Lessons from 15+ years of CWD Research in Wisconsin

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Topics

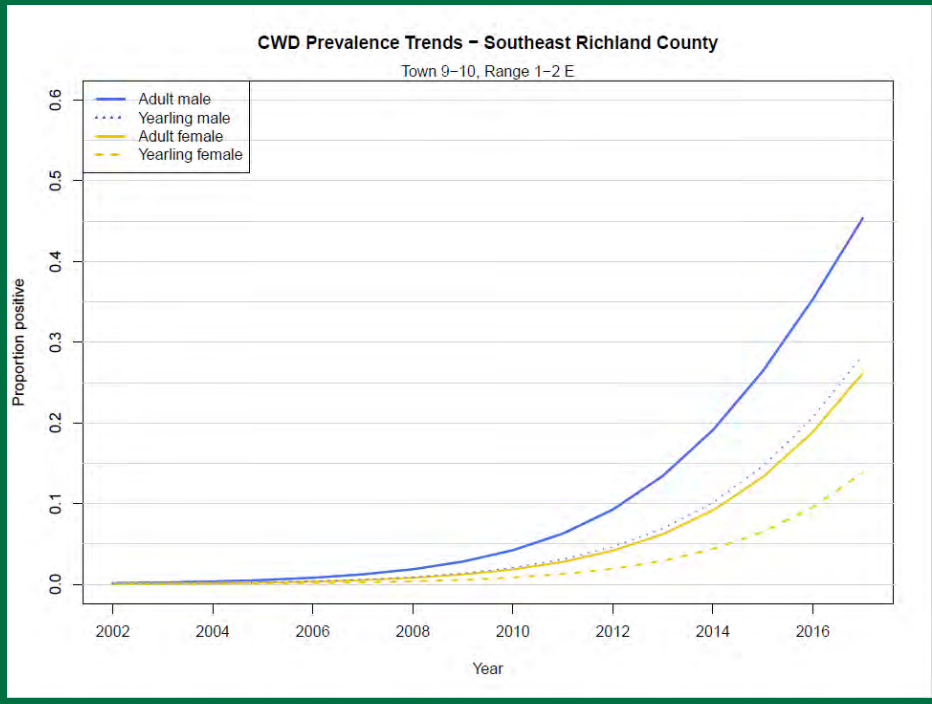
- Long term epidemics
- Which deer are at risk
- Direct vs. Indirect transmission
- Routes of spread
- Mode of transmission (DD vs FD)
- Management Implications and Options
- Management and Research Needs

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).

