



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2016 Work Plan

Date of Report: July 23, 2019

Date of Next Status Update Report: January 30, 2020

Date of Work Plan Approval: June 7, 2016

Project Completion Date: June 30, 2023

Does this submission include an amendment request? No

PROJECT TITLE: Minnesota Invasive Terrestrial Plants and Pests Center – Phase III

Project Manager: Robert Venette

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Location: Statewide

| | |
|------------------------------|-------------------|
| Total Project Budget: | \$3,750,000 |
| Amount Spent: | \$568,001 |
| Balance: | <hr/> \$3,181,999 |

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Appropriation Language:

\$3,750,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the Invasive Terrestrial Plants and Pests Center to conduct research to prevent, minimize, and mitigate the threats and impacts posed by terrestrial 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. PROJECT STATEMENT:

Funding is requested to accelerate priority research that will protect Minnesota's prairies, wetlands, forests, and agricultural resources from terrestrial invasive plants and pests, including non-native weeds, pathogens, and insects. The Minnesota Invasive Terrestrial Plants and Pests Center (MITPPC) leads research that will provide new tools and techniques to:

- predict and prevent the arrival of new terrestrial invasive threats (e.g., pathway analyses for giant hogweed, soybean rust, and Asian longhorned beetle)
- detect and rapidly respond to new pest arrivals in the state (e.g., early detection tools for Dalmatian toadflax and brown marmorated stinkbug)
- mitigate impacts from well-established threats (e.g., improved integrated pest management for soybean aphid, buckthorn, and oak wilt);
- minimize impacts from measures to control invasive threats (e.g., protection of water quality and wildlife habitat);

The MITPPC was established at the University of Minnesota under ML 2014, Chapter 312, Article 13, Section 44. The MITPPC is administratively located in the College of Food, Agricultural, and Natural Resources Sciences. Research and outreach activities of the Center are conducted in close collaboration with state, federal, local and tribal governments, nongovernmental agencies, the private sector, Extension, and other colleges and universities. The MITPPC leverages existing expertise and infrastructure at the University, including Research and Outreach Centers located across the state, and the Departments of Entomology, Plant Pathology, Agronomy & Plant Genetics, Horticultural Science, Applied Economics, Fisheries Wildlife & Conservation Biology, Bioproducts & Biosystems Engineering, Plant Biology, and Ecology Evolution & Behavior.

The MITPPC relies on a strategic prioritization process to set its research direction. Financial resources are directed towards research that (i) addresses the invasive terrestrial plants and pests which pose the greatest threat to Minnesota and (ii) has the greatest potential to substantially improve management. A more expansive prioritization is nearing completion and will guide the construction of future Requests for Funding.

II. OVERALL PROJECT STATUS UPDATES:

Status as of January 31, 2017:

There has been no spending on this appropriation to-date.

Amendment Request (01/30/2017)

We are requesting to adjust the activity 1 completion dates in order to accommodate a spring 2017 RFP.

Amendment Approved (2/06/2017)

Status as of July 31, 2017:

A Request for Pre-proposals was issued for terrestrial invasive species research in March 2017. This RFP's timing was aligned with the LCCMR RFP in the hopes of streamlining and clarifying the appropriate funding process for terrestrial invasive species research. The MITPPC received 13 pre-proposals, requesting \$6 million. Pre-proposals were received from seven university departments and from three university colleges. Each of the pre-proposals has a deep partnership with an implementing agency or organization. The pre-proposals are currently under internal technical review. Project managers with highly rated pre-proposals will be invited to prepare full proposals. Full proposals will be sent for peer-review by scientific experts outside the University of Minnesota.

Amendment Request (12/15/2017)

The MITPPC is requesting to add a research project to this appropriation. The research proposal, "MITPPC #1, Fungi in Ash Trees: Towards protecting trees from emerald ash borer and new diseases," by Dr. Robert Blanchette, of the UMN Plant Pathology department, seeks a greater understanding of the relationship between fungi associated with emerald ash borer (EAB). This work complements other MITPPC-funded EAB projects and

will provide researchers with much needed data on this relationship with a goal of a potential biocontrol for the invading insect.

Amendment Approved (2/1/2018)

Status as of January 31, 2018:

Currently, the MITPPC has five full proposals under consideration. Two research projects have completed work plans and are to be amended into the MITPPC ML 2016 work plan. One of the projects is in external review; the remaining two are in work plan development. Funding of these five projects are estimated to total \$2.3 million. The balance of this appropriation will be used to fund the ML 2016 January 2018 RFP.

Status as of July 10, 2018:

A second RFP was issued under this appropriation in January 2018. It solicited 12 pre-proposals. Of those, one was not eligible for consideration, as it did not address a priority species. The remaining 11 pre-proposals were reviewed by nine faculty at the University of Minnesota. Three pre-proposals have been invited to develop full proposals. We anticipate external review of those documents to begin later this summer. We anticipate that this process will round out the portfolio of projects funded under the ML 2016 appropriation. Per LCCMR instructions, this report does not contain a narrative update for each project, as they only began work within the last six months.

On April 19, 2018, Robert Venette and Heather Koop met with LCCMR staff to revise reporting procedures for this project. The changes were to be implemented immediately to make reporting as simple as possible. The revised procedures will be tested for 1 year. This document is meant to be the primary vehicle to describe research plans and report significant accomplishments of sub-projects funded by this appropriation. Here will be found a brief narrative of relevant Center-related activities and a table with the current status of each sub-project. Each sub-project will be described with outcomes and activities with corresponding completion dates with enough detail to adequately convey what work is being conducted, why, and the projected impact. A budget for each subproject will be attached to the overall work plan, however budgets for sub-projects will not report on sub-activities. Separate sub-project work plans will not be required. MITPPC will maintain copies of research addenda for each sub-project and make them available to LCCMR staff upon request. Dissemination activity will be reported with each sub-project; overall MITPPC dissemination will be reported in the overall dissemination section of the work plan.

A draft of this report was submitted to LCCMR staff on June 27, 2018. This updated version addresses requested points of clarification.

Amendment Request (8/1/2018)

This update includes three amendment requests. First, MITPPC requests to add three sub-projects to Activity 1 in this work plan:

- “Sub-project 2 Understanding the Benefits and Limitations of Using Goats for Invasive Plant Control” by Dr. Tiffany Wolf for \$445,533
- “Sub-project 3 Genetic Control of Invasive Insect Species: Phase I” by Dr. Michael Smanski for \$296,655
- “Sub-project 4 Dwarf Mistletoe Detection and Management in Minnesota” by Dr. Marcella Windmuller-Campione for \$455,606

These three projects had developed separate sub-project work plans, which were approved formally by LCCMR staff on 2/19/2018 (Wolf), 2/28/2018 (Smanski), and 4/19/2018 (Windmuller-Campione).

Second, we request changes to the structure of this report that affect how research projects supported by MITPPC are described, how research accomplishments are reported, and how budget activity is summarized. With this report, MITPPC will begin using revised budget templates provided by LCCMR staff and a revised format to this document as suggested by LCCMR staff. These changes will be implemented on a trial basis for one year.

Finally, we request the addition to Activity 1 of an additional sub-project, “Sub-project 5: Developing a Spatially Explicit Bio-economic Dispersal Model to Aid with the Management of Brown Marmorated Stink Bug” by Drs. Senait Senay and Terrance Hurley for \$561,348. Pursuant to the administrative changes described above, a separate work plan has not been prepared for this sub-project. A complete, peer-reviewed research addendum for the sub-project is maintained by MITPPC and is available upon request. A synopsis of the project is provided in the updates to Activity 1.

With addition of Subprojects 2-5, the amount of unobligated funding (i.e., the “reserve”) is reduced by \$1,759,142 from \$3,250,000 to \$1,490,858.

Amendment Approved (8/6/2018)

Status as of January 31, 2019: MITPPC activities during this reporting period focused on completing the process of external review, incorporation of comments, and approval of proposal. The addition of three research projects, described below, from this 2018 RFP. Previously approved projects continue to make progress in establishing their research teams, labs, and protocols. Individual project summaries may be found later in this document.

Amendment Request (March 25, 2019)

MITPPC requests a modification of “Sub-project #2, Understanding the benefits and limitations of using goats for invasive plant control.” For this sub-project, the research team would like to decrease personnel by \$5,456 from \$404,888 to \$399,432 with a commensurate increase in professional services from \$8,000 to \$13,456. This change is due to not hiring an undergraduate student during the first year and the increase in plot fees and the subscription price for research software to help with the management of activities one and two.

MITPPC requests the addition to Activity 1 of three research sub-projects to this appropriation. The sub-projects are:

- “Sub-project 6 Management of Invasive Knotweeds” by Dr. Alan Smith for \$579,670
- “Sub-project 7 Improved Detection and Future Management of Leafy Spurge and Common Tansy using Remote Sensing, Mechanistic Species Distribution Models, and Landscape Genomics ” by Dr. David Moeller and Dr. Ryan Runquist for \$422,000
- “Sub-project 8 Using Plants to Control Buckthorn: an Expanded Approach” by Dr. Peter Reich for \$560,000.

These research projects total \$1,561,670. Currently, \$1,490,858 remains in this appropriation. Upon approval of the amendment request, reserves for this appropriation will be \$0. We request to make up the difference of \$70,812 by using reserves from ML 2015, Ch. 76, Art. 2, Sec. 6a for Sub-project 7 Improved Detection and Future Management of Leafy Spurge and Common Tansy using Remote Sensing, Mechanistic Species Distribution Models, and Landscape Genomics.

Pursuant to the administrative changes described above, separate work plans have not been prepared for the three sub-projects. A complete, peer-reviewed research addendum for each sub-project is maintained by MITPPC and is available upon request. A synopsis of each sub-project is provided in the updates to Activity 1.

With this amendment, we also provide budget amounts for each sub-project.

Amendment Approved (4/2/2019)

Status as of July 31, 2019:

The first round of projects (sub-projects 1-5) continued apace with their work. Noteworthy highlights include: Nearly 500 species of fungi in ash trees attacked by emerald ash borer have been identified; some may be new to science (sub-project #1). Only approximately 0.2% of buckthorn seeds that are eaten by goats are viable after passing through a goat's digestive system (sub-project #2).

The second round of sub-projects' child accounts (sub-projects 6-8) were established for work to commence at the beginning of July 2019.

We are not asking for any amendments to these research sub-projects at this time.

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

Status as of July 31, 2022:

Status as of January 31, 2023:

Overall Project Outcomes and Results:

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Accelerate research on high priority terrestrial invasive species

Description:

By using funds from the 2014 General Fund appropriation, the MITPPC conducted a rapid prioritization in the spring of 2015 to identify immediate research needs among state agencies with primary responsibility for the management of terrestrial invasive plants and pests on public and private lands. The resulting Request for Proposals resulted in four projects that were funded under an ML 2014 ENRTF appropriation.

A more expansive research prioritization was initiated in May 2015 to systematically evaluate threats posed by a wider array of terrestrial invasive plants, pathogens, and insects/arthropods. The more expansive prioritization will be used to allocate the remaining research funds from the M.L. 2014 and M.L. 2015 ENRTF appropriations.

Upon the completion of the expansive research prioritization, MITPPC will prepare a request for proposals and work-plans to conduct research to address identified priority invasive species. Proposals will be sent for peer review to ad hoc scientific reviewers in the field of research, which will allow for rapid turnaround of proposals to expedite work to be completed. The ad hoc scientific reviewers will make recommendations to MITPPC's Director on the suitability of the project for funding. Final award decisions will be made with the consent of the Associate Dean for Research and/or the Dean (both College of Food, Agricultural and Natural Resources Sciences, University of Minnesota). A small portion of funds (not to exceed 30% of this allocation) will be held to conduct research on emerging issues that might not have been addressed during the prioritization or to conduct cross-cutting research that addresses more than one priority species.

These selected proposals are to be considered sub-projects with respect to this work plan. Detailed sub-project work plans and budgets will be submitted to LCCMR for review and approval. The details about each sub-project work plan will be included as attachments to this document. Regular activity updates and budget updates will be provided by sub-project leaders and MITPPC to LCCMR. This overarching work plan and budget will be updated accordingly to include general progress of the Center and a synopsis of activities completed by each sub-project. The budget updates for this overall work plan will provide summaries of expenditures (by budget line item) for each sub-project. Detailed sub-project reports and associated budget updates will be prepared by investigators in cooperation with the MITPPC Director and Associate Director. MITPPC will provide LCCMR with updates to this overall work plan and each sub-project as a single packet.

The Center will initiate and/or accelerate coordinated, applied research according to the prioritized list of pest and plant species that threaten Minnesota’s prairies, urban and rural forests, wetlands, and agricultural resources as identified through this assessment process. Depending on the net impacts associated with each species, research may include new control methods including bio-control and technology, development of integrated pest management tools that minimize non-target impacts of control, early detection of and/or rapid response to new threats, and establishment prevention. The Center infrastructure is vital to improving Minnesota’s capacity and response time to preventing and limiting introduction of new terrestrial invasive species. All research projects will include an analysis of any consequences related to the management of prioritized species to the State’s non-target flora, fauna or our soils, water and climate.

Workforce development and training experts in invasive species management is also critical. A core component of each project will be funding of graduate students and postdoctoral associates to work with existing faculty.

Existing faculty with less than 12-month appointments may include in the budget up to 25% of their time in their role as the project leader. Providing salary through these awards will secure faculty time and intellectual effort in the projects, assuring that we are attracting the resources to provide project design, effort, and mentoring of the graduate students and post-docs in their research development. We do not anticipate hiring any new faculty for the projects.

The Center will support multiple projects by research teams, each comprised of a UMN faculty member from one of the participating departments, one graduate student and