Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID: 012-A**

Forest Regeneration – Validating Operational Seed Zones

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 796,395

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

Minnesota forests ecosystems are maintained by continual reforestation efforts. This project will update guidelines for seed sourcing to ensure that the right seed is being planted in the right place.

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Location

Region: Statewide

County Name: Aitkin, Anoka, Beltrami, Benton, Blue Earth, Carlton, Carver, Cass, Chisago, Cook, Crow Wing, Dakota, Dodge, Faribault, Fillmore, Freeborn, Goodhue, Hennepin, Houston, Hubbard, Isanti, Itasca, Kanabec, Kandiyohi, Koochiching, Lake, Lake of the Woods, Le S

City / Township:

Alternate Text for Visual:

Our visual shows a map of the six MN DNR seed transfer zones (101-106) and images of our two study species, red and bur oak. In addition, we illustrate three possible outcomes of our research. The first image shows a scenario where our data confirms the current seed zone delineation and, therefore, no policy change would be recommended. However, the second two scenarios illustrate how our data might show that there are either too many zones, too few zones, and/or the zones boundaries are in the wrong place.

_____ Funding Priorities _____ Multiple Benefits _____ Outcomes _____ Knowledge Base

_____ Extent of Impact _____ Innovation _____ Scientific/Tech Basis _____ Urgency

_____ Capacity Readiness _____ Leverage _____ TOTAL _____%

PROJECT TITLE: FOREST REGENERATION – VALIDATING OPERATIONAL SEED ZONES

I. PROJECT STATEMENT

In this project, we will use best scientific practices to test the validity of the MN seed transfer zone map (see figure), which was developed in the 1970s based on the best information available at that time. This map dictates where public land managers can harvest seed to be planted back into a given location for forest regeneration (i.e. within the same seed zone). Each year, foresters use these guidelines to replant a minimum of 10,000 acres of MN forests, 35% by seeds and 65% by seedlings. **However, the number of seed zones and their specific locations have never been scrutinized using contemporary scientific methods.** The *best scientific approach* for defining seed zones requires two kinds of data: 1) the location of maximum survival and growth of the trees, and 2) the location of genetically similar stands of trees. We will collect both kinds of information.

What we expect to learn: Imagine taking our current seed transfer zone map (see figure) and overlaying it with a map that shows tree populations that are genetically similar and survive and grow well in a given area. Would you see six zones based on experimental data? Would the boundaries of these zones line up with the six zones we currently have? This project will reveal three possible outcomes (see figure for illustrations of the scenarios):

- **The six zones line up** (Scenario 1). If so, we have confirmed that we are using best practices for forest regeneration, and seed sourcing policy does not need to change.
- **There are fewer than six zones** (Scenario 2). In this case, we have too many zones. This leads to a higher cost because seeds need to be collected, kept separate, propagated, and replanted into "extra" zones.
- **Seed zone boundaries don't line up** (Scenario 3). In this case, the trees are being planted into areas in which they will not thrive, thereby preventing natural regeneration.

Which species we will use: This project will focus on two ecologically important tree species: red oak and white pine. These species have more genetic variability across their range than many other species, which make them good for a test of seed zone validity. Both species also play an important role in sustaining wildlife and providing timber resources to local industry.

How we will get and use the data: We will collect and use the data as follows.

- **Collect** seeds from across the state, raise seedlings, and then plant both seeds and seedlings into the four zones which are forested (zones 102, 104, 105, and 106).
- **Measure** germination, growth, survival AND genetic similarity to identify natural population boundaries.
- **Compare** the data collected to the current zones and make policy recommendations.
- **Raise awareness** about how to manage healthy forests that are critical for industry, recreation, and wildlife that sustain hunting and tourism.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: ***Measure survival and growth of trees sampled across four MN test sites*** **Budget: $ 452,120**

We will establish four 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 4 seed zones x 2 populations per seed zone x 200 replicates of seeds= 12,800; 100 replicates of seedlings = 6,400). We will measure: spring and fall mortality, height, diameter, leaf number, leaf thickness, and the timing of budburst and leaf fall (oaks only). 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 8 populations per species, start seedlings	November 2018
2. Prep. 4 planting sites, including St. Croix State Park and Hartley Nature Center, Duluth	August 2019
3. Plant seeds and 1 year old seedlings into 4 sites according to a randomized block design	May 2020
4. Measure plant survival and growth; use data to determine suitability of seed sources	June 2021

Activity 2: ***Determine genetic differences between trees in different seed zones***

Budget: $ 326,367

We will sample 15 individuals from 26 locations each of red oak and white pine across the state plus the eight populations that will be planted into the four test sites specified in Activity 1. We will examine the tree's DNA using the genotyping-by-sequencing approach. This will show the extent (or lack) of genetic differences between tree stands and provide information about the tree's 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 2020
3. Analyze data, interpret differences, and reevaluate the zones	May 2021

Activity 3: ***Raise public awareness of forestry practices*** **Budget: $ 17,908**

In two sites located in heavily visited areas (e.g. St. Croix State Park and Hartley Nature Center in Duluth), we will post interpretive signs that explain the project and the value of healthy forests to wildlife, clean air and water, recreation, communities, and forest 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 also publish our work and present it to conservation organizations, county, state, and federal agencies.

