

Bighorn and Domestic Sheep Disease Research at WSU

- What causes bighorn sheep pneumonia?
- Where does it come from?
- What can be done about it?



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Number 1 limiting factor: pneumonia

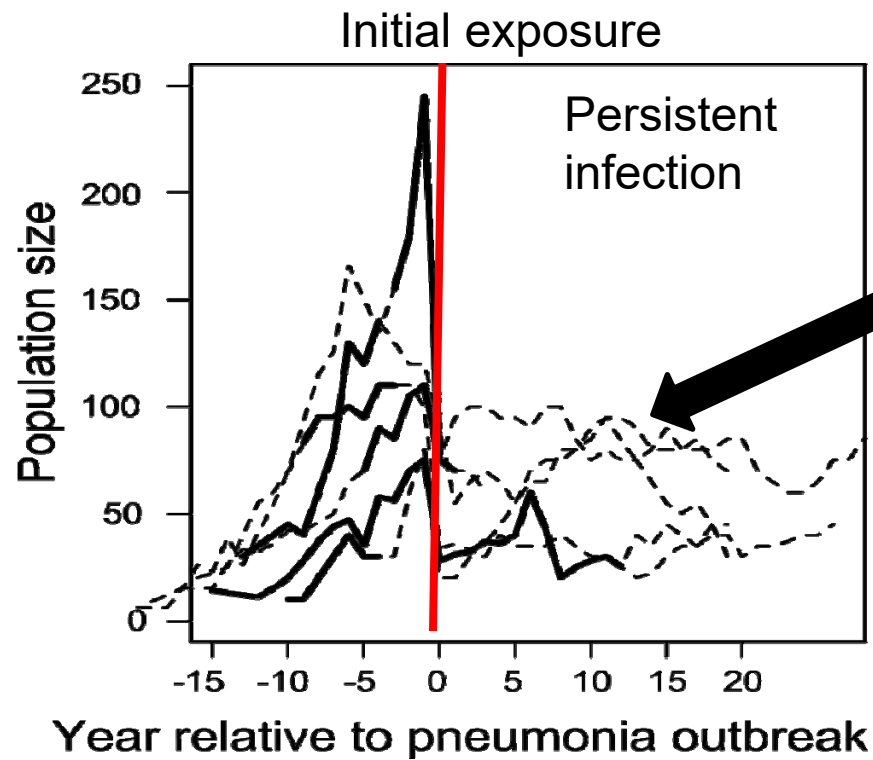
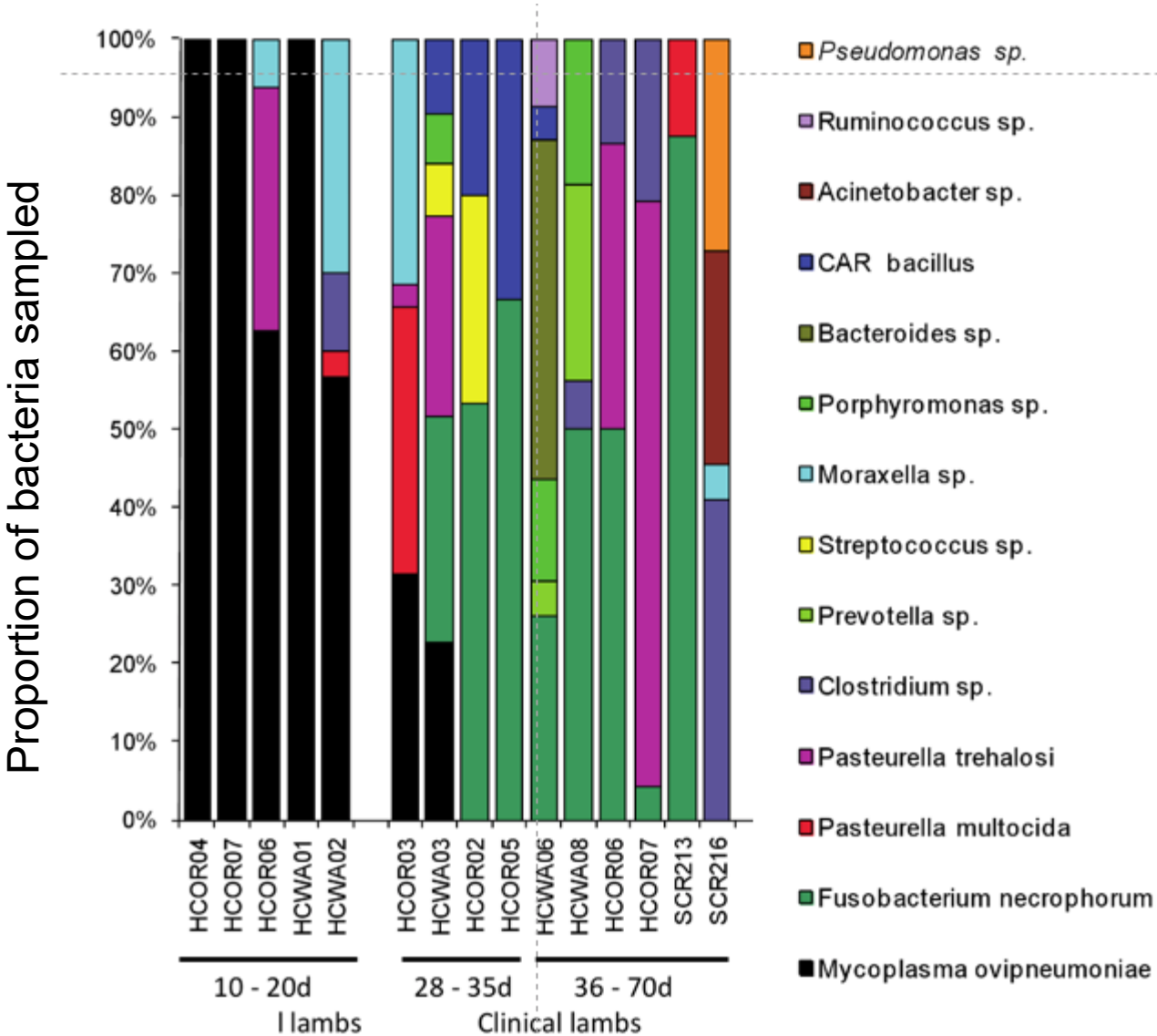


