

Rocky Mountain Bighorn Sheep/Domestic Sheep And Domestic Goat Interactions: A Management Prospective

VICTOR L. COGGINS, Oregon Dept of Fish and Wildlife, 65495 Alder Slope Road, Enterprise, OR 97828 U.S.A.

Abstract: Interactions of Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*), domestic sheep (*Ovis aries*) and goats (*Capra hircus*) in Hells Canyon are discussed. Case histories of domestic sheep and goats co-mingling with bighorns are presented. Some short-term encounters did not result in disease outbreaks, however other contacts with domestic sheep and goats resulted in pneumonia outbreaks in bighorn herds. The timing of the onset of disease following known contact with domestic sheep and management options are summarized. Management actions discussed include: 1.) Buffer zones between domestic sheep, goats and bighorns. 2.) The degree of interaction that constitutes contact with domestics. 3.) The instances in which bighorns should be removed.

Key words: Rocky Mountain bighorn sheep, domestic goats, domestic sheep, co-mingling, pneumonia outbreaks.

Respiratory disease is considered one of the most significant problems associated with bighorn sheep (*Ovis canadensis*) management (Aune et al. 1998).

Pneumonia epizootics, common in the western U.S. and southern Canada, have devastated many bighorn herds (Onderka and Wishart 1984, Coggins 1988, Foreyt 1989, Cassirer et al. 1996, Aune et al. 1998). Domestic sheep contact with bighorns has been the suspected cause of many pneumonia outbreaks (Martin et al. 1996, Miller 2000). A domestic goat has been circumstantially implicated in one Hells Canyon bighorn epidemic that killed over 300 bighorns (Cassirer et al. 1996). Five separate die-offs have been documented in Hells Canyon since reintroductions in 1971. Studies in progress in Hells Canyon indicate disease is a major problem and was responsible for 83% and 90% of ram and ewe mortality, respectively between 1998 and 2001 (Cassirer 2002).

This paper reports on domestic sheep and goat interactions with Rocky Mountain bighorns in the Hells Canyon area of Washington, Oregon and Idaho.

Case histories of some of these encounters are chronicled. Recommendations for management actions are also included.

STUDY AREA

The Snake River and Hells Canyon border the states of Oregon, Idaho and Washington. The area is very rugged terrain with elevations from 243 m (800 ft.) near Lewiston, Idaho to nearly 3,000 m. (10,000 ft.) in the Wallowa Mountains, Oregon. Much of Hells Canyon is on the Wallowa-Whitman and Payette National forests. Some cattle grazing occurs and a few domestic sheep still graze on several allotments on the Payette N. F. and private lands. Canyon bighorn habitat is steep and rocky with an abundance of perennial grasses. Alpine habitats are steep and rocky with green grass and forbs available through the summer.

HISTORY

Historically, bighorn sheep were abundant in Hells Canyon but were totally extirpated by the mid-1940s. Reintroductions started in 1971 when domestic sheep still grazed much of Hells

Canyon. Economics, land use changes, allotment buyouts, and in one case, court action has resulted in the removal of most domestic sheep from public land.

Reintroductions to vacant bighorn habitat and preventing bighorn interaction with domestic sheep and goats have been major management activities. The April 2002 population of the study area was estimated at 850 bighorns.

METHODS

This paper is based on many personal observations by the author and other Hells Canyon wildlife personnel. It includes data from Oregon Department of Fish & Wildlife Wallowa District files and monthly reports and Hells Canyon Initiative reports. A compilation of literature concerning contact between

domestic sheep, goats and bighorns is included.

RESULTS

Bighorn/Domestic Sheep Interactions

Most wildlife biologists, wildlife veterinarians, and researchers have concluded that bighorn sheep and domestic sheep should not occupy the same ranges and should be kept apart (Martin et al. 1996, Schommer and Woolever 2001). From a management prospective, this may involve removing bighorns from domestic sheep ranges or domestic sheep from bighorn range. A frequently asked question by wildlife managers is "What constitutes contact?" To help answer the question, eleven summaries of interactions between domestic and bighorn sheep are discussed

Table 1. Hells Canyon Rocky Mountain bighorn/domestic sheep interactions 1984-2001.

