



# Environment and Natural Resources Trust Fund (ENRTF) M.L. 2016 Work Plan

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**Date of Report:** December 4, 2015

**Date of Next Status Update Report:** January 1, 2017

**Date of Work Plan Approval:**

**Project Completion Date:** June 30, 2019

**Does this submission include an amendment request?**  N

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**PROJECT TITLE:** Dutch Elm Disease Resistance—Phase 2

**Project Manager:** Robert Blanchette

**Organization:** University of Minnesota

**Mailing Address:** 1991 Upper Buford Circle, 495 Borlaug Hall

**City/State/Zip Code:** St. Paul, MN 55108

**Telephone Number:** (612) 625-0202

**Email Address:** robertb@umn.edu

**Web Address:** <http://forestpathology.cfans.umn.edu/>

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**Location:** Statewide

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**Total ENRTF Project Budget:**

**ENRTF Appropriation:** \$200,000

**Amount Spent:** \$0

**Balance:** \$200,000

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**Legal Citation:** M.L. 2016, Chp. xx, Sec. xx, Subd. xx

**Appropriation Language:**

## I. PROJECT TITLE: Dutch Elm Disease Resistance—Phase 2

### II. PROJECT STATEMENT:

This project continues our previous work (ENRTF project 2013-06-06) to identify elms [American (*Ulmus americana*), red (*Ulmus rubra*) and rock (*Ulmus thomasii*) elms] from across Minnesota with resistance to Dutch elm disease, test them rigorously and have a number of genetically different trees with resistance available to benefit urban and greater Minnesota landscapes.

Dutch elm disease (DED) is a vascular wilt caused by *Ophiostoma novo-ulmi*, and is vectored by several elm bark beetles. This exotic disease was introduced to the United States in the late 1920's and has killed millions of elms in Minnesota over the past five decades. So many trees have died people have just about given up hope for this tree. Losses from this invasive and exotic pathogen have been devastating causing an ecological disaster. There is no tree more beautiful or well suited for urban conditions than the elm. They tolerate salt, pollution and other stresses better than other trees. Removing and disposing of diseased trees and other control programs are expensive. Municipal budget constraints over recent years have meant that less funding is available for control and elm mortality has increased steadily. We now find other introduced pests, such as the Emerald Ash Borer, threatening Minnesota ash trees and the need for new trees to be used for replanting in urban areas is greater than ever. Elms also play a vital part in the ecology of Minnesota's forests. They provide important food and shelter for wildlife, they are excellent trees for wetlands and add to the biodiversity of a healthy forest (for example, 213 species of moths and butterflies are supported by elms). Elms can also be used for making furniture, boxes, crates and other wood products.

However, hope is not lost for the elm! Previous studies, as well as our own investigations, have indicated that some elms have survived and appear to have special characteristics making them resistant to Dutch elm disease. Here we are continuing our work, where clones are propagated and grown from these trees and injected with the fungus. Results show some trees survive. Having a large genetic stock of hardy and resistant native Minnesota elms is vital to fight this deadly fungus. This project will:

**1. Survey and identify resistant elm trees.** In phase 1 of our work funded by ENRTF we identified and tested elms on interest and have discovered several showing resistance in the greenhouse and have prepared field trials for several sections for testing. Arborists and city foresters throughout Minnesota have identified candidate elms that appear to have some level of DED resistance. They survive where all other elms have died. Screening (injecting with the fungus in greenhouse and field trials) will identify 20 more of these trees to find additional resistant trees. Once trees are selected they will be propagated using methods we have developed. To better understand what factors are responsible for selected elms to be resistant, studies will focus on anatomical and other tree defense reactions occurring in selected resistant elms.

**2. Screen selected trees and begin preliminary work to better understand resistant mechanisms in selected elms.** To determine if trees are resistant, rigorous testing is needed. This is done by injecting trees with the fungus in greenhouse studies followed by additional field testing. The data show that elms with some resistance to Dutch elm disease exist in Minnesota and our testing via statewide screening will reveal which of those demonstrate a high degree of resistance, which is anticipated to be a large number of them.