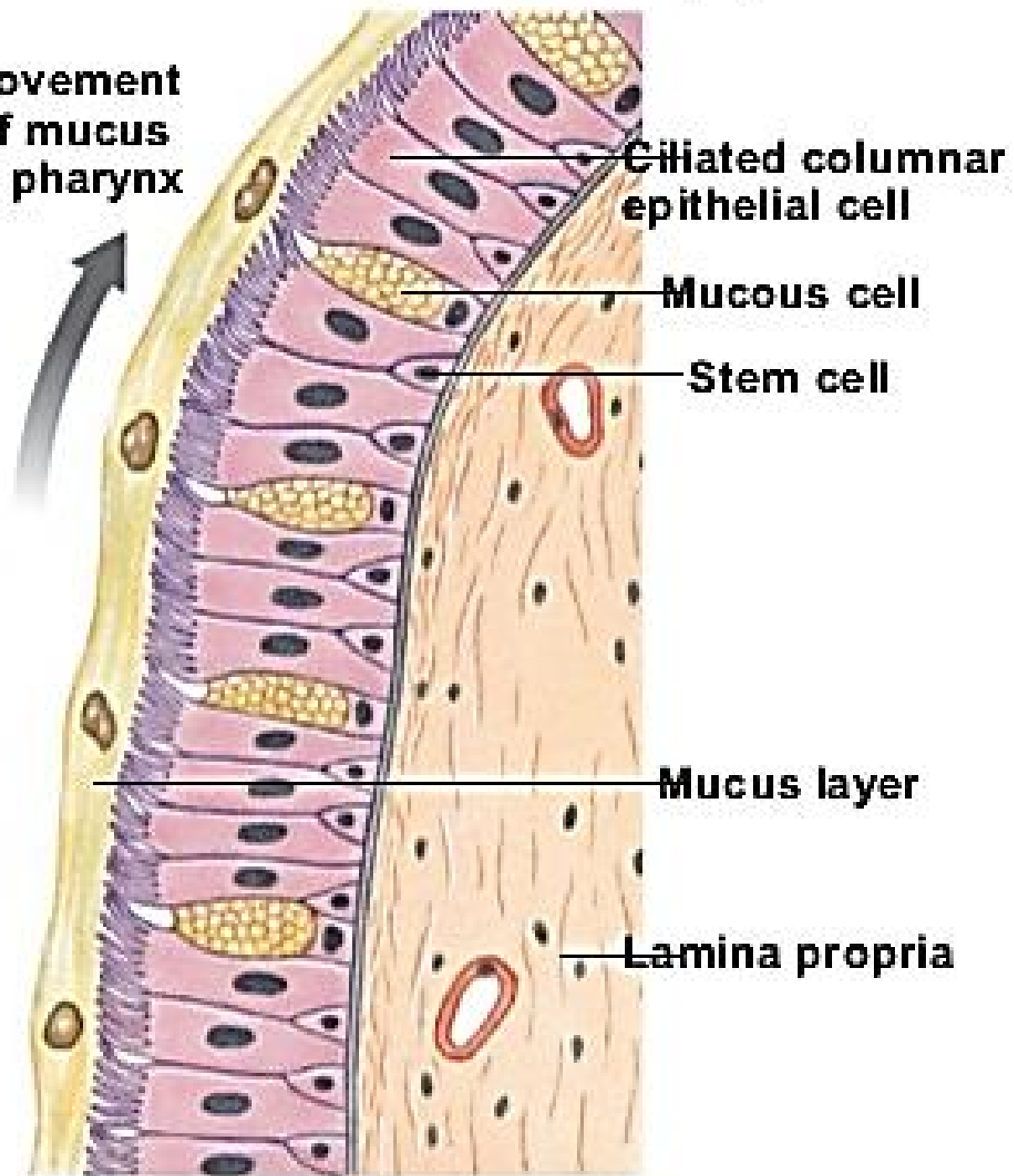
Figure by Kezia Manlove



Bacteria in BHS lambs with pneumonia



**Movement
of mucus
to pharynx**



Bacteria that live in the back of the throat
move down to the lungs causing pneumonia