Date	Location	Sex and age of bighorn	Within 100 meters of domestics	Observed with domestics	Time with domestics	Outcome
July, 1984	Pattersall farm Union, OR	Adult ewe (transplant)	Yes Farm flock	Yes	5 days	Found dead on 8th day.
June, 1988	Maxwell farm Imnaha, OR	Yearling rams (2)	Yes Farm flock	No	0	No disease-captured and taken to lab.
June, 1990	Enterprise, OR	Yearling rams (2)	Yes Farm flock	Yes	5-10 minutes	No disease-free ranging.
Nov., 1993	Witherrite farm Imnaha, OR	2.5 year ram	Yes Farm flock	Yes	2 days	No disease-captured and taken to lab.
Oct., 1994	Tollgate, OR	2.5 year ram	Yes Range band	Yes	12-24 hours	Died from pneumonia at lab.
June, 1995	Temperance Creek, OR	Yearling ram	Yes Range band	Yes	48 hours	Died from pneumonia at lab.
April, 2000	Minam, OR	3 ewes (transplant)	Yes Farm flock	No	0	No disease-free ranging.
April, 2000	Tick Hill, OR	Yearling rams (2)	Yes Range band	Yes	8 hours	No disease-captured and taken to lab.
July, 2000	Enterprise, OR	Ewe & lamb (transplant)	Yes Farm flock	Yes	>5 minutes	No disease-free ranging.
July, 2001	Asotin, WA	Yearling rams (2)	Yes Farm flock	Yes	>5 days	No disease-captured and taken to lab.
Aug., 2001	Little Sheep Creek, OR	5 ewes, 1 yrlyg. Ram (transplant)	Yes Farm flock	No	0	No disease-free ranging.
Summary	Yearling rams - 4/11, 36% 2 year rams - 3/11, 28% Ewes - 4/11, 36% (all transplants)		100%	8/11 73%	0->5 days	Mortality 3/11 (27%)

From Oregon Department of Fish and Wildlife, Wallowa District files.

(Table 1).

Eleven domestic sheep-bighorn interactions occurred with 27% resulting in disease problems and death to wild sheep. All interactions were treated as emergencies and serious threats to bighorns. Bighorns that were with domestics for over a few minutes were removed from the wild. Bighorns were not removed when wildlife personnel at the scene believed that there was no nose-to-nose contact. Most of those not removed were closely monitored (radio-collared or known animals) and could be removed if disease developed. Young rams (1 and 2 year olds) were involved in 67% of the interactions while 36% of the encounters were transplanted ewes. Four case histories of individual incidents follow:

Incident 1: Tollgate Ram.—On October 3, 1994, a 2½ yr old bighorn ram, probably from the Wenaha, Oregon herd, joined a range band of domestic sheep in the Tollgate area of the northern Blue Mountains, Oregon. The shepherd roped the bighorn and tied it to a tree. The bighorn was with domestics from 12-24 hours before being picked up by wildlife personnel and taken to the Idaho Wildlife Health Lab. It appeared healthy at the time of capture but died from pneumonia 6 days later. Ten domestic sheep from this band were also tested and one shared an identical *P. haemolytica* type A, biogroup 1, serotype 2 with the dead bighorn (Bulgin 1995).

Incident 2: Tick Hill Yearling Ram.—In April, 2000, a radio-collared yearling ram, transplanted from Alberta in February, 2000, moved to Tick Hill in the Wallowa Valley, Oregon about 400 meters from a flock of domestic buck sheep. Though monitored daily, it was found in a corral

with the domestic bucks on April 20. The ram was drugged, taken to Washington State University, tested, and treated with antibiotics for a dart injury. Eventually, it was moved to the Idaho Wildlife Health Lab and added to the captive herd. The ram appeared healthy, except for a permanent limp from the dart injury. Although the ram did not get pneumonia, it died of a drug overdose in late summer, 2001.

