Lessons from 15+ years of CWD Research in Wisconsin

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Topics

- Long term epidemics
- Which deer are at risk
- Direct vs. Indirect transmission
- Routes of spread
- Mode of transmission (DD vs FD)
- Management Implications and Options
- Management and Research Needs
CWD Epidemics are Long-term

- Epidemic cycles last for decades – much longer than deer management time frames
- Epidemics are characterized by increasing prevalence and geographic spread
- Deer populations decline when prevalence hits 20-30% in adult females
- Once CWD is established eradication is nearly impossible without eradication of animals (Norway).
Increasing CWD Prevalence

- Prevalence slowly increases then accelerates
- Infection risk is related to prevalence
- Prevalence patterns indicate CWD likely present in WI for > 20-30 years before discovery
Increasing Spatial Spread

- Slow initial rate of natural spread
- Highways and rivers slow spread, but not much
- CWD spreads across the landscape – yearling dispersal
- Rate of spread increases with prevalence
- Two outbreaks in WI and IL are merging
Which Deer are at Risk

- Infection depends on age, sex, and PrP genotype
- Prevalence increases with age – longer time of exposure
- Adult males have 2x higher prevalence than adult females
Infection and Mortality Rates

- Males have 4x higher rate of CWD infection than females
- Males die much faster from CWD than females – leaves 2x prevalence
- Average longevity for bucks reduced to 4 months
- Average longevity for does reduced to 6 months
Western Population Studies (Radiotelemetry)

- **Bolder, Colorado – Mule deer** (Miller et al. 2008)
  - Pop growth < 1 unhunted; 25% CWD prev; Higher mortality in CWD infected deer

- **RMNP, Colorado – Elk** (Monello et al. 2014)
  - Pop growth = 1.0; Prev > 13% Pop growth < 1; Higher mortality in CWD infected elk

- **Wyoming – White-tailed deer** (Edmunds et al. 2016)
  - Pop growth = 0.9; Females (42%) > Males (29%); CWD infected deer 4.5 times higher mortality

- **Wyoming – Mule deer** (DeVivo PhD 2015)
  - Pop growth = 0.74; Males (50%) > Females (30%); CWD infected deer 2.8 times higher mortality
**PrP Genetic Susceptibility in White-tailed Deer**

- **Wild type**
  - ~55% of free-ranging WTD
  - Most commonly associated with CWD infection
  - CWD susceptible

- **96 GG**
  - ~35% of free-ranging WTD
  - Underrepresented among CWD infected WTD
  - Partially resistant to CWD

- **96 GS**
  - ≤10% of free-ranging WTD
  - Underrepresented among CWD infected WTD
  - Partially resistant to CWD

- **96 SS**

No genotypes are immune to CWD
PrP Genotype and CWD

All genotypes are susceptible to CWD:

- Some genotypes have slower rate of CWD infection and/or progression, but may shed prions longer?
- More resistant genotypes are uncommon and may have reduced fitness

Evolution of population resistance is complicated, likely will take decades, and the outcome is still unknown

96 GG
96 GS
96 SS
Mule Deer and Elk

- **Mule deer**
  - 225S vs 225F
  - 225FF are least susceptible but uncommon (5%) in wild mule deer

- **Elk**
  - 132M vs 132L
  - 132LL are least susceptible and less common
  - 132L frequency higher when CWD present > 30-50 years
Relative Susceptibility of Species

- Deer are more likely to be infected than sympatric elk

- White-tailed deer may have higher rates of infection than mule deer?

