

**Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 121-D

Northward Expansion of Ecologically Damaging Species

Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: \$ 213,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 - June 2020

Summary:

This work will predict the future Northern expansion of two species (American bullfrogs and Red-eared slider turtles) that have great potential to negatively alter the fish communities of Minnesota's lakes and streams.

Name: Suzanne McGaugh

Sponsoring Organization: U of MN

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St. Paul MN 55108

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Web Address _____

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Current distribution for American bullfrogs and Red-eared slider turtles and watersheds proposed for sampling.

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



PROJECT TITLE: Northward expansion of ecologically damaging species

I. PROJECT STATEMENT

Minnesota has experienced dramatically warmer temperatures in the past decades. Many species reach a northern range limit to their distribution in Minnesota. To the extent that this pattern is influenced by the adaptive capacity of populations at the range edge (e.g. limited tolerance to cold), species with limited ranges in Minnesota (or range limits to the south of the state) are expected to expand their ranges northward as the climate warms. At least some of these species are expected to impact Minnesota native aquatic wildlife, including fish stocks. Given that northern fish populations contribute greatly to local community revenue and the health of the ecosystems, understanding how northern-expanding predators may impact fish communities is critical.

Our study will assess the potential for northward expansion of American bullfrogs and Red-eared sliders in Minnesota’s waterways. These species are both predators of juvenile fish and these two species are among the most pervasive and detrimental invasive aquatic vertebrate species on the planet. When they are introduced into waterways where they are not native, both species outcompete and feed on native species, restructure the food webs, and threaten native species with extinction. Although American bullfrogs and Red-eared sliders have limited ranges in Minnesota, they are expected to expand northward through the state as temperatures continue to increase with climate change.

We will assay stomach contents to determine if these two species are eating larval fish and, if so, which fish species they are impacting. We will measure their thermal tolerances and genetics in different parts of their range and to understand what physiological processes and genes may be responsible for northern expansion. We will use these data to build a niche model to predict future impacts on Minnesota lakes, streams, and fish stocks.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Population and stomach contents survey

Budget: \$90,000

We will survey species occurrence and abundance along North-South transects in drainage systems that American bullfrogs and Red-eared sliders are presently known to inhabit, as well in drainage systems immediately to the north (e.g. Red River Basin, upper reaches the Mississippi Headwaters Basin, Lake Superior Basin) to survey for recent northward expansion. We will perform stomach contents analyses to determine if Northern-expanding species are eating recreationally important fish species. We will perform these surveys over three summer field seasons.

Outcome	Completion Date
1. <i>Estimate abundance of American bullfrog and Red-eared slider turtles in Minnesota waterways.</i>	May 2020
2. <i>Estimate predation on native species by American bullfrog and Red-eared slider turtles.</i>	May 2020

Activity 2: Thermal tolerance

Budget: \$41,000

We will measure the thermal tolerances (sensitivity and duration of activity over a range of environmental temperatures) of the focal species at the northern range edge and in more southern localities. If adaptation to climate constrains northward dispersal, no differences in thermal tolerance are expected between the range edge and more southern localities. Broader thermal tolerance and/or increased tolerance to cold at the range edge would be evidence of adaptive evolution to climate and more rapid northward range expansion than expected based on species tracking favorable conditions as the climate warms. Thermal tolerance data will be used to generate species-specific models of the future of climatically-suitable habitats across the state based on predicted rates of environmental warming.



Outcome	Completion Date
1. Determine the role of climate in restricting the northward expansion of species.	May 2020
2. Predict the future distributions of species under predicted rates of warming.	May 2020

Activity 3: Genetic analyses

Budget:\$ 82,000

To understand whether the spread of the American bullfrog and Red-eared slider is due entirely to passive Northern expansion or is supplemented by human-mediated introductions (e.g. pet trade, food industry), we will conduct genome-wide genetic analyses to determine the location of origin of Minnesota-collected individuals. To perform this analysis, we must have a reference set of individuals for comparison to the Minnesota individuals. Thus, we will also include individuals along two north-south transects which extend into Iowa and Missouri. If individuals in Minnesota are very different from their neighbors to the south, we will conclude that individuals in Minnesota are the result of human-mediated introductions. Since we are including genome-wide genetic markers, we will assay whether some of these markers exhibit genetic signatures that implicate them in colonization of new habitats and withstanding colder conditions.

Outcome	Completion Date
1. Pinpoint location of origin of non-native invasive species from genetic analyses.	May 2020
2. Identify genes that may aid in colonization of new habitats.	May 2020

III. PROJECT STRATEGY

A. Project Team/Partners

Drs. Suzanne McGaugh and Ken Kozak from the University of Minnesota Department of Ecology, Evolution and Behavior will lead the project and advise a graduate student. They each will receive one-month of summer salary for three years. McGaugh and Kozak have strong backgrounds in herpetology, conservation genetics, and niche modeling. Much of the funds requested will provide support for a University of Minnesota graduate student to conduct the fieldwork and data analyses as well as an undergraduate student to help with the fieldwork.

