Understanding Drivers of Chronic Wasting Disease Among White-tailed Deer in Northwest Arkansas

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Introduction

- Chronic Wasting Disease (CWD) is a 100% fatal neurodegenerative disease found in white-tailed deer and other cervid species.
- Transmitted by prions through direct or indirect exposure.
- Symptoms of CWD include behavioral changes, body deterioration, cognitive decline, and neurodegeneration.
- CWD has been found in over 30 U.S. states and other countries since its' discovery in 1967[1].
- CWD prevalence can reach 40-50% in wild populations and 80 -100% in captive populations.[1]

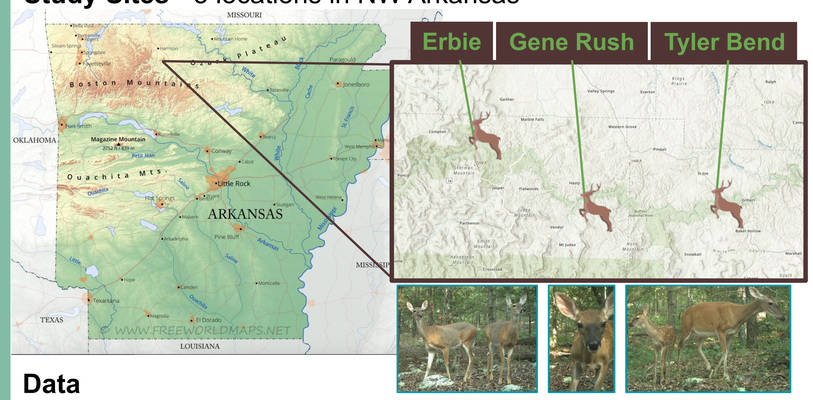
Objectives

I. Identify spatial trends in CWD prevalence across the study area and within each site.
II. Determine the relationship between deer density, human density, environmental variables such as land cover type and disease prevalence.
III. Create an interactive web application of CWD status for individual captured deer of different sexes and ages across years and seasons to visualize infection trends.

Data and Methods

Study Organisms - White-tailed deer (*Odocoileus virginanius*)

Study Sites - 3 locations in NW Arkansas



Data

- For the analysis, we used telemetry, camera, and capture mark-recapture data from the study area.
- RAMALT and ELISA testing for host CWD status
- We obtained soil type data for each trap site from the USDA Web Soil Survey[2] and land cover type from the EPA EnviroAtlas Interactive Maps[3].

Data and Methods continued

Statistical Analysis

- Ordinary kriging for spatial interpolation over different sites, seasons, life stages, and sexes.
- General additive models (GAMs) used to understand predictors to of overall prevalence.
  - Deer density, human density, elevation, land cover type, and distance from the Buffalo River.
- Binary Logistic GAM for host CWD Status
  - Sex and estimated age in addition to variables used for overall prevalence.

Results

I. Spatial autocorrelation of overall CWD prevalence was present in two specific situations.

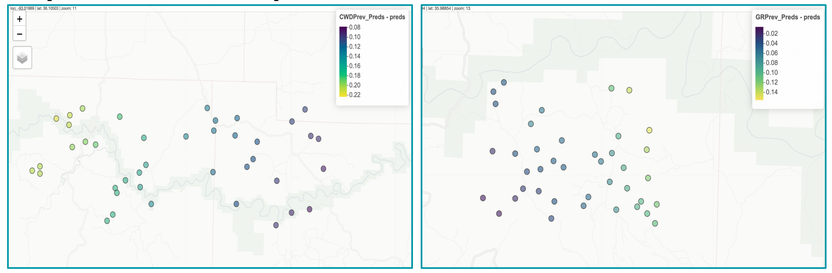


Figure 1 (Left): Map of predicted Winter prevalence across the entire study area. Moran's I was calculated (p=0.001), indicating there is spatial autocorrelation.
Figure 2 (Right): Map of predicted female prevalence at the Gene Rush site. Spatial trends were evident through Moran's I (p=0.002).

Predicted Winter prevalence decreased from the West to East direction while predicted female prevalence increased.

II. Deer density (p=0.0312) and Elevation (p=0.0058) are important predictors for overall CWD prevalence in the best fit model.

Model Rank	Terms			AIC	ΔAIC
1	s(DeerDensity)	Elevation	s(OpenArea)	91.9	0
2	s(DeerDensity)	Elevation	s(DevelopedArea)	92.3	0.4
3	s(DeerDensity)	Elevation	s(RiverDist)	92.9	1.01
6	Intercept-only			97.3	6.18

Figure 3: Best fit GAM models selected through Akaike Information Criteria (AIC). The intercept-only model was included for comparison.

Land cover-type and **distance to the Buffalo River** appeared to play a role in overall prevalence as well.

References

(1) Steven N. Winter, Luis E. Escobar; CHRONIC WASTING DISEASE MODELING: AN OVERVIEW. J Wildl Dis 1 October 2020 **(2)** EPA https://www.epa.gov/enviroatlas/enviroatlas-interactive-map
(3) USDA Web Soil Survey https://websoilsurvey.nrcs.usda.gov/app/

Results continued

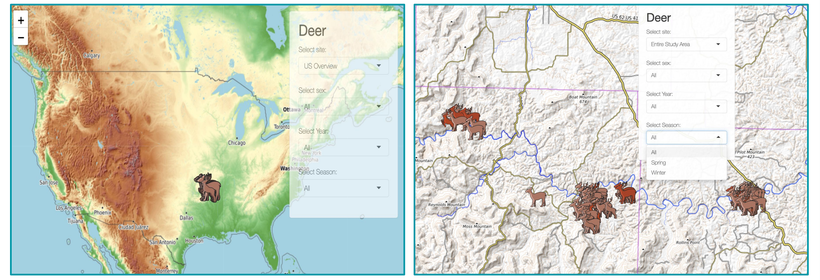
II. Estimated age of deer significantly affects the probability of CWD status(p=0.00345) in the best fit model.

Model Rank	Terms					AIC	ΔAIC
1	s(Deer Density)	Elevation	s(Estimated Age)	s(Open Area)		170.4	0
2	s(Deer Density)	Elevation	s(Estimated Age)	s(Developed Area)	Forest Area	170.5	0.12
3	s(Deer Density)	Elevation	s(Estimated Age)	s(RiverDist)	s(Developed Area)	170.6	0.28
4	Intercept-only					192.3	21.96

Figure 5: Best fit model selection was done through AIC comparison.

As deer density **increased**, the probability of deer being CWD positive also **increased** whereas elevation had the **opposite** effect. Deer **aged 2-4** were most likely to be CWD positive.

III.The RShiny application displaying the deer capture data



Figures 4 & 5: Images of the interactive web application of deer capture data. Users can generate maps of host CWD status at trap sites for deer of different sexes across seasons and years.

Conclusions and Future Directions

- Spatial trends of CWD prevalence present in specific situations - could be due to an absence of spatial infection trends or too few data points between sites and requires more deer captures.
- Deer density and environmental variables appear to be key predictors of overall CWD prevalence.
- Predictors of CWD status support management of deer populations, especially post natal dispersal (~2 years of age).
- ShinyApp available for managers to understand infection trends.

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