Domestic / Wildlife Interactions

Mycoplasma ovipneumoniae

in Alaska

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Domestic/Wildlife Interactions

- Predation
- Habitat competition: Land, forage, water
- Pathogen issues: (> 60% are zoonotic)
  - Brucellosis: Greater Yellowstone Area
  - TB: Michigan
  - Parasites (*Ticks)*:
    - Lyme Disease, Anaplasmosis, Babesia
    - Cattle Fever Ticks Texas
    - Moose Winter Tick
  - Rabies
  - Avian Influenza
  - Plague and Respiratory Pathogens

Negative Ecosystem Impacts

- Threaten Wildlife Health and Endangered Species
- Threaten Livestock Health
- Threaten Public Health
- Threaten Food Production, Food Security
- Threaten the preservation of Natural Habitat
- Threaten Local Economy
  - agricultural, tourism, guiding, hunting
- Threaten National Economy
  - International Trade

Mycoplasma ovipneumoniae (M. ovi)

- Sporadic Pneumonia outbreaks; some large die-offs (75-90% mortality) of bighorn sheep (BHS)
- Some reports of reduced BHS lamb survival following the pneumonia outbreaks - *sustainability*
- Wild sheep – appear to have *lower resistance* to some respiratory pathogens of domestic livestock



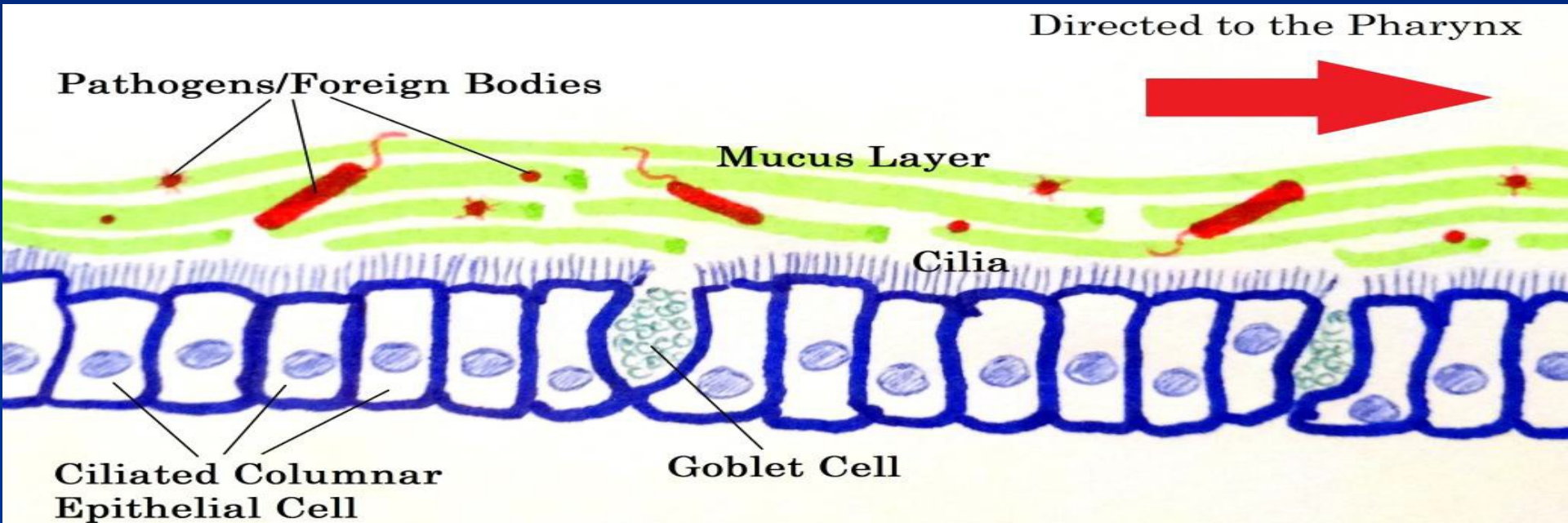
M. ovi typically causes relatively mild disease in domestic sheep

- ‘Coughing syndrome’ in young lambs
- Reduced growth rate and weight gains
- Severe pneumonia has been reported, especially in young goats

- NAHMS Sheep study:
  60 -80 % of large farms had M. ovi detected
- USDA Pack Goat Study:
  < 4% of farms (+) detected

Mycoplasma ovipneumoniae (M. ovi)

- Pathogen of sheep and goat species (Caprinae)
  Reported that clinical illness <u>may</u> be more severe in wildlife
- *"<u>Carrier status</u>"* in sheep and goats
- Diagnostic testing challenging
  - **<u>Bacteria difficult to culture</u>**
- **Pathology** by disrupting lower airway function



Alaska Situation

- Proposals to Board of Game // Alaska Dept. of Fish and Game (ADF&G)
  - Remove Sheep and Goats from the “Clean List”
  - Permit required by ADF&G:
    - To import sheep or goats into the State of Alaska
    - To own sheep or goats within 15 air mile of wild sheep habitat
  - Health certification – free of *Mycoplasma ovipneumoniae*
  - Containment of sheep and goats in an “approved facility”

Yukon Order 10-30-18

- No farms above 1,000 meters elevation
- Premises registration, annual inspection
- Fencing requirements
- Animal ID, inventory and records
  - Any births, purchases, imports, deaths recorded
- Annual testing for pathogens of concern
  - Animals that are (+) or carriers > destroyed
- Movement by permit only
- Immediately report any escapes