B. Project Impact and Long-Term Strategy

Our work will provide predictions of impact on Minnesota’s waterways of two species that are notorious aquatic ecosystem invaders. We will present the results to the general public at the Minnesota State Fair and the University of Minnesota’s Bell Museum and to the scientific community in scientific journals and conferences. In the future, we would like to expand this project to species we hypothesize will not have a substantial ecological or environmental impact to understand how aquatic communities in Minnesota may shift with climate change.

C. Timeline Requirements

We request funding for three years, starting July 1, 2017. This timeline provides three field seasons for Activity 1. Animals collected during field season 1 (2017) and field season 2 (2018) will be used for thermal tolerance assays in Activity 2 during the 2017-2018 and 2018-2019 academic years. DNA samples collected during field season 1 (2017) and field season 2 (2018) will be used for Activity 3, and DNA will be supplied to the genotyping facility at Cornell University by October 2018. Typical turn-around is approximately 10-12 weeks, and we expect data to be returned from Cornell and genetic analyses to commence by January 2019. Analyses of data and writing of a scientific publication will be finished by June 30, 2020.

2016 Detailed Project Budget

Project Title: Northward expansion of ecologically damaging species

IV. TOTAL ENRTF REQUEST BUDGET 3 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel: McGaugh, PI (75% salary, 25% benefits, 100% FTE); One month of summer salary is requested for 3 years (3 months total across the proposal) for participation and supervision of site sampling, DNA extractions, DNA analysis, data interpretation, publication preparation, and dissemination of results.	36000
Personnel: Kozak, PI (75% salary, 25% benefits, 100% FTE); One month of summer salary is requested for 3 years (3 months total across the proposal) for participation and supervision of site sampling, DNA extractions, DNA analysis, data interpretation and publication preparation and dissemination of results.	40000
Personnel: One graduate student will be paid to perform transects, take tissue samples, perform DNA extractions, analyze DNA data and write reports of results for two academic years (51% salary, 49% benefits; 50% FTE during academic year) and three summers (85% salary, 15% benefits; 50% FTE during summer).	102000
Personnel: (100% salary, 0% benefits, 19% FTE); One undergraduate student will be paid for 16 weeks for the first and second summers of research to aid in field work.	14000
Equipment/Tools/Supplies: Field supplies: Cutler supply frog nets 13.95 x 4 nets, Turtle traps from Memphis Net \$58.53 each x 10 traps, 10ft rebar for securing traps \$4.78 (Home Depot) x 20 rebar; Sardine bait 15.82 per pack of 12 (Walmart) x 10 packs; Cabela's Nylon Minnow Seine Net to place between two turtle traps \$61.99 x 5 nets; Cabela's Women's 3mm Stockingfoot Waders 59.99; Herter's Men's Roaring Fork Lug-Sole Waders 79.99; 5 gallon bucket 3 pack (Home Depot) 8.55; Old Town Saranac 160 Canoe Green 16 Ft 799.99; Economy Wood Canoe Paddle 19.99 x 2; 10 in. Bastard-Cut Mill File for scute notching \$6.95 each x 5	2000
Equipment/Tools/Supplies: Qiagen Dneasy DNA extraction kit 250 individuals: \$690 x 2 kits; Axygen Scientific T200C pipet tips: Case of 20000 for \$493.78; Thermo Scientific™ Nalgene™ General Long-Term Storage Cryogenic Tubes 1.5mL: Case of 500 for \$357.20; Fisher Scientific Premium Microcentrifuge Tubes: 1.5mL: Case of 500 for \$63.00 x 2; Syringes and needles for blood sampling: \$150; Shipping to RAD sequencing facility on dry ice overnight: \$75; 96 well semi-skirted PCR plate: Case of 25 for \$124.00	3000
Travel: Travel to sampling sites, approximately 2000 miles per summer x first 2 summers, \$0.54 UM mileage rate	2000
Additional Budget Items: Lab Services: RAD sequence analysis for ~180 DNA samples each from two species. Four plates of sequencing, 90 individuals sequenced per plate with 5 individuals replicated per plate for accuracy quantification. \$3040 per plate for processing and sequencing through Cornell University Institute of Biotechnology. \$120 for GBS optimization; \$976 for bioinformatics. DNA quantification pico green assays: \$2.07 per sample x 400 samples at University of Minnesota Genomics Center.	14000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	213000

V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non-State \$ To Be Applied To Project During Project Period:	N/A	
Other State \$ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: <i>Indirect costs (53% & 54% MTDC) associated with this proposal</i>	93,000	<i>Secured</i>
Funding History:	N/A	
Remaining \$ From Current ENRTF Appropriation:	N/A	

