

M.L. 2016 Project Abstract

For the Period Ending July 30, 2021

PROJECT TITLE: MITPPC Sub-project 3: Genetic Control of Invasive Insect Species: Phase I
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

APPROPRIATION AMOUNT: \$296,655

AMOUNT SPENT: \$296,655

AMOUNT REMAINING: \$0

Sound bite of Project Outcomes and Results

We have demonstrated (in lab cages) a powerful new approach to combat invasive insect pests. Genetically engineered male insects would be released to mate with wild females, who would not have offspring. This can crash a wild population, and it is applicable to any sexually reproducing insect.

Overall Project Outcome and Results

With the overall goal of demonstrating our innovative genetic biocontrol approach in the pest insect Spotted Wing *Drosophila*, we had three specific objectives on this project: (i) demonstrate a proof-of-concept in the model laboratory insect and close cousin to SWD, *Drosophila melanogaster*, (ii) translate what we learned from *D. melanogaster* into the SWD species, and (iii) study the genome sequence of wild SWD so we can precisely design our engineered biocontrol agents to effectively suppress wild SWD populations in Minnesota.

Our outcomes and results for the first objective exceeded project expectations. We succeeded in making the proof-of-concept in *D. melanogaster*, and the engineered insects were 100% incompatible with wild-type flies. We made over a dozen versions. We also added additional genetic control elements to automatically sort the males from females, making the technology more economical to deploy for pest control.

We did not meet our objective two milestones (completing the engineering of SWD), however, we made good progress in that direction. Near the end of the award, we succeeded in making our first transgenic SWD flies, so we should be able to move quickly now in finishing the engineering process.

Our results from the third objective exceeded expectations. While we initially planned to sequence the genome of 20 wild-caught flies, we instead invented a new approach that allowed us to sequence the relevant genes from over 10,000 wild flies. We are using this data in our current engineering efforts with SWD.

This was a high-risk/high-reward project. We were able to overcome a tremendous amount of technical risk on the project so far, and the approach is looking very promising. We plan to continue to make progress towards Objective 2 in our second Phase of this project.

Project Results Use and Dissemination

We have disseminated our results through the normal channels available to academic labs (regional, national, and international conferences and workshops; peer-reviewed publications; patents; etc.). We are most proud of two high-impact publications from this work. The first was published in [Nature Communications](#) in 2020, and the

[second](#) is currently undergoing peer review at a top-ranked journal. We will have at least two additional papers submitted in the next year that stem from this project.

ML 2016, CH 186, Art. 2, Sec. 6a Sub-Project Abstract

For the Period Ending December 31, 2021

PROJECT TITLE: Subproject #4: Dwarf Mistletoe Detection and Management in Minnesota

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: ML 2016, CH 186, Art. 2, Sec. 6a

APPROPRIATION AMOUNT: \$ 433,250

AMOUNT SPENT: \$ 433,250

AMOUNT REMAINING: \$0

Sound bite of Project Outcomes and Results

We were able to identify key considerations for the early detection of the invasive American dwarf mistletoe on jack pine, including different detection methods and the need for field-level biology and identification education for foresters and loggers.

Overall Project Outcome and Results

American dwarf mistletoe is an invasive species that infects and kills jack pine, a native tree species of Minnesota. American dwarf mistletoe is not currently present in Minnesota but has been detected in neighboring Canadian provinces. The goal of our project was to utilize Minnesota's native dwarf mistletoe, eastern spruce dwarf mistletoe (ESDM), to explore options for detection and management. Just like American dwarf mistletoe, ESDM results in mortality for its host tree, black spruce. We tested different types of detection methods. Google Earth was able to detect mortality, but we were unable to determine if mortality was caused by ESDM. Winter sampling resulted in higher potential false positives due to snow cover on tree. Summer sampling provided a clear view of the trees but movement within the stands were more difficult. Summer sampling was also used to explore impact of ESDM on forest ecosystems. ESDM is not a binary variable; lower levels of ESDM in black spruce stand resulted in higher tree species diversity and did not negatively impact regeneration.

With this new insight we explored different methods for predicting ESDM at the individual tree level and at the stand level using multiple different datasets. At the landscape level, we identified areas that have greater potential for impact from ESDM and linked those with stand and environmental variables which can provide foresters and natural resource management tools to prioritize management.

An additional part of our project was conducting focus groups and surveys with foresters and loggers within northern Minnesota. We found variable opinions regarding management and knowledge about ESDM and foresters and loggers identified the need for additional information about mistletoe and more data on results of management. We identified the need for training as a key component when considering early detection for the invasive American dwarf mistletoe.

Project Results Use and Dissemination

Results have been shared through talks at local, regional, and national meetings. We shared results through a special symposium: [Lake States Lowland, Wet, and Floodplain Forests](#). Published papers include:

- [Influence of eastern spruce dwarf mistletoe on stand structure and composition in northern Minnesota](#),
- [The Difficulty of Predicting Eastern Spruce Dwarf Mistletoe in Lowland Black Spruce](#),
- [Results of a Qualitative Assessment of Northern Minnesota Loggers' and Foresters' Perspectives and Experiences with Dwarf Mistletoe in Black Spruce Stands](#), and
- [Results of a Survey of Minnesota Foresters Regarding Knowledge of and Treatment Practices for Dwarf Mistletoe in Black Spruce Stands in Northern Minnesota](#) .