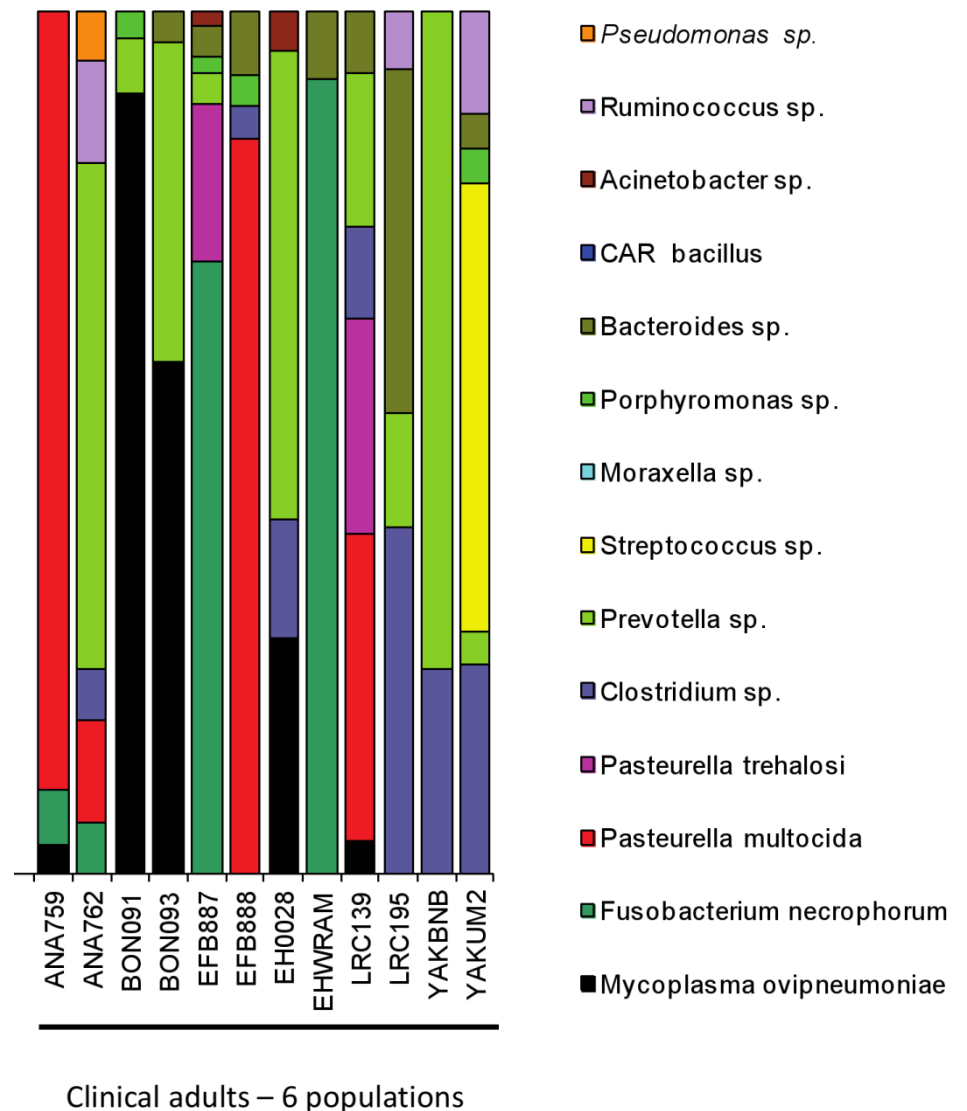
