Clean Water Fund

Final Report

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ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

CLEAN WATER LAND & LEGACY AMENDMENT

UNIVERSITY OF MINNESOTA
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Clean Water Fund Final Report

[Minnesota Session Laws - 2021, 1st Special Session, Chapter 1—H.F. No.13, Article 2, Section 9, Para. (d)]

Per the requirements set forth in Minnesota Statue 3.197, the cost as of January 12, 2024 to study water's role in transporting chronic wasting disease prions and prepare this report is $1,077,382.

Watch the companion video at https://z.umn.edu/waterways

Executive Summary of Findings

The fate of chronic wasting disease (CWD) prions in the environment has been an area of research interest since the turn of the century. However, little is known about prions in water - how they interact, how to detect them, and how to remediate contaminated water. CWD prions have been detected in runoff from a CWD-endemic area during peak snowmelt (Nichols et al., 2009), but not during low flow conditions throughout the rest of the year. These prions were found in the solid sludge of a separated wastewater sample but not in the liquid portion, suggesting that prions are more likely to be associated with solid particles in an aquatic environment. Additional studies regarding prion persistence in water present conflicting results. One study found that prions degraded more slowly in organic-rich wastewater than buffered lab solutions (Miles et al., 2011), but other studies report the opposite (Maluquer de Motes et al., 2008; Marin-Moreno et al., 2016). Depending on the study, persistence in wastewater ranged from a few weeks (Maluquer de Motes et al., 2008) to nine months (Marin-Moreno et al., 2016). Persistence has not been extensively studied in environmental waters, such as lakes and streams.

Water contaminants and water quality concerns are often initially assessed as either dissolved in water (e.g., chloride, nitrate) or attached to sediments (e.g. metals, pesticides, phosphorus). Water can determine how far and how fast prions are transported from CWD positive regions, but to what extent does water carry infectious prions from the landscape to and through the waterways of Minnesota? Given what has been found in the above-mentioned wastewater studies, we hypothesized CWD prions will move on sediments and behave like other sediment-bound contaminants in watershed and water quality studies. Given the combination of soil-based CWD knowledge, erosion from CWD-infected areas to streams, lakes, and wetlands, are of particular concern. We utilized our multidisciplinary team's array of knowledge and experience in hydrology, soils, epidemiology, and molecular biology, along with advanced prion detection techniques, to investigate this hypothesis.

Through the research project as described below, the high-level findings include:

- CWD prions should be considered primarily a 'sediment-associated' contaminant for water movement and treatment processes.
- We detected prions in runoff water samples collected from sites draining historic and current areas known to contain CWD-positive cervids.
- Moving from north to south across the state, watersheds containing CWD-positive cervids have an increasing transport risk and decreasing storage risk.

Objective 1

Identify mechanisms for the accumulation, persistence, and spread of chronic wasting disease prions (CWD prions) through waterways by multiple methods including literature review, environmental sampling, and laboratory testing and analysis.

Literature Summary

Prions readily bind to many different types of soil minerals, and the strongest binding occurs in a classification of clays known as shrink-swell clays (Johnson et al., 2006; Saunders et al., 2009; Saunders et al., 2011; Wyckoff et al., 2013; Kuznetsova et al., 2020; Booth et al., 2021). Clay soil particles carry a negative charge on their mineral surfaces, which attract positively-charged particles. A primary feature of the prion protein is its flexibly disordered N-terminus, which contains a high number of positively-charged peptides. As such, the most significant binding mechanism of soil and prion proteins appears to be the attraction between the prion protein's positively charged N-terminus and the soil's negatively charged clay mineral surfaces (Bartelt-Hunt & Bartz, 2013).

Clay mineral binding protects prions from degradation (Booth et al., 2021) and may enhance both persistence in the environment as well as disease transmission (Johnson et al., 2007; Wyckoff et al., 2016, Dorak et al., 2017). For example, one study in Illinois found that where clay soils were dominant, there were fewer cases of CWD infection detected (Dorak et al., 2017), whereas another study in Colorado found almost the exact opposite: clay content in soil was associated with fewer cases of infection (Walter et al., 2011). These conflicting results suggest that additional soil properties can perhaps play a role in prion persistence and bioavailability in the environment resulting in differing levels of infectivity. Similarly, a more recent study found that CWD prions bound to soils and minerals became harder to recover and detect over time, yet CWD prions were still infectious in the same capacity (Kuznetsova et al., 2020). These results indicate that CWD persistence, detection, and infectivity could have significant long-term implications for wildlife and landscape management.

Scrapie prions are recorded to persist in soils and retain infectivity for at least 16 years (Georgsson et al., 2006). As expected, researchers also continue to detect CWD in the soil of a Wisconsin farm which previously housed CWD-positive white-tailed deer (*Odocoileus virginianus*, WTD) more than 15 years ago (S. Lichtenberg, personal communication). The strong affinity prions have for binding to soil particles may suggest that prion transport occurs through soil and sediment erosion. Water movement within soil pore spaces can also transport prions below the soil surface (Somerville et al., 2019). This could be ecologically problematic as, "prions contacting clay soils could be rapidly immobilized on the soil surface, forming potent reservoirs for efficient transmission. In contrast, prions contacting sandy soils may be more readily transported," (S. Saunders et al., 2012).

In sum, CWD prion accumulation, persistence, and spread through waterways is likely predominantly the result of prion attachment to soil and sediment in water rather than a strong attachment to the water molecules themselves. However, environmental prion persistence and infectivity have been studied much more extensively through the terrestrial environment such as in soils and environmental surfaces rather than within aquatic environments. This still remains a largely open avenue to be explored.

Field and Laboratory Activities

The research team collected water, wetland, and soil samples throughout multiple seasons from a CWD-contaminated site in north central Minnesota. Water samples were collected from multiple specific locations draining from the known CWD-contaminated farm and associated positive carcass area. This sample set was examined for the presence of CWD prions in water and associated sediments utilizing real-time quaking induced conversion (RT-QuIC) assay. Furthermore, a series of laboratory experiments was conducted using these samples, including incubations to assess water-sediment partitioning in surface-water-like conditions over 28 days. Water samples were collected from an additional CWD-contaminated area in southeastern Minnesota and tested for CWD prions, both with and without removing waterborne sediments present under field-collection conditions.

Main Result

To determine whether prions in water would bind to sediments and other particulates versus being carried by the water itself, we conducted a series of laboratory experiments adding (or spiking) environmental water samples with known concentrations of CWD prions. In the first set of experiments, water with different sediment concentrations (or TSS levels) was spiked, and was subsequently filtered and tested for CWD every two weeks for 28 days. CWD was not found in the unspiked samples, nor was it found in the filtered portion of the high sediment samples over time, although it remained detectable in the lower sediment samples (Figure 1). Importantly, in this first set of experiments, we determined that at high sediment levels, any added CWD prion moved out of the 'water' phase and onto the sediment, which could then be filtered out. In another round of experiments, we were able to separate the sediment from the water in large enough amounts to test each phase. Every 7 days, we collected water from the spike experiments, filtered it, and tested