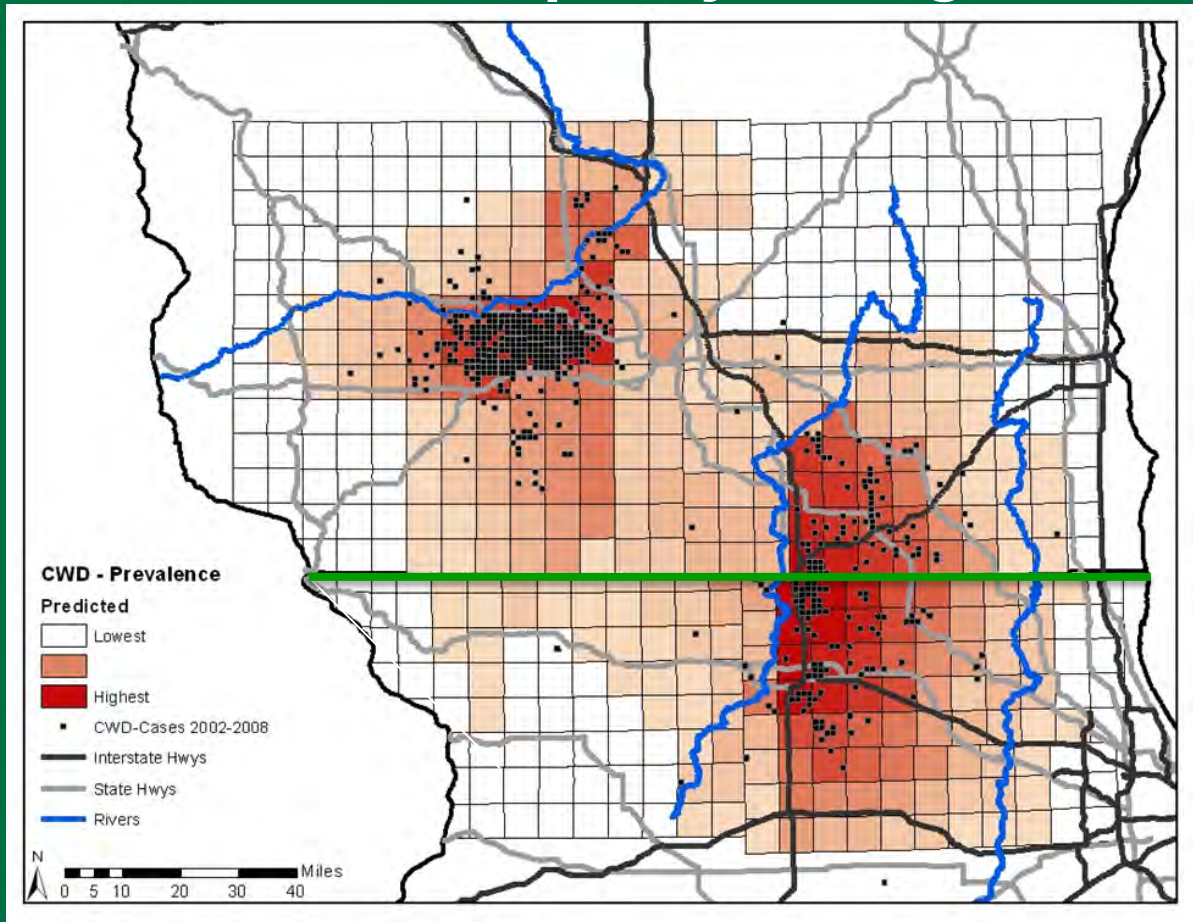
Increasing CWD Prevalence

- 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



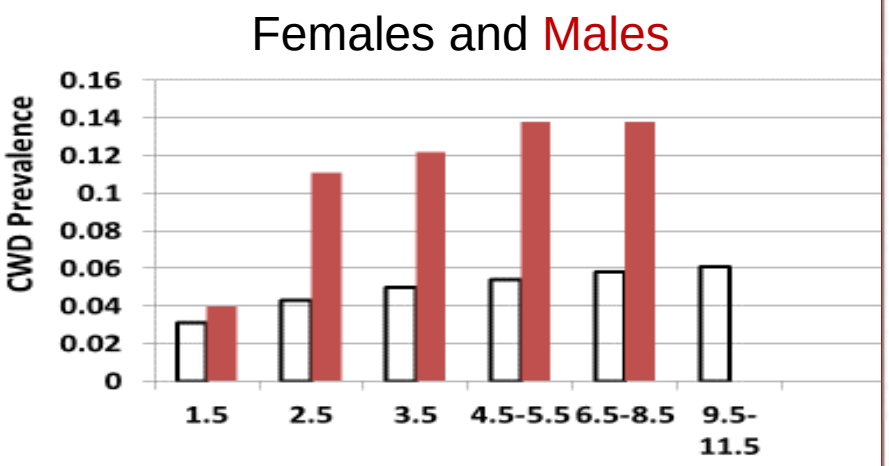
Increasing Spatial Spread

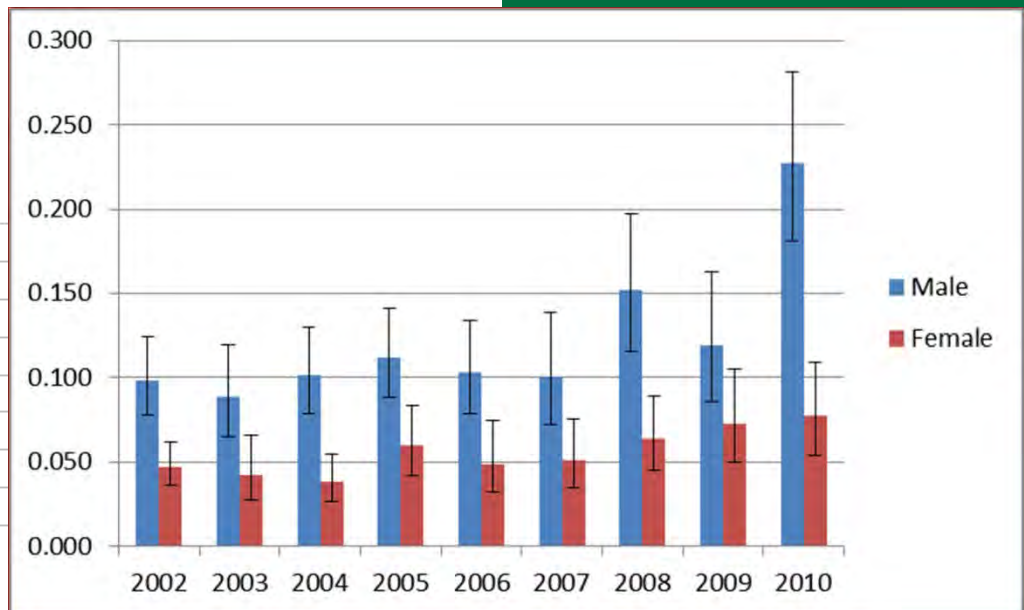
- Slow initial rate of natural spread
- Highways and rivers slow spread, but not much
- CWD spreads across the landscape – yearling dispersal
- Rate of spread increases with prevalence
