

# Chronic Wasting Disease



## Review of Disease Transmission and Control

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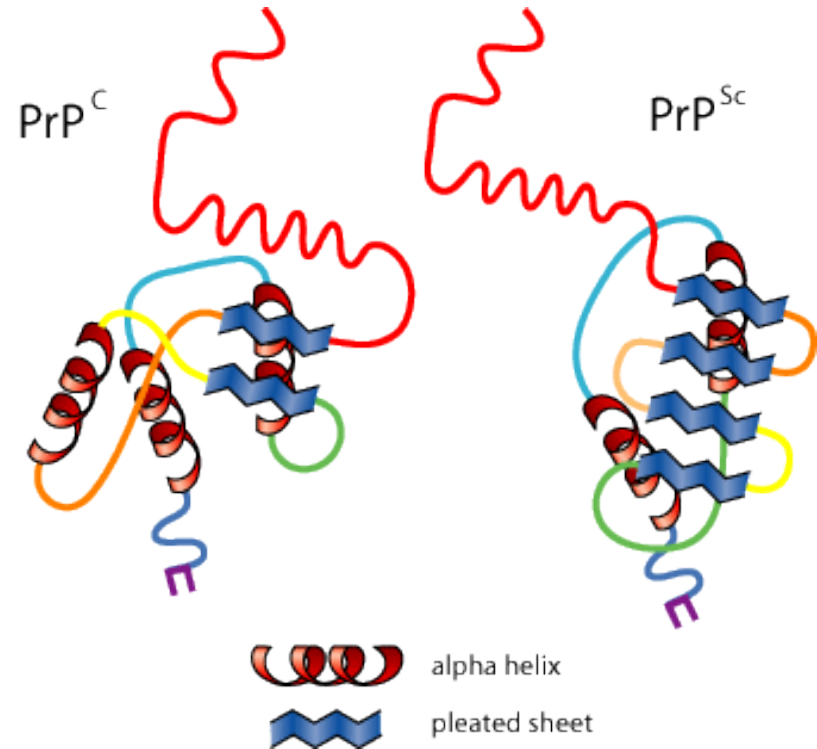
# Chronic Wasting Disease

- Transmissible Spongiform Encephalopathy (TSE) includes scrapie, BSE, MSE, FSE, and CJD/vCJD
- Etiology: Abnormal prion protein ( $\text{PrP}^{\text{cwd/res}}$ ) induces conformational changes in other normal prions ( $\text{PrP}^{\text{c}}$ ) over a long incubation period (years).
- Characteristics:
  - $\text{PrP}^{\text{c}}$  sensitive to proteolytic digestion
  - $\text{PrP}^{\text{cwd/res}}$  resistant to proteolytic digestion ( $\uparrow$   $\beta$ -sheets)



# Normal Function of Prion Protein

- Antioxidant
- Metal transporter
- Cell adhesion molecule
- Signal transducer
- Neuron support
- Memory function

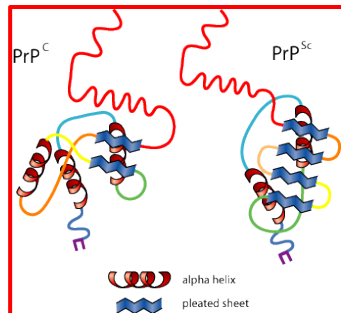


# Protein Misfolding and Neurodegeneration

## PrP<sup>C</sup>

- “The normal protein”
- Glycoprotein at the cell surface and inserted in the plasma membrane
- Secondary structure dominated by **alpha helices**
- Easily soluble
- Easily digested by proteases
- Encoded by a gene designated

## PRNP

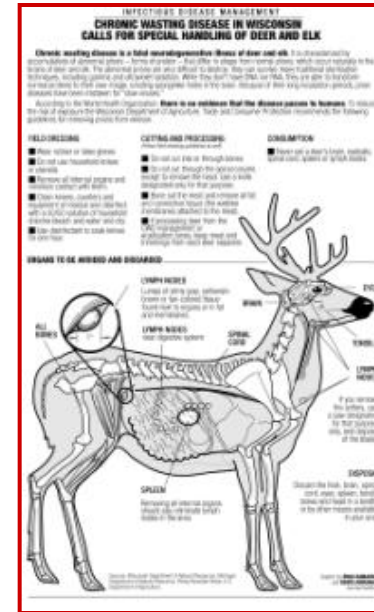


## PrP<sup>CWD</sup>

- “The abnormal, disease-producing protein”
- Same A.A. sequence as the normal protein. Primary structures identical
- Secondary structure dominated by **beta conformation (pleated sheets)**
- Insoluble in all but the strongest solvents
- Highly resistant to digestion by proteases
- PrP<sup>CWD</sup> converts the PrP<sup>C</sup> into more of itself upon contact, and binds together forming aggregates (Prusiner,2001)
- Not known if aggregates are the cause of the cell damage or are simply a side effect of the underlying disease process
- Histopath - senile plaques, neurofibrillary tangles, Lewy bodies, intracellular inclusions, and spongiform degeneration

# Chronic Wasting Disease

- First reports/observations of CWD
  - Captive mule deer (CO research facility) – 1967
  - Free-ranging elk, mule/WTD deer (CO, WY) – 1981
  - Farmed elk (SD) – 1997
- Genera: *Cervus*, *Odocoileus*, *Alces*
- Clinical Signs: Behavioral changes, emaciation, weakness, ataxia, salivation, aspiration pneumonia, progressive death.
- Transmission:
  - Saliva, feces, urine
  - Environmental contamination
  - Minimum incubation period 12 mo. (expt'l 6 mo.)
  - No link to human disease thus far.



