USGS WISCONSIN COOPERATIVE WILDLIFE RESEARCH UNIT

FISCAL YEAR 2024

(October 1, 2023-September 30, 2024)

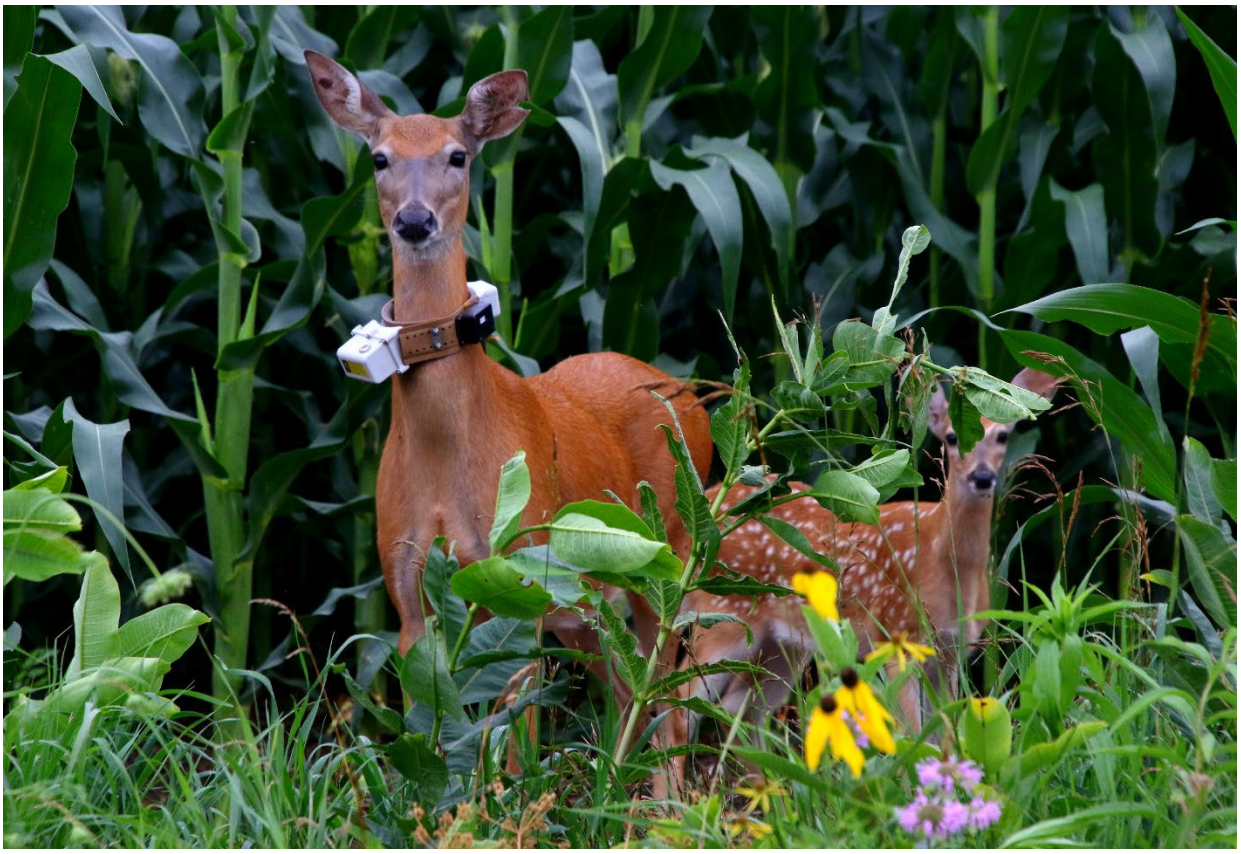


Photo of video camera-GPS collared doe and fawn at a field edge near Dodgeville, WI courtesy of Jerry Davis, cooperating landowner

ANNUAL REPORT

USGS WISCONSIN COOPERATIVE WILDLIFE RESEARCH UNIT

Room 204 Russell Labs
1630 Linden Drive
University of Wisconsin-Madison
Madison, WI 53706
Phone: 608/263-4519
Fax: 608/262-9922

COOPERATING AGENCIES:

U.S. Geological Survey
University of Wisconsin
Wisconsin Department of Natural Resources
Wildlife Management Institute
U.S. Fish and Wildlife Service

October 1, 2023-September 30, 2024

MISSION STATEMENT
OF THE
WISCONSIN COOPERATIVE WILDLIFE RESEARCH UNIT

The Cooperative Units Program of the U.S. Geological Survey has been an integral part of the Department of Wildlife Ecology at the University of Wisconsin-Madison since 1972. With direction from the Coordinating Committee, the Unit's research has been conducted on a wide variety of wildlife topics in cooperation with federal agencies, the University, the Wisconsin Department of Natural Resources, and various private organizations. The Unit's research spans the range from problem-oriented projects designed to provide cooperators with useful information on resource issues to basic scientific discovery to move the state of knowledge forward.

Work has been carried out in both terrestrial and aquatic environments. Major areas of present research include the effects of agriculture on wildlife populations, wildlife disease issues, and global climate change. The Unit, along with cooperating scientists, has the expertise to investigate environmental problems from the cellular to the landscape level. Current Unit personnel have research interests that include population ecology, community ecology, disease ecology, and landscape ecology. Future project selection is primarily dependent on the needs of the cooperators and the availability of funds.

