



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2013 Work Plan

Date of Status Update Report: September 28, 2012
Date of Next Status Update Report: January 2014
Date of Work Plan Approval: June 11, 2013
Project Completion Date: June 30, 2016 **Is this an amendment request?** NO

PROJECT TITLE: Finding Disease Resistant Elm Trees in Minnesota

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Location: Statewide

Total ENRTF Project Budget:	ENRTF Appropriation:	\$200,000
	Amount Spent:	\$0
	Balance:	\$200,000

Legal Citation: M.L. 2013, Chp. 52, Sec. 2, Subd. 03h

Appropriation Language:

\$200,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to evaluate and identify native Minnesota elms resistant to Dutch elm disease to assist with limiting the susceptibility of the state's elms to Dutch elm disease. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Finding Disease Resistant Elm Trees in Minnesota

II. PROJECT STATEMENT:

We propose to find 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 large number of genetically different trees with resistance available so that this magnificent shade tree and important forest species will be brought back to its previous grandeur.

Dutch elm disease (DED) is a vascular wilt caused by two closely related fungi, *Ophiostoma ulmi* and *Ophiostoma novo-ulmi*, and is vectored by several elm bark beetles. This devastating wilt disease 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 and it has caused 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. Their seed provides important food 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.

There is new hope for the elm! We have observed that some elms have survived and appear to have special characteristics making them resistant to Dutch elm disease. In our preliminary work, seedlings were 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. Our proposed project would:

- 1. Survey and identify resistant elm trees.** From preliminary research supported by the Minnesota Turf and Grounds Foundation we identified and tested several elms and found 3 with different levels of resistance. We have information from arborists and city foresters about many other candidate elms from throughout Minnesota that appear to be resistant. They survive where all other elms have died. Screening (injecting with the fungus in greenhouse and field trials) will identify which of these trees are truly resistant. Once trees are selected they will be propagated using methods we recently developed.
- 2. Screen selected trees.** 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 preliminary data shows that elms resistant to Dutch elm disease exist in Minnesota. Our testing will show which trees are resistant and with state wide screening we expect to find 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 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. PROJECT STATUS UPDATES:

Project Status as of (January 2014):

Project Status as of (September 2014):

Project Status as of (March 2015):

Project Status as of (September 2015):

Project Status as of (March 2016):

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1:

Description: Identify and grow resistant Minnesota elms for testing.

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 to get elm cuttings to grow by rooting of the branch material have been made and these methods will be used in these investigation. We will use methods developed at the University of Minnesota to propagate elms that appear to have resistance will be selected from diverse locations throughout the state where elms grow. 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 25 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 we should be able to still evaluate a substantial number (25) 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: \$ 69,567
Amount Spent: \$ 0
Balance: \$69,567

Activity Completion Date:

Outcome	Completion Date	Budget
<i>1. Find and propagare 15 Minnesota elms that appear to have disease resistance</i>	9/2014	\$34,784
<i>2. Find and propagare 10 additional Minnesota elms that appear to have disease resistance</i>	9/2015	\$34,783

Activity Status as of (January 2014):

Activity Status as of (September 2014):

Activity Status as of (March 2015):

Activity Status as of (September 2015):

Final Report Summary:

ACTIVITY 2:

Description: Screen selected elms for resistance

Using previous methods found to be successful, replicated studies using the seedlings 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 cloned seedlings are needed for this testing and all experiments will be replicated. To serve as a control, susceptible elm seedlings will also be injected for comparison. Disease

progression will be noted over several months and clones that show resistance planted in the field for further testing.

Summary Budget Information for Activity 2:

ENRTF Budget: \$ 68,567
Amount Spent: \$ 0
Balance: \$68,567

Activity Completion Date:

Outcome	Completion Date	Budget
1. Complete disease screening for elms obtained during the first year	9/2015	\$34,284
2. Complete disease screening for second year elm selections	3/2016	\$34,283

Activity Status as of (September 2014):

Activity Status as of (March 2015):

Activity Status as of (September 2015):

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: \$ 61,866
Amount Spent: \$ 0
Balance: \$61,866

Activity Completion Date:

Outcome	Completion Date	Budget
1. Field planting of selected elms	10/2015	\$30,933
2. Disease screening of elms in the field	6/2016	\$30,933

Activity Status as of (March 2015):

Activity Status as of (September 2015):

Activity Status as of (March 2016):

Final Report Summary:

V. DISSEMINATION:

Description:

Dissemination of information about this project will begin with a 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 will be initially set up as a page at: <http://forestpathology.cfans.umn.edu/> but will receive its own url at Minnesota_elms.cfans.umn.edu once the project begins. Presentations will be made at arborists and nursery meetings in Minnesota and documentation of results made in general articles and scientific publications.

