Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)

Project Title: **ENRTF ID: 210-F**

Forest Regeneration: Right Seed in the Right Place?

Category: F. Methods to Protect, Restore, and Enhance Land, Water, and Habitat

Sub-Category:

Total Project Budget: $ 476,336

Proposed Project Time Period for the Funding Requested: June 30, 2022 (3 yrs)

Summary:

Minnesota forest ecosystems are maintained by continual reforestation efforts. This project will help the DNR determine the best sources of seeds to plant in the diverse habitats of our state.

Name: Julie Etterson

Sponsoring Organization: U of MN - Duluth

Title: Professor

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Image of Minnesota seed zones, image of study species (red oak), and evidence from a previous study showing that red oak does better when planted north of its home zone.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%
____ If under $200,000, waive presentation?			

PROJECT TITLE: Forest regeneration: Right seed in the right place?

I. PROJECT STATEMENT

We will collect tree seeds from across the state, see if are genetically different by looking at their DNA, and then grow them up in two planting sites to determine where they survive and grow best. Our partners at the DNR Division of Forestry (see letter of support) will use the information to revise our state seed zone map (see figure). The revised seed map will ensure that public and private landowners can confidently plant trees in the most appropriate locations, ultimately leading to greater survival and growth of trees, and healthy Minnesota forest ecosystems.

- **Will the results have a big impact?** Yes. The State Forest Nursery uses the seed zone map to decide which seeds and seedlings to send to federal, state, county, and city foresters, as well as private citizens, for replanting tens of thousands acres of Minnesota forests every year.
- **What's wrong with the map we are using now?** The number of seed zones and their dividing lines are not backed up with experimental studies. This research will provide that scientific justification.
- **Are other people doing similar experiments?** Yes, in other states and in Canada. This is a hot topic in forestry and similar experiments are being conducted across the USA for the same reasons.

Phase 1. Northern red oak: This proposal represents phase 1 of this effort, and will focus on northern red oak, an important hardwood tree species for sustaining wildlife, including white-tailed deer and wild turkey, and providing timber and fuelwood resources for local industry. We will test different species in the future.

The bottom line: This project will tell us whether seedlings do best in their recommended 'home' zones based on the current seed zone map, or whether they would do better when planted in northern zones. Data from a Nature Conservancy/UMD experiment indicates that red oak has higher survival and growth when it is planted one or two zones north of its recommended zone (see figure).

- **The threat**: If seedlings do better outside of their home zone it means that we are currently planting trees in a way that limits their growth and survival. If this is true, then we are not regenerating Minnesota forests in the best way to support timber and recreation economies.
- **The opportunity**: Results will provide an opportunity to revise current seed zones, as is being done in many other states, based on rigorous genetic and growth trial data.

How we will get and use the data:

- **Collect** seeds from across the state, raise seedlings, and then plant both seeds and seedlings at the General Andrews Tree Improvement Center, north of Twin Cities, and on state land in northern MN.
- **Measure** germination, growth, survival and DNA differences to identify unique populations.
- **Compare** results to the current seed zones and make DNR seed zone policy recommendations.
- **Communicate** the importance of healthy forests for industry, recreation, hunting and tourism.

II. PROJECT ACTIVITIES AND OUTCOMES

ACTIVITY 1: *Measure where trees grow best* **Budget: $231,412**

Collect seeds from least eight populations (two per forested seed zone). Plant seeds and seedlings at two sites, one in near the Twin Cities and one in northern MN (3,200 seeds and 1,600 seedlings per site). Measure: spring and fall mortality, height, diameter, leaf number, leaf thickness, and the timing of budburst and leaf fall. We will analyze data to determine if plants perform better in their own home seed zone versus elsewhere.

Outcome	Completion Date
1. Collect seed from at least 8 populations, start seedlings	November 2019

2. Prepare the planting sites – one in central and one in northern Minnesota	August 2020
3. Plant seeds and 1 year-old seedlings into sites according to a randomized block design	May 2021
4. Measure plant survival and growth; use data to evaluate suitability of seed sources	June 2022

ACTIVITY 2: ***Identify genetic differences between tree stands*** **Budget: $ 236,192**

We will sample 15 individuals from 26 locations of northern red oak across the state plus the eight populations that will be planted into the test sites specified in Activity 1. We will examine the tree DNA using the genotyping-by-sequencing approach. This will show the extent (or lack) of genetic differences between forest stands and provide information about tree ancestry that complements the survival and growth data.