Respiratory Disease

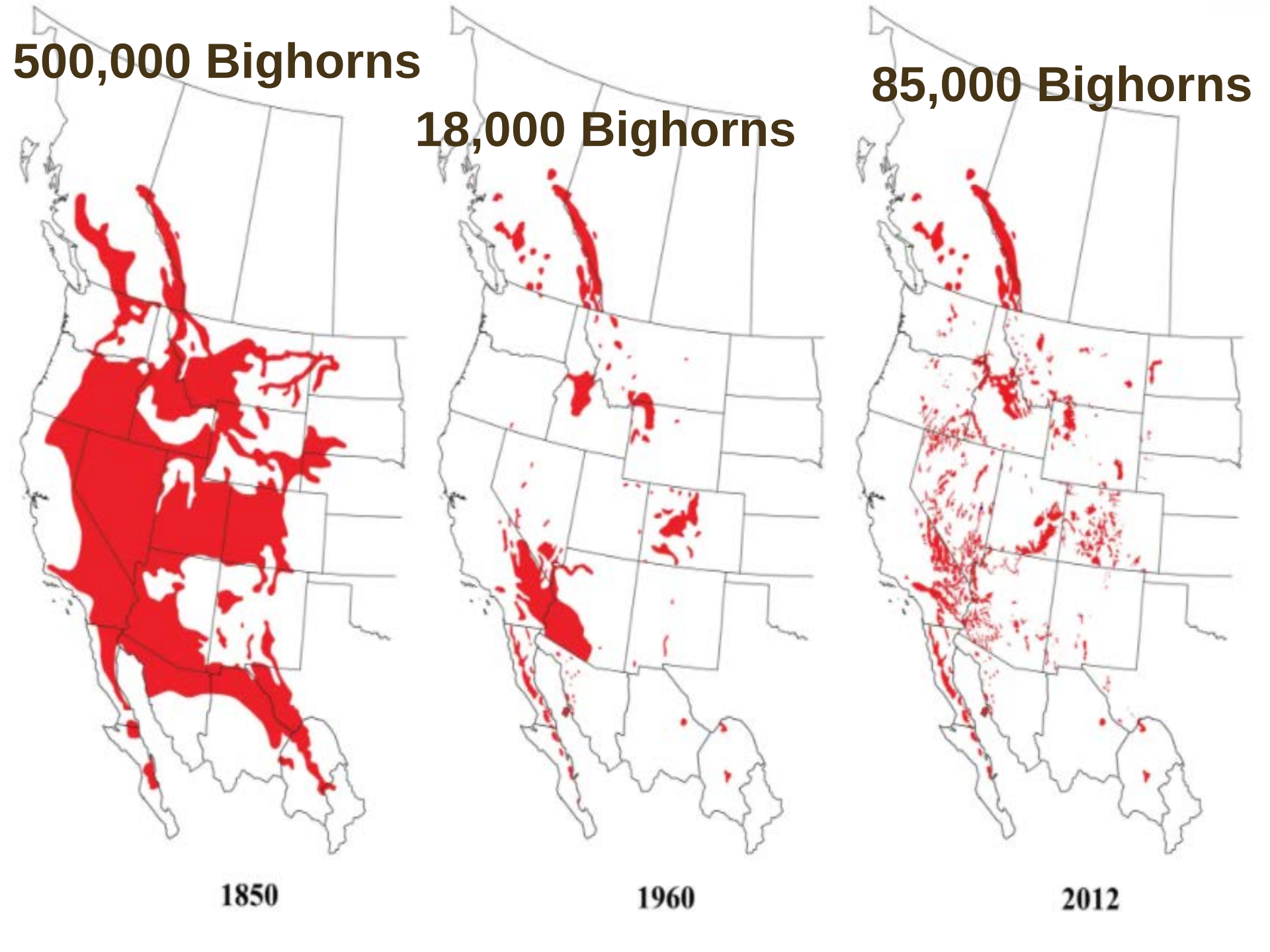
- Pneumonia Outbreak :**Multifactorial** and involve **Multiple Pathogens**
- *Mycoplasma ovipneumoniae* (*M. ovi)*
- Pasteurella bacteria
  - *Pasteurella haemolytica*
  - *Bibersteinia trehalosi*
- *Fusobacterium necrophorum*
- Other bacteria (*Truperella pyogenes*)
- Respiratory viruses
- Parasites - *Lungworms*

Disease is Multifactorial

- Presence of the Pathogen – dose, virulence
- Combination of many factors are involved:
  - Health stressors – other parasites, pathogens
  - Population density – (↑ crowding/contact)
  - Nutrition –protein, energy, mineral, water
    - Quality of graze/browse – carrying capacity
  - Fragmentation and restriction of range/habitat
  - Genetic susceptibility to clinical disease
  - Human interaction: *competition for resources*
    - tourism, hunting, urban expansion
    - *Interaction with livestock*
- Not a simple issue, no easy solution

What is the situation in the Western States?

- Bighorn sheep: Population Decline 15,000 - 18,000 estimated in 1960….
- Urban expansion = Habitat loss, hunting pressure, competition with livestock
- Morbidity/Mortality events: respiratory disease
- Focus on wildlife conservation: Recovery
  - habitat preservation, reintroductions, focused management efforts


500,000 Bighorns
18,000 Bighorns
85,000 Bighorns
1850
1960
2012

Alaska: Unique Situation

- Not comparable to Western U.S. or Canada
  - No history of morbidity/mortality events
- Minimal fragmentation or loss of habitat
- Smaller number of farms and livestock
  - **~120** Sheep/Goat farms (NASS statistics)
  - Average <13 animals/farm (**< 2,000** sheep, goats)
  - Lower density: ⇩ probability for interaction
- Fewer importations/year
- No free grazing, animals are contained /fenced, some degree of separation


WASH.
OREG.
CALIF.
San Francisco
NEV.
IDAHO
MONT.
WYO.
UTAH
ARIZ.
COLO.
N. MEX.
N. DAK.
S. DAK.
NEBR.
KANS.
OKLA.
TEXAS
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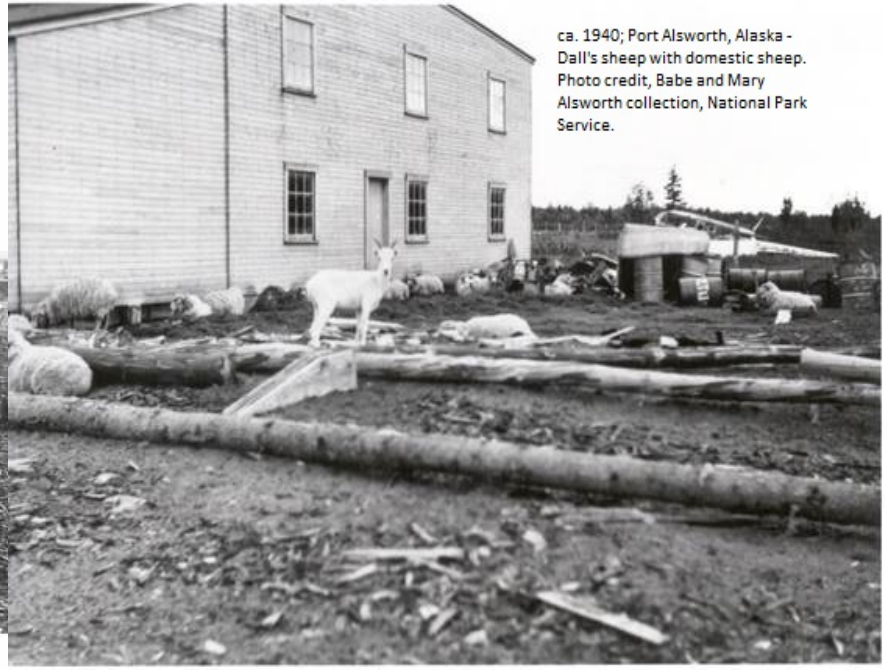
MASS.
VT.
N.H.
ME.
Jacksonville
0
250
500
MILES