Status as of (January 2014):

Status as of (September 2014):

Status as of (March 2015):

Status as of (September 2015):

Status as of (March 2016):

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget:

Budget Category	\$ Amount	Explanation
U of M Personnel:		
Scientist - pathology	\$ 92,000	50% time 71% salary, 29% fringe, for 3 years)
Scientist – horticulture	\$ 48,000	25% time (71% salary, 29% fringe, for 3 years)
Undergraduate students (3)	\$ 40,000	100% salary, \$5000/year per student. Three students will be involved with the project during years 1 and 2 and two students involved in year 3.
Professional/Technical/Service Contracts:	\$	
Equipment/Tools/Supplies:		
Greenhouse and field supplies	\$6,500	pots, stakes, pruning supplies, fertilizers, container substrates. Supplies are for 3 years.
Laboratory Supplies	\$6,500	microbiology and inoculation materials, general laboratory materials, fungal genotyping, growth hormone for cuttings, propagation supplies. Supplies are for 3 years.
Travel Expenses in MN:	\$4,500	Survey and collection of Resistant Elms
Other:		
Greenhouse maintenance costs	\$2500	Maintenance fees \$1000 per year for 2 years
TOTAL ENRTF BUDGET:	\$200,000	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than \$3,500: N/A

Number of Full-time Equivalent (FTE) funded with this ENRTF appropriation: 1 FTE per year plus part time students.

Number of Full-time Equivalent (FTE) estimated to be funded through contracts with this ENRTF appropriation: N/A

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
Non-state			
Minnesota Turf and Grounds Foundation	\$15,000	\$	These funds will be applied for in 2013 and are expected but we have not been granted these funds yet.
State			
University of Minnesota	\$41900	\$	Blanchette (co-PI) salary and fringe for one month per year for 3 years Gillman (co-PI) salary and fringe for one month per year for 3 years
University of Minnesota	\$36900		
TOTAL OTHER FUNDS:	\$93,800	\$	

VII. PROJECT STRATEGY:

A. Project Partners:

Dr. Robert Blanchette (Co-PI, UMN) is a professor and Benjamin Held (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.

Dr. Jeff Gillman (Co-PI, UMN) is an associate professor and Chad Giblin (UMN) is a research scientist in the Department of Horticulture Science. They will take part in finding, propagating and field planting of resistant elms.

Funds will be utilized evenly in this cooperative project and both partners and their labs using \$100,000 each over three years to accomplish the objectives proposed.

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 Gillman show great promise in obtaining DED resistant elm cultivars that will grow well in Minnesota and across the northern United States. The results from this work will provide new elms 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 some information will be completed 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. Spending History:

Funding Source	M.L. 2007 or FY08	M.L. 2008 or FY09	M.L. 2009 or FY10	M.L. 2010 or FY11	M.L. 2011 or FY12-13

Minnesota Turf and Grounds Foundation		\$20,000	\$20,000	\$12,000	\$15,000
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VIII. ACQUISITION/RESTORATION LIST: N/a

IX. MAP(S): N/A

X. RESEARCH ADDENDUM:N/A

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted not later than January 2014, September 2014, March 2015, September 2015, March 2016. A final report and associated products will be submitted between June 30 and August 15, 2016 as requested by the LCCMR.

Attachment A: Budget Detail for M.L. 2013 Environment and Natural Resources Trust Fund Projects

