Selenium Supplementation, Parasite Treatment, and Management of Bighorn Sheep at Lostine River, Oregon

VICTOR L. COGGINS,[1] Oregon Department of Fish and Wildlife, 65495 Alder Slope Road, Enterprise, OR 97828, USA

Abstract: Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) were restored to Hells Canyon when 20 sheep were released in Oregon in the Lostine River drainage in 1971. The Lostine bighorn sheep population was studied and managed intensively since then. Since 1977, salt supplemented with selenium and other trace minerals was available to bighorn sheep on the Lostine winter range. Blood selenium levels in the Lostine bighorn population are the highest of all populations tested in Hells Canyon. In 2002, removal of selenium-supplemented salt from the Lostine winter range resulted in a drop in whole blood selenium levels. Wintertime mineral supplementation continued in 2003, resulting in a return to previous whole blood selenium levels. Notwithstanding high selenium levels, the Lostine bighorn population experienced an all-age pneumonia epizootic in 1986/1987, followed by periods of poor lamb survival. Beginning in 1982 the bighorn sheep at Lostine River were treated periodically with fenbendazole for lungworm (*Protostrongylus* spp.). From 2003 to 2005 sheep were treated with ivermectin for lungworm and scabies mites (*Psoroptes* spp.). These parasites were not detected in December 2005 or January/February 2006 and appear to be absent or, if present, occurring at very low levels.

BIENN. SYMP. NORTH. WILD SHEEP AND GOAT COUNC. 15:98-106

Key words: Hells Canyon, Lostine River, lungworm, Oregon, *Ovis canadensis canadensis*, *Protostrongylus* spp., *Psoroptes* spp., Rocky Mountain bighorn sheep, scabies, selenium.

[1] *Email address: vic.l.coggins@state.or.us*

Rocky Mountain bighorn sheep were re-established in Oregon in 1971 with the release of 20 animals from Jasper National Park, Alberta, Canada into the Lostine River drainage. The Lostine population, grew and numbered 95 bighorn sheep by 1978. The sheep winter on high elevation grasslands near the original release site and migrate southeast to summer on alpine ranges in the Wallowa Mountains.

The Lostine bighorn sheep population is one of the Hells Canyon study herds and was intensively studied, managed, and monitored throughout the year from aircraft and the ground since 1999. Animals are habituated to human presence by years of winter feeding for the purpose of trapping and transplanting, disease testing, disease and parasite treatment, and individual marking. A corral trap is used to capture animals for blood sampling, ear tagging, and radio-collaring. Forty-three bighorns of an estimated population of 90 currently are individually marked. Annual repetitive ground surveys are used to determine lamb survival, ram to ewe ratios, and total

numbers. Research activities have identified home range use and causes of mortality (Cassirer 2005a).

The winter population objective of approximately 80 animals is maintained by means of transplants and hunting. The Lostine sheep population is used as a source to re-stock vacant ranges. A limited-entry season for rams began in 1978 and a season for 2 any-ram tags was authorized in 2006. Other management activities included purchase of the 400 ha Lostine Wildlife Area by the Oregon Department of Fish and Wildlife, prescribed spring burns to control conifer and shrub encroachment on winter range, noxious weed control, and water development. In addition, domestic sheep allotments on summer ranges were eliminated; one by negotiations and the other by purchase. No domestic sheep allotments were active in the Wallowa Mountains since 1999.

Herein we describe the selenium status of the Lostine bighorn sheep population of the Hells Canyon area of Oregon, and examine the effects of selenium supplementation on whole blood levels in bighorn sheep. Treatments for lungworm (*Protostrongylus* spp.) and scabies mites *(*Psoroptes* spp.) detected in bighorn sheep at Lostine River also are described.

