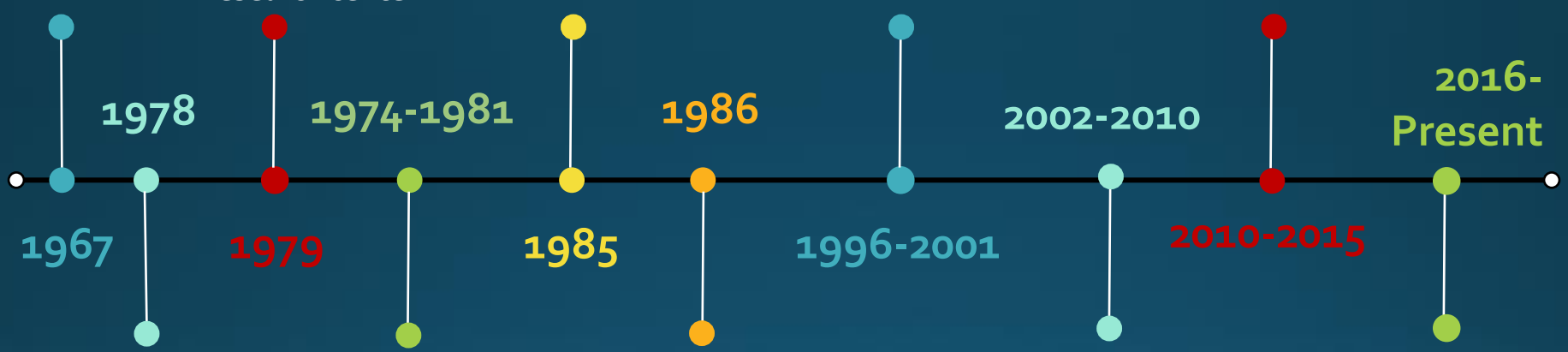
Chronic Wasting Disease

CWD Timeline



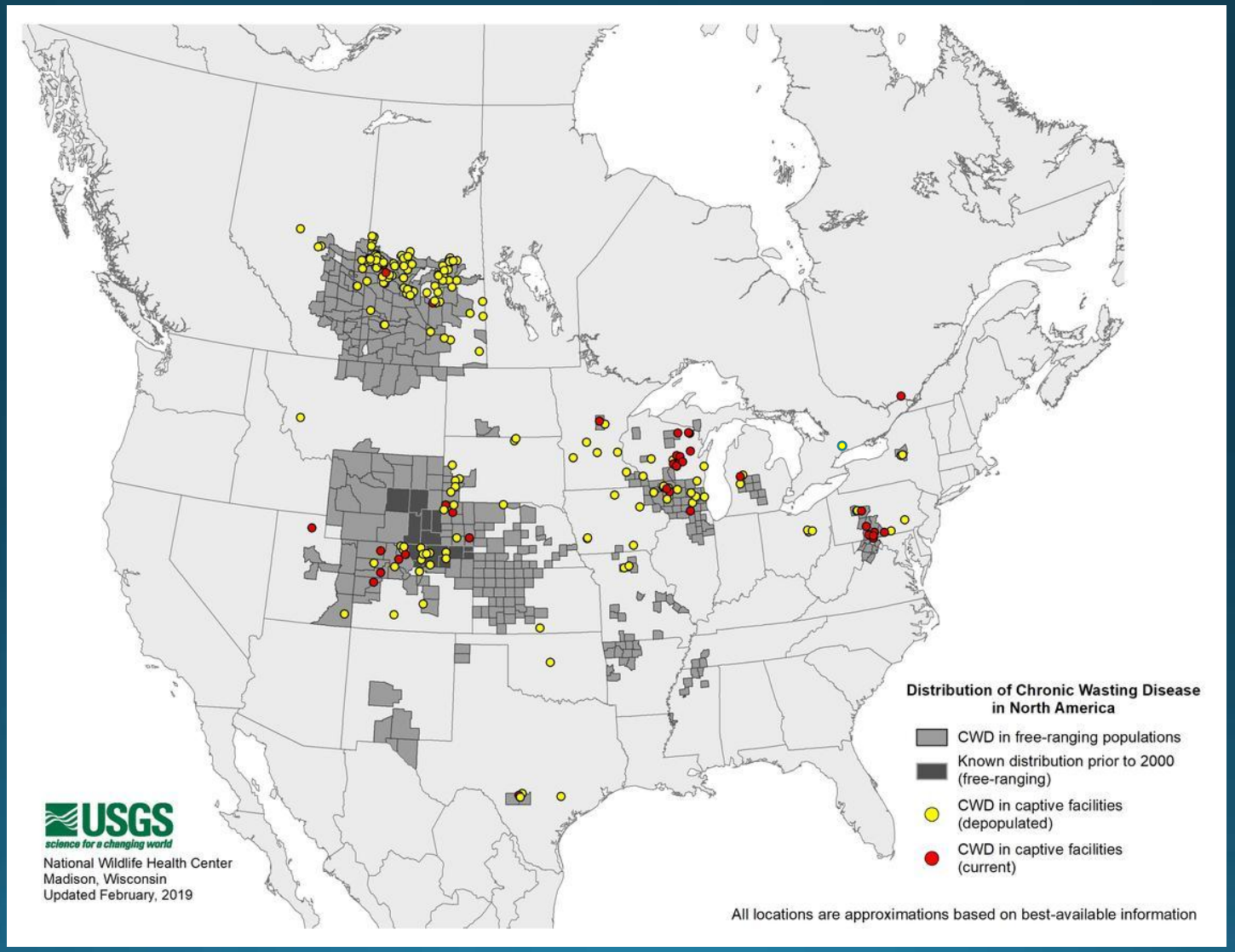
Distribution of CWD

South Korea - 2000

Norway - 2016

Finland - 2018

Sweden - 2019



Regulation concerning additional requirements for imported hay and straw for animal feed

Legal basis: Adopted by The Norwegian Ministry of Agriculture and Food 22 October 2018 on the basis of Law 19 December 2003 No 124 relating to Food Production and Food Safety (Food Act) §§ 12, 15, 17 and 19, cf. Delegation Decision 19 December 2003 No 1790.

Hay and straw from USA and Canada must also be accompanied by attestation from an official veterinarian certifying that the product was harvested in a state or province where Chronic Wasting Disease has not been detected.

§ 3 *Additional requirements*

Hay and straw for feed that is imported to Norway must:

a) be accompanied by a declaration from the producer that the product has been stored for two months in the country of origin and that it was harvested from farms where manure has not been used as fertilizer for the past two years, and

b) be accompanied by attestation from an official veterinarian in the country of origin certifying that the product was harvested from farms where there are no restrictions because of contagious animal disease.

Hay and straw from USA and Canada must also be accompanied by attestation from an official veterinarian certifying that the product was harvested in a state or province where Chronic Wasting Disease has not been detected.