- Two outbreaks in WI and IL are merging



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



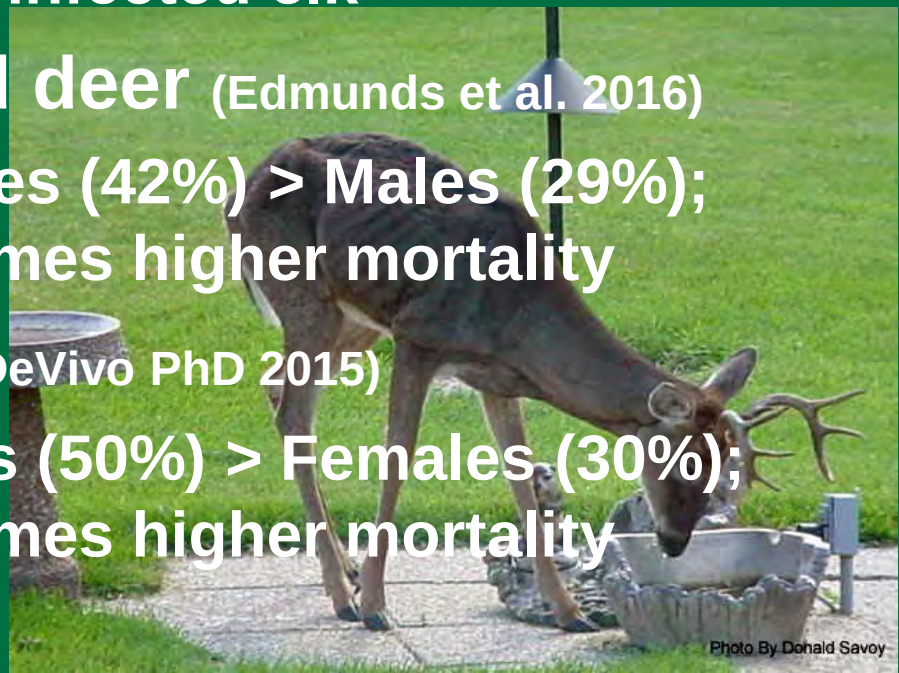


Infection and Mortality Rates

- 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**

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

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

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

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?

