Response to F-2:
Strengthen the project record by additional review of currently available scientific information on disease transmission from domestic sheep and goats to wild sheep.

We reviewed 9 additional papers on disease transmission from domestic sheep and goats to wild sheep.

- Recent findings indicate that in addition to domestic sheep domestic goats also can carry other disease organisms with serious consequences for bighorn sheep.
- Bighorn sheep (BHS) are more susceptible to developing fatal pneumonia than the related species *Ovis aries* (domestic sheep [DS]).
- Outbreaks of bronchopneumonia in previously healthy populations of BHS often result in high death rates among all age groups initially, followed by years of impaired recruitment due to pneumonia in lambs.
- *Mannheimia haemolytica* consistently causes fatal bronchopneumonia in BHS under natural and experimental conditions.
- Odds of a pneumonia epizootic were >3.3 times greater if domestic sheep or goats are used for weed control in a BHS herd's area of high risk (the area of each herd distribution plus a 14.5-km buffer from that boundary).
- Contact with feral goats appears to result in BHS exposure to pathogens.
- The central role of domestic sheep and goats in BHS exposure to pathogens is well documented; pathogen transmission from domestic to bighorn sheep is the only supported hypothesis in experimental trials.
- Risk of pneumonia epizootics is positively associated with greater amounts of private land, weed control with domestic sheep and goats, history of a pneumonia epizootic in a herd or a nearby herd, and higher density of BHS herds.
- Although the majority of bighorns in one study (Drew et al. 2014) were males, documented BHS contact with domestic sheep or goats did not correlate with either the bighorn breeding season or estrus in the domestic species.
- Management implications include the need for species separation and rapid responses to contact situations because 28% of the BHS died with evidence of respiratory disease following domestic ruminant contact (Drew et al. 2014).

After review of these additional papers, the decisions made in the Forest Plan to restrict domestic sheep and goats, including pack goats, on the SNF remain unchanged. This additional literature review was included in the "2015 Amendment to the 2013 Biological Evaluation for the Revised Shoshone National Forest Land and Natural Resource Management Plan", which is part of the project record.

We reviewed the following additional papers to reach this determination.

Fox, K. A., Rouse, N. M., Huyvaert, K. P., Griffin, K. A., Killion, H. J., Jennings-Gaines, J., . . . Miller, M. W. (2015). Bighorn sheep (ovis canadensis) sinus tumors are associated with coinfections by potentially pathogenic bacteria in the upper respiratory tract. *Journal of Wildlife Diseases, 51*(1), 19-27. doi:http://dx.doi.org/10.7589/2014-05-130

Sells, S. N., Mitchell, M. S., Nowak, J. J., Lukacs, P. M., Anderson, N. J., Ramsey, J. M., Gude, J. A. and Krausman, P. R. (2015), Modeling risk of pneumonia epizootics in bighorn sheep. The Journal of Wildlife Management, 79: 195–210. doi: 10.1002/jwmg.824

Besser, T. E., Cassirer, E. F., Potter, K. A., Lahmers, K., Oaks, J. L., Shanthalingam, S., ... & Foreyt, W. J. (2014). Epizootic Pneumonia of Bighorn Sheep following Experimental Exposure to Mycoplasma ovipneumoniae. *PloS one*, *9*(10), e110039.

Drew, M. L., Rudolph, K. M., Ward, A., & Weiser, G. C. (2014). Health status and microbial (*Pasteurellaceae*) flora of free-ranging bighorn sheep following contact with domestic ruminants. *Wildlife Society Bulletin*, *38*(2), 332-340.

O'brien, J. M., O'brien, C. S., MCcarthy, C., & Carpenter, T. E. (2014). Incorporating foray behavior into models estimating contact risk between bighorn sheep and areas occupied by domestic sheep. *Wildlife Society Bulletin*,*38*(2), 321-331.

Shannon, J. M., Whiting, J. C., Larsen, R. T., Olson, D. D., Flinders, J. T., Smith, T. S., & Bowyer, R. T. (2014). Population response of reintroduced bighorn sheep after observed commingling with domestic sheep. *European Journal of Wildlife Research*, *60*(5), 737-748.

Herndon, Caroline N., Sudarvili Shanthalingam, Donald P. Knowles, Douglas R. Call, and Subramaniam Srikumaran. 2011. Comparison of passively transferred antibodies in bighorn and domestic lambs reveals one factor in differential susceptibility of these species to *Mannheimia haemolytica*-induced pneumonia. Clinical and Vaccine Immunology 18, no. 7 (July): 1133-1138.

Miller, D. S., Weiser, G. C., Aune, K., Roeder, B., Atkinson, M., Anderson, N., ... & Clarke, P. R. (2011). Shared bacterial and viral respiratory agents in bighorn sheep (*Ovis canadensis*), domestic sheep (*Ovis aries*), and goats (*Capra hircus*) in Montana. *Veterinary medicine international*, *2011*.

Wehausen, J. D., Kelley, S. T., & Ramey, R. R. (2011). Domestic sheep, bighorn sheep, and respiratory disease: a review of the experimental evidence. *California Fish and Game*, *97*(1), 7-24.