Incident 3: Hurricane Creek Ewe and Lamb.—On July 23, 2000, wildlife personnel responded to a report of a radio-collared ewe and the ewe's lamb walking down the Hurricane Creek Highway toward the town of Enterprise, Oregon. The pair, also Alberta transplants, was seen near a farm flock of sheep. The ewe had jumped in with the domestic sheep but when the farm flock ran at the ewe, the ewe quickly jumped out and resumed its journey in the direction of town. After a lengthy chase, both animals were captured. The lamb was ear-tagged and both animals were given antibiotics. They were then released near other transplanted bighorn sheep. The ewe was monitored periodically and to our knowledge did not develop pneumonia. Both animals joined the Lostine herd and have been seen frequently through April 2002 in good health.

Incident 4: Little Sheep Creek.—On August 3, 2001, a group of 5 ewes (4 Alberta transplants with radio collars) and 1 yearling ram were found walking up the Imnaha Highway, Oregon within 100 meters of a flock of domestic sheep and goats. This farm flock is penned near the owner's house at night and driven out to pasture daily. The 6 appeared very interested in the domestics and frequently sniffed the ground near droppings. Wildlife personnel herded the bighorns

several miles east toward the area they had recently come from. The owner of the sheep and goats was asked to contact the department when the 6 came close to her range. These bighorns were obviously attracted to the domestics and returned to the ranch area a number of times. On one occasion, they tried to come into the corral where the domestics were penned but were driven away with dogs and gunfire. After three weeks, the older ewes were hazed with a shotgun and birdshot and chased with fixed-wing aircraft. The group finally moved on and returned to their range in the Hells Canyon Wilderness 22 km (14 miles) away. Monitoring has occurred monthly and there have been no disease problems. They have remained on their Hells Canyon range through March 2002.

Fatal Attraction

At least some bighorn sheep are attracted to domestic sheep, further complicating the problem of keeping the two species separate. Our experience and that of others indicates that young rams are attracted to domestic sheep. We also documented ewe movements to domestics in four cases and had several cases of ewes showing interest in domestics with small lambs.

Incident 4 above shows that some ewe groups are attracted to domestics. All of the four ewe groups that moved to domestics were recent transplants.

DOMESTIC SHEEP MOVEMENTS

Domestic sheep are also capable of moving considerable distances to bighorn ranges. A case was recently documented when a domestic ewe strayed from a private land range band and moved a minimum of 48 km (30 air miles) to the Wenaha bighorn herd range. This ewe joined some cattle and followed them to a

ranch and feed lot. The ewe was removed by wildlife personnel and later claimed by her owner. This movement took the ewe through rugged terrain, significant timber, and involved at least one river crossing. Though cougar (*Felis concolor*) and American black bear (*Ursus americanus*) densities in this area are high, the ewe survived. This was a very dangerous situation for Wenaha bighorns because the domestic was first reported in their herd range in late September 2001 and was not removed until late January 2002. No contact with bighorns was documented, however the feedlot where the domestic sheep was captured was within 200 meters of frequently used bighorn habitat.

In a March 2002 incident, a stray domestic ewe, presumably from the same sheep allotment, moved 19 km (12 air miles) south, across two rivers and joined some mule deer. This was not occupied bighorn range, but the ewe was removed to prevent further straying.

These incidents show that contact can also occur from long-range movements by stray domestic sheep. A bighorn herd in a remote area, miles from the nearest domestic sheep, may still have the potential for contact and resulting disease.

Time from Bighorn Exposure to Domestic Sheep Until Disease Outbreak

Penned studies offer some insight into the time between exposure of bighorns to domestic sheep and the onset of disease (Table 2). In 6 controlled or accidental experiments, one case of a wild ewe with domestics and bighorn rams with a domestic ewe (Table 1), the time from contact until sickness or death varied from 6-30 days. In the wild, time of contact was much more difficult to determine but in the two cases reported, the time from contact to sickness was 25-30 days. Documented contact between tagged

Table 2. Time between exposure of bighorns to domestic sheep and onset of pneumonia or death.