Project Title: Finding Disease Resistant Elm Trees in Minnesota													
Legal Citation: M.L. 2013, Chp. 52, Sec. 2, Subd. 03h													
Project Manager: Robert Blanchette													
M.L. 2013 ENRTF Appropriation: \$ 200,000													
Project Length and Completion Date: June 30, 2016													
Date of Update: September 19, 2012													
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET			Activity 1 Budget	Amount Spent	Balance	Activity 2 Budget	Amount Spent	Balance	Activity 3 Budget	Amount Spent	Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM			<i>Identify and grow resistant Minnesota elms for testing.</i>			<i>Screen selected elms for resistance</i>			<i>Field testing of selected clones with resistance</i>				
Personnel (Wages and Benefits)			61,667		61,667	61,667		61,667	56,666		55,666	180,000	180,000
Scientist position 1; \$92,000, 50% time (71% salary, 29% fringe for 3 years); 50% FTE													
Scientist position 2; \$48,000, 25% time (71% salary, 29% fringe for 3 years); 25% FTE													
3 Undergraduate student positions \$40,000, 25% time (100% salary, 0% fringe); 75% FTE													
Equipment/Tools/Supplies													
Greenhouse and field supplies: pots, stakes, pruning supplies, fertilizers, container substrates			2,200		2,200	2,200		2,200	2,100		2,100	6,500	6,500
Laboratory supplies: microbiology and inoculation materials, general laboratory materials, fungal genotyping, growth hormone for cuttings, propagation supplies			2,200		2,200	2,200		2,200	2,100		2,100	6,500	6,500
Travel expenses in Minnesota: Survey and collection of Resistant Elms Mileage(\$3200), lodging (\$1000), meals (\$300)			2,000		2,000	1,500		1,500	1,000		2,100	4,500	4,500
Other													
Greenhouse maintence: Maintenance fees are \$1500 for the propagation and \$1000 for the inoculations			1,500		1,500	1,000		1,000				2,500	2,500
COLUMN TOTAL			\$69,567		\$69,567	\$68,567		\$68,567	\$61,866		\$61,866	\$200,000	\$200,000

019-B Finding Disease Resistant Elm Trees in Minnesota – Blanchette

This cooperative project between the Departments of Plant Pathology (R. Blanchette and B. Held) and Horticultural Science (J. Gillman and C. Giblin) at the University of Minnesota proposes to find Native elms from across Minnesota with resistance to Dutch elm disease, test them rigorously and discover genetically diverse trees with resistance available for planting. This program will return a magnificent shade tree and important forest species back to the yards, boulevards, woodlots and hearts of Minnesotans.

Additional information on procedures:

Survey and identify resistant elm trees:



Left photo: An elm in the northwest metro that has survived decades when Dutch elm disease has killed all other nearby elms.



Right photo: A beautiful elm on the State Capital grounds has survived and may be resistant to the disease. This tree, in addition to many others that have survived high disease pressure, needs to be tested.

Propagate from selected resistant trees



Elm branches from suspected resistant trees are used to make cuttings.



Cuttings can be rooted using hormones and propagation procedures



Rooted cuttings are grown in the greenhouse for testing

Screening selected elms in the greenhouse and field



Seedlings grown from the resistant trees are wounded and inoculated with spores of the fungus that causes Dutch elm disease.

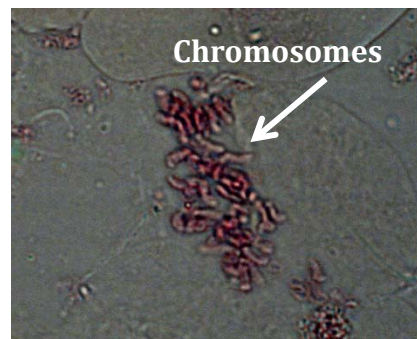
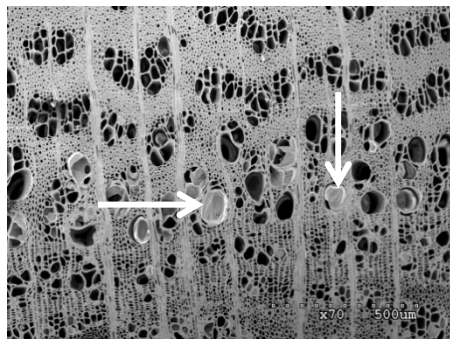


Symptoms of the disease in seedlings. Tree with resistance at left, without resistance at right.



Testing under field conditions is essential to be certain that trees are resistant.

Study defense mechanisms in elms



Elms that are resistant have structural and chemical defenses that protect them. Studying the mechanisms of resistance will provide faster more efficient methods to select resistant elms. **Left photo** – Cross section of elm wood showing physical barriers to stop the fungus (arrows). **Right photo** –Chromosome numbers in elms vary widely impacting the genetic makeup of the trees and likely resistance.

Benefits

- The elm, recently selected as one of the ten most influential plants in MN, will be planted again reversing decades of devastating losses from Dutch elm disease.
- Growing native Minnesotan 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 can be alleviated by the planting of resistant elms.
- Resistant elms can 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.

Finding Disease Resistant Elm Trees in Minnesota



Identify elms from the Minnesota landscape with possible resistance to Dutch elm disease



Obtain cuttings from identified trees for propagation



Inject seedlings with the pathogen



Select resistant trees after they have been injected



Study tree defense mechanisms in resistant trees



Propagate selected resistant seedlings and plant in field trials for additional testing and screening



The goal of this project is to have native resistant elms that can be grown throughout the Minnesota landscape and return this majestic tree to its previous grandeur

