‘Zombie Deer Disease’ Affecting 24 U.S. States

‘Zombie deer’ are spreading across North America. The technical term is chronic wasting disease, and while it isn’t an immediate threat to humans, it’s something to be aware of.

Feb 21, 2019, 10:02 PM
CWD – random musings to tie it all together
- Ontario Federation of Anglers & Hunters Annual Conference

Bryan Richards
USGS National Wildlife Health Center
National Wildlife Health Center
Madison, Wisconsin

Safeguarding wildlife and ecosystem health through dynamic partnerships and exceptional science

OIE Collaborating Centre for Research, Diagnosis and Surveillance of Wildlife Pathogens
Emerging Diseases Investigated by NWHC

- **1970s**
  - Avian Botulism
  - Duck Plague
  - Lead Poisoning

- **1980s**
  - Inclusion Body Disease
  - Avian Cholera
  - Hawaiian Malaria & Pox

- **1990s**
  - West Nile Virus
  - Coral reef health
  - Amphibian Malformations
  - Chytrid fungus

- **2000**
  - Monkeypox
  - Chronic Wasting Disease

- **2010**
  - White-Nose Syndrome
  - Plague
  - Salamander Chytrid
  - Avian Influenza
  - Newcastle Disease
  - Snake Fungal Disease
“Proof” of Prion Hypothesis

- Alternative theories:
  - Slow virus (Manuelidis)
  - Spiroplasma (Bastian)
  - Copper deficiency (Brown)

- Strong evidence for prions:
  - PrP<sup>0/0</sup> (knock-out) mice immune to TSEs
  - Synthetic prions cause TSE-like disease (Prusiner)
  - Protein Misfolding Cyclic Amplification (PMCA)
    - “Amplified” prions – infectious in experimental animals

- Peer-reviewed publications:
  - Compelling argument for prion hypothesis
  - Failure to identify alternative agents

Scientific consensus

According to some researchers, Spiroplasma mirum is the causative agent of animal TSEs. However, when this organism was inoculated intracerebrally into raccoons, they did not succumb to any form of disease, and neither lesions nor abnormal prion protein of TSE was detected in the brains of these animals when necropsied at 30 months postinoculation.

- Hamir, 2011.
Transmissible spongiform encephalopathies (TSEs) are a family of diseases that have been documented in numerous mammalian species, including cattle, sheep, humans, and members of the deer family (Cervidae or cervids), among others. Decades of scientific research have been dedicated to understanding the cause and treatment of TSEs, including chronic wasting disease (CWD) of cervids. The consensus that has emerged from this research indicates that prions (misfolded proteins) are the causative agents of TSEs, including CWD.”
"However, alternate theories regarding the cause of CWD have been postulated and continue to be examined by some in the scientific community. These theories, which explore possible etiologies including viruses, bacteria, trace mineral imbalances, and others, have been advanced for many years and often are supported by peer-reviewed, scientific publications. While our understanding of CWD epidemiology can benefit from diverse research perspectives and investigations, the preponderance of scientific information currently available strongly supports prions as the causative agent of all TSEs, and this is accepted by the vast majority of scientists working in this field."

Association of Fish and Wildlife Agencies
Statement on Chronic Wasting Disease Etiology
“The Association of Fish and Wildlife Agencies (AFWA) supports the scientific consensus regarding prions as the causative agent of CWD and endorses use of the above and other available management strategies by state, federal, provincial, and territorial wildlife agencies as well as research that further elucidates the epidemiology of CWD and identifies effective management practices.”
CWD in Wisconsin – stakeholder support, misinformation

CWD down in Wisconsin

Letter: Don't over-hype impact of Chronic Wasting Disease
Feb 18, 2016

Letter to the editor: Tone down CWD talk
By Pineandlakes Echo Journal on Nov 24, 2017 at 6:30 a.m.

Letter to the Editor - Deer farming not the reason for CWD
Oct 20, 2017

Dr. Don Davis: Don’t fear CWD deer
Expanding on that thought ….

- Change the conversation
- Simple and effective
- Sow seeds of doubt
- Practiced by multiple constituency groups, multiple important scientific issues
- Stakeholder support is mandatory;
  - challenging to obtain/sustain support when there is “doubt”
Cumulative Distribution of Chronic Wasting Disease (CWD) Detections in Southern and Central Wisconsin 2001 - 2018

Data: Wisconsin Department of Natural Resources
Mapping: USGS National Wildlife Health Center
Background

- Three CWD-positive, hunter-killed deer were detected in western Dane County, Wisconsin, pursuant to the 2001 hunting season.
Background

- Three CWD-positive, hunter-killed deer were detected in western Dane County, Wisconsin, pursuant to the 2001 hunting season.