Location	Incident or experiment	Year (s)	Exposure to domestic sheep until sickness or death	Outcome	Source
Methow Game Range, WA	Methow bighorn & domestic sheep penned together (a).	1979	26-28 days	Eleven domestics/14 bighorns (13 of 14 died)	Foreyt and Jessup (1982)
Lava Beds, CA	Lava Beds, CA bighorn sheep exposed to domestics.	1980	25-60 days	Entire herd 43 California bighorns died.	Foreyt and Jessup (1982)
Union, OR	Pattersall domestics Wenaha ewe #2	1984	5-8 days	Ewe moved with Pattersall farm flock and died.	ODFW Wallowa District File
Edmonton, AB	Two bighorn & 2 domestic sheep penned together (b)	1985-86	26-30 days	Became sick 26th day, euthanized day 30.	Onderka and Wishart (1988)
Lostine, OR	Lostine ram exposed to sick domestic ewe.	1986-87	30-50 days	Seventy percent of 110 bighorns died.	Coggins (1988)
WA State Univ.	Two bighorns, 2 domestic sheep penned together (b).	1987	14 days	Both bighorns died.	Foreyt (1990)
WA State Univ.	Fiberoptic scope contaminated by domestic sheep used on 3 of 10 captive bighorns (b).	1987	7-12 days	All 10 captive bighorns sick, 3 died.	Foreyt (1990)
WA State Univ.	Two bighorns, 2 domestic sheep penned together (b).	1993	6-8 days	Both bighorn sheep died.	Foreyt (1994)
Summary	Penned studies (6) Wild herds (2)		6-26 days 25-30 days	23 of 31 died 120 of 153 died	

a) Large pen or paddock.

b) University study, controlled conditions.

Lostine rams and a sick domestic ewe in early October 1986 likely resulted in the Lostine bighorn pneumonia outbreak in 1986-87. By November 27, 1986, the pneumonia epidemic was ongoing with most bighorns sick and many dead (Coggins 1988).

While no documented contact with domestic sheep was reported, the following incident offers further information on the time from exposure to a sick bighorn until the onset of disease. A suspected pasteuriosis epizootic in the Beaver Creek herd on the Colorado-Utah border started when a radio-collared bighorn ram apparently contracted pneumonia and returned to the primary range coughing and appearing sick (Singer et al. 2000). Within three weeks of his return, the majority of the Beaver Creek population was also coughing and sick. In this case, the herd was reduced to 7

animals and these survivors were later humanely destroyed.

DOMESTIC GOATS

Domestic goats are being used as pack animals and for weed control in bighorn sheep habitat. I believe this trend constitutes a serious disease threat to bighorn herds as some goats carry *Pasteurella spp.* that has been implicated in bighorn disease episodes (Ward et al. 2001). While not as definitive as the case for domestic sheep being a significant source of disease to bighorns, my experience and Ward's recent study indicates some domestic goats are likely potential sources of disease to bighorns. The following are case histories of goat/bighorn interactions:

Incident 1: Hells Canyon Goat --
Domestic goats have been circumstantially implicated in a pneumonia outbreak in

Hells Canyon and suspected in others. A major epizootic occurred in 1995-96 in northern Hells Canyon. A domestic goat either escaped or was released by local residents and joined a group of bighorns. Bighorns in the area became sick and a large number began dying from pneumonia. An epidemic ensued; resulting in the spread of the disease over 64 km (40 miles) south through 8 herds killing over 300 bighorns (Cassirer et al. 1996). A sick bighorn ewe collected with the healthy appearing goat shared a genetically identical *Pasteurella* (Rudolph et al. In prep). This collection was made at the onset of the epidemic where the first sick bighorns were seen.