**3. Field testing of elms.** Our goal is to obtain a diverse selection of elms from Minnesota that are genetically different but all have degrees of resistance. Field testing is essential and will be done on trees from our preliminary research as well as new selections made from this project. Field testing will also be used to identify trees with the best growth and hardiness characteristics.

### III. OVERALL PROJECT STATUS UPDATES:

Project Status as of [January 30, 2017]:

Project Status as of [September 30, 2017]:

Project Status as of [March 30, 2018]:

Project Status as of [December30, 2018]:

Project Status as of [June 30, 2019]:

**Overall Project Outcomes and Results:**

**IV. PROJECT ACTIVITIES AND OUTCOMES:**

**ACTIVITY 1: Identify and grow resistant Minnesota elms for testing.**

**Description:**

With the help of landowners, park and city personnel, arborists, state and national forest managers as well as our surveys of the Minnesota landscape we will identify large, mature elms that have survived heavy pressure from Dutch elm disease. Cuttings will be taken from the growing tips of these trees and rooted and/or grafted in the greenhouse to obtain sufficient numbers of each tree for disease screening. Recently, advances in elm propagation to grow new trees by rooting of the branch material have been made and these methods will be used in these investigation. To reduce costs associated with obtaining cuttings from the tops of large elms thought to be resistant, we will solicit the help of city foresters and arborists to get the elm cuttings from the tops of these trees. We expect to obtain propagation material from a minimum of 20 trees. Since the allocated funds were less than the original amount requested, the number of trees that can be screened has been reduced from the original proposal plan. Although this is less than our original goal due to the reduced funding allocation, we should be able to still evaluate a substantial number of trees. As surveys are made, all elm trees with possible resistance will be noted and could be used for possible future propagation work and screenings as additional funds are obtained.

**Summary Budget Information for Activity 1:**

**ENRTF Budget: \$ 59,033**

**Amount Spent: \$ 0**

**Balance: \$ 59,033**

<b>Outcome</b>	<b>Completion Date</b>
<i>1. Find and propagate 10 Minnesota elms that appear to have disease resistance</i>	12/2017
<i>2. Find and propagate 10 additional Minnesota elms that appear to have disease resistance</i>	12/2018

Activity Status as of [January 30, 2017]:

Activity Status as of [September 30, 2017]:

Activity Status as of [March 30, 2018]:

Activity Status as of [December30, 2018]:

**Final Report Summary:**

**ACTIVITY 2: Screen selected elms for resistance and evaluation of resistance mechanisms**

**Description:**

Using previous methods found to be successful, replicated studies using the clonal trees obtained from Activity 1 will be grown in the greenhouse and tested for resistance to Dutch elm disease. The Dutch elm disease fungus from Minnesota will be injected into these trees and disease monitored. This screening method provides an excellent way to select the trees with the most potential for resistance. For these studies, the fungus will be grown in the laboratory and a spore suspension obtained. A known quantity of spores will be used to inoculate each seedling. A large number of clones are needed for this testing and all experiments will be replicated. To serve as a control, susceptible elm genotypes will also be injected for comparison. Disease progression will be noted over several months and clones that show resistance will be planted in the field for further testing. How do resistant elms tolerate Dutch elm disease infection? This question remains unanswered but would be pivotal in the battle against this invasive disease. These studies will involve a preliminary investigation into the mechanisms involved in tree defense during infection. Determining mechanisms of resistance will aid in finding new more rapid methods to select additional native elms that are resistant to the disease.

**Summary Budget Information for Activity 2:**

**ENRTF Budget:** \$ 81,934  
**Amount Spent:** \$ 0  
**Balance:** \$ 81,934

<b>Outcome</b>	<b>Completion Date</b>
1. Complete disease screening for elms obtained during the first year and evaluations completed on resistance mechanisms	12/2017
2. Complete disease screening for second year elm selections	12/2018