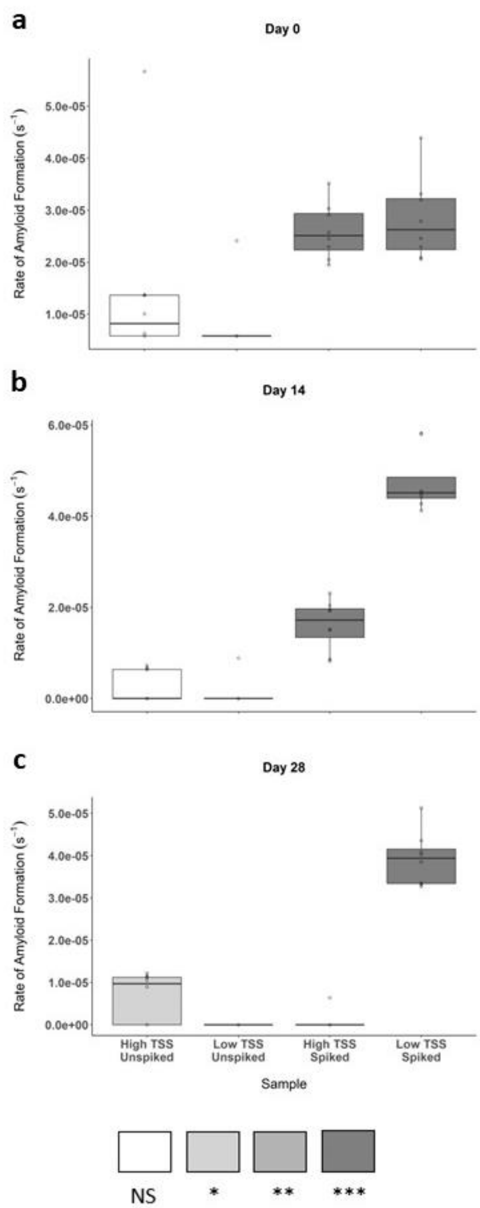

Figure 1. Results of initial spiking experiment comparing water samples with different levels of Total Suspended Solids (TSS) with ("Spiked") and without ("Unspiked") added amounts of CWD-prion. Darker grey boxes indicate detection of CWD prion according to laboratory protocols and standards.

filtered water (samples where all sediment and particulates were removed) and filtered-out sediment aliquots for prions. We found that sediments partitioned from water (UL and OS "sediments" panels in Figure 2) were consistently positive for CWD, but the detection of CWD prions in water (UL and OS "water" panels in Figure 2) after filtration was inconsistent. Prions readily partitioned to sediments and remained there for at least 28 days (Figure 2). Often, prions were not consistently detectable in water after filtration; however, in the absence of sediments to bind to, prions could still remain in water (Figure 1 - low TSS portions)). Moving forward to examine water quality threats posed by CWD and the possibility of CWD moving through watershed environments, CWD prions should be considered primarily a 'sediment-associated' contaminant for water movement and treatment processes.

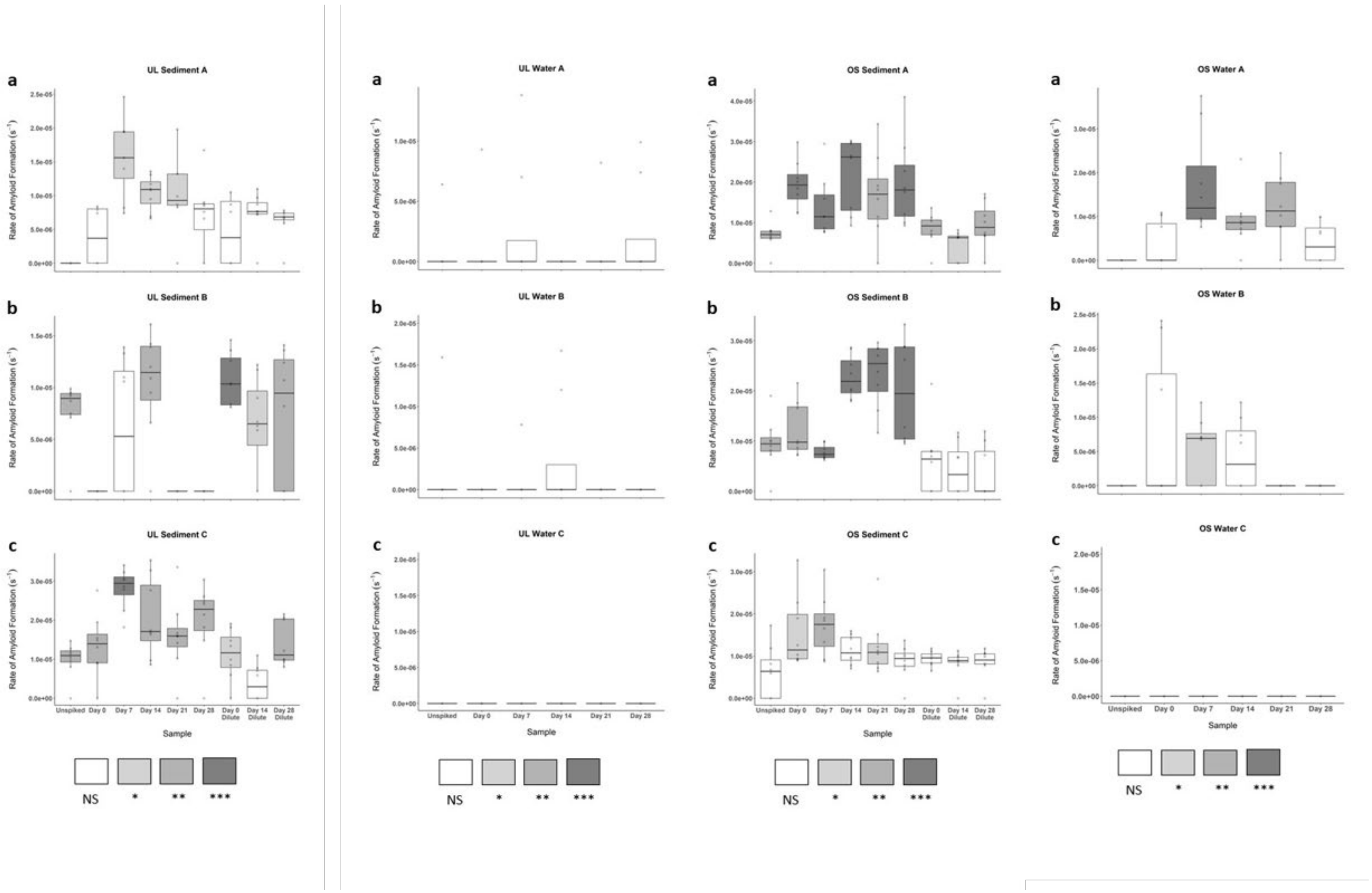

Figure 2. RT-QuIC assay results of prion spike experiments using sediment-laden water from two contaminated sites in north central Minnesota. UL and OS represent two different point locations associated with the Beltrami County Focal Site. A-C represent three RT-QuIC trials, meaning 3 different laboratory trials using the same environmental samples. After spiking with CWD-positive deer tissue, sediment and water were separated by filtration and then analyzed using RT-QuIC. ***In both unspiked and spiked samples, sediments are consistently CWD-positive.*** *Filtered waters are often CWD-negative, with only a few positives that appear inconsistently.* ***Thus, it can be concluded that prions in environmental waters will most likely be found bound to sediment particles, rather than free-floating in the water.***

Objective 2

Characterize CWD prion abundance in waterways immediately downstream of regions known to be positive for CWD.

Activities

The research team collected water, wetland, and soil samples multiple times over the course of several seasons (July and September 2021, May and August 2022, April and August 2023) from a CWD-contaminated site in north central Minnesota (Beltrami County Focal Site). Collections were designed to follow the flow path of waters draining from the contaminated site and to take advantage of areas of concentrated sediments settled from the water column along the flow paths, such as at the entrance to culverts where ditches flow beneath road crossings. All collections at the north central Minnesota site were conducted following depopulation of a known CWD-positive cervid farm in May 2021. Water samples were collected once from an additional CWD-contaminated site in southeastern (SE) Minnesota and tested for CWD prion presence in samples with and without sediments included. The SE Minnesota water samples were collected in March 2021, approximately three years after depopulation of the infected cervid farm. This location has also had cases of CWD infection detected in wild deer for two years prior to sample collection. We tested samples utilizing the RT-QuIC assay.