§ 4 *Controll and decisions*

Legislation

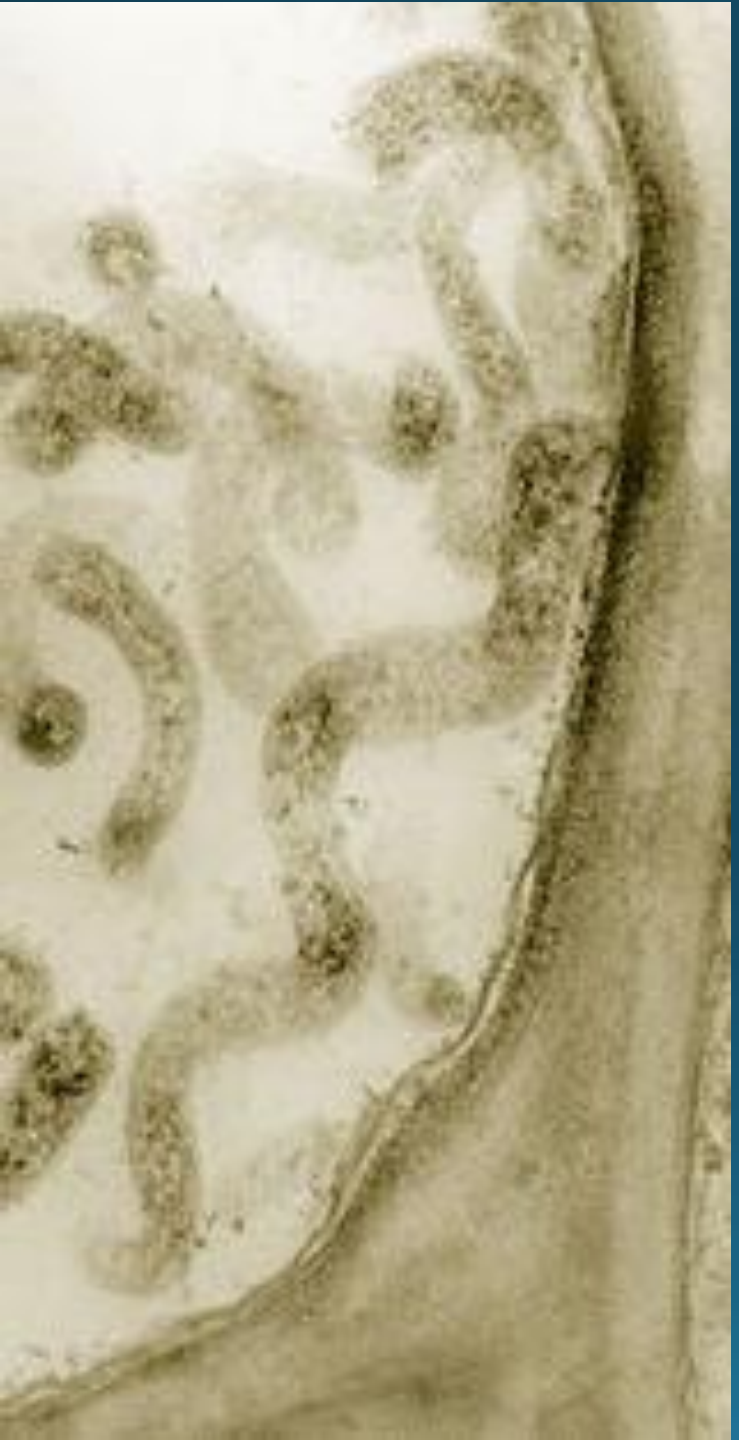
S.2252: Chronic Wasting Disease Support for States Act.

- Amend Health Protection Act – support research and efforts to develop and implement management strategies

H.R.4454: Companion to S.2252

H.R.6272: Chronic Wasting Disease Transmission in Cervidae Study Act

- To authorize NAS study to identify predominant pathways and mechanisms of CWD transmission and spread.



Spiroplasma

Research on Spiroplasma bacteria as cause of spongiform encephalopathies conducted by Dr. Bastian since 1979.

Results have not been repeated by other researchers.

Research has supported the role of prions as the primary cause of TSEs, including CWD, for over 40 years. Stanley Prusiner who discovered prions won the Nobel Prize for medicine in 1997.

Prion Theory

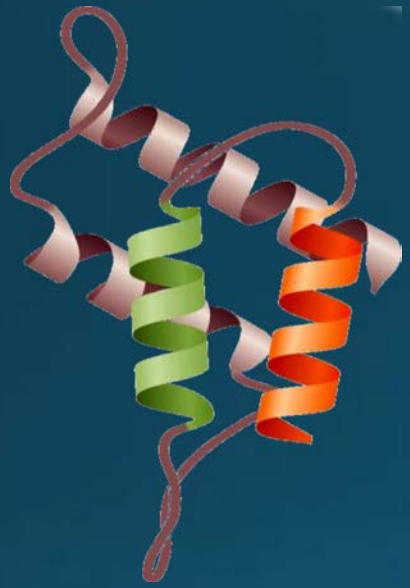
Material remains infectious after destruction of DNA/RNA

Mice lacking prion protein gene do not get disease

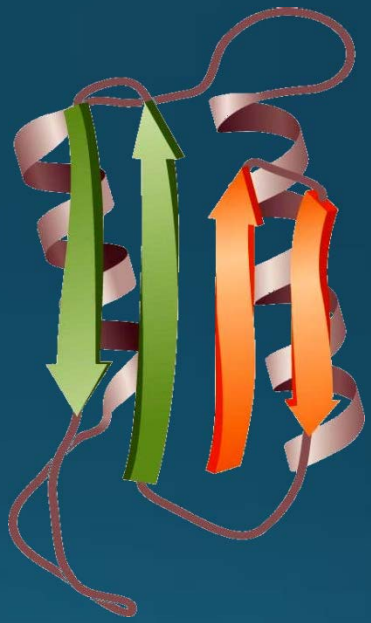
Synthetic prions have been made and they cause disease

