

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

Project Title:

ENRTF ID: 137-E

Forest Regeneration: Maximizing the Value of Our Investment

Category: E. Air Quality, Climate Change, and Renewable Energy

Total Project Budget: \$ 732,046

Proposed Project Time Period for the Funding Requested: 3.5 years, September 2017 - August 20

Summary:

Minnesota invests heavily in forest regeneration. But are we planting seeds that maximize the future returns on our investment? Our statewide planting trials and genetic research will answer this question.

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Sponsoring Organization: U of MN - Duluth

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Map of seed sampling and planting design for White Pine and Red Oak

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



PROJECT TITLE: FOREST REGENERATION – MAXIMIZING THE VALUE OF OUR INVESTMENT

I. PROJECT STATEMENT: Are we regenerating Minnesota forests with seeds from the most appropriate climate zone? Currently, forest regeneration is accomplished by collecting and replanting seeds *within* the six seed zones that were developed by MNDNR in the 1970’s (see figure). With climate change, temperatures in northern zones now match the historical climate of more southern zones. Thus, it is no longer clear whether seeds will grow better in their home zone or whether they will grow better in a zone further north. In other words, is it possible that tree populations are already mismatched with climate? If so, forest regeneration may be less effective because seedlings will not thrive, and this problem will worsen as climate change continues into the future. **Therefore, it is becoming increasingly important to experimentally test whether forest trees sampled from MN seed zones still match the local climate. Although similar work has been done for prairie flowers, our research is critical because it focuses on trees that are important for forestry and our state economy.**

We propose to test the extent of climate matching for two economically important tree species that are predicted to be “winners” with climate change: White Pine (*Pinus strobus*) and Red Oak (*Quercus rubra*). These species are key to the MN forest industry that contributes \$12.7 billion to our state economy directly and through the employment of more than 40,000 people. Moreover, white pine is an iconic species that historically dominated vistas of the northern MN forests and has been the focus of intense conservation efforts. This research will improve management practices of these species by providing: 1) essential data to guide seed source decisions for reforestation, 2) baseline genetic analyses showing regional differences across the state and hotspots of genetic diversity, and 3) demonstration test plots for public outreach about climate change.

The state of the art for testing the validity of seed transfer zones involves both classical garden studies and cutting-edge genetic techniques. We plan to do both. In our garden studies, we will sample populations from across the state, plant them into four test sites, and monitor survival and growth for the duration of the grant. In our genetic study, we will map the genetic structure of populations, including old growth stands, to identify genetically distinct populations and reservoirs of diversity. Together, these pieces of information will provide the best possible guidance for selecting seed sources for forest regeneration in light of current and impending climate change. Importantly, we will also use the test sites as a platform to raise awareness about the impact of climate change in MN and how we can manage our resources to maintain healthy forests.

Activity 1: Survival and growth of trees sampled across MN and tested in four sites **Budget: \$ 373,073**

We will establish four 10-acre tests sites that will be planted with seeds and seedlings of white pine and red oak according to a standard design (total number of plants: 2 species x 4 sites x 5 seed zones x 2 populations per seed zone x 200 replicates = 16,000 seeds and x 100 replicates = 8,000 seedlings). We will measure: spring and fall mortality, height, diameter, leaf number, leaf thickness, and the timing of bud burst and leaf fall (oaks only). Data will be analyzed to determine if plants perform better in their own seed zone versus seed zones further north. This information will used to confirm or reevaluate current seed source selection for forest regeneration in MN in light of climate change.

Outcome	Completion Date
1. Collect seed from 10 populations per species, start seedlings	November 2017
2. Prepare 4 sites for planting, including fence construction	August 2018
3. Plant seeds and 1 year old seedlings into 4 sites according to a randomized block design	May 2019
4. Measure plant survival and growth; use data to determine suitability of seed sources	June 2020

Activity 2: Genetic differences between seed zones and new vs. old growth trees **Budget: \$ 350,241**

We will sample 15 individuals from 32 populations each of red oak and white pine across the state (including old growth stands and the test sites) and generate genetic data using an approach called genotype-by-sequencing. The genetic information will be used to determine the extent of (or lack of) differences between seed zones and



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2017 Main Proposal

Project Title: FOREST REGENERATION – MAXIMIZING THE VALUE OF OUR INVESTMENT

differences between old growth and managed forests. We will map genetically unique populations, determine the extent to which they are interconnected by gene flow, and use this information to reevaluate seed zones.

Outcome	Completion Date
1. Collect tissue from 32 populations of each species and extract DNA	October 2018
2. Genotype-by-sequencing optimization and generation of genetic data (N= 960)	August 2019
3. Interpret differences between current zones, new vs. old growth, and reevaluate zones	May 2020

Activity 3: Raising public awareness of forestry practices and climate change

Budget: \$ 8,732

A primary goal is to explain to the general public the importance of the MN forestry and the impact of climate change on effective forest regeneration. Our test sites (at least one of which will be at an MN State Park) will serve as a platform for outreach by installing interpretive signs, and using our sites as focal points for regional workshops. In addition, we will present our findings as research publications, presentations at national meetings, universities, regional citizen meetings, K-12 schools, and through the UMD biology curriculum.

