

## Test and Cull Experiment on California Bighorn Sheep Herd in Snowstorm Mountains, Nevada, 2011-2017

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### Narrative on Herd History, Disease Event and Test and Cull Experiment

- The Snowstorm Mountain California bighorn herd was reintroduced from 3 releases of 27 total bighorn from Idaho and British Columbia in 1985 and 1988, then augmented in 1995 with 15 bighorn. The population steadily grew to 100 adults by 1999.
- The population was never captured for disease surveillance or for transplant stock before the disease event in 2011.
- A domestic sheep trailing route along private land has always existed in the valley south of the Snowstorm Mountains (within 5 miles of occupied bighorn habitat) and over the years there have been a handful of stray domestic sheep that have been reported and some removed by the operator.
- In May 2011, a stray domestic ewe was killed at the base of the mountain with permission from the ranch manager. Disease testing revealed no Movi from PCR but with standard bacteria detected from pharyngeal culture. In early July bighorn ewes and normal number of lambs were observed. On July 21, reports of domestic ewe and lamb on southeast end of the mountain. On July 25, helicopter survey found no domestic sheep. On August 6, 2 domestic ewes observed in the core bighorn habitat.
- On August 18, a routine helicopter bighorn survey for lamb and ram ratios observed 2 domestic sheep in core bighorn habitat. Following NDOW/Nevada Dept. of Agriculture MOA, permission was given by domestic sheep owner to lethally remove them. Both animals were killed and samples taken. Also a yearling bighorn ram was sacrificed for testing. The next day its carcass was examined by state Agriculture veterinarian and revealed 20% of lung was lost to pneumonia infection.
- On August 30, an aerial netgun capture was conducted to assess animals during the disease event. A total of 7 live and 3 dead bighorn (sacrificed for necropsy) were sampled and 7 VHF or GPS collars were deployed for future monitoring.
- All sampled bighorn had evidence of pneumonia and all 7 of the live sheep were positive for *Mycoplasma ovipneumoniae* (Movi) (see Mycoplasma Prevalence Testing Table). The predominant bacteria recovered from the lungs of the bighorn was *Pasteurella multocida*. *Bibersteinia trehalosi* was also recovered. (see Bacteria Prevalence Testing Table). One animal had *M. haemolytica* cultured from the nasal, pharyngeal and tonsillar area. *P. multocida* was not recovered from any of the domestic sheep. Lung isolate strains of *Bibersteinia trehalosi* from the two domestic sheep that were euthanized at the same time as one of the bighorn on August 18 were not related to the lung isolate strains recovered from the bighorn (pulse field gel electrophoresis (PFGE)).
- The Movi strain that was recovered from 10 captured bighorn was identical in all sheep and distinct from other strains of Movi recovered in bighorn herds in Nevada and across the western states that experienced recent die-off events. (Figure 1). We recovered Movi via PCR from a sinus swab from 1 of the domestic sheep harvested on August 18.

It was an exact match to the strain recovered from the lungs of 3 bighorn euthanized on August 29 (Figure 2).

- The 2011 disease transmission and event resulted in a 60% loss of adults by pneumonia and negligible lamb recruitment 4 of the next 5 years.
- Testing of bighorn ewes was conducted 5 of the next 6 years, 2012 -2017. The population declined to 32 adults by 2017 (see Population Demography Table below). By late 2015 all ewes had been tested at least once and collared (n=27, including previously marked ewes) with a few of the rams tested and collared to confirm ram dispersal among the 4 subherds. See Pathogen Testing Tables below for Movi and and bacteria prevalence each year.
- In support of the Test and Cull Research at South Dakota State University (SDSU), a “non-selective” cull was conducted in December 2014 with 10 ewes and 1 ram being captured, removed, and translocated to the SDSU research facility. Their Movi status was 3 of the 10 ewes were positive by PCR and the ram was indeterminant. Additional adult losses occurred from lion predation and a Blue-Tongue episode in 2015. Figure 3 displays the geography of the 4 subherds that are monitored for specific subherd lamb ratios during the summer months.
- Only 1 lamb was recruited into the herd the summer 2015. There were 5 lambs recruited from 25 ewes into the herd late summer 2016.
- A “selective” Test and Cull was conducted in February 2017. Six ewes that tested positive on PCR to Movi were transported to SDSU to support ongoing research of supershedders. One ewe that tested positive was lethally removed on the mountain in late April and 1 ewe that was negative died from capture injuries.