Study area

The Lostine bighorn population is located in the Wallowa Mountains in the northeast corner of Oregon (45º 23’ 53.51’’ N, 117º 23’ 20.66’’ W). The Wallowa Mountains encompass an area of approximately 575 km² and are part of the Hells Canyon area of Oregon, Idaho, and Washington. The bighorn sheep winter range on the Lostine is on a high elevation southwest-facing grassland slope with rugged limestone outcroppings. Most of the area was burned in a wildfire in August 1966. North slope vegetation presently is composed of grasses and shrubs with considerable conifer regeneration. Controlled burns conducted on the lower slopes in 1992 and 2004 reduced tree and shrub encroachment. Elevations range from 1,341 m to nearly 2,286 m on the lower Sheep Ridge. Periodic warm fronts and strong winds generally keep the grassy south slopes snow-free.

Summer range for the Lostine bighorn sheep herd is characterized by U-shaped glaciated valleys, alpine basins, rugged precipitous terrain, and sharp ridge tops (Matthews and Coggins 1994). Elevation ranges from 1,400 to 3,000 m. Dense timber stands occur below 2,287 m. Douglas-fir *(Pseudotsuga menziesii)*, white fir *(Abies concolor)*, and western larch (*Larix occidentalis)* are the most abundant tree species. Scattered timber stands occur above 2,287 m with subalpine fir (*Abies lasiocarpa)*, and white-bark pine (*Pinus albicaulis)* predominating. Forbs and grasses are the most abundant plant forms on high elevation ridge tops. Avalanche chutes provide additional open feeding areas.

Specific Management

1. Wintertime selenium supplements

The Wallowa Mountains located in the Hells Canyon area of northeast Oregon have low selenium levels in soil and forage (M. Lathrop, local veterinarian, personal communication). Local stockmen supplement the diet of domestic cattle and sheep with selenium to prevent white muscle disease caused by low selenium levels. Since 1977, salt supplemented with selenium and other trace minerals were made available to bighorn sheep on the Lostine winter range (Coggins 1977). Commercial 50 lb blocks contain 0.009% selenium by weight as well as other trace minerals. Bighorn sheep readily use salt blocks placed on the Lostine winter range.

From 1999 to 2006, whole blood samples were collected by Hells Canyon Initiative biologists and veterinarians from bighorn sheep in the Lostine population and from 5 other bighorn sheep populations in the Hells Canyon area of Oregon, Washington, and Idaho. Whole blood samples also were collected from the Lostine population in 1982. The Analytical Sciences Laboratory, University of Idaho, Moscow, Idaho analyzed samples for selenium and other trace minerals such as zinc, iron, and copper.

2. Lungworm treatment with fenbendazole and ivermectin

To identify the intensity of *Protostrongylus* spp. lungworm larvae and other parasites in bighorn sheep on the Lostine winter range, fecal samples were collected regularly since 1975. Dr. Bill Foreyt, Washington State University (WSU), conducted the analyses using Baermann technique. The bighorn sheep at Lostine River were treated with fenbendazole in alfalfa pellets for lungworm control periodically since 1985 (Foreyt et al. 1990b). More recently ivermectin in alfalfa pellets was used for lungworm control and from 2003 to 2005 for scabies control (Coggins and Matthews 2003).

3. Treatment for Scabies

Hair loss in bighorn ears is considered visual evidence of scabies was first observed in December 2002 and *Psoroptes* spp. mites were identified in ear swabs from sheep in the Lostine population in January 2003 (Dr. Bill Foreyt, WSU, personal communication). Treatment started in February 2003 using alfalfa pellets (WSU deer ration #9017) with 13.5 mg ivermectin powder per pound of pellets. Drug dosages were increased to 18 mg ivermectin per pound of pellets in 2004. Dr. Bill Foreyt prescribed the dosage rate for treatment pellets. Treatment pellets were prepared by the WSU feed department. The procedure consisted of providing pellets for a period of 8 to 9 d, with a break of 1 to 4 wk between treatments to allow mite eggs time to hatch and thus make the treatment more effective.

Number and composition of bighorn sheep at the feed site was recorded. An estimate of the amount of pellets consumed and drug ingested by the sheep present was made at each feeding. Visual hair loss in the ears of individual sheep was noted and scored from 0 to 2, depending on severity. Ear swabs collected from all captured bighorn sheep were sent to WSU for analysis. Treatments were completed in 2003, 2004, and 2005, but not in 2006.