Main Results

CWD prions were found in waterways, particularly on settled sediments, draining from known CWD-contaminated sites. Sediments extracted from stream channel samples collected downstream of the north central Minnesota cervid farm tested positive for CWD (Figure 2 “OS Sediment” A, B, C panels Unspiked sediment), based on RT-QuIC analysis, approximately two years after assumed first infection on the farm and one year after the farm depopulation. CWD prions from this site were all affiliated with stream channel sediments and were not detected in water after sediments were removed (see Objective 1 results, Figures 1-2). Water samples collected in areas draining from a known positive cervid farm in SE Minnesota indicate prion detection in runoff water samples 3 years post depopulation, however, larger sample sizes will be needed to determine status with more certainty (Figure 3).

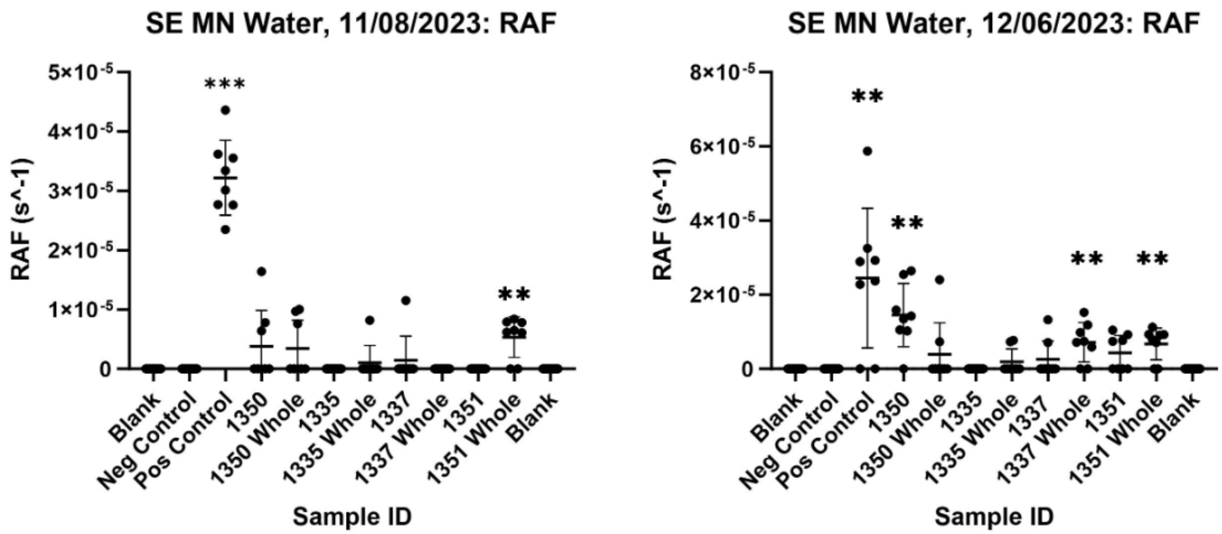

Figure 3. RT-QuIC assay results of prion spike experiments using sediment-laden water from two contaminated sites in north central Minnesota. UL and OS represent two different point locations associated with the Beltrami County Focal Site. A-C represent three RT-QuIC trials, meaning 3 different laboratory trials using the same environmental samples. After spiking with CWD-positive deer tissue, sediment and water were separated by filtration and then analyzed using RT-QuIC. ***In both unspiked and spiked samples, sediments are consistently CWD-positive.*** *Filtered waters are often CWD-negative, with only a few positives that appear inconsistently.* ***Thus, it can be concluded that prions in environmental waters will most likely be found bound to sediment particles, rather than free-floating in the water.***

Objective 3

Model and forecast CWD contamination and spread based on landscape ecology and hydrology.

Activities

The research team focused on two different spatial scales to examine scenarios under which CWD prions are likely to move into surface water bodies and move through watersheds. Statewide, we used our main findings under Objective 1, that CWD prions are found associated with aquatic sediments, and previously published studies showing strong and persistent associations with soils on the landscape (see Literature Review under Objective 1) to assess where CWD prions are likely to move downstream versus where they are likely to be retained on the landscape locally. One particular site of known CWD prion contamination, the Beltrami County Focal Site, was examined in much higher spatial detail.

Statewide Analysis

Statewide analysis utilized published geographic information from the Environmental Protection Agency EnviroAtlas organized by Hydrologic Unit Code 12 (HUC 12) across the state of Minnesota (Table 1). Three primary analyses were conducted to show the possible spread of

CWD prions to and through Minnesota's surface waterways: to determine (1) transport risk, (2) storage risk, and (3) downstream watershed delineation.

Table 1. Datasets used for analyses under Objective 3. All data are from published federal data and available from the USEPA EnviroAtlas database and/or the USDA.

Data Set	Description
HUC 12 Watershed Boundaries	Watersheds as delineated by the United States Geological Survey according to surface topography and uniquely identified at the sub watershed level.
RUSLE – Revised Universal Soil Loss Equation	Soil loss or erosion estimate regularly used in natural resource assessments with estimates available across the nation – USDA.
Stream Density	The ratio of the total length of streams in the watershed to the total area of the watershed.
Wetland Cover	Percent of the HUC 12 watershed in woody and emergent herbaceous wetland according to the National Land Cover Dataset
USDA's Web Soil Survey	Soil data and information produced by the National Cooperative Soil Survey, operated by the USDA Natural Resources Conservations Service (NRCS)

Transport risk was determined using the average risk of erosion, or soil loss from landscape into waterways, based upon the Revised Universal Soil Loss Equation (RUSLE), and the stream network density. Erosion and stream density are both positive and additive factors in estimating transport risk. Higher erosion and higher stream network density increase the risk of CWD prions, bound to soils, moving from the landscape to the river network, where they could be transported on the timescale of other sediment-bound contaminants. Each factor was scaled from 1-10 based upon its own numerical range so that both erosion and stream density contributed equally to the overall transport risk. Their sum was broken into 5 categories based upon natural breaks in the data distribution to indicate transport risk category across the state by HUC 12 watershed.

Storage risk represents the risk that CWD prions would remain within their watershed, rather than exit the watershed through the surface water network. Conceptually, it is the opposite of transport risk, described above. Storage risk was determined at the HUC 12 watershed scale based upon the RUSLE erosion risk and the percentage of total area in each HUC 12 watershed in wetland land cover. In this case, wetland cover is a positive factor, meaning when wetland cover increases, the risk of storage of CWD prions in the watershed increases. Erosion, or soil loss, is a negative factor, meaning that a higher predicted rate of soil loss decreases storage risk, as prions bound to particles are more likely to leave the watershed through erosion rather than remain in the watershed. Each of these two factors were scaled 1 to 10 based on their full range. The scaled value for soil loss was subtracted from the scaled value for wetland cover for each HUC 12 watershed. Again, five categories of values were created for visualization of relative storage risk across watersheds.

