USGS WISCONSIN COOPERATIVE WILDLIFE RESEARCH UNIT

FISCAL YEAR 2023

(October 1, 2022-September 30, 2023)



ANNUAL REPORT

USGS WISCONSIN COOPERATIVE WILDLIFE RESEARCH UNIT

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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, 2022-September 30, 2023

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
Eric Kruger	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 *(effective 9/11/2023)*
Carolyn Rindahl/Susan Laufenberg	Administrative Assistant, University of Wisconsin-Madison

Cooperating Scientists

Dr. Bruce Klein	Professor, School of Medicine and Public Health, University of Wisconsin-Madison
Dr. Zach Peery	Associate Professor, Department of Forest and Wildlife Ecology, University of Wisconsin-Madison
Dr. Ben Zuckerberg	Associate Professor, Department of Forest and Wildlife Ecology, University of Wisconsin-Madison

ACADEMIC PERSONNEL

Academic Staff

Alison Ketz (Wendy Turner) (Scientist II). Alison is a statistician building an integrated population model to understand white-tailed deer population dynamics in the chronic wasting disease (CWD) endemic region of southwest Wisconsin and the effects of CWD on deer survival.

Marie Gilbertson (Wendy Turner) (Scientist I). 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.

Post-doctoral Researcher

Heather Inzalaco (Wendy Turner). Heather is developing and managing 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.

Graduate Students

Completed degrees

Zoe Barandongo (Wendy Turner) (Ph.D., Wildlife). Zoe studied microbiological, molecular and genetic factors that affect the persistence, infectivity and virulence of *Bacillus anthracis* strains in southern Africa, with a focus on bacteriophages in soils and bacterial genomes. (*Completed August 2023*)

Heather Inzalaco (Wendy Turner) (Ph.D., Comparative Biomedical Sciences). Heather studied the indirect transmission pathway for chronic wasting disease, looking at prion accumulation in soils at carcass sites, supplemental feeding/bait sites, natural areas of deer aggregation and in ticks. (*Completed May 2023*)

Samantha Hoff (Wendy Turner) (Ph.D., Ecology and Evolutionary Biology, University at Albany, co-advised by Ing-Nang Wang). Samantha studied the ecology of the northern long-eared bats, and mechanisms supporting persistence of coastal populations despite white-nose syndrome infection, including factors influencing occupancy, hibernation behavior, and population genetics. (*Completed May 2023*)

Matt Hunsaker (Wendy Turner) (M.S., Wildlife). Matt investigated how movement patterns, activity patterns, and mate search strategies of male white-tailed deer change over the breeding season, and how these are affected by the timing of hunting season. (*Completed May 2023*)

Casey Pendergast (Wendy Turner) (M.S., Ecology and Evolutionary Biology, University at Albany, co-advised by Ing-Nang Wang). Casey studied foraging activity and diet of coastal northern long eared bat populations during the hibernation period. (*Completed May 2023*)

Kamini Govender (Wendy Turner) (M.S., Veterinary Science, University of Pretoria, co-advised by Henriette van Heerden). Kamini studied *Bacillus anthracis* spore persistence among pathogen strains and in different soil types from Kruger and Etosha National Parks in southern Africa. (*Completed November 2022*)

Prudent Mokgokong (Wendy Turner) (M.S., Veterinary Science, University of Pretoria, co-advised by Henriette van Heerden). Prudent conducted whole genome analysis of virulence factors in isolates of *Bacillus anthracis* from Kruger National Park, South Africa. (*Completed November 2022*)

New and continuing graduate students

Amélie Dolfi (Wendy Turner) (Ph.D., Wildlife). Amélie is developing models of anthrax transmission dynamics. She uses 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.

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.

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 developing improved serological and molecular techniques for identifying *Bacillus anthracis* infections versus genetically similar microbial neighbors.

Nurul Islam (Wendy Turner) (Ph.D., Wildlife) Nurul is a new graduate student/veterinarian developing a research project on white-tailed deer behaviors and chronic wasting disease transmission risk in southwest 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 a new graduate student developing a project on coyote and bobcat movement ecology, predation/scavenging of white-tailed deer, and effects on chronic wasting disease spread.

