PREDICTING SUMMER LAMB MORTALITY IN FREE RANGING BIGHORN SHEEP

HOLLY A. AKENSON[1], Oregon Department of Fish and Wildlife, 107 20th St., La Grande, OR 97850

Abstract: Summer lamb mortality occurs for several years following a *Pasteurella* associated bighorn die-off. Factors influencing this summer lamb mortality are not well understood. Lamb mortality studies conducted after a die-off have been hampered by low sample sizes due to the difficulty in locating dead lambs and culturing uncontaminated bacteriology and virology samples. Summer lamb mortality was evaluated in the Wenaha herd of Rocky Mountain bighorn sheep in Oregon. A technique was developed to maximize the number of fresh lamb carcasses found in summer. The focus of searches for lamb carcasses was guided by behaviors of bighorn sheep rather than random searches, close distance observations, or a focus on scavengers. Lamb carcasses less than 24 hours old and critically ill lambs were located through recognition of behavioral cues of lambs, their dams, and their social group. Since carcasses were located and preserved immediately after death, post-mortem bacterial contamination was minimized. *Pasteurella trehalosi* (*Pasteurella haemolytica* biotype T) biogroups 2b and 2 were cultured from lungs of 3 dead lambs that were less than 7 weeks old. The use of behavioral cues to locate sick or dead lambs was particularly effective since bighorn groups were widely spaced and most observations were made from long distances due to terrain and habitat.

INTRODUCTION

Die-offs of Rocky Mountain bighorn sheep populations (*Ovis canadensis*) from pneumonia have been associated with *Pasteurella haemolytica* bacteria (Onderka and Wishart 1984, Bailey 1986, Coggins 1988, Akenson and Akenson 1992, Ryder et al. 1992, Cassirer 1996). The pneumonia caused a high mortality rate in all age-classes and resulted in poor lamb recruitment for several years following the die-off. A high rate of lamb mortality during summer was responsible for the post die-off poor lamb recruitment (Festa-Bianchet 1988, Akenson and Akenson 1992, Coggins and Matthews 1992).

Following a die-off, lamb carcasses can be collected, tissues examined, and bacteria and viruses cultured to identify the active pathogens responsible for lamb mortality, and potentially the pathogen associated with the die-off. Unfortunately, in free ranging bighorns it is difficult to find lamb carcasses that can be cultured before autolysis has occurred. Few lamb carcasses have been examined or cultured after a die-off. An effective method is needed to detect sick lambs and locate carcasses in the field.

The health status of a bighorn lamb can be determined by interpreting the behavior of its dam within a social context. Bighorn sheep are a social species. They have predictable behavior patterns. Ewes with newborn lambs join other ewe-lamb pairs a few days after lambing (Geist

[1] Present address: Taylor Ranch Wilderness Research Sta., HC 83, Cascade, ID 83611

1971). Lambs readily form bonds with other lambs, playing and feeding together within the nursery group. Ewes with lambs remain in groups throughout the summer. Akenson and Akenson (1992) located lamb carcasses by observing agitated behaviors of bighorn ewes whose lambs had recently died. Ewes have been observed staying in the vicinity of their dead lambs for up to 3 days (Geist 1971, Akenson and Akenson 1992). As a result of the strong social bonds between a ewe and its lamb and among ewes, the behavior of a ewe can be interpreted to indicate that its lamb may be weakened or dead. This paper describes a technique for observing and interpreting ewe and lamb behavior within a social context to predict imminent lamb mortality or to find lamb carcasses within 24-hours of death.

I thank Oregon Department of Fish and Wildlife and the Foundation for North American Wild Sheep for financial support. I appreciate the efforts of Oregon Department of Fish and Wildlife and Idaho Department of Fish and Game personnel in capturing and radio collaring bighorn ewes.