History of Livestock Imports to Alaska

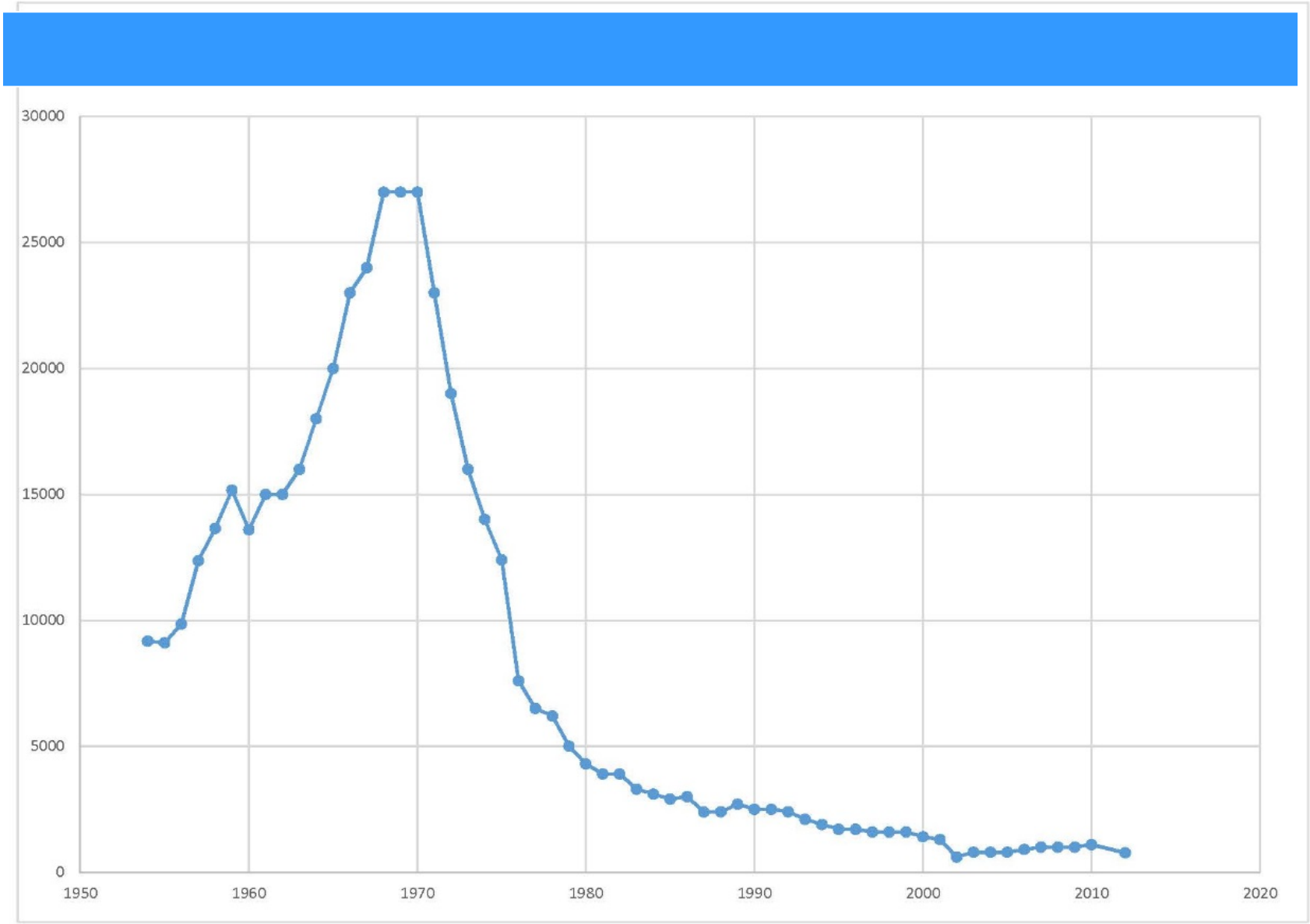
- Cattle – 1733 - 1867 from Russia
- Reindeer – 1892 - 1902
- Sheep and goats – beginning in 1853

Property of Special Collections, University of Washington Libraries.



ca. 1940; Port Alsworth, Alaska - Dall's sheep with domestic sheep. Photo credit, Babe and Mary Alsworth collection, National Park Service.

Populations of Domestic Sheep in Alaska



Wild Sheep Working Group

- Organized by the Alaska Farm Bureau and the Wild Sheep Foundation in 2018

- Discuss options and strategies to prevention spread of M. ovi to wildlife (* Dall's Sheep)
  - Regulations
  - Separation – no contact
  - "M. ovi free status" – must be defined
- Need data from Alaska
  - Evaluate prevalence of M. ovi in livestock / wildlife
  - Understand the epidemiology of the pathogen

Livestock Study

- Using USDA, NASS statistics develop a sampling plan to evaluate AK farms
- Domestic livestock sample collection:
  - Veterinarians collect samples
    - Client/patient confidentiality – used farm code
  - Follow established protocols
    - Nasal, conjunctival swabs and serum
  - Nasal Swabs submitted to 2 Laboratories:
    - Animal Disease Research, (ARS-USDA) Lab
    - Washington State Animal Diagnostic Lab: WADDL