PERSONNEL AND COOPERATORS

Coordinating Committee

Cyndy Loftin	Eastern Region Supervisor, Cooperative Research Units U.S. Geological Survey, Reston, VA
Timothy Van Deelen	Chair, Department of Forest and Wildlife Ecology University of Wisconsin-Madison
Scott Hull (Office of Applied Science) and Jasmine Batten (Bureau of Wildlife Management)	Representatives, Wisconsin Department of Natural Resources, Madison, WI
William Moritz	Representative, Wildlife Management Institute, Johnstown, OH
Bradly Potter	Representative, U.S. Fish and Wildlife Service, East Lansing, MI

Unit Staff

Wendy Turner	Unit Leader, Wildlife
Christian Che-Castaldo	Assistant Unit Leader, Wildlife
Carolyn Rindahl	Administrative Assistant, University of Wisconsin-Madison

ACADEMIC PERSONNEL

Academic Staff

Marie Gilbertson (Wendy Turner) (Scientist II). Marie is a quantitative ecologist studying deer movement ecology and CWD transmission in southwest Wisconsin and is the veterinarian overseeing our deer captures. Her project investigates the impact of CWD infection on deer movement behavior, and the impact of deer movements and contacts on CWD spread.

Alison Ketz (Wendy Turner) (Scientist II). Alison worked in collaboration with the WDNR and the USGS National Wildlife Health Center to understand deer population dynamics in the CWD-endemic region of southwestern Wisconsin. (*End date December 2023*)

Post-doctoral Researchers

Amélie Dolfi (Chris Che-Castaldo). Amélie is developing movement models using integrated step-selection analyses and agent-based approaches to simulate movement by white-tailed deer and other species in different landscapes. These simulated datasets will be used to validate density or abundance estimates based on Snapshot Wisconsin camera trap data.

John Draper (Wendy Turner, co-mentored by Dan Walsh at MT-W-CRU). John is leveraging historical information maintained by state agencies to evaluate impacts of CWD management activities on white-tailed deer population and disease dynamics, and to establish a framework that will improve coordination and information exchange.

Heather Inzalaco (Wendy Turner). Heather developed and managed our new prion lab at UW-Madison. Her project is studying prion deposition at CWD positive deer carcass sites and the effect of scavengers on environmental prion concentrations and CWD transmission risk. (*End date August 2024*)

Graduate Students

Completed degrees

Amélie Dolfi (Wendy Turner) (Ph.D., Wildlife). Amélie developed models of anthrax transmission dynamics. She used agent-based models to investigate the interactions of *Bacillus anthracis* with its herbivorous hosts comparing two ecosystems in southern Africa that vary in outbreak dynamics. (*August 2024*)

Sunday Ochai (Wendy Turner) (M.S., Veterinary Tropical Diseases, University of Pretoria, co-advised by Henriette van Heerden). Sunday is studying the ecology of anthrax in South Africa and is developing improved serological and molecular techniques for identifying *Bacillus anthracis* infections versus genetically similar microbial neighbors. (*May 2024*)

New and continuing graduate students

Kimberlie Vera (Wendy Turner) (Ph.D., Wildlife). Kimberlie is studying anthrax transmission dynamics in a guild of herbivorous mammals, investigating how environmental variation affects host physiology, movement patterns, anthrax exposure risk and predation risk.

Nurul Islam (Wendy Turner) (Ph.D., Wildlife) Nurul is studying white-tailed deer behaviors based on accelerometers and video camera collars to understand chronic wasting disease transmission risk in southwest Wisconsin.

Michael Menon (Wendy Turner, co-mentored with Timothy Van Deelen) (Ph.D., Wildlife). Michael is developing a project on spatio-temporal patterns of wolf predation on white tailed deer and CWD dynamics in northern Wisconsin.

Stephanie Katircioglu (Wendy Turner) (M.S., Wildlife). Stephanie is studying prion accumulation in soils at deer scrapes and food plots and white-tailed deer behaviors that shed prions and expose deer to prions in the environment.

Aaron Groves (Wendy Turner) (M.S., Wildlife). Aaron is studying coyote and bobcat movement ecology, predation/scavenging of white-tailed deer, and effects on chronic wasting disease spread.

Visiting Students

Bijit Khadka (Chris Che-Castaldo) (Ph.D., Wildlife, advised by Timothy Van Deelen and Jon Pauli). Bijit is building a reproducible data pipeline and spatial databases of permit data collected for federally listed species managed by the U.S. Fish and Wildlife Service, specifically freshwater mussels and bats.

NEW PROJECTS ($406,064 in funding)

Building ecological data pipelines for listed species permit data

Investigators: *Christian Che-Castaldo, USGS, Wisconsin Cooperative Wildlife Research Unit; Erik Olson, Midwest Regional Headquarters, USFWS; Andy Allstadt, Midwest Regional Headquarters, USFWS; Bijit Khadka, Wisconsin Cooperative Wildlife Research Unit*
Funding: *Wisconsin, DNR $56,505*
Expected Completion: *January 20, 2025*

The purpose of this project is to provide technical assistance to the United States Fish and Wildlife Service (USWFS) by developing semi-automated methods to organize and standardize information it collects from permit holders so that it can be more easily used for managing federally endangered, threatened, and at-risk species. To do this, the University of Wisconsin Madison will build a series of reproducible data workflows and pipelines using the R programming language and SQL for permit data collected for freshwater mussels, bee and/or bat species to convert these data from excel spreadsheets into a series of standardized spatial databases united by a common data schema. These workflows and pipelines will be constructed in such a way that they can be re-used by USFWS for additional species in the future. We will also produce a data paper to submit to a peer reviewed scientific journal fully describing the datasets for the three groups of species listed above. These activities will better enable the USFWS to use species permit data to address critical recovery and management needs. In addition, this project will be used to train a University of Wisconsin Madison graduate student in advanced data science methods, with an emphasis on building reproducible workflows.