Incident 2: Getta Creek Goats.--A large herd of 1200 range goats was used to control weeds on a ranch next to the Big Canyon, Idaho bighorn herd during April-late June 2000. Before the goat invasion, Big Canyon bighorns appeared healthy with good numbers of lambs. Scabies *Psoroptes* spp, was found in this herd during July 2000. Bighorns from this herd were reported to be near the goats (some reportedly sick) and dead bighorns began to be picked up in September 2000. Pneumonia deaths were documented in the lower Imnaha, Oregon herd in September. During November 2000, some adult bighorns from the Muir Creek, Oregon herd began to die. Most Big Canyon lambs died but the Muir Creek and Imnaha herds had 79 and 42 lambs per 100 ewes, respectively, during March 2001. Radio telemetry studies have linked these herds through ram movements. Dead sheep were taken to Washington State University Animal Disease Diagnostic Lab for necropsy. Pneumonia was found to be the most common cause of death. Many individual bighorns were apparently not affected. Cause and effect evidence is

admittedly lacking, but I believe this disease outbreak started with the goats and adjacent Big Canyon bighorns and spread to the other two herds.

Incident 3: Warner Mountains Goats.--At least one other case of domestic goats being suspected in a disease outbreak occurred in the Warner Mountains of N.E. CA. A complete die-off of California bighorns occurred and feral goats were found on the range in an area used by rams. While proof of contact is lacking, Jessup (1988) stated "the potential of goats to carry pathologic *Pasteurella* spp. bacteria to bighorn should be recognized"

It also appears that some goats do not carry pneumonia causing bacterias. Foreyt (1994) penned 2 yearling bighorn rams in a 0.4 ha enclosure at Washington State University for 60 days with 3 wether domestic goats. The bighorns survived and appeared healthy at the termination of the trial.

DISCUSSION

Buffer Zones

Buffer zones have frequently been recommended to keep bighorns and domestics spatially separated. Bureau of Land Management guidelines (1998) have recommended 13.5 km (9 miles) between domestic sheep and bighorns except where topographic features or other barriers prevent physical contact. Unfortunately, a number of bighorns in our studies have moved up to 80 km (50 miles) through small towns, heavily farmed valleys and across major rivers and reservoirs. Some bighorns appear attracted to domestic sheep. We have documented movements, up to 48 km (30 miles), by domestic ewes from allotments. This was through heavily forested areas and rugged canyons, further complicating keeping the two species apart. In summary, while buffer zones

clearly help, the greater the distance between the two, the better.

Transplants

While translocations of bighorns are necessary to restock vacant habitat, they appear to increase the chances for interactions with domestics. Transplants frequently move greater distances than animals from established herds. I have observed movements where transplants have mixed with several different bighorn herds, further increasing the potential for spreading disease.

Contact

To wildlife personnel managing bighorns, the question of what constitutes contact and what management action should be taken when a domestic sheep/goat/bighorn interaction occurs is important. Immediate removal is the safest approach but we have documented 8 cases of close encounters that did not result in disease. If bighorns have mingled with domestics, we remove them from the wild. In situations where they were in close proximity for a short time, we hazed or drove them away from domestics. These frequently involved radio collared animals that could be located later to check on health status and removed if necessary.

In the case of domestic sheep on bighorn range, immediate removal is recommended. If possible, sheep owners should be notified before removal. If the owner is unknown, the local livestock brand inspector should be contacted before removal. In all cases, action needs to be immediate. It appears that the longer the two species are together the more likely it is for bighorns to contract pneumonia.

Quarantine

It appears from the 8 contact cases described, if sickness does not develop in bighorns in 30 days, pneumonia from the encounter is not likely to occur. To quarantine bighorns for 30 days may be a method of determining if wild sheep are infected or not. The bighorn quarantine pen should be away from domestic sheep, goats, or bighorns with a history of sickness. We have not returned any bighorns to wild herds that have been held in captivity for more than a few hours.

