

**Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 012-A

Emerging Threats to Minnesotas Wildlife

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: \$ 874,447

Proposed Project Time Period for the Funding Requested: 2 Years, July 2014 to August 2016

Summary:

Many emerging threats to wildlife are acquired from the environment, yet little is known about environmental source or spread. Identifying hot spots and risk factors for exposure will improve protection.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ Employment	_____ TOTAL _____%



PROJECT TITLE: Emerging threats to Minnesota's wildlife

I. PROJECT STATEMENT

Novel diseases are emerging that threaten wildlife populations we hold dear in Minnesota. Emerging diseases have already led to declines in wildlife populations and threaten biodiversity. With hunting, fishing, and outdoor recreation revenues of tens of billions of dollars, wildlife and fisheries resources are not something Minnesota can afford to lose to invading pathogens. To mitigate these disease threats we must understand where deadly pathogens are harbored in the environment and how they are transmitted to wildlife. Our proposal will create a system to collect foundational data on disease occurrence throughout MN's environment.

As environmental and climate changes upset the equilibrium of ecosystem health, emerging diseases are an ever-growing concern: impacting the landscape itself as well as fish, wildlife, and human inhabitants. Little data exists to accurately assess disease risks due to emerging or invasive pathogens that we know little about, hampering wildlife and fisheries management. Compounding this problem, many of these zoonotic pathogens also have the potential to infect humans yet disease ecology falls outside the purview of either wildlife or human health agencies. Thus our collaborators at the DNR and MDH are calling for data on disease ecology and pathogen prevalence in the environment to inform their management actions.

Our goal is to establish a statewide baseline survey of foundational data to identify and quantify emerging diseases as well as define their critical environments. Data will be efficiently collected with scientific sampling methods called 'transects', designed to statistically represent all of Minnesota's major biomes (prairie, deciduous, and coniferous forests; see attached figure) and intersect a wide range of temperature and precipitation levels. To effectively utilize the time and money invested in the transect study, we have assembled a diverse team of disease biologists to implement a multifaceted sampling approach that will collect soil, water, and tick samples to assess the prevalence of multiple pathogens within each sample. We are focusing on diseases emerging and infecting multiple species in MN with lethal impacts on wildlife resources (see Table for examples). In addition to addressing immediate disease threats, these data-collection transects will establish a disease monitoring network to detect new pathogens that may threaten MN's natural resources.

Ultimately, our research outcomes will prepare Minnesota to control disease expansion in our treasured wildlife populations. We will provide information crucial to help managers mitigate disease threats to wild populations, including species important to conservation and consumptive use. As an additional benefit of our research, we will be able to help public officials improve the safe human enjoyment of MN's outdoors.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Sample lakes, soils, and woodlands to detect disease

Budget: \$ 292,871

Soil, water and arthropod samples representing the range of Minnesota's ecological and climatological variation will be collected from 200 sample locations along transects (depicted in the attached map). Findings from the first summer will identify disease hot spots, resulting in repeat sampling of 50 hotspots in the second summer.

Outcome	Completion Date
1. Sample collection– full transect	Summer 1
2. Sample collection – target areas / hot spots	Summer 2

Activity 2: Use DNA-based tests to detect emerging pathogens

Budget: \$ 348,671

Samples collected above will be analyzed, by highly sensitive DNA-based detection methods, for presence/prevalence of the pathogens inhabiting our lakes, soils, and woods (see Table for example pathogens).

Outcome	Completion Date
1. Determine invasion status of <i>Naegleria</i> , <i>Heterosporosis</i> , and <i>Bd</i> in lakes	Year 1/Year 2
2. Determine the prevalence of tick-borne pathogens in fields and woods	Year 1/Year 2
3. Identify environmental reservoirs of <i>Blastomyces</i> from soil samples	Year 1/Year 2



Environment and Natural Resources Trust Fund (ENRTF)

2014 Main Proposal

Project Title: Emerging threats to Minnesota's wildlife

4. Determine distribution of MDR in the environment	Year 1/Year 2
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Activity 3: Determine environmental factors associated with disease emergence Budget: \$ 232,905

Data on emerging diseases in MN's environment will be used to map high-risk areas, and use epidemiological models to determine what environmental factors influence presence/prevalence of these pathogens. By understanding links between the environment and pathogens, we will predict how/where disease risk will change as the environment is altered and climate changes.

