



Environment and Natural Resources Trust Fund (ENRTF) Minnesota Invasive Terrestrial Plants and Pests Center (MITPPC) M.L. 2015 Work Plan

Date of Report: April 27, 2017

Date of Next Status Update Report: June 30, 2017

Date of Sub-Project Work Plan Approval:

Project Completion Date: Aug 31, 2018

Does this submission include an amendment request? No

SUB-PROJECT TITLE: MITPPC #9: Characterizing dispersal of larval gypsy moth to improve quarantine regulations

Sub-Project Manager: Brian Aukema

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Location: Lake and Cook counties

Total ENRTF Project Budget: \$35,000

ENRTF Appropriation: \$35,000

Amount Spent: \$0

Balance: \$35,000

Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 6a

Appropriation Language:

\$5,000,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Invasive Terrestrial Plants and Pests Center established in Laws 2014, chapter 312, article 13, section 44, to conduct research to prevent, minimize, and mitigate the threats and impacts posed by invasive plants, pathogens, and pests to the state's prairies, forests, wetlands, and agricultural resources. This appropriation is available until June 30, 2023, by which time the project must be completed and final products delivered.

I. SUB-PROJECT TITLE: MITPPC #9: Characterizing dispersal of larval gypsy moth to improve quarantine regulations

II. SUB-PROJECT STATEMENT:

The most ideal regulatory and mitigation measures for invasive species will contain the pest but not adversely affect commerce. Balancing these objectives can pose unique challenges. For example, state and federal regulations against the European gypsy moth *Lymantria dispar* (Lepidoptera: Erebidiae) restrict movement of regulated articles such as logs and firewood. This situation is a major problem for pulp and lumber mills and firewood producers that reside outside regulated areas in Minnesota and Wisconsin but receive wood harvested from areas inside the quarantine zones. When “clean” piles are staged in infested areas at any point in the supply chain, they risk acquiring late instar larvae (technical term for caterpillars) that move from proximate host trees in search of pupation sites. (In order to grow, larvae must periodically shed their exoskeleton. Gypsy moth larvae do this up to five times before pupating to become an adult moth. The stage between molts is called an instar. The tiny larvae that emerge from an egg are first instars; they molt to become second instars and so-on to become sixth instars.) Adults emerging from pupal cases can crawl onto the logs, mate, and oviposit fresh egg masses - thus spreading the insect to previously “clean” areas.

Hence, an isolation or buffer zone is commonly employed around log decks (i.e., staging areas where cut trees are piled and stored before processing). Identifying the most appropriate size of a buffer zone around a pile as a mitigation measure depends on defining the movement potential for larval gypsy moths in the field. Current practice utilizes a buffer distance of 100 feet, but the origin of this guideline is unclear. Typically, larvae do not move far from their host trees, as they pupate in the soil directly below the tree in which they were feeding. In outbreak situations, however, caterpillars can crawl farther to find food.

The United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA-APHIS), has provided \$133,000 to determine how feeding status and age affect gypsy moth dispersal, and what cues affect movement. The hypothesis is that late instar larvae in outbreak situations, where defoliation of surrounding vegetation is occurring, will be more prone to moving in search of food or pupation sites. USDA-APHIS is funding the mark-resight experiments to track movement and navigation, including distance, wandering of the larvae, ground temperature, and wind speed. These field studies will use harmonic radar to locate the insects. To date, we have found that late instars can move more than 100 feet in search of food or shelter in less than 12 hours, but the angle of incident light strongly affects dispersal patterns.

Laboratory studies are not included in the USDA-APHIS grant and are essential to complete the research protocol. The scope of work described here will complete the research project and provide the data necessary to fully understand larvae movement. Our goal is to provide improved science-based guidelines to restrict movement of gypsy moths without restricting commerce. This work will benefit the forest industry – especially loggers and firewood producers - in Minnesota and Wisconsin.

