

Potential Disease Agents in Domestic Goats in Idaho and Oregon and their Relevance to Bighorn Sheep Management

MARK L. DREW, *Idaho Department of Fish and Game, 1820 South Trout Road, Eagle, Idaho. 83616; Mark.drew@idfg.idaho.gov*

GLEN C. WEISER, *University of Idaho, 1020 East Homedale Road, Caldwell, Idaho 83607*

ALTON C. S. WARD, *University of Idaho, 1020 East Homedale Road, Caldwell, Idaho 83607*

ABSTRACT Domestic goats are raised for meat, milk, and hair production, and are also used as herd goats for rangeland weed control and as pack animals. There is some controversy about the relative risk of disease transmission between domestic goats and free-ranging bighorn sheep (Foreyt 1994a, 2009; Miler et al. 2008). Domestic sheep, domestic goats, and wild bighorn sheep are all susceptible to a pneumonia that is multifactorial with variable consequences depending on the specific pathogen and the host species. We report here on a survey with the objectives of evaluating the health status and disease exposure of pack and herd domestic goats, and using this information to develop risk management criteria for situations in which domestic goats may come into contact with bighorn sheep. We defined herd goats as animals that were assembled and used for various purposes, including pets, companions, raised for 4H, or rangeland weed control, and defined pack goats as animals that were assembled and used for packing. We sampled 43 herd goats from 7 herds, and 48 pack goats from 11 groups. Blood was collected by jugular venipuncture and serum harvested after centrifugation. Serum was tested for antibodies to Anaplasmosis, Bluetongue (BT), Bovine Respiratory Syncytial Virus (BRSV), Bovine Viral Diarrhea (BVD), *Brucella ovis*, Caprine Arthritis and Encephalitis (CAE), Epizootic Hemorrhagic Disease (EHD), Infectious Bovine Rhinotracheitis (IBR), Leptospirosis, and Parainfluenza 3 (PI3). Feces were collected by digital removal from the rectum and tested for the presence of gastrointestinal parasites by flotation in saturated sugar solutions (Foreyt 1994b). Nasal and oropharyngeal swabs were collected and submitted for Pasteurellaceae culture. Goats in this study were in generally good health, although most goats did harbor various pathogens and parasites. The pack goats were exclusively male (4 intact and 44 wethers). Herd goats consisted of 30 females, 12 wethers, and 1 intact male. The average age of pack goats was 7.4 years and of herd goats was 3.1 years. The majority of animals and herds had low to no titers to most pathogens assessed. No goats had antibodies against Anaplasmosis, IBR, or Leptospirosis. One herd goat was seropositive for *Brucella ovis* and three herd goats were seropositive to BVD and PI3. Antibodies to BT and EHD were prevalent in pack goats (25 of 48, 52.1%, seropositive to BT and 26 of 48, 54.2%, seropositive to EHD) but not in herd goats (2 of 41, 4.8% seropositive to both viruses; $\chi^2=23.2$, $df=1$, $P=0.001$). Animals with positive titers came from 9 of 11 (82%) pack goat herds and 1 of 7 (14%) herd goat herds. Antibodies to CAE were found in 7 pack goats belonging to 5 herds and in 7 herd goats belonging to 3 herds, with the majority of seropositive animals from 2 pack goat herds and 1 herd goat herd. Only herd goats had individual animals with high or moderate levels of coccidia oocysts. Two pack goats and 7 herd goats had *Nematodirus* spp. ova. Individuals in 6 goat herds (3 pack and 3 herd) had greater than 30 eggs/g for *Strongylus* spp. Eggs of *Trichuris* spp. were found in 4 pack goats and 5 herd goats with only 1 pack goat having a high egg count. Oropharyngeal swabs yielded isolates of one or more Pasteurellaceae species from 43 of 48 (89.5%) pack goats and from 41 of 43 (95.3%) herd goats. The frequency of Pasteurellaceae isolation was similar between herd and pack goats ($\chi^2=2.5$, $df=1$, $P=0.41$). Isolates of *Bibersteinia trehalosi* were found in 33 of 48 (68.8%) pack goats and 34 of 43 (79.1%)

herd goats, with no significant differences between herd types ($\chi^2 = 1.2$, $df = 1$, $P = 0.26$). The majority of *B. trehalosi* isolates were biogroup 2 (21 of 33 (64%) for pack goats and 27 of 34, (79%) for herd goats), and very few were hemolytic (1 of 33, 3.0%) and 7 of 34 (20.5 percent, isolates from pack and herd goats, respectively). *Mannheimia haemolytica* was not found in any of 48 pack goats, but was isolated from 14 of 43 herd goats (33 percent) ($\chi^2 = 9.8$, $df = 1$, $P = 0.002$). Isolates from both groups of goats were predominantly the unnamed *Mannheimia* species. Low numbers of *M. glucosida*, *M. ruminalis*, and *M. varigena* were found in both groups of goats. Most isolates of *Mannheimia* spp. from pack and herd goats were hemolytic (22 of 26, 84.6%) and 36 of 54, 66.7%), respectively. Based on biogrouping, most isolates from pack goats (20 of 26 isolates (77%) and herd goats (40 of 54 isolates, 74%) were of high to moderate disease potential for bighorn sheep (Jaworski et al. 1998). Goats in this study were exposed to, or had evidence of the presence of several pathogens that have been reported from bighorn sheep. Both pack and herd goats in this study were found to have respiratory bacteria that have been associated with pneumonia in bighorn sheep (Ward et al. 2002, Jaworski et al. 1998). The prevalence of Pasteurellaceae isolated from domestic goats in this study is comparable to others (Ward et al. 2002) and these results can be used to define the typical oropharyngeal flora of domestic goats. Differences between pack and herd goats in this study are likely due to differences in age structure, herd size, and the extent of interaction between goats from different sources. Contact between bighorn sheep and domestic goats under field conditions has been documented (Rudolph et al. 2003, 2007; Jansen et al. 2006). Infectious keratoconjunctivitis (pink eye) has been transmitted from domestic goats to bighorn sheep under range conditions (Janson et al. 2006) and *Mannheimia* spp. have been shown to be shared between bighorn sheep and feral goats, although the sharing was limited to interaction among 3 animals and did not appear to be involved in the large bighorn sheep die-off occurring in the area (Ward et al. 1997, Jansen et al. 2006, Rudolph et al. 2007). However, due to the possibility of transmission, management of domestic goats in areas in or near bighorn sheep habitat should be conducted to minimize the risk of the spread of disease agents. Recommendations for management of pack goats should include avoiding direct contact between goats and bighorn sheep, using a tether or lead rope at all times when in the presence of free-ranging bighorn sheep, and keeping goats under close control when in areas in which bighorn sheep could be present. Parasite control is highly recommended as a best management practice and should be required prior to use of goats in bighorn sheep habitat to minimize the risk of parasite transmission to bighorn sheep.

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KEYWORDS bighorn sheep, disease risk, domestic goats, microbiology, *Ovis canadensis*, Pasteurellaceae

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