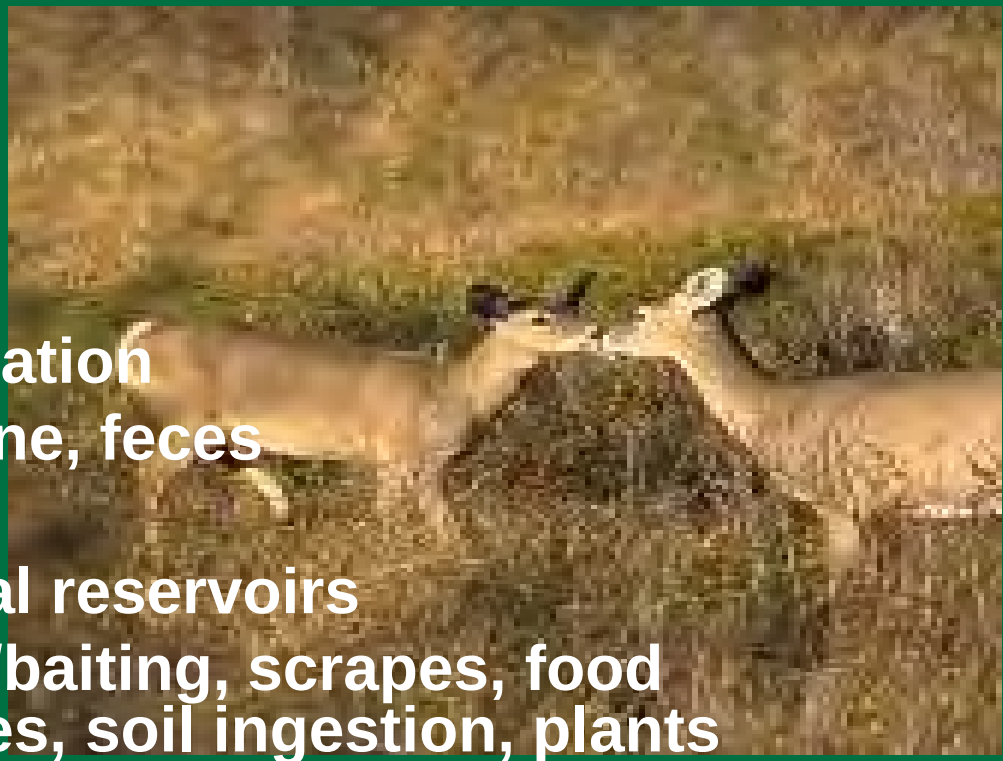
- PrP genotypes have differential susceptibility – but no genotypes are immune

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?

