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LITERATURE REVIEW REGARDING THE COMPATIBILITY BETWEEN BIGHORN AND DOMESTIC SHEEP

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Abstract: A literature review was conducted regarding the compatibility of bighorn sheep and domestic sheep. In both fenced studies and free ranging herds, most contact between bighorn sheep and domestic sheep has resulted in pneumonia in bighorns and the deaths of all or most bighorns while domestic sheep remained healthy. Published research has shown that *Pasteurella haemolytica* (usually biotype A, serotype 2) is the major pathogen responsible for the death of bighorn sheep after contact with domestic sheep. DNA fingerprinting has proven the transfer of *Pasteurella* spp. between bighorn and domestic sheep under both controlled "experimental" and range conditions. No studies reported any bighorn herds, fenced or free ranging, that have come into contact with domestic sheep and remained healthy. No vaccine currently exists that will prevent bighorn sheep from developing pneumonia after contact with virulent strains of *Pasteurella*. With the current information, almost all wildlife professionals, wildlife veterinarians and researchers have concluded that bighorn sheep and domestic sheep should not occupy the same ranges or be managed in close proximity to each other, because of the potential adverse effect from disease on bighorn sheep.

BACKGROUND

This is an updated report and literature review of information pertaining to the compatibility of bighorn and domestic sheep. The original review was requested by Regional Forester, John Lowe in 1993, with the content to be used as the basis for future decisions for the management of bighorn sheep and domestic sheep within the boundaries of Hells Canyon National Recreation Area, on the Wallowa-Whitman National Forest.

Current bighorn sheep numbers in the western United States have been estimated to be less than 1% of what they were prior to presettlement (Goodson 1982). Rocky mountain bighorn sheep (*Ovis canadensis canadensis*) were native to much of the mountain and canyon country which currently comprises a large proportion of the Wallowa-Whitman National Forest in Northeast Oregon and western Idaho. Specifically, historical accounts indicate that bighorns were numerous in the drainages in and around the Wallowa Mountains (Bailey 1936), the lower Imnaha River, Snake River, Grande Ronde River, Elkhorn Mountains, Powder River, and Joseph Canyon. The last Rocky Mountain bighorn sheep were gone from northeastern Oregon by 1945 (Oregon's Bighorn Sheep Management Plan 1992). Current numbers of Rocky Mountain bighorn sheep in the Hells Canyon National Recreation Area are also a fraction of what they were historically. Archaeological studies indicate wild sheep were a significant ungulate food item for Native Americans (USDA Forest Service Report 1991).

Following enormous population declines in the United States in the late 1800s and early 1900s, bighorn populations did not recover, in contrast to many other wildlife species. Bighorns have demonstrated less tolerance than other native North American ungulates to poor range conditions, interspecific competition, over hunting, and stress caused by loss of habitat (Desert Bighorn Council 1990). Most important, they have shown a much greater susceptibility to diseases (Goodson 1982).

In the last century wild sheep numbers have declined, their populations suffering from a wide variety of diseases, some that they have contracted from domestic sheep (Geist 1971). Some of these include scabies, chronic frontal sinusitis, internal nematode parasites, pneumophilic bacteria, footrot, parainfluenza III virus, bluetongue virus, and contagious ecthyma (Desert Bighorn Council 1990). Documented bighorn die-offs were recorded as early as the mid-1800s and have continued up to the present (Table 1) (Goodson 1982, Foreyt and Jessup 1982, Coggins 1988, Onderka

et.al. 1988, Foreyt 1989, Desert Bighorn Council 1990, Foreyt 1990, Callan et.al. 1991, Hunter 1993, Foreyt 1993, Foreyt et.al. 1994). Bighorn sheep die-offs have occurred in every state in the western United States. In recent years biologists and researchers have suspected that even casual contact between bighorn sheep and domestic sheep may lead to respiratory disease and fatal pneumonia in the bighorns (Onderka and Wishart 1988). The role of domestic sheep in the epizootiology of bighorn sheep pneumonia is an important issue in multiple use management (Foreyt et.al. 1994).