Outcome	Completion Date
1. Collect tissue from 32 locations per species and extract DNA	October 2019
2. Genotyping-by-sequencing optimization and generation of genetic data	June 2021
3. Analyze data, interpret differences, and reevaluate the zones	May 2022

ACTIVITY 3: ***Raise public awareness of forestry practices for healthy forests*** **Budget: $ 8,732**

We will post an interpretive sign at one of the sites that explains the project and the value of healthy forests to wildlife, clean air and water, recreation, and the timber industry. In addition, we will present our findings to the public at campfire talks, regional citizen meetings, K-12 schools, and through the UMD biology curriculum. We will publish our work and present it to conservation organizations, county, state, and federal agencies.

Outcome	Completion Date
1. Install interpretive sign at one of the test sites	May 2021
2. Conduct four public workshops with a field trip component; design curriculum	June 2022
3. Present findings at national and regional meetings, at public schools, and to the press	June 2022

III. PROJECT PARTNERS

A. Partners receiving ENRTF funding: The **DNR Division of Forestry** will receive modest funds to contract with seed collectors, for seedling propagation and preparation at test sites, and consultation (see budget for details; funds will be supervised by Paul Dubuque at DNR).

B. Partners NOT receiving ENRTF funding: The following partners will provide input receive the results for use in improving Minnesota forests: Carrie Pike, Area Regeneration Specialist, **US Forest Service - State and Private Forestry;** Meredith Cornett, Director of Science for Minnesota, **The Nature Conservancy;** Andrew David, Assistant Professor of Forest Genetics, **Minnesota Tree Improvement Cooperative**; Kathleen Preece, Executive Director, **Minnesota Forest Resources Partnership** (logger/landowner/forester organization)

IV. LONG-TERM IMPLEMENTATION AND FUNDING

This work is critical to forest management but has never been conducted in MN. While many "boots on the ground" techniques increase the survival of individual trees (i.e. plant bigger seedlings), this proposal will contribute to the long-term success of forest regeneration by ensuring that the match between seeds the seed zone map that guides their planting location is scientifically defensible and based on current research practices. Our **r**ecommendations will influence the management of 4 million acres of DNR administered lands as well as many other public and private forests**.** If results suggest that current seed zones need revision, DNR will be well positioned to **develop red oak seed transfer policies for the state.** Future work funded by LCCMR and other federal agencies will test other species so that scientifically based policies guide forest regeneration in Minnesota.

V. TIME LINE REQUREMENTS

Three years.

2019 Proposal Budget Spreadsheet

Project Title: Forest regeneration: Right seed in the right place?