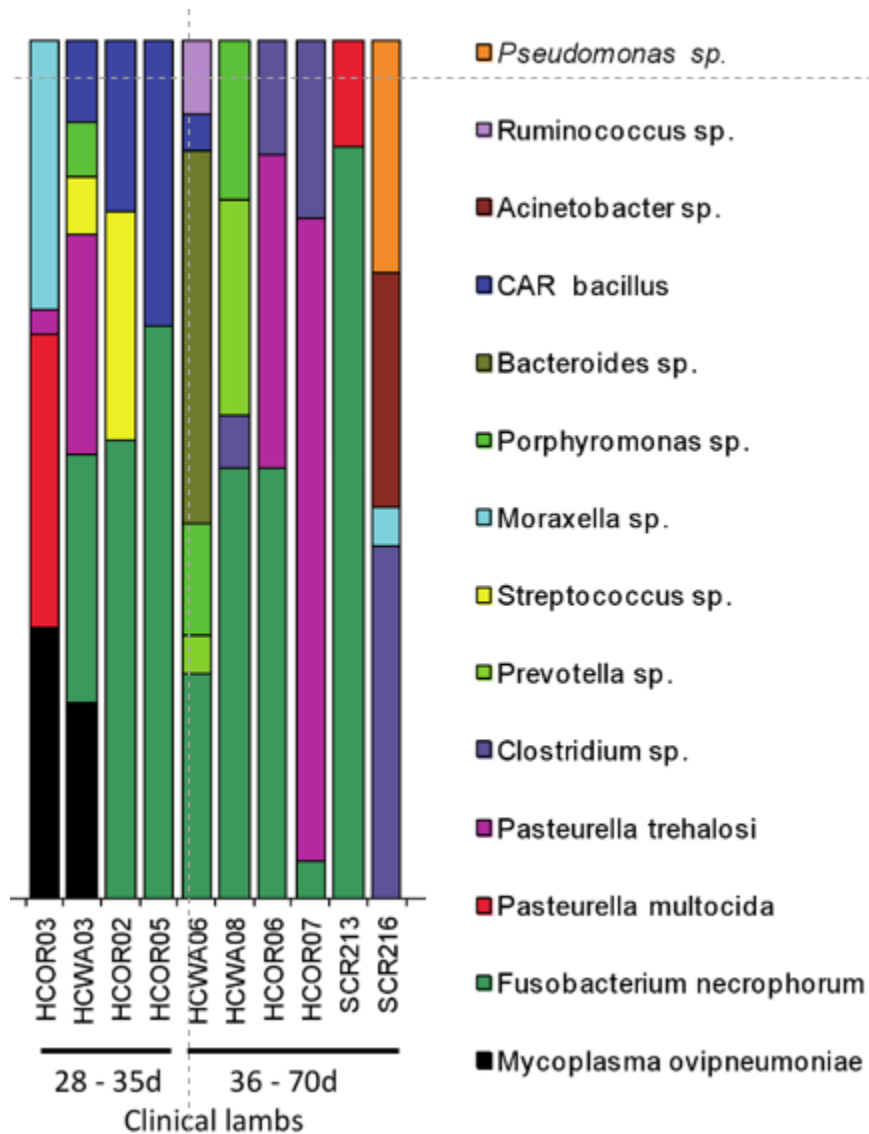