Advancing trail camera monitoring through simulation

Investigators: *Christian Che-Castaldo, USGS, Wisconsin Cooperative Wildlife Research Unit; Jennifer Stenglein, Office of Applied Science, Fish Wildlife and Parks Division, Wisconsin Department of Natural Resources; Amélie Dolfi, Wisconsin Cooperative Wildlife Research Unit*
Funding: *Wisconsin, DNR $349,559*
Expected Completion: *March 31, 2027*

The Snapshot Wisconsin trail camera network provides continuous photo data across Wisconsin to understand the status of wildlife populations. Distribution, relative abundance indices, sex and age ratios, and abundance estimates can all be derived from trail camera data. However, Snapshot Wisconsin trail cameras are set up non-randomly – along trails and in locations that are at the discretion of volunteer trail camera monitors – and are spaced far apart relative to most home range sizes of Wisconsin's wildlife. Additionally, wildlife move and interact on a heterogenous landscape and do not conform to the assumptions of many trail camera modeling methods that assume random and independent animal movement. Variable detection probability of individuals and differences in camera viewshed all complicate the ability to get accurate estimates and metrics from existing trail camera modeling methods.

The best way for us to understand how the Snapshot Wisconsin trail camera network can provide accurate estimates and metrics for a variety of wildlife species is to have known populations. We do not have the ability to census our actual wildlife populations statewide, but a realistic simulation of Wisconsin and its wildlife could be used to provide known populations over which to test various models and estimators. Integrated step-selection analyses coupled with agent-based approaches provide rules (e.g., movement, affinity for a group) to individuals that play out on a simulated landscape to be able to observe population processes and dynamics. This could be a promising approach.

The models created by this project will provide a known animal population for researchers to use as 'truth' when developing the correct methods for occurrence, abundance indices, sex and age ratio metrics, and abundance estimates from Snapshot Wisconsin trail camera data. Additionally, the individual-based model can be used to simulate changes in animal populations to build understanding of how well the methods and metrics used can track population trend, a product of high value in wildlife decision-making.

ONGOING PROJECTS ($4,293,370 in funding)

Investigating environmental transmission of chronic wasting disease

Investigators: *Wendy Turner, Wisconsin Cooperative Wildlife Research Unit; Stuart Lichtenberg, University of Wisconsin-Madison; Daniel Walsh, USGS, Montana Cooperative Wildlife Research Unit; Daniel Storm, Wisconsin DNR; Allen Herbst, USGS NWHC; Stephanie Katircioglu, Wisconsin Cooperative Wildlife Research Unit*

Funding: *USGS Biological Threats Program, $264,305*

Expected Completion: *August 31, 2025*

Chronic wasting disease is a fatal disease affecting deer species, which has negative effects on affected populations and wildlife conservation. Chronic wasting disease is caused by an infectious misfolded protein, called a prion. These prions can be transmitted directly, from an infected to a susceptible host through close contact, or indirectly, through host contact with prions in the environment. Little is currently known about the environmental transmission pathway, and its importance in disease spread in deer populations. This project investigates environmental transmission of chronic wasting disease in white-tailed deer (*Odocoileus virginianus*) in southwestern Wisconsin. The first objective is to examine prion amounts found in soils and on plants at suspected prion reservoir sites and how these change over time. The second objective is to evaluate deer behavior at potential environmental reservoirs to assess exposure risks through both environmental reservoirs and specific host behaviors. Project outcomes will directly benefit the Wisconsin Department of Natural Resources, with findings on environmental transmission risk conducted in a high-prevalence area where the disease was first detected in Wisconsin. Our results will also benefit stakeholders working to understand and slow the spread of chronic wasting disease across North America, including federal, state and tribal agencies in at-risk areas.

Modeling host behavior and environmental transmission of chronic wasting disease

Investigators: *Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Jun Zhu, University of Wisconsin-Madison; Dan Walsh, USGS, Montana Cooperative Wildlife Research Unit; Jim Powell, Utah State University; Nurul Islam and Marie Gilbertson, Wisconsin Cooperative Wildlife Research Unit*

Funding: *USDA NIFA, NSF-NIH-USDA Ecology and Evolution of Infectious Diseases program, $2.5 million*