Downstream watershed analysis was conducted to indicate the direction by which CWD prions might move through connected watersheds. The location of known CWD-positive cervid farms was obtained from the State of Minnesota Board of Animal Health based upon their location within a HUC 12 watershed. Project staff did not know the precise location, only the county and HUC 12 watershed in which the farm was located, and the year that it was determined positive for CWD. Each watershed with a known CWD-positive cervid farm was assessed for its transport risk and storage risk (described above). Additionally, known hydraulic networks and flow direction were used to determine the downstream flows to show the next 10 watersheds downstream of known positive farms. The downstream analysis was conducted to show flow direction, once CWD prions move from positive farms to waterways. Flow can continue through additional downstream-connected watersheds, however, travel time estimates are beyond the scope of the current project.

Beltrami County Focal Site

The future of CWD contamination and spread across Minnesota will be highly variable due to the heterogeneous nature of our state's landscape ecology and hydrology. Specifically, slope, soil characteristics, amount of rainfall, land cover type, and level of CWD contamination are expected to contribute to the persistence, accumulation, and transport of CWD prions through the local environment. One method we have used to visualize the ecological variation across the landscape is through use of the RUSLE (Table 1). By combining the variables that contribute to the RUSLE along with other factors we know to be important to prion distribution and persistence, we might reasonably infer the CWD contamination patterns that we may observe at our study sites. This more detailed and fine-grained spatial data can be used only when examining a single site, as opposed to the whole state. This focal-site analysis demonstrates the level of analysis possible at the individual landowner scale.

MNPRO has been studying CWD persistence at a CWD-positive white-tailed deer (*Odocoileus virginianus*, WTD) dumpsite in Beltrami County, Minnesota. Using this site as our test case, we gathered data from sources noted in Table 1 for each soil type present at the dumpsite. Some of these data included standard estimates for the susceptibility of a soil type to erosion (included in RUSLE). In addition to erosion estimates, we integrated other knowledge from the literature about what we might expect to happen to CWD prions based on known soil characteristics. For example, we know that humic acids and soil organic matter can degrade CWD prion infectivity (Kuznetsova et al., 2018; S. E. Saunders et al., 2011). Therefore, we added soil organic matter data to the equation as well. Similarly, the literature suggests that cation-exchange capacity (CEC) and pH can affect prion persistence in soils (Cooke & Shaw, 2007; Dorak et al., 2017). Soils with higher CEC are able to bind CWD prions more tightly and irreversibly, thus they might be expected to retain CWD prions at the surface. In contrast, soils with a high pH are less likely to bind and retain CWD prions (Dorak et al., 2017).

Main Results

Statewide Analysis

Transport risk of CWD prions in each Minnesota HUC 12 watershed indicates higher risk in the southern, particularly southeastern part of the state. This represents a high risk for any CWD prions in the environment, such as on soil or carried in runoff from CWD-positive areas, to move to the stream and river network, and subsequently travel downstream (Figure 4).

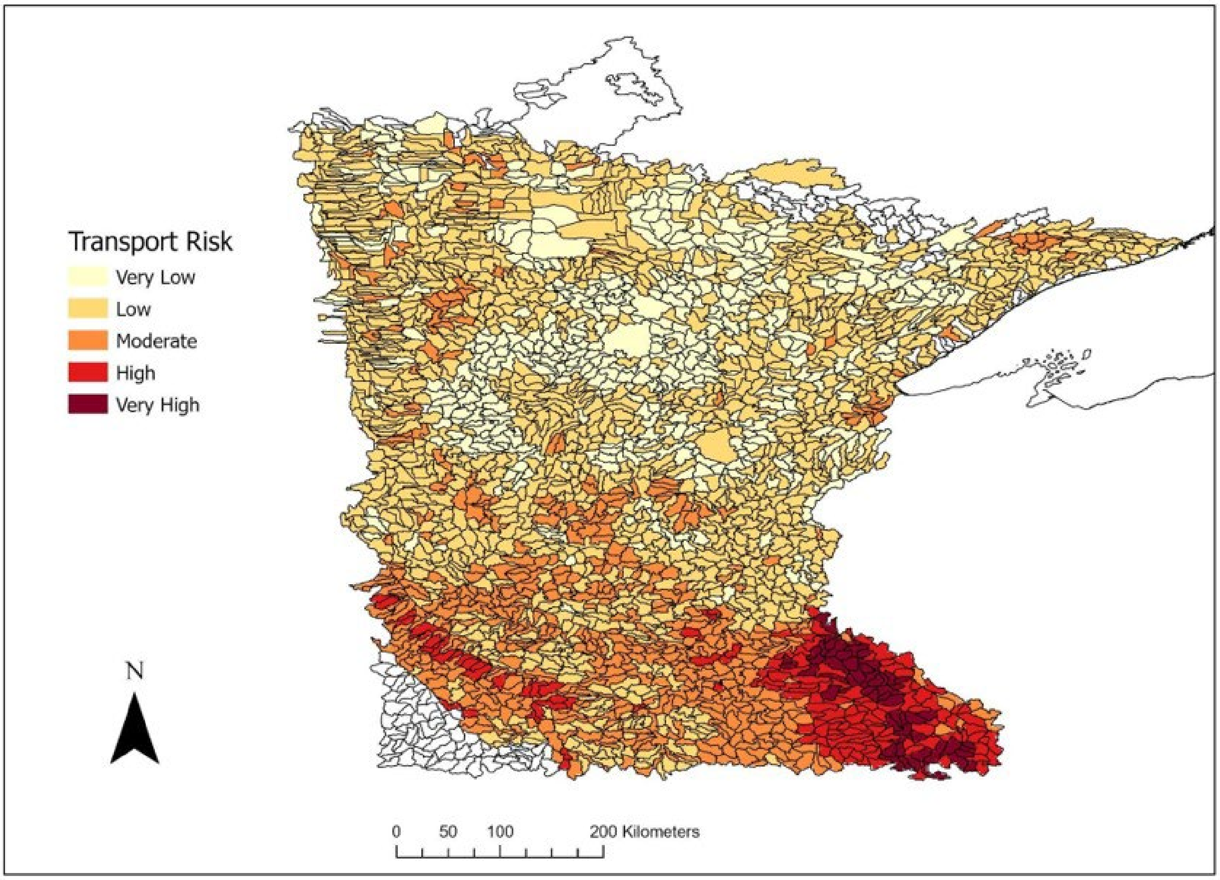

Figure 4. Map of transport risk of prions in each Minnesota HUC 12 watershed.

Storage risk of CWD prions in each Minnesota HUC 12 watershed indicates higher storage risk across the northern portion of the state, particularly in the north central region. In these areas, CWD prions in the environment are likely to remain on soils, and any erosion is more likely to remain local, such as trapped in wetlands (Figure 5).