Same microbiology in adults and lambs with pneumonia!

Lambs

=

Adults



Pneumonic bighorn sheep populations:

M. ovipneumoniae status (PCR and serology)

Kanab Creek	AZ	+	Pancake Range	NV	+
Old Dad Mtn (2013+)	CA	+	Ruby Mtns	NV	+
Marble Mtn	CA	+	Tonopah	NV	+
Peninsular	CA	+	Snowstorm Mtns	NV	+
White Mts	CA	+	Pilot / Leppy Hills	NV/UT	+
Fossil Ridge	CO	+	Imnaha (1996+)	OR	+
Redbird	ID	+	Lostine (1987+)	OR	+
L Salmon River	ID	+	Sheep Mt	OR	+
Morgan Cr	ID	+	Muir	OR	+
Anaconda	MT	+	Custer SP	SD	+
Bonner	MT	+	Hill City	SD	+
Cinnabar Basin	MT	+	Rapid Cr	SD	+
E.F. Bitterroot	MT	+	Spring Cr	SD	+
Lower Rock Cr	MT	+	Stansbury Mtns (2016+)	UT	+
Upper Rock Cr	MT	+	Asotin Cr (2012+)	WA	+
Sun River (2011+)	MT	+	Black Butte	WA	+
Tendoy Mtns	MT	+	Tieton (2013+)	WA	+
San Andreas	NM	+	Wenaha	WA	+
E. Humboldt	NV	+	Yakima (2009+)	WA	+
Hays Canyon	NV	+	Gros Ventre	WY	+
Montanas (2016+)	NV	+	Whiskey Mt	WY	+

Healthy bighorn sheep populations:

M. ovipneumoniae status (PCR and/or serology)

Ram Mt	AB	-	Stonewall Mtns	NV	-
Cadomin	AB	-	Imnaha (to 1995)	OR	-
Kofa	AZ	+	Lostine (to 1986)	OR	-
Silverbell	AZ	-	Lookout	OR	-
Superstition Mtns	AZ	-	Coglan Butte	OR	-
Spence's Bridge	BC	-	Badlands (south)	SD	-
Old Dad Mtn (to 2006)	CA	-	Elk Mtns	SD/WY	-
Sierra Nevada	CA	-	Antelope Isl	UT	-
Sun River (to 2011)	MT	+	Stansbury Mtns (to 2016)	UT	-
Missouri Breaks	MT	+	Clemans Mt	WA	-
Paradise/Parma	MT	-	Asotin Cr (to 2012)	WA	-
Wild Horse Island	MT	-	Manson	WA	-
Navaho	NM	-	Mt Hull	WA	-
Bare Mtns	NV	-	Palmer Lake	WA	-
Montanas (to 2016)	NV	-	Quilomene	WA	-
Monte Cristos	NV	-	Sinlahekin	WA	-
Muddy Mtns	NV	-	Swakane	WA	-
Pine Forest	NV	-	Tieton (to 2013)	WA	-
River Mtns	NV	-	Tucannon	WA	-
			Yakima Cyn (to 2007)	WA	-

M. ovipneumoniae infection consistently found in pneumonic bighorn sheep populations

Bighorn sheep populations with observed pneumonia:
42 / 42 evidence of Movi infection / exposure

Bighorn sheep populations without observed pneumonia
4 / 35 evidence of Movi infection / exposure

Mycoplasma ovipneumoniae:

<i>Level</i>	<i>Odds Ratio</i>	<i>95% CI</i>
Population	undefined	42.9 – ∞

Evidence that Movt causes bighorn sheep pneumonia

- Movt is the first bacterium to infect the lungs
- Single epidemic strains of Movt spread within all-ages outbreaks and persist causing lamb outbreaks
- All-age pneumonia outbreaks occur when Movt is introduced into a previously Movt-negative herd
- All-age pneumonia outbreaks occur when a new Movt strain is introduced into a herd previously infected with another strain
- Experimental exposure to Movt reproduces the naturally occurring disease

AN EPIZOOTIC OF *MYCOPLASMA OVIPNEUMONIAE* INFECTION IN CAPTIVE DALL'S SHEEP (*OVIS DALLI DALLI*)

Author(s): Sandra R. Black, Ian K. Barker, Kay G. Mehren, Graham J. Crawshaw, Soren Rosendal, Louise Ruhnke, Jan Thorsen, and P. Suzanne Carman