Outcome	Completion Date
1. Install interpretive signs at each of the test sites	May 2019
2. Conduct four public workshops with a field trip component; curriculum integration	June 2020
3. Present findings at national and regional meetings, public schools, and to the press	June 2020

III. PROJECT STRATEGY

A. Project Team: Julie Etersson (Dept. of Biology, UMD) will contract seed and seeding planting crews and oversee the establishment and measurement of plants in the test sites. Briana Gross (Dept. of Biology, UMD) will supervise tissue collection and DNA work. Rick Klevorn (MN DNR - Silviculture Program Coordinator) will contract vendors for seed collection, seedling growth, site preparation, installation of interpretive signs, and, importantly, make policy recommendations. All members will participate in raising public awareness through outreach. *Each team member* will receive LCCMR funding as well as provide in-kind support for the project.

Project Partners: Partners from The Nature Conservancy, Meredith Cornett (Director of Science MN, SD, ND) and Jim Manolis (Forest Conservation Program Director), will consult on site selection and promote outreach.

B. Project Impact and Long-Term Strategy: This project will either confirm that seed zones set in the 1970’s are still appropriate for current use, or will result in recommendations for new seed zone policies: either outcome will ensure that our investment in reforestation is maximized. This work will be conducted in partnership with the DNR Silviculture Program so that policy recommendations can be communicated directly and will have a rapid impact on the ground. **Policy recommendations that emanate from this work will influence the management of 4 million acres of DNR land holdings as well as many other private and public forests.**

Our state forests are an integral part of larger natural systems that sustain MN's environment, economy, and communities. An investment now into these experiments will pay off over the coming decades by providing valuable information about: 1) survival and growth of many populations over the 50+ year life-span of the trees, 2) a map of genetically distinct populations that will serve as a baseline for continued tracking of genetic change over time, 3) a set of updated silvicultural guidelines that will be disseminated to key audiences, such as the MN Forest Resources Council and the Sustainable Forest Education Cooperative, and 4) long-term demonstration sites for public education about the impact of climate change on MN forests. Our vision is to continue to measure trees in our test sites for two years beyond the scope of this grant and repeat the work on a ~10-year cycle with funding that will be sought from the LCCMR, the National Science Foundation, and other sources.

C. Timeline Requirements: Activity 1 = 3 years; Activity 2 = 3 years; Activity 3 = 1.5 years. By the end of the granting period, we will be able to evaluate the appropriateness of MN seed zones based on seed germination and seedling establishment (Activity 1) as well as population differences in DNA sequence (Activity 2). Once the test sites are established, both types of data can be reaped from these experiments for decades to come for ongoing reevaluation of seed sources to maximize the value of our investment in forest regeneration in MN.

