Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2011 Work Plan

Date of Status Update:
Date of Next Status Update: 12/1/2011
Date of Work Plan Approval: 6/23/2011
Project Completion Date: 6/30/2014 **Is this an amendment request?** _____

Project Title: Change and Resilience in Boreal Forests in Northern Minnesota

Project Manager: Lee Frelich
Affiliation: U of MN
Address: 1530 N Cleveland Ave
City: St Paul **State:** MN **Zipcode:** 55108

Telephone Number: (612) 624-3671
Email Address: freli001@umn.edu
Web Address:

Location:

Counties Impacted: Cook, Lake, St. Louis

Ecological Section Impacted: Northern Superior Uplands (212L)

Total ENRTF Project Budget:	**ENRTF Appropriation $:**	150,000
	Amount Spent $:	0
	Balance $:	150,000

Legal Citation: M.L. 2011, First Special Session, Chp. 2, Art.3, Sec. 2, Subd. 03i

Appropriation Language:
$75,000 the first year and $75,000 the second year are from the trust fund to the Board of Regents of the University of Minnesota to assess the potential response of northern Minnesota's boreal forests to observed and predicted changes in climate conditions and develop related management guidelines and adaptation strategies. This appropriation is available until June 30, 2014, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Change and resilience in boreal forests in northern Minnesota

II. PROJECT SUMMARY:

Boreal forests of spruce, fir, paper birch, aspen and jack pine cover more than 2 million acres of land on the Border Lakes Ecological Subsection of northern Minnesota. These forests are near the southern edge of their geographic range. With a warmer climate boreal tree species will be under increased stress from heat, drought, fires, storms, and insect pests. Therefore, the health and productivity of these forests may be jeopardized by a warmer climate. To plan for these changes, we need to know whether the forest is poised to respond in a resilient fashion as the boreal tree species decline. We can accomplish this goal by answering these questions:

1. Will temperate forest species now at the northern edge of their range in the Border Lakes, such as red maple, sugar maple, American basswood, bur oak, pin oak, red oak, and white pine expand to take the place of declining boreal species such as spruce and fir?
2. Are sufficient seed source populations already present for these temperate species to fill in the niche vacated by boreal tree species, and are those temperate populations already expanding?
3. Will invasive plant species (e.g. buckthorn) be able to jump in and take advantage of the warming climate and changing forest situation, possibly displacing native species?
4. Will boreal species like spruce, fir and jack pine be able to persist under a future warmer climate in areas with locally cooler climates (thermal refuges) such as bogs and north-facing hillsides?

With this project we will obtain the information necessary to answer these questions and provide the scientific basis for climate change adaptation plans for a variety of scenarios (from low to high magnitudes of change) that may occur over the next century. These goals will be accomplished by surveying the forest to assess the abundance of colonies of temperate species at the northern edge of their range, the potential for these colonies to expand, and whether invasive species are present that may interfere with forest adaptation to climate change. We will also measure temperature in areas with varied physiographic settings (e.g. bogs, and north and south facing hillsides), for 2 years to assess whether cool microclimates exist that may allow persistence of boreal tree species on some parts of the landscape. This information will be used to prepare adaptation and management options for commercial and BWCAW wilderness forests. Finally, via presentations and workshops in the Border Lakes Ecological Subsection, we will inform forest managers regarding future scenarios for forest health and resilience, and options for adaptation to climate change. The audience will include staff of the Superior National Forest, Minnesota DNR, County and Tribal forestry divisions. We will also reach out to the public via lectures and the media.

III. PROJECT STATUS UPDATES:

Project Status as of December 31, 2011:

Project Status as of June 30, 2012:

Project Status as of December 31, 2012:

Project Status as of June 30, 2013:

Project Status as of December 31, 2013:

Project Status as of June 14, 2014:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Survey abundance of temperate species (e.g. maple and oak) and invasive species within Border Lakes boreal forests.