Outcome	Completion Date
1. Map(s) with distribution of emerging pathogens across ecological zones	Year 2
2. Epidemiological and predictive models for emerging pathogens	Year 2
3. Work with partners to determine perceived risk, develop outreach materials	Year 2

Through early detection of pathogens and identification of environmental or climatic risk factors associated with these diseases, we can proactively mitigate disease threats to MN's natural resources.

III. PROJECT STRATEGY

A. Project Team/Partners

Our team includes ecological, epidemiological, diagnostic, and public health experts at the University of Minnesota, who will receive the funds. We are working in close collaboration with partners in the MN Departments of Natural Resources, Health, Explore Minnesota, and the Minnesota Recreation and Park Association who will contribute expertise but will not receive funds.

B. Timeline Requirements

Collection of field data will take place between May and October. Both transects (200 sites) will be sampled 2014, 50 identified hotspots will be re-sampled in 2015. Laboratory analysis will be conducted in years 1 and 2 to identify pathogen prevalence in the environmental samples. Statistical and ecological modeling will extend into year 2 with development of prevalence maps and models, and the impact of climate change on these models.

C. Long-Term Strategy and Future Funding Needs

At the completion of these studies, valuable baseline prevalence maps for major environmentally acquired pathogens, as well as information about environmental factors that affect prevalence will be generated. These data will be interpreted and disseminated to the public through both state agencies and private partners (see Letters of Support and Project Management section). Over the longer term, the established transects provide the opportunity for future sampling to assess the changing nature of environmental conditions and disease risks that affect Minnesota's natural resources and our enjoyment of the outdoors.

Table 1: Representative pathogens that affect Minnesota's wildlife and will be studied in this proposal

Pathogen	Vector	Species Affected	Wildlife Impacts	Human Impacts
Tick born disease (bacteria / viruses)	Ticks	Many: winter ticks on moose of most concern	parasite burden can decrease survival	diseases from wildlife cross- over to humans
Heterosporosis (parasites)	Water	Fish: sport fish species of most concern	fish death can threaten populations	fillets are inedible decreasing fish value
<i>Batrachochytrium dendrobatidis</i> (fungus)	Water	Amphibians of many species	death, population declines, extinctions	disruption of ecosystem services
<i>Naegleria fowleri</i> (amoebae)	Water	Many: fish, rodents (squirrels), humans	unknown	deadly neurological infection
<i>Blastomyces dermatitidis</i> (fungus)	Soil	Many: wolves, bear, dogs, cats, rodents, humans	blindness, pneumonia, and death	susceptible to disease and death
Antibiotic-resistance (bacteria)	Soil	Many: concern for wildlife with farm contact	life-threatening bacterial infections	bacterial infections may be untreatable

2014 Detailed Project Budget

Project Title: Identifying and Mitigating Disease Risks in Minnesota's Outdoors

IV. TOTAL ENRTF REQUEST BUDGET 2 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel:	\$ 533,447
8 Professors, each @ 2 weeks effort/year for 2 years (75% salary, 25% benefits)	\$ 73,311
2 weeks summer effort per professor X 8 professors X 2 years = 32 weeks total effort individual salaries vary, but range from \$86,795 to \$106,477)	
4 Research Associates, each @ 100% effort/year for 2 years (83% salary, 17% benefits)	\$ 376,936
yearly salary of \$39,264 + \$7853 benefits X 4 associates X 2 years = \$376,936	
4 Research Assistants, each @ 50% effort/year for 2 years (100% salary)	\$ 83,200
26 weeks X 5 days/week X 8 hours/day X \$10/hour X 4 assistants X 2 years = \$83,200	
Equipment/Tools/Supplies:	\$ 278,000
Supplies to collect soil, water, and arthropod samples from 250 sites	\$ 28,000
Reagents to isolate DNA from 250 soil, 250 water, and 100 arthropod samples	\$ 32,500
Reagents to amplify DNA by PCR from 250 soil, 250 water, and 100 arthropod samples	\$ 32,500
Reagents to sequence amplified DNA from 250 soil, 250 water, 100 arthropod samples	\$ 150,000
Reagents and supplies to test bacterial antibiotic resistance in 250 soil samples	\$ 15,000
Survey and outreach supplies to inform public and state agencies of disease risk	\$ 20,000
Travel: Lodging and transportation costs for research assistants to collect soil, water, and arthropod samples along transects from May through October for two years	\$ 63,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 874,447