NEW PROJECTS ($288,334 in funding)

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, Wisconsin Cooperative Wildlife Research*

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

Expected Completion: *August 31, 2024*

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.

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*

Funding: *Wisconsin DNR, $75,000*

Expected Completion: *June 30, 2025*

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 can 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 fills 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 builds 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 is 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 aim 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 will provide an understanding of the extent and significance of prion contamination in the environment, which can subsequently inform management actions and disease prediction models.

ONGOING PROJECTS ($6,702,666 in funding)

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*

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.

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*

Funding: *Wisconsin DNR, $322,394*

Expected Completion: *August 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.

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*

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.

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

Investigator: *Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Alison Ketz, University of Wisconsin-Madison*
Funding: *Wisconsin Department of Natural Resources, $375,415*
Expected Completion: *June 30, 2024*

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 is 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 is being done in collaboration with Daniel Storm (Wisconsin Department of Natural Resources) and Dan Walsh (US Geological Survey).

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

Investigator: *Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit*
Funding: *Wisconsin Department of Natural Resources,* $476,247
Expected Completion: *June 30, 2024*

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.

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*
Funding: *USGS Emerging Diseases, $264,305*
Expected Completion: *August 31, 2023*

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.

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, University of Pretoria*

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

Expected Completion: *November 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 investigates 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 builds on 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 are linking 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 are identifying 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 will develop models predicting anthrax transmission dynamics across ecosystems. In a broader sense, this research will facilitate the development of predictive tools to better manage public health and related policies for complex, multi-host zoonotic diseases such as anthrax.

PROJECTS COMPLETED THIS YEAR

A Retrospective Analysis of California Spotted Owl Territory Occupancy in Southern California

Investigator: *M. Zachariah Peery, Department of Forest and Wildlife Ecology, University of Wisconsin-Madison*
Funding: *U.S. Fish and Wildlife Service, (RWO-147)*
Completion: *December 31, 2022*

Spotted owls reside at the epicenter of forest management debates in the western US. The current status of the southern California spotted owl population is not well understood following the end of our demographic study in the San Bernardino Mountains in 1998. However, semi-regular occupancy surveys have been conducted since that time that include most, if not all, of the territories surveyed as part of the original demography study. This project analyzed spotted owl occupancy data, spanning a 32-year period (1988 to 2019), to address the current territory occupancy rate of California spotted owls in the San Bernardino Mountains, the trend in the territory occupancy rate from 1998 to 2019, and how territory occupancy has been affected by factors such as habitat loss due to wildfire and fuels treatments.

Estimating grassland bird populations to inform landscape-level conservation in Wisconsin

Investigators: *Benjamin Zuckerberg, University of Wisconsin-Madison, and Christine A. Ribic, USGS, University of Wisconsin-Madison*
Funding: *U.S. Fish and Wildlife Service, (RWO-144)*
Completion: *April 3, 2023*

A primary goal of the Upper Mississippi River and Great Lakes Joint Venture (UMRGL JV) is to “strive for sustainable populations of all birds through regionally coordinated conservation actions based on the best (or state-of-the-art) scientific information and techniques available." To achieve this goal, accurate and unbiased bird population estimates are needed. Flawed inferences about population status can waste limited resources or prevent managers from recognizing when populations are vulnerable. Thus, the need for robust population estimates is apparent. The goal of this project was to provide an assessment of Partners-In-Flight (PIF) population estimates in comparison to those derived from Wisconsin’s 2nd BBA point-count project, and to integrate Breeding Bird Atlas (BBA) and Breeding Bird Survey (BBS) data for analysis of Wisconsin’s grasslands as well as to predict population estimates to the entire UMRGL JV region. We used Wisconsin’s BBA point-count data to build species-specific hierarchical models that incorporated habitat and detection covariates to derive population estimates for 20 species that vary in their abundance and breeding habitat and compared PIF and our BBA derived estimates for all focal species, constructed a shared model that integrates BBA and BBS data and compared those estimates to both “single” (BBS only and BBA only) data estimates, demonstrated the applicability of our shared model to determine the importance of three focal grassland landscapes in Wisconsin for two “umbrella” grassland species, and estimated population size for the 20 species across the UMRGL region using BBA data from three states (MN, OH, WI) that have at least two years of BBA point-count data, and BBS data from all states within the UMRGL JV region.