FINDINGS

There is strong evidence (Table 1) that the presence of domestic sheep with bighorn sheep caused the loss of part or all of the affected bighorn sheep population. The lack of compatibility between domestic sheep and bighorn sheep is evidenced by the fact that no bighorn populations exist anywhere in the state of Nevada where domestic sheep are currently being grazed (McQuivey 1978). Goodson (1982) reported that no bighorn sheep herds, that occurred with domestic sheep on their ranges were increasing except those on ranges where use by domestic sheep has been significantly reduced. With the information currently available, most wildlife professionals, wildlife veterinarians and researchers have concluded that bighorn sheep and domestic sheep should not occupy the same ranges or be managed in close proximity to each other, because of the potential adverse effect on the bighorn sheep (Jessup 1980, Foreyt and Jessup 1982, Goodson 1982, Jessup 1982, Kistner 1982, Wishart 1983, Coggins 1988, Jessup 1988, Onderka et.al. 1988, Foreyt 1989, Foreyt 1990, Desert Bighorn Council 1990, Callan et.al. 1991, Coggins and Matthews 1992, Foreyt 1992, USDI BLM Technical Committee 1992, Ward 1993, Foreyt et.al. 1994, Foreyt 1994, Pybus et.al. 1994, Hunter 1995, Foreyt 1995, University of Idaho 1995).

Of the numerous pathogens affecting bighorn sheep, *Pasteurella haemolytica* is the most important respiratory pathogen of bighorn sheep, and *Pasteurella multocida* may also be important in the pneumonia complex (Foreyt 1993).

Based on experimental data, bighorn sheep are more susceptible to fatal pneumonia than are domestic sheep. Based on all published experimental data, bighorn sheep die after close association with domestic sheep (Foreyt 1993).

Bighorn sheep are highly susceptible to domestic sheep strains of *Pasteurella* spp. while domestic sheep are refractory to bighorn sheep strains (Onderka 1986). Bighorn sheep die after inoculation with specific "strains" of *P. haemolytica* of "healthy" domestic sheep origin (Onderka et.al. 1988, Foreyt et.al. 1994). Biotype T strains of *P. haemolytica* (*P. treahola*) are found predominately in bighorns and other wild ruminants, biotype A strains of *P. haemolytica* are found predominately in domestic sheep (Foreyt 1993). In a study at the University of Idaho, Biotypes A, T and 3 were isolated from both bighorn and domestic sheep. In culture positive individuals, biotype T organisms were isolated from 76% of the bighorns and 21% of the domestic sheep, while biotype A organisms were isolated from 30% of the bighorns and 75% of the domestic sheep (Ward et.al. 1990). There are many serotypes (10-20 or more) of *P. haemolytica* found in both bighorn and domestic sheep. There are many DNA types (50-100 or more) of *P. haemolytica* in bighorns and domestics. Different DNA types are present within a serotype and different serotypes are within a ribotype. Most *P. haemolytica* serotypes and DNA types look the same on agar, multiple colonies have to be typed from each animal. Multiple biotypes and serotypes can be isolated from the same animal. Tonsillar (pharyngeal) samples yield the highest isolation rate of *P. haemolytica*, nasal swabs have limited value except for the fact that healthy bighorn sheep rarely have *P. haemolytica* detected by nasal swabs. *P. haemolytica* survives for less than 24 hours in the environment, survival on dead animals and on many swabs, placed in medium, is often less than 24 hours, but tends to be longer on swabs. For the highest isolation rates of *P. haemolytica*, special steps must be taken to assure good sampling and preservation of samples.

Studies at Washington State University, one in Edmondton, Canada and one at the Caine Veterinary Center, Boise, Idaho have shown that specific types of *Pasteurella haemolytica* and *P. multocida* can be directly transmitted to bighorn sheep from domestic sheep (Onderka and Wishart 1988, Foreyt 1989, Foreyt 1990, Foreyt 1992, Hunter IDFG Letter Dated October 14, 1993) Table 1.