Goats

The three bighorn disease outbreaks in proximity to goats and recent studies by Ward et al. (2002) indicate some goats could cause pneumonia outbreaks in wild sheep. Recommendations in a September 3, 1998 letter to goat packers indicate domestic goats should "avoid approaching wildlife within 50 feet" (Hunter et al. 1998). We have treated goats the same as domestic sheep even though the evidence for causing bighorn pneumonia outbreaks is not as strong.

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

Goats

Circumstantial evidence has linked domestics to the most severe bighorn disease outbreak in Hells Canyon in modern times. However, the penned study found that bighorns did not contract disease from the goats they were penned with, but not all goats may carry bacteria causing fatal pneumonia. More study is needed using goats from other sources, especially those from herds with disease histories and those that have been kept with domestic sheep. Until additional research proves otherwise, it is

recommended goats be considered as dangerous to bighorns as domestic sheep.

Domestic Sheep

Case histories of close encounters by bighorns with domestic sheep that did not result in disease should not leave wildlife managers complacent. It appears from this data that the longer the two are together, the more likely disease will result. The manager at the scene will have to assess the risk of a potential epidemic and take appropriate action. Wild sheep should be removed from contact with domestics immediately as should any domestic sheep found with bighorns.

Buffer Zones

Buffer zones are usually established as the result of a political compromise between woolgrowers and wildlife managers or administrators. The greater the distance between the two the better. Long-range movements by bighorns, especially rams and transplants, have been well documented. Domestic sheep also may move many miles and be the source of disease epidemics as well.

Elimination of domestic sheep or goat allotments or farm flocks in proximity to bighorns will be much more effective in preventing disease outbreaks than buffer zones.

SUMMARY

- 1.) Three of 11 bighorn interactions with domestic sheep resulted in pneumonia or death.
- 2.) Eight cases where bighorns were in close proximity to domestics did not result in disease.
- 3.) Sixty percent of interactions with domestic sheep for more than 8

hours resulted in sickness or death of bighorns in 5-30 days.

- 4.) Both bighorns and domestic sheep may move long distances 80 km (50 miles) and 61 km (38 miles) respectively and appear to be attracted to each other.
- 5.) Domestic goats have been suspected of causing several bighorn sheep disease outbreaks.
- 6.) *P. trehalosi* strains isolated from domestic goats have caused disease in bighorns.
- 7.) **KEEP BIGHORNS SEPARATED FROM DOMESTIC SHEEP AND GOATS!**

ACKNOWLEDGMENTS

The Hells Canyon Initiative is a cooperative project between the Oregon Department of Fish and Wildlife, Idaho Department of Fish and Game, Washington Department of Fish and Wildlife, Bureau of Land Management, the U.S. forest Service and the foundation for North American Wild Sheep. The Foundation for North American Wild Sheep (FNAWS) and chapters, Oregon Hunters Association and chapters, the Turner Foundation and other groups and individuals have provided major funding and support. A number of people assisted with the collection of data for this paper including Pat Matthews and Mike Hansen, Oregon Department of Fish and Wildlife; and Frances Cassirer and Wendy Lammers, Idaho Fish and Game. Special thanks to Rosemary Peterson and Vicki Coggins for correcting and typing this paper.

