Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)

Project Title: **ENRTF ID: 027-A**

Wildlife Health and Reproduction Among Different Quality Habitats

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 484,000

Proposed Project Time Period for the Funding Requested: 4 years, July 2016 to June 2020

Summary:

We will determine if fragmented agricultural and urban grasslands/wetlands contribute a significant percentage of total reproductive output for a common bird in comparison to more contiguous habitat.

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Sponsoring Organization: U of MN

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Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Flow chart of experimental plan.

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

PROJECT TITLE: Wildlife health and reproduction among different quality habitats

I. PROJECT STATEMENT

We will determine if a significant percentage of yearly reproductive output for a common songbird is derived from fragmented grasslands/wetlands embedded in agricultural and urban matrices and whether these areas are capable of producing offspring that are as healthy as offspring from more intact core habitats.

Our specific OUTCOMES include:

1. Understanding whether fragmented grasslands/wetlands contribute a significant proportion of annual reproduction for the red-winged blackbird (*Agelaius phoeniceus*), a widespread songbird that breeds in these habitats.
2. Determining whether birds from agricultural and urban habitats have similar reproductive success, health, and stress levels as birds from more pristine, contiguous habitat.

Background: Minnesota's grasslands and wetlands are vital for the sustainability of native wildlife and plants, yet these ecosystems have suffered reductions in excess of 90% in the past 150 years due to the expansion of agriculture and urban/suburban development. Grasslands and wetlands are home to many species, including some that live in both fragmented and undisturbed habitats. However, it is unknown if the fragmented habitat embedded in the agricultural and urban matrix (i.e. the majority of the landscape) is responsible for a large proportion of their reproductive output, or if most reproductive output comes from contiguous, core habitats.

We propose to compare reproduction and health in red-winged blackbirds (*Agelaius phoeniceus*) in three habitat types: (a) the prairie core areas defined by the Minnesota Prairie Landscape Conservation Plan (e.g. Lac Qui Parle Wildlife Management Area), (b) small grassland/wetlands within the agricultural matrix (e.g. 40-120 acre Wildlife Management Areas) and (c) urban and suburban habitats. Our goals are to understand if fragmented habitat accounts for a substantial proportion of the reproductive output of a target species and to understand if birds raised in fragmented habitat are equally as healthy as birds raised in core habitat. This comparison is essential to understand the long-term reproductive potential of birds, as the majority of their historic habitat has shifted in size and composition and is expected to continue doing so.

The red-winged blackbird, an indicator species for wetland habitats, is an excellent species for this study, because 1) its breeding biology has been studied for decades, making it an ideal system to examine how changes in environment affect survival and reproduction, 2) red-winged blackbirds occur at sufficiently high densities across the Midwest to obtain statistically robust data regarding the impacts of habitat fragmentation and agriculture on wildlife health, 3) red-winged blackbirds have a short generation time, allowing us to follow individuals from hatching to adulthood, and 4) in-depth comparison of reproduction, health, and stress across habitats requires substantial personnel, which necessitates concentration on a focal species. Trends detected in red-winged blackbirds can then be used to guide future projects on other species.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: <u>Assay for differences in reproduction among habitat types</u> **Budget: $205,000**

We will produce an estimate of the proportion of reproductive output that occurs in fragmented habitats relative to core habitats. We will match sites for marsh area and vegetation across the three habitat types (prairie core, small agricultural matrix sites, urban/suburban) and target 15 grassland/wetlands per habitat type. We will monitor as many nests as possible per site (target: 25-40 nests) and measure the number of eggs, nestlings, fledglings, and broods produced per female per year. These time- and staff-intensive surveys will help us understand how important fragmented habitat is to the reproductive output of the species. We will quantify trends over four breeding seasons to buffer against year-to-year variability and track birds across their lifespans.

Next, we will understand how being raised in fragmented versus core habitat impacts the potential for future reproduction by performing a cross-fostering experiment. Nestlings from fragmented habitat will be deposited into nests of core habitat (and vice versa) in year 1 and year 2, and their reproduction will be tracked in subsequent years. This experiment will allow us to test the effects of natal and foster environment on a chick's potential to reproduce in the future. We will determine whether chicks raised in fragmented habitat ultimately reproduce less than chicks raised in core habitat, regardless of where they were hatched.