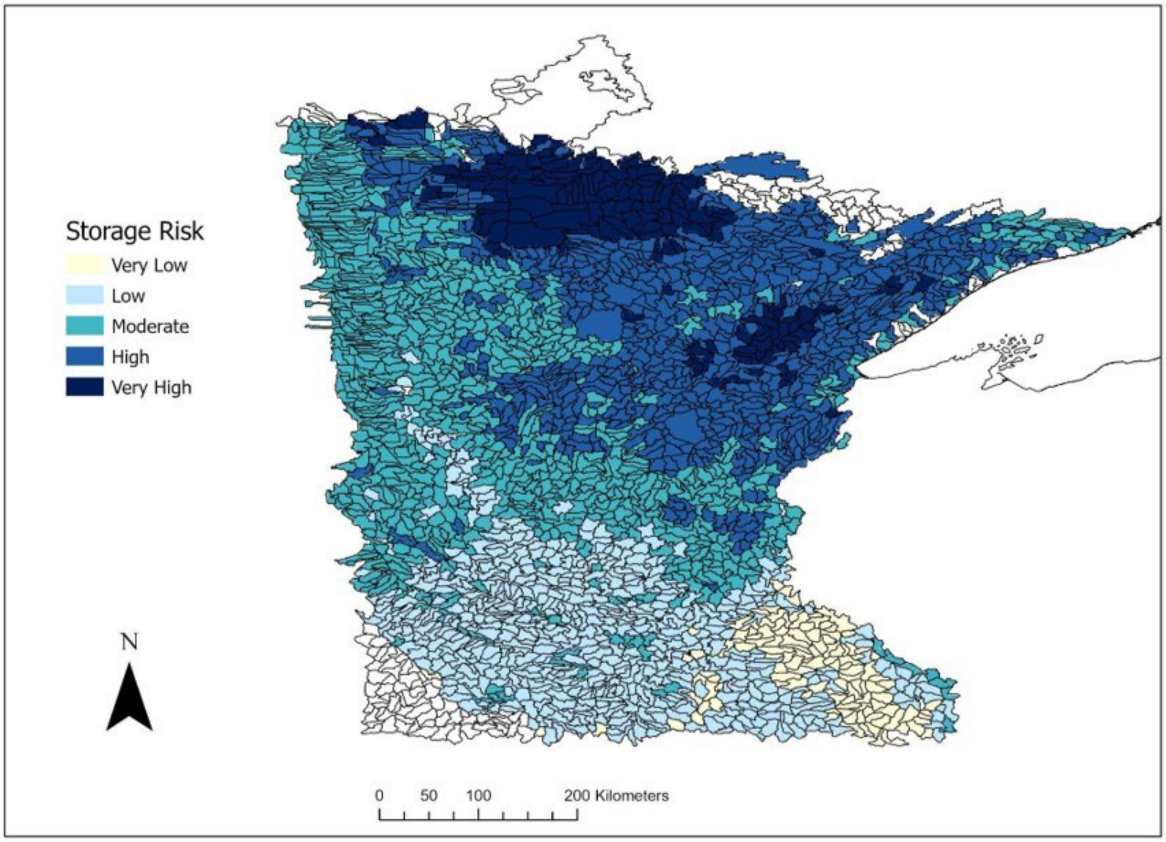

Figure 5. Map of storage risk of prions in each Minnesota HUC 12 watershed.

Watershed analysis shows the positive farm in north central Minnesota, which is the farm associated with the Beltrami County Focal Site, is in a watershed with relatively low transport risk (Figure 6) and relatively high storage risk (Figure 7). Moving from north to south across the state, watersheds containing CWD-positive cervid farms have an increasing transport risk and decreasing storage risk. Downstream flow analysis, shown in Figure 8, draws attention to the major watersheds of the state with more CWD-positive cervid farms, and how these watersheds contribute to the river network. Water from the farms in east central and southeastern Minnesota, flows into the St. Croix and Mississippi River network, as does water from the farms in west central Minnesota via the Minnesota River. Water from the Beltrami County Focal Site Farm flows to the Red River watershed and will eventually flow into Canada, even though it is very near the topographic and continental divide with the Upper Mississippi River.

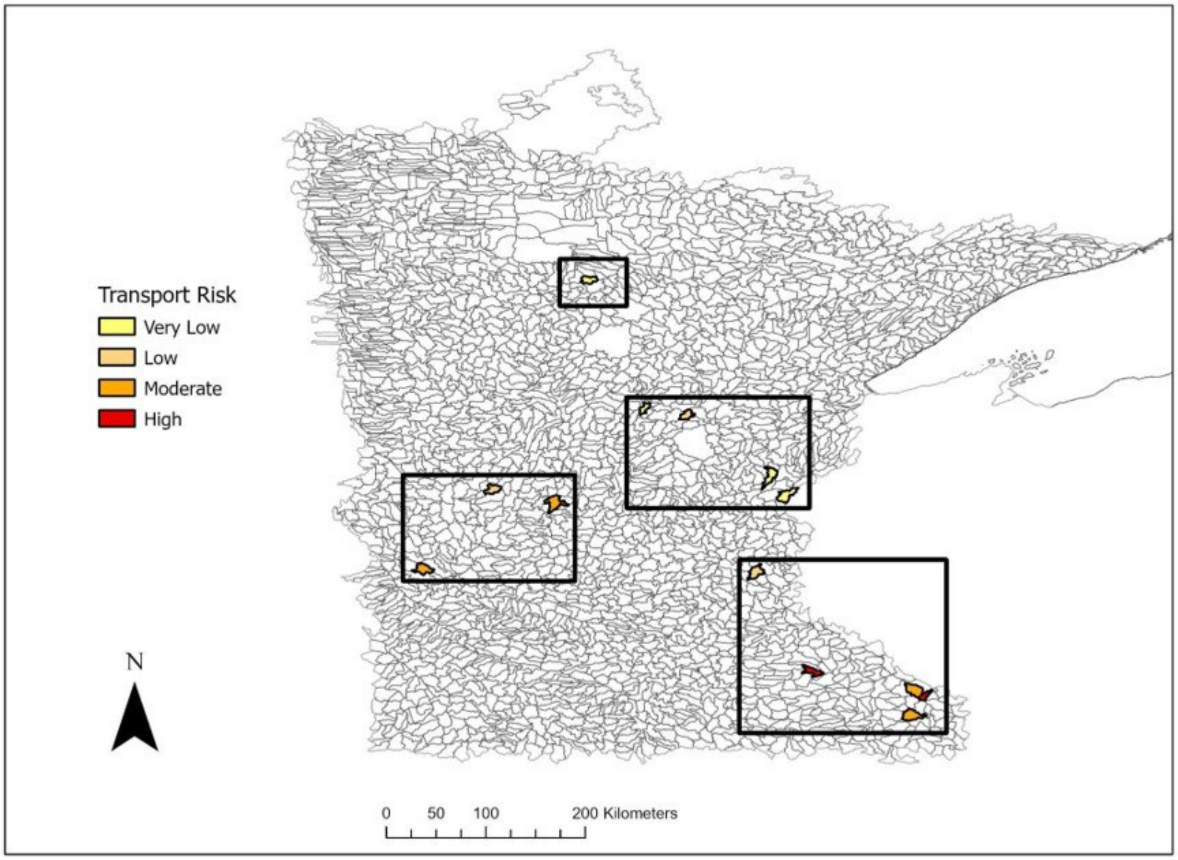

Figure 6. Map of transport risk of prions in Minnesota HUC 12 watersheds that contain a CWD-positive farm (depopulated).