Results and Discussion

Low selenium levels in forage were suspected as a contributing factor for bighorn sheep declines in Wyoming (Dean et al. 2002). Hnilicka et al. (2002) hypothesized that wetter conditions resulted in less selenium uptake by bighorn sheep from forage growing on granitic summer range soils, thus lowering lamb health and survival in the Whiskey Mountains, Wyoming. In Hells Canyon, differences in selenium values among populations were not significantly related to adult survival, lamb survival, recruitment, population growth, or occurrence of epizootics (Cassirer 2005a).

In 1982 and 1999 to 2006, 116 whole blood samples collected from all age and sex classes in the Lostine bighorn sheep population were analyzed for selenium levels (Table 1).

Table 1. Winter selenium levels (ppm wet weight) in whole blood of 116 bighorn sheep from the Lostine population in Oregon.

Year	*n*	Mean	SD	Minimum	Maximum	Difference
1982	12	0.224	0.047	0.15	0.29	0.14
1999-2000	15	0.392	0.092	0.21	0.54	0.33
2000-2001	10	0.384	0.184	0.127	0.573	0.446
2001-2002	19	0.313	0.134	0.1	0.49	0.39
2002-2003	10	0.365	0.125	0.12	0.54	0.42
2003-2004	15	0.467	0.078	0.36	0.62	0.26
2004-2005	15	0.434	0.124	0.27	0.78	0.51
2005-2006	20	0.524	0.156	0.29	0.82	0.53

Regardless of high selenium levels, the Lostine bighorn sheep population experienced an all-age pneumonia epizootic in 1986/1987 after known contact with domestic sheep (Coggins 1988). The herd experienced 66% mortality. Poor lamb survival, likely from pneumonia, was documented for 2 yr following the outbreak with 11 lambs per 100 ewes in 1987 and 10 lambs per 100 ewes in 1988 (Coggins and Matthews 1992). Lamb survival was below 25 lambs per 100 ewes in 1996/1997 and 1997/1998 and decreased to 9 lambs per 100 ewes in 2003/2004 (Figure 1). Clinical signs of pneumonia were observed in lambs in the summers of 1996, 1997, and 2003, but no dead sheep were recovered and the cause was not determined. We believe pneumonia is the primary cause of summer lamb mortality.

This study was conducted due to speculation that selenium levels may be naturally higher on the Lostine range and not the result of supplementation. In December 2001, salt with no selenium or trace minerals was provided to assess whether whole blood selenium levels would decline in the Lostine population. Mean blood selenium levels from 9 bighorn sheep captured at that time was 0.41 ppm. In February 2002, selenium blood levels in 10 sheep declined to 0.22 ppm (Figure 2). In March 2002, selenium-supplemented salt was provided once again to the bighorn sheep on the Lostine winter range. Selenium levels in 10 sheep in January 2003 increased to 0.37 ppm. Thus selenium blood levels for the Lostine population returned to levels similar to those prior to removal of the selenium-supplemented salt (0.37-0.58 ppm). Selenium supplementation has continued through 2006.

Blood samples for selenium analyses were collected from 6 Hells Canyon bighorn sheep populations from 1997 to 2005, including the Lostine population (Table 2) (Cassirer 2005b). Selenium levels in all populations were much lower than in the Lostine herd. Supplemental salt is accessible to some of these herds, but not with any regularity. Either these herds do not use artificial licks or only small portions of the sheep use them. Winter population densities in the Lostine area are higher than other herds and most animals use licks regularly (Figure 3).

