



Environment and Natural Resources Trust Fund (ENRTF) M.L. 2014 Work Plan

Date of Report: January 15, 2014
Date of Next Status Update Report: November 15, 2014
Date of Work Plan Approval:
Project Completion Date: June 30, 2017
Does this submission include an amendment request? N

PROJECT TITLE: Mountain Pine Beetle Invasive Threat to Minnesota’s Pines (UMN Activities 2 & 3)

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Location: Statewide (survey Activity 1); with insect work undertaken both in the Quarantine Lab at the University of Minnesota as well as out-of-state in the Black Hills of South Dakota to avoid unintentional introduction of this pest to Minnesota

Total ENRTF Project Budget:	ENRTF Appropriation:	\$175,000
	Amount Spent:	\$0
	Balance:	\$175,000

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 04e-1

Appropriation Language:

\$175,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota and \$75,000 the second year is from the trust fund to the commissioner of agriculture to survey for the presence and characterize the potential risk of the invasive mountain pine beetle to Minnesota's pine forests to inform early detection and rapid response. This appropriation is available until June 30, 2017, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Mountain Pine Beetle Invasive Threat to Minnesota's Pines (UMN Activities 2 & 3)

II. PROJECT STATEMENT:

This project focuses on survey and characterization of risk to Minnesota's pines from mountain pine beetle. Native to the western United States and Canada, mountain pine beetle is the most devastating forest insect in North America. In the fall of 2012, mountain pine beetle was found in a shipment of logs to Minnesota. Fortunately, the insect was dead, but live insects may be here already.

Mountain pine beetle reproduces in almost all species of pines. It breeds in the water-conducting tissues of the tree, just underneath the bark, much like emerald ash borer. During outbreaks, mountain pine beetle *must* kill their tree in order to reproduce. The insect can only breed in trees larger than 5" diameter, so prefers healthy, larger diameter trees. US Forest Service data from 2011 indicates that Minnesota has 191,000,000 red, jack, and white pines large enough for mountain pine beetle to attack. Our pine forests create valuable wildlife habitat, regulate water runoff, and promote recreational opportunities. To date, mountain pine beetle has impacted almost 125 million acres of mature pine forests in western North America.

This project is being initiated due to two high-priority routes of entry to Minnesota (see graphic page):

- 1. Through import of green logs into the state from proximate western states with the insect.** Interstate movement of logs is not regulated, so it is challenging to quantify the extent of this risk. The Minnesota Department of Agriculture (MDA) recently formed an expert task force on mountain pine beetle. Early investigation revealed one supplier in Montana who indicated they distribute wood to 900 builders, including "hundreds" in Minnesota and Wisconsin. Minnesota Department of Agriculture attempted contact with 79 business potentially receiving wood from western sources. Seventeen businesses were interviewed and 5 did state importing pine from western areas in the past. One site visit was made to a business as a result and dead mountain pine beetle were found in lodgepole pine logs from Montana. Raw wood imports brought Douglas fir beetle, a kissing cousin of mountain pine beetle, to Grand Rapids, MN, a few years ago. For unknown reasons, those insects died after being established from 2002-2006. The state was very fortunate, and needs to learn from that experience. This project implements critically-needed statewide monitoring and should be continued until evidence suggests the beetle could not establish here.
- 2. From the northwest through a corridor of jack pine stretching across Canada's boreal forest into northern Minnesota.** Currently, an ongoing outbreak of mountain pine beetle in western Canada totals 45 million acres in size, making it the world's largest outbreak of any forest insect. The insect is typically kept in check by cold winter temperatures, but recent warming trends have unleashed the beetle over the Rocky Mountains on a path to Minnesota's pines. In a "good" year, the insects can disperse up to 500 miles (even visible on Doppler radar). Minnesota is 500 miles from the Black Hills of South Dakota, but there is little pine forest in between. We are twice this distance from the approaching front in Canada, but there is contiguous pine in between. Estimating the approaching front is difficult, as monitoring is an imperfect science: much like emerald ash borer, we know where trees have died, not how much closer the beetle is now.