- In response, the Wisconsin Department of Natural Resources (DNR) sampled over 40,000 deer in 2002, establishing a baseline for the geographic footprint of CWD at that time.
Background

- Over 228,000 CWD samples have been collected by the Wisconsin DNR since 2001
Background

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- By the end of the 2018 sampling season, over 5200 CWD-positive deer had been detected in 26 Wisconsin counties
Background

- Over 228,000 CWD samples have been collected by the Wisconsin DNR since 2001.
- By the end of the 2018 sampling season, over 5200 CWD-positive deer had been detected in 26 Wisconsin counties.
- This data set, the largest of its kind, has been instrumental for studying the progression of CWD in Wisconsin.
The Changing Distribution of CWD

- The following series of slides portrays the changing geographic distribution of CWD in Wisconsin since its initial detection in 2001, through the end of the 2018 surveillance season.
2001 Positive Samples

Statewide:
Samples: 1092
Positive: 3

Data: Wisconsin Department of Natural Resources
2002 Cumulative

Statewide:
Samples: 40,351
Positive: 205

Data: Wisconsin Department of Natural Resources
2003 Cumulative

Statewide:
Samples: 15,210
Positive:  117

Data: Wisconsin Department of Natural Resources
2004 Cumulative

Statewide:
Samples: 19,221
Positive: 145

Data: Wisconsin Department of Natural Resources
2005 Cumulative

Statewide:
Samples: 24,972
Positive: 181

Data: Wisconsin Department of Natural Resources
2006 Cumulative

Statewide:
Samples: 30,453
Positive: 205

Data: Wisconsin Department of Natural Resources
2007 Cumulative

Statewide:
Samples: 9338
Positive: 135

Data: Wisconsin Department of Natural Resources
2008 Cumulative

Statewide:
Samples: 12,346
Positive:  181

Data: Wisconsin Department of Natural Resources
2009 Cumulative

Statewide:
Samples: 7278
Positive: 179

Data: Wisconsin Department of Natural Resources
2011 Cumulative

Statewide:
Samples: 5321
Positive: 239

Data: Wisconsin Department of Natural Resources
* Washburn County Positive (2011)
2012 Cumulative

Statewide:
Samples: 6636
Positive: 339

Data: Wisconsin Department of Natural Resources
2013 Cumulative

Statewide:
Samples: 6725
Positive: 357

Data: Wisconsin Department of Natural Resources
2014 Cumulative

Statewide:
Samples: 5489
Positive:  331

Data: Wisconsin Department of Natural Resources
2015 Cumulative

Statewide:
Samples: 3158
Positive: 299

Data: Wisconsin Department of Natural Resources
2016 Cumulative

Statewide:
Samples: 6158
Positive: 448

Data: Wisconsin Department of Natural Resources
2017 Cumulative

Statewide:
Samples: 9909
Positive: 600

Data: Wisconsin Department of Natural Resources
* Lincoln, Oneida Counties Positive (2017)
2018 Cumulative

Statewide:
Samples: 17,106
Positive: 1050

Data: Wisconsin Department of Natural Resources
Positive CWD samples per year, Wisconsin

Data: Wisconsin Department of Natural Resources
Is it serious?
Why care about CWD?

- Data from several sources suggest that heavily-infected cervid populations will not thrive in the long-term.
- Data on CWD prions and experience with other animal prion diseases suggest minimizing human exposure to these agents is prudent.

Miller & Fischer, 2016
Why care?

With respect to deer:

- Geographic spread
- Increasing prevalence (locally)
- Demonstrated population impacts
Why care?