Expected Completion: *August 31, 2027*

Understanding the principles of infectious disease transmission is crucial for identifying management tools for disease control and prevention. Elucidating such principles is challenging in host-pathogen systems when transmission occurs both directly and indirectly through the environment. Researchers must disentangle diverse multi-scale drivers, from fine-scale host interactions with pathogens in environmental reservoirs to large-scale movements of natural populations in heterogeneous landscapes. A general analytical framework is lacking to link direct and environmental transmission processes and data streams across spatiotemporal scales. This gap limits understanding and management of a broad range of human and animal pathogens transmitted both directly and environmentally: from cholera in humans, to African swine fever in livestock, to white nose syndrome and chronic wasting disease (CWD) in wildlife. We will address this gap by developing a broadly applicable model framework, linking landscape structure, host movement ecology, pathogen distribution and transmission modes, and allowing examination of how individual-level processes affect spatiotemporal dynamics of disease within a population. This analytical approach will be applied to CWD, a fatal prion disease of free-ranging cervids. CWD is an ideal study system because the infectious agent, a mis-folded protein known as a prion, can be transmitted directly or from environmental reservoirs. Heterogeneities in host habitat, behavior, and movement mediate direct transmission, but also deposition of prions into the environment and subsequent environmental transmission. Prion kinetics in heterogeneous environments further shape transmission risk. We propose a deterministic model scaffold that formally incorporates heterogeneities in social behavior and movement with pathogen retention, transport, and infection potential in complex landscapes. A novel application of multi-scale homogenization to our models will analytically link fine-scale pathways of infection with large-scale population processes. Lab, field, and statistical analyses will parameterize prion transmission and host movement, leveraging data and expertise from Wisconsin Department of Natural Resources. We will embed competing models in an uncertainty framework that allows us to assess the relative importance of transmission pathways and to evaluate system responses to population management and landscape disturbance.

Movement of deer in southwest Wisconsin and its role in CWD spread

Investigators: *Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Daniel Storm, David MacFarland, Scott Hull, Wisconsin DNR; Daniel Walsh, USGS, Montana Cooperative Wildlife Research Unit; Marie Gilbertson, Wisconsin Cooperative Wildlife Research Unit*

Funding: *Wisconsin Department of Natural Resources,* $476,247

Expected Completion: *June 30, 2025*

This project focuses on the spatiotemporal context of how landscape heterogeneity, seasonality, and deer movement behavior (individually and in aggregate) affect chronic wasting disease (CWD) spread. The goal is to better understand the mechanisms of CWD spread and the causes of the observed directional (rather than uniform) CWD diffusion and growth across the landscape. The project will investigate the impact of CWD infection on deer movement behavior, and the reverse, the impact of deer movement behaviors and contacts on CWD spread. Understanding the times and places where deer are most likely to congregate and the weather, landscape, phenological and demographic factors that alter movement patterns and direct and indirect contact rates will help predict CWD dynamics and may inform management activities. Further, better understanding how sex- and age-specific movements and habitat selection vary according to landscape composition and configuration, weather, plant and crop phenology is of interest to ecologists and the general public and may help managers understand variation in deer population dynamics.

Wolf predation and chronic wasting disease in Wisconsin

Investigators:	*Timothy Van Deelen, University of Wisconsin - Madison; Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Eliezer Gurarie, SUNY College of Environmental Science and Forestry; Michael Menon, Wisconsin Cooperative Wildlife Research Unit*
Funding:	*Great Lakes Indian Fish and Wildlife Commission, $225,000*
Expected Completion:	*December 31, 2026*

The potential impact of selective removal of CWD-positive deer by canids like wolves and coyotes on CWD transmission dynamics is under-investigated, yet an important consideration for wildlife managers. For example, it is unknown whether canids might preferentially target CWD-infected prey, and what the consequences could be for long term population dynamics of predators, prey and disease. However, given the chronic nature of CWD and its neurological and physical effects, symptomatic individuals are expected to have a heightened risk of predation. In this project, we propose to investigate the potential effects of selective harvesting and predation by: (1) understanding the spatial and temporal patterns of wolf and coyote predation on deer, (2) developing a spatially explicit model that encapsulates dynamics of deer (including CWD), canid, and human interactions and (3) creating a generalizable, web-based tool for managers to be able to explore the consequences of targeted management strategies for CWD in the Great Lakes region. In particular, the leading edges of expanding CWD prevalence and wolf re-establishment are two phenomena that are just beginning to meet in Wisconsin. Understanding how predation might mitigate CWD spread will enable managers to quantify the payoff for maintaining wolves or coyotes on the landscape, identify areas where canid predation can be beneficial for disease control, and explore how background levels of recreational hunting of both deer and their canid predators affects these natural processes. The potential role of selective predation on CWD dynamics has enormous management significance for exercise of native peoples' treaty rights, the multi-billion-dollar recreational sport of deer hunting, and the important resources generated for conservation and management of all wildlife.

Investigating causes and impacts of pneumonia on white-tailed deer

Investigators: *Pauline L. Kamath, University of Maine, Orono; Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Marie Pinkerton, University of Wisconsin-Madison; Daniel Walsh, USGS, Montana Cooperative Wildlife Research Unit; Daniel Storm, Wisconsin DNR; Zoe Barandongo, University of Maine, Orono (previously WCWRU)*