Description:
A graduate student and undergraduate student assistant will survey large tracts of forest via transects to assess the number and geographical distribution of outlying colonies of temperate tree species and invasive plant species (e.g. buckthorn), as well as evidence regarding current or future potential expansion of their populations within the southern margin of the boreal forest. This data will allow us to assess whether temperate tree species are poised to expand as the climate warms, and the extent to which invasive species may interfere with forest adaptation to climate change. These data will likely also be related to Activity 2 (see below), since temperate and invasive species are more likely to invade areas on the landscape with warmer temperatures. To the extent possible, we will develop models of temperate and invasive species expansion for various future scenarios. Regarding timeline (which will apply to Activities 1 and 2), we will hire a graduate student beginning in September 2011, who will then be prepared during the 2011-2012 academic year to carry out the field work during the field seasons (May-October) of 2012 and 2013. An undergraduate student field assistant will be hired during the field seasons of 2012 and 2013.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 66,035
Amount Spent: $ 0
Balance: $ 66,035

Activity Completion Date:

Outcome	Completion Date	Budget
1. Map showing distribution of temperate tree species	December 31, 2013	$ 25,000
2. Map showing distribution of invasive species	December 31, 2013	$ 25,000
3. Models of temperate and invasive species expansion	June 30, 2014	$ 16,035

Activity Status as of December 31, 2011:

Activity Status as of June 30, 2012:

Activity Status as of December 31, 2012:

Activity Status as of June 30, 2013:

Activity Status as of December 31, 2013:

Activity Status as of June 30, 2014:

Final Report Summary:

ACTIVITY 2: Characterize temperature distribution on the forested landscape.

Description:
The graduate student and assistant will place 100 HOBOs (small devices originally developed for NASA space programs, that record temperature on an hourly basis and store the data for up to a year for later download to a computer) in the field to measure the effect of topographical features, such as south and north facing slopes, bogs and lakeshores on local climate. This data will be collected for two years, starting in May 2012 and including the 2012 and 2013 growing seasons (for three years if possible; we will seek funding from other sources to continue data collection through the 2014 field season). Analyses of this data will allow us to make maps showing observed temperature distribution

as well as to develop models to predict temperatures across the landscape. The temperature analyses will in turn allow us to predict areas that could serve as refuges for boreal species (cold areas) in a warming climate and areas where invasion of temperate and invasive species is more likely (warm areas).

Summary Budget Information for Activity 2:

ENRTF Budget: $ 62,166
Amount Spent: $ 0
Balance: $ 62,166

Activity Completion Date:

Outcome	Completion Date	Budget
1. Maps of observed temperature	December 31, 2013	$ 30,000
2. Maps and models of cold (boreal species refuges) and warm (temperate species invasion) areas on the landscape	June 30, 2014	$ 32,166

Activity Status as of December 31, 2011:

Activity Status as of June 30, 2012:

Activity Status as of December 31, 2012:

Activity Status as of June 30, 2013:

Activity Status as of December 31, 2013:

Activity Status as of June 30, 2014:

Final Report Summary:

ACTIVITY 3: Outreach and education on forest adaptation options.

Description:
Develop and present two workshops, one each for managers of commercial forests and managers of the Boundary Waters Canoe Area Wilderness. Develop a public lecture to be presented at 10 or more locations throughout the state. The workshop for forest managers will be geared towards Forest Service, State, County and Tribal forest managers and will be offered through the University of Minnesota Sustainable Forests Education Cooperative at Cloquet Forestry Center. The workshop for wilderness managers will be offered at a location convenient for Superior National Forest staff (probably their Duluth headquarters). The public presentation will be aimed at small landowners and wilderness users and presented at venues throughout the state (e.g. Vermilion Community College in Ely).