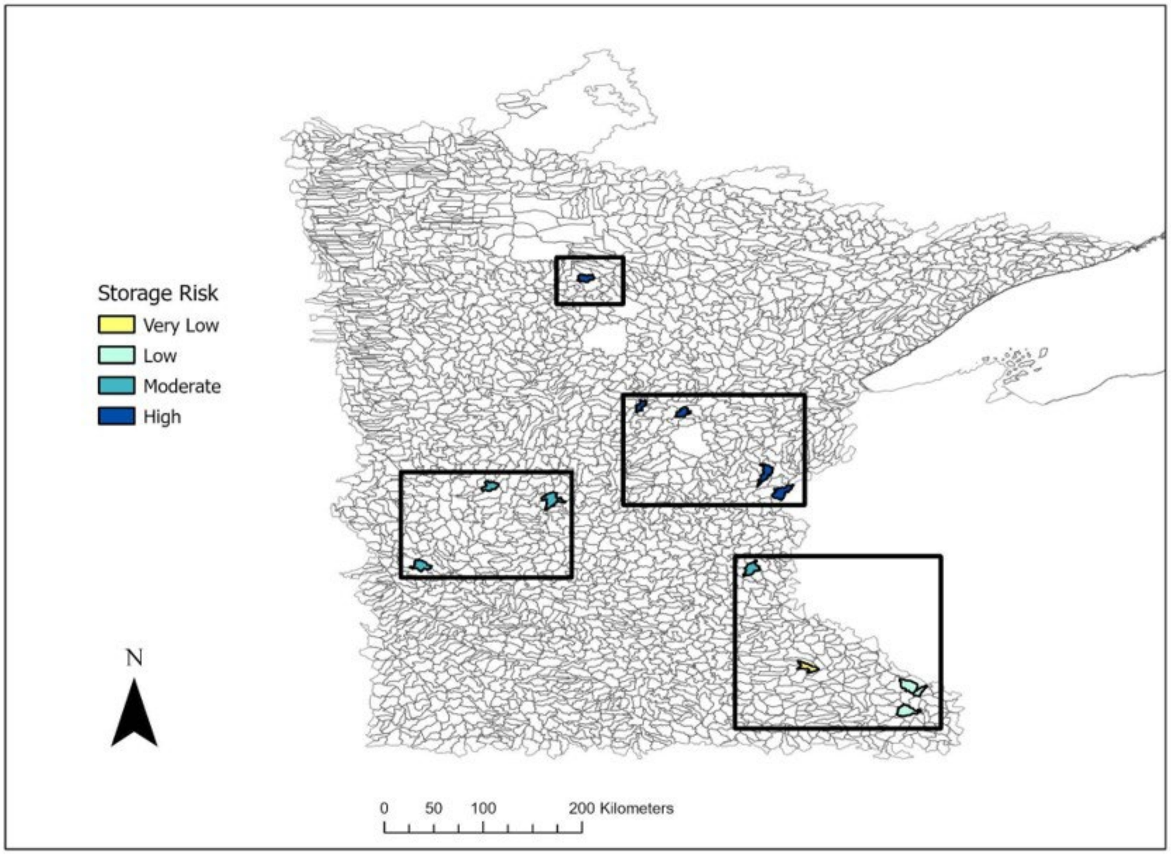

Figure 7. Map of storage risk of prions in Minnesota HUC 12 watersheds that contain a CWD-positive farm (depopulated).

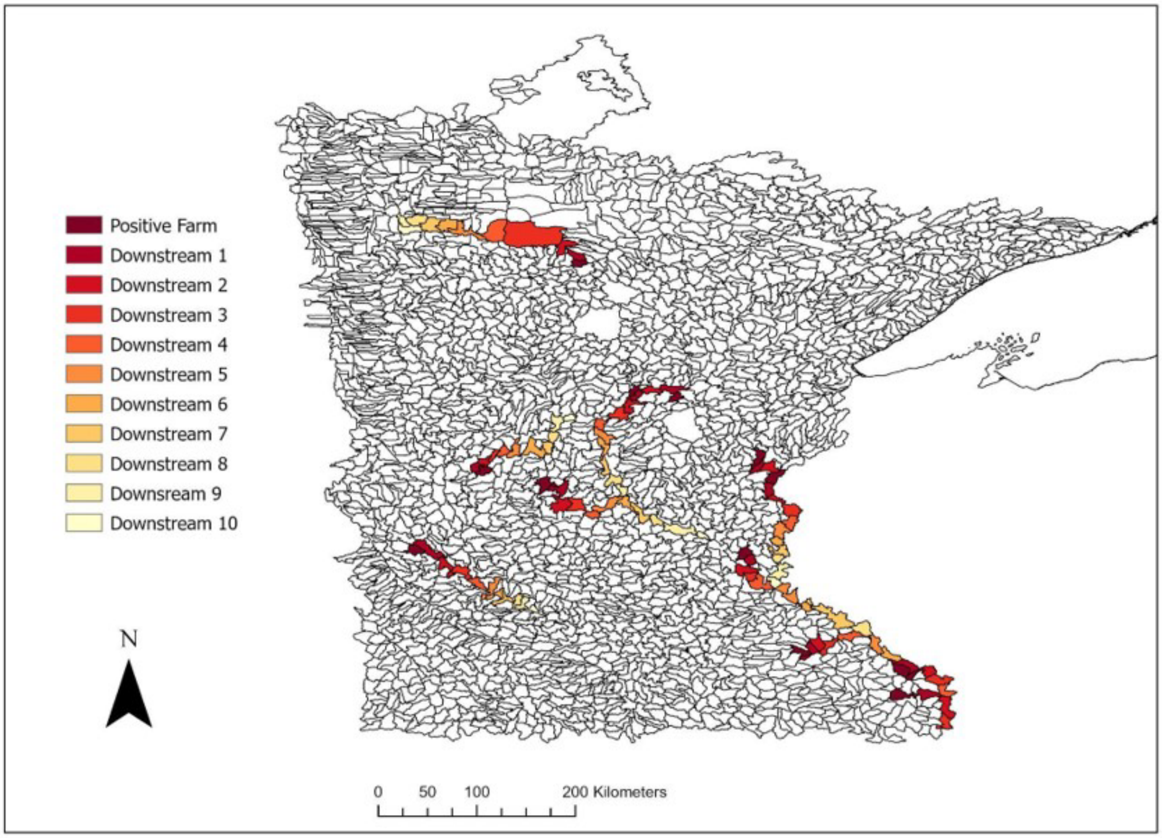

Figure 8. Map showing the hypothetical flow of CWD prions through Minnesota watersheds if they were to enter the stream. In the event that prions were to enter the streams of a watershed with a CWD positive farm (depopulated), this is a prediction of the flow path those prions would take through the next 10 downstream watersheds, based on how watersheds in Minnesota flow to one another.

Beltrami County Focal Site

By adding more detailed soil variables into the site-level RUSLE calculations, we were able to produce a relative prion score for predicting what we might expect for prion bioavailability and movement in this soil environment. Here, we use prion bioavailability to describe the condition when the prions present in the environment are biologically available for animal uptake and exposure. Results indicate soil types typically associated with hardwood forest cover at the dumpsite study area have a much higher risk of prion transport and bioavailability than the younger and wetland soils also present at the study site. This combined data allows for a more detailed and nuanced look at where CWD prions may be more or less persistent and bioavailable, and for evaluating infectivity risk at our study site (Figures 9-10).