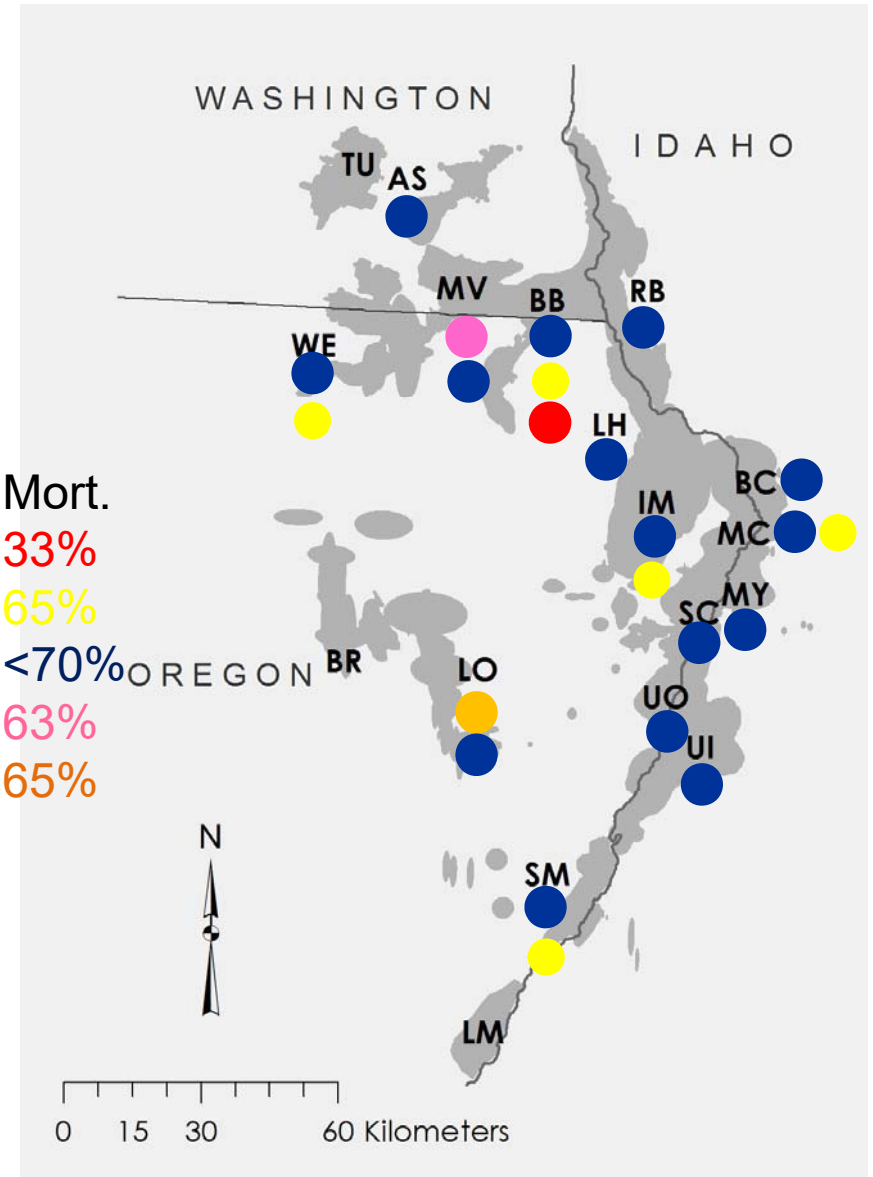
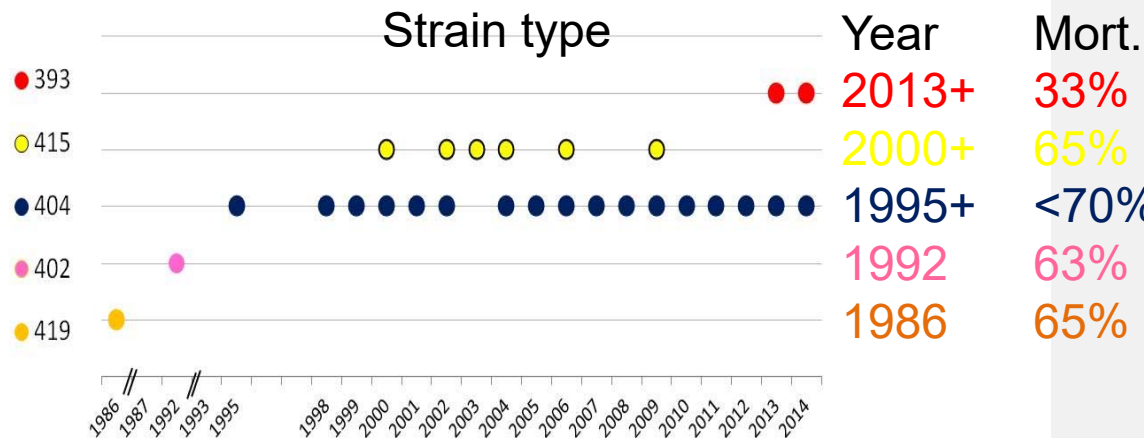
Source: Journal of Wildlife Diseases, 24(4):627-635.

- Toronto zoo: outbreak of fatal bronchopneumonia in one of two groups of Dall's sheep
- Followed exposure/contact of that subgroup with domestic sheep
- Disease was accompanied by seroconversion to Movt
- Outbreak suggests that thornhorn sheep are similarly susceptible to Movt induced epidemic pneumonia as bighorn sheep

Where does Movi come from?