Funding: *Wisconsin DNR, $350,179*

Expected Completion: *December 31, 2024*

Within the United States, deer represent an important source of food and revenue, while also hosting pathogens that put healthy deer populations at risk and jeopardize human health and food security. Developing tools for disease surveillance in important recreational and sustenance species like deer will thus be paramount for detecting and responding to outbreaks and spillover events. In Wisconsin, the Department of Natural Resources has been monitoring the white-tailed deer (*Odocoileus virginianus*) population for chronic wasting disease (CWD) since 1999. Recently, surveillance efforts have identified additional mortalities in deer attributed to pneumonia. Interestingly, such mortalities have been observed in deer both with and without CWD, suggesting the presence of a yet unknown etiologic agent in this population. This study will compare the respiratory tract microbial communities of deer that died with pneumonia to those that died without pneumonia, and to hunter-harvested deer. Preliminary results show high prevalence (9.8-41.4% of BLAST-ed reads) of the Gram-negative bacteria *Fusobacterium necrophorum* in pneumonia-positive individuals, and a lack thereof in control individuals. While *F. necrophorum* has been previously identified as a cause of mortality in deer, it remains unclear whether it is the direct cause of pneumonia-related mortality in this case or an opportunistic colonizer of already diseased deer. This project aims to confirm the etiologic agent(s) responsible, characterize their distribution, identify risk-factors underlying host mortality, and understand the association with CWD. Ultimately, this information will help inform management strategies and developing disease surveillance systems for the Wisconsin deer population.

Assessing risks associated with CWD-positive deer carcasses, scavenging, and carnivore movement within a CWD endemic area

Investigators: *Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Dan Storm, Office of Applied Science, Fish Wildlife and Parks Division, Wisconsin Department of Natural Resources; Marie Gilbertson, Heather Inzalaco and Aaron Groves, Wisconsin Cooperative Wildlife Research Unit*

Funding: *USDA-APHIS, $213,334*

Expected Completion: *August 31, 2025*

Scavengers may mitigate CWD transmission risk through removal of infectious materials from carcass sites but may also transport CWD prions into new areas through wide-ranging movement behavior. Investigations of carcass sites and scavenger-mediated management of CWD-affected areas have remained underexplored due to limitations in sensitivity of prion detection tools. CWD-positive deer carcasses can act as important sources of environmental

prion contamination and subsequent transmission, by depositing CWD prions from infectious tissues into the environment, creating “hot spots" for environmental CWD transmission. However, few carcasses go unnoticed or unutilized by scavenging wildlife, and cervid-consuming predators and scavengers may alter patterns of disease spread through removal or dispersal of prions on the landscape. This project fills key gaps in knowledge about how scavengers alter prion deposition from CWD-infected carcasses into the environment at local and landscape scales through assessing prion distributions at deer mortality sites and quantifying scavenger foraging and movement behaviors in a CWD endemic areas. Our objectives are to 1) assess the effects of CWD-positive carcasses and vertebrate scavengers on prion deposition and distribution in soils at deer carcass sites and 2) quantify animal activity at deer carcass sites and scavenger movement ecology to evaluate host exposure risk and the effects of scavengers on carcass consumption and prion removal or dissemination. This project will improve understanding of prion dynamics in soils at CWD-positive carcass sites and how scavenging of CWD-positive carcasses influences those dynamics. Findings from this project will provide information that is directly relevant to state regulatory and oversight agencies. Private landowners will also find this information valuable when making decisions regarding deer carcass or gut pile disposal practices conducted on their properties.

Looking backwards to know where to go: leveraging historical data to guide CWD management

Investigator: *Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Daniel Walsh, USGS, Montana Cooperative Wildlife Research Unit; Daniel Storm, Wisconsin DNR; John Draper Wisconsin/Montana Cooperative Wildlife Research Units*

Funding: *USGS Emerging Diseases, $264,305*

Expected Completion: *December 31, 2024*

Management of chronic wasting disease (CWD) is one of the most significant challenges facing many wildlife agencies in North America. One of the difficulties in managing this disease is that CWD-affected species range across jurisdictional boundaries; yet currently there is little communication or coordination among management agencies regarding CWD response. Unified efforts to evaluate the effectiveness of the suite of management actions that agencies have applied for disease control are lacking. This project is aimed at filling these gaps by leveraging historical information maintained by state agencies to evaluate impacts of CWD management activities on population and disease dynamics and establishing a framework that will improve coordination and information exchange. This framework will serve as the basis for the creation of an adaptive management strategy for CWD mitigation among Midwestern, state and federal, wildlife management agencies. The objectives of this project are to investigate the impacts of deer harvest regulations on the realized harvest within and between states in the Midwest, tie the analytical results to CWD dynamics to determine the harvest regulations most likely to have the desired outcome for managing CWD, and plan an adaptive management workshop for participating state agencies to effectively use the results of the modeling effort regarding harvest strategies.

PROJECTS COMPLETED THIS YEAR

Transmission and evolution of a persistent pathogen: anthrax infection dynamics comparing two natural systems

Investigators: *Wendy C. Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Pauline L. Kamath, University of Maine, Orono; Henriette van Heerden and Sunday Ochai, University of Pretoria; Yen-Hua Huang, Zoe Barandongo, Amélie Dolfi, Kimberlie Vera, Wisconsin Cooperative Wildlife Research Unit*

Funding: *National Science Foundation, Ecology and Evolution of Infectious Diseases Program, $2.5 million*