This project uses a collaborative multi-agency team to undertake two objectives. The Minnesota Department of Agriculture will assume Objective 1 (Activity 1), while the University of Minnesota will undertake Objective 2 (Activities 2 & 3).

Objective 1. Survey state locations for presence of mountain pine beetle. If low numbers of insects have been introduced, they may persist for a number of years before exploding (similar to emerald ash borer).

Unlike emerald ash borer, there *is* an effective trap and lure. Management of isolated, endemic populations may not be impossible – *if* we know they are there first.

Objective 2. Characterize the risk to Minnesota’s pine species. Studies by Canadian researchers indicate that jack pine is an excellent food source for the insect. We will characterize development and winter survival in red, white, and Scots pines to inform and direct rapid response management for Minnesota’s pine species.

III. PROJECT STATUS UPDATES:

Project Status as of November 15, 2014:

Project Status as of May 15, 2015:

Project Status as of November 15, 2015:

Project Status as of May 15, 2016:

Project Status as of November 15, 2016:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1 (MDA): Survey Minnesota pine forests for mountain pine beetle

(Note: This description is copied from the separate workplan for MDA for project coherence. For Budget and Outcomes, please see MDA workplan.)

Description:

MDA will survey pine locations during the timeframe of potential MPB flight period (July – September) throughout Minnesota for three years. Sites will be selected based on known or suspected importation routes of green timber. MDA will identify trap contents for mountain pine beetle, related species and natural enemies. We anticipate that we will be able to maintain a total of approximately 100 traps. These traps will be divided across sites to optimize the number of sites trapped and the trapping coverage at each site. We expect that there will be approximately 25 targeted sites with 4 traps surrounding each site, however the actual number of sites trapped each year may vary based on the discovery of new sites or the determination that previously trapped sites do not justify additional survey.

ACTIVITY 2 (UMN): Determine attractiveness and developmental rate in Minnesota’s pines

Description:

Beetles will develop faster, slower, or not at all in “new” tree species. Initial Canadian data suggests that mountain pine beetle can easily kill and reproduce in jack pine. A graduate student will characterize development of mountain pine beetle in logs of red, jack, white, and Scots pine. We will do this by harvesting logs of these species in Minnesota and driving them immediately to the Black Hills of South Dakota where there are active populations of mountain pine beetle. *Note: we will conduct this work outside of the state of Minnesota, as we have no desire to inadvertently introduce this insect to Minnesota.* We will use the Wheaton College Science Station just outside of Rapid City, South Dakota as a home base for summer work. This location is in the middle of several excellent field sites.

Mountain pine beetles will be collected from flight traps in the Black Hills and then introduced to the Minnesota logs in the WCSS laboratory. Mountain pine beetle will readily infest fresh material when they are confined in a small gel capsule over a small nick through the surface of the bark. We will also infest local South Dakota logs harvested from lodgepole and Ponderosa pine. This will allow us to determine attraction/reproduction relative to usual western hosts. Logs of all species will be deployed from the Science Station to the field and the number of flying mountain pine beetles attracted to the infested logs and captured

in flight traps will be counted. We will aim for 12 field sites, but that number may be adjusted due to populations of beetles and travel distance from the WCSS.

A second subset of logs will be infested and then screened to prevent escape or additional invasion. The logs will be stored outdoors in South Dakota. Some of these infested logs will be transported to back to Minnesota in the winter directly to the Quarantine Laboratory at the University of Minnesota (see Activity 3, below). There, cold hardiness in Minnesota’s pines and western hosts will be tested. The remaining logs will be preserved in South Dakota until the following summer to count emerging progeny and determine reproductive rates. These experiments will be repeated twice.