Range of Red-eared slider
Trachemys scripta elegans



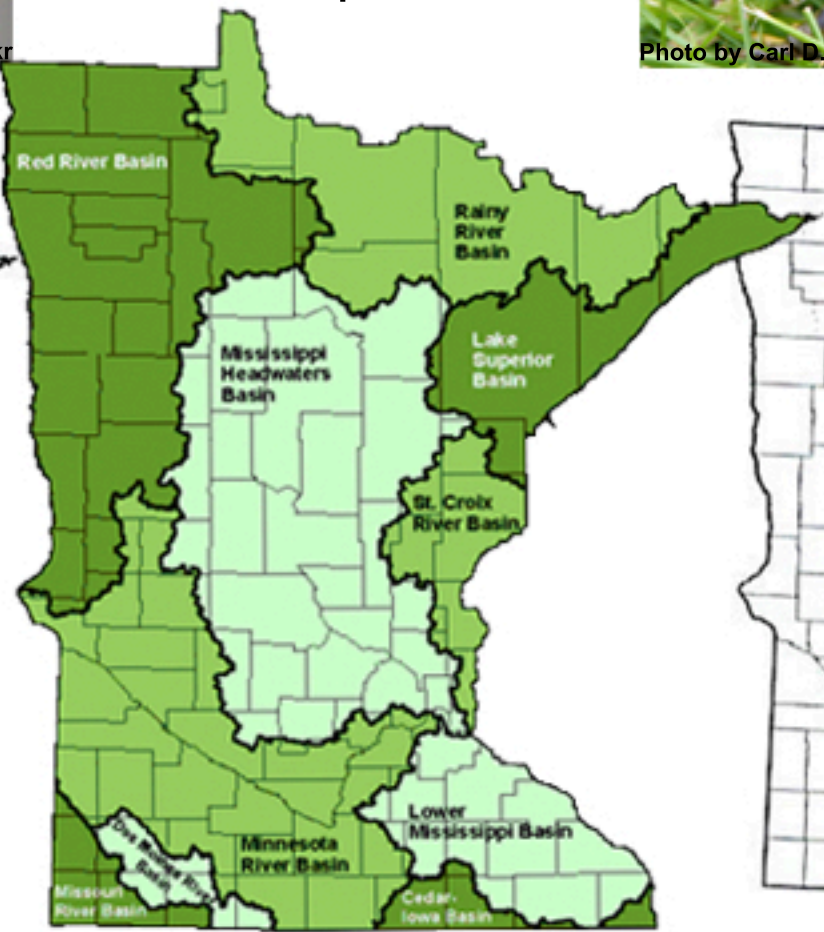
Photo by Jim Capaldi, Flickr

Range of American bullfrog
Lithobates catesbeianus



Photo by Carl D. Howe

**Sampling planned for
Minnesota River Basin,
Mississippi Headwaters Basin,
Red River Basin,
and Lake Superior Basin**



Half-filled circles = vouchered pre-1960
Solid circles = vouchered post-1960
Unfilled circles = sighting or literature record

Project Manager Qualification and Organization Description

Suzanne Elaine McGaugh

Assistant Professor, Department of Ecology, Evolution, and Behavior, University of Minnesota-TC

Education:

B.S. Ecology, Evolution, and Behavioral	2003	University of Texas-Austin
Ph.D. Genetics	2009	Iowa State University
Post-doctoral Associate	2009-2012	Duke University
Post-doctoral Associate	2012-2013	Washington University in St. Louis
Post-doctoral Associate	2014	Iowa State University

As a relatively new professor, I am working to establish a locally important research program. My research career until this point has focused on understanding how variable environments can produce plastic and genetic changes in a variety of species. During my undergraduate and graduate careers, I worked for the conservation of a desert-spring ecosystem. This work included applying conservation genetics to understand how fragmented aquatic habitats embedded in a desert produced different population structures for species with different habitat needs. My most recent research focuses on genetics within and between populations of turtles and fish.

Kenneth H. Kozak

Associate Professor and Curator, Department of Fisheries, Wildlife & Conservation Biology, and Bell Museum of Natural History, University of Minnesota-TC

Education:

B.S. Biology	1995	Johnson State College
M.S. Zoology	1999	Clemson University
Ph.D. Evolution, Ecology & Population Biology	2005	Washington University in St. Louis
Post-doctoral Associate	2005-2007	Stony Brook University

My research expertise is on understanding on how species diversify, spread, and accumulate across the landscape over time. To address these questions, I combine data and quantitative analyses from the fields of population genetics, phylogenetics, and spatial ecology. My most recent research focuses on understanding the causes of mountaintop endemism in amphibians and on predicting the range dynamics of these narrow-ranging species in response to climate change.

Organization Description: The Department of Ecology, Evolution and Behavior at the University of Minnesota creates and disseminates information through internationally respected research and teaching at undergraduate and graduate levels. Synthesis of how biological communities interact and evolve, and how this complexity may shift over time is key to tackling current and future environmental issues.

<http://www.cbs.umn.edu/eeb/>