Completion: *September 30, 2024*

Anthrax is a globally distributed disease of wildlife, livestock, and humans. Successful prediction of and response to outbreaks of anthrax is limited by a lack of understanding of the geographic differences in the ecology of the pathogen as well as the pattern of disease outbreaks. This project investigated the roles of host, pathogen, and environment to understand how the pathogen-host interaction evolves and contributes to the differences in anthrax occurrence between two study areas: Etosha National Park, Namibia, and Kruger National Park, South Africa. The project built upon detailed records of disease and population dynamics in each park as well as archived pathogen samples and new data collection and analyses and mathematical modeling to understand these different dynamics. We linked variability in *B. anthracis* genomes to phenotype (i.e., pathogen survival in the environment, virulence to hosts, and transmission across host and geographic range). We identified host immunological signatures of infection and genes under pathogen-mediated selection in four species: plains zebra (*Equus quagga*), greater kudu (*Tragelaphus strepsiceros*), blue wildebeest (*Connochaetes taurinus*) and common impala (*Aepyceros melampus*). We are building landscape-level models of epidemiology and population dynamics incorporating host movement, transmission routes, pathogen virulence, and host resistance. Finally, we are develop models predicting anthrax transmission dynamics across ecosystems. In a broader sense, this research aimed to facilitate the development of predictive tools to better manage public health and related policies for complex, multi-host zoonotic diseases such as anthrax.

Assessing chronic wasting disease environmental prion reservoirs

Investigators: *Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Dan Storm, Scott Hull, Dave MacFarland, Office of Applied Science, Fish Wildlife and Parks Division, Wisconsin Department of Natural Resources; Marie Gilbertson, Wisconsin Cooperative Wildlife Research; Dan Walsh, USGS, Montana Cooperative Wildlife Research Unit; Heather Inzalaco, Wisconsin Cooperative Wildlife Research Unit*

Funding: *Wisconsin DNR, $75,000*

Completion: *June 30, 2024*

The prevalence of CWD continues to increase endemically and spread broadly over North America. However, transmission risks and CWD dynamics associated with environmental

prion reservoirs remain poorly understood due to the lack of efficient diagnostic tools. With advances in prion assay technology (RT-QuIC), the proposed research aimed to fill key gaps in knowledge about ecologically- and management-relevant environmental sources of CWD transmission. For example, dynamic scent-marking sites (i.e., deer scrapes) are thought to be an important source of CWD transmission. Forehead and periorbital glands play a central role in scrape site marking, however little is known regarding the relative prion loads these glands produce or their consequent risk for CWD transmission. In addition, soils associated with CWD-infected carcass sites may act as prion reservoirs and lead to indirect exposure of cervids and other wildlife to CWD. However, prion loads and accumulation dynamics at these sites are unknown. Furthermore, scavenging of CWD-infected carcasses could increase the spatial extent of prion contamination associated with these carcasses—but may simultaneously dilute the "hot spot" nature of these sites. Understanding the role of scavenging wildlife in structuring prion contamination in the environment would provide valuable information for carcass management in CWD-affected areas. This project aimed to fill key gaps in knowledge about environmental prion dynamics by advancing RT-QuIC as a tool for examining prion presence/absence and loads associated with host, landscape, and community-level factors of importance in CWD ecology. This project built off previous work funded by the WI-DNR to leverage prion assay technology (real-time quaking-induced conversion; RT-QuIC) to detect chronic wasting disease (CWD) prions in deer tissues and environmental reservoirs. Our aim was to evaluate prion loads in tissues and biotic and abiotic environmental sources (e.g., soil, feces from scavenger species) that are ecologically relevant for CWD dynamics. To better understand environmental CWD dynamics, we aimed to semi-quantitatively characterize CWD prion loads in a range of deer tissues, deer scent glands, soils at CWD-infected deer carcass sites, and scavenger scats. Outcomes aimed to provide an understanding of the extent and significance of prion contamination in the environment, which can subsequently inform management actions and disease prediction models.

Influence of chronic wasting disease on deer survival and population dynamics in southwest Wisconsin

Investigator:	*Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Daniel Walsh, USGS, Montana Cooperative Wildlife Research Unit; Daniel Storm, David MacFarland, Scott Hull, Wisconsin DNR; Alison Ketz, Wisconsin Cooperative Wildlife Research Unit*
Funding:	*Wisconsin Department of Natural Resources, $301,527*
Completion:	*December 8, 2023*

Chronic wasting disease (CWD) was discovered in Wisconsin white-tailed deer harvested in fall 2001. Since then, CWD prevalence has increased in all sex and age classes and increased in spatial extent. For example, in the highest-prevalence areas, prevalence exceeds 30 percent in adult males and 15 percent in adult females. It is uncertain what impact CWD is currently having on deer populations and what impact it may have as prevalence increases. Studies in the western USA have found that CWD negatively impacts elk and mule deer survival and population size, but no field research has documented the impact of CWD on white-tailed deer survival or population growth in Wisconsin. Further, there is not any ongoing work in the Midwest that specifically addresses the direct impact of CWD on deer survival. Additionally,

there is evidence for a genetic basis in variation in CWD-susceptibility, but it is not known if survival differs between deer of differing genetic makeup. Not knowing the contribution of CWD, predators, habitat change, or other potential factors makes it difficult to develop an effective management strategy. A better understanding of factors affecting survival and population growth would enable more informed deer population management, by facilitating antlerless quota adjustment in the face of changes in mortality rates from other sources. Studying the impact of CWD, or of any one source of mortality, on survival and population growth is difficult. The impact depends in part on competing sources of mortality and reproduction rates, all of which need to be quantified. A robust and sophisticated modeling framework is needed to understand spatiotemporal patterns in CWD prevalence and deer demographic rates. The goal of this research was to provide technical information, scientific guidance, and related assistance to WDNR scientists and policy makers regarding deer population dynamics in the CWD-endemic region of southwestern Wisconsin. This project was being done in collaboration with Daniel Storm (Wisconsin Department of Natural Resources) and Dan Walsh (US Geological Survey).