USDA NASS 2017 Farm Census

# Farms	Aleutian-Kodiak Islands	Southcentral Anchorage-MatSu-Valdez-Cordova	Kenai Peninsula	Interior/ Fairbanks Delta - Yukon to Canada	Southeast	Total farms
Sheep	2	24	6	17	0	49
Goat	0	33	18	20	2	73
Total	2	57	24	37	2	122
# Animals						Total animals
Sheep	~55	348	196	189	~45	833
Goat	40	455	~105	172	~31	803
Total	95	803	301	361	76	1,636

Livestock Study Protocol

- Voluntary participation

  Sample plan: evaluate farms in each region

- Survey completed by farmer
  - Focus on management and husbandry practices
- All animals tested on the farm, repeated (3x) sampling at ~ 4 and then 8 weeks later
  - Duplicate Nasal Swabs ~ 20% of animals on farm
- Data returned to the Veterinarian / Client
  - summary data to State Veterinarian

Mycoplasma testing

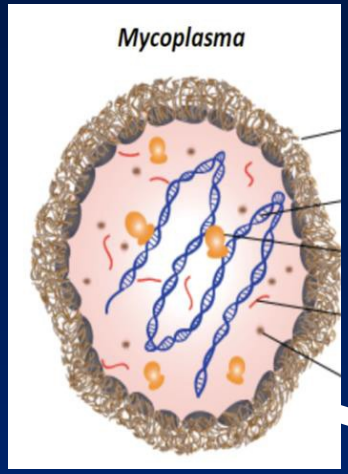
- **Serology – test for antibodies**
  - **Past exposure, not presence of M. ovi bacteria**
- **Test for bacteria:**

  1. Culture the M. ovi - *very difficult*

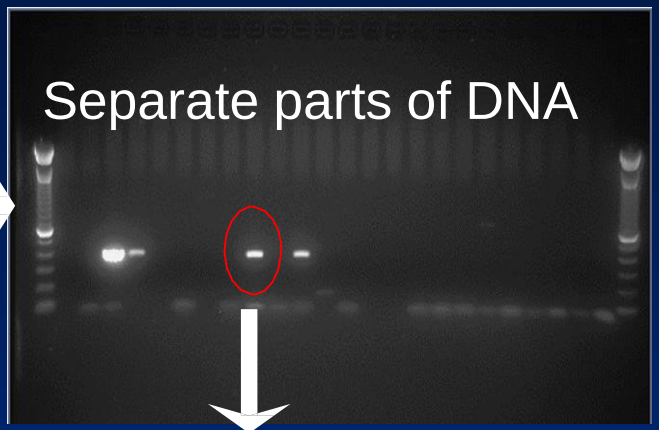
  2. PCR + sequencing - detect *DNA fingerprint*

  - **DNA is isolated from a swab or tissue sample**
  - **Small sections of the M. ovi genetic code are evaluated**
  - **Several different tests are used – each looking for different sections of the M. ovi genetic code**

Mycoplasma testing



Polymerase chain reaction (**PCR)** (amplifies DNA) for Mycoplasma



Sequence DNA :

TCAATAATTTTGAATAATTTG
TACTGAACTCAATAATTCGT

Compare to reference sequences -GenBank

Positive detection: DNA sequence from the sample matches the reference sequence of the known Mycoplasma **≥97% similarity**

16S rRNA gene

IGS (intergenic spacer)

23S rRNA gene

LM40 PCR
~361 bases

IGS PCR
~485 bases

Mycoplasma "universal" (UM) PCR
(GPO-1 & MGSO primers)
~717 bases

Mycoplasma genome:
~500,000-1,000,000 bp

Current Results for the Study

- 43 farms: (samples from 656 animals)
  - 7 of 43 were sheep farms
  - 4 of 43 had both sheep and goats
  - 32 of 43 were goat farms
- 11 of 43 farms **(26 %)** M. ovi was detected
  - sheep farms 4/7 (57%)
  - goat farms 4/32 (12%)
  - consistent with finding of some other studies
- 32 of 43 **(74%)** had no M. ovi detected

M. ovi: Summary Data

	#	Non - Detect	Detected	% Prevalence
Total # Animals	656	631	25	3.8%
Goats	485	473	12	2.5%
Sheep	171	158	13	7.6%

Comparison of Laboratory Data

- **Study not an inter-laboratory comparison**
  - Duplicate samples - not identical**
  - Test (PCR) Methodology was not identical
- Total of **573** duplicate samples:

	Detected	Non-Detect	% detection
USDA-ARS	33	540	6 %
WADDL	18	555	3 %

- Results were extraordinarily similar
  - 95% concordance or agreement

ADF&G Wildlife Study Goals (2017-2020)

- Determine the distribution of M. ovi and other respiratory mycoplasmas in Alaskan wild ungulates
  - Evaluate proximity to domestic animals
  - Culture and isolate as possible, genotype and then compare genotype (strains) of *Mycoplasma* spp. found in Alaskan wildlife

ADF&G Wildlife Study Goals

- Evaluate the impact of *Mycoplasma* spp. on herd health of wild ungulates
  - Herd performance and survival over time

- Evaluate intraspecific dispersal of sheep and goat hosts as a measure of the potential pathogen spread among those species