Summary Budget Information for Activity 3:

ENRTF Budget: $ 21,799
Amount Spent: $ 0
Balance: $ 21,799

Activity Completion Date:

Outcome	Completion	Budget

	Date	
1. Adaptation guidelines for forest managers	December 31, 2013	$ 11,000
2. Presentations and workshops	January-June 2014	$ 10,799

Activity Status as of December 31, 2011:

Activity Status as of June 30, 2012:

Activity Status as of December 31, 2012:

Activity Status as of June 30, 2013:

Activity Status as of December 31, 2013:

Activity Status as of June 30, 2014:

Final Report Summary:

V. DISSEMINATION:

Description:
Activity 3 **"**Outreach and education on forest adaptation options**"** above integrates dissemination to the public and forest managers within Minnesota into the project. In addition, we will publish at least two research papers in the peer-reviewed scientific literature, and seek media outlets that will more widely disseminate the findings. Once the data is complete and in its final form, it will be available from the University of Minnesota Center for Forest Ecology upon request.

Status as of December 31, 2011:

Status as of June 30 2012:

Status as of December 31, 2012:

Status as of June 30 2013:

Status as of December 31 2013:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget:

Budget Category	$ Amount	Explanation
Personnel:	$ 133,376	Frelich, project manager, advise graduate students, supervise undergraduate students, analyze data, write papers and co-write papers with graduate student, present workshops on climate adaptation (0.3 FTE for 2.0 years, $33,662 salary, $11,070 benefits, on soft money). Graduate student, collect and analyze field data, write papers (0.5 FTE for 2.0 years, $39,158 salary, $32,963 benefits). Undergraduate assistant, help collect field data during summer, assist with analysis in the lab during academic year (0.23 FTE for 2.0 years, $16,000 salary, $523 benefits).
Professional/Technical Contracts:	$0	
Service Contracts	$0	
Equipment/Tools/Supplies:	$5,500	100 Hobo units to record temperatures on an hourly basis at remote field sites, approximately $42 each, and two GPS units for navigation in remote areas.
Capital Equipment over $3,500:	$0	
Fee Title Acquisition:	$0	
Easement Acquisition:	$0	
Professional Services for Acq:	$0	
Printing:	$0	
Travel Expenses in MN:	$10,000	Summer field work for graduate student and undergraduate assistant, including lodging (camp grounds and university field station facilities will be used as much as possible to reduce costs), car rental and mileage for 4 months (2 months for each of 2 summers). Also included is mileage for visits while field work is in progress by project manager Frelich, mileage for travel by Frelich, Reich and Montgomery to present workshops. All travel will be in state.
Other:	$1,124	Materials for workshops and public education, including duplication and dissemination of results.
TOTAL ENRTF BUDGET:	**$150,000**	

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: 1.03 for each of two years, total 2.06

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			
In kind contribution, U of MN	$30,000	$	Peter Reich, Regents Professor ($20,000 in kind salary), and Rebecca Montgomery, Associate Professor ($10,000 in kind salary). See project partners below for details.
State			
	$0	$	
TOTAL OTHER FUNDS:	**$30,000**	**$**	

VII. PROJECT STRATEGY:

A. Project Partners: Lee Frelich is the project manager, partially supported by project funds, and will be the advisor/supervisor to the graduate and undergraduate students, and will participate directly in the field work and data analyses. Peter Reich will collaborate and provide expertise on forest ecology, tree population dynamics and landscape ecology, and help with data analyses. Reich will not receive support from this grant and will contribute $20,000 of in-kind services. Rebecca Montgomery is a new addition to the project partners since preliminary version of the proposal was submitted. She will collaborate by providing expertise on forest ecology and co-advise a graduate student. A graduate student, likely to be David Chaffin, who has been accepted by the Natural Resource Science and Management Ph.D. Program at the U of MN, to start during September 2011, will be supported by project funds for two years as a 50% Research Assistant, and take on this project as part of his Ph.D. research. An undergraduate student to be determined will be hired with project funds as a field assistant during the summers of 2012 and 2013.