Outcome	Completion Date
1. Install interpretive signs at each of the test sites	May 2020
2. Conduct four public workshops with a field trip component; design curriculum	June 2021
3. Present findings at national and regional meetings, at public schools, and to the press	June 2021

III. PROJECT STRATEGY

A. Project Team:

Personnel	Role (activity)	Financial support
Julie Etterson	Oversee planting and measuring trees in test sites; outreach (1, 3)	Summer support
Briana Gross	Supervise tissue collection and DNA work; outreach (2, 3)	Summer support
Paul Dubuque	Site selection, seed procurement, & seedling production; outreach (1, 3)	None
Postdoc	Supervise field work; writing and analysis (1, 3)	Salary + fringe
Technician	Supervise DNA lab work (2)	Salary + fringe
M.S. students	Measure trees and do lab work (1, 2)	Salary + fringe
Undergrads	Measure trees and do lab work (1, 2)	Salary

B. Project Impact and Long-Term Strategy:

- **Validate** that seed zones set in the 1970s are still appropriate for current use, or recommend revised seed zone policies, thereby assuring the most effective reforestation efforts
- **Communicate** policy recommendations to DNR Division of Forestry, MN Forest Resources Council, and MN Forest Resources Partnership
- **Educate** the public
- **Measure** test sites over the 50+ year life-span of the trees with future funding from LCCMR, National Science Foundation, US Forest Service, or other sources

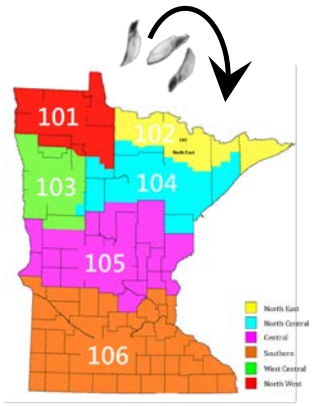
This work is critical to all public forested land management but has never been conducted in MN. While many "boots on the ground" techniques increase the survival of seedlings and seeds at the site level, this proposal will contribute to the long-term success of reforestation practices statewide by ensuring that seed transfer guidelines are scientifically defensible and based on current best research practices. **Policy recommendations that emanate from this work will influence the management of 4 million acres of DNR administered lands as well as many other private and public forests.** Public lands and the timber they produce are an integral part of larger natural systems that sustain MN's environment, economy, and communities. An investment now into these experiments will reap dividends for decades.