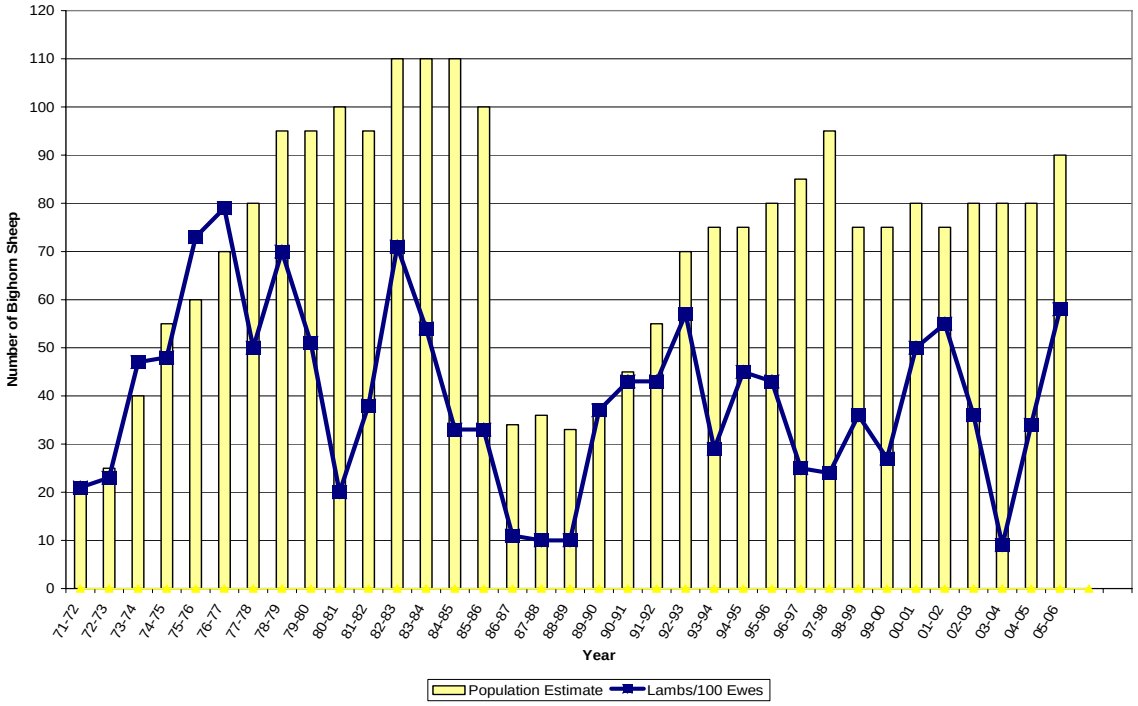

Figure 1. Annual population estimate and productivity of the Lostine bighorn sheep herd in Oregon, 1971 to 2006.

The Lostine population has a long history of wintertime feeding with salt supplemented with selenium and trace minerals. It also has the highest selenium levels of any of the Hells Canyon populations tested (Table 2). Notwithstanding high selenium levels, disease outbreaks and poor lamb survival occurred in the Lostine bighorn sheep population. However, lamb survival in the Lostine population has been better than other Hells Canyon populations that reported minimal lamb survival over a several year period. Similar to the Lostine population, these other Hells Canyon populations also have been in close proximity to domestic sheep or goat herds. Mean selenium values for the Asotin bighorn herd was 0.09 ppm. These were the lowest in Hells Canyon herds, yet pneumonia has not been detected in Asotin sheep and lamb survival has been good (Cassirer 2005a).

The lungworm-pneumonia complex was identified historically as the causative factor for a number of pneumonia epizootics (Buechner 1960, Forrester 1971, Worley, et al. 1988). Foreyt and Johnson

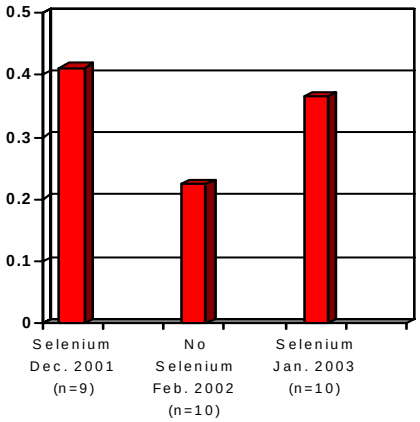

Figure 2. Whole blood selenium (ppm ww) of bighorn sheep in the Lostine population with and without selenium-supplemented salt.