CWD-prion accumulation dynamics at bait sites for free-ranging deer

Investigators: *Wendy Turner, USGS, Wisconsin Cooperative Wildlife Research Unit; Stuart Lichtenberg, University of Wisconsin-Madison*

Funding: *USDA APHIS Wildlife Services, Wild Cervid Chronic Wasting Disease Management and Response Activities, $216,635*

Completion: *June 30, 2023*

Attracting deer with food or minerals to specific locations for the purpose of sport hunting, observation, or tagging is a common practice. CWD-infected deer shed prions into the environment, raising the possibility that bait sites in CWD zones may become "hot spots" of prion deposition. Regulation of deer baiting is inconsistent across jurisdictions, and no empirical data have been reported regarding the impact of deer baiting on prion deposition onto the landscape. The project addressed this critical knowledge gap and provided data that can be used to inform regulatory decision making. This project quantified the extent of prion deposition at former and active bait sites within CWD zones in southern Wisconsin and Tennessee. This work provides insight into environmental transmission risk and for future decisions regarding management regulations and recommendations for deer baiting.

PUBLICATIONS AND PROFESSIONAL PAPERS

Peer-reviewed articles
Unit Staff (bolded) and students/scientists/postdocs (underlined)

Barandongo, Z.R. A.C. Dolfi, Y-H. Huang, K. Rysava, S.A. Bruce, P.L. Kamath, H. van Heerden and **W.C. Turner**. 2023. The persistence of time: the lifespan of *Bacillus anthracis* spores in environmental reservoirs. *Research in Microbiology*, https://doi.org/10.1016/j.resmic.2023.104029

Fry, T. F. K.; Ketz, A.C., Duncan, C., Van Deelen, T. R., Goldberg, T. C., & Atwood, T. L., (2023) Longitudinal assessment of relationships between changing environmental conditions and the physiology of Southern Beaufort sea polar bears (*Ursus maritimus*). *Global Change Biology,* 00, 1–16. doi: https://doi.org/10.1111/gcb.16883

Fry, T. F. K.; Owens, L. A., Ketz, A. C. Goldberg, T. C. & Atwood, T. L., (in press) Serum Virome of Southern Beaufort Sea Polar Bears (*Ursus maritimus*). *Conservation Physiology,* 11(1) coad054, https://doi.org/10.1093/conphys/coad054

Gilbertson, M. L. J., E. E. Brandell, M. Pinkerton, N. Meaux, M. Hunsaker, D. Jarosinski, W. Ellarson, D. P. Walsh, D. J. Storm, **W. C. Turner.** 2022. Cause of death, pathology, and chronic wasting disease status of white-tailed deer mortalities in Wisconsin. *Journal of Wildlife Diseases.* 58(4): 803-815. https://doi.org/10.7589/JWD-D-21-00202

Gilbertson, M.L.J., A. Ketz, M. Hunsaker, D. Jarosinski, W. Ellarson, D.P. Walsh, D.J. Storm, **W.C. Turner**. 2022. Agricultural land use shapes dispersal in white-tailed deer (*Odocoileus virginianus*), *Movement Ecology*, 10:43. https://doi.org/10.1186/s40462-022-00342-5

Hoff, S., C.J. Pendergast, L. Johnson, E. Olson, D. O'Dell, Z. Dowling, K.M. Gorman, C. Herzog and **W.C. Turner**. In press. Seasonal roost characterization and fall behavior of coastal northern myotis (*Myotis septentrionalis*) populations, *Journal of Mammalogy*

Ketz, A. C., Storm, D. J., Barker, R. E., Apa, A. D., Oliva-Aviles, C., & Walsh, D. P. (2023) Assimilating ecological theory with empiricism: Using constrained generalized additive models to enhance survival analyses, *Methods in Ecology and Evolution*, 00, 1–16. https://doi.org/10.1111/2041-210X.14057

Huang, Y.-H., N. Owen-Smith, M.D. Henley, J.W. Kilian, P.L. Kamath, S.O. Ochai, H. van Heerden, J.K.E. Mfune, W.M. Getz, **W.C. Turner**. 2023. Variation in herbivore space use: comparing two savanna ecosystems with different anthrax outbreak patterns in southern Africa, *Movement Ecology,*11:46. https://doi.org/10.1186/s40462-023-00385-2