At the time of the February 2017 capture the ewe/lamb composition by subherd was:

South Fork Little Humboldt River - 6 ewes, 1 lamb  
Kelly Creek- 9 ewes, 2 lambs  
Owyhee Bluffs- 6 ewes, 4 lambs  
Winters Ridge- 1 ewe, 0 lambs

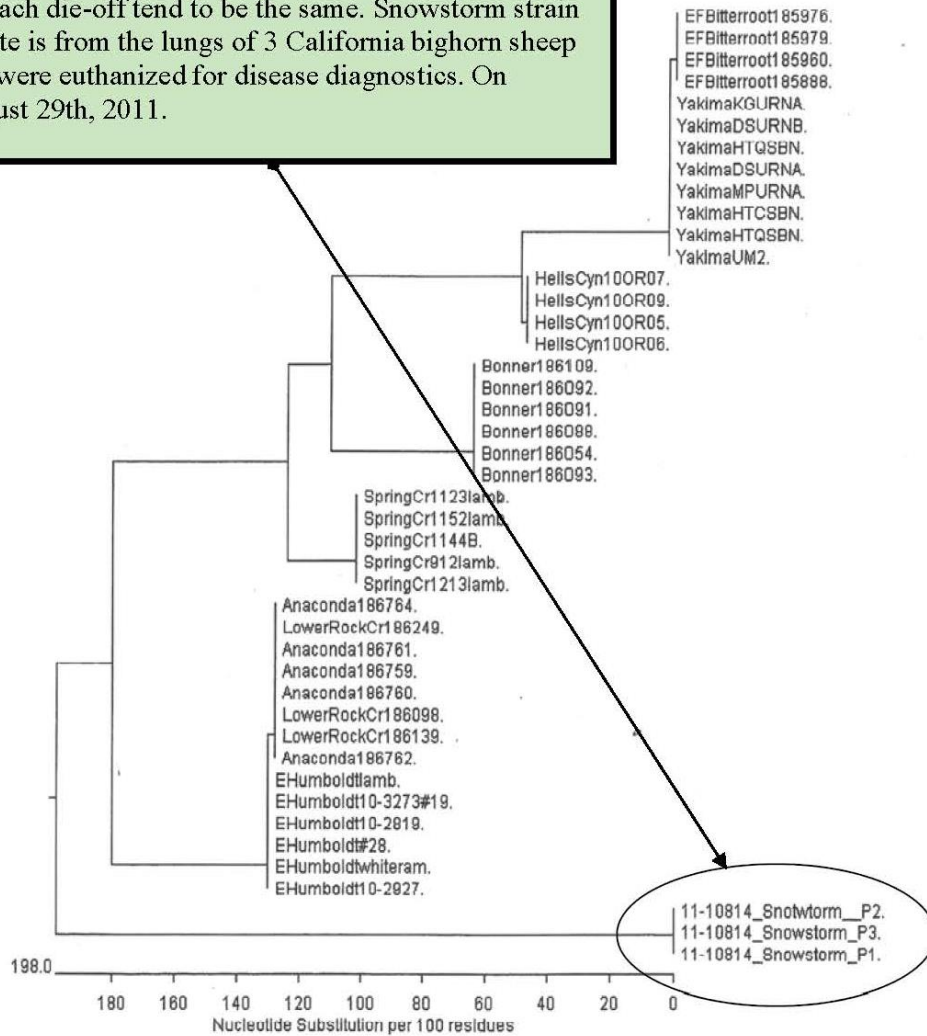
- Ground surveys in May showed ewe/lamb composition by subherd as:

South Fork Little Humboldt River - 2 adult ewes/1 yrlg ewe/1 lamb  
Kelly Creek- 6 adult ewes/1 yrlg ram/5 lambs  
Owyhee Bluffs- 5 adult ewes/2 yrlg ewes & 2 yrlg rams/ 4 lambs  
Winters Ridge- Zeroed out

Figure 1

### IGS strain typing dendrogram for *Mycoplasma ovipneumoniae*

Dendrogram shows that similar to other die-offs across the western U.S. from 2008—2010. The strain isolate for each die-off tend to be the same. Snowstorm strain isolate is from the lungs of 3 California bighorn sheep that were euthanized for disease diagnostics. On August 29th, 2011.

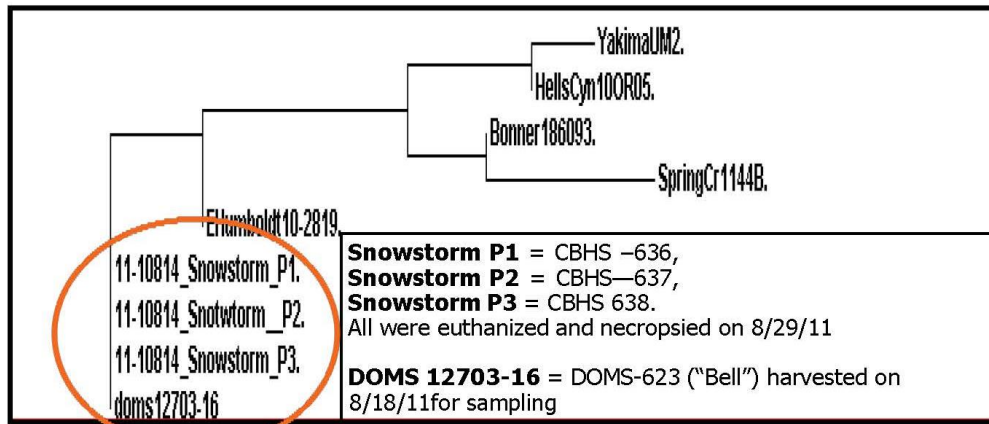


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Figure 2

IGS strain typing for Mycoplasma ovipneumoniae isolates



Dendrogram indicates that isolates from:

- 11-10814\_Snowstorm\_P1
- 11-10814\_Snowstorm\_P2
- 11-10814\_Snowstorm\_P3

are identical to the strain of *M. ovi* recovered from the sinus cavity of 1 of 2 domestic sheep found co-mingled with bighorn sheep.