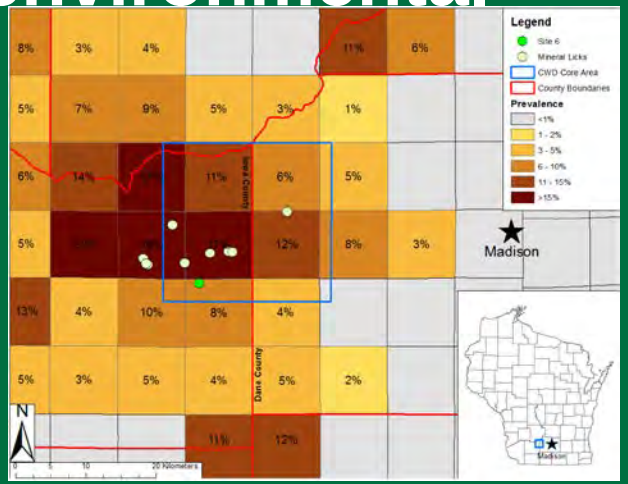


Potential Environmental Reservoirs

- 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

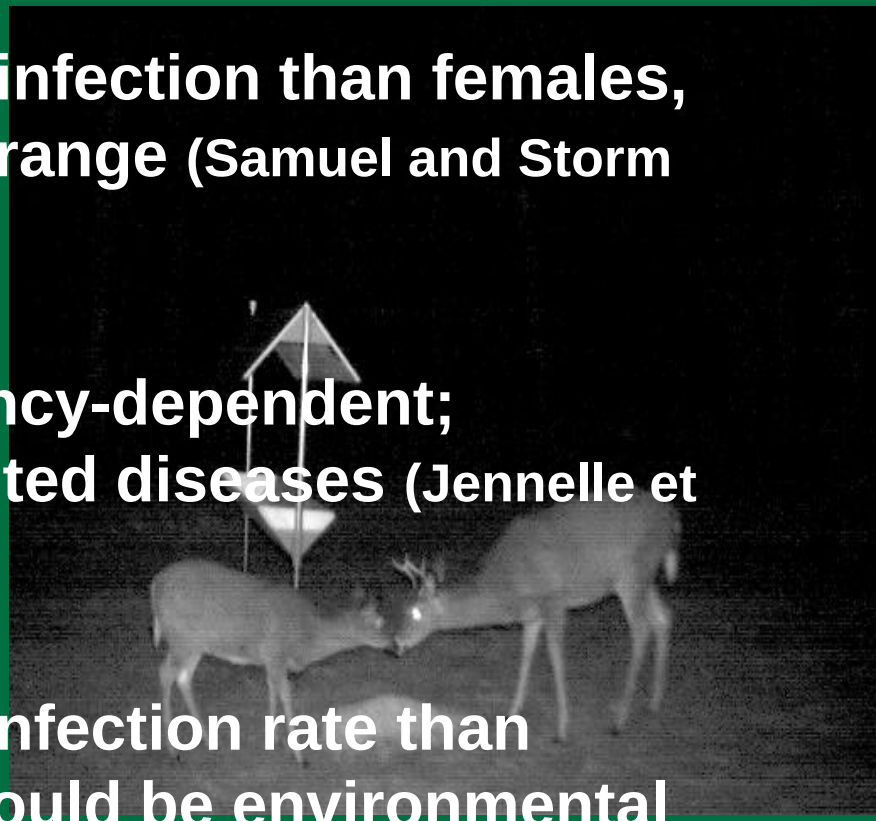
- CO studies show direct and indirect transmission are feasible in captive setting (Miller et al. 2004)

- 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 longitivy 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