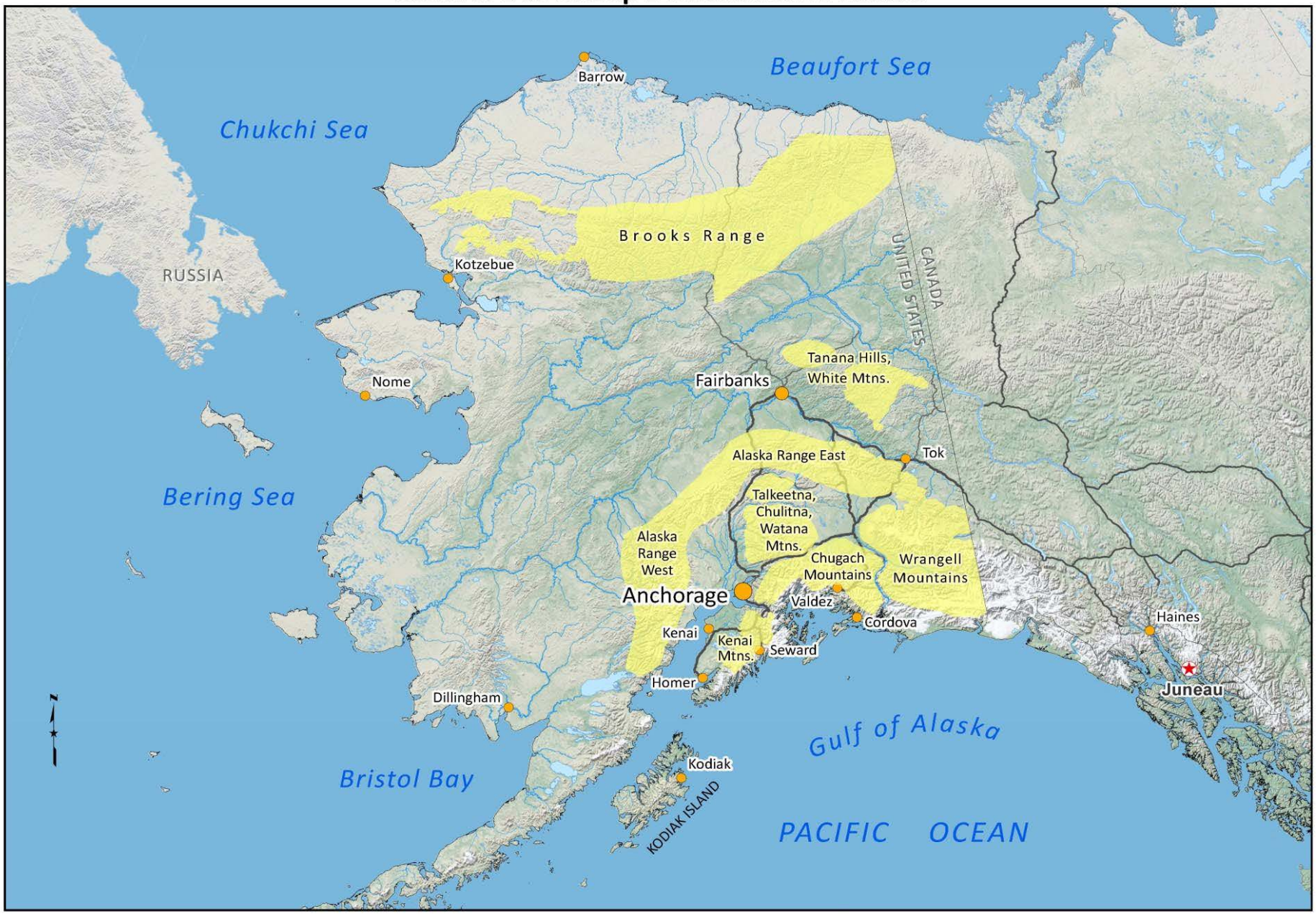
ADF&G Wildlife Study

- Nasal swabs, blood samples collected:
  - Routine wildlife population surveys
    - (Dall's sheep, Mtn Goat, Moose, Caribou, Bison, Muskox)
  - Morbidity/Mortality investigations
  - Evaluation of captive wildlife populations
- Nasal swabs collected from hunter harvested Dall's sheep

Sampling Effort 2004-2019

Type Sampled	Species	Number of animals	Number of samples
Wildlife live capture/release	Dall's sheep, caribou, moose, mountain goats, muskox, wood bison	3,703	4,061 nasal swabs 261 lung samples
Hunter harvested or found dead	Above species + plains bison, Sitka black tailed deer		
Captive/zoo ungulates	Various		
Domestic animals	Sheep and goats	656	