# Goals for CWD HCP Program

[http://www.aphis.usda.gov/animal\\_health/animal\\_diseases/cwd](http://www.aphis.usda.gov/animal_health/animal_diseases/cwd)

- Establish a voluntary national CWD herd certification program for farmed deer, elk, and moose.
- Establish minimum standards for interstate movement of cervids



# FY2013 Budget Overview

- FY2012 CWD Program Budget was \$1.925 M
  - Reflects \$13.9 M reduction from FY 2011
  - Eliminated funds for: Indemnity, State /Tribal cooperative agreements (wild cervid surveillance), farmed cervid CWD testing, and CWD research.
- FY2013 - APHIS/VS “ECSR” Commodity Health Line
  - Equine, Cervid, Small Ruminants
  - Funds essential activities for surveillance & program operations with flexibility to respond to new and emerging health concerns.
  - Further budget reductions proposed. Current CR until March 2013.



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# CWD Interim Final Rule

- CWD Herd Certification Program and Interstate Movement of Farmed or Captive Deer, Elk, and Moose
- Published in the Federal Register on June 13, 2012 (Docket No.00-108-8)
- Public comment period extended until 8/13/2012
- IFR effective date was 8/13/2012
  - Part 81 delayed enforcement until 12/10/2012 (180 days after publication)
- APHIS will issue final rule after public comments have been considered.



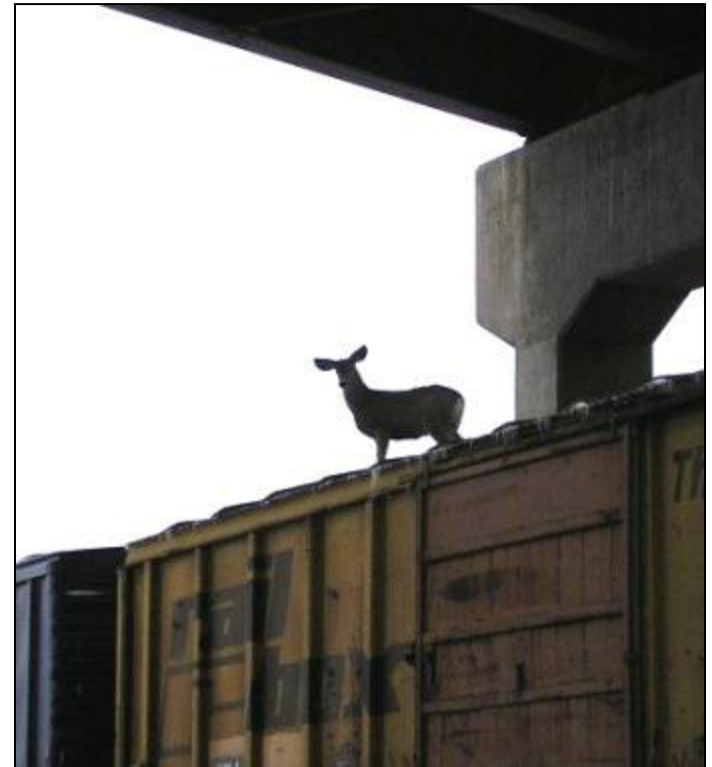
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# Federal Preemption

- Revised CWD rule does not preempt State laws except for transit of (otherwise eligible) farmed or captive cervids through states.
- Other State rules/ laws may be more stringent than federal CWD rule.



# Cervid Species Affected by Rule

- Revised federal rule only applies to the following genera known to be susceptible to CWD by natural infection:
  - *Cervus* (elk, red deer, sika deer)
  - *Odocoileus* (WTD, MD, BTD)
  - *Alces* (moose)
- States may have requirements for other cervid species.



Photo courtesy Leslie Kent- 2010

# Objectives of the CWD Rule

- Provide uniform minimum standards for state CWD herd certification programs (HCPs).
- Provide uniform minimum standards for interstate movement of CWD susceptible species.
- Provide a regulatory framework to support domestic and international markets for farmed cervids and cervid products.
- Provide consistent approach towards minimizing risk of introduction and transmission of CWD in cervid populations.



# CWD Rule Provisions

- Voluntary national herd certification program (HCP) for farmed cervids (deer and elk)
  - Fencing requirements
  - Animal ID and herd inventory requirements
  - Surveillance - testing mortalities >12 months
  - Herd status – based on years of surveillance and participation in HCP
- Interstate movement minimum requirements
- *Indemnity provided based on funding availability*
  - No indemnity funds currently available



# CWD Program Standards

- Annual review by representatives of the cervid industry and State/Federal agencies; FR notice to inform stakeholders of any revisions. **CWD Working Group review in process.**
- Part A – Herd Certification Program
  - Assist State agencies in maintaining CWD-certified herds
  - Provide guidance on procedures to certify herds as low risk for CWD by remaining in compliance with requirements in 9 CFR 55.
  - Provide guidance on complying with minimum requirements for interstate movement in 9 CFR 81.
- Part B – Guidance on Response to CWD-affected herds
  - Provides suggested best management practices that may be used by State and herd owner to manage CWD-affected herds.

