



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2015 Work Plan

Date of Report: October 29, 2014

Date of Next Status Update Report: January 2016

Date of Work Plan Approval:

Project Completion Date: June 30, 2020

Does this submission include an amendment request? No

PROJECT TITLE: Emerald Ash Borer Ecological and Hydrological Impacts – Phase II

Project Manager: Anthony D’Amato

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Location: Statewide

Total ENRTF Project Budget:

ENRTF Appropriation: \$400,000

Amount Spent: \$0

Balance: \$400,000

Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 06b

Appropriation Language:

\$400,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to assess the potential impacts of emerald ash borer on Minnesota black ash forests and quantify potential impacts on native forest vegetation, invasive species spread, and hydrology. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Emerald Ash Borer Ecological and Hydrological Impacts – Phase II

II. PROJECT STATEMENT:

Black ash swamps cover over one million acres of northern Minnesota and provide critical habitat for wildlife and serve many important functions, including flood regulation and carbon storage. The ecology and functioning of these swamps is greatly threatened by the introduced, Emerald Ash Borer (EAB), which has been decimating native populations of ash throughout the Lake States and is currently located in Superior, WI on the doorstep of the vast acreages of black ash in northern Minnesota. Although cold winter temperatures may kill some EAB, there is no evidence cold temperatures will stop the spread and survival of this introduced pest in northern Minnesota, an area with over 1 billion black ash trees. This project is a continuation of the Ecological and Hydrological Impacts of Emerald Ash Borer project that received ENRTF funding in 2010. This project has established a large-scale network of research sites in black ash swamps that is assessing potential EAB impacts and evaluating potential mitigation strategies, including establishing non-host tree species in these areas. The initial phase of this work has already identified significant potential impacts of EAB and pre-emptive harvesting on native plants and forest hydrology, including loss of native plant diversity and increased flooding, but continued funding is needed to ensure that additional progress can be made towards developing strategies for increasing the resilience of black ash swamps to EAB, as well as anticipating landscape-level impacts of this insect pest.

The goals of this project are:

1. To increase our understanding of the long-term impacts of EAB on the ecology and hydrology of black ash forests in Minnesota and to develop appropriate strategies for increasing the resilience of these critical habitats to the effects of EAB. The project will achieve this goal by examining the long-term hydrological and ecological response of black ash forests to treatments simulating EAB and evaluating the survival and growth of potential replacement species for black ash.
2. The second goal of this project is to generate an assessment of the vulnerability of northern Minnesota black ash forests and associated infrastructure (i.e., roads) and natural features (streams and lakes) to EAB impacts. The project will accomplish this by mapping the location and extent of black ash swamps throughout northern Minnesota and determining potential changes in hydrology and forest habitats that can be expected once EAB spreads through northern Minnesota.

The accomplishment of the above-listed goals will yield critical information for anticipating the regional impacts of EAB on wildlife habitat and ecosystem services, including flood regulation and carbon sequestration across northern Minnesota. By examining existing experiments and field trials aimed at developing strategies for increasing the resilience of black ash forests to EAB, this project will provide much-needed management guidance for resource managers to address this pressing forest health threat. This guidance will include recommendations on alternate tree species to favor/establish in these areas and appropriate management regimes. In addition, the maps and datalayers of black ash forest wetlands across northern Minnesota will be a critical tool for developing landscape-level plans and vulnerability assessments for these threatened forest types. These tools will be particularly useful in designating conservation and mitigation priorities based on the proximity of black ash habitats to infrastructure and aquatic systems that could be negatively impacted by changes in forest hydrology, as well as areas containing known populations of sensitive species.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of January 2016:

Project Status as of July 2016:

Project Status as of January 2017:

Project Status as of July 2017:

Project Status as of January 2018:

Project Status as of July 2018:

Project Status as of January 2019:

Project Status as of July 2019:

Project Status as of January 2020:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: *Determine the long-term impact of EAB on native plant communities, spread of invasive species, and hydrology*

Description: We will conduct continued monitoring of the research and demonstration sites established in Phase One to assess the long-term impacts of EAB on native plant communities, spread of invasive species, and hydrology. These sites are large-scale manipulations of black ash systems that allow for assessments of the ecological impacts of EAB on black ash forests, and for evaluations of potential adaptive management actions for sustaining the ecological functions of black ash systems after the loss of this species to EAB. Each site is over 25 acres in size and has the following treatments replicated using a split-plot, complete block design.