General Dall Sheep Distribution in Alaska



Data Sources:
ADFG
ESRI Data & Maps, 2004

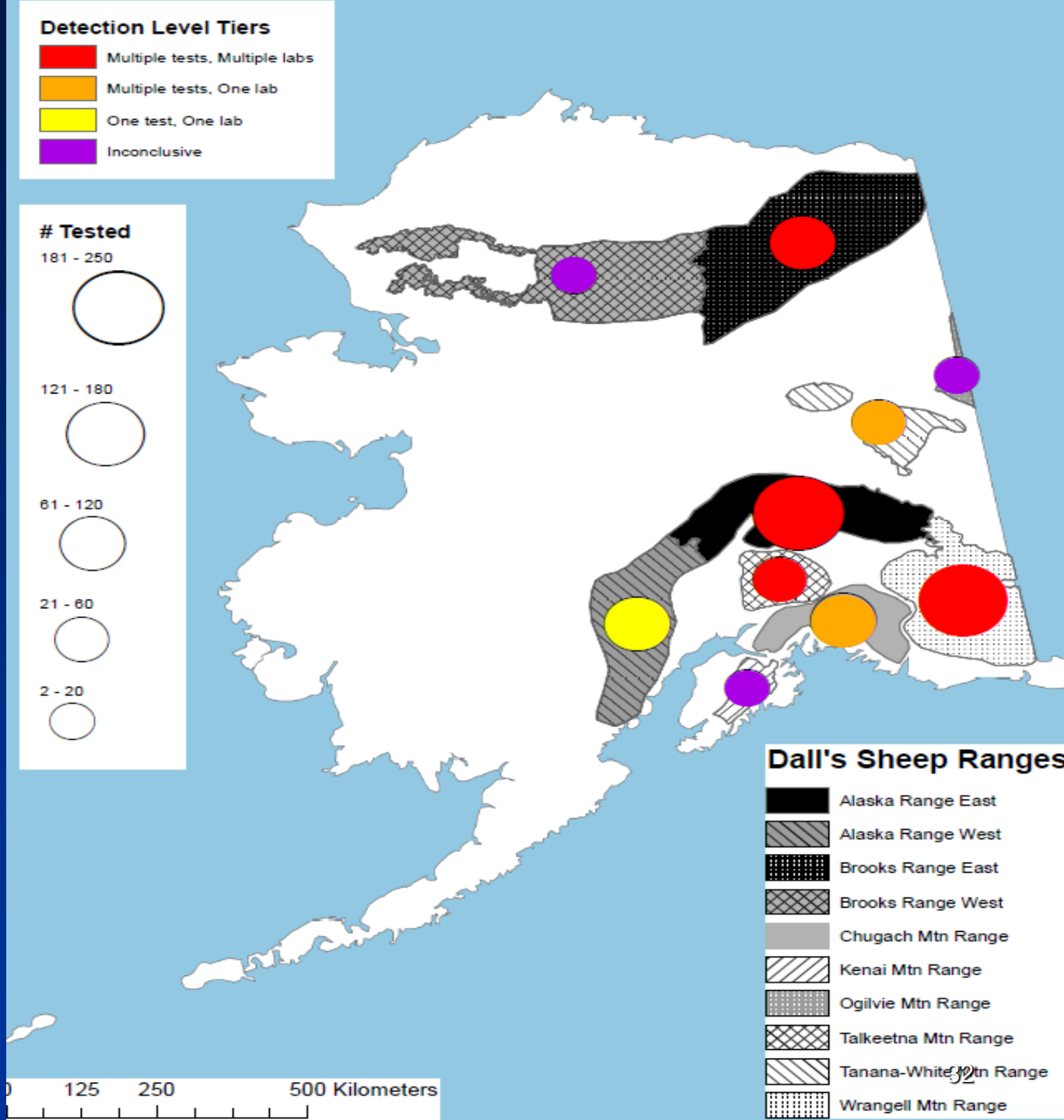
0 50 100 200 300 400 500 Miles

Alaska Dept. of Fish & Game
2014

M. ovi detections in Dall's sheep 2004* -2019

All years
All sources
All methods

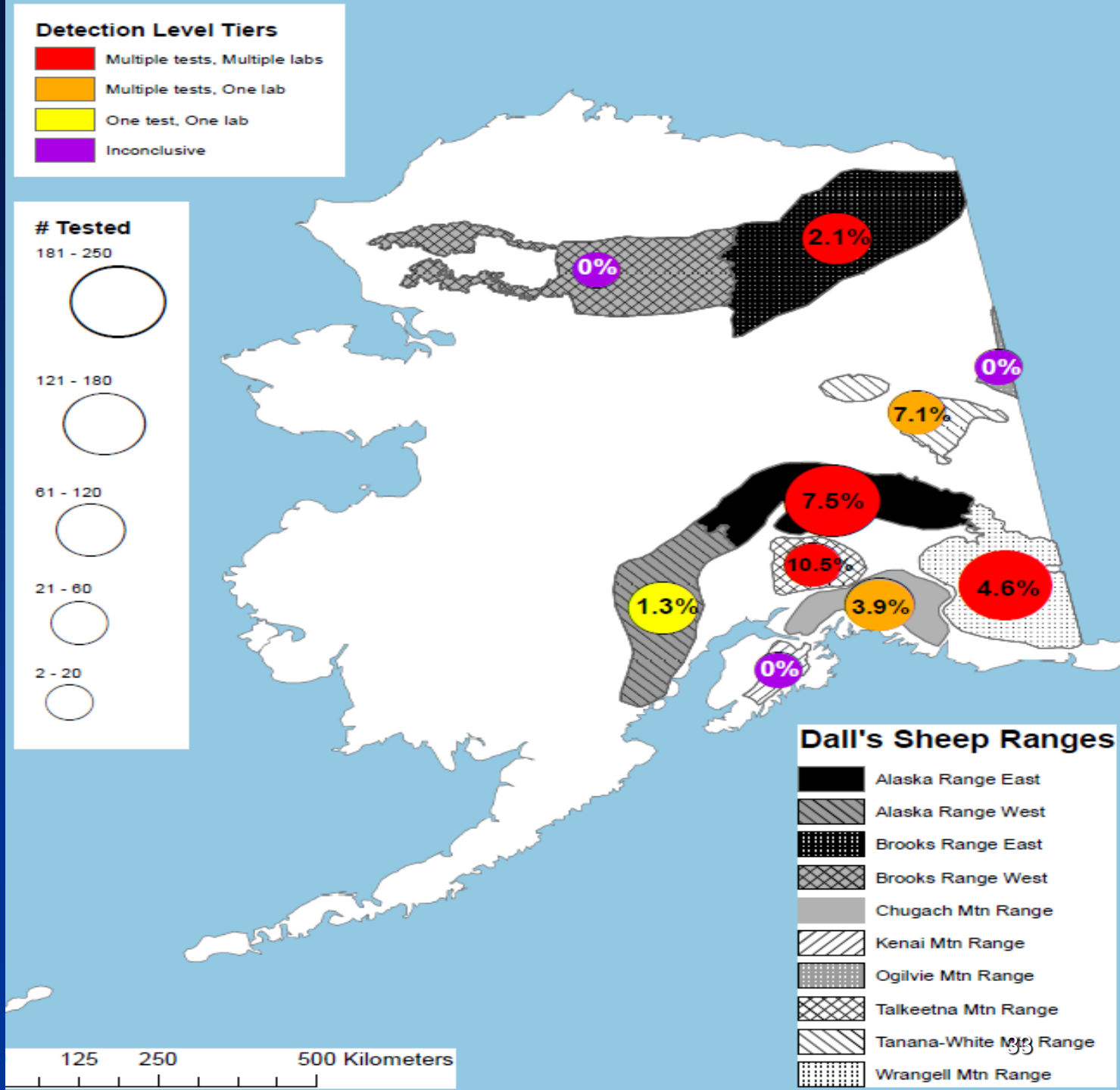
Positive M. ovi detection
2004 ARW



M. ovi detections in Dall's sheep tested 2018-19