- With respect to deer:
  - Geographic spread
Known Distribution of Chronic Wasting Disease (CWD) in North America

2000 – 2018

Based on best-available data provided by States, Provinces, USDA & CFIA
Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2002

Legend

- Free-ranging
- Commercial captive
- Existing
- 2002 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2003

Legend
- Free-ranging
  - Existing
  - 2003 detection

- Commercial captive
  - Existing
  - 2003 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2004

Legend

Free-ranging
- Existing
- 2004 detection

Commercial captive
- Existing
- 2004 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2005

Legend
Free-ranging
- Existing
- 2005 detection
Commercial captive
- Existing
- 2005 detection

Based on best-available data provided by States, Provinces, USDA & CFIA

National Wildlife Health Center
CWD Distribution - 2006

Legend

Free-ranging
- Existing
- 2006 detection

Commercial captive
- Existing
- 2006 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2007

Legend
- Free-ranging
- Commercial captive
  - Existing
  - 2007 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2008

Legend

Free-ranging

- Existing
- 2008 detection

Commercial captive

- Existing
- 2008 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2009

Legend

Free-ranging
- Existing
- 2009 detection

Commercial captive
- Existing
- 2009 detection

Based on best-available data provided by States, Provinces, USDA & CFIA.
CWD Distribution - 2013

Legend
- Free-ranging
- Commercial captive
- Existing
- 2013 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2015

Legend

Free-ranging
- Existing
- 2015 detection

Commercial captive
- Existing
- 2015 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2016

Legend
- Free-ranging
- Existing
- 2016 detection
- Commercial captive
  - Existing
  - 2016 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
CWD Distribution - 2018

Legend
- Free-ranging
- Commercial captive
  - Existing
  - 2018 detection

Based on best-available data provided by States, Provinces, USDA & CFIA
Current known distribution of CWD

Distribution of Chronic Wasting Disease in North America

- CWD in free-ranging populations
- Known distribution prior to 2000 (free-ranging)
- CWD in captive facilities (depopulated)
- CWD in captive facilities (current)

All locations are approximations based on best-available information.
Why care?

- With respect to deer:
  - Geographic spread
  - Increasing prevalence (locally)
    - Wyoming
    - Colorado
    - Saskatchewan
    - Alberta
    - West Virginia
    - Wisconsin

* Other jurisdictions also report increasing prevalence
Wisconsin – increasing prevalence
Wisconsin – increasing prevalence

Data: Wisconsin Department of Natural Resources
Why care?

- With respect to deer:
  - Geographic spread
  - Increasing prevalence (locally)
  - **Demonstrated population impacts**
    - Mule deer
    - White-tailed deer
    - Elk
Lambda and population performance

Population growth

1.5  50% per year population growth

--- Harvestable surplus ---

Stationary population

0.5  50% per year population decline

Population decline

RMNP elk – 1.0 (Monello et al. 2014)

Wyoming WTD – 0.90 (Edmunds et al. 2016)

Wyoming MD – 0.79 (DeVivo et al. 2017)
Endemic chronic wasting disease causes mule deer population decline in Wyoming

Melia T. De Vivo\textsuperscript{1c,*}, David R. Edmunds\textsuperscript{2}, Matthew J. Kauffman\textsuperscript{3}, Brant A. Schumaker\textsuperscript{1}, Justin Binfet\textsuperscript{4}, Terry J. Kreeger\textsuperscript{5},\textsuperscript{9}, Bryan J. Richards\textsuperscript{6}, Hemmann M. Schätzl\textsuperscript{7}, Todd E. Cornish\textsuperscript{1}

Abstract

Chronic wasting disease (CWD) is a fatal transmissible spongiform encephalopathy affecting white-tailed deer (Odocoileus virginianus), mule deer (Odocoileus hemionus), Rocky Mountain elk (Cervus elaphus nelsoni), and moose (Alces alces shirasii) in North America. In southeastern Wyoming average annual CWD prevalence in mule deer exceeds 20% and appears to contribute to regional population declines. We determined the effect of CWD on mule deer demography using age-specific, female-only, CWD transition matrix models to estimate the population growth rate ($\lambda$). Mule deer were captured from 2010–2014 in southern Converse County Wyoming, USA. Captured adult ($\geq$ 1.5 years old) deer were tested ante-mortem for CWD using tonsil biopsies and monitored using radio telemetry. Mean annual survival rates of CWD-negative and CWD-positive deer were 0.78 and 0.32, respectively. Pregnancy and fawn recruitment were not observed to be influenced by CWD. We estimated $\lambda = 0.79$, indicating an annual population decline of 21% under current CWD prevalence levels. A model derived from the demography of only CWD-negative individuals yielded: $\lambda = 1.00$, indicating a stable population if CWD were absent. These findings support CWD as a significant contributor to mule deer population decline. Chronic wasting disease is difficult or impossible to eradicate with current tools, given significant environmental contamination, and at present our best recommendation for control of this disease is to minimize spread to new areas and naïve cervid populations.
Smith: CWD-positive deer die at three times rate of non-diseased animals in Wisconsin study
Why care?