- Movi can't live in the environment; a live animal source is needed
- Movi infects only sheep and goat species (Caprinae)
 - Rare, unconfirmed reports from other species
- Therefore, the most likely Movi sources include:
 - Infected bighorn sheep
 - Infected domestic sheep
 - Infected domestic goats
 - Infected mountain goats
- If infected wild sheep and goats are ruled out, domestic sheep and goats are the only remaining possibility

Movi strains in Hells Canyon: 1986 - 2014





Movi in domestic sheep and goats

- Most farms carry Movi
 - Sheep:
 - 88% of 450 flocks; ~60% of 300 animals (USDA CEAH)
 - Goats:
 - 83% of 6 herds, 36% of 58 animals
 - 58% of 16 herds, 28% of 84 animals
- Domestic sheep farms typically carry multiple, diverse strains of Movi

USDA CEAH: <https://tinyurl.com/gvhwkvk>; Besser, unpublished data;
Heinse and others, Wildlife Soc Bull 2016

Movi effects in domestic sheep and goats

Movi typically causes relatively little/mild disease

But:

- ‘Coughing syndrome’ in weaned lambs
- Associated with reduced weight gains
- Severe pneumonia has been reported, especially in goats
- USDA Sheep 2011 study: Movi negative herds less likely to report pneumonia, or if present, reported fewer pneumonia cases *
- WSU 2016 study: Movi decreased growth rates in lambs from weaning (50#) to slaughter (135#): 7% decrease in ADG *

Jones 1982; Rifatbegovic 2011; Goltz 1986 **Preliminary data, do not cite*

Links between domestic sheep and bighorn pneumonia?



Mixing of bighorn and domestic sheep

- Mix domestic sheep with bighorn sheep -> pneumonia outbreak
 - Greater than 95% bighorn sheep death loss
- Mix cattle, llamas, or horses with bighorn sheep: No pneumonia outbreaks (occasional individual disease)
 - Less than 10% death loss
- Mix Movi-negative sheep or goats with bighorn sheep: No epidemic pneumonia

Movi transmission on the range

Movi genotyping (DNA fingerprinting) confirms Movi transmission under natural range conditions between :

- Domestic sheep and bighorn sheep
- Domestic goats and bighorn sheep

Bighorn sheep or mountain goat sources of Movi are easily ruled out by failing to find the epidemic strain in nearby herds

Domestic sheep or goat operations are more difficult to rule out: more operations; obtain permission for sampling; sorting out multiple stains

What can be done about bighorn sheep pneumonia?

Three principles for management of infectious disease*

- Reduce exposure to the causative agent*
- Increase non-specific host resistance*
- Increase specific host resistance*

*Radostits, Blood and Gay: Large Animal Veterinary Medicine

What can be done about bighorn sheep pneumonia?

Three principles for management of infectious disease*

- Reduce exposure to the causative agent*
 - Minimize contact with domestic sheep/goats
 - Closing public lands grazing allotments with high risk of contact
 - Educating private land sheep producers about the need for separation: fencing, preventing strays, reporting foraging bighorns
 - Reduce or eliminate Movi in nearby domestic sheep/goats
 - Minimize contact with infected bighorn sheep
 - Test and cull in infected bighorn sheep herds – promising to date!
- Increase non-specific host resistance*
- Increase specific host resistance*

*Radostits, Blood and Gay: Large Animal Veterinary Medicine

What can be done about bighorn sheep pneumonia?

Three principles for management of infectious disease*

- Reduce exposure to the causative agent*
- Increase non-specific host resistance*
 - Preferred approach! But nobody knows if it can be done!
 - Nutrition? Genetics? Stress? Population size / structure?
 - Work in progress; no guarantee of success
- Increase specific host resistance*

*Radostits, Blood and Gay: Large Animal Veterinary Medicine

What can be done about bighorn sheep pneumonia?

Three principles for management of infectious disease*

- Reduce exposure to the causative agent*
- Increase non-specific host resistance*
- Increase specific host resistance*
 - Vaccine?
 - Respiratory mycoplasmas are a very challenging vaccine target – high strain variability; poor immunogenicity
 - TB prediction: vaccine unlikely next 20+ years

*Radostits, Blood and Gay: Large Animal Veterinary Medicine

Thanks!

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