Summary Budget Information for Activity 2:

ENRTF Budget: \$ 125,700
Amount Spent: \$ 0
Balance: \$ 125,700

Activity Completion Date: June 30, 2017

Outcome	Completion Date	Budget
1. Comparison of Minnesota’s pines for attractiveness to flying beetles	06/30/2016	\$56,850
2. Comparison of development times in Minnesota’s pines	06/30/2016	\$56,850
3. Comparison to western pine hosts and final results reported	06/30/2017	\$12,000

Activity Status as of November 15, 2014:

Activity Status as of May 15, 2015:

Activity Status as of November 15, 2015:

Activity Status as of May 15, 2016:

Activity Status as of November 15, 2016:

Final Report Summary:

ACTIVITY 3 (UMN): Characterize cold tolerance in Minnesota’s pines

In western pines, cold tolerance differs depending on species of pine. The same graduate student and an undergraduate summer worker will characterize the effects of freezing temperatures on beetle mortality levels in logs of red, jack, white, and Scots pine under quarantine conditions at the U of M to inform risk maps.

Freshly cut pines will be infested with adult mountain pine beetle and screened as per Activity 2. Beetles will be allowed to reproduce and offspring to develop until late December or early January. This approach provides adequate time and conditions for mountain pine beetle to naturally acclimate to cold. Preliminary observations (D. Rosenberger, U of MN, data not shown) indicate that mountain pine beetle from cut logs are as cold hardy as from standing trees of the same host (i.e., ponderosa pine).

We use artificial infestation because the pine species of interest do not occur with the current range of mountain pine beetle. Also, mountain pine beetle prefers to colonize large diameter trees so transplanting eastern species is not a feasible option.

In December/January, infested logs will be secured in triple containment (i.e., three independent means to prevent the escape of the insects) and returned to Minnesota. Under secure conditions, infested logs will be peeled and the distribution of life stages noted. Cold hardiness of recovered insects will be measured in three ways. We will measure the supercooling points of overwintering life stages. The supercooling point is the temperature at which insects begin to freeze. Mountain pine beetle uses a freeze-avoidant strategy to survive the winter on western pines because individuals will die if they freeze. The insect produces cryoprotectants and is able to prevent freezing until temperatures approach -35°C. However, we recognize that the overwintering strategy might be different on new pine species. So, we will also measure the lower lethal temperature of the insect. For these measurements, insects are cooled to randomly-selected temperatures between 0 and -40°C. Insects are immediately removed upon reaching these temperatures. Survival (as demonstrated by normal behavior of the insect) will be recorded at 24, 48, and 72 hours after cold exposure. These studies will allow us to determine if some individuals might die before or upon freezing or if some fraction of the population can survive freezing. Lastly, if we can obtain enough insects, we will measure lower lethal time. For these

measures, insects will be held at sub-zero temperature for up to 160 days. Batches of insects will be removed at regular intervals and survivorship assessed. At the conclusion of experiments, material will be returned to South Dakota.

Summary Budget Information for Activity 1:

ENRTF Budget: \$ 49,300
Amount Spent: \$ 0
Balance: \$ 49,300

Activity Completion Date: June 30, 2017

Outcome	Completion Date	Budget
1. <i>Determination of lower lethal temperature in Minnesota's pines</i>	06/30/2017	\$49,300

Activity Status as of November 15, 2014:

Activity Status as of May 15, 2015:

Activity Status as of November 15, 2015:

Activity Status as of May 15, 2016:

Activity Status as of November 15, 2016:

Final Report Summary:

V. DISSEMINATION:

Description:

This work will be shared with relevant stakeholders through meetings and presentations (e.g., Upper Midwest Invasive Species Council, MN Forest Resource/Stewardship Council, North Central Forest Pest Workshop, etc.). Presentations have already been given on this important topic for groups such as the Great Lakes Log Crafters Association. We will be available for media requests, as well. This insect is well known in the western United States and Canada and western media outlets periodically request interviews from personnel in states at risk of introduction or invasion to find out about preparedness levels.