Nutrition, Feeding, and Congregation

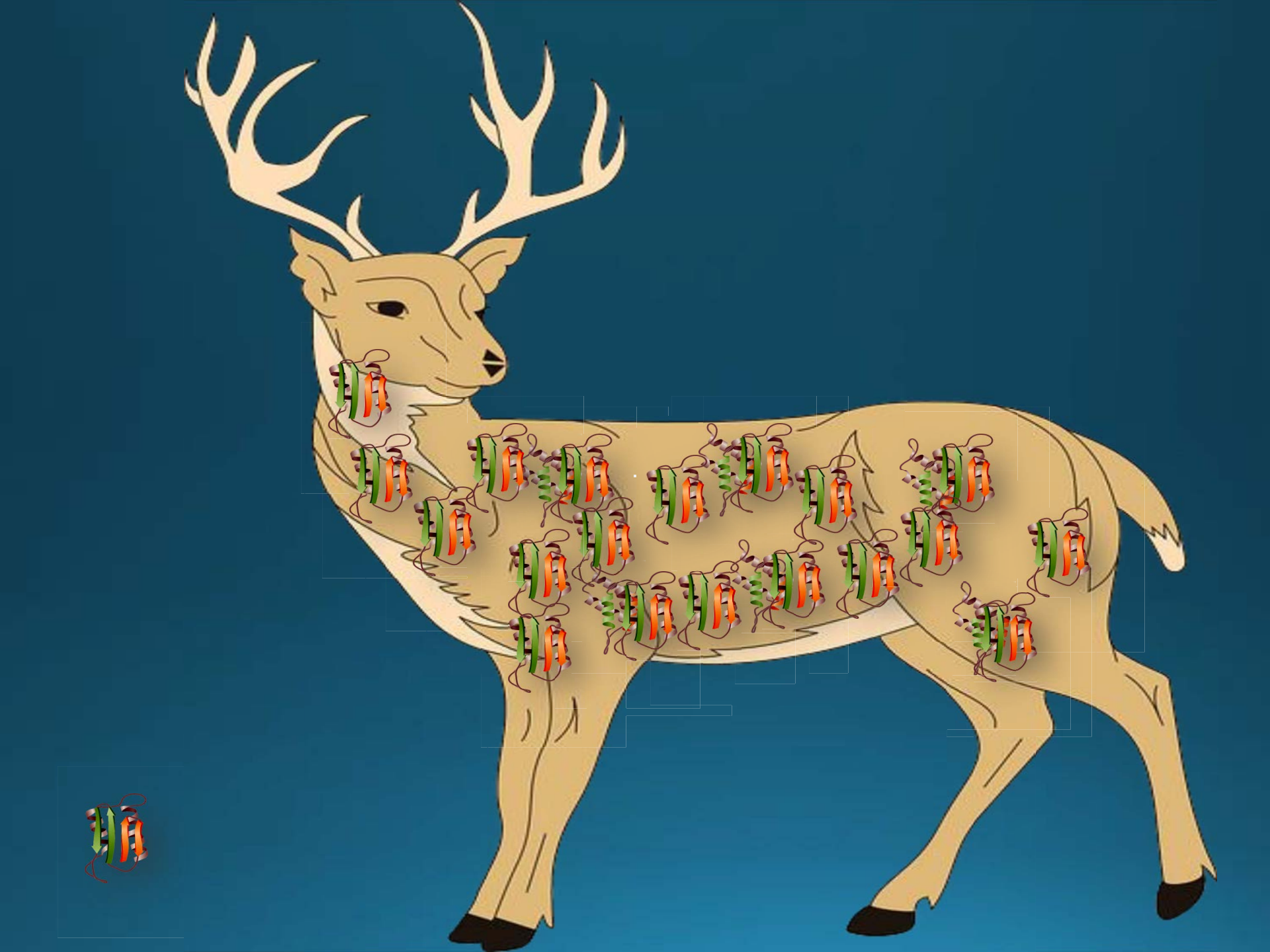
Prion Simplified



Normal Protein



Abnormal Prion Protein



True or False?

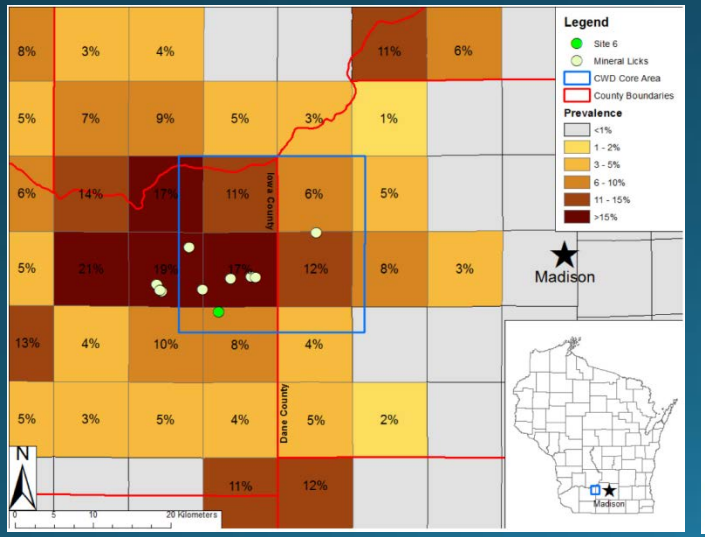
Improving the nutritional condition of cervids will boost their immune system and help them fight off CWD?

Artificial Concentration

- Increased animal-animal contact
- Increased environmental accumulation of prion
- Increased likelihood of prion exposure
- Prion exposure likely higher
- May restrict movement, alter migration and local distribution patterns

Sources of Environmental Concentration

- Mejía-Salazar, María Fernanda, et al. "Use of environmental sites by mule deer: a proxy for relative risk of chronic wasting disease exposure and transmission." *Ecosphere* 9.1 (2018): e02055.
- Plummer, Ian H., et al. "Mineral licks as environmental reservoirs of chronic wasting disease prions." *PloS one* 13.5 (2018): e0196745.



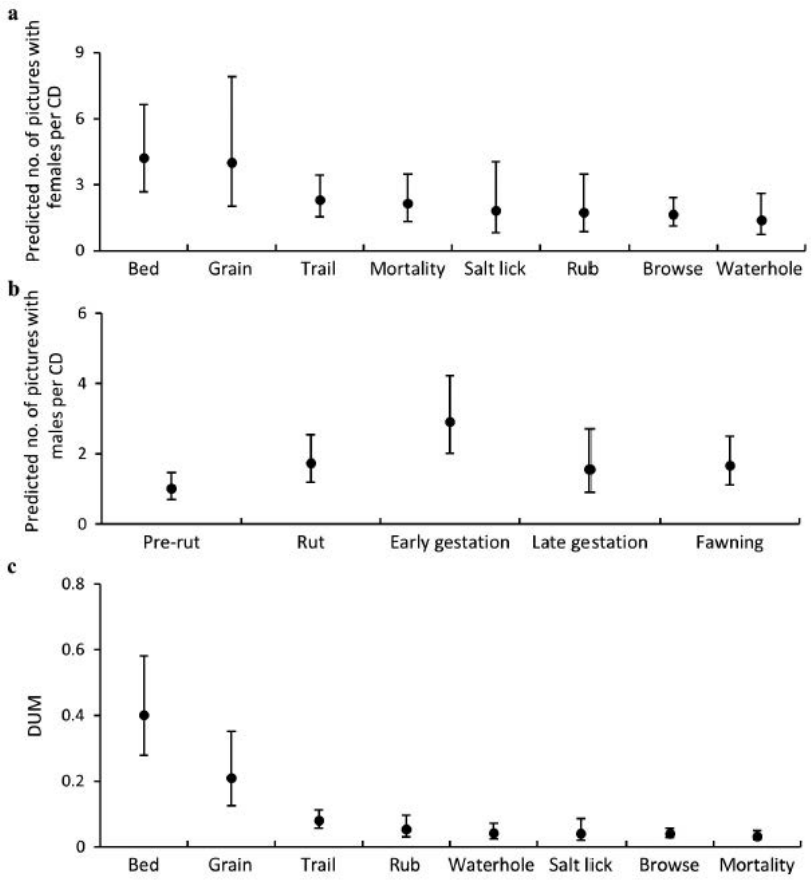


Fig. 3. Predicted number of pictures (a) with females by site type and (b) with males by season per camera-day (CD) per station, and (c) predicted intensity of visitation measured as deer-use minutes per CD. Error bars indicate 95% confidence interval.

Soils

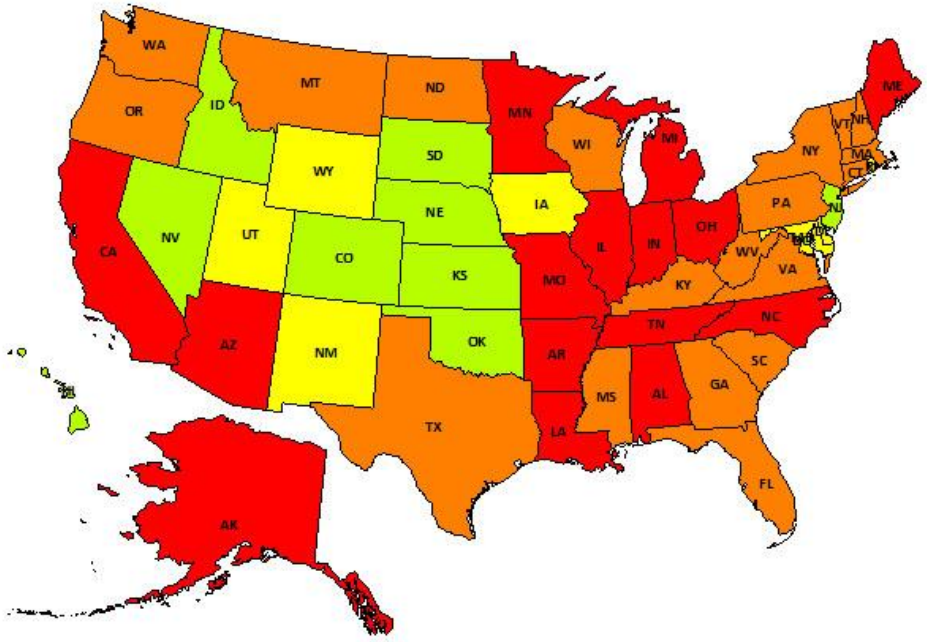
Prions bind to soil

- Clay soils

Soil binding may affect infectivity and environmental persistence

Carcass Disposal

Rules Governing Interstate Transport of High-risk Cervid Carcass Parts[1,2]