Foreyt et.al. 1994 published the results of a study where DNA fingerprinting was used to pinpoint the origin of bacteria that lead to the death of bighorn sheep. Identified was the specific DNA type that caused the death of the bighorn sheep. The DNA type originated in the domestic sheep and had not been present in bighorn sheep before they were inoculated. The bacteria was *Pasteurella haemolytica* (biotype A, serotype 2).

In wild situations, domestic sheep and bighorn sheep association often results in death of the bighorns and does not affect the domestics. Often this is based on circumstantial evidence, because direct disease transmission is difficult to substantiate under field

conditions. The finding of a shared *Pasteurella* spp. (by DNA fingerprinting) between feral domestic sheep and bighorn sheep in a Nevada study suggests the *Pasteurella* spp. can be transmitted between the bighorn and domestic sheep under range conditions (Hunter 1995, Hunter 1996 personnel communication). Deaths occur in bighorns after association with domestic sheep because strains of *P. haemolytica* that are nonpathogentic in domestic sheep are transmitted from domestic sheep to bighorns resulting in pneumonia and death of the bighorns (Foreyt 1993, Foreyt et.al. 1994).

When bighorn sheep experience a pneumonia episode, all age mortality often occurs. Lambs that are born into these populations generally experience low survival rates for approximately 3 to 5 years or more after the initial pneumonia (Foreyt 1990, Coggins and Matthews 1992, Ward et.al. 1992, Foreyt 1995, Hunter 1995). Observations of bighorn sheep have provided evidence that pneumonia associated *Pasteurella* infections may contribute to the high lamb mortality (Jaworski et.al. 1993).

Essentially all ungulates carry some strains of *P. haemolytica* (Foreyt 1995). Experimentally, elk, deer, mountain goat, cattle, llama and domestic goat association with bighorn sheep did not result in pneumonia in bighorns (Foreyt 1992, Foreyt 1993, Foreyt 1994). Evaluation of samples from Idaho and Alaska bighorn sheep has conclusively demonstrated that free roaming bighorn sheep which have not had contact with domestic sheep are not free of *P. haemolytica* (Ward 1990, Heimer et.al. 1992). There are isolates of *P. haemolytica* in some domestic sheep that are not lethal in bighorn sheep (Foreyt 1993).

There are bighorn sheep die-offs due to pneumonia that have occurred without any association with domestic sheep (Goodson 1982, Onderka and Wishart 1984, Foreyt 1989, Ward 1993 and Ryder et.al. 1994). Researchers agree that there are five primary factors that cause pneumonia in bighorn sheep. These are: 1) the presence of bacteria such as *P. haemolytica* and *P. multocida*, types indigenous to bighorn sheep, which with other factors can predispose bighorns to pneumonia, 2) the presence of stress, examples include: depleted forage or human disturbance, 3) the presence of lungworms, 4) the presence of viruses, and 5) exposure to a virulent strain of *P. haemolytica* from domestic sheep. Research indicates that the first four factors are relatively common at times for bighorn sheep (Foreyt 1995).

Bighorn sheep, in particular young rams, have a propensity to travel outside their home range. Domestic sheep in rugged terrain, have a tendency to stray from the main flock. Because of both behaviors, buffers between the two species, unless very large, have often failed.

Although attempts have been made, no effective vaccine currently exists that will prevent bighorn sheep from developing pneumonia after contact with virulent strains of *P. haemolytica* (Foreyt 1995).

CONCLUSIONS

1) In both fenced studies and free ranging herds, most contact between bighorn sheep and domestic sheep has resulted in pneumonia in bighorns and the deaths of all or most bighorns while domestic sheep remained healthy.

2) Thirteen fenced studies, some of which were circumstantial evidence, in six states or provinces resulted in: 9 cases where all bighorns died from pneumonia, while from 50% to 83% were lost in the other 4 studies.

3) Additionally, 18 incidents involving free ranging bighorns in 8 states or provinces linked contact with domestic sheep to bighorn die-offs (Table 1).

4) DNA fingerprinting have proven the transfer of *Pasteurella* spp. between bighorn and domestic sheep under both controlled "experimental" and range conditions.