III. OVERALL SUB-PROJECT STATUS UPDATES:

Sub-Project Status as of June 30, 2017:

Sub-Project Status as of December 31, 2017:

Sub-Project Status as of June 30, 2018:

Overall Sub-Project Outcomes and Results:

IV. SUB-PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Lab-based studies of dispersal ability of gypsy moth larvae

Description: Field studies will determine the effect of age on walking behavior of gypsy moth larvae using harmonic radar. However, movement of larvae prior to 5th instar is likely to be impeded by harmonic radar tags.

Hence, we will use a servosphere, also known as a locomotory compensator, to quantify the amount and type of movement of third – sixth instar larvae. A servosphere is a specialized piece of equipment that is designed to measure the walking behavior of insects. The servosphere has four primary parts: (i) a low-friction, spherical walking surface; (ii) a digital video recording camera to record orientation; (iii) a sensory stimulus source; and (iv) a dedicated microcomputer to electronically capture insect behavior. The stimulus can be a visual or chemical cue. When placed on the servosphere, insects begin to walk towards or away from the stimulus. In our studies, larval movement will be recorded for an hour at a time, and we will record total distance, straight line distance (initial point to final point), and tortuosity (a ratio of these two measures, which provides an estimate of “wandering” behavior). We will examine effects of developmental stage, feeding status, and light stimuli on behavior. We will use this information to identify “worst case” conditions, i.e., the set of circumstance that lead to the farthest distance walked. Behaviors of 5th and 6th instars in the laboratory will be compared with behaviors measured in the field.

The servosphere is a critical piece of equipment because it allows researchers to study mid- to long-distance locomotion of small to mid-size insects in confined spaces. This activity would be done in the quarantine lab. Gypsy moth is an insect under federal quarantine, which imposes strict limitations on the locations and types of experiments that can be conducted. The approach ensures that no insects will escape as can occur during field studies with multiple individuals. Further, our preliminary studies on the walking behavior of gypsy moth larvae in Wisconsin showed that even large individuals (2-2 ½ inches long) can be difficult to track over time. So, recovery and observation of third instars (approximately ½ inch long) or fourth instars (slightly less than 1 inch long) is not reliable nor practical in the field.

Summary Budget Information for Activity 1:

ENRTF Budget:	\$ 35,000
Amount Spent:	\$ 0
Balance:	\$ 35,000

Outcome	Completion Date
1. Determine effects of developmental stage, feeding status, and environmental stimuli on larval movement to determine “worst case” conditions	December 31, 2017
2. Determine the maximum and expected distances that gypsy moth larvae can move as a foundation for a new recommendation for isolation zones around commercial log decks	April 31, 2018

Sub-Project Status as of June 30, 2017:

Sub-Project Status as of December 31, 2017:

Sub-Project Status as of June 30, 2018:

Final Report Summary:

V. DISSEMINATION:

Description: We will share our findings with Minnesota agencies and citizen groups so that public information and decision making is based on the best available science. We will submit updates of our progress through the University of Minnesota, College of Food, Agricultural, and Natural Resource Sciences, and College of Biological Sciences via websites, social media, and publications. We will use social media and other news outlets to communicate our research when warranted. Additionally, we will present our findings at national and international conferences. Peer-reviewed publications will be disseminated at the earliest possible date.

Sub-Project Status as of June 30, 2017:

Sub-Project Status as of December 31, 2017:

Sub-Project Status as of June 30, 2018:

Final Report Summary:

VI. SUB-PROJECT BUDGET SUMMARY:

This section represents an overview of the preliminary budget at the start of the project. It will be reconciled with actual expenditures at the time of the final report. See the Sub-Project Budget document for an up-to-date project budget, including any changes resulting from amendments.

A. ENRTF Budget Overview:

Budget Category	\$ Amount	Overview Explanation
Equipment/Tools/Supplies:	\$33,500	\$33,500 for servosphere and data acquisition system
Other:	\$1,500	BSL-2 quarantine facility rent, shipping charges to receive egg masses from laboratory colonies in the northeastern US (shipping follows federally mandated biosecurity procedures and containers are only opened inside the quarantine facility)
TOTAL ENRTF BUDGET:	\$35,000	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than \$5,000: A servosphere is necessary for controlled experimentation with a federally quarantined insect in order to measure movement and dispersal of early-developmental stages of the insect. Purchase of the equipment is the only viable option for this research. Such specialized equipment is not available for rent. No other laboratory in the Upper Midwest has the equipment available for loan or could undertake these studies on our behalf. The servosphere will be made available to other researchers for use at the University of Minnesota. No fees will be charged to recover capital costs, but fees for maintenance expenses may be necessary.

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

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	\$ Amount Spent	Use of Other Funds
MGK, Inc. Fellowship	\$45,000	\$35,000	Graduate research assistant (salary & fringe)
US Department of Agriculture, Animal & Plant Health Inspection Service	\$72,000	\$0	Graduate research assistant (salary & fringe), supplies, & travel
UMN Indirect rate 52%	\$18,200	\$0	Indirect costs associated with implementation of project
TOTAL OTHER FUNDS:	\$135,200	\$35,000	

VII. PROJECT STRATEGY:

A. Project Partners: Scott Myers and Paul Chaloux (USDA-APHIS) will continue to consult on the proposed experiments. They provided partial funding for the first two years of preliminary data collection as we seek to improve quarantine practices that will not adversely affect forest product movement. Kimberly Theilen-Cremers and Marissa Streifel (Minnesota Department of Agriculture) and Brian Kuhn (Wisconsin Department of

Agriculture, Trade and Consumer Protection) also provide regulatory advice and feedback. None of the project partners will be receiving funds from this sub-project.

B. Project Impact and Long-term Strategy: The total funding secured from non-MITPPC sources to date through the projected completion of Mr. Wittman's degree is \$178,000. Full project support for all salary and field study commitments has been provided by the USDA APHIS Gypsy Moth Program with in-kind support from WI-DATCP and MDA. We are in the final year of study. A University of Minnesota's McLaughlin Gormley King Fellowship to Mr. Wittman is currently supporting this work to spring 2017.

The regulatory manual for USDA APHIS is currently undergoing revision and we hope that project results will reduce risk of movement for gypsy moth while not restricting trade.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	\$ Amount
USDA APHIS, Methods development and proof of concept for larval movement	2014-2016	\$61,000

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

X. RESEARCH ADDENDUM: A research addendum was developed after a panel of researchers from the University of Minnesota provided competitive reviews of a pre-proposal of this work. The addendum was distributed to relevant experts outside the University of Minnesota and reviewed for scientific novelty, appropriateness of methods, qualifications of the research team, and potential impact on invasive species management. The research addendum was modified as necessary in response to comments received during the peer-review process. The final document provides a technically detailed description of the research to be completed under this sub-project work plan. The research addendum is on file with the Minnesota Invasive Terrestrial Plant and Pest Center.

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted in December and June of each year. A final report and associated products will be submitted between August 31, 2018 and Nov 30, 2018.

Environment and Natural Resources Trust Fund
Minnesota Invasive Terrestrial Plants and Pests Center
M.L. 2015 Sub-Project Budget



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Sub-Project Manager: Brian Aukema
Organization:University of Minnesota
Sub-Project Budget: \$35,000
Sub-Project Length and Completion Date: 1.5 years, Aug 31, 2018
Date of Report: April 27, 2017

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	Lab-based studies of dispersal ability of gypsy moth larvae				
Capital Expenditures Over \$5,000	\$33,500	\$0	\$33,500	\$33,500	\$33,500
LC-770 servosphere and data acquisition system	\$33,500	\$0	\$33,500	\$33,500	\$33,500
Other	\$1,500	\$0	\$1,500	\$1,500	\$1,500
Quarantine lab rent	\$1,400	\$0	\$1,400	\$1,400	\$1,400
Shiping fees to receive egg masses	\$100	\$0	\$100	\$100	\$100
COLUMN TOTAL	\$35,000	\$0	\$35,000	\$35,000	\$35,000