No high-risk parts, regardless of CWD status of exporting jurisdiction (15)

Import rules apply to entire CWD-positive jurisdiction, regardless of number or distribution of cases (19)

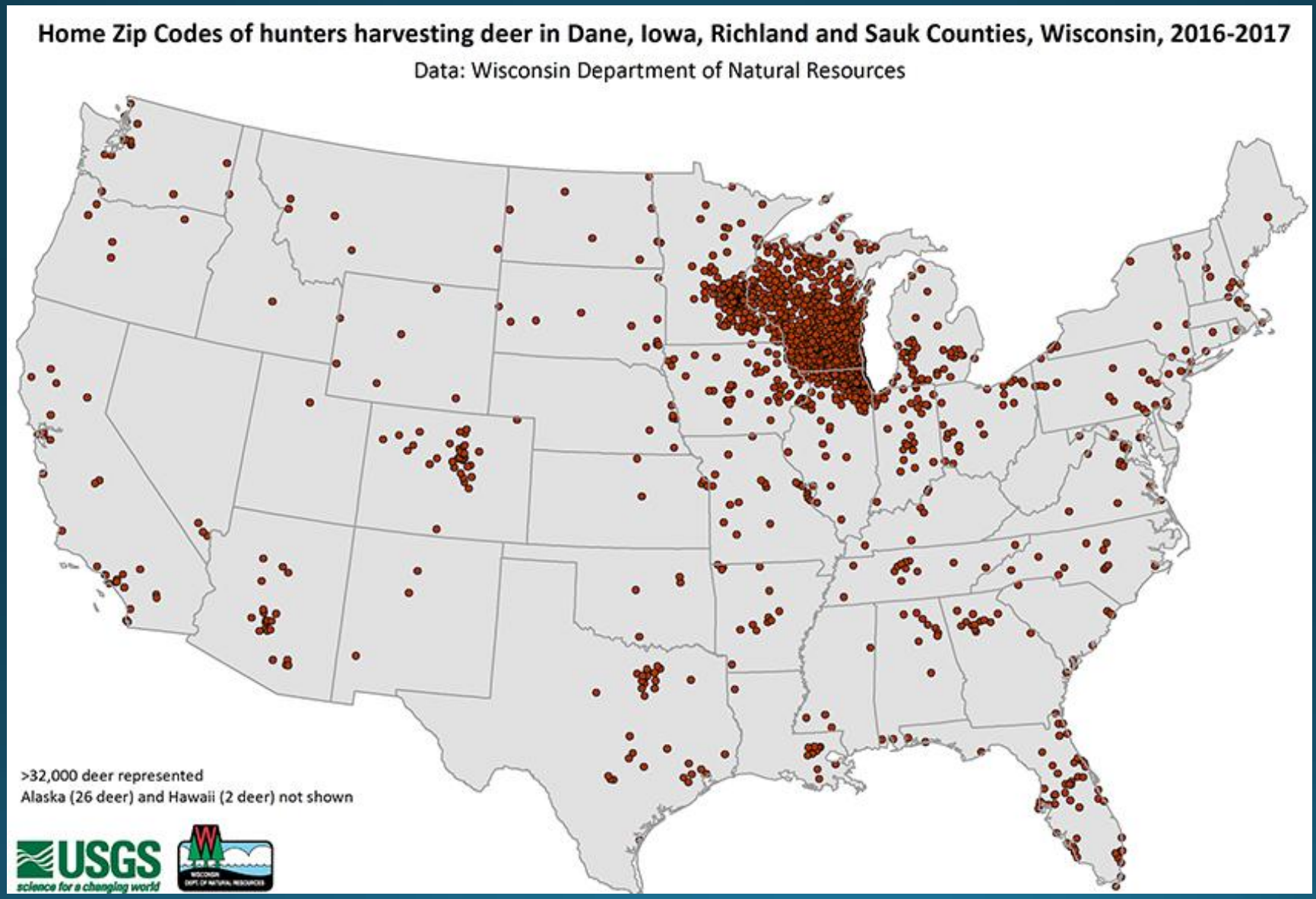
Import rules apply to positive units only, not entire jurisdiction (7)

No rules restricting importation of high-risk cervid parts (9)

[1]High risk carcass parts may include one or more of the following: head (brain, tonsils, eyes, lymph nodes), spinal cord, spleen, skull plate with attached antlers if visible brain or spinal cord is present, cape if visible brain or spinal cord is present, upper canine teeth if root structure or other soft material is present, any object or article containing visible brain or spinal cord material or brain-tanned hide.

[2]Consult state's website for complete rule details. Intended as a summary of **general** rules only.

Revision Date: 7/24/2018


Home Zip Codes of hunters harvesting deer in Dane, Iowa, Richland and Sauk Counties, Wisconsin, 2016-2017
Data: Wisconsin Department of Natural Resources
>32,000 deer represented
Alaska (26 deer) and Hawaii (2 deer) not shown
USGS
science for a changing world

Recommended Methods of Carcass Disposal

Incineration in an Environmental Protection Agency-approved conventional incinerator, air curtain incinerator, or cement kiln.

High-pressure alkaline hydrolysis followed by burial of the treated material in an active, licensed landfill.

Composting – significantly reduce prion, but not eliminate. Can follow by incineration, alkaline hydrolysis or landfill.

Approved Landfill.

Carcass Disposal via Landfill

Properly licensed and operated landfills offer one of the most economically feasible options for disposal of carcasses and parts, particularly in high volumes.

While disposal via landfill may not eliminate infectious prion, carcass parts disposed of in a landfill would be inaccessible to cervids and may functionally contain the CWD prion (Jacobson et al., 2009).

It is important that carcasses are properly covered after disposal in a landfill to prevent scavenging.

Jacobson, K. H., S. Lee, D. McKenzie, C. H. Benson, and J. A. Pedersen. 2009. Transport of the pathogenic prion protein through landfill materials. Environmental science & technology, 43(6), 2022–2028.

Incineration/Hydrolysis in Practice

	Incinerator-5000 Lb.	Alkaline Hydrolysis-4000 Lb	
	Therm-Tec	Bio-Response	Gyver Industries
Machine Cost/Unit	$300,000	$212,500	$1,350,000
Building Contraction Cost	$240,000	$240,000	$240,000
Gas Line	$30,000	$30,000	$30,000
Sewage Line	N/A	$30,000	$30,000
Pressurized	N/A	$15,000	$15,000
Total Capital Cost	**$570,000**	**$527,500**	**$1.665,000**
Rate ($/ton)	$500	$300	$380
Low-High Tons/Year	60-180	60-180	60-180
Operational Cost/Year	**$30,000-$90,000**	**$18,000-$54,000**	**$22,800-$68,400**

Dent, D.; Hayashida, P.; Joyce, R.; Kirkpatrick, S. An Analysis of Carcass Disposal Methods for Teton County Integrated Solid Waste & RecyclingPage. University of Wyoming.