Status as of November 15, 2014:

Status as of May 15, 2015:

Status as of November 15, 2015:

Status as of May 15, 2016:

Status as of November 15, 2016:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview (UMN Activities 2 & 3 only):

Budget Category	\$ Amount	Explanation
Personnel:	\$ 144,000	One graduate student at 50%FTE for 2 years, one undergraduate summer student at 30% FTE each of 3 years, 1 summer faculty time at 15% FTE for 3 years
Equipment/Tools/Supplies:	\$4,200	Lab and field supplies
Printing:	\$600	Printing/poster charges for dissemination of results
Travel Expenses in MN:	\$2,000	\$1,00 each of two years collecting pine material to transport to Black Hills (est. 2 day truck rental plus 750 miles at \$0.39/mile plus one night lodging x 2 trips each year) July & Aug for Activity 2

Other:	\$24,200	<ul style="list-style-type: none"> • Travel to, from, among field sites in Black Hills of South Dakota (\$19,500) • Rental of UMN Quarantine Facility 3 years (\$4,500) • Cellular air time prepaid 2 years for safety in case of field emergencies (\$200). Proposed as cheaper than ACR ResQLink+ Personal locator beacon (\$289, REI) or SPOT tracker (\$100+\$100 subscription). We have used satellite phones (Iridium) in past research, but cell reception is acceptable at WCSS so propose this as least expensive route; if unallowable will pursue more expensive option.
TOTAL ENRTF BUDGET:		\$175,000

Explanation of Use of Classified Staff:

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

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 2.35

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
Non-state			
Canada: NSERC TRIA-Net \$3M Cdn (in kind)	\$0	\$	Because Canadian grant funds cannot be spent outside of Canada, these funds cannot support work in Minnesota. However, we will be in touch with Canadian workers on their projects (invasion pathway through the Canadian boreal forest) and their ongoing spread control work
State			
Waived indirect costs of 52% U of M \$91,000	\$0	\$	
TOTAL OTHER FUNDS:	\$0	\$	

VII. PROJECT STRATEGY:

A. Project Team/Partners

Similar to the ongoing EAB projects on biological control, detection, and monitoring, this proposal is a joint partnership with the MDA, USDA Forest Service, and the University of Minnesota.

Receiving funds: The MDA (Abrahamson) will lead the survey efforts (Activity 1). The U of M and the Forest Service (Aukema/Venette) will lead the characterization of risk to Minnesota's pines through studies of reproduction and cold tolerance (Activities 2/3).

Not receiving funds: The Forest Service will not receive funds. All institutions will provide in-kind equipment, facilities, intellectual input, and GIS/technical support, and we will collaborate with the DNR and other federal agencies, including Canadian. As stated above, a collaborative Canadian research team was recently awarded

\$3M from their federal authorities to study the approaching eastward invasion front. Our proposal complements their and does not overlap.

B. Project Impact and Long-term Strategy:

This project has immediate impact for Minnesota by surveying whether the insect has established in the state, given that dead insects were found on imported pine logs in the fall of 2012 with a random inspection. Mountain pine beetle can exist for years at “endemic” levels where it reproduces in but does not kill trees. When environmental conditions permit, the insect suddenly erupts and begins killing trees until either 1) it runs out of trees to kill or 2) unfavorable winter temperatures kill a significant portion of the insects.

A longer-term strategy has already begun here and elsewhere. In Minnesota, the threat of mountain pine beetle has prompted convening of an expert task force through the Minnesota Department of Agriculture. Several outreach presentations have been given to relevant stakeholder groups highlighting the necessity to reduce likelihood of transporting the insect – or any of its associates – to the state.

In the event that mountain pine beetle is found or arrives in the near future, the work on risk assessment in various pine species and cold tolerance will inform rapid response strategies. We will know within a few years which tree species produce the most beetles, and what level of cold might be needed to kill populations in the winter.

LCCMR has not spent any funds on the emerging mountain pine beetle problem to date. Over the past 10 years, Canada has spent \$1.5B on spread control and mitigation of ecologic consequences. This figure does not include \$285,000 earmarked this year by provinces such as Ontario that share a border with MN. Wisconsin has already deployed sentinel traps in five locations for early detection.