- a) **Ash mortality:** Four levels of ash mortality were implemented at each site in four acre areas (n=8 for each mortality treatment): 1) retain all ash (control), 2) simulated EAB mortality by girdling all ash, 3) group selection harvests (remove groups of ash in 0.1 acre acres covering 20% of unit), and 4) harvest of all ash (clearcutting). For girdling treatments, all trees within 4 acre patches were girdled using draw knives. Harvests and girdling occurring in winter 2011. Each treatment is surrounded by a 5 acre, untreated buffer to minimize influence on adjacent treatments.
- b) **Planting:** Each ash mortality treatment is split with two levels of planting treatment: no planting and planting. For the planting treatments, we have planted a range of native species most likely to grow within the wet forest conditions, including northern white cedar, tamarack, American elm, swamp white oak, and red maple. Half of the seedlings were planted the growing season prior to the implementation of the mortality treatments and the other half at the beginning of the growing season following treatment implementation.

Across these treatments vegetation and hydrological measurements have occurred yearly on 576 sampling plots covering over 200 acres of black ash swamps. These measurements will be continued with Phase Two of the study. In particular, all vegetation, including trees, understory vascular plants, invasive species, and forest regeneration will be measured annually for five years within a series of nested plots. Hydrological impacts of ash mortality treatments will continued to be assessed with a series of piezometers (screened PVC tubing) installed in the central portion of each treatment area. Pressure transducers within each piezometer continuously measure ground water tables during the growing season to directly assess treatment effects on groundwater storage and transport. These measurements will be continued for five years. Meteorological data (precipitation, temperature, wind speed, relative humidity, and solar radiation) will also be collected continuously at each treatment area to estimate surface and soil evaporation with the Penman equation. Estimates of evapotranspiration components (i.e., transpiration and evaporation) and precipitation will be used

to estimate treatment effects on site water balance. Results from these collective measurements will be synthesized into a final report describing the long-term impacts of EAB on black ash wetlands in northern Minnesota.

Summary Budget Information for Activity 1:

ENRTF Budget: \$157,783
Amount Spent: \$ 0
Balance: \$ 157,783

Outcome	Completion Date
1. Measure the long-term impacts of EAB on forest hydrology, including flooding impacts	<i>September 2019</i>
2. Measure the long-term impacts of EAB on native plant communities and spread of invasive plant species	<i>September 2019</i>
3. Final report of activity results submitted	<i>June 2020</i>

Activity Status as of January 2016:

Activity Status as of July 2016:

Activity Status as of January 2017:

Activity Status as of July 2017:

Activity Status as of January 2018:

Activity Status as of July 2018:

Activity Status as of January 2019:

Activity Status as of July 2019:

Activity Status as of January 2020:

Final Report Summary:

ACTIVITY 2: *Develop and implement recommendations for mitigating impacts of EAB on black ash forests, including planting suitable non-host tree species*

Description: The growth and survival of planted and natural seedlings representing non-host species for EAB, including American elm, northern white cedar, and tamarack, and established in Phase One will be monitored yearly to develop recommendations for species to plant to increase the resilience of black ash forests to EAB. Measurements include over 3,000 seedlings across a range of ash mortality and management conditions. Seedling survival and growth has been measured for four years and will continue for an additional five years under Phase Two to determine the suitability of different tree species as options for increasing the resilience of black ash wetlands. Planted seedlings will be measured for basal stem diameter and total height to determine rates of growth and vigor. In addition, the presence of deer browse damage will also be recorded. Volumetric moisture will be measured periodically within the seedling subplots throughout the next five growing seasons using TDR moisture probes. Light availability for each seedling will also be assessed at the center of each plot using a LAI-2000 plant canopy analyzer. Measurements collected under Activity 1 related to vegetation and hydrology will be used to develop predictive equations for determining the conditions most conducive for

different tree species to survive within black ash wetlands. These models and findings from our long-term evaluations of seedling survival and growth will be summarized as part of a management guide for increasing the resilience of black ash wetlands to EAB.