**Activity Status as of [January 30, 2017]:**

**Activity Status as of [September 30, 2017]:**

**Activity Status as of [March 30, 2018]:**

**Activity Status as of [December 30, 2018]:**

**Final Report Summary:**

**ACTIVITY 3: Field testing of selected clones with resistance**

**Description:**

To confirm that trees showing resistance in greenhouse inoculation trials are truly resistant, it is essential to grow the trees in the field and inoculate under field conditions. Trees selected from the greenhouse experiments that showed high levels of resistance to the inoculations with the Dutch elm disease fungus will be grown in the University of Minnesota tree nursery. Replicated plots of selected trees will be inoculated with a spore suspension of the Dutch elm disease fungus and monitored for symptom development and disease resistance. We anticipate having nine experimental units of each genotype divided into three blocks with three replicates for each block in field experiments. Susceptible elm trees will also be planted in the field and inoculated for comparison. Additional evaluations will be done to determine the tree's growth rate and general growth characteristics to determine their suitability for planting in Minnesota.

**Summary Budget Information for Activity 3:**

**ENRTF Budget:** \$ 59,033  
**Amount Spent:** \$ 0  
**Balance:** \$ 59,033

<b>Outcome</b>	<b>Completion Date</b>
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1. Field planting of selected elms	12/2018
2. Disease screening of elms in the field	6/2019

**Activity Status as of [January 30, 2017]:**

**Activity Status as of [September 30, 2017]:**

**Activity Status as of [March 30, 2018]:**

**Activity Status as of [December 30, 2018]:**

**Final Report Summary:**

**V. DISSEMINATION:**

**Description:**

Dissemination of information about this project will be placed on our Elm web site to inform the public about the project and statewide survey for elm trees in Minnesota that have survived Dutch elm disease. This web site is at: <http://elms.umn.edu> .Presentations will be made at arborist and nursery meetings in Minnesota and documentation of results presented at scientific meetings and in general articles and scientific publications.

**Status as of [January 30, 2017]:**

**Status as of [September 30, 2017]:**

**Status as of [March 30, 2018]:**

**Status as of [December 30, 2018]:**

**Final Report Summary:**

**VI. PROJECT BUDGET SUMMARY:**

**A. ENRTF Budget Overview:**

Budget Category	\$ Amount	Overview Explanation
Personnel:		
Scientist – Plant Pathology	\$ 54,226	20% time (66% salary, 34% fringe, for 3 years)
Scientist – Forest Resources	\$ 53,874	25% time (66% salary, 34% fringe, for 3 years)
Undergraduate students (3)	\$ 45,000	20% (100% salary, \$5000/year per student.) Three students will be involved with the project for 3 years.
Graduate Student (1)	\$ 22,000	25% time (56% salary, 44% benefits, for 1 year).
Professional/Technical, Service Contracts	\$0	N/A
Equipment/Tools/Supplies:		
Greenhouse and field supplies	\$6,600	pots, stakes, pruning supplies, fertilizers, container substrates (\$2,200/yr, 3 years)
Laboratory Supplies	\$6,300	microbiology and inoculation materials, general laboratory materials, fungal genotyping, growth hormone for cuttings, propagation supplies. (\$2,100/yr 3 years).
Capital Expenditures over \$3,500:	\$0	N/A
Fee Title Acquisition:	\$0	N/A

Easement Acquisition:	\$0	N/A
Easement – Long-term Monitoring, Management, and Enforcement	\$0	N/A
Professional Services for Acquisition:	\$0	N/A
Printing:	\$0	N/A
Travel Expenses in MN:	\$3,000	Survey and collection of Resistant Elms from Minnesota
Other: Greenhouse maintenance costs	\$9,000	Maintenance fees \$2000 per year for 3 years, Field plot fees, sampling fees for getting cuttings from large trees (\$3,000).
<b>TOTAL ENRTF BUDGET:</b>	<b>\$200,000</b>	

**Explanation of Use of Classified Staff:** N/A

**Explanation of Capital Expenditures Greater Than \$5,000:** N/A

**Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:** 3

**Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:** N/A

**B. Other Funds:**

Source of Funds	\$ Amount	
	Proposed	Use of Other Funds
<b>Non-state</b>		
Minnesota Turf and Grounds Foundation	\$20,000	These funds will be applied for in 2016 and are expected but we have not been granted these funds yet.
<b>State</b>		
University of Minnesota	\$70,835	Blanchette (Project manager) salary and fringe for one month per year for 3 years; and Johnson (co-PI) salary and fringe for one month per year for 3 years. These funds will be allocated for the project.
<b>TOTAL OTHER FUNDS:</b>	<b>\$90,835</b>	