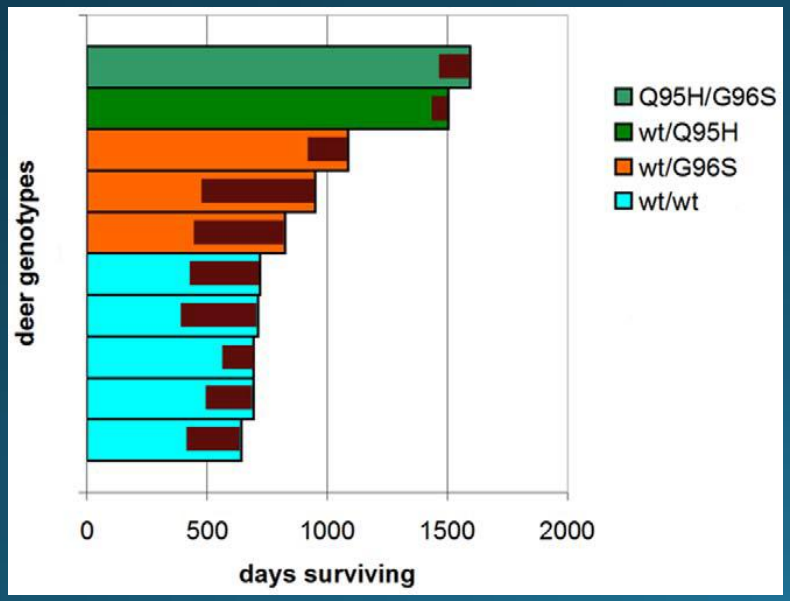
Genetics and CWD

- Genetics can influence the length of time animals survive in the face of CWD
- No true resistance identified

Deer

White-tailed Deer:

- Codon 96 G/S (G less)
- Codon 95 H/Q (Q less)
- Codon 116 A/G (G less)

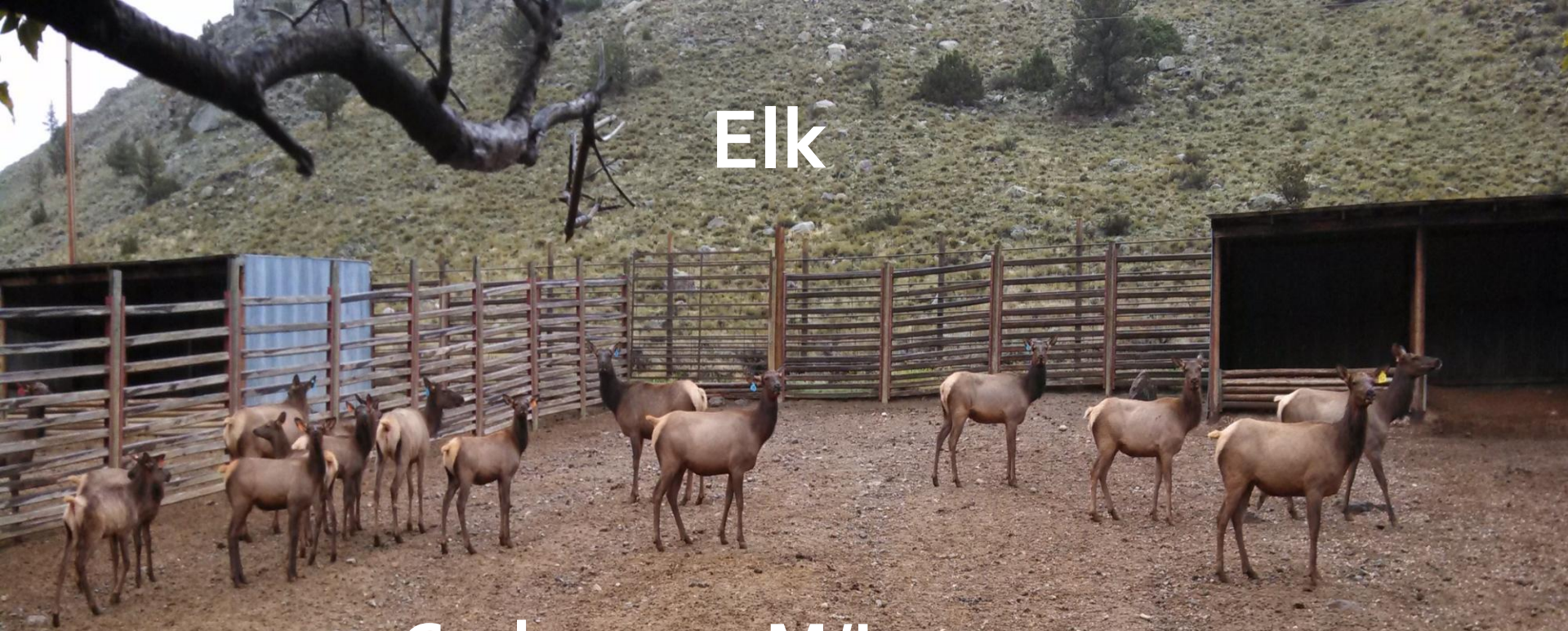


Johnson, Chad J., et al. "Prion protein polymorphisms affect chronic wasting disease progression." PLoS One 6.3 (2011): e17450.

Mule Deer:

- Codon 225 S/F (S less)
  - SS: ~1.9 years
  - F: ~2.1 years?
  - FF: ~2.5-4.9 years (Does not stain with IHC – ELISA preferred)
- Codon 20 G/D (D less; Canada only)

Elk



Codon 132 M/L

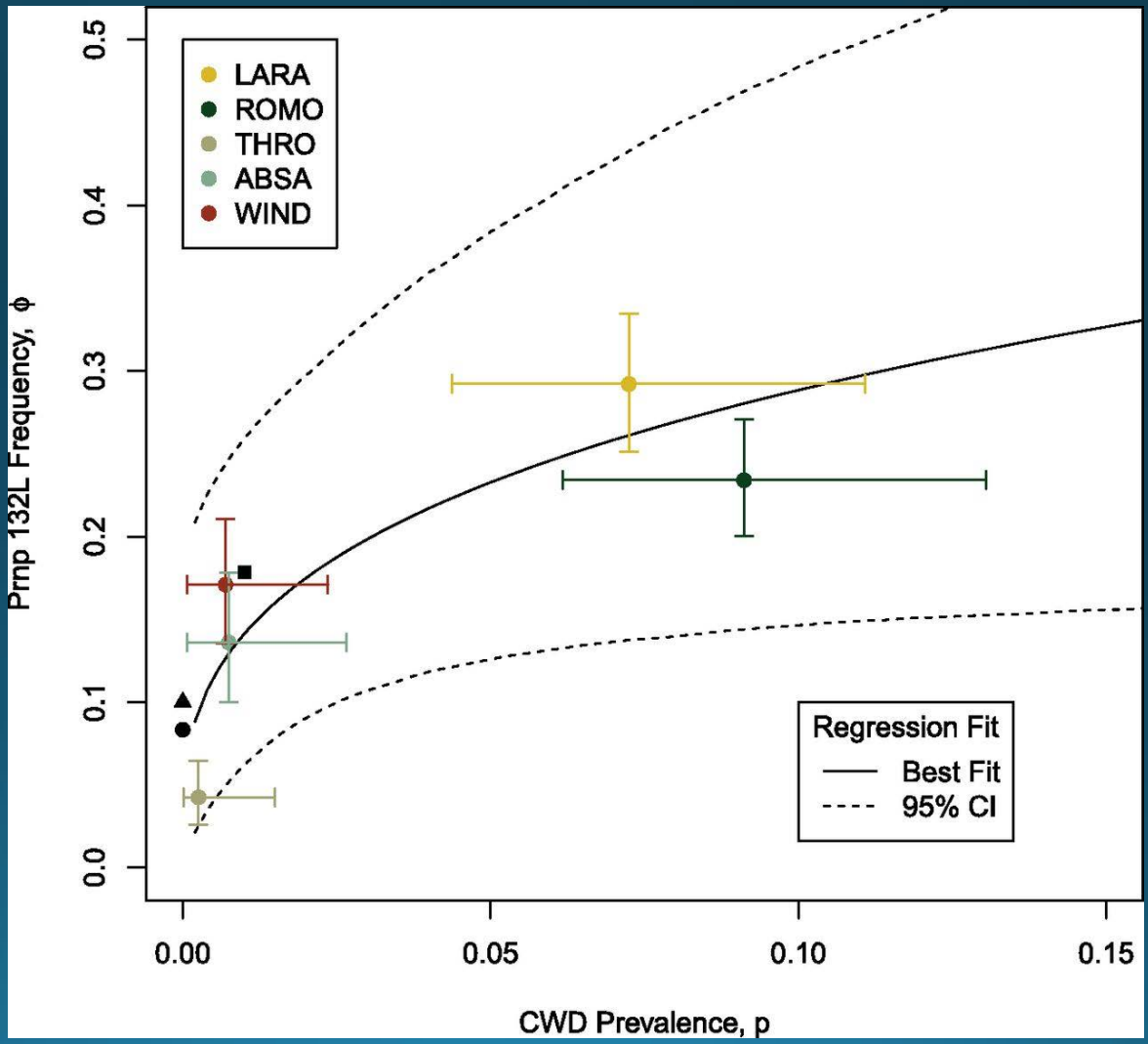
Elk Genotype	Survival
MM	2-7 years
ML	4-9 years
LL	7-?? years