STUDY AREA AND METHODS

The Wenaha herd of Rocky Mountain bighorn sheep in northeastern Oregon experienced a die-off in 1996. The die-off was part of the widespread Hells Canyon die-off that started in late 1995. I monitored the Wenaha bighorn sheep in 1997 to assess summer lamb mortality during a *Pasteurella* vaccine trial (Cassirer et al. 1998). Twelve radio-collared ewes and their associated groups were located from the ground several times per week from May through mid July. Group composition, location, and lamb health were determined. The bighorn ewes used bunchgrass slopes and rims in and adjacent to the Wenaha-Toucannon Wilderness. Bighorn groups were widely dispersed along 25 km of river corridor. I used a 40 power spotting scope to monitor lambs up to 2.5 km away on the opposite side of a 370 m deep canyon.

Clinical symptoms of pneumonia, including coughing, nasal discharge, weakness, and head shaking, were documented. Individual lambs were watched for up to one hour to determine health status. When a ewe was observed standing or bedded alone, acting agitated, or vocalizing and travelling rapidly, the ewe was watched and vicinity scanned for evidence that a lamb was sick or dead. Searches for a dead lamb were conducted in the vicinity of the ewe. Dead lambs were collected, then necropsied at the Idaho Fish and Game Wildlife Health Lab. Nasal and pharyngeal swabs and tissues were cultured and *Pasteurella spp.* identified by DNA restriction enzyme assay (Jaworski et al. 1993) at University of Idaho Caine Veterinary Teaching Lab.

RESULTS

Fourteen lambs were observed with 32 ewes of the Wenaha herd. Median date of birth was May 26 (range May 18-June 3, n=14). Five lambs had died by July 16; all were under 7 weeks old. Three of the lamb carcasses were recovered within 24 hours of death. These lambs were 10, 19, and 47 days old. Two strains of *Pasteurella trehalosi* (also referred to as *Pasteurella haemolytica* biotype T) were cultured from lungs of the 3 bighorn lambs. Two lambs had the non-hemolytic biogroup 2b, while 1 lamb had the hemolytic biogroup 2.

The presence of clinical pneumonia symptoms did not consistently predict lamb mortality. Coughing was observed in several lambs, but some lambs coughed that did not die immediately, while other lambs died although coughing was not observed. Long distance observations made it difficult to see nasal secretions. Ward et al. (1992) described symptoms of bighorn lambs with inner ear irritations, exhibited by head tilting, ear drooping, ear scratching, and head shaking. Within 72 hours death from *Pasteurella* associated pneumonia was imminent for these captive lambs. Ear scratching and head shaking were observed in lambs and ewes, but it was unclear whether insects or inner ear irritations caused these responses.

The behavior of a bighorn ewe was more reliable for indicating the presence of a newly dead lamb than random searches or focusing on scavenger activity. All 3 recovered lamb carcasses were located based on behavioral cues exhibited by the dam. Each ewe exhibited several of these actions:

- The ewe was alone
- The ewe was agitated, scanned the area, and vocalized frequently
- The ewe travelled rapidly between the group and its dead lamb
- The ewe bedded near its dead lamb
- The ewe remained in the vicinity of the carcass when approached by a human

One ewe displayed several cues that indicated her lamb had died. The ewe and her 9-day old lamb had just joined a nursery group 1 km from the lambing area. A major thunderstorm occurred that afternoon. In the evening the agitated ewe ran between the lambing area and their location prior to the storm. A carcass could not be located through the spotting scope. In the morning the ewe was in the lambing area without her lamb. A ground search was fruitless and the ewe left the area. After more than 15 hours of known separation the ewe and lamb were reunited. They pair moved 2 km from the group and remained near a crevice in a cliff for 3 days before rejoining the nursery group.

The behavior of a ewe could also indicate that its lamb was sick. On 3 occasions different ewes from the Wenaha herd were observed leaving their group to stay with the sick lamb. Each ewe responded to its sick lamb with these behaviors:

- The ewe left the group to remain with its lamb
- The ewe nuzzled or pawed its lamb to urge it to stand, nurse, or travel
- The ewe vocalized and ran back and forth between the lamb and the group
- The ewe was aggressive (horn threat, teeth grinding) to human approach

One sick lamb was so weak that it remained bedded when captured by hand. As we searched for this lamb, its dam vocalized, ran toward us, isolated one person on a ledge with a horn threat then when 2-5 m away, horn threatened 2 other people. We found the lamb 3 m from us. The lamb died while being carried out of the wilderness.