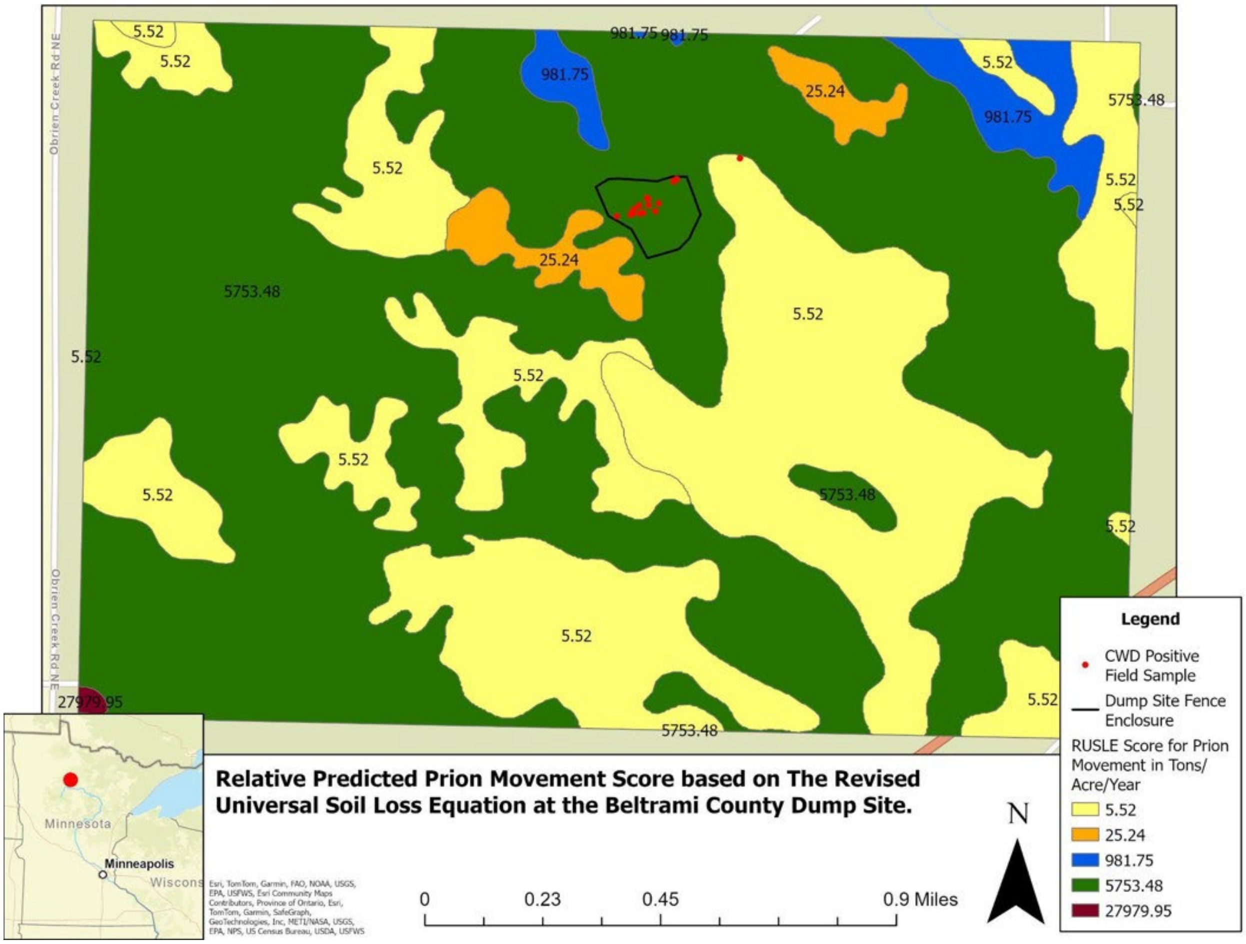

Figure 9. Relative predicted prion movement and bioavailability risk score based on RUSLE-based erosivity score. Our team used this to estimate of prion bioavailability and movement risk with soil loss at the Beltrami dump site. RUSLE was estimated using the EnviroAtlas Database and other soil features impacting prion bioavailability were collected from Web Soil Survey (See Table 1). Put together, this data allows us a better look at where prions may be more and less mobile and bioavailable for infectivity.

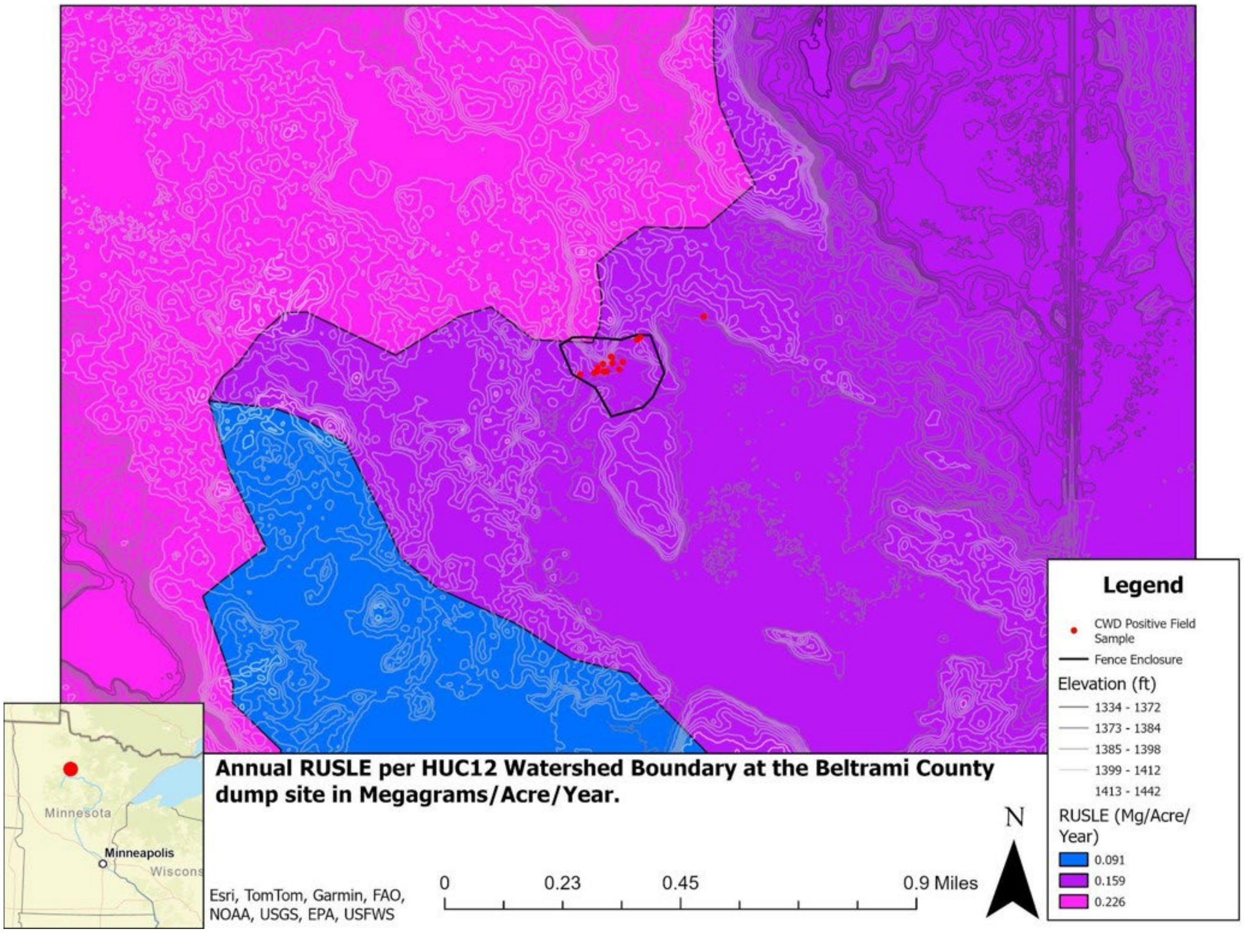

Figure 10. Annual RUSLE in Megagrams/Acre/Year per HUC12 Watershed Boundary surrounding the Beltrami County dump site area. RUSLE was estimated using the EnviroAtlas Database. When paired with elevation data, we are able to analyze directionality and scale with prion movement and bioavailability to assess contamination risk.

Objective 4

Evaluate remediation strategies for prion-contaminated waterways.

Work on this objective relies heavily on the findings from Objectives 1 and 2, and the key overall finding that in water environments, CWD prions prefer to be associated with sediments. This led to our team's investigation of soil-related remediation efforts, which are currently in progress. Prior studies have demonstrated that association with clay minerals alters chemical remediation of prions (Booth et al. 2021). It is quite likely that similar complications will exist when attempting to remediate sediments, with the additional variable of saturated conditions leading to further complexity.