Outcome	Completion Date
1. Estimate of the proportion of reproduction occurring in fragmented vs. core habitats.	December 2019
2. Quantification of the impact of natal vs. foster (hatching vs. raising) environment on future reproduction.	December 2019

Activity 2: Quantify and compare health of birds among habitat types **Budget: $279,000**

We will determine if the chicks hatched or raised in fragmented habitat are at a disadvantage across their lives. The birds from the surveys and the cross fostering experiment in Activity 1 will be measured across all study years for several key components of health. First, we will measure body condition and internal and external parasite loads across years. Second, we will measure synthetic hormones and heavy metals to evaluate the impact of these chemicals on reproduction. Third, we will quantify markers of elevated stress and resilience to stress (e.g. cortisol, reactive oxygen species production, antioxidants, and DNA damage). Fourth, we will evaluate DNA modification to determine if being raised in a fragmented habitat drastically alters these modification patterns. These modifications are environmentally sensitive, often establish early in development, impact gene function, and can be inherited, yet their impacts on individual survival are only beginning to be studied in wildlife biology. Our study will be among the first to apply these analyses to wild populations and combine them with longitudinal monitoring of a wild population. We will produce an integrative model that will rank all of these factors (including habitat type) to determine which are the best at predicting reproductive success. Such a model will be a valuable tool to help direct ameliorating efforts toward the most severe risk factors to wildlife reproductive success.

Outcome	Completion Date
1. Quantify health of resident adults and offspring across life between habitat types.	March 31, 2020
2. Estimate of the immediate and long-lasting health consequences of raising environment	March 31, 2020
3. Evaluate resiliency to fragmented habitats with innovative method	June 30, 2020

III. PROJECT STRATEGY

A. Project Team/Partners: UMN faculty Drs. McGaugh and Barker and postdoctoral researcher Dr. Liu will receive resources from ENRTF. All three will lead a team of students to help accomplish Activities 1 & 2.

B. Project Impact and Long-Term Strategy: Our work will provide concrete, publicly archived data measuring the proportion of new offspring produced from fragmented versus core habitats each year. A simple measure of the proportion of fledglings per unit area, however, may overlook whether offspring health and future reproductive potential are on par with birds from more pristine, core habitats. Our work will allow us to identify the type(s) of habitat, stage(s) in development, and the biochemical markers that have the greatest impact and are the most accurate predictors of health and future reproduction. Thus, our work will provide valuable information about the reproductive ecology and potential physiological effects for species living in areas of different quality as delimited by the MN Prairie Conservation Plan.

C. Timeline Requirements: We request 4 years of funding. With funding starting on July 1, 2016, which is the end of the blackbird breeding season, we will need to start the project prior to funding (in March 2016) and fund the postdoctoral associate for 4 months from McGaugh's University of Minnesota non-sponsored funds. The study will proceed for the breeding seasons of 2016-2019 to ensure our measures are robust to yearly variability but also to follow the health and reproduction of fledglings from each habitat type and from the cross-fostering experiment.

2016 Detailed Project Budget

Project Title: Wildlife health and reproduction among different quality habitats

IV. TOTAL ENRTF REQUEST BUDGET *4* years

BUDGET ITEM	AMOUNT
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, reproductive ecology, and health and stress measures of redwinged blackbirds	$37,000
Personnel: Barker, Co-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, reproductive ecology, and health and stress measures of redwinged blackbirds	$39,000
Personnel: One postdoctoral researcher is needed to help monitor the nests and birds, perform cross fostering experiment, perform DNA damage, hormone, heavy metal and stress assays. (82 % salary, 18% benefits, 100% FTE, 40 months)	$184,000
Personnel: One graduate student will be paid to perform cross fostering experiment, perform DNA damage, hormone, heavy metal and stress assays 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; 100% FTE during summer).	$107,000
Personnel: One undergraduate student will be paid for 16 weeks for the second, third, and fourth summers of research and 4 weeks for the first summer of research (100% salary, 0% benefits, 100% FTE).	$29,000
Equipment/Tools/Supplies: Field supplies: 500 Darvic bird bands, 2 mist nets, 4 net poles, 1000 blood sampling tubes, 1000 small gauge hypodermic needles, lumber and plastic coated wire mesh for two walk-in traps, two 25lb bags of sunflower seeds for walk-in traps, 2 pairs of binoculars, 4 pairs of hip waders, 2 pairs of calipers, 3 pesola scales for different sized birds.	$2,000
Equipment/Tools/Supplies: Assays: DNA Damage, Antioxidant, Cortisol, Estradiol, Testosterone, Corticosterone, Progesterone kits will be purchased. This amount will allow assays from approximately 40 adults from each habitat (parents of the monitored nests and nests used for cross-fostering) as a baseline. We plan on banding and measureing these components in 500 chicks across all habitat types for year 1 and year 2 (total 1000 chicks) and recapturings those birds in subsequent years. For each recapture, we will measure these assays again. We budget for assays on 600 recaptures (perhaps the same bird over multple years) and will allow duplicate measures of approximately 15% of the samples to ensure repeatability. Additional funds will be used for quantifying heavy metals with HPLC. For the heavy metal assays we may be restricted to using adult birds due to the requirments of sample volume.	$30,000
Travel: Travel to sampling sites, approximately 5000 miles per summer x 4 summers, $0.575 UM mileage rate	$12,000
Additional Budget Items: Lab Services: DNA modification assays on 10 birds from 4 of the cross-fostering treatmetnts (Urban to Core, Agricultural to Core, Core to Urban, and Core to Agricultural) for a baseline and after habitat switch measures. Pricing often decreases on these services over time. If budget allows, we will increase the number of birds sampled and number of repeated measures from the same birds throughout lifespan.	$44,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 484,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
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: *Indirect costs (52% MTDC) associated with this proposal*	228,000	*Secured*
Funding History:	N/A	
Remaining $ From Current ENRTF Appropriation:	N/A	