LITERATURE CITED

- AUNE, K., N. ANDERSON, D. WORLEY, L. STACKLANGE, J. HENDERSON, AND J. DANIEL. 1998. A comparison of population and health histories among seven Montana bighorn sheep populations. Biennial Symposium Northern Wild Sheep and Goat Council. 11-46-69.
- BULGIN, J. M. Tollgate bighorn ram bacteria report. State of Idaho. Jan 30, 1995. 1 p.
- BUREAU OF LAND MANAGEMENT. 1998. Revised guidelines for domestic sheep and goat management in native wild sheep habitats. U.S.D.I., Bureau of Land Management Oregon State office, Portland, Oregon. U.S.A. 3 pp.
- CALLAN, R. J., T. D. BUNCH, G.W. WORKMAN, AND R. E. MOCK. 1991. Development of pneumonia in desert bighorn sheep after exposure to a flock of exotic wild and domestic sheep. JAVNA. Vol 198, No.6
- CASSIRER, E. F. 2002 August - October 2001, Hells Canyon Quarterly Report, Idaho Fish and Game. Lewiston, Idaho. 2pp.
- _____, L. E. OLDENBERG, V. L. COGGINS, P. FOWLER, K. M. RUDOLPH, D.L. HUNTER AND W. J. FOREYT, 1996. Biennial Symposium Northern Wild Sheep and Goat Council. 10:78-86.
- COGGINS, V. L. AND P. E. MATTHEWS. 1988-2001. Oregon Department of Fish and Wildlife. 180 pp.
- _____. 1988 The Lostine Rocky Mountain Bighorn Sheep die off and domestic Sheep. Biennial Symposium Northern Wild Sheep and Goat Council, 6:57-64.
- FOREYT, W. J. AND D. A. JESSUP, 1982. Fatal pneumonia of bighorn sheep following association with domestic sheep. Journal of Wildlife Diseases, vol. 18, No. 2.6 pp.
- _____. 1989 Fatal Pasteurella haemolytica pneumonia in bighorn sheep after direct contact with clinically normal domestic sheep. American Journal Veterinary Research. 50:341-344.
- _____. 1990. Pneumonia in bighorn sheep: effects of Pasteurella haemolytica from domestic sheep and effects of survival on long term reproduction. Biennial Symposium Northern Wild Sheep and Goat Council. 7:92-101
- _____. 1994. Effects of controlled contact exposure between healthy bighorn sheep and llamas, domestic goats, mountain goats, cattle, domestic sheep, or mouflon sheep. Biennial Symposium Northern Wild Sheep and Goat Council. 9:7-14
- HUNTER, D. L., B. R. HILLMAN, AND A. C. S. WARD. Letter to domestic goat packers. State of Idaho. September 3, 1998. 1 p.
- JESSUP, D. A. 1998. Warner Mountains bighorn sheep final report. State of California, May 9th Memorandum. 4pp.
- MARTIN, K. D., T. SCHOMMER, AND V. L. COGGINS. 1996. Literature review regarding the compatibility between bighorn and domestic sheep. Biennial Symposium Northern Wild Sheep and Goat Council. 10-72-77.
- MILLER, M. W. 2000. Pasteurellosis. In Infections Diseases of Wild Mammals, 3rd edition, E. S. Williams and I.K. Barker, eds. Iowa State University Press, Ames, Iowa.
- ONDERKA, D. K. AND W. D. WISHART, 1984. A major bighorn sheep die off in southern Alberta. Biennial Symposium Northern Wild Sheep and Goat Council. 4:356-363.

- RUDOLPH, K. M., D. L. HUNTER, R. B.
RIMLER, E. F. CASSIRER, W. J. FOREYT,
AND A. C. S. WARD. In prep. Sharing
of *Pasteurella* spp. between free
ranging bighorn sheep and feral goats.
Idaho Department of Fish and Game,
Wildlife Health Lab, Caldwell, ID. 14
pp.
- SCHOMMER, T., AND M. WOOLEVER. 2001.
A process for finding management
solutions to the incompatibility
between domestic and bighorn sheep.
U.S. Forest Service Report. 54 pp.
- SINGER, F. J., E. WILLIAMS, M. M. MILLER,
AND L. C. ZEIGENFUSS. 2000.
Population growth, fecundity, and
survivorship in recovering populations
of bighorn sheep. *Restoration Ecology*.
Vol. 8 No. 45, pp. 75-85.
- WARD, A. C. S., G. C. WEISER, W. J.
DELONG, G. H. FRANK.. 2002.
Characterization of *Pasteurella* spp
isolated from healthy domestic pack
goats and evaluation of the effects of a
commercial *Pasteurella* vaccine.
*American Journal of Veterinary
Research*. Vol. 63 No. 1, pp 119-124.