- PrP genotypes have differential susceptibility – but no genotypes are immune
Shedding of CWD Prions

- Deer begin shedding prions in saliva, feces, and urine early (<3-6 months) post-infection and long before clinical signs.
- Prions persist in the environment for years if not decades.
Direct vs Indirect Transmission

- Direct transmission via:
  - Body fluids
  - Saliva and urine
  - Blood

- Environmental contamination
  - Carcasses, saliva, urine, feces

- Suspected environmental reservoirs
  - Mineral licks, feeding/baiting, scrapes, food sources, water sources, soil ingestion, plants

- Magnitude of direct and indirect transmission in free-ranging populations?
Potential Environmental Reservoirs

- Prions bind to soil which can increase virulence
- CWD detected in water (CO) and mineral licks (WI)
- Plants can uptake prions in stems and leaves in the lab
- Norway banned hay and straw imports from CWD areas in 2018
Mineral Licks

- We detected CWD prions in 9 of 11 mineral licks in southcentral Wisconsin where disease has been present for decades.
- Detections were in both soil and water.
- Unable to quantify prion levels, but appeared to be low.
- Importance of mineral licks as environmental reservoir still uncertain.
Evidence of Environmental Transmission

- CO studies show direct and indirect transmission are feasible in captive setting (Miller et al. 2004)

- CO study correlation with clay soils and CWD infection (Walter et al. 2011)

- WI found no correlation with soil types and CWD infection at 2 different spatial scales (Robinson et al. 2013, Storm et al. 2013)
Evidence for Direct Transmission

- Related females in WI more likely to become infected than females sharing the same habitat (Grear et al. 2010)

- Males have 3-4 times higher infection than females, but only 1.3-1.5 larger home range (Samuel and Storm 2016)

- CWD transmission is frequency-dependent; characteristic of socially limited diseases (Jennelle et al. 2014)

- However, fawns have lower infection rate than mothers – one hypothesis would be environmental exposure (Samuel and Storm 2016)
Why is the route of transmission important?

- Environmental reservoirs and longevity of prions still unknown

- Short-term management – control/eradication of prions sources. Control of deer vs environmental reservoirs

- Long-term management – environmental reservoirs likely enhance disease transmission (Almberg et al. 2011)
My Likely Scenario

Relative CWD Infection

- Total
- Environment
- Direct
Routes of Spread

- Human assisted movement of live animals, carcasses, or other infectious materials
Natural CWD Spread

- Yearling males are programmed to disperse
- Yearling prevalence increases with time
- The result is faster spread of CWD over time
- Seasonal migrations make it more complex
Mode of CWD Transmission

- Analyses indicate FD transmission – new infections increase as prevalence increases

- Higher prevalence leads to higher infection and spread – accelerating growth

- Unlikely to eradicate CWD once established

- Manage CWD by reducing prevalence
Density Dependent Transmission

CWD Prevalence

Deer
Frequency Dependent Transmission

Deer

CWD Prevalence
“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
Management Implications

- Unlikely to eradicate CWD once established
- Infection will accelerate with prevalence
- Population impacts will increase with female prevalence due to CWD mortality
- Population declines at 25-30% female prevalence in WTD
- Will also increase rate of spread via dispersal of infected yearlings and migration
- Males have higher infection and mortality from CWD – fewer trophy deer
CWD Management Options

- New areas of infection
  - Aggressive removal of deer to eliminate disease
  - New York is one successful example of local eradication, but there are other examples
- Control prevalence
  - FD transmission requires a reduction in prevalence to reduce the rate of new infections
  - Higher removal of CWD+ deer – test and cull
  - Reduction in males – highest prevalence
- Control spread – reduce dispersal of infected yearlings
  - Reduce prevalence of yearling dispersers
  - Reduce population size to reduce # of yearlings
  - Reduce/change seasonal migration?
Management Goals and Needs

- Prevention is key
- Or early detection and eradication efforts
- Management strategies to contain disease and keep prevalence/infection rates low to reduce mortality
- Silver bullet – vaccine to help disease management
- Political and financial support from deer hunters and public
- Stronger together – national/international collaboration and cooperation to develop control strategies and conduct research
Research Priorities

- CWD research in free-ranging wildlife is challenging and long-term
- Vaccine development to prevent or delay infection
- Factors that drive high male infection rates
- Long-term host genetics and pathogen adaptation
- Role of environmental reservoirs in transmission
- Species barriers and risk for human, livestock, wildlife health
Thank you!

Questions and Discussion