Genetic Shift

South Converse:

- 2001-2003: 2% F allele
- 2010-2014: 22% F allele
- Population underwent significant decline
- Models suggest declines despite genetic shift

Laramie Peak Elk



Prion Strains

Multiple strains of CWD identified

-Different conformations or aggregation states

Emergence of new strains could lead to adaptability to new hosts or hosts with different genetics

Prion Strains: Lessons from Scrapie

Worldwide – ranked 3rd highest cause of sheep and goat losses

Classical Scrapie

first identified in 1700s

- Codons 136,154,171

Atypical Scrapie

first identified in Norway in 1998

Table 2.1 Ovine five group risk classification system

Risk group	Genotype	Susceptibility
1	ARR/ARR	Highest genetic resistance
2	ARR/AHQ	Genetic resistance
	ARR/ARH	
	ARR/ARQ	
3	AHQ/AHQ	Low genetic resistance
	AHQ/ARH	
	AHQ/ARQ	
	ARH/ARH	
	ARH/ARQ	
	ARQ/ARQ	
4	ARR/VRQ	Genetic susceptibility
5	AHQ/VRQ	Highest genetic susceptibility
	ARH/VRQ	
	ARQ/VRQ	
	VRQ/VRQ	

Live Animal Testing

Tonsil biopsy

- May miss very early cases
- Animal must be fully sedated
- Equipment expensive (>$300)
- Concerns over ability to clean equipment
- Concerns over oral lesions leading to enhanced transmission

Rectal biopsy

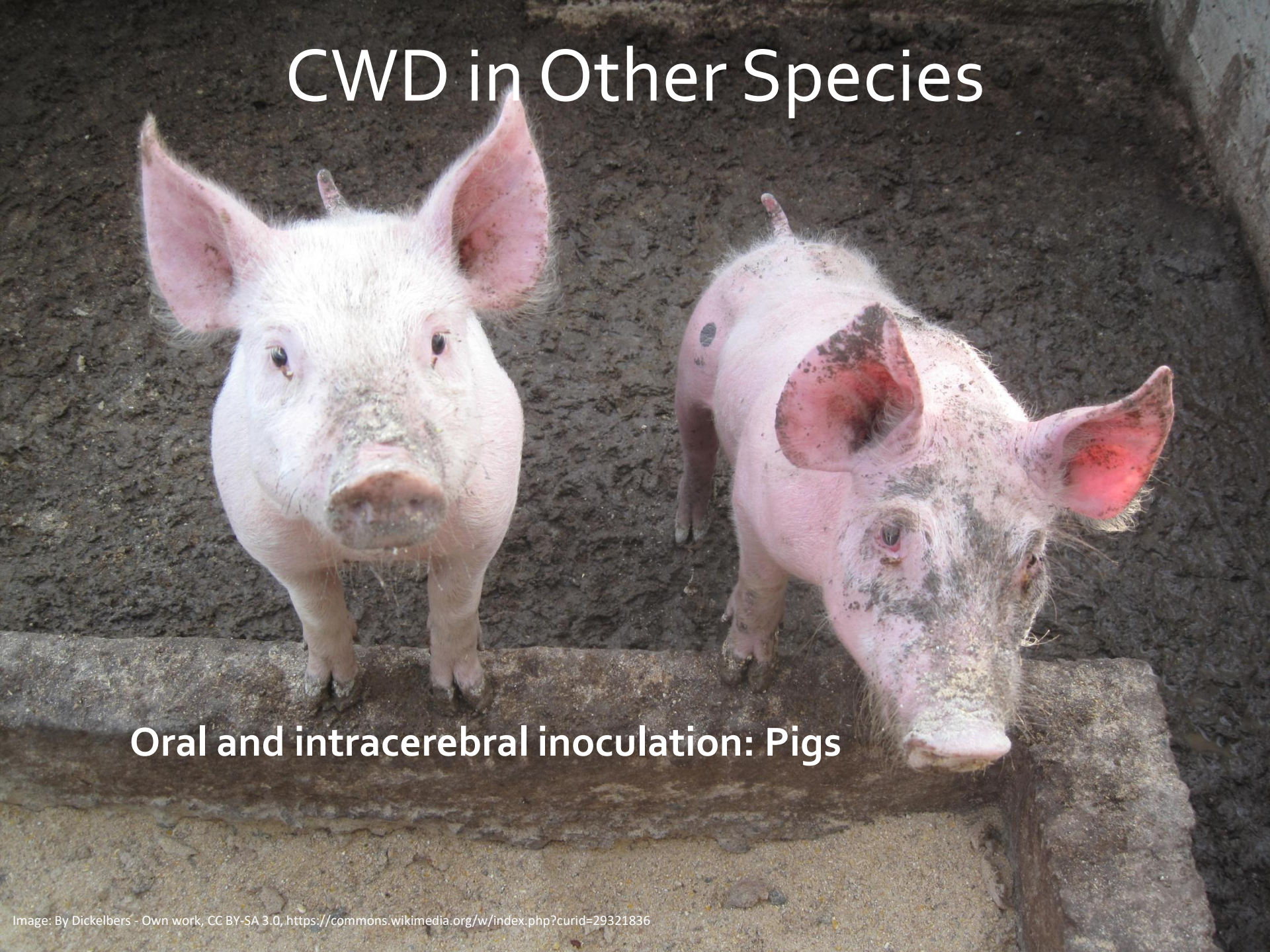
- Will miss early cases
- Sedation unnecessary (but some sedation preferred)
- Variable sensitivity based on skill of sampler, age of animal
- Cheap, disposable tools

CWD in Other Species

Intra-cerebral inoculation: cattle and sheep

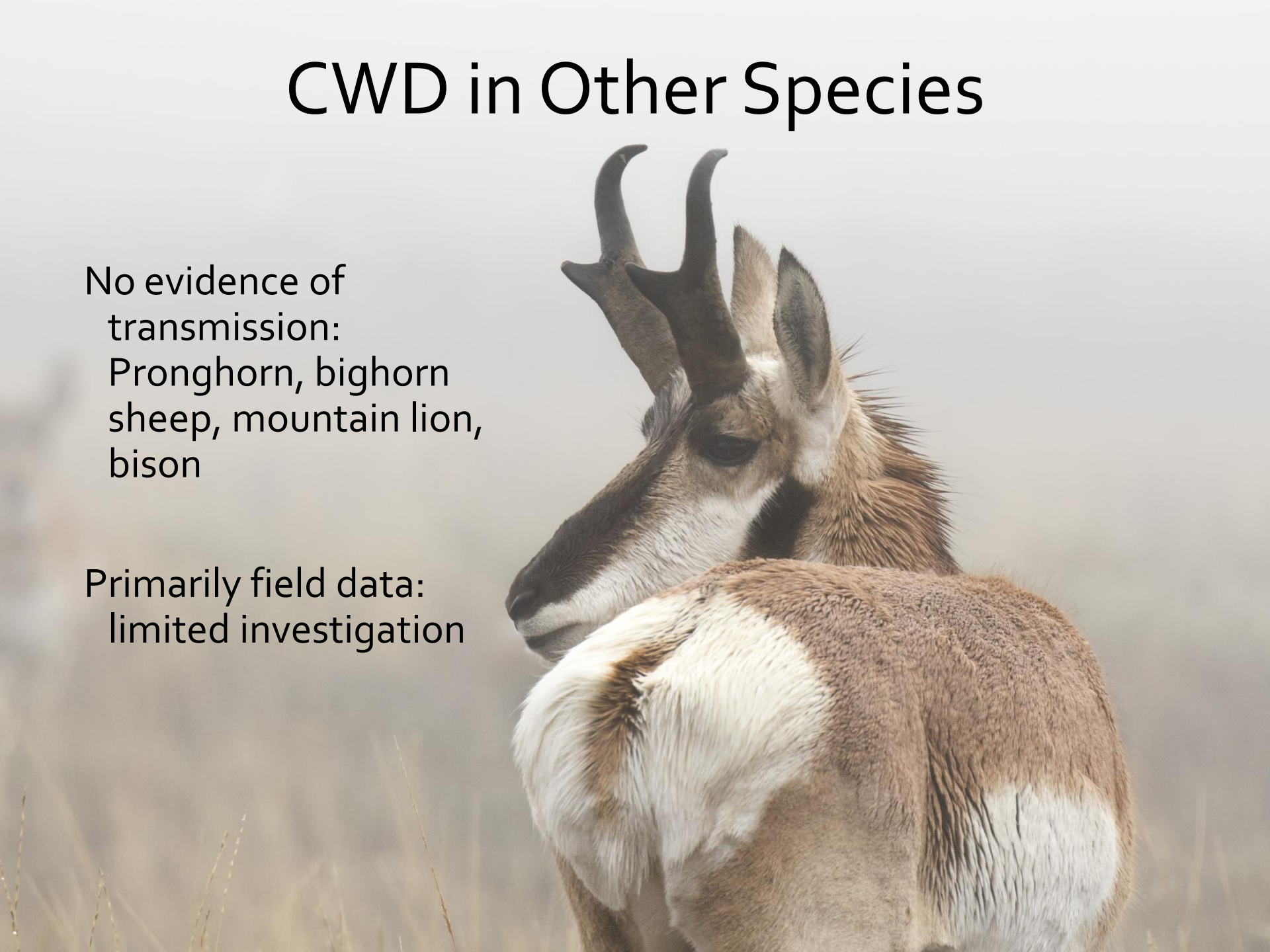
No evidence of disease with oral inoculation or prolonged commingling

CWD in Other Species



Oral and intracerebral inoculation: Pigs

CWD in Other Species



No evidence of transmission: Pronghorn, bighorn sheep, mountain lion, bison

Primarily field data: limited investigation

Predators and CWD

Mountain lions selectively prey on CWD infected animals.

Modeling suggests selective wolf predation may decrease CWD prevalence.

Prion Pass Through

Coyotes:

- CWD detected in feces ~ 3 days
- No evidence of CWD

Crows:

- Scrapie detected in feces ~ 4 hours
- No evidence of CWD

Mule Deer

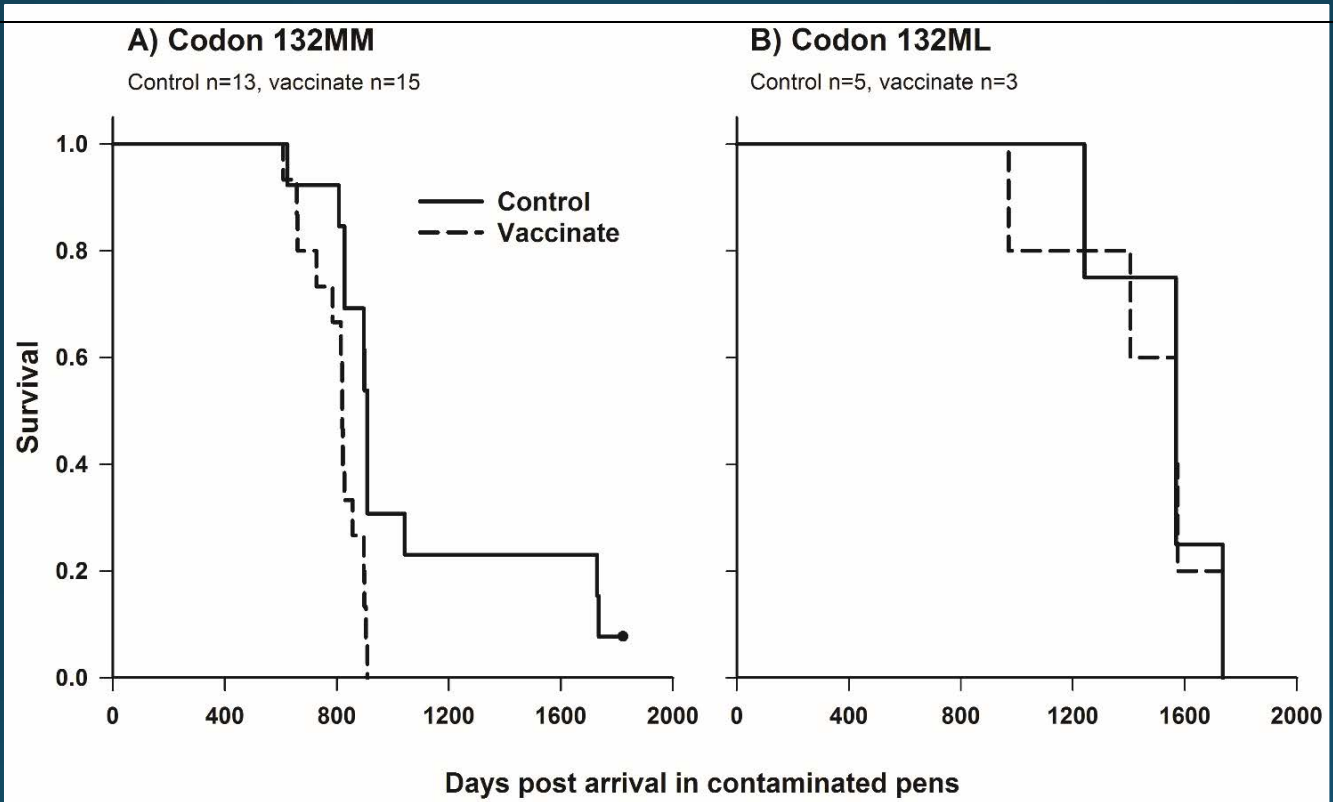
- CWD detected in feces ~ 8-11 months

Why Not Create a Vaccine?

Vaccines

- Challenge in targeting only the abnormal prion while sparing the normal protein
- Multiple vaccine attempts, none fully successful
- One vaccine may have delayed disease onset (small sample size n=5)

WGFD Vaccine Trial

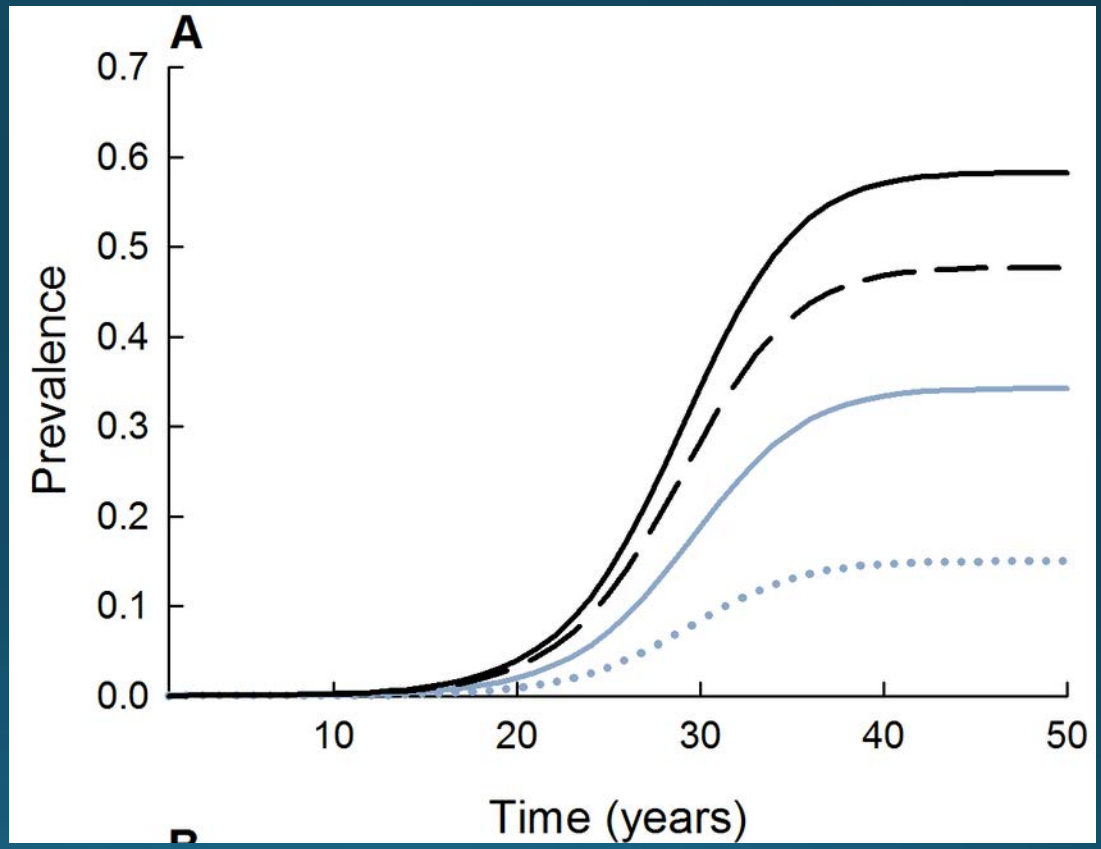


Group	Mean Survival (Days)	Range Survival (Days)	95% Confidence
Vaccinates	800	608-909	751-848
Controls	1083	623-1974+	849-1317

Vertical Transmission

Nalls, Amy V., et al. "Mother to offspring transmission of chronic wasting disease in reeves' muntjac deer." *PloS one*8.8 (2013): e71844.

Selariu, Anca, et al. "In utero transmission and tissue distribution of chronic wasting disease-associated prions in free-ranging Rocky Mountain elk." *The Journal of general virology* 96.Pt 11 (2015): 3444.



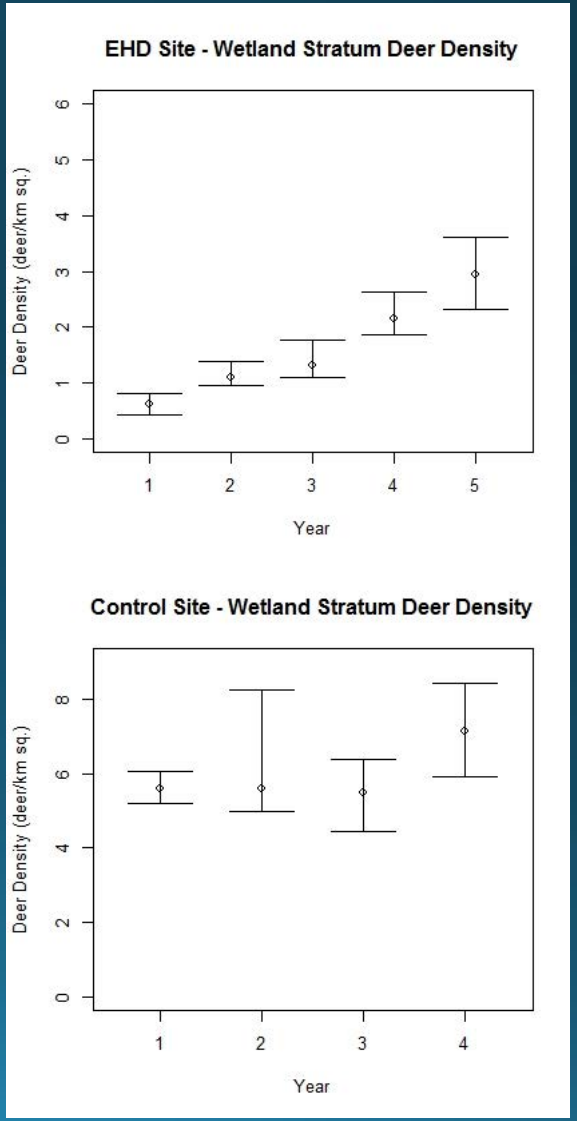
Predicted CWD prevalence for fawns (dotted), male yearlings (dashed), female adults (solid blue), and male adults (solid black) using transmission estimates from the best supported sex-specific frequency-dependent model. This scenario represents a no-harvest strategy, initiating CWD in a deer population with initial density of ≈9 deer km−2 with density-dependent fecundity as a population regulation mechanism (K≈77 deer km−2). *Figure: Jennelle, Christopher S., et al. "Transmission of chronic wasting disease in Wisconsin white-tailed deer: implications for disease spread and management." PLoS One 9.3 (2014): e91043.*

Epizootic Hemorrhagic Disease and Bluetongue

- Viral diseases in ungulates
- Transmitted by biting flies (gnats, midges)
- Outbreaks in summer and fall
- Most common in white-tailed deer
- Also seen in mule deer, pronghorn, bighorn sheep, elk, bison
- Can result in large-scale die-offs

EHD and Bluetongue

- Found throughout the state, but especially Eastern/Northeastern WY (<7,200 ft)
- Cyclic in nature with periodic large-scale die-offs that can significantly reduce populations.
- Once frost occurs, vectors die and mortality ends
- Populations typically rebound within 2-5 years



Current WGFD Research Efforts

Multi-state conservation grant project: Population management and CWD outcomes

Statewide mule-deer genetics

Population studies: Bates Hole, Sheep Mountain, Upper Powder River

Captive – Timing of CWD shedding in elk

Questions?