Inzalaco, H.N., F. Bravo Risi, R. Morales, D.P. Walsh, D.J. Storm, **W.C. Turner**, S.S. Lichtenberg. 2023. Ticks harbor and excrete chronic wasting disease prions, *Scientific Reports,* 13:7838. https://doi.org/10.1038/s41598-023-34308-3

Ochai, S.O., J.E. Crafford, P.L. Kamath, **W.C. Turner**, H. van Heerden. 2023. Development of conjugated secondary antibodies for wildlife disease surveillance, *Frontiers in Immunology*, 14: 1221071. https://doi.org/10.3389/fimmu.2023.1221071

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

Dolfi, A., K. Kausrud, K. Rysava, C. Champagne, Y-H Huang, Z.R. Barandongo, **W.C. Turner.** Season of death, pathogen persistence and wildlife behavior alter number of anthrax secondary infections from environmental reservoirs, Center for Ecology and the Environment Spring Symposium, UW-Madison, 1-2 May, 2023. (Contributed Oral)

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. Wildlife Disease Association Annual Meeting. Athens, Georgia, USA. July 30 – August 4, 2023 (Contributed Oral)

Gilbertson, M.L.J., A. Ketz, M. Hunsaker, D. Jarosinski, W. Ellarson, D.P. Walsh, D.J. Storm, **W.C. Turner**. Land use shapes dispersal in white-tailed deer (*Odocoileus virginianus*). 29th Annual Conference, The Wildlife Society, Spokane, Washington, 6-10 November 2022. (Contributed Oral)

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. 4th International Chronic Wasting Disease Symposium. Denver, Colorado, USA. May 30 – June 2, 2023. (Contributed Poster)

Inzalaco, H.N., E.E. Brandell, S. Wilson, M. Hunsaker, D.R. Stahler, K. Woelfel, D.P. Walsh, D.J. Storm, S.S. Lichtenberg, **W.C. Turner**. A prion in a poop-stack: detection tools and carnivore-based surveillance of chronic wasting disease. 4th International Chronic Wasting Disease Symposium. Denver, Colorado, USA. May 30 – June 2, 2023. (Contributed Poster)

Inzalaco, H.N., S.S. Lichtenberg, F. Bravo Risi, R. Morales, D.P. Walsh, D.J. Storm, **W.C. Turner**, J.A. Pedersen. Black-legged ticks (*Ixodes scapularis*) harbor and excrete chronic wasting disease prions from infected blood meals. 29th Annual Conference, The Wildlife Society, Spokane, Washington, 6-10 November 2022. (Contributed Poster)

Ketz, A. Anomaly detection: A multivariate time series algorithm for predicting changes in real time. Oral Presentation for the Wildlife Society Annual Conference, November 8, 2022, Spokane, Washington. (Contributed Oral)

Ochai, S.O., Ahmady-Moghaddam, N., Ströbele, J., Lenfers, U.A., Dolfi, A., Snyman, L., Archer, E., Turner, W.C., Clemen, T., & van Heerden, H. The role of host and environment in the transmission of anthrax: An agent-based modelling approach. Savanna Science Networking Meeting, Skukuza, South Africa, 6-9 March, 2023. (Contributed Oral)

Ochai, S.O., Hassim, A., Lekota, K.E., van Schalkwyk, L.O., de Klerk-Lorist, L., Turner, W. & van Heerden, H. Soil ecosystem diversity: the elusive piece of the puzzle in anthrax enzootics in Kruger National Park? Savanna Science Networking Meeting, Skukuza, South Africa, 6-9 March, 2023. (Contributed Oral)

Ochai, S.O., J. Crafford, P..L. Kamath, **W.C. Turner**, and H. van Heerden. Development of conjugated secondary antibodies for wildlife disease surveillance: implications for infectious disease surveillance, Inaugural Africa One Health Network Workshop, Accra, Ghana, 3-7 October, 2022. (Contributed Oral)

Turner, W.C. Anthrax in African wildlife: the role of bacterial diversity in transmission dynamics of a clonal pathogen. Microbial Population Biology, Gordon Research Conferences, Andover, NH, July, 2023. (Invited Oral)