V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non-State \$ Being Applied to Project During Project Period:	\$ -	
Other State \$ Being Applied to Project During Project Period:	\$ -	
In-kind Services During Project Period:	\$ 395,766	<i>Secured</i>
Typical costs to outsource DNA-based analysis of soil, water, or arthropod samples to commercial laboratories is \$150 per sample per organism. Commercial costs to screen 600 samples for 8 organisms would be \$720,000. University of Minnesota researchers can perform the same analysis for \$324,234 (2 associates, reagents for DNA isolation, amplification, and sequencing), a cost savings of almost \$400,000.		
Remaining \$ from Current ENRTF Appropriation (if applicable): N/A	\$ -	
Funding History:	\$ 80,000	
Improving Emerging Fish Disease Surveillance in Minnesota Project Manager: Katharine Pelican Goal: Develop a PCR assay and sequencing methods to identify heterosporosis in fish and perform a preliminary using fish submitted to the Veterinary Diagnostic Laboratory. The current study would use this assay to monitor and model heterosporosis in Minnesota on a state-wide scale using our transect methodology.		

Emerging Diseases & Minnesota's Environment



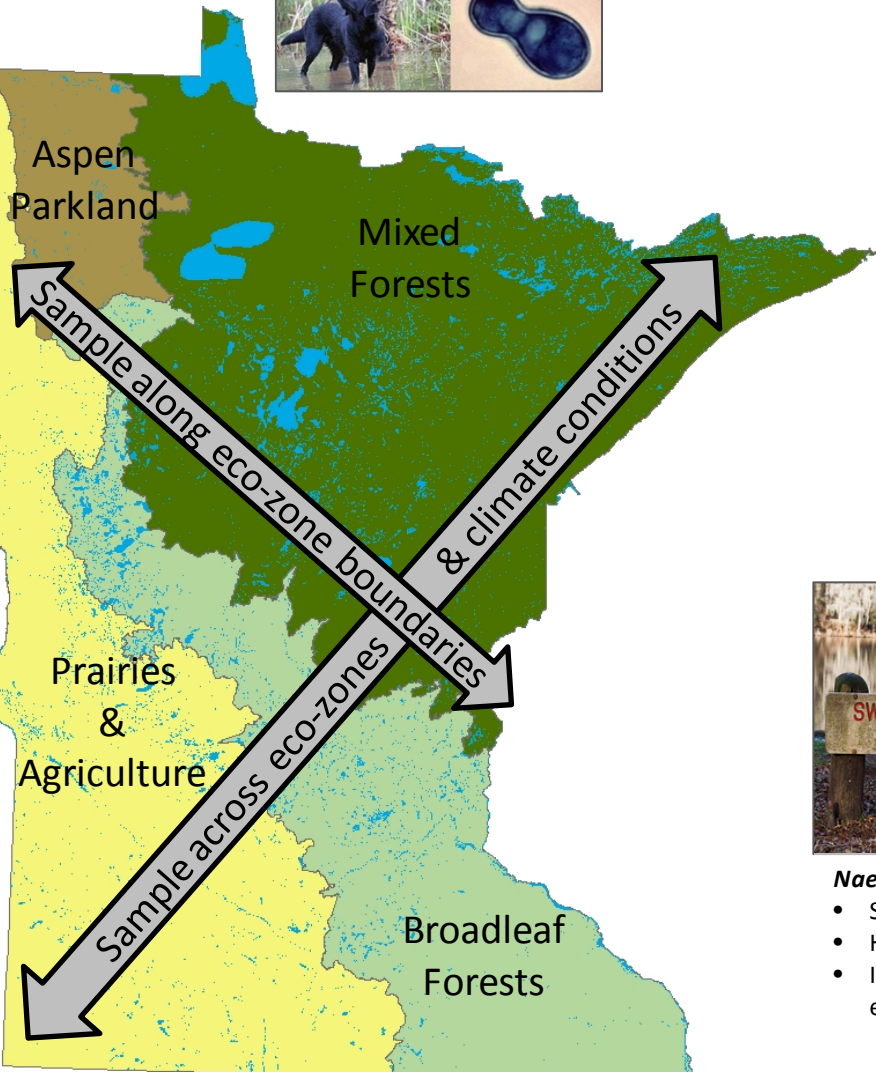
Blastomyces dermatitidis

- Endemic to Minnesota soils
- Causes disease in dogs, wildlife, and humans



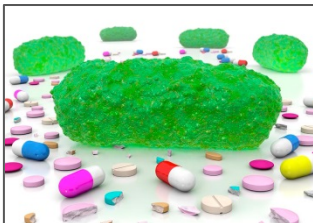
Tick-borne disease

- Moose burdened with ticks
- Human disease cases rising
- Strong links between environment and tick spread