Dissemination

Presentations

- Schwabenlander, M., Bartz, J., Carstensen, M., Fameli, A., Glaser, L., Larsen, R., Li, M., Lindsey, L., Oliver, J., Shoemaker, R., Rowden, G., Stone, S., Walter, W., Wolf, T., Larsen, P. Implementing a veterinary forensics approach to investigate chronic wasting disease at a deer carcass disposal site. Southeast Deer Study Group annual meeting. February 2023.
- Detection of Chronic Wasting Disease in Environmental Matrices at a White-Tailed Deer Carcass Dumpsite. Maddie Grunklee. UMN College of Veterinary Medicine Graduate Programs - Admitted Students Day Poster Session, St. Paul, MN. March 2023.
- Schwabenlander, M., Bartz, J., Carstensen, M., Fameli, A., Glaser, L., Larsen, R., Li, M., Lindsey, L., Oliver, J., Shoemaker, R., Rowden, G., Stone, S., Walter, W., Wolf, T., Larsen, P. Implementing a veterinary forensics approach to investigate chronic wasting disease at a deer carcass disposal site. 4th International Chronic Wasting Disease Symposium, Denver, CO, United States. June 2023.
- Detection of Chronic Wasting Disease in Soil at a White-Tailed Deer Carcass Dumpsite. Maddie Grunklee. 4th International Chronic Wasting Disease Symposium, Denver, CO. June 2023.
- Wille, E. A., Karwan, D. L., Lichtenberg, S. S., Grunklee, M., Rowden, G., Ferguson-Kramer, V., Schwabenlander, M. D., Wolf, T. M., Larsen, P. A. Hydrological Transport and Persistence of Chronic Wasting Disease. Gordon Research Conference on Catchment Science, Andover, New Hampshire, June 18-22, 2023.
- Wille, E. A., Karwan, D. L., Lichtenberg, S. S., Grunklee, M., Rowden, G., Ferguson-Kramer, V., Schwabenlander, M. D., Wolf, T. M., Larsen, P. A. Hydrological Transport and Persistence of Chronic Wasting Disease in Minnesota. Minnesota Water Resources Conference, St. Paul, Minnesota, October 17-18, 2023.

Outreach Events

2021

- Southeast Deer Study Group (SEDSG) Conference - Feb. 24, 2021
- Learning Is ForEver (LIFE) | Rochester Community and Technical College - Mar. 10, 2021
- Granger Amish Community Focus Group - April 10, 2021
- Minnesota Deer Hunters Association Executive Committee Meeting: CWD in MN - April 17, 2023

- UMN Ruminant Research Seminar - April 26, 2021
- Modern Carnivore Podcast - April 29, 2021
- U of Oklahoma: Emerging Zoonosis - May 25, 2021
- Lone Star Outdoor Podcast - June 1, 2021
- Northcentral United States Animal Health Association (USAHA) Meeting - June 7, 2021
- American Veterinary Medical Association Meeting - July 31 - Aug. 1, 2021
- MN House Natural Resources Committee: CWD update - Sept. 14, 2021
- CWD Public Meetings
    - Winona County - Sept. 28, 2021
    - Bemidji - Sept. 28, 2021
    - Kelliher - Sept. 29, 2021
- University of South Dakota: Department of Biology - Oct. 18, 2021
- UMN Extension Series - Oct. 19, 2021
- CWD Presentations for Texas Deer Association, Texas Deer Breeders, and Caesar Kleberg Wildlife Leadership - Oct. 29, 2021
- Board of Animal Health (BAH) Fall Work Conference - Nov. 16, 2021
- CWD Presentation for US House Agriculture Committee Staff - Dec. 16, 2021

2022

- Mississippi State University CWD Educational Videos - begun Jan. 23, 2022
- CWD Presentation for Texas Deer Ranchers - Mar. 2, 2022
- Caesar Kleberg Wildlife Institute 2022 Deer Research Meeting - Mar. 4, 2022
- Update for Environment and Natural Resources Finance and Policy Committee - Mar. 15, 2022
- University of Minnesota (UMN) College of Veterinary Medicine (CVM): Issues Class - Mar. 17, 2022
- Iskigamizige-Giizis Maple Sugar Moon Pow Wow - April 16, 2022
- Pathways 2022: Human Dimensions of Wildlife Conference - May 1, 2022
- North American Congress for Conservation Biology - July 1, 2022
- Wildlife Disease Association Annual Meeting - July 28, 2022
- Association of Fish & Wildlife Agencies (AFWA) Science and Research Committee Meeting - Sept. 16, 2022
- Leech Lake Student Initiative for Reservation Veterinary Services (SIRVS) Clinic - Oct. 15, 2022
- CWD Pint Night: BAH and Minnesota Department of Natural Resources (MN DNR) - Oct. 26, 2022
- Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) Conference - Oct. 28, 2022
- Governor's Deer Hunting Opener Reception - Nov. 3, 2022
- Mille Lacs SIRVS Clinic - Nov. 12, 2022
- Texas Parks & Wildlife Department (TPWD) CWD Symposium - Dec. 6, 2022
- Michigan DNR: Midwest Biologist Monthly Meeting - Dec. 20, 2022

2023

- USDA Stakeholder Update - Jan. 11, 2023
- Gathering Ground: Ecology of Prions in Soil - Feb. 7, 2023
- MN House of Representatives: Legislative Hearing Re: HB 1202 - Feb. 7, 2023
- SEDSG Conference - Feb. 27 - 28, 2023
- UMN CVM: Issues class - Mar. 6, 2023
- CVM Admitted Student Day - Mar. 7, 2023
- Outdoor News: Deer and Turkey Classic - Mar. 10 - 12, 2023
- UMN Community Outreach and Veterinary Education (COVE): Spring Break Event - Mar. 14, 2023
- UMN Speaking Science - Mar. 24, 2023
- Molecular Basis of Healthy Aging Conference - Mar. 26, 2023
- CVM Research Day - April 6, 2023
- Earl E. Bakken Medical Devices Center: Design of Medical Disease Conference - APril 18, 2023
- UMN Spring Undergraduate Research Symposium - April 25, 2023
- CVM 75th Anniversary Discovery Station - May 8, 2023
- 4th International CWD Conference - May 30 - June 2, 2023
- Fillmore County Fair - July 19-21, 2023
- MN State Fair - Aug. 24 - Sept. 4, 2023
- Leech Lake Band of Ojibwe Division of Resource Management: CWD Informational Event - Oct. 11, 2023
- Minnesota Water Resources Conference - Oct. 17-18, 2023
- CWD Pint Night: Backcountry Hunters and Anglers - Oct. 26, 2023
- Hunters' Extravaganza - Nov. 1, 2023
- Native American Calling: Radio Panel Discussion - Nov. 16, 2023
- Texas Parks & Wildlife Commission Meeting - Nov. 1, 2023
- Auburn College of Forestry, Wildlife, and Environment Seminar Series - Nov. 4, 2023
- MN Department of Health Zoonotic Diseases Unit’s 8th Annual Emerging Issues Gathering - Dec. 7, 2023
- CWD for Real Estate: Introduction to CWD, Prions, and Why They Matter to the Real Estate Industry - Dec. 18, 2023

Students and Staff Supported

Undergraduate Students

- Rachel Schomaker (CBS)

Master’s Students

- Madeline K. Grunklee (CFANS)

PhD Students

- Manci Li (CVM)
- Anu Wille (CFANS)

Post-doctoral

- Laramie Lindsay (CVM)

Staff

- Sarah Gresch (CVM)
- Adam Reinschmidt (CVM)
- Gage Rowden (CVM)
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