C. Timeline Requirements: Three years.

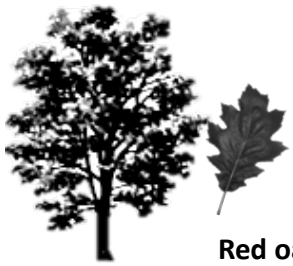
IV. TOTAL ENRTF REQUEST BUDGET: 3 years		
BUDGET ITEM		**AMOUNT**
Personnel: (salary, fringe)		**$601,490**
1 Postdoc (66.5%, 33.5%) 100% FTE, 3 yrs. Supervision & full time participation in research	$183,512	
1 Lab Tech (72.8%, 27.2%) 100% FTE, 1 yr. DNA extraction & genetic data generation	$57,798	
3 Undergrads (100% salary) 25% FTE, 3 yrs. Site preparation, planting & measurement	$47,184	
3 MS students (83.1%, 16.9%) 25% FTE, 2 yrs. Field data collection, analysis, & management	$239,168	
Dr. Etterson - 1 month summer salary for effort (66.5%, 33.5%) 8% FTE, 3 yrs	$41,168	
Dr. Gross - 1 month summer salary for effort (66.5%, 33.5%) 8% FTE, 3 yrs	$32,660	
Professional/Technical/Service contracts:		**$71,756**
DNR Consulting: Advice regrading site and seed selection during 6 meetings (2 meetings/year, 4 hrs/meeting, 1 person/meeting, $111/hr)	$2,716	
Contracted through DNR: Seed collection ($2,500), seedling production ($6,060), site preparation for four 10-acre sites ($10,000), and plastic mesh or bud caps for seedling/seed protection ($8,080) - DNR will conduct competitive bidding	$26,640	
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	
Genotyping-by-sequencing services (enzyme optimization, DNA digestion and ligation, and Illumina sequencing): $72/oak * 95 oaks + $72/pine * 95 pines + $38/pine * 380 pines = $28,120	$28,120	
Equipment/Tools/Supplies:		**$46,278**
Molecular supplies: 26 DNA extraction kits @ $329/kit = $8,554; $3 of disposables (pipette tips, tubes, gloves) for 618 extractions = $1,854; 100% molecular-grade EtOH, mortors and pestles, dry ice = $1,838; Reagents and plastics for DNA quantification = $884; Total = $13,130	$13,130	
Field supplies: >12,000 metal labels = $5,100; hardware cloth, tinsnips, landscape staples for seed cages (to prevent seeds from being eaten) = $26,548; shovels, kneepads, dibblers, gloves, measuring tape, envelopes for seeds = $1285; notebooks, sharpies, pencils, clipboards = $215; Total = $33,148	$33,148	
Acquisition:		**N/A**
Travel: Budgeted amounts are based on standard rates for the University of Minnesota.		**$76,871**
Mileage, lodging and meals for UMD planting and measuring crew: 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 in year 2 and year 3.	$4,652	
Mileage, lodging and meals for UMD tissue collecting: Travel within Minnesota to 32 populations each for red oak and white pine for sampling.	$9,215	
Additional Budget Items:		**N/A**
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =		**$796,395**
V. OTHER FUNDS		
SOURCE OF FUNDS	**AMOUNT**	**STATUS**
Other Non-State $ to be applied to project during project period	**N/A**	$21,684
MN Lake Superior Coastal Program (NOAA) annual grant for coastal red oak, molecular work	$21,684	Pending
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		$518,502
MNDNR salary, seed collection, test site selection, and test site preparation	$25,000	Secure
Unrealized indirect cost return from this proposal (above)	$380,345	Secure
Etterson/Gross (1 month salary during academic year x 3 years)	$73,090	Secure
Indirect cost return Addl Salaries/Fringe Benefit and Travel	$65,067	Secure
Funding history:	**N/A**	**N/A**
Remaining $ from current ENRTF appropriation	**N/A**	**N/A**

CURRENT PRACTICE

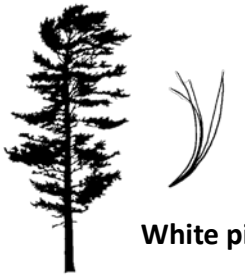
Six MN DNR seed transfer zones.
Seeds from zone 102 are planted back into 102.



TEST SPECIES



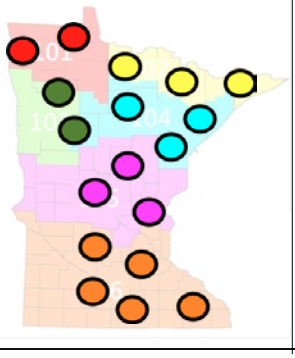
Red oak



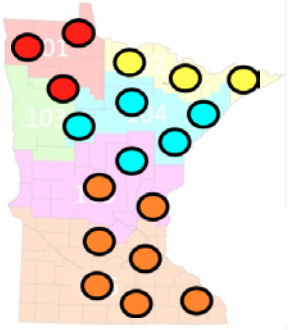
White pine

THREE POSSIBLE OUTCOMES FROM THIS WORK

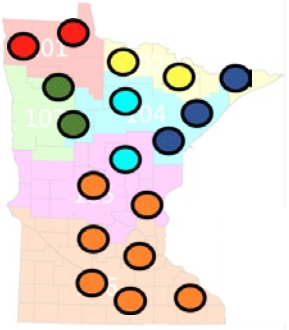
<u>SENARIO 1:</u>
Matching experimental data & seed zones.
Survival, growth and genetic similarity delineate six seed transfer zones. *No policy change needed.*



<u>SCENARIO 2:</u>
Mismatched experimental data & seed zones.
Data show fewer seed transfer zones. *Recommend reducing the number of zones to match the data.*



<u>SCENARIO 3:</u>
Mismatched experimental data & seed zones.
Data show different zone boundaries. *Recommend realigning zones to match the data.*



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 yrs & 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, & 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
2016	Fellow, Institute on the Environment, U of MN TC

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 & help mentor graduate & undergraduate students. Etterson will be responsible for contracting seed & seedling plant crews & oversee the establishment of test sites. She will collaborate with Briana Gross for the molecular genetic work & the DNR personnel for seed sourcing & site selection.

Organization Description

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