B. Project Impact and Long-term Strategy: This project will capitalize on results from a previous workshop on Climate Change Adaptation and Biodiversity Conservation in Minnesota (Co-Organized by Frelich, June 2008), by using the Border Lakes forests as the first area to undergo detailed analyses for climate change adaptation using principles gathered from the scientists at the 2008 meeting. Also, the results with public education and policy will be carried forward after the termination of this project by Greater Quetico-Superior Climate Change Adaptation Plan Alliance, a coalition of environmental groups that has held preliminary organizational meetings and is pursuing their own funding. This project will also serve as a pilot for future climate change adaptation plans for other ecoregions of the state, and as a national model for this type of planning. This project will also provide the first instance where researchers have had detailed data on temperatures in a forested region where trees actually grow (rather than from flat paved areas such as airports, where trees don't grow), as well as a more detailed assessment of the status of invasive species in the boreal forest than has been previously published. The Forest Ecology Lab at the University of Minnesota has had a world-class research program in northern Minnesota since 1992, and this will continue indefinitely into the future. This LCCMR funded project will be an integral step in this long-term forest ecology program.

C. Spending History: N/A This specific project has no ENTRF spending history.

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. MAP(S): Map submitted with original proposal is attached.

X. RESEARCH ADDENDUM: See research addendum

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted not later than December 31, 2011, June 30 2012, December 31, 2012, June 30 2013, and December 31, 2013. A final report and associated products will be submitted between June 30 and August 1, 2014 as requested by the LCCMR.

Attachment A: Budget Detail for M.L. 2011 (FY 2012-13) Environment and Natural Resources Trust Fund Projects

Project Title: Change in resilience in boreal forest in northern Minnesota

Legal Citation: *Fill in your project's legal citation from the appropriation language*