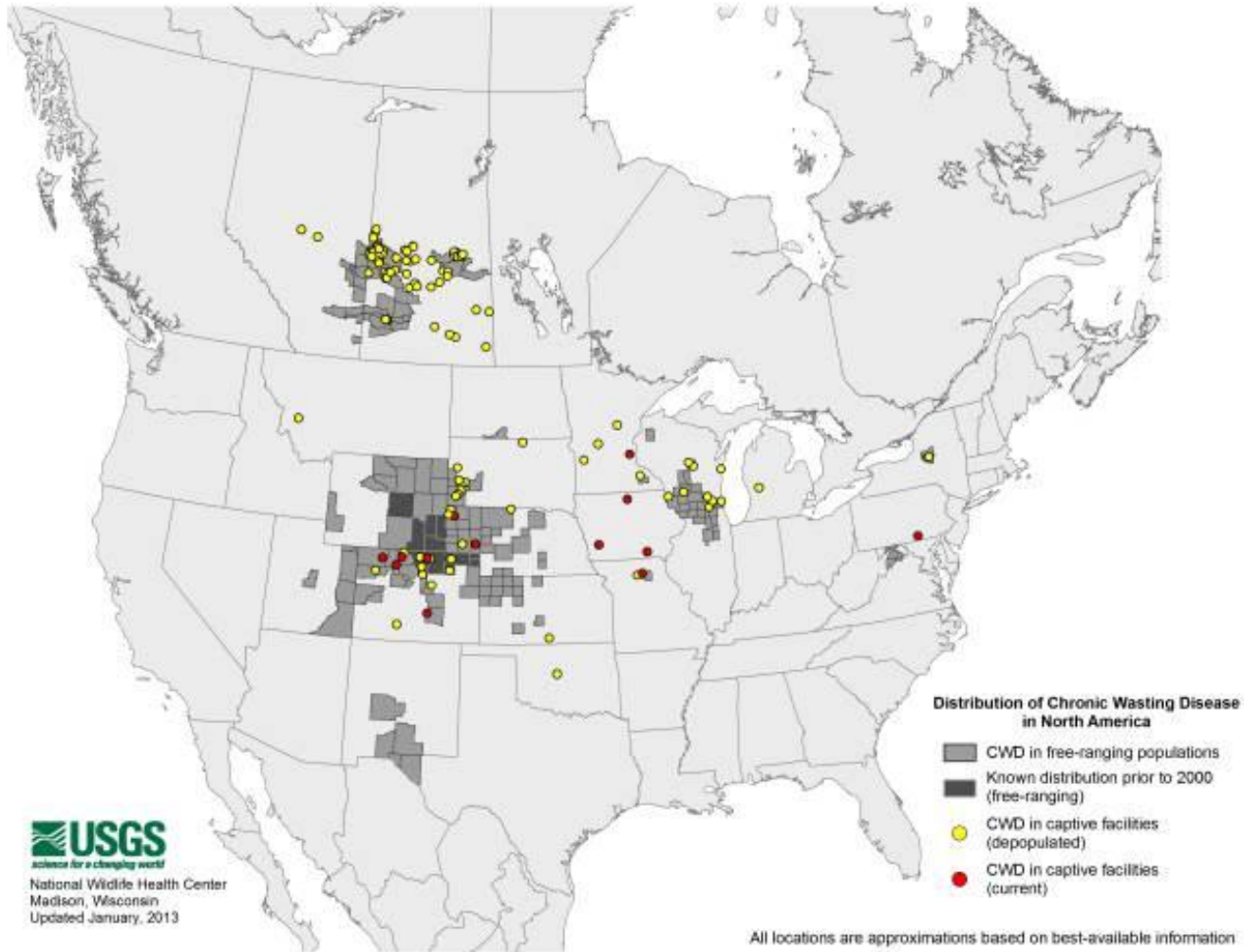


# Current CWD Status 2013

- **Wild cervids:** CWD has been detected in **17** states: CO, IL, KS, MD, MN, MO, ND, NE, NY, NM, SD, TX, UT, VA, WI, WV, WY
- **Farmed cervid herds:** CWD has been detected in **60** farmed cervid herds (40 elk herds, 19 WTD herds, 1 red deer herd) in **13** states: CO, KS, IA, MI, MN, MO, MT, NE, NY, OK, PA, SD, WI
- In 2012: farmed red deer (MN); farmed elk (CO); farmed WTD (IA, PA) wild WTD (KS, MO, WI); wild mule deer (TX)
- 14 positive farmed herds remain
  - 7 Elk herds (CO); 3 Elk herds (NE)
  - 1 Red deer herd (MN)
  - 1 WTD herds (IA), *hunt facility was depopulated*
  - 1 WTD herd (PA) *was depopulated*



# Chronic Wasting Disease



**USGS**  
*science for a changing world*  
 National Wildlife Health Center  
 Madison, Wisconsin  
 Updated January, 2013