% Detection is a **Proxy** for Prevalence

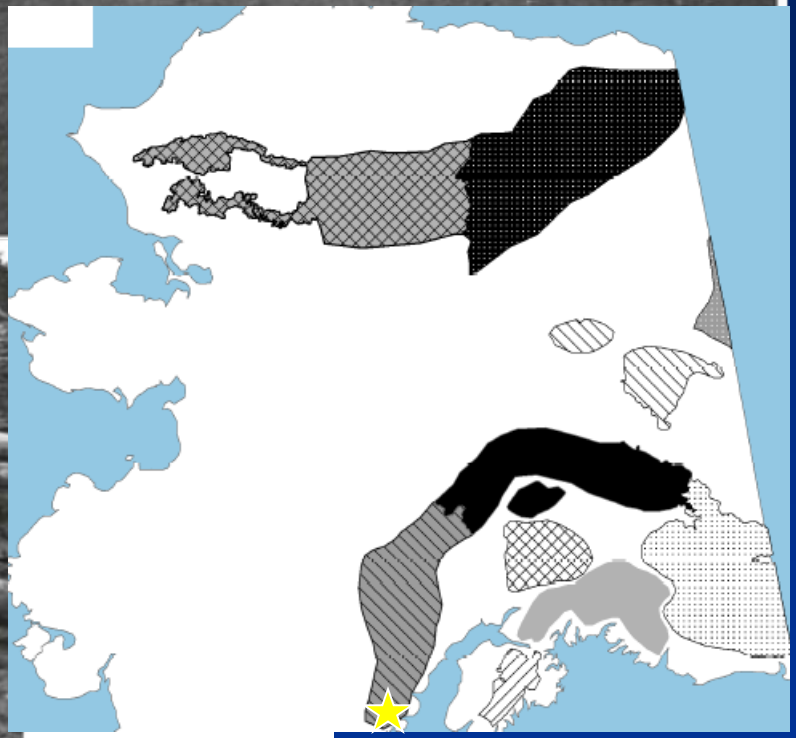
(Non-random sampling)



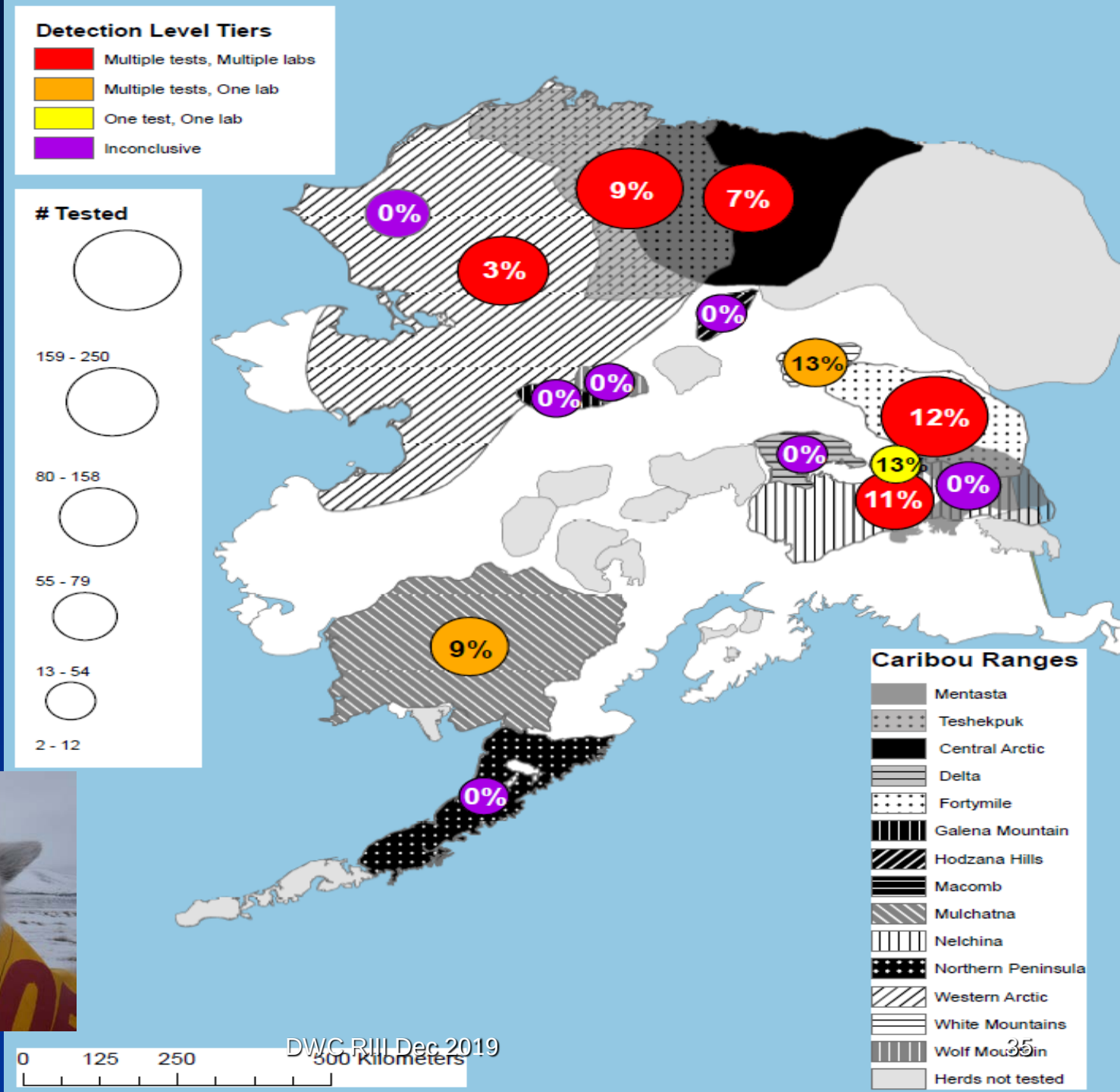
Summary

M ovi was detected in Dall's sheep lungs in the earliest available samples, 2004…
Potential exposure to domestic livestock was much earlier

This photo was taken in back of Babe Alsworth's hanger at Port Alsworth in the 1940s. Babe had goats from about 1945