Turner, W.C., Z.R. Barandongo, A. Dolfi. Anthrax transmission dynamics: heterogeneity in pathogen survival and host behavior affects secondary infections arising from infectious carcass sites. Wildlife Disease Association annual meeting, Athens, GA, August, 2023. (Contributed Oral)

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. International Congress for Conservation Biology, Kigali, Rwanda, 23-27 July, 2023. (Contributed Oral)

Walton, D., M. L. J. Gilbertson, M. Cunningham, D. Onorato, J. Ringer, H. Stewart, M. E. Craft. Monitoring Seroprevalence of Infectious Diseases in the Florida Panther. Wildlife Disease Association Annual Meeting. Athens, Georgia, USA. July 30 – August 4, 2023 (Contributed Oral)

Data Publications

Inzalaco, H. N. & Lichtenberg, S. S. 2023. Ticks harbor and excrete chronic wasting disease prions. US Geol. Surv. Data Release https://doi.org/10.5066/P9CAMSWN

W.C. Turner and Z.R. Barandongo**.** 2023. Zebra anthrax carcass site pathogen and soil data from Namibia, 2010-2021: U.S. Geological Survey data release, https://doi.org/10.5066/P9TDAY91

Theses and Dissertations

Barandongo, Z.R. 2023. *Anthrax in African wildlife: Bacillus anthracis spore survival, bacteriophages and genetic diversity in southern Africa,* Ph.D. UW-Madison Wildlife Ecology.

Govender, K. 2023. *Investigation of Bacillus anthracis spore survival in soils from Kruger National Park in South Africa and Etosha National Park in Namibia.* M.Sc. in Veterinary Science, University of Pretoria.

Hoff, S. 2023. *Refugia from white-nose syndrome: ecology and behavior of northern myotis coastal populations.* Ph.D. University at Albany, Ecology and Evolutionary Biology.

Hunsaker, M. 2023. *Movement ecology of male white-tailed deer during the breeding season in southwest Wisconsin*, M.S. UW-Madison Wildlife Ecology.

Inzalaco, H. 2023. *Soil, scat, and (Ixodes) scapularis: Assessing environmental factors in the chronic wasting disease system,* Ph.D. UW-Madison Comparative Biomedical Sciences.

Mokgokong, P. 2023. *Comparative genomics of Bacillus anthracis strains from anthrax outbreaks in Kruger National Park, South Africa,* M.Sc. in Veterinary Science, University of Pretoria.

Pendergast, C.J. 2023. *Hibernation behavior and winter feeding of northern myotis in coastal populations after white-nose syndrome invasion,* M.S. University at Albany, Ecology and Evolutionary Biology.

HONORS AND AWARDS

Unit Leader:
Performance award, USGS, 2022
Group STAR Award for planning/leading breakout sessions at All Hands Meeting, USGS CRU program, 2023

Unit students/scientists:
Barandongo, Z.R. 2023. Recipient of the Terry Amundson Memorial Scholarship award for Wildlife Ecology/Veterinary Sciences ($1000), Department of Forest and Wildlife Ecology, UW-Madison.

Dolfi, A. 2023. Hastings award for outstanding female student ($1000), Department of Forest and Wildlife Ecology, UW-Madison.

Dolfi, A. 2023. Vera and Donald Wallach Scholarship ($1000), College of Agriculture and Life Sciences, UW-Madison.

Inzalaco, H.N. 2023. Recipient of the Terry Amundson Memorial Scholarship award for Wildlife Ecology/Veterinary Sciences ($1000), Department of Forest and Wildlife Ecology, Madison, WI.

Inzalaco, H.N. 2022. Best Student Research Poster Award, The Wildlife Society, 29th Annual Conference, Spokane, WA.

Vera, K. 2023. Finalist for Best Student Oral Talk Competition, International Congress for Conservation Biology, Kigali, Rwanda.