All locations are approximations based on best-available information

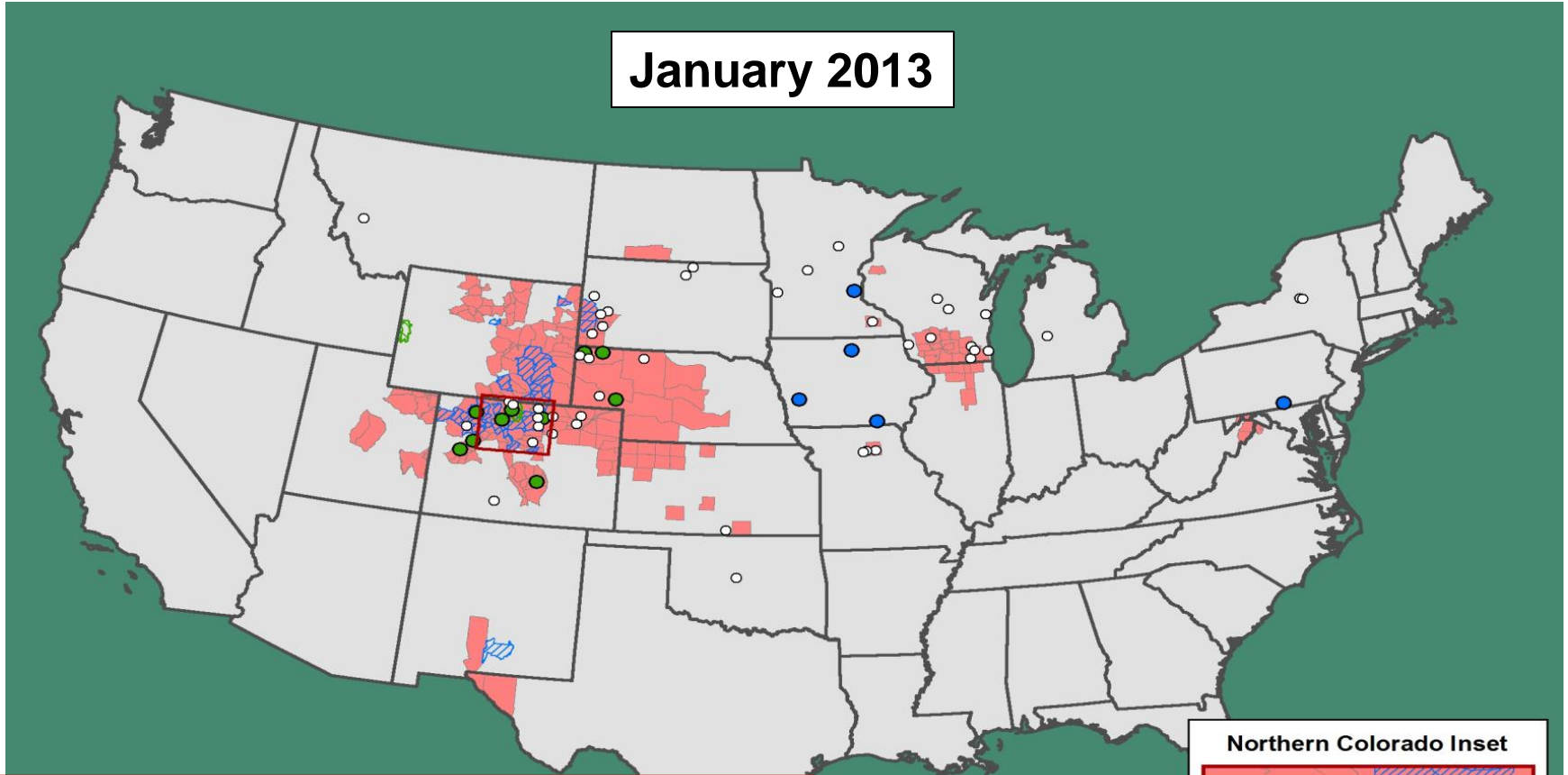


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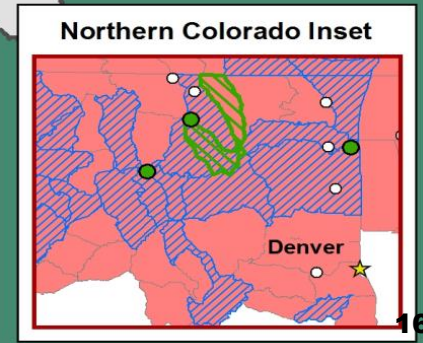


# CWD Positive Farmed Cervid Herds and Wildlife

January 2013



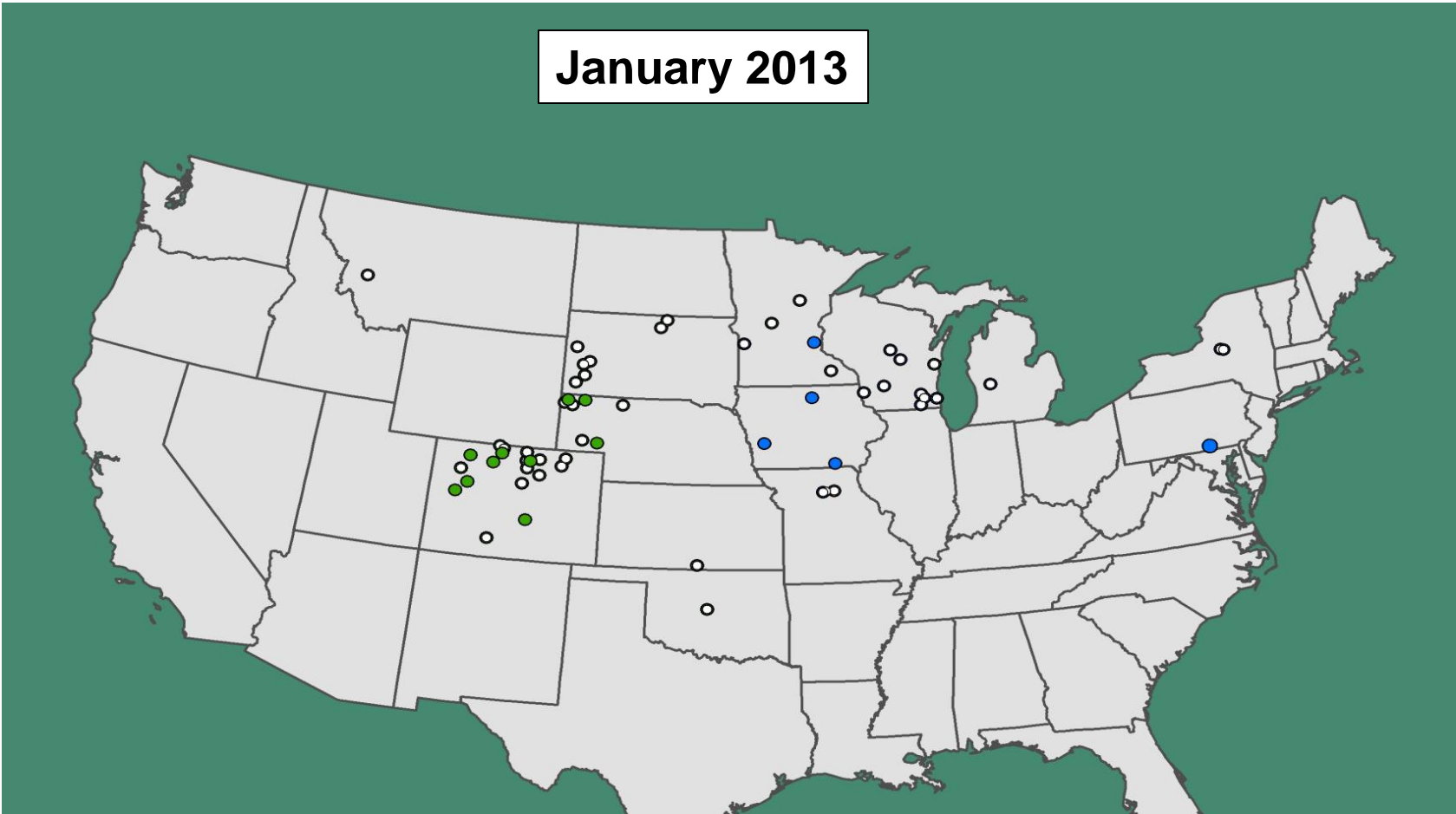
- Positive Captive Elk Herds
- Positive Captive WTD or Red Deer Herds
- Depopulated Positive Captive Cervid Herds
- Game Management Units with Positive Deer
- ▨ Game Management Units with Positive Elk
- ▨ Game Management Units with Positive Moose