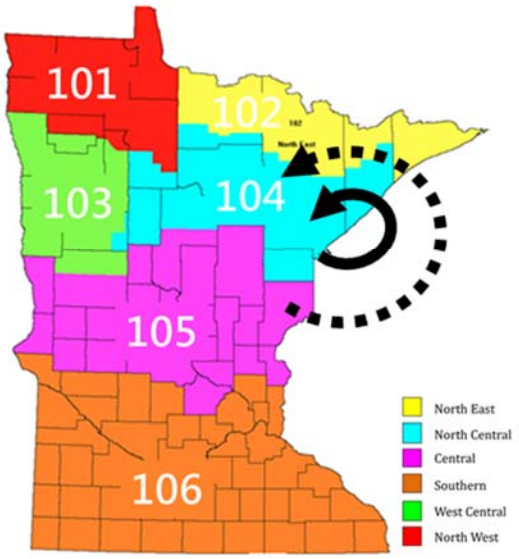
IV. TOTAL ENRTF REQUEST BUDGET: 3 years

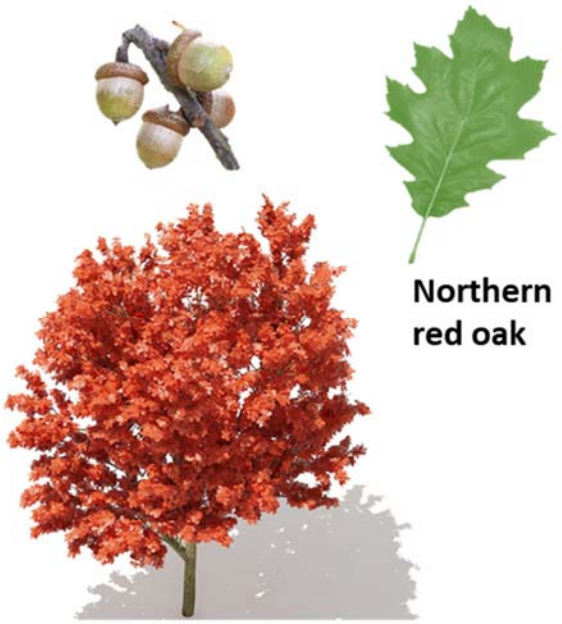
BUDGET ITEM	AMOUNT	
Personnel:		**$ 361,151**
1 Postdoc at .75 FTE, (82% salary/18% fringe) 3 yrs. Supervision & full-time participation in research	$ 137,634	
1 Lab Tech at .75 FTE, (79% salary/21% fringe) 2 yrs. DNA extraction & genetic data generation	$ 44,223	
4 Undergrads at .25 FTE, (100% salary/0% fringe) 3 yrs. Site preparation, planting & measurement	$ 48,030	
2 MS students at .25 FTE, (59% salary/41% fringe) 3 yrs. Field data collection, analysis, & managemer	$ 93,448	
Dr. Etterson and Dr. Gross at .11 FTE each (75% salary/25% fringe) summer salary for effort (project advisement, implementaion, and data analysis), 1/2 month per summer x 3 yrs	$ 37,816	
Professional/Technical/Service Contracts:		**$ 35,600**
DNR Contracting: Seed collection ($1,250), seedling production ($2,020), site preparation for 2 4-acre sites ($2,500), and plastic tubing for seedling protection ($8,000) - competitive bidding	$ 13,770	
Production & installation of permanent interpretive sign at one site in year 2 - competitive bidding	$ 4,080	
Contractors for seed & seedling planting - competitive bidding	$ 2,550	
Genotyping-by-sequencing services (enzyme optimization, DNA digestion and ligation, and Illu-mina sequencing): $40/sample * 380 samples = $15,200	$ 15,200	
Equipment/Tools/Supplies:		**$ 24,390**
Molecular supplies: 18 DNA extraction kits @ $329/kit = $6,000; $2.50 of disposables (pipette tips, tubes, gloves) per extractions = $1,070; 100% molecular-grade EtOH, mortors and pestles, dry ice = $1,490; Reagents and plastics for DNA quantification = $530	$ 9,090	
Field supplies: >6,000 metal labels = $2,500; hardware cloth, tinsnips, landscape staples for seed cages (to prevent seeds from being eaten) = $12,500; shovels, kneepads, dibblers, gloves, meas-uring tape, envelopes for seeds = $200; notebooks, sharpies, pencils, clipboards = $100	$ 15,300	
Acquisition (Fee Title or Permanent Easements):	**N/A**	
Travel: Budgeted amounts are based on standard rates for the University of Minnesota.		**$ 55,195**
Mileage, lodging & meals for crew: 14 1-wk trips to 2 sites in yr 2, 7 1-wk trips to 2 sites in yr 3	$ 41,328	
Mileage, lodging & meals for outreach: 1.5 weeks of travel in yr 2 & yr 3	$ 4,652	
Mileage, lodging & meals tissue collecting: Travel to sample 32 pops of red oak	$ 9,215	
Additional Budget Items:	**N/A**	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$**	**476,336**

V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:		
MN Lake Superior Coastal Program (NOAA) annual grant for coastal red oak, molecular work	$ 21,684	*Secure*
Other State $ To Be Applied To Project During Project Period:	N/A	N/A
In-kind Services To Be Applied To Project During Project Period:	$ -	
MNDNR salary, seed collection, test site selection, & test site preparation	$ 36,000	*Secure*
Unrealized indirect cost return from this proposal	$ 257,221	*Secure*
Etterson/Gross (1 month salary during academic year x 3 yrs) for project advisement, implementaion, and data analysis.	$ 73,090	*Secure*
Past and Current ENRTF Appropriation:	N/A	N/A
Other Funding History:	N/A	N/A