Summary Budget Information for Activity 2:

ENRTF Budget: \$85,180
Amount Spent: \$ 0
Balance: \$ 85,180

Outcome	Completion Date
1. Measure the long-term survival and growth of potential replacement species for black ash	<i>September 2019</i>
2. Develop and implement recommendations for increasing the resilience of black ash forests to EAB	<i>January 2020</i>
3. Present recommendations to DNR, Minnesota Legislature, and National Forests	<i>May 2020</i>

Activity Status as of January 2016:

Activity Status as of July 2016:

Activity Status as of January 2017:

Activity Status as of July 2017:

Activity Status as of January 2018:

Activity Status as of July 2018:

Activity Status as of January 2019:

Activity Status as of July 2019:

Activity Status as of January 2020:

Final Report Summary:

ACTIVITY 3: *Assess the vulnerability of black ash forests and associated resources and infrastructure for northern Minnesota*

Description: The distribution, extent, and configuration of black ash forests across northern Minnesota will be mapped based on multispectral and multitemporal satellite digital data and regional forest inventories. Landsat Thematic Mapper (TM) images from different points in the growing season will be used to identify black ash forest wetlands, given the unique phenology of this tree species in terms of leaf expansion relative to other deciduous species in northern Minnesota. Field validation will be conducted based on forest inventory data to determine the accuracy of classification schemes developed for identifying black ash forest habitats. ArcGIS 10.2 and ENVI+IDL will be used for processing Landsat imagery and generating maps of black ash forest wetlands. Forest composition maps depicting the extent and characteristics of black ash forest across northern Minnesota will be created to determine areas with the highest degree of vulnerability to EAB and to inform management and mitigation priorities.

Maps generated under this activity will be used to locate 30 other black ash swamp sites beyond Phase One sites to conduct additional hydrologic monitoring and vegetation sampling. These sites will be used to fully represent

the range of conditions and vulnerabilities of black ash swamps in the state and will span the primary Native Plant Communities (NPCs) in which black ash constitutes a significant component (WFn55 and WFn64). We will establish a series of sampling plots and hydrological monitoring stations at each additional black ash site for examining vegetation and water table conditions in these areas. Vegetation will be sampled at one time during Phase Two to generate a description of the native plant communities characterizing black ash swamps and the potential for naturally-occurring tree seedlings to serve as replacement species for black ash. Hydrological measurements will follow similar protocols as those used for Phase One and will involve the installation of a piezometer in the central portion of each swamp and the use of pressure transducers to measure ground water tables during the growing season to assess patterns of groundwater storage and transport in these areas. Hydrological measurements will occur for four years to account for monthly and yearly variability in precipitation patterns. Water budget models will be developed from hydrological measurements occurring under Activity 1 and 3 and used to determine the relative magnitude of groundwater change that could be expected for a given black ash wetland following EAB infestation. These estimates will be paired with our maps of black ash wetlands to identify areas where EAB may have the greatest impacts on regional hydrology.

Summary Budget Information for Activity 3:

ENRTF Budget: \$157,037
Amount Spent: \$ 0
Balance: \$157,037

Outcome	Completion Date
1. Develop statewide map of black ash forest wetlands using remote sensing and forest inventory data	<i>June 2018</i>
2. Measure hydrology and vegetation at black ash sites across northern Minnesota	<i>September 2018</i>
3. Assess statewide vulnerability of black ash forest wetlands	<i>September 2019</i>

Activity Status as of January 2016:

Activity Status as of July 2016:

Activity Status as of January 2017:

Activity Status as of July 2017:

Activity Status as of January 2018:

Activity Status as of July 2018:

Activity Status as of January 2019:

Activity Status as of July 2019:

Activity Status as of January 2020:

Final Report Summary:

V. DISSEMINATION:

Description: The final product of this project will be an interpretive report describing (a) the long-term impacts of emerald ash borer (EAB) on the hydrology and plant communities in black ash swamps in Minnesota, (b) management recommendations for increasing the resilience of black ash wetlands to EAB, and (c) assessments

of the statewide vulnerability of black ash communities to this threat. This report will be made available on the internet as a Department of Forest Resources Staff Paper Report. In addition, several manuscripts will be written based on this research and submitted for publication in peer-reviewed journals. A fact sheet summarizing principal findings of this project will be distributed to LCCMR members and legislators at the state and federal level. Results will be presented at state and national forest management and forest health conferences, and notably to agency and individual participants in the Sustainable Forests Education Cooperative. Results will also be used to inform the development of a management guide for minimizing the impacts of EAB on black ash forests. All reports and publications from this project will be made available via the Department of Forest Resources (www.forestry.umn.edu) and Sustainable Forestry Education Cooperative (<http://sfec.cfans.umn.edu/index.htm>) websites.

Status as of January 2016:

Status as of July 2016:

Status as of January 2017:

Status as of July 2017:

Status as of January 2018:

Status as of July 2018:

Status as of January 2019:

Status as of July 2019:

Status as of January 2020:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	\$ Amount	Overview Explanation
Personnel:	\$ 374,000	One month of faculty summer salary and fringe (0.36) for five years (PI-D'Amato; 0.1FTE); one month of faculty summer salary and fringe (0.36) for five years (Co-PI Falkowski; 0.1FTE); Post-doctoral researcher examining impacts of EAB on hydrology and native plant communities; salary and fringe (0.1812) for five years (0.5 FTE); Research associate coordinating collection of ecological field data from black ash forests; Salary and fringe (0.3040) for five years (0.75 FTE); Work-study undergraduate student to assist with data collection and processing; Salary and fringe (0.0743) for 5 years
Equipment/Tools/Supplies:	\$14,000	Supplies for constructing wells for monitoring hydrology at each site (\$10500), Haglof distance measuring equipment (\$700), stake whiskers for marking subplots (\$110), calipers for measuring

		seedling growth (\$320), supplies for constructing frames for measuring understory vegetation (\$150), diameter tapes for measuring overstory trees (\$150), and data loggers for micrometeorological measurements (\$2070)
Travel Expenses in MN:	\$12,000	Due to the high number of study sites and logistics associated with visiting and measuring black ash wetland sites \$12,000 is budgeted for domestic travel within Minnesota. This money will be used to pay for mileage (75%) and lodging (25%) for researchers, the field technician, and graduate and undergraduate students. Mileage costs are associated with rental of a field vehicle through the University of Minnesota motorpool for four field seasons. Travel reimbursement will follow University of Minnesota protocols.
TOTAL ENRTF BUDGET:		\$400,000

Explanation of Use of Classified Staff: NA

Explanation of Capital Expenditures Greater Than \$5,000: NA

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 8.54

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

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
Non-state			
U.S. Department of Interior, Northeast Climate Science Center.	\$ 165,000	\$0	Funds from this source will be used to develop methodology for quantifying regional vulnerability of black ash swamps and will directly complement the research proposed in this LCCMR project. In addition, funds from this source will be used to develop outreach materials related to increasing resilience.
USDA FS Northern Research Station	\$90,000	0	In-kind salaries provided by U.S. Forest Service Researcher (0.5 FTE; B. Palik), as well as in-kind use of Forest Service ATV, vehicle, and trailer.
State			
University of Minnesota	\$10,009	\$0	In-kind salaries provided by UMN Researchers (0.01 FTE; L. Nagel)
TOTAL OTHER FUNDS:	\$265,009	\$0	

VII. PROJECT STRATEGY:

A. Project Partners: The project team largely includes the same partners as Phase One and will be led by scientists at the University of Minnesota, Dept. of Forest Resources, including Professors Anthony D’Amato, Michael Falkowski, and Linda Nagel, and a scientist with the USFS, namely Dr. Brian Palik, and Dr. Rob Slesak of the Minnesota Forest Resources Council. Cooperators will include DNR Ecological and Water Resources and Forestry and the Chippewa and Superior National Forests.