C. Spending History:

Funding Source	M.L. 2008 or FY09	M.L. 2009 or FY10	M.L. 2010 or FY11	M.L. 2011 or FY12-13	M.L. 2013 or FY14
U of M Graduate School Fellowship for PhD Student to recruit Derek Rosenberger			\$42,0000		

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. VISUAL ELEMENT or MAP(S): See shared MDA – UMN graphic

X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: N/A

XI. RESEARCH ADDENDUM: N/A

XII. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than 11/15/2014, 5/15/2015, 11/15/2015, 5/15/2016 and 11/15/2016. A final report and associated products will be submitted between June 30 and August 15, 2017.

Environment and Natural Resources Trust Fund

M.L. 2014 Project Budget



Project Title: Mountain Pine Beetle Invasive Threat to Minnesota's Pines (UMN Activities 2 & 3)

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 04e-1

Project Manager: Brian Aukema

Organization: University of Minnesota

M.L. 2014 ENRTF Appropriation: \$175,000

Project Length and Completion Date: 3 year project, to be completed June 30, 2017

Date of Report: January 15, 2014

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET

BUDGET ITEM	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
Survey (See MDA budget)											
Attractiveness and development in Minnesota's pines											
Determine cold tolerance											
Personnel (Wages and Benefits)				\$102,000		\$102,000	\$42,000		\$42,000	\$144,000	\$144,000
1 Graduate Research Assistant: \$41,500 in year 1, \$42,500 in Year 2, evenly shared between Activities 2 & 3, 50% FTE for 2 years											
1 Undergraduate Research Assistant or Technician: \$8,000 each of 3 years (92% salary, 8% benefits), 40 hours/week in summers Activity 2 (may be three different students)											
U of M: One 3 year PTE faculty \$12,000/year (80% salary, 20% fringe) for method development Activity 2											
Equipment/Tools/Supplies											
Lures, ethanol for storing collected insects, screening, staples, rope, misc. field supplies for Activity 2				\$2,700		\$2,700				\$2,700	\$2,700
Syringes and thermocouples for Activity 3							\$1,500		\$1,500	\$1,500	\$1,500
Printing											
Scientific posters for dissemination results (\$200/year) split between Activities 2 & 3				\$300		\$300	\$300		\$300	\$600	\$600
Travel expenses in Minnesota											
\$1,000 each of two years collecting pine material to transport to Black Hills (est. 2 day truck rental plus 750 miles at \$0.39/mile plus one night lodging x 2 trips each year) July & Aug for Activity 2				\$2,000		\$2,000				\$2,000	\$2,000
Other											
Travel expenses outside of Minnesota: Activity 2: \$7,600/year for first two years. Work will be conducted in Black Hills of SD to avoid introduction of MPB to MN. Flight season typically mid-July through August or early Sept, approx. 60 days. Expenses include pickup truck rental 2 x 2 mo rental of 3/4 ton trucks at \$800/mo, plus est. 3600 miles/year gas at \$0.39/mi, total \$4,600 year; includes deploying trap lines to collect MPB, procuring lodgepole pine from Big Horn Mtns, WY, deploying MN and western pines to field sites in Black Hills, checking attraction every 3d from base station. Travel includes \$1,500 lodging for team inclusive of research base space at Wheaton College Science Station in South Dakota (storage of logs from MN, use of upper classrooms to infest material to deploy to field). Budget also allows two overnight trips to fetch material for Activity 3 approx October, Jan two years in trucks for return to UMN Quarantine Facilities (est. \$1,400; 2 trips x 2 trips x \$100 truck rental x 1200 miles at \$0.39 + hotel). \$1.5K each of three years also budgeted for travel to meet with MPB specialists to share findings and stay abreast of management strategies and progress slowing spread from Canada.				\$16,700		\$16,700	\$2,800		\$2,800	\$19,500	\$19,500
Cell phone airtime: \$100/year for 2 years pay-as-you-go for safety emergencies in the field on Activity 2. Proposed as cheaper than ACR ResQLink+ Personal locator beacon (\$289, REI) or SPOT tracker (\$100+\$100 subscription). We have used satellite phones (Iridium) in past, but cell reception is acceptable at WCSS so propose this as least expensive route.				\$200		\$200				\$200	\$200
UMN Quarantine Facility Activity 2									\$4,500	\$4,500	\$4,500
COLUMN TOTAL				\$123,900	\$0	\$123,900	\$51,100	\$0	\$51,100	\$175,000	\$175,000