Lamb behavior that was inconsistent with typical lamb social patterns was also an indicator that the lamb was near death. These behaviors were observed from long distances. The health of lambs was most readily assessed when the bighorn group travelled or fed. Three critically ill lambs displayed the following behaviors (ordered by increasing severity of illness):

- The lamb lagged behind a travelling group
- The lamb stumbled or bedded when it followed the group
- The lamb remained bedded when the group moved away
- The lamb would not/could not move uphill
- The lamb could not be encouraged by its dam to follow the group
- The lamb oriented its body away from the group, then moved downhill and away from the group (2 lambs ended up in a brushy draw or riparian)
- The lamb bedded or stood motionless and was inattentive to the activities of the other bighorns
- One lamb stood with a bison-like posture: its back was rounded and its head was lowered.
- The lamb was alone after the bighorn group moved away
- The sick lamb was found dead within 16 hours of the last live observation on 2 occasions

Bighorn social groups provided additional cues to confirm that a lamb was critically ill. Under normal conditions ewes and lambs showed strong group cohesion. The following behaviors were observed when a sick lamb was present:

- Bighorns in the group directed their attention toward a lamb that was detached from the group
- The group moved toward the lamb
- The group moved away from the lamb
- A ewe was aggressive to a lamb

In one incident a ewe and lamb joined the sick lamb. This ewe and the dam of the sick lamb moved off when the dam could not encourage the lamb to follow. The healthy lamb remained with the 18 day-old sick lamb despite the healthy lamb's dam repeatedly encouraging it to follow. This ewe returned to the lambs and butted the sick lamb in the side 4 times. The dam of the sick lamb observed this interaction, but did not interfere. The 2 ewes and healthy lamb fed away from the sick lamb. The next morning the sick lamb was dead. Its dam was 250 m away. A necropsy revealed that this lamb had pneumonia, as well as a punctured rumen and bruises on both sides of the body (presumably from being butted, but possibly from a fall or being pawed).

DISCUSSION

The criteria described in this paper for recognizing the health status of lambs is based on a small sample of bighorn lambs that were observed sick or dead. Despite the small number of

individuals, ewe behaviors observed in this study were consistent. Some were the same as ewe behaviors described in other bighorn populations (Geist 1971, Akenson and Akenson 1992). The behavioral responses of these ewes to their sick and dead lambs are likely ubiquitous among bighorn sheep.

Advantages. The use of bighorn behavior to locate lamb carcasses has several advantages over other methods. A ewe's behavior can indicate that a lamb has died and focus the search area so lamb carcasses can be recovered rapidly and in greater numbers. The dam of the dead lamb can be identified by its agitated behavior. In comparison, routinely scanning an area used by bighorn sheep to find carcasses is inefficient. Carcasses located from scavenger activity are usually not intact for post-mortem examinations and too decayed for bacteriology and virology culture. Lamb mortality studies requiring radio-instrumentation of lambs are expensive, can cause significant disturbance in lambing areas, and are logistically not possible in many areas. Using bighorn sheep behavior to indicate lamb mortality does not require live animal handling, is inexpensive, unobtrusive, and is effective for long distance observations. Since imminent mortality can be predicted by bighorn behavior, intensive follow-up monitoring results in less contaminated carcasses than those collected using other methods. Although clinical symptoms of pneumonia in free ranging bighorn sheep are difficult to detect while observing bighorn behavior from long distances, the presence of pneumonia symptoms does not necessarily lead to imminent lamb mortality.

Limitations. There are several limitations of this technique. It requires good vantage points for observing bighorn sheep. Each group must be observed daily to maximize recovery of uncontaminated carcasses. If a ewe and its sick or dead lamb are segregated from other sheep they are more difficult to locate. There is a danger to humans approaching an aggressive ewe to collect a dead lamb. Since observations of ewes with dead lambs have been limited, it is not known whether ewes respond in the same manner to lambs that died from predation or other non-disease causes of mortality.