Table 2. Winter selenium levels (ppm wet weight) in whole blood of 214 bighorn sheep from 6 herds in the Oregon, Washington, and Idaho portions of Hells Canyon, 1997 to 2005.

Winter Range	*n*	Mean	SD	Minimum	Maximum	Difference
Asotin, WA	13	0.09	0.06	0.03	0.22	0.19
Imnaha, OR	27	0.11	0.07	0.02	0.26	0.24
Wenaha, OR	25	0.11	0.08	0.02	0.33	0.31
Black Butte, WA	16	0.19	0.09	0.06	0.38	0.32
Redbird, ID	17	0.21	0.07	0.11	0.33	0.22
Lostine, OR	**116**	**0.39**[a]	**0.15**	**0.10**	**0.82**	**0.72**

[a] Includes 1982 data

(1980) recommended using anthelmintic drugs to reduce lungworm infection and improve herd health. Following this recommendation, the Lostine population was treated in January 1982 in an attempt to reduce the number of larvae and improve lamb survival. Lamb survival improved from a low of 20 lambs per 100 ewes in 1981 to 71 lambs per 100 ewes in 1983. However, lamb survival declined to 33 per 100 ewes in 1984 and 1985, and then an all-age epizootic occurred in 1986/1987. Lungworm treatment did not prevent the disease outbreak nor improve lamb survival from 1987 to 1989 (Figure 1). Lungworm levels continued to decline with repeated treatments (Table 3).

Scabies was introduced to Hells Canyon in December 1984 when 28 bighorns were transplanted from the Salmon River, Idaho to the Wenaha River drainage near the Oregon–Washington border. Scabies mites were confirmed in a transplanted ewe with infested ears. Scabies spread to other Hells Canyon bighorn herds over time and likely caused heavy mortality sheep in the Cottonwood Creek area, Washington (Foreyt et al. 1990a).

Several rams with clinical symptoms of scabies were observed in the Lostine bighorn sheep population in December 2002. Following treatment with ivermectin in alfalfa pellets during February 2003, January-February 2004, and February 2005. No clinical evidence of scabies was observed in 2006 and all 20 ear-swabs collected in 2006 were negative for mites.

Figure 3. Bighorns at the salt lick, Lostine River, Oregon.

Table 3. Lungworm larvae in fecal samples from the Lostine bighorn sheep population in Oregon, 1981 to 2006. Lungworm treatment years in bold print.

Year	*n*	Number of samples with lungworm larvae	% Infected
1981	10	10	100
1982	32	20	63
1983	12	7	58
1984	60	38	63
1985	20	15	75
1987	18	4	**22**
1988	21	1	**5**
1989	3	0	**0**
1990	7	0	**0**
1991	6	0	**0**
1992	8	1	**13**
1994	12	0	**0**
1995	19	0	**0**
1997	Composite	0	**0**
1999	21	0	**0**
2000	54	2	**4**
2001	27	0	**0**
2002	10	1	**10**
2003	18	1	**6**
2004	43	0	**0**
2005	24	1	**4**
2006	39	0	**0**

No treatment was given in 2006. Annual monitoring of the Lostine bighorn population will continue and if scabies is detected, the population will be treated again.

Conclusions

1. Supplementing bighorns with selenium salt resulted in increased selenium blood levels in the Lostine bighorn sheep population.
2. All-age pneumonia outbreaks occurred in the Lostine bighorn sheep population regardless of higher selenium levels in whole blood. Lamb survival in the Lostine population was higher than other Hells Canyon populations exposed similarly to domestic livestock, suggesting that disease recovery time may have been shortened because of higher selenium levels.
3. When selenium-supplemented salt was re-introduced, selenium whole blood levels for the Lostine population returned to levels similar to those prior to removal.
4. Fenbendazole and ivermectin administered to the Lostine bighorn sheep population in alfalfa pellets reduced lungworm levels dramatically.
5. Improved lamb survival occurred for two years following treatment for lungworm, but lower numbers of larvae did not prevent an all-age epizootic or subsequent periodic poor lamb survival.
6. Ivermectin in alfalfa pellets appeared to greatly reduce or eliminate *Psoroptes* spp. in the Lostine bighorn sheep population.
7. No mites were detected in the Lostine sheep in 2006 and there was no visual evidence of hair loss attributed to scabies.