- **With respect to deer:**
  - Geographic spread
  - Increasing prevalence (locally)
  - Demonstrated population impacts

- **With respect to human health:**
Human Risk?

What the science suggests:

- No known cases where CWD has crossed into a human host
- A large number of research studies have been conducted
  - Conversion occurs at a low rate (multiple studies)
- There is a remote, but positive (non-zero) risk of transmission to humans
- Recent science suggests that the “species barrier” may not be as robust as once suspected
Response to the science:

- From the World Health Organization (WHO):
  
  No tissue that is likely to contain the BSE agent, nor part or product of any animal which has shown signs of a TSE should enter the (human or animal) food chain. All countries should ban the use of ruminant tissues in ruminant feed.
Response to the science:

- From the US Centers for Disease Control (CDC):
- ... hunters should take the following steps when hunting in areas with CWD:
  - Strongly consider having the deer or elk tested for CWD before you eat the meat.
  - If your animal tests positive for CWD, do not eat meat from that animal.
Why Care?

- Data from several sources suggest that heavily-infected cervid populations will not thrive in the long-term.
- Data on CWD prions and experience with other animal prion diseases suggest minimizing human exposure to these agents is prudent.
- The “ick” factor and the future of deer management

Miller & Fischer, 2016
Vaske & Lyon, 2011
Why Care?

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- The “ick” factor and the future of deer management
- Unanticipated consequences
Grass Plants Bind, Retain, Uptake, and Transport Infectious Prions

Sandra Pritzker, Rodrigo Morales, Fabio Moda, Ulfat Khan, Glenn C. Telling, Edward Hoover, and Claudio Soto

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Prion Research Center, Department of Microbiology, Immunology, and Pathology, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523, USA

Present address: IRCCS Foundation Carlo Besta Neurological Institute, 20133 Milan, Italy

SUMMARY

Prions are the protein-based infectious agents responsible for prion diseases. Environmental prion contamination has been implicated in disease transmission. Here, we analyzed the binding and retention of infectious prion protein (PrPSc) to plants. Small quantities of PrPSc contained in diluted brain homogenate or in excretory materials (urine and feces) can bind to wheat grass roots and leaves. Wild-type hamsters were efficiently infected by ingestion of prion-contaminated plants. The prion-plant interaction occurs with prions from diverse origins, including chronic wasting disease. Furthermore, leaves contaminated by spraying with a prion-containing preparation retained PrPSc for several weeks in the living plant. Finally, plants can uptake prions from contaminated soil and transport them to aerial parts of the plant (stem and leaves). These findings demonstrate that plants can efficiently bind infectious prions and act as carriers of infectivity, suggesting a possible role of environmental prion contamination in the horizontal transmission of the disease.
Agricultural commodities?
Agricultural commodities

**Chronic wasting disease (CWD) in cervids**

- High and straw from the United States and Canada must also be accompanied by a certificate from a public veterinarian that the product has been harvested in states or provinces where no Chronic Wasting Disease has been detected in deer animals.

**New additional requirements for imports of high and straw for animal feed from countries outside the EEA**

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Why Care?

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- The “ick” factor and the future of deer management
- Unanticipated consequences
Likely Outcomes (deer)

- CWD will continue to spread geographically
- CWD prevalence will continue to grow locally
- Population impacts in localized areas
  - Harvestable surplus will diminish
  - Population declines in some herds
  - Open question – regional population impacts
- Demographic impacts will be observed
  - Older age cohorts will diminish
- Hunters will alter their behavior
WHAT CAN BE DONE?
CWD Management

- Address anthropogenic spread of disease
  - Identify risk
  - Implement preventative measures
- Address CWD where it occurs
  - Management efforts, to-date, have been largely ineffective
    - Social and political pressure
  - Opportunities exist for responsible management agencies to alter the course of disease
  - Stakeholder support is paramount
“I’m here about the details.”
Recommendations for Adaptive Management of Chronic Wasting Disease in the West
WAFWA Adaptive Management

- **Reduce artificial points of host concentration**
  - Identify point sources of food/water
  - Work with landowners to mitigate point source and reduce deer density

- **Harvest management**
  - Increase buck harvest
  - Bias harvest towards bucks
  - Shift timing of harvest …