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, Center for Ecology and the Environment Executive Committee, UW-Madison (2021-present)
Co-organizer, Center for Ecology and the Environment Fall Symposium (2022)
Chair, Hiring committee for Assistant Unit Leader, Wisconsin Cooperative Wildlife Research Unit (2022-2023)
Chair, Hiring committee for administrative assistant for CRU (2023)
Co-organizer, Departmental Seminar Committee (2022-present)

Teaching

Unit Leader:

Instructor, FWE 875: Special Topics in Wildlife Disease, UW-Madison, Spring 2023
Guest lecturer, FWE 360 Extinction of Species, UW- Madison, Fall 2022
Guest lecturer, PP/Bot 123 Plants, Parasites and People, UW-Madison, Fall 2022

Media Coverage

HealthDay News. 2023. Ticks may be spreading 'wasting disease' among Wisconsin deer. https://www.drugs.com/news/ticks-may-spreading-wasting-among-wisconsin-deer-113791.html

WFMZ 69NEWS. 2023. Ticks may be spreading 'wasting disease' among Wisconsin deer. https://www.wfmz.com/health/ticks-may-be-spreading-wasting-disease-among-wisconsin-deer/article_258ea017-11e4-5b93-b0c3-d93cda1a659d.html

KULR8 News. 2023. Ticks may be spreading 'wasting disease' among Wisconsin deer. https://www.kulr8.com/lifestyles/health/ticks-may-be-spreading-wasting-disease-among-wisconsin-deer/article_6bad5eb6-190c-5ef2-8881-acb99e4aac8a.html

U.S. News. 2023. Ticks may be spreading 'wasting disease' among Wisconsin deer. https://www.usnews.com/news/health-news/articles/2023-07-14/ticks-may-be-spreading-wasting-disease-among-wisconsin-deer

Today Headline. 2023. Ticks may be able to spread chronic wasting disease between Wisconsin deer. https://todayheadline.co/ticks-may-be-able-to-spread-chronic-wasting-disease-between-wisconsin-deer-sciencedaily/

Sullivan county Democrat. 2023. Ticks could spread CWD! https://www.scdemocratonline.com/stories/ticks-could-spread-cwd,108939

Wide Open spaces. 2023. New study says ticks could be spreading chronic wasting disease. https://www.wideopenspaces.com/do-ticks-spread-chronic-wasting-disease/

Science Blog Newsletter. 2023. Tick-borne transmission of chronic wasting disease examined in new study. https://scienceblog.com/538652/tick-borne-transmission-of-chronic-wasting-disease-examined-in-new-study/

Wisconsin Department of Natural Resources, Field Notes Newsletter. 2023. Thinking outside the box: Investigating the roles of ticks and predators as environmental factors in CWD. https://dnr.wisconsin.gov/topic/Research/articles/july2023#articleOne

Ask by Geeks. 2023. Ticks may be able to spread chronic wasting disease among Wisconsin deer. https://askbygeeks.com/lifestyle/health/588869/

Science Daily. 2023. Ticks may be able to spread chronic wasting disease between Wisconsin deer. https://www.sciencedaily.com/releases/2023/07/230707153844.htm#:~:text=A%20new%20study%20finds%20that,spread%20between%20deer%20in%20Wisconsin

Verve Times. 2023. Study suggests ticks could transmit chronic wasting disease among Wisconsin's deer population. https://vervetimes.com/sciencedaily-study-suggests-ticks-could-transmit-chronic-wasting-disease-among-wisconsins-deer-population/

News Groove. 2023. Ticks may be able to spread chronic wasting disease between Wisconsin deer. https://www.newsgroove.co.uk/ticks-may-be-able-to-spread-chronic-wasting-disease-between-wisconsin-deer/

News Wise. 2023. Ticks may be able to spread chronic wasting disease between deer. https://www.newswise.com/articles/ticks-may-be-able-to-spread-chronic-wasting-disease-between-deer?sc=rsla

EurekaAlert! 2023. Ticks may be able to spread chronic wasting disease between Wisconsin deer. https://www.eurekalert.org/news-releases/994915

Phys.Org. 2023. Ticks may be able to spread chronic wasting disease between Wisconsin deer. https://phys.org/news/2023-07-chronic-disease-wisconsin-deer.html

Mirage News. 2023. Ticks could spread chronic wasting disease in Wisconsin deer. https://www.miragenews.com/ticks-could-spread-chronic-wasting-disease-in-1042944/