Disease outbreaks occurred in the Lostine bighorn sheep population despite lungworm larvae reduction and selenium supplementation. Lamb survival in the Lostine population was higher than other Hells Canyon populations similarly exposed to domestic livestock. Scabies control may be accomplished by feeding ivermectin in alfalfa pellets. We believe separation of bighorns and domestic sheep and goats is still the best disease prevention.

Acknowledgements

Thank you to all of the State Wildlife Department personnel and volunteers who helped with gathering data, trapping, and sampling bighorns at Lostine River. Pat Matthews, Frances Cassirer, Tim Schommer, Crystal Strobl, and Mike Hansen provided assistance in the field. Daarla Klages assisted greatly with preparation of this paper. Oregon Hunter Association and Chapters and Oregon Foundation for North American Wild Sheep provided important financial support and volunteer labor for constructing a new sheep trap and habitat improvements.

Literature cited

Buechner, H. K. 1960. The bighorn sheep in the United States, its past, present, and future. Wildlife Monograph 4: 1-174.

Cassirer, F. E. 2005a. Ecology of disease in bighorn sheep in Hells Canyon, USA. Dissertation, University of British Columbia, Vancouver, BC, Canada.

Cassirer, F. E. 2005b. Hells Canyon initiative annual report, fiscal year 2005. Idaho Fish and Game, Lewiston, ID, USA.

Coggins, V. L. 1977. Wallowa district monthly report, January 1977. Oregon Department of Fish and Wildlife, Enterprise, OR, USA.

Coggins, V. L. 1988. The Lostine Rocky Mountain bighorn sheep die-off and domestic sheep. Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 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. Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 8: 147-154.

Coggins, V. L., and P. E. Matthews. 2003. Wallowa District monthly report, January 2003. Oregon Department of Fish and Wildlife, Enterprise, OR, USA.

Dean, R., P. Hnilicka, T. Kreeger, and T. Delcurto. 2002. An investigation into the selenium required for Rocky Mountain bighorn sheep. Proceedings of the Biennial

Symposium of the Northern Wild Sheep and Goat Council 13: 95-99.

Foreyt, W. J., and R. Johnson. 1980. Treatment for lungworms *(Protostrongylus* spp.*)* in Rocky Mountain bighorn sheep (*Ovis c. canadensis*) with albendazole. Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 2: 248-261.

Foryet, W. J., V. Coggins, and P. Fowler. 1990a. Psoroptic scabies in bighorn sheep in Washington and Oregon. Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 7: 135– 142.

Foreyt, W. J., T. Parker, and V. Coggins. 1990b. Safety and efficacy of fenbendazole against *Protostrougylus* spp. infections in Rocky Mountain bighorn sheep *Ovis canadensis canadensis*. Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 7: 118-124.

Forrester, D. J. 1971. Bighorn sheep lungworm-pneumonia complex. Pages 158-173 *in* J.W. Davis and R.C. Anderson, editors. Parasitic diseases of wild mammals. Iowa State University Press, Ames, IA, USA.

Hnilicka, P. A., J. Mionczynski, B. J. Mincher, J. States, M. Hinschberger, S. Oberlie, C. Thompson, B. Yates, and D. D. Siener. 2002. Bighorn sheep lamb survival, trace minerals, rainfall, and air pollution: Are there any connections? Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 13: 69-94.

Matthews, P. E., and V. L. Coggins. 1994. Status and history of mountain goats in Oregon. Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 9: 69-74.

Worley, D. E., C. A. Yde, G.W. Brown, and J. J. McCarthy. 1988. Lungworm surveillance in bighorn sheep: Possible applications for population density estimates and range use assessment. Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 6: 77-83.