A. MN DNR Seed Zone Map





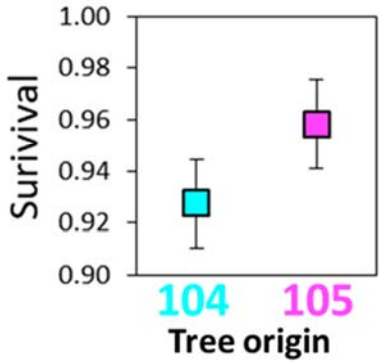
Northern red oak

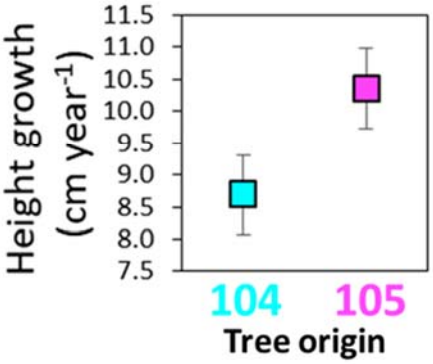
Current practice: Plant seeds and seedlings into their "home" zone. For example, plant seeds and seedlings from zone 104 back into sites in zone 104.

This experiment asks: Do southern seed sources survive and grow better in northern sites? For example, is it better to plant seeds and seedlings from zone 105 into zone 104?

B. Do we already know something about this question?

Yes. A study conducted by the The Nature Conservancy and Etterson at UMD showed that northern red oak trees from **zone 105** survived at higher percentages and grew faster when planted into forest regenerations sites in **zone 104** and **zone 102**.





Data is from 2,500 trees that were planted into 20 sites in northeastern Minnesota in seed zones 104 and 102 and monitored for four years.

IX. F. Project Manager Qualifications

Project Manager: Dr. Julie R. Etterson
Affiliation: University of Minnesota Duluth, Department of Biology
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Etterson has been studying plant adaptation to the environment more than twenty years and has successfully managed large-scale field experiments as Principal Investigator that were funded by the National Science Foundation (>$2 million). She has extensive experience supervising a large lab group that includes technicians, post-doctoral researchers, graduate students, and undergraduate students.

Recent Work Experience

2018-present	UMD Coordinator for the Institute on the Environment
2017-present	Full Professor, UMD
2008-2017	Associate Professor, Dept. of Biology, UMD
2016-present	Fellow, Institute on the Environment, UMTC
2012-present	Grad. Faculty, Conservation Biology Program, UMTC
2005-present	Grad. Faculty, Integrated Biological Sciences Program, UMD
2002-2008	Assistant Professor, UMD
2000-2002	Postdoctoral Researcher, Evolutionary Genetics, UVA
2003-present	Senior Grad. Faculty, Adjunct. Dept. of Plant Biol. Sciences, UMTC

Education

U of MN Twin Cities	Minneapolis, MN, US	Biology, *Summa cum laude*	B.S., 1994
U of MN Twin Cities	Minneapolis, MN, US	Ecology	Ph.D., 2000
University of Virginia	Charlottesville, VA, US	Evolutionary genetics	Postdoc, 2000-2002

Project Responsibilities

Etterson will supervise a postdoctoral researcher, Dr. Dustin Haines (PhD University of Minnesota in Ecology, 2015) who coordinate time-intensive data collection and help mentor graduate and undergraduate students. Etterson will be responsible for contracting seed and seedling plant crews and oversee the establishment of test sites. She will collaborate with Briana Gross for the molecular genetic work and the DNR personnel for seed sourcing and site selection.

Organization Description

The University of Minnesota Duluth Swenson College of Science and Engineering supports excellence in research and education at the undergraduate and graduate levels. The Department of Biology in particular comprises over 15 research active faculty and attracts hundreds of majors each year. Research focusing on Minnesota's natural areas is a prominent component of our department's teaching and research practices.