University of Wisconsin-Madison News. 2023. Ticks may be able to spread chronic wasting disease between Wisconsin deer. https://news.wisc.edu/ticks-may-be-able-to-spread-chronic-wasting-disease-between-wisconsin-deer/

Science News Net.in. 2023. Ticks may be able to spread chronic wasting disease between deer. https://sciencenewsnet.in/ticks-may-be-able-to-spread-chronic-wasting-disease-between-deer/

WXPR News. 2023. Ticks may be a source for chronic wasting disease in deer. https://www.wxpr.org/energy-environment/2023-07-04/ticks-may-be-a-source-of-spread-for-chronic-wasting-disease-in-deer

Kiowa County Press. 2023. Ticks may carry infectious levels of chronic wasting disease. https://kiowacountypress.net/content/ticks-can-carry-infectious-levels-chronic-wasting-disease

Wisconsin Public Radio. 2023. Study finds ticks could possibly spread chronic wasting disease. https://www.wpr.org/wisconsin-study-finds-ticks-could-spread-chronic-wasting-disease-CWD

Post Bullet. 2023. Blacklegged ticks carry, probably spread chronic wasting disease. https://www.postbulletin.com/sports/northland-outdoors/blacklegged-ticks-carry-probably-spread-chronic-wasting-disease

University of Minnesota- Center for Disease Research and Policy. 2023. Ticks may be able to indirectly spread chronic wasting disease. https://www.cidrap.umn.edu/chronic-wasting-disease/ticks-may-be-able-indirectly-spread-chronic-wasting-disease

University of Minnesota- College of Veterinary Medicine News. 2023. Ticks may be spreading chronic wasting disease. https://vetmed.umn.edu/news/ticks-may-be-spreading-chronic-wasting-disease.

The Wildlife Society. 2023. Best student poster explores the role of ticks in CWD transmission. https://wildlife.org/best-student-poster-explores-the-role-of-ticks-in-cwd-transmission/

Wisconsin State Journal. 2023. Why ticks may also be bad for Wisconsin's deer. https://madison.com/news/local/environment/cwd-ticks-deer-wisconsin-hunting/article_8b66d544-24fd-11ee-b81e-13096c74fb3d.html

Real Tree. 2023. Are ticks spreading CWD? https://realtree.com/brow-tines-and-backstrap/ticks-spreading-cwd

Utah Public Radio. 2023. Ticks carry infectious levels of chronic wasting disease. https://www.upr.org/utah-news/2023-07-03/ticks-can-carry-infectious-levels-of-chronic-wasting-disease

Pioneer Press. 2023. Blacklegged ticks carry, likely spread chronic wasting disease, study finds. https://www.twincities.com/2023/06/10/blacklegged-ticks-carry-likely-spread-chronic-wasting-disease-study-finds/

Duluth News Tribune. 2023. Blacklegged ticks carry, probably spread chronic wasting disease. https://www.duluthnewstribune.com/sports/northland-outdoors/blacklegged-ticks-carry-probably-spread-chronic-wasting-disease

News Beezer. 2023. Ticks have been found to harbor and release prions of chronic wasting disease. https://newsbeezer.com/southafrica/ticks-have-been-found-to-harbor-and-release-prions-of-chronic-wasting-diseases/

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Star Tribune. 2023. New research shows that swallowed ticks could spread chronic wasting disease in wild deer. https://www.startribune.com/ticks-chronic-wasting-disease-deer-minnesota-wisconsin-outdoors/600284506/

Lyme Disease Association, Inc. 2023.Chronic wasting disease: transmission by ticks. https://lymediseaseassociation.org/news/chronic-wasting-disease-transmission-by-ticks/

Outdoor News. 2023. Research shows ticks could spread CWD in deer population. https://www.outdoornews.com/2023/06/21/research-shows-ticks-could-spread-cwd-in-deer-population/

Field and Stream. 2023, Are ticks spreading chronic wasting disease? https://www.fieldandstream.com/conservation/are-ticks-spreading-chronic-wasting-disease/

The Medical News. 2023. Ticks found to harbor and release prions of chronic wasting disease. https://www.news-medical.net/news/20230517/Ticks-found-to-harbor-and-release-prions-of-chronic-wasting-disease.aspx