence of bacteria such as *P. haemolytica* and *P. multocida*, types indigenous to bighorn sheep, the presence of stress from sources such as depleted forage or human disturbance, the presence of lungworms, and the presence of viruses. Several BHS population management practices should also come under review; 1) the practice of transferring animals from one herd to another without a complete diagnostic work-up, 2) including a genetic profile of the transplants; 3) the occurrence of BHS disease and major die-offs are often associated with BHS herds reaching peak population (Monello et al., 2001). 4) Stagnant BHS populations in the presence of other 'protected' or 'desirable' wildlife such as wolves or mountain lions. All of these factors affect BHS populations permanently, not just temporarily, like domestic sheep in an adjacent allotment. It is time to allow research to continue and to remove domestic sheep from the focus of bighorn sheep health issues and to make land use decisions based on what is really known under natural conditions and not what is believed to be true.

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