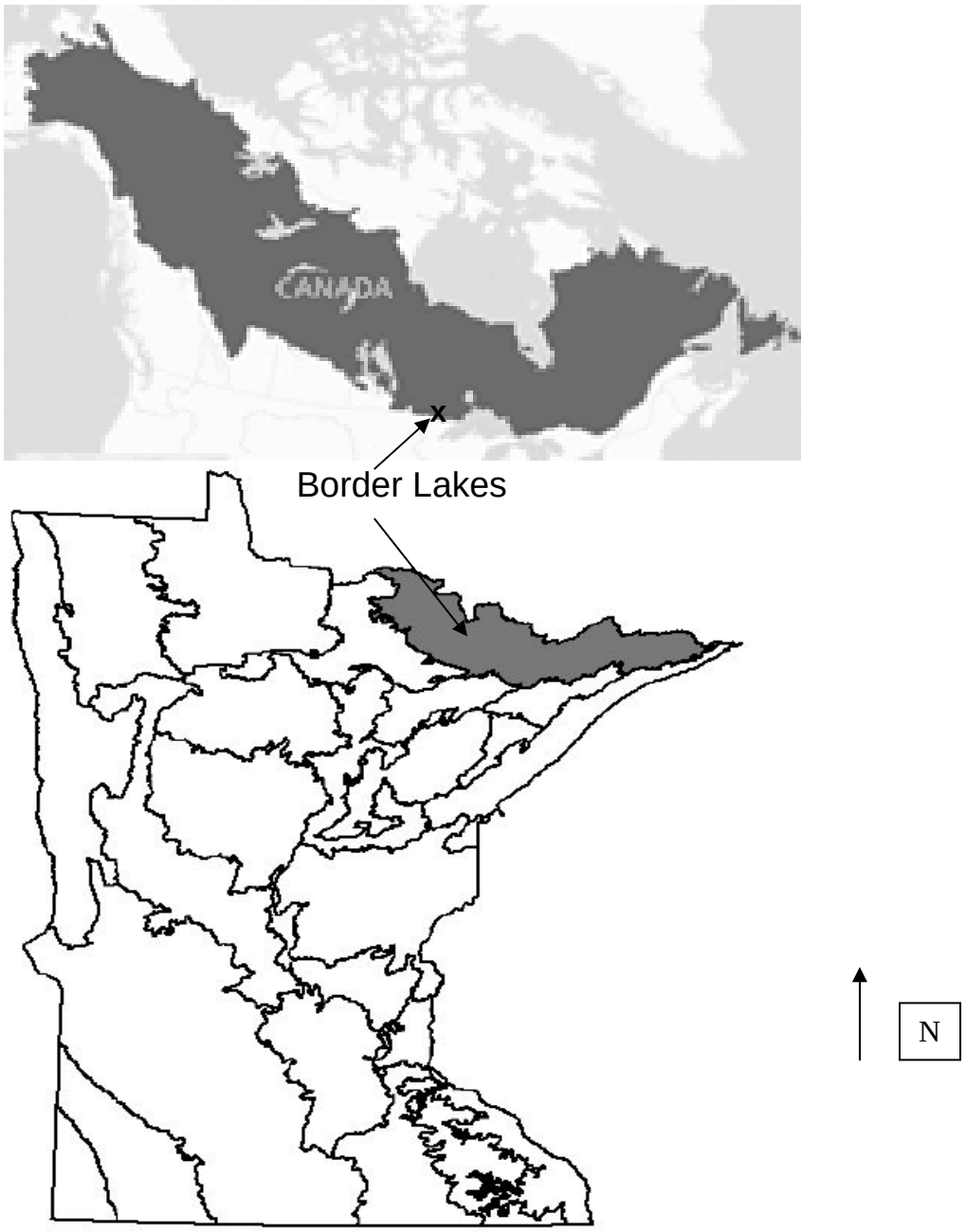
Project Manager: Lee E. Frelich

M.L. 2011 (FY 2012-13) ENRTF Appropriation: $ *150,000*

Project Length and Completion Date: 3.0 years, July 1, 2011-June 30, 2014

Date of Update: June 2, 2011

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	***Survey abundance of temperate species***			***Characterize temperature distribution on the***			***Outreach and education on forest***				
Personnel (Wages and Benefits)	61,535	0	61,535	52,166	0	52,166	19,675	0	19,675	133,376	133,376
Frelich, project manager, advise graduate students, supervise undergraduate students, analyze data, write papers and co-write papers with graduate student, present workshops on climate adaptation (0.3 FTE for 2.0 years, $44,732, 75% salary, 25% benefits).											
Graduate student, collect and analyze field data, write papers (0.5 FTE for 2.0 years, $72,121, 54% salary, 46% benefits).											
Undergraduate assistant, help collect field data during summer, assist with analysis in the lab during academic year (0.23 FTE for 2.0 years, $16,523, 97% salary, 3% benefits).											
Equipment/Tools/Supplies 100 Hobo units to record temperatures on an hourly basis at remote field sites, approximately $42 each, and two GPS units for navigation in remote areas.	0	0	0	5,500	0	5,500	0	0	0	5,500	5,500
Travel expenses in Minnesota Summer field work for graduate student and undergraduate assistant, including lodging (camp grounds and university field station facilities will be used as much as possible to reduce costs), car rental and mileage for 4 months (2 months for each of 2 summers). Also included is mileage for visits while field work is in progress by project manager Frelich, mileage for travel by Frelich, Reich and Montgomery to present workshops. All travel will be in state.	4,500	0	4,500	4,500	0	4,500	1,000	0	1,000	10,000	10,000
Other Materials for workshops and public education, including duplication and dissemination of results.	0	0	0	0	0	0	1,124	0	1,124	1,124	1,124
COLUMN TOTAL	**$66,035**	**$0**	**$66,035**	**$62,166**	**$0**	**$62,166**	**$21,799**	**$0**	**$21,799**	**$150,000**	**$150,000**



Map. The Border Lakes Subsection (Lower map, shaded, map credit: MN DNR) lies at the southern margin of the North American boreal forest dominated by spruce, fir and jack pine (Upper map, dark gray, map credit: Global Forest Watch Canada). The Border Lakes is also close to the northern range limit for temperate forest species sugar maple, red maple, American basswood, red oak, bur oak, and white pine, which may replace the boreal species with a warmer climate.