Mountain Pine Beetle: Invasive Threat to Minnesota's Pines

OBJECTIVE 1: Has it reached us yet?

This beetle was imported into Dodge County, Minnesota, fall 2012. Fortunately, this mountain pine beetle was dead, but pioneers may have reached us previously.



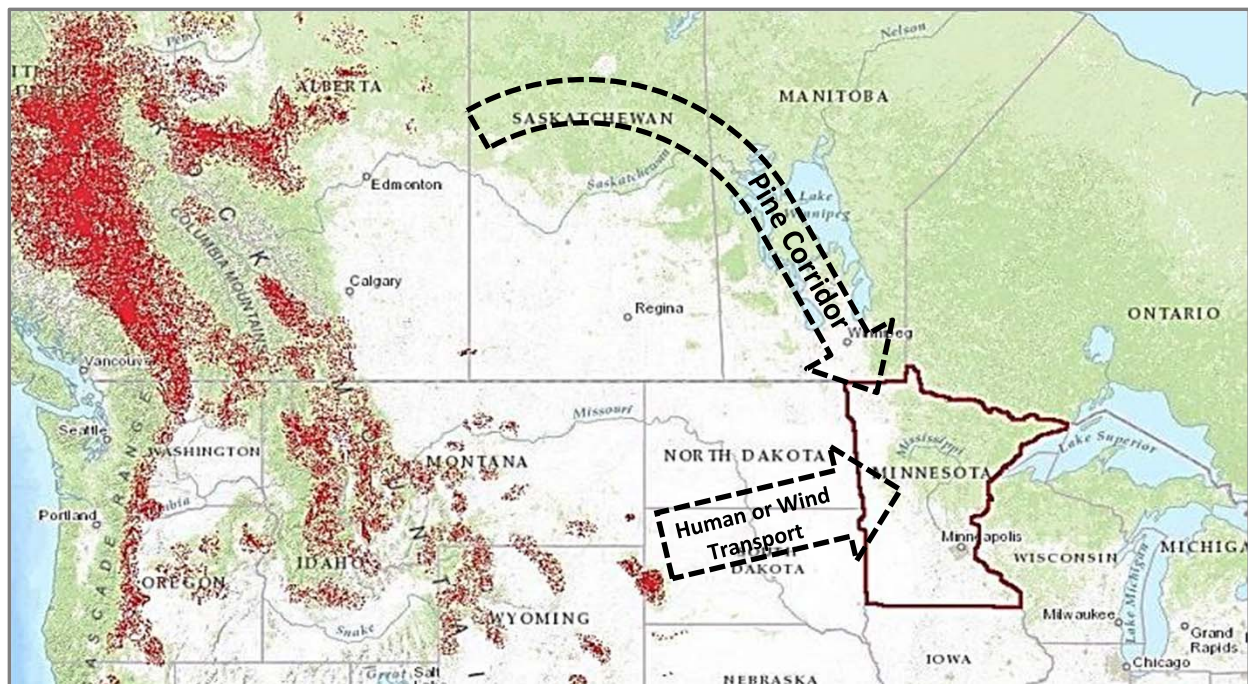
OBJECTIVE 2: How destructive will it be to our pine forests?

The insect appears to do better on pines in newly invaded areas. We need to know how much better our pines may be than its usual western pines.



GOAL

Informed rapid response to this invasive threat



Shaded areas indicate conifer forest. Dark areas on the left indicate the current extent of forests with high mortality due to mountain pine beetle. Routes to Minnesota from current epidemic populations are shown.