PUBLICATIONS AND PROFESSIONAL PAPERS

Peer-reviewed articles

Unit Staff (bolded) and unit-associated students/scientists/postdocs (underlined)

Dolfi, A., K. Kausrud, K. Rysava, C. Champagne, Y-H Huang, Z.R. Barandongo, **W.C. Turner**. 2024. Season of death, pathogen persistence and wildlife behavior alter the number of anthrax secondary infections from environmental reservoirs, *Proceedings of the Royal Society B - Biological Sciences*, 291: 20232568. https://doi.org/10.1098/rspb.2023.2568



Gilbertson, M.L.J., L.J. Long, H.N. Inzalaco, **W.C. Turner**, D.J. Storm. 2024. Effective field sampling of rectoanal mucosa-associated lymphoid tissue for antemortem chronic wasting disease testing in white-tailed deer, *Journal of Wildlife Diseases*, 60 (4): 996–1003. https://doi.org/10.7589/JWD-D-24-00020

Article highlighted on journal cover, with photo by Gary Jones

Hoff, S., B.A. Mosher, M. Watson, L. Johnson, E. Olson, D. O'Dell, C.J. Pendergast, D.A. Bogan, C.J. Herzog and **W.C. Turner**. 2024. Widespread occupancy of the Endangered northern myotis on Northeastern Atlantic Coastal Plain islands, *Endangered Species Research,* 54:141-153. https://doi.org/10.3354/esr01335

Hoff, S., C.J. Pendergast, L. Johnson, E. Olson, D. O'Dell, Z. Dowling, K.M. Gorman, C. Herzog and **W.C. Turner**. 2024. Seasonal roost characterization and fall behavior of coastal northern myotis (*Myotis septentrionalis*) populations, *Journal of Mammalogy*, 105:(2): 277-288. https://doi.org/10.1093/jmammal/gyad102

Inzalaco, H.N., E.E. Brandell, S. Wilson, M. Hunsaker, D.R. Stahler, K. Woelfel, D.P. Walsh, T. Nordeen, D.J. Storm, S.S. Lichtenberg, **W.C. Turner**. 2024. Detection of prions from spiked and free-ranging carnivore feces, *Scientific Reports*, 14: 3804. https://doi.org/10.1038/s41598-023-44167-7

Prentice, M.B., M.L.J. Gilbertson, D.J. Storm, **W.C. Turner**, D.P. Walsh, M.E. Pinkerton, P.L Kamath. 2024. Metagenomic sequencing sheds light on microbes putatively associated with pneumonia-related fatalities of white-tailed deer (*Odocoileus virginianus*), *Microbial Genomics*, 10:001214. https://doi.org/10.1099/mgen.0.001214

Şen, B., **C. Che-Castaldo**, H. J. Lynch, F. Ventura, M.A. LaRue & S. Jenouvrier. 2024. Detecting stochasticity in population time series using a non-parametric test of intrinsic predictability. *Methods in Ecology and Evolution*, 15(10), 1834-1846, https://doi.org/10.1111/2041-210X.14423

Şen, B., **C. Che-Castaldo** & H.R. Akçakaya. 2024. Species distribution models built with opportunistic data can distinguish source populations from sinks. *Journal of Animal Ecology* 00:1–11. https://doi.org/10.1111/1365- 2656.14201

Wu, H., C. Flynn, C. Hall, **C. Che-Castaldo**, D. Samaras, M. Schwaller & H.J. Lynch. 2024. Penguin colony georegistration using camera pose estimation and phototourism. *PLOS ONE* 9(10): e0311038. https://doi.org/10.1371/journal.pone.0311038

Posters and Papers Presented at Professional Meetings
Unit Staff (bolded) and students/scientists/postdocs (underlined)

Che-Castaldo, C. & M. Schwaller, Scaling Up: Satellite Super-Resolution Modeling for Large-Scale Penguin Population Monitoring. International Statistical Ecology Conference, Swansea, UK, July 2024 (Contributed Poster)

Che-Castaldo, C., M. Schwaller & H. Lynch. Identifying Population Tipping Points Through Imagery Super-resolution. NASA Biological Diversity and Ecological Conservation Team Meeting, Silver Spring, MD, May 2024 (Invited Talk)

Dolfi, A. M. Gilbertson, L. White, **W. Turner** Pathogen transmission, host movement, and landscape features alter the spatial distribution of environmentally transmitted pathogens, Ecology and Evolution of Infectious Diseases annual meeting, Palo Alto, CA June 2024 (Contributed Poster)

Gilbertson, M.L.J. A. Ketz, M. Hunsaker, D.P. Walsh, D.J. Storm, **W.C. Turner**. Seasonal variation in white-tailed deer (Odocoileus virginianus) habitat selection, encounter locations, and chronic wasting disease transmission potential. Wisconsin Chapter of The Wildlife Society Winter Meeting, Green Bay, WI, February 2024 (Contributed Talk)