Naegleria fowleri

- Significant fish pathogen
- Has killed three children in Minnesota
- Important links to lake temperature and environmental factors



Antibiotic resistant bacteria

- Highly resistant bacteria cause severe infections in many species
- Unknown amounts of bacteria are multiplying in the environment

07/24/2013



Batrachochytrium dendrobatidis (Bd)

- Chytrid fungus kills many amphibian species
- Population extinctions threaten biodiversity
- Environmental conditions influence fungal growth



Heterosporis

- Recent spread to more than 25 MN lakes
- Infects important fish species
- Parasite destroys muscle tissue, rendering the fish unfit for human consumption and killing fish



PROJECT MANAGER QUALIFICATIONS & ORGANIZATION DESCRIPTION

The proposed project, entitled "Identifying and mitigating emerging diseases in Minnesota's environment", is a cross-disciplinary effort at the University of Minnesota spanning five departments. By combining expertise and resources from multiple disciplines, we will be able to rapidly survey, analyze, and model the prevalence of many pathogens associated with Minnesota's wildlife and their impact on ecosystem health, disease ecology, and residents/tourists. The qualifications of each of the co-investigators are indicated below:

Project Manager

Kirsten Nielsen, Department of Microbiology. Dr. Nielsen is an Associate Professor in the Department of Microbiology at the University of Minnesota. Dr. Nielsen studies the ecology, transmission, genetics, and pathogenesis of eukaryotic pathogens. She has extensive experience managing large inter-disciplinary research projects and their related budgets. Dr. Nielsen will manage the overall project, oversee water and soil sampling, and DNA analysis of fungal pathogens.

Co-Investigators

Stacie Robinson, Department of Veterinary Population Medicine. Dr. Robinson's studies focus on applying genetic techniques to transmission dynamics, spatial spread, and impacts of disease. She will assist Dr. Nielsen in project management and oversee tick collection and detection of the various tick-associated diseases.

Meggan Craft, Department of Veterinary Population Medicine. Dr. Craft is an infectious disease ecologist specializing in theoretical disease models at the intersection of environmental, human, and animal health. She will develop models for prevalence and spread of the water, soil, and tick-borne pathogens.

Tim Johnson, Department of Veterinary and Biomedical Sciences. Dr. Johnson studies antimicrobial resistance of bacteria. He will analyze soil bacteria for drug resistance related to land use and impact for human exposure.

Joseph Knight, Department of Forest Resources. Dr. Knight studies how changing land use and climate change affects natural resources using geospatial methods such as remote sensing and geographic information systems. He will develop the transect sampling strategy and geospatial maps of pathogen prevalence within Minnesota.

Clarence Lehman, Department of Ecology, Evolution, and Behavior. Dr. Lehman is a theoretical ecologist focusing on computer models of climate change impact on biological systems. He will develop computational models for how climate change predictions impact pathogen emergence in our Minnesota outdoors.

Katey Pelican, Department of Veterinary Population Medicine. Dr. Pelican is head of the Ecosystem Health Initiative at the University of Minnesota and is focused on improving health at the intersection of animals, humans, and the environment. She will explore intersections between the pathogens and their environments.

Nicholas Phelps, Veterinary Diagnostic Laboratory, co-Investigator. Dr. Phelps is a Certified Fish Health Inspector and leads the fisheries and extension activities for the College of Veterinary Medicine. He will examine the emergence and spread of heterosporosis in our Minnesota lakes.

Ingrid Schneider, Department of Forest Resources, co-Investigator. Dr. Schneider is Director of the Tourism Center and is focused on human-nature relationships in recreation and tourism settings. She will examine how visitors and tourists perceive disease threats in Minnesota parks and forests and how managers/planners can mitigate these stresses.

In addition to our research faculty, we also have a number of collaborators both within the state government and public organizations that will work with us to develop and distribute our data (See Letters of Support):

John Edman, Explore Minnesota Tourism Director

Courtland Nelson, Director, Division of Parks and Trails, Minnesota Department of Natural Resources

Joni Scheftel, State Public Health Veterinarian, Minnesota Department of Health

Kirk Smith, Food, Vector Borne, and Zoonotic Disease Unit, Minnesota Department of Health

Michelle Snider, Executive Director, Minnesota Recreation & Parks Association