Caribou % detection All sources 2012-2019



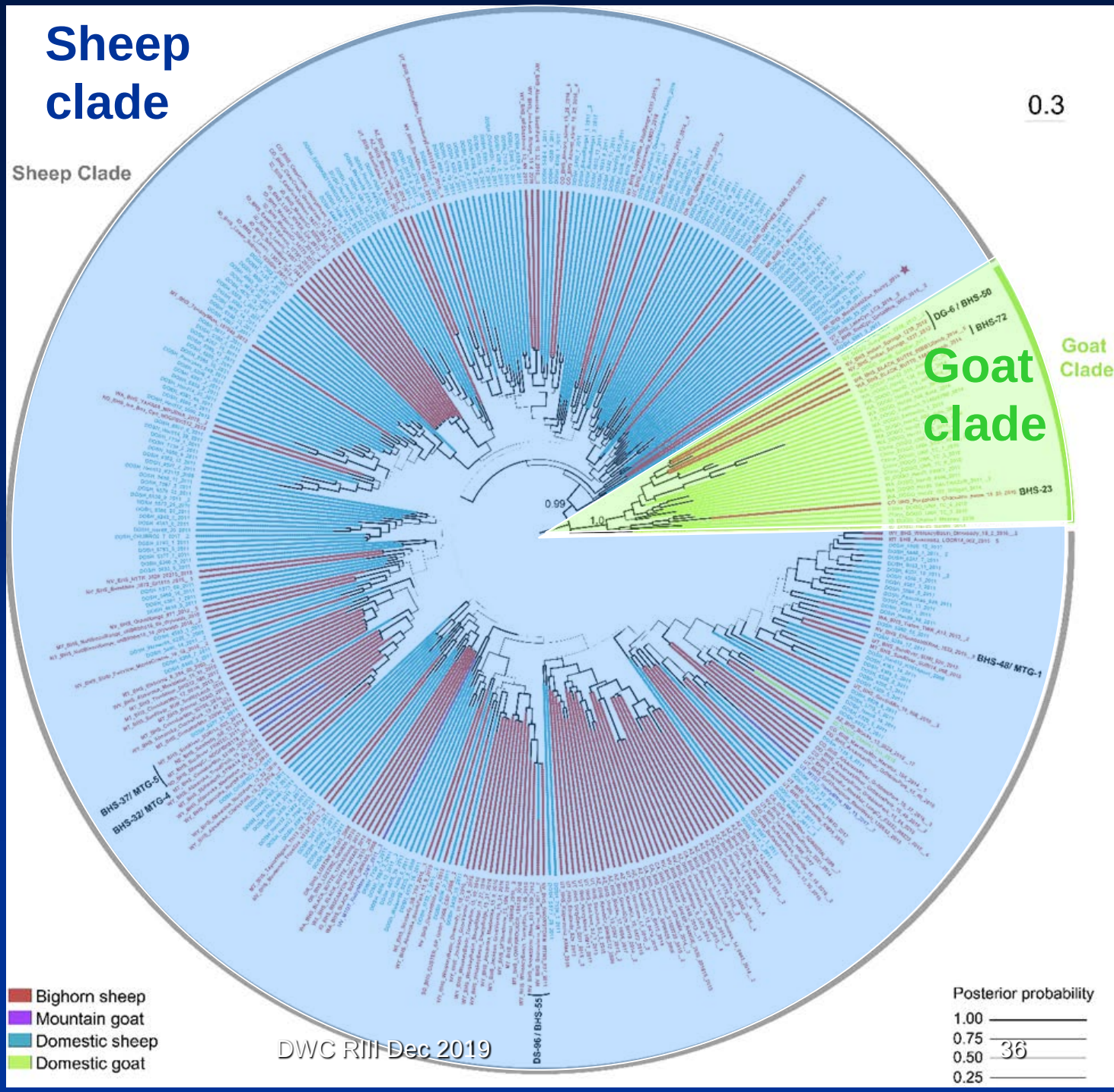
Kamath et al 2019

M. ovipneumoniae consensus tree

Alaskan wildlife:
Have strain typed

- 11 Dall's sheep from 3 range areas sampled from 2004-2019
- 12 caribou from 5 herds collected 2007-2019
- All but one sequence is identical
  - Differs by 1 base pair

- The sequences are most closely related to those in the sheep clade



Summary of Strain Typing

- Archived samples of lungs from 2004 Alaska Range Dall's Sheep and 2007 Arctic Caribou reveal essentially the same strain type as contemporary Dall's Sheep and Caribou across AK
- Geographic and species distribution consistent with an enzootic organism

Summary

- Presence of an enzootic strain does not suggest any decrease in vulnerability or risk from other M. ovi strains or respiratory pathogens
- Does not decrease the risk of an outbreak of respiratory disease of the enzootic stain under additional stressors
- **Respiratory Disease** is a multifactorial and multi-pathogen condition



Comparing Tests

- **USDA and WADDL: ~375 split wildlife samples**
  - **High overall concordance or agreement**

- **One laboratory had many more (+) detections**
  - **One lab not detecting (+) some strains in Alaska**
  - **Strong disagreement from experts at each lab**
  - **Variable results → uncertainty ?**

Emphasis: **There is a lot we do not know about this pathogen.**

Publications of Alaska Study

- Emergence of *Mycoplasma ovipneumoniae* in wildlife species beyond the subfamily *Caprinae*
- *Mycoplasma ovipneumoniae* associated with polymicrobial pneumonia in a free-ranging yearling caribou (*Rangifer tarandus tarandus*) from Alaska, USA
- Laboratory concordance study for the detection of *Mycoplasma ovipneumoniae*

Summary

- There are multiple pathogens (bacteria, viruses, fungi, parasites, prions) that may be a significant threat
  - M. ovi is just one component
- Presence of M. ovi in wildlife ≠ protection,
  - Exposure to one strain of M. ovi is not-protective to infection with a different strain
- Need for Whole Genome Sequencing
  - Better define strain differences
  - Understand epidemiology of the pathogen

Next Steps in Alaska

- Dependent on the study results
  - Await results wildlife study and continue to collect samples from livestock and wildlife
  - Use data for RA and **Science Based Decision**
- Evaluate options for mitigation action:
  - No action
  - Regulatory action
    - "M. ovi free status" , mandatory testing
  - Management of livestock to decrease wildlife interaction or separation

What are the costs?

Use a "One Health or Ecosystem Approach"

Livestock / Wildlife Interaction

- Husbandry and Management of Livestock
  - Maintain secure fences
  - Secure feeds and feed troughs
  - Herd health/husbandry management plan
- Landscape Management – protect habitat
- Disease Surveillance – domestic and wildlife
- Morbidity/Mortality Investigations
- Regulatory options:
  - Reportable disease
  - Import requirements
  - Mandatory testing

In Summary

- Domestic/Wildlife interactions may pose a threat to both wildlife and domestic animals
- Alaskan Collaborative Partnership:
  - Producers, wildlife biologist, veterinarians, Farm Bureau, State, Federal Agencies
- Identify management strategies to reduce and mitigate Livestock/Wildlife interactions – ***the Agricultural community must take the lead on this issue now***

Ecosystem approach: consider all impacts and consequences

Questions ?

Acknowledgements

- Livestock owners and local veterinarians
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