- **Harvest targeting disease foci**
  - Develop harvest strategy to maximize removal of infected individuals
A FEW CASE STUDIES
CWD in New York

Map: NY DEC
<table>
<thead>
<tr>
<th>Year</th>
<th>Season Dates</th>
<th>Total Days</th>
<th>Season Regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Oct 24- Jan 31</td>
<td>100</td>
<td>Earn-a-Buck All Season</td>
</tr>
<tr>
<td>2003</td>
<td>Oct 30- Jan 3</td>
<td>66</td>
<td>Earn-a-Buck All Season</td>
</tr>
<tr>
<td>2004</td>
<td>Oct 28- Jan 2</td>
<td>67</td>
<td>Earn-a-Buck All Season</td>
</tr>
<tr>
<td>2005</td>
<td>Oct 27- Nov 13 Nov 19- Jan 3</td>
<td>64</td>
<td>Earn-a-Buck: Early Season Only</td>
</tr>
<tr>
<td>2006</td>
<td>Oct 14-Oct 22 &amp; Nov 18- Dec 10</td>
<td>32</td>
<td>No Earn-a-Buck</td>
</tr>
</tbody>
</table>
wDEZ Core Area Deer Population Estimates

- 66 days EAB
- 67 days EAB
- 64 days EAB (1/2)
- 32 days No EAB
CWD in Wisconsin
CWD in Alberta

- CWD detected in 2005
- Intensive agency culling
  - Effectiveness: ~200/day
Status: CWD in Alberta

- “... the program failed in the crucial area of maintaining support .... and was not delivered in 2009 ....”
  - Pybus et al. 2009.

Overall CWD Prevalence in Alberta

![Map showing CWD prevalence in Alberta](Government of Alberta)
CWD in Norway

- 2016 initial detection
- Reindeer in Nordfjella (7)
  - Moose (3), Red Deer (1)
    - Strain differences?
- Active management
  - Intensive sampling
  - Eliminate herd unit
  - Protracted fallow

http://www.hjortevilt.no
CWD in Norway

Norway kills 1400 wild reindeer

https://home.1und1.de/magazine/leben/tiere/norwegen-toetet-1400-wilde-rentiere-32825544
CWD in Tennessee, Mississippi

Tennessee Wildlife Resources Agency
Ontario and CWD - considerations

- **Goal:**
  - Assure you do not have CWD, and keep it that way
Ontario and CWD - considerations

- **Surveillance**
  - Do not want to be Tennessee, Arkansas, ...

- **Preventative measures**
  - Identify potential routes for introduction of infectious material
  - Block them
    - Regulatory measures
    - I&E

- **Communications**
  - Engage stakeholders
  - Open, honest, science-based info
  - Explore alternative delivery methods
  - What is the goal
  - What are the risks, what are we doing, what more can be done to address those risks

- **Support science**
  - It’s not up to someone else to help protect your future

- **Hunt**
  - Share the resource and the legacy
  - Arm yourself with information
  - Take appropriate precautions – for both your family and the resource
“You’ll have to be aggressive; remove all sources … and all potential movement. Cut wider and deeper than you ever think necessary. The deer will come back; but you’ll get one chance. If CWD gets widely established, you’ll have it for a very long time.”

-Dr. Elizabeth Williams, 1996

-Following confirmation of CWD on a game farm in Saskatchewan – asked what we should do if it spills over into public wildlife.
THANK YOU!
CWD prevention – managing risk

- Home Zip Codes of hunters harvesting deer in Dane, Iowa, Richland and Sauk counties, WI, 2016-2017

>32,000 deer represented
Alaska (26 deer) and Hawaii (2 deer) not shown

Data: WI Department of Natural Resources
CWD prevention – managing risk
Preventative measures
- reduce risk of disease introduction/amplification

- Introduction risks
  - Game farm movements/imports
  - Game farm/wild contacts, escapes
    - Double-fences may help, but not complete protection
  - Hunter carcass movements/imports/disposal
  - Raw taxidermy specimens
  - Contaminated soil?
  - Urine-based lures?
  - Movement of farm commodities?

- Establishment/Amplification risks
  - Feeding and baiting
  - High deer densities

- Mitigating risks
  - Regulations
  - Education & Information
“There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of facts.”

- Mark Twain
“All models are wrong, but some are useful.”

- George Box, 1987

Box created the Department of Statistics, UW-Madison, 1960