There were several interesting results from monitoring summer lamb mortality in the Wenaha herd. Two strains of *Pasteurella trehalosi* were isolated from lungs of the bighorn lambs, biogroup 2b and biogroup 2. Both of these strains were found in bighorns sampled during the Hells Canyon die-off in 1995-1996. Biogroup 2b, a non-hemolytic strain was identified in 71% of bighorn sheep and biogroup 2, a hemolytic strain was cultured from 5% of bighorn sheep that were sampled during the Hells Canyon die-off (Cassirer et al. 1996). *Pasteurella trehalosi* biogroup 2 was implicated in a bighorn sheep die-off in central Idaho in 1989-1992 (D. Hunter, Idaho State Wildlife Veterinarian, lab report 7/9/97). Foreyt (1990) found that post die-off mortality in captive bighorn lambs did not occur until after lambs were 6-11 weeks old since lambs were apparently protected for several weeks by passive immunity from colostrum. In the Wenaha herd, mortality from pneumonia occurred in lambs under 7 weeks old indicating that colostral immunity may not function adequately. Sams et al. (1996) found that transfer of passive immunity through colostrum absorption was compromised in an overpopulated and malnourished herd of white-tailed deer (*Odocoileus virginianus*). Perhaps the multiple year

summer lamb mortality that occurs following a *Pasteurella* die-off is triggered by interference in colostrum absorption by lambs of die-off survivors.

CONCLUSION

Sick lambs and lamb carcasses were located during a study of lamb mortality by observing and interpreting bighorn ewe and lamb behaviors. Ewes and lambs displayed distinctive behaviors when a lamb died or was critically ill. When I recognized these behavioral cues I was able to identify sick lambs that would die within 24 hours, to locate lamb carcasses less than 24 hours after death, to identify a ewe whose lamb had recently died, and know where to search for the carcass. A bighorn ewe's behavior was the most reliable indicator that its lamb was critically ill or dead. The ewe's behavior alerted me to intensively watch the lambs for signs of illness. Critically ill lambs should be monitored for 24 hours to document mortality and recover carcasses immediately after death. The localized nature of a ewe's activities identified the site of the lamb carcass or sick lamb. The bighorn lamb's behavior was the best indicator of the lamb's health. Lamb health was most readily assessed when the group was travelling, since a sick lamb lagged behind the group. These techniques were very effective for long distance assessment of the health status of individual lambs. Since carcasses could be located and recovered quickly by using this method, all 3 carcasses collected were intact and could be cultured for bacteria and viruses. Strains of *Pasteurella trehalosi* were isolated from the lungs of all 3 lamb carcasses.

LITERATURE CITED

Akenson, J. J. and H. A. Akenson. 1992. Bighorn sheep movements and summer lamb mortality in central Idaho. Bienn. Symp. North. Wild Sheep and Goat Counc. 8:14-27.

Bailey, J. A. 1986. The increase and dieoff of Watertown Canyon bighorn sheep. Bienn. Symp. North. Wild Sheep and Goat Counc. 5:57-64.

Cassirer, E. F., L. E. Oldenburg, V. L. Coggins, P. Fowler, K. Rudolph, D. L. Hunter, and W. J. Foreyt. 1996. Overview and preliminary analysis of a bighorn sheep die-off, Hells Canyon 1995-96. Bienn. Symp. North. Wild Sheep and Goat Counc. 10:78-86.

Cassirer, E. F., K. Rudolph, P. Fowler, V. L. Coggins, D. L. Hunter, and M. W. Miller. 1998. Evaluation of a ewe vaccine as a tool for increasing bighorn lamb survival following Pasteurellosis epidemics. Bienn. Symp. North. Wild Sheep and Goat Council. (in press).

Coggins, V. L. 1988. The Lostine Rocky Mountain bighorn sheep die-off and domestic sheep. Bienn. Symp. North. Wild Sheep and Goat Counc. 6:57-64.

Coggins, V. L. and P. E. Matthews. 1992. Lamb survival and herd status of the Lostine bighorn herd following a *Pasteurella* die-off. Bienn. Symp. North. Wild Sheep and Goat Counc. 8:147-154.