**VII. PROJECT STRATEGY:**

**A. Project Partners:**

Dr. Robert Blanchette (Project Manager, UMN) is a professor and Dr. Benjamin Held (Co-PI, UMN) is a research scientist in the Department of Plant Pathology. They will take part in the finding and screening of resistant elms

in the greenhouse and field. Graduate Student Garrett Beier will be involved with the investigations on resistant mechanisms that occur in elms.

Gary Johnson (Co-PI, UMN) is a professor and Chad Giblin (Co-PI, UMN) is a research fellow in the Department of Forest Resources. They will take part in finding, propagating and field planting of resistant elms.

**B. Project Impact and Long-term Strategy:**

The main goal of this research is to identify and propagate resistant elms from Minnesota. Testing for resistance must be rigorous and thorough and field trials are essential. Using our screening methods recently developed, this joint effort between Professors Blanchette and Johnson along with Research Scientists Benjamin Held and Chad Giblin show great promise in obtaining elms resistant to Dutch elm disease that will grow well in Minnesota and across the northern United States. The results from this work will benefit Minnesotans living in urban and greater parts of the state to provide new elm selections that are native to Minnesota with a high level of resistance and it will return this magnificent tree back into our urban and forest landscapes.

Although a great deal of information will be obtained from the field trials during the 3 years, it can take 5-6 years for more comprehensive observations. These field trials will continue at the University Research Center after the project has ended. It will also take a few years to propagate the selected trees in sufficient numbers so they are available for release to the nursery industry and the public.

**C. Funding History:**

<b>Funding Source and Use of Funds</b>	<b>Funding Timeframe</b>	<b>\$ Amount</b>
Minnesota Turf and Grounds Foundation	FY 2013 to FY2015	\$37,000
ENRTF 2013-06-06	FY 2013 to FY 2015	\$200,000

**VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS: N/A**

**IX. VISUAL COMPONENT or MAP(S):**

**X. RESEARCH ADDENDUM: N/A**

**XI. REPORTING REQUIREMENTS:**

Periodic work plan status update reports will be submitted not later than January 2017, September 2017, March 2018, and December 2018. A final report and associated products will be submitted between June 30 and August 15, 2019 as requested by the LCCMR.