Compare habitat types

Prairie Core Areas

Agricultural matrix WPA, WMA

Urban matrix

At least 15 marshes per habitat type
Total of at least 45 marshes

→ Measure the number of nests per hectare and number of eggs, nestlings, fledglings, and broods produced per female per year.

→ **OUTCOME:** Determine how much reproduction occurs in fragmented habitat relative to core habitat, accounting for year-to-year variability. Extrapolate from our data to state-wide land cover using MLCCS.

→ Measure markers of health from chicks and adults

→ **OUTCOME:** Understand if adults and offspring from fragmented habitat are as healthy as birds from core habitats across their lives.

Cross-fostering

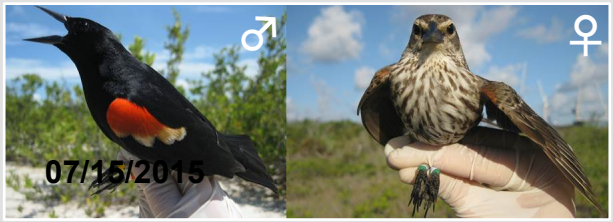
Transfer freshly-hatched chicks between nests in fragmented and core habitat. As an experimental control, chicks will also be transferred between nests within a single habitat type.

Agricultural matrix WPA, WMA ⇄ Prairie Core Areas

Urban matrix ⇄ Prairie Core Areas

→ Measure health at time of transfer and fledging

→ Measure health and reproduction of cross-fostered chicks as adults



→ **OUTCOMES:**
Quantify the importance of habitat fragmentation during development on short and long-term health and reproduction across habitat type.

Determine whether chicks hatched in a fragmented habitat are 'rescued' if they are raised in a intact habitat.

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 matrix produced different population structures for species with different habitat needs. My most recent research focuses on how the genetic pathways responsible for stress responses differ between reptiles (including birds) and mammals.

F. Keith Barker
Associate Professor, Department of Ecology, Evolution, and Behavior, University of Minnesota-TC

My research focus is on patterns and processes of evolution in a major vertebrate radiation—the passerine birds. In particular, my lab is studying the population biology of the red-winged blackbird, including understanding patterns of phenotypic and genetic differentiation among populations. We recently completed a study on genetic relationships of phenotypically similar "bicolored" blackbird populations in California and Mexico and showed that these bicolored populations are most closely related to one another, to the exclusion of adjacent typical populations, despite being separated by nearly 3000 kilometers.

Irene Liu
Postdoctoral Research associate named in the proposal, to be employed by University of Minnesota-TC

Education:

B.S. Zoology	2006	University of Maryland, College Park
B.A. Spanish Language and Literature		
Ph.D. Biology	2014	Duke University
Post-doctoral Associate	2014-	Duke University

I am interested in the link between behavioral and molecular evolution of vertebrates. My Ph.D. research used lab, field, and computational methods to characterize the evolution of reproductive proteins and mating systems in New World blackbirds. My work with an endangered island endemic led to a collaboration with the U.S. Fish and Wildlife Service to document the species' conservation genetics. I have since been involved in defining management units, determining the extent of gene flow between populations, and advising whether either population is suitable for genetic rescue of the other. I seek to use both basic and applied methods to understand how variation at the molecular level can lead to fitness consequences at the organismal level.

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/