# Remaining CWD Positive Captive Cervid Herds

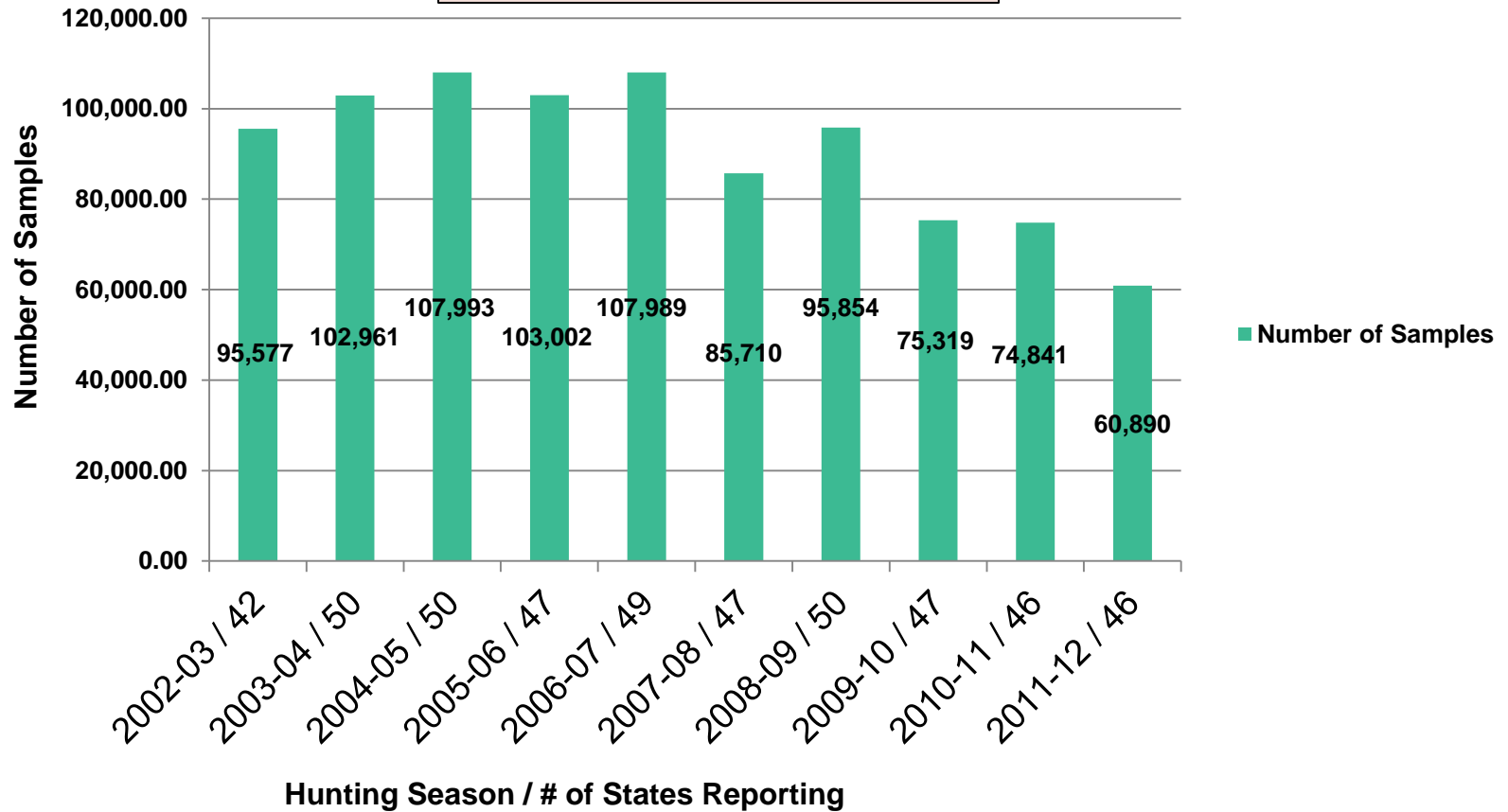
January 2013



- Positive Captive Elk Herds
- Positive Captive WTD or Red Deer Herds
- Depopulated Captive Cervid Herds