**Environment and Natural Resources Trust Fund  
M.L. 2016 Project Budget**



**Project Title:** Dutch Elm Disease Resistance - Phase.2

**Legal Citation:**

**Project Manager:** Robert A. Blanchette

**Organization:** University of Minnesota

**M.L. 2016 ENRTF Appropriation:** \$200,000.

**Project Length and Completion:** Date: 3 years, June 30, 2019

**Date of Report:** December 4, 2015

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
<b>BUDGET ITEM</b>	<i>Identify and grow resistant Minnesota elms</i>			<i>Screen selected elms for resistance and</i>			<i>Field testing of selected clones with</i>				
<b>Personnel (Wages and Benefits)</b>	\$48,733	\$0	\$48,733	\$74,634	\$0	\$74,634	\$51,733	\$0	\$51,733	\$175,100	\$175,100
Scientist – Plant Pathology \$54,226. (66% salary, 34% benefits) 20% FTE each year for 3 years											
Scientist - Forest Resources \$53,874 (66% salary, 34% benefits) 25% FTE each year for 3 years											
3 Undergraduate Students \$45,000 (100% salary, 0% benefits) 20% FTE each for 3 years											
1 Graduate Student \$22,000 (56% salary, 44 benefits) 25%FTE for one year											
<b>Equipment/Tools/Supplies</b>	\$4,300	\$0	\$4,300	\$4,300	\$0	\$4,300	\$4,300	\$0	\$4,300	\$12,900	\$12,900
Greenhouse and field supplies: pots, stakes, pruning supplies, fertilizers, container substrates (\$2,200/yr, 3 years)											
Laboratory Supplies: microbiology and inoculation materials, general laboratory materials, fungal genotyping, growth hormone for cuttings, propagation supplies. (\$2,100/yr 3 years).											
<b>Travel expenses in Minnesota</b>	\$3,000	\$0	\$3,000	\$0	\$0	\$0	\$0	\$0	\$0	\$3,000	\$3,000
Survey and collection of resistant elms from Minnesota. Mileage \$2000, Lodging \$500., Meals \$500.											
<b>Other</b>	\$3,000	\$0	\$3,000	\$3,000	\$0	\$3,000	\$3,000	\$0	\$3,000	\$9,000	\$9,000
Greenhouse and field plot maintenance costs. Maintenance fees \$2000 per year for 3 years, Field plot fees, sampling fees for getting cuttings from large trees (\$3000).											
<b>COLUMN TOTAL</b>	<b>\$59,033</b>	<b>\$0</b>	<b>\$59,033</b>	<b>\$81,934</b>	<b>\$0</b>	<b>\$81,934</b>	<b>\$59,033</b>	<b>\$0</b>	<b>\$59,033</b>	<b>\$200,000</b>	<b>\$200,000</b>



## 131-D Winning the Dutch Elm Disease Battle. Phase II – Blanchette

This cooperative project between the Departments of Plant Pathology (R. Blanchette and B. Held) and Forest Resources (C. Giblin and G. Johnson) at the University of Minnesota was funded in 2013 (ENTRF #2013-06-06) to find native elms from across Minnesota with resistance to Dutch elm disease. This funding ends June 30, 2016 and this Phase II request continues the project for 3 years. This program will return a magnificent shade tree and important forest species back to the yards, boulevards, woodlots and hearts of Minnesotans.

### Accomplishments (2013 to 2015):

- ✓ Surviving elms have been identified and collections made from 25 trees
- ✓ Propagation of these trees has been completed
- ✓ Methods to screen for disease-resistance were developed and greenhouse inoculations have been performed
- ✓ Elms surviving greenhouse inoculation planted in the field
- ✓ Over 100 additional large survivor elms throughout MN have been identified
- ✓ Field inoculations began in 2014
- ✓ 15 public and scientific presentations given and 2 publications completed



Results indicate that some surviving elms have resistance to Dutch elm disease

### Work Schedule (now to June 30, 2016):

- Additional surviving elms identified will be added into the database
- Greenhouse inoculations of trees propagated in 2014 to be completed
- Surviving elms planted out in the field for inoculation trials
- Field inoculation of selected trees to be done spring 2016

### Phase II Objectives (July 1, 2016 to June 30, 2019):

- Propagate 20 more surviving elm trees including more rock and red elm
- Continue resistance testing in greenhouse and field using our proven methods
- Study mechanisms of resistance to be used for more rapid screening
- Establish demonstration field plots with the selected resistant elms and continue outreach activities

## Phase II

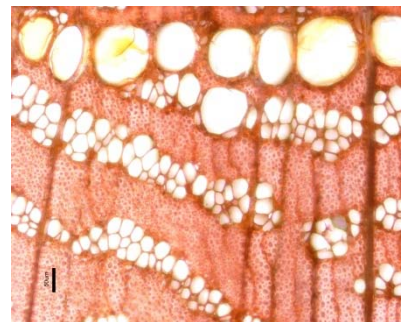
Propagate and test additional elms to obtain a diverse population of resistant trees



Disease resistance testing



Identifying what makes trees resistant - to be used for more rapid screening



Wood anatomy of resistant elm

### Project Benefits:

- The American elm, recently selected as one of “Top 10 Plants that Changed Minnesota”, will be planted again reversing decades of devastating losses from Dutch elm disease.
- Growing Minnesota-native elms with proven Dutch elm disease resistance will benefit the nursery industry and the economy of Minnesota.
- Environmental and ecological losses in forests and natural areas from Dutch elm disease will be alleviated by the planting of resistant elms.
- Resistant elms will help fill the need for new trees that will be needed for replanting from the threats of other invasive pests, such as the Emerald ash borer.