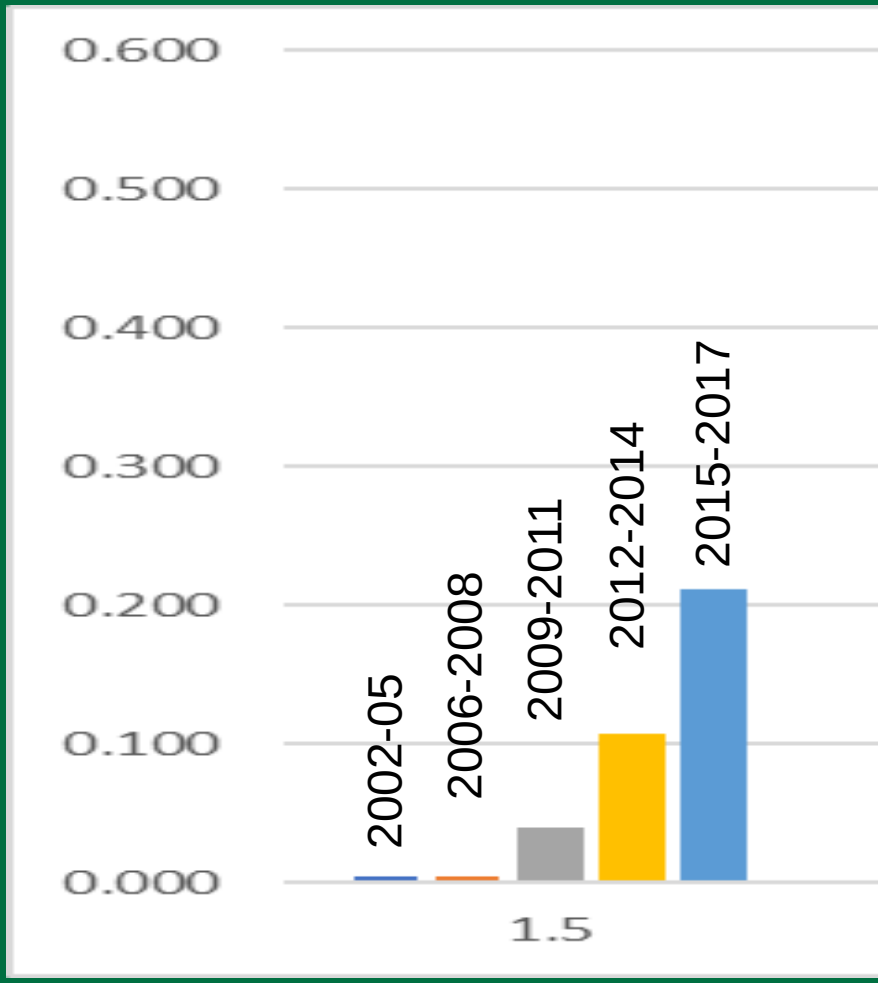
Routes of Spread

- **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

Prevalence in Yearling Males

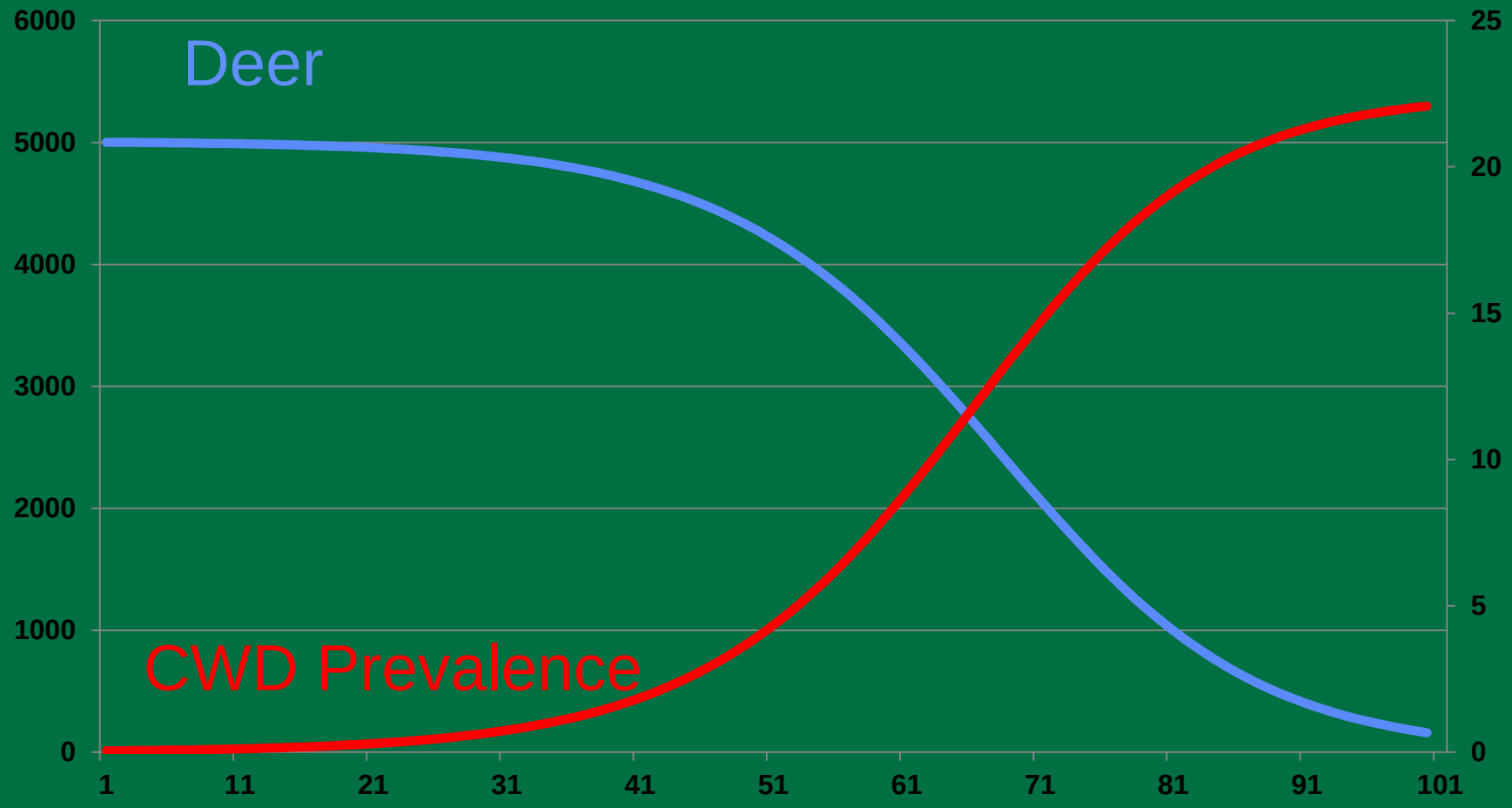


Mode of CWD Transmission

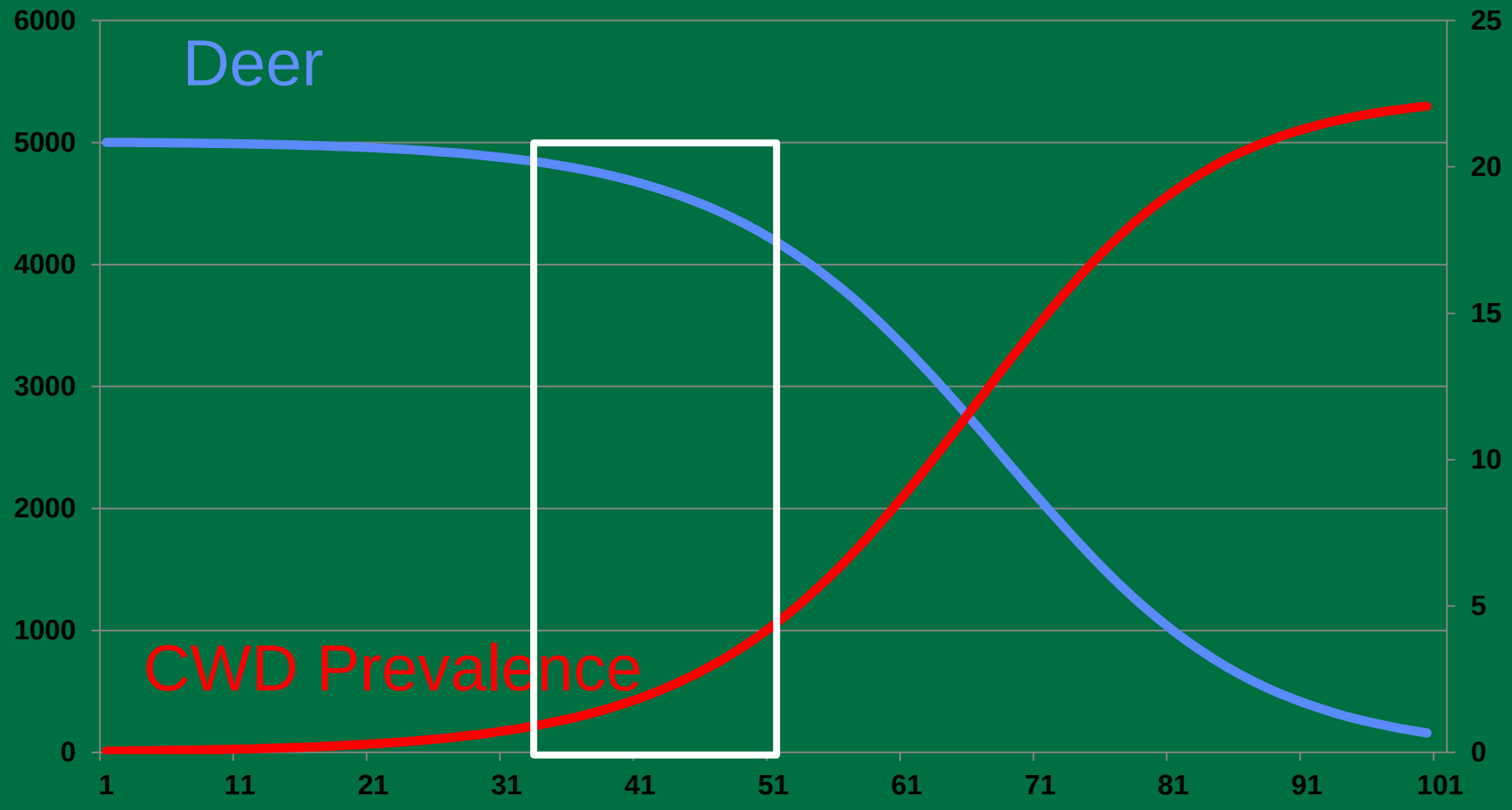
- Analyses indicate FD transmission – new infections increase as prevalence increases
- Higher prevalence leads to higher infection and spread – accelerating growth
- Unlikely to eradicate CWD once established
- Manage CWD by reducing prevalence