B. Project Impact and Long-term Strategy: This project is a continuation of the Ecological and Hydrological Impacts of Emerald Ash Borer project that received \$636,000 of 2010 funding from the ENRTF. This work has identified the potential for significant, immediate alterations to native plant communities and the amount of flooding in forested wetlands in northern Minnesota due to EAB. We have begun developing and implementing mitigation strategies for these impacts, including planting non-host tree species; however, additional funding is critical for generating long-term assessments of the effectiveness of these strategies and the duration of EAB impacts. A key product that will be developed from Phase Two will be the development and implementation of recommendations for increasing the resilience of black ash forests to EAB and these will be formalized into statewide guidelines through consultation with the DNR.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	\$ Amount
ENRTF: "Ecological and Hydrological Impacts of Emerald Ash Borer." M.L. 2010, Chp. 362, Sec. 2, Subd. 6b	June 2009-2015	\$636,000

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

IX. VISUAL COMPONENT or MAP(S): N/A

X. RESEARCH ADDENDUM: Peer reviewed in Phase I

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than January 2016, June 2016, January 2017, June 2017, January 2018, June 2018, January 2019, June 2019, and January 2020. A final report and associated products will be submitted between June 30 and August 15, 2020.



Project Title: Emerald Ash Borer Ecological and Hydrological Impacts – Phase II

Legal Citation: Fill in your project's legal citation from the appropriation language - this will occur after the 2015 legislative session.

Project Manager: Anthony D'Amato

Organization: Department of Forest Resources, University of Minnesota

M.L. 2015 ENRTF Appropriation: \$ 400,000

Project Length and Completion Date: 5 Years, June 30, 2020

Date of Report: October 29, 2014

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
BUDGET ITEM	<i>Determine the long-term impact of EAB on native plant communities, spread of invasive species, and hydrology</i>			<i>Develop and implement recommendations for mitigating impacts of EAB on black ash forests, including planting suitable non-host tree species</i>			<i>Assess the vulnerability of black ash forests and associated resources and infrastructure for northern Minnesota</i>				
Personnel (Wages and Benefits)	\$137,283	\$0	\$137,283	\$81,080	\$0	\$81,080	\$155,637	\$0	\$155,637	\$374,000	\$374,000
PI summer salary and fringe (0.36) for five years to lead project and develop project reports and publications (PI-D'Amato; one month per year=0.38 FTE over project period, \$37,604)											
Co-PI summer salary and fringe (0.36) for five years to lead remote sensing analyses and mapping of black ash wetlands (Co-PI Falkowski; one month per year=0.38 FTE over project period, \$23,958)											
Post-doctoral researcher examining impacts of EAB on hydrology and native plant communities; salary and fringe (0.1812) for five years (24 wks per year=2.5 FTE over project period, \$140,650)											
Research associate coordinating collection of ecological field data from black ash forests; Salary and fringe (0.3040) for five years (39 wks per year=3.75 FTE over the project period, \$145,099)											
Work-study undergraduate student to assist with data collection and processing; Salary and fringe (0.0743) for 5 years (16 wks per year=1.53 FTE over the project period, \$26,689)											
Equipment/Tools/Supplies											
Supplies for constructing wells for monitoring hydrology at each site (\$10500), Haglof distance measuring equipment (\$700), stake whiskers for marking subplots (\$110), calipers for measuring seedling growth (\$320), supplies for constructing frames for measuring understory vegetation (\$150), diameter tapes for measuring overstory trees (\$150), and data loggers for micrometeorological measurements (\$2070)	\$11,500	\$0	\$11,500	\$2,100	\$0	\$2,100	\$400	\$0	\$400	\$14,000	\$14,000
Travel expenses in Minnesota											
Due to the high number of study sites and logistics associated with visiting and measuring black ash wetland sites \$12,000 is budgeted for domestic travel within Minnesota. This money will be used to pay for mileage (75%) and lodging (25%) for researchers, the field technician, and graduate and undergraduate students. Mileage costs are associated with rental of a field vehicle through the University of Minnesota motorpool for four field seasons. Travel reimbursement will follow University of Minnesota protocols.	\$9,000	\$0	\$9,000	\$2,000	\$0	\$2,000	\$1,000	\$0	\$1,000	\$12,000	\$12,000
COLUMN TOTAL	\$157,783	\$0	\$157,783	\$85,180	\$0	\$85,180	\$157,037	\$0	\$157,037	\$400,000	\$400,000