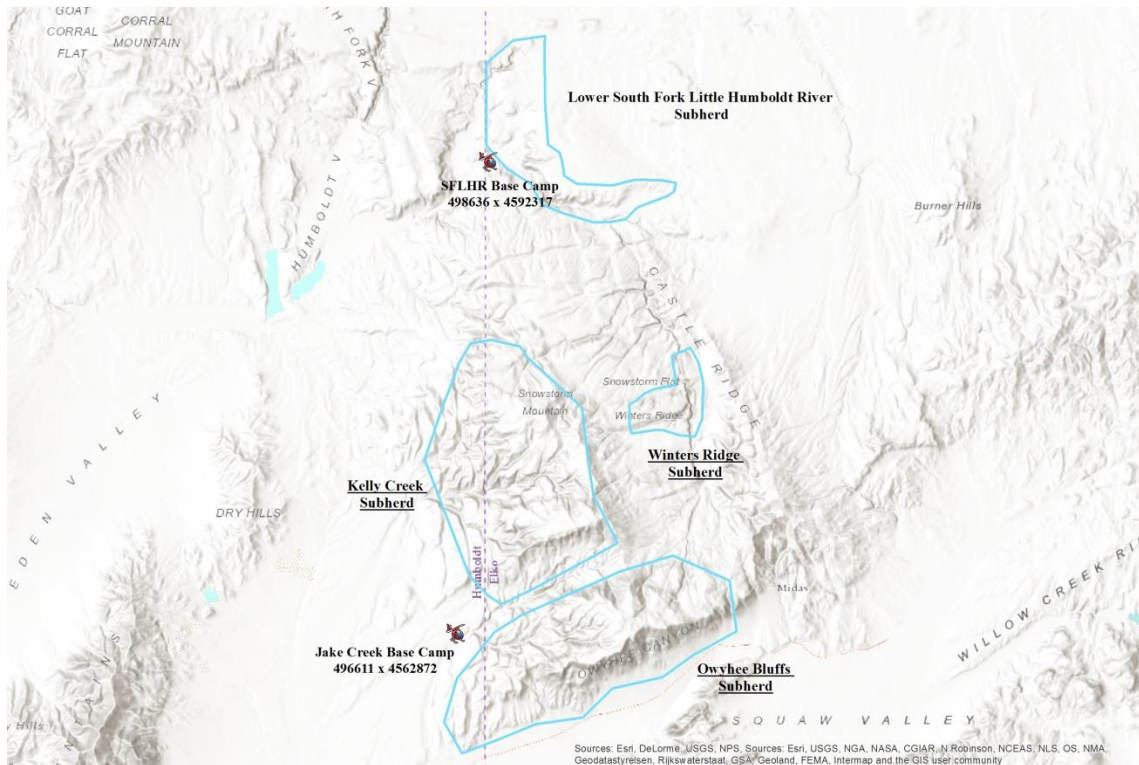


Figure 3. Snowstorm Bighorn Subherd Home Ranges at time of December 2014 Capture

## Population Demography

Year	Herd/Management Status	Late Summer Survey Results					Population Status	
		Rams	Ewes	Lambs	Totals	Lambs/100 Ewes	Pop Estimate	Lambda
2000-2010	stable to increasing	17	40	17	74	43.0	120	1.2
2011	known disease transmission	17	31	1	49	3.2	130	1.1
2012	post disease event		31	1		3.2	65	0.5
2013		12	35	3	50	8.6	60	0.9
2014	Test	13	26	7	46	26.9	50	0.8
2015	Test and Cull	20	25	1	46	4.0	50	1.0
2016	Test	15	24	5	44	21	40	0.8
2017	Test and Cull	?	19	9	28	47	32	0.8

## Mycoplasma Prevalence Testing

Year	Herd/Management Status	Movi - ELISA			Movi - PCR		
		sample size	Movi - ELISA pos	Movi - ELISA % +	sample size	Movi - PCR pos	Movi - PCR % +
2011	known summer disease transmission	9	5	56	9	8	89
2012	post disease event	18	18	100	19	19	100
2014	Test	20	18	90	20	6	30
2015	Test and Cull	13	7	54	13	6	46
2016	Test	13	10	77	13	5	38
2017	Test and Cull	--	--	--	14	4	29

## Bacteria Prevalence\* Testing

Date Sampled	Sampling Effort: Animal Status	Sample Size	Pasteurella multocida	Bibersteinia trehalosi	Mannheimia haemolytica	Arcanobacterium pyogenes	Trueperella pyogenes
8/30/2011	7 live bighorn; 2 necropsied	9	56	89	22	67	0
8/30/2011	2 necropsied domestic sheep	2	0	P**	M	0	0
2012	Live bighorn	18	22	100	44	28	0
2014	Live bighorn	9	11	89	11	0	0
2015	Live bighorn	8	0	50	38	0	38
2017	Live bighorn	10	80	50	0	0	50

\*Prevalence - % of total sample positive or P - predominant pathogen, M - moderately detected

\*\*Lung isolate strains not related to single euthanized CBS on same day