Density Dependent Transmission

Frequency Dependent Transmission



Frequency Dependent Transmission

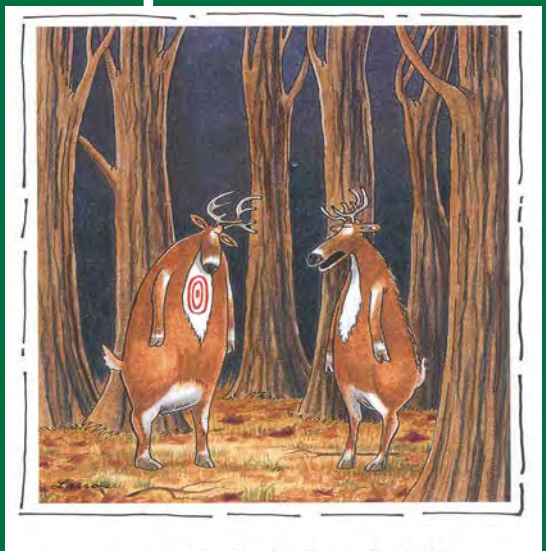


“You’ll have to be aggressive; remove all sources … and all potential movement. Cut wider and deeper than you ever think necessary. The deer will come back; but you’ll get one chance. If CWD gets widely established, you’ll have it for a very long time.”

-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

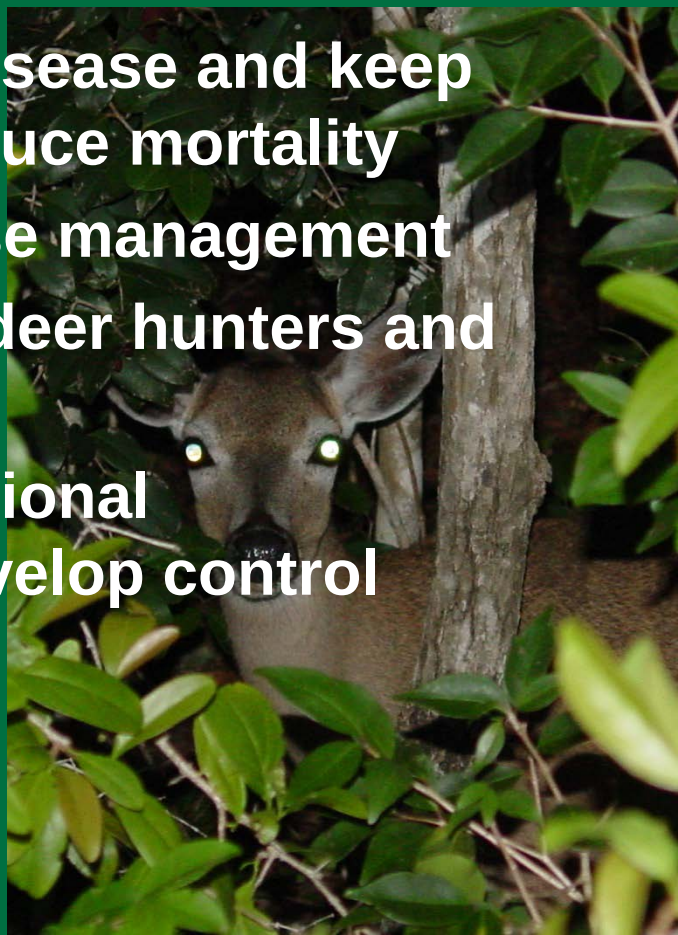


CWD Management Options

- 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