2017 Detailed Project Budget

Project Title: FOREST REGENERATION – MAXIMIZING THE VALUE OF OUR INVESTMENT

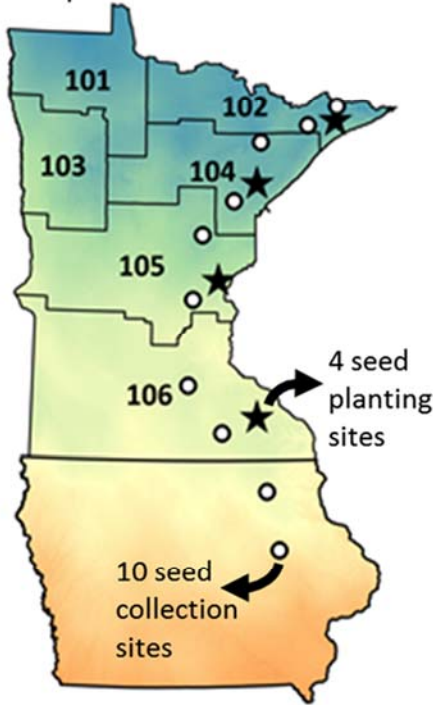
IV. TOTAL ENRTF REQUEST BUDGET: 3 years

BUDGET ITEM	AMOUNT	
Personnel:		
Postdoctoral researcher - 1 position (77.6% salary, 22.4% benefits: 100% FTE) (12 mo/yr; July 1, 2017-June 30, 2020). For supervision and full time participation in research.	\$	175,374
Lab Technician - 1 position (72.6% salary, 24.7% benefits: 100% FTE) (12 mo/yr; July 1, 2017-June 30, 2018). For one year of work on DNA extraction and	\$	55,138
PhD student - 1 position (82.4% salary, 17.2% benefits: 100% FTE) (12 mo/yr; July 1, 2018-June 30, 2019). For one year of work on tissue collection, genetic data generation and analysis.	\$	43,258
Undergraduate students - 3 summer positions (100% salary, 0% benefits: 25% FTE) (2 summers). For site preparation, labeling seedlings and seeds, and measurements.	\$	30,195
MS students - 2 summer research positions (82.4% salary, 17.4 % benefits: 25% FTE) (2 summers)	\$	25,022
Etterson/Gross - For course buy-out for two semesters for project management	\$	25,334
Etterson - For effort 1/2 month in summer (66.3% salary, 33.7% benefits: 8% FTEs) (3 summers)	\$	19,199
Gross - For effort 1/2 month in summer (66.3% salary, 33.7% benefits: 8% FTE) (3 summers)	\$	15,888
Professional/Technical/Service Contracts:		
Contracted through DNR: Seed collection (\$2,500), seedling production (\$6,060), site preparation for four 10-acre sites (\$10,000), and permanent deer fencing for four 10-acre sites (\$101,000 - quote from Deutschland Fencing via DNR)	\$	119,560
Contracted production and installation of permanent interpretive signs at all 4 sites	\$	4,080
Contractors for seed and seedling planting (4,000 seeds and 2,000 seedlings at each of 4 sites)	\$	10,200
Genotype-by-sequencing services (enzyme optimization, DNA digestion and ligation, and Illumina sequencing): \$42.30/oak * 480 oaks and \$138.30/pine * 480 pines	\$	86,659
Equipment/Tools/Supplies:		
Molecular supplies: pipette tips, microfuge tubes, liquid nitrogen, dry ice, etc.	\$	12,120
Field supplies: hardware cloth, shovels, labels, sharpies, landscape staples, etc.	\$	33,148
Travel:		
Mileage, lodging and meals for UMD planting and measuring crew (all within MN) 14 week-long visits to each of 4 sites in year 2, 7 week-long visits to each of 4 sites in year 3.	\$	63,004
Mileage, lodging and meals for outreach: 1.5 weeks of travel within MN in year 2 and year 3.	\$	4,652
Mileage, lodging and meals for UMD tissue collecting: Travel within MN to 64 sample populations.	\$	9,215
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$	732,046
V. OTHER FUNDS		
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period:	N/A	N/A
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:		
Foregone indirect costs for amount above (52% currently, 53% in FY2018, 54% in MNDNR salary, seed collection, test site selection, and test site preparation	\$	333,061 <i>Secured</i>
UMD IBS summer stipend match for MS Students (2 x 2 years) and PhD student	\$	25,000 <i>Secured</i>
Etterson & Gross (1 month salary each during academic year x 3 years)	\$	14,000 <i>Pending</i>
UMD travel and registration to meetings for faculty and graduate students (3	\$	69,479 <i>Secured</i>
Foregone indirect cost return for additional Salaries/Fringe Benefit, and Travel	\$	7,145 <i>Pending</i>
	\$	48,686 <i>Secured</i>
Funding History:	N/A	N/A
Remaining \$ From Current ENRTF Appropriation:	N/A	N/A

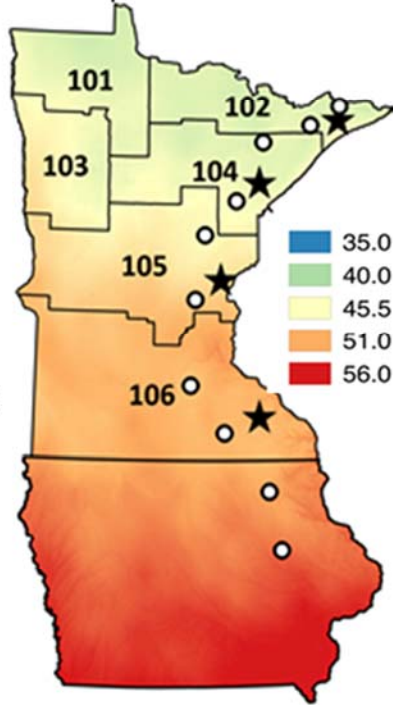


Should we revise the six seed zones (101-106) established by the MN DNR 40 years ago?

A. Average Annual temperature 1950-2000



B. Predicted Annual temperature 2050



C. Two study species with their geographical ranges





Project Manager Qualifications

Project Manager: Dr. Julie R. Etterson
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Etterson has been studying response of plants to climate change more 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, postdoctoral researchers, graduate students, and undergraduate students.

Recent Work Experience

2000-2002	Postdoctoral Researcher, Evolutionary Genetics, University of Charlottesville, VA
2002	Assistant Professor, U of MN Duluth
2003	Senior Grad. Faculty, Adjunct. Dept. of Plant Biol. Sciences, U of MN TC
2005	Grad. Faculty, Integrated Biological Sciences Program, U of MN Duluth
2008	Associate Professor, Dept of Biology, U of MN Duluth
2012	Grad. Faculty, Conservation Biology Program, U of MN TC
2016	Full Professor, pending at the U of MN Board of Regents

Education

U of MN Twin Cities	Minneapolis, MN, US	Biology, <i>Summa cum laude</i>	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 who coordinate time-intensive data collection and help mentor graduate and undergraduate students. Etterson will be responsible for contracting seed and seeding plant crews and oversee the establishment of test sites. She will collaborate with Briana Gross for the molecular genetic work and Klevorn 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.