Gilbertson, M., A. Ketz, D. Walsh, D. Storm, **W. Turner**. Disease-induced impacts on movement in a large ungulate, Ecology and Evolution of Infectious Diseases annual meeting, Palo Alto, CA June 2024 (Contributed Poster)

Gilbertson, M.L.J. A. Ketz, M. Hunsaker, D.P. Walsh, D.J. Storm, **W.C. Turner**. Seasonal variation in white-tailed deer (Odocoileus virginianus) habitat selection, encounter locations, and chronic wasting disease transmission potential. Wisconsin Chapter of The Wildlife Society Winter Meeting, Green Bay, WI, February 2024 (Contributed Talk)

Inzalaco, H. N. E. E. Brandell, S. Wilson, M. Hunsaker, D. R. Stahler, K. Woelfel, D. P. Walsh, T. Nordeen, D. J. Storm, S. S. Lichtenberg, **W. C. Turner**. A prion in a poop-stack: detection tools and carnivore-based surveillance for chronic wasting disease. The Wildlife Society annual meeting, Louisville, KY, November 2023 (Contributed Poster)

Ketz, A. D.J. Storm, **W.C. Turner**, G. Stauffer, D.P. Walsh. Progression of a chronic wasting disease epizootic: A spatiotemporal integrated population model, The Wildlife Society annual meeting, Louisville, KY, November 2023 (Contributed Oral)

McGahan, I. F. Mandujano, D. Storm, M. Gilbertson, S. Lichtenberg, J. Powell, D. Walsh, J. Zhu, **W. Turner**. Modeling host behavior and environmental transmission of chronic wasting disease. Conference of Research Workers in Animal Diseases (CRWAD), Chicago, IL, January 2024 (Contributed Poster)

Vera, K.B., M.L.J. Gilbertson, R.S. Hetem, W.M. Strauss, H. Joel, Y.-H. Huang, C.C. Cloete, J.W. Kilian, P.L. Kamath, H. van Heerden, J.K.E. Mfune, **W.C. Turner**. The effects of severe drought on herbivore movement patterns, physiology, survival and anthrax risk in Etosha National Park, Namibia, The Wildlife Society annual meeting, Louisville, KY, November 5-9, 2023 (Contributed Oral)

Turner, W.C. Chronic wasting disease transmission dynamics from environmental reservoirs. Wisconsin Chapter of The Wildlife Society Winter Meeting, Green Bay, WI, February 2024 (Contributed Talk)

Turner, W.C. Highly persistent environmentally-mediated pathogens reveal key drivers of transmission heterogeneity. Ecology and Evolution of Infectious Diseases Annual Conference, Palo Alto, CA, June 2024 (Invited Keynote)

Theses and Dissertations

Dolfi, A. 2024. *Using simulation models to determine mechanisms driving outbreak dynamics and spatial distribution of environmentally transmitted pathogens,* Ph.D. UW-Madison Wildlife Ecology program,

Ochai, S.O. 2024. *Diagnoses and the roles of host and environment in the transmission of anthrax in Kruger National Park.* Ph.D. in Veterinary Tropical Diseases at University of Pretoria, South Africa.

HONORS AND AWARDS

Assistant Unit Leader:
2024 Golden Goose Award Recipient, The American Association for the Advancement of Science, https://www.goldengooseaward.org

PROFESSIONAL ACTIVITIES AND OUTREACH

Professional Activities

Unit Leader:
Associate Editor, *Journal of Wildlife Diseases* (August 2022-present)
Academic Editor, *PLOS ONE* (December 2018 – present)

Member, Institutional Biosafety Committee, U.S. Geological Survey (2024)

Member, Chronic Wasting Disease Science Team, U.S. Geological Survey, member (August 2021-present)

Co-organizer, Departmental Seminar Committee, Department of Forest and Wildlife Ecology, UW–Madison (2022-present)

Dinner guest, Women in Science and Engineering career mentorship Industry Dinner event for female and underrepresented gender undergraduates, UW-Madison Housing Learning Community, December 2023

Panelist, Demystifying the process of academic job searches, put on by Justice, Equity, Diversity, Inclusion committee, Department of Forest and Wildlife Ecology, UW-Madison, October 2023

Assistant Unit Leader
Representative, Justice, Equity, Diversity, and Inclusion Committee, Forest and Wildlife Ecology Department, UW–Madison (2023-present)

Teaching

Unit Leader:
Guest lectures
FWE 379 Principles of Wildlife Management & Conservation, UW – Madison, Spring 2024
FWE 548 Diseases of Wildlife, UW–Madison, Fall 2023
FWE 360 Extinction of Species, UW–Madison, Fall 2023

Media Coverage

Forbes, 2024, Basic Research Matters: Meet The Winners Of 2024's Golden Goose Awards, https://www.forbes.com/sites/michaeltnietzel/2024/10/04/basic-research-matters-meet-the-winners-of-2024s-golden-goose-awards/

The American Association for the Advancement of Science, 2024, 13th Annual Golden Goose Award Honors Scientists Whose "Silly Sounding Research" Lead to Major Breakthroughs, https://www.aau.edu/newsroom/leading-research-universities-report/13th-annual-golden-goose-award-honors-scientists