5) No studies reported any bighorn herds, fenced or free ranging, that have come into contact with domestic sheep and remained healthy.

6) Published research has shown that *Pasteurella haemolytica* (usually biotype A, serotype 2) is the major pathogen responsible for the death of bighorn sheep after contact with domestic sheep.

7) No vaccine currently exists that will prevent bighorn sheep from developing pneumonia after contact with virulent strains of *Pasteurella* spp.

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Table 1. Bighorn declines and die-offs believed to have resulted from contacts with domestic sheep.

Location	Cause of die-off	Results	Year(s)	Source
Sun River, Mont.	Unknown	>70 died	1910-35	Goodson (1982)*
Upper Rock Ck., Mont.	Unknown	All died	1965-70s	Goodson (1982)*
Thompson Falls, Mont.	Unknown	All died	1940-60	Goodson (1982)*
Kootenay Natl. Pk. BC., Can.	Pneumonia		1939	Goodson (1982)*
Bull River, BC., Can.	Pneumonia	96% died	1965	Brandy (1968) in Goodson (1982)*
MacQuire Creek, BC., Can.	Pneumonia		1981-82	Davidson in Goodson (1982)*
Lava Beds Natl. Mon., Cal***	Pneumonia	All died	1980	Blaisdell (1982)* and Hunt (1980)
Mormon Mtns., Nev.	Pneumonia	50% died	1980	Jessup (1981)*
Dinosaur Natl. Mon., Colo.	Unknown	All died	1950	Barmore (1962) in Goodson (1982)*
Rock Ck., Mont.	Unknown	6 left	1900-20	Goodson (1982)*
Rocky Mtn. Natl. Pk., Colo.	Pneumonia	All died	1917-30	Packard (1939a, (1939b) in Goodson (1982)*
Methow Game Range, Wash.***	Pneumonia	13 of 14 died	1979-81	Foreyt and Jessup (1982)*
Warner Mtn., Cal.	Pneumonia	All died	1988	Weaver (1988)*
Latir Parks, N.M.	Pneumonia	All died	1978-82	Sandoval (1988)*
Utah St. Univ., Utah**	Pneumonia	All died	1970s	Spillett in Goodson (1982)*
Univ. BC., Can.**	Pneumonia	All died	1970s	Herbert in Goodson (1982)*
Colorado St. Univ., Colo.**	Pneumonia	All died	1970s	Hibler in Goodson (1982)*
Lostine, Or.	Pneumonia	70% died	1986	Coggins (1988)
Utah St. Univ., Utah**	Pneumonia	4 of 5 died	1988	T.D. Bunch (Utah St. Univ. Pers. Comm.)*
Sheep River Alberta, Can.**	Pneumonia	2 of 2 died	1988	Onderka (1988)
Wash. St. Univ., Wash.**	Pneumonia	6 of 6 died	1989	Foreyt (1989)
Wash. St. Univ., Wash.**	Pneumonia	2 of 2 died	1990	Foreyt (1990)
Utah St. Univ., Utah**	Pneumonia	5 of 5 died	1991	Callan (1991)
Wash. St. Univ., Wash.**	Pneumonia	2 of 2 died	1991	Foreyt (1991)
Wash. St. Univ., Wash.**	Pneumonia	5 of 6 died	1992	Foreyt (1992)
Caine Vet. Cnt., Boise, ID**	Pneumonia	2 of 4 died	1993	Hunter (1993) (IDFG pers. Comm.)
East Range, Nev.	Unknown	85 died	1992-93	Hunter (1993) (IDFG pers. Comm.)
Desatoya Range, Nev.	Pneumonia		1992-93	Tanner (1993) (NDW pers. comm.)
Tollgate Ram	Pneumonia	died	1994	Hunter (1996) (pers. comm.)
Hells Canyon Ram (BR95014)	Pneumonia	died	1995	Hunter (1995)

* From Desert Bighorn Council 1990
** University Controlled Conditions
*** Large Pen or Paddock

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