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During winter 2009-2010, the Western Association of Fish and Wildlife Agencies (WAFWA) and its member agencies experienced nine bighorn sheep pneumonia die-offs in five western states. “In a bad year, there may be two or three bighorn die-offs somewhere in the West. This winter, we dealt with three to four times that many die-offs,” said Utah Division of Wildlife Resources Director Jim Karpowitz.

In mid-November 2009, coughing and obviously-ill bighorn sheep were reported to Montana Department of Fish, Wildlife and Parks (FWP) and Nevada Department of Wildlife (NDOW) personnel by hunters, other outdoor enthusiasts, and landowners. In Washington, railroad workers reported dead bighorn sheep lying trackside in early December to Washington’s Department of Fish and Wildlife (WDFW). “By mid-February, Utah Division of Wildlife Resources documented sick bighorns in one of our herds,” according to UDWR big game coordinator Anis Aoude. In early March, Wyoming Game and Fish Department (WGFD) personnel found bighorns showing classic signs of pneumonia.

Upon agency inspection of nine different herds, from five to eighty percent of the bighorns observed exhibited symptoms of respiratory disease, including prolonged and severe coughing, nasal discharge, lethargy, abnormal walk/gait, reluctance to move upslope, and abnormal bedding behavior. Variability in percentage of bighorns with signs of respiratory disease may reflect differences in responsible pathogens among the reported outbreaks. Pneumonia was subsequently confirmed in each herd via necropsy of dead bighorns.

Agency response to bighorn sheep die-offs ranged from establishment of designated “containment areas” where agency personnel culled (i.e., lethally removed) bighorns exhibiting symptoms of pneumonia as well as a few non-symptomatic bighorns, to aggressive capture, treatment, and radio-collaring of both sick and apparently-healthy bighorn sheep. “Culling actions were taken in an attempt to minimize or prevent contact and possible disease transmission between obviously-sick bighorns and neighboring wild sheep sub-herds,” according to Tom Carlsen, wildlife biologist with Montana FWP. In Nevada, according to NDOW big game staff biologist Mike Cox, “capture/treatment strategies were designed to deliver doses of long-acting, single dose antibiotics, in addition to vitamins and anti-inflammatory agents; bighorns were either ear-tagged or radio-collared, to facilitate monitoring and to evaluate short- and long-term survival.”

“In every case, bighorns that were either found dead, culled, or captured, treated, and released were sampled, with agency personnel collecting a thorough set of diagnostic samples,” said Donny Martorello, Washington DFW bighorn sheep section manager. In some cases, vegetation and soil samples were also collected, to evaluate forage quality and trace mineral availability.

Laboratory results are available in many of these bighorn die-offs, but not yet in all. “Bacterial agents, solely or in concert with other pathogens, appear to be the leading cause of these pneumonia die-offs,” stated Dr. Peregrine Wolff, NDOW wildlife veterinarian. “Certain species and strains of bacteria (*Mannheimia haemolytica*, *Pasteurella multocida*, *Bibersteinia trehalosi*, *Mycoplasma ovipneumoniae*), alone or in combination, tend to be lethal in bighorn sheep,” according to WAFWA Wildlife Health Committee Chair Dr. Kristin Mansfield, WDFW’s wildlife veterinarian.

Prior to these outbreaks, bighorn sheep numbers were estimated at 1,600-1,700 in these nine herds. The ~890 bighorns which died this winter represent just over 1% of the total number of bighorn sheep in the western U.S. and Canada. Estimated losses

within individual herds ranged from 5 to 95%, not unusual based on pneumonia die-offs documented elsewhere in previous years. In at least 7 of the 9 die-offs, estimated losses exceeded 43%.

While direct evidence of co-mingling may not be available in every circumstance, at least three of the nine bighorn die-offs were preceded by known or likely association between bighorn sheep and domestic sheep or goats. In many instances, domestic sheep and/or goat hobby herds or farm flocks occur on the periphery of occupied bighorn range, while in others, grazing allotments or use of domestic sheep/goats for fuels management and/or noxious weed control may have placed wild and domestic sheep in close proximity, on or adjacent to public lands where bighorns reside. “While domestic sheep and goats can carry these bacteria without causing them any harm, when they pass them to bighorn sheep, bighorns more often than not will develop pneumonia and die. It appears that the bighorn sheep immune system is simply not equipped to deal with these pathogens,” added Dr. Mansfield.

“Efforts are underway in most western states and provinces to achieve or maintain effective separation between wild and domestic sheep,” said Kevin Hurley, WAFWA Wild Sheep Working Group Chair from Wyoming. State wildlife agency protocols, while not universally popular or understood, call for lethal removal of bighorns that have associated with domestic sheep or goats.

“Federal land and state wildlife management agencies try to manage for separation, to keep domestic and bighorn sheep apart,” according to U.S. Forest Service Full Curl Program Coordinator Melanie Woolever. However, that is far easier said than done. Young bighorn rams often wander great distances, especially during the breeding season, and may encounter domestic sheep or goats, far outside normal or typical bighorn range. Sometimes, those bighorns may serve as their own vectors, bringing bacterial pathogens from domestic sheep and goats back to their source herds, or adjacent herds.

In some of these bighorn sheep die-offs, willing landowners or grazing permittees have allowed state wildlife agency personnel to sample their domestic animals, for comparative diagnostic results. In other die-offs, comparative testing of domestic sheep and/or goats has either not been pursued or has been precluded.

Agencies are summarizing information on these pneumonia die-offs, evaluating their response protocols and the efficacy of those responses, finalizing lab/diagnostic serology, lab culture, parasitology and other sampling results, identifying short- and long-term monitoring strategies, and adaptively formulating future response protocols. Monitoring of bighorn survival and subsequent lamb production/recruitment will continue during spring and summer 2010, and beyond.

Frustration with these bighorn sheep die-offs runs high, both within the wildlife management agencies, and for the wild sheep conservation organizations. Hundreds of thousands of dollars, and thousands of man-hours go into reintroducing bighorn sheep where they were eliminated from native ranges in the early 1900s, only to have a disease like pneumonia kill so many bighorns. “It’s really tough to watch these outbreaks occur, but the agencies and their wild sheep partners will keep working to ensure bighorn sheep occupy western mountain ranges,” said UDWR Director Karpowitz. “When it’s a long-established transplant or a native herd that takes this kind of hit, it’s even tougher to deal with,” added WAFWA Wild Sheep Working Group chair Hurley.

Table 1. Bighorn sheep pneumonia die-offs, winter 2009-2010, in 5 states (MT, NV, WA, UT, WY), as of 6/21/2010.

BHS Die-off Location	Pre die-off Estimated BHS Population Size	# BHS Culled	# Known Add'l Mortalities	Estimated % BHS Mortality	Estimated # BHS Mortalities	Known, Likely or Possible Association with Domestic Sheep or Goats, Prior to BHS Die-off
East Fork Bitterroot, MT	200-220	80	N/A	50%	~100	Known
Bonner/W Riverside, MT	160-180	99	4	68%	~110	Known
Lower Rock Creek, MT	200	18	N/A	43%	87	Possible
Upper Rock Creek, MT	~340	39	N/A	60%	~200	Possible
East Humboldt Range, NV	160-180	1	113	80%	140	Likely
Ruby Mountains, NV	160	1	36	65%	100	Possible
Yakima River Canyon, WA	280	69	42	33%	99	Possible
N slope Uinta Mountains, UT	50-70	51	0	95%	50	Unknown
Gros Ventre River, WY	50-60	2	0	5%	2	Unknown
Totals	1600-1680	360	195		888	