# CWD Surveillance in Wild Cervids

September 2012

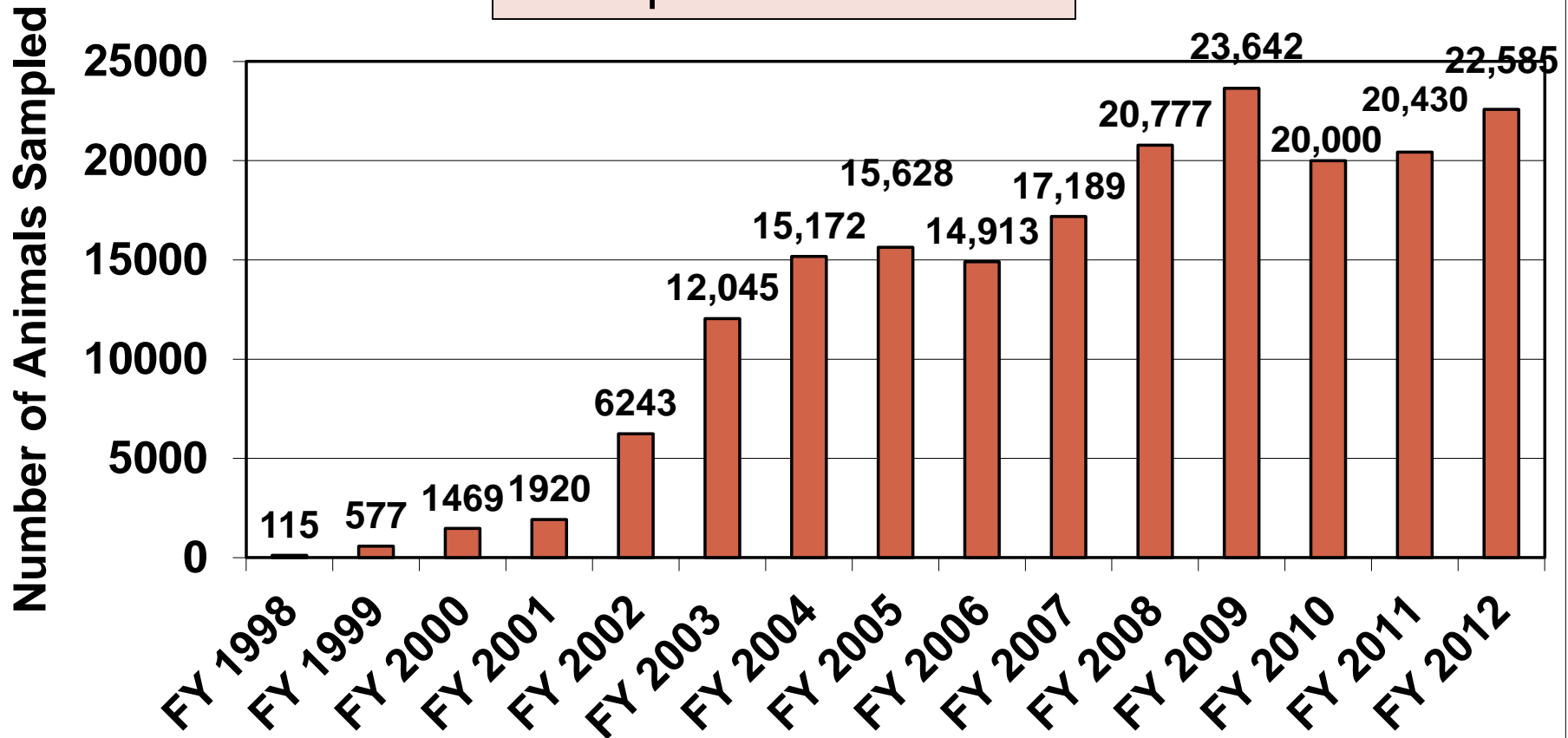


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# Surveillance in Farmed Deer and Elk

September 2012

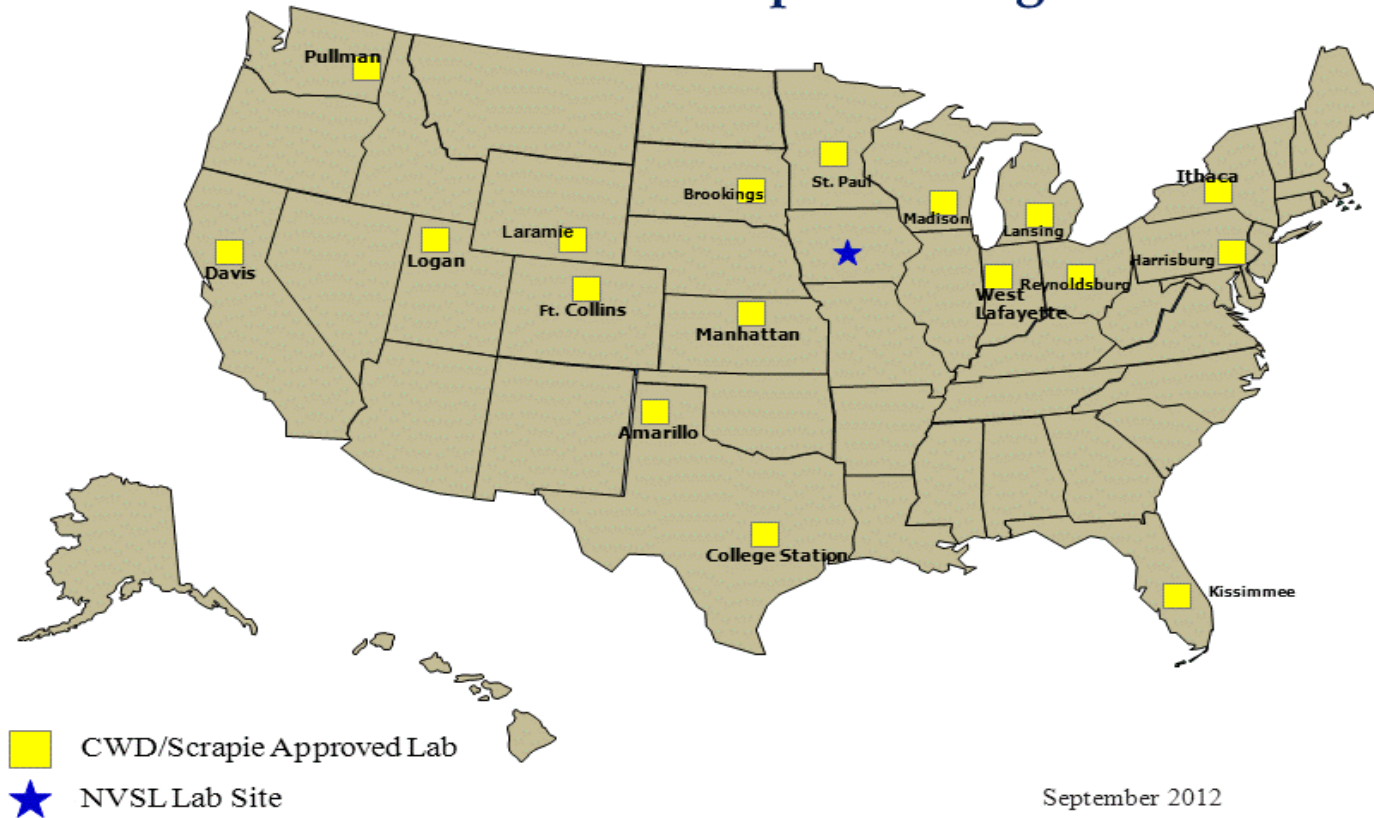


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# USDA Approved Laboratories for CWD

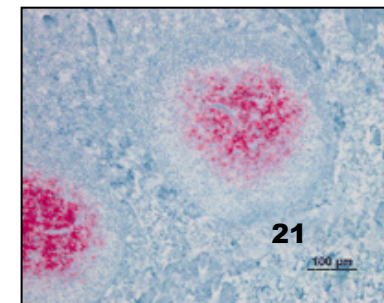
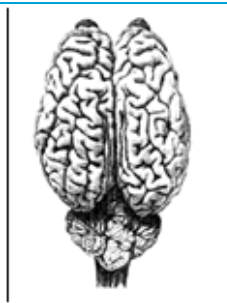
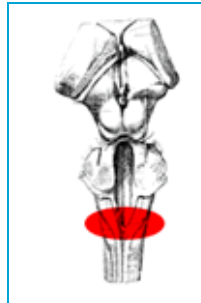
## Laboratories Approved to Conduct CWD and Scrapie Testing



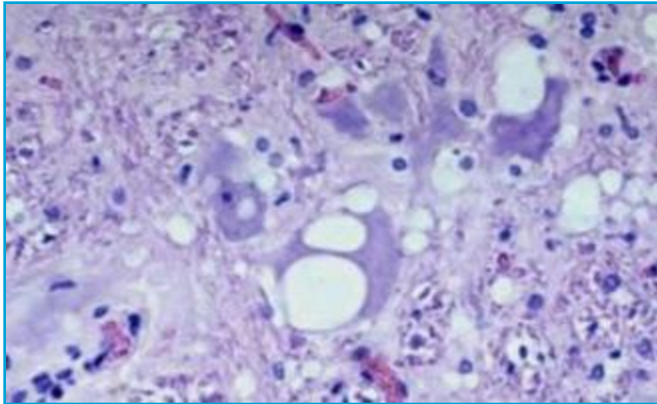
**September 2012**

# CWD Diagnostic Updates

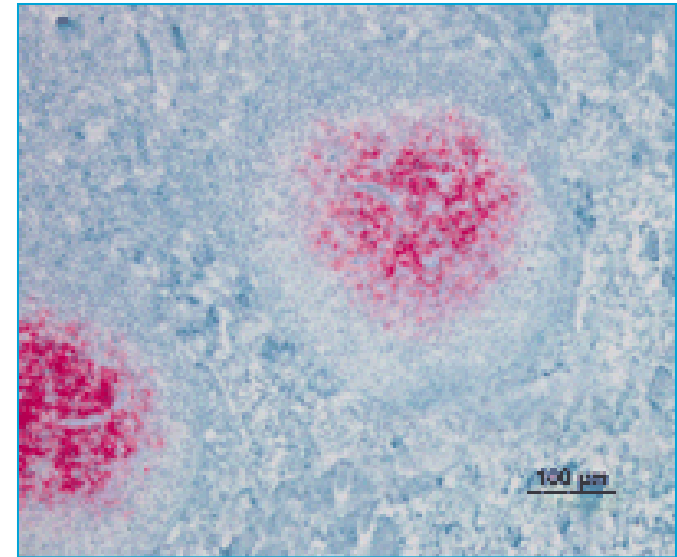
- CWD HCP Official Tests
  - Immunohistochemistry (IHC)
  - Histopathology and Western Blot
- Pending approval as Official Test
  - Rapid ELISA (Medial RPLN, Obex)
- Live animal test – (experimental)
  - RAMALT (rectal biopsy) - WTD (*Thomsen, et.al 2012*)
  - RAMALT – RMNP Elk (*Monello, Wild, et.al 2013*)



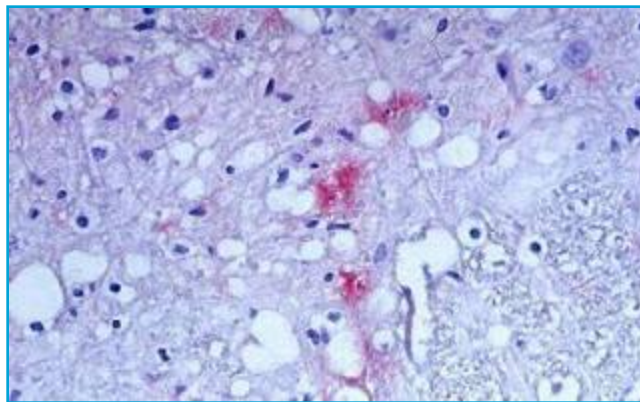
# CWD Diagnosis



Vacuolation in brain tissue



IHC Staining in rectal mucosa



IHC staining prions in brain

**CNS (obex region), RPLN,  
tonsil, *rectal mucosa*\***

# CWD and Cervid Genetic “Resistance”

- Elk (and Red Deer)
  - **Homozygous LL - codon 132** - allele encoding leucine
  - Experimental protracted subclinical period >50 months
  - MM and ML have much shorter incubation periods
- White tailed Deer
  - PRNP polymorphisms at **codon 96** cause delay in clinical onset and disease progression (*PLoS One*, 2011)
- Fallow deer – experimental ‘natural exposure’ to CWD did **not** produce disease in over 7 years
- CWD susceptibility/resistance in other cervids???



# Research Updates

- Detection methods – PMCA, RT-QUIC
- Vaccination – Expt'l studies (U. Saskatchewan)
- CWD experimental transmission studies (IC, oral)
  - Cattle – no evidence of disease
  - Sheep (QQ suffolk) – similar presentation to scrapie
  - Fallow deer – Brain lesions (IC route); None (oral route)
  - Red deer - MM genotype – similar to CWD in elk
  - Reindeer – CWD (oral) – clinical disease by 2 years + pathology
- Scrapie transmission studies to deer (IC, oral)
- Important to consider interpretation of experimental findings to relevance to natural disease events





# Prion Persistence in Soils

- Binding to fomite surfaces, minerals, and soil types (sandy, quartz, clay) – (*Pederson, 2006+*)
- Unknown time duration for environmental persistence, bioavailability, or to remain infectious
  - CWD reported at least 2.2 years (*Miller, 2004*)
  - Scrapie reported 16 years (*Georgsson, 2006*)
- Detection is difficult (experimental methods)
  - Bioassays (Intra-cranial, oral inoculations)
  - PMCA (protein misfolding cyclic amplification)
  - RT-QUIC (real time - quaking-induced conversion)
- Degradation – research studies
  - Lichens (serine protease) (*Johnson, 2011*)
  - Metal oxides (manganese) (*Russo, 2009*)



# Prion Decontamination Methods

## Physical Methods

- Irradiation
- Dry Heat
- Autoclaving (sx instruments)
- **Soil removal**
- Composting (not effective)



# Prion Decontamination Methods

## Chemical Methods

- Acids and bases (1-2 M NaOH)
- Alkylating agents
  - Formaldehyde
  - Glutaraldehyde
- Detergents
- Phenols (Environ LpH™)
- Halogens (NaOCl -20,000 ppm)
- Organic solvents
- Oxidizing agents
- Minerals /Salts (MnO<sub>2</sub>)
- Proteolytic enzymes



# Disposal Options

- Freeze carcasses pending CWD test results
- After CWD test results – options:
  - Burial (on site)
  - Landfill
  - *Rendering (see FDA guidance)*
  - Incineration
  - Alkaline Hydrolysis/ “Digestion”



# Burial

## Placement of carcasses in unlined trenches or pits

- PROS

- Easy to construct
- Economic
- Large capacity

- CONS

- **No inactivation of prions**
- Ground and surface water contamination
- Human health (rotting carcasses)
- Local opposition
- Legal & regulatory constraints



# Landfill

Engineered site lined with composite (clay and plastic) liner;  
 Constructed with leachate collection & management system

- PROS

- Good capacity
- Good carcass containment
- Ground water monitoring ability
- Good pick-up network & services

- CONS

- **No inactivation of prions**
- Local opposition “NIMBY”
- Waste water treatment plant may not accept “prion” contaminated water
- Minimal leachate control



# Dedicated Rendering & Disposal

Rendering: a cooking process that produces water, fat and protein for animal consumption

## • PROS

- Good capacity
- **Some inactivation**
- Good pick-up & network services
- Good mass reduction
- Less expensive?

## • CONS

- **Potential for animal feed contamination**
- Few local renderers
- Concerns of local waste water treatment plants



**FDA Center for Veterinary Medicine guidance on rendering:**

<http://www.fda.gov/downloads/AnimalVeterinary/GuidanceComplianceEnforcement/GuidanceforIndustry/UCM052506.pdf>



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# Incineration

Disposal by carcass burning, pyres, ACD, cremation, industrial waste disposal

## • PROS

- **Some inactivation**
- Good mass reduction
- Accepted method in US & UK



Open air pyre



## • CONS

- Limited capacity
- **Regulatory constraints (Clean Air Act)**
- Generally expensive
- Concerns about airborne dispersal of prions
- No collection network

Air Curtain Destructor





# Alkaline Hydrolysis / “Digestion”

High temperature, pressure, pH for carcass breakdown

## • PROS

- **Inactivation**
- Good mass reduction
- Accepted method in US & UK

## • CONS

- **Low capacity**
- Only handles tissues
- **Generally expensive**
- High initial cost
- **By-product disposal difficult**



# Present and Future Challenges

- Sustaining wild cervid surveillance
- Prion decontamination issues
- Prion persistence in soils and the environment
- Research needs
  - Diagnostics – live animal CWD test
  - Vaccination/other preventive medicine
  - Food Safety /Public Health?
- Funding (indemnity, research, surveillance)



# Resources

- Wildlife Disease Association: [www.wda.org](http://www.wda.org)
- SE Cooperative Wildlife Disease Study
  - [www.scwds.org](http://www.scwds.org)
- CWD Alliance: [www.cwd-info.org](http://www.cwd-info.org)
- AAWV: [www.aawv.org](http://www.aawv.org)
- USFWS: [www.usfws.gov](http://www.usfws.gov)
- USGS/ National Wildlife Health Center
  - [www.nwhc.usgs.gov](http://www.nwhc.usgs.gov)
- USDA/APHIS/Veterinary Services and Wildlife Services
  - [www.aphis.usda.gov](http://www.aphis.usda.gov)
- State F&G/ DNR agencies: [www.dnr.state.md.us](http://www.dnr.state.md.us)
- CDC: [www.cdc.gov](http://www.cdc.gov)



# Questions?



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**[http://www.aphis.usda.gov/animal\\_health/animal\\_diseases/cwd/](http://www.aphis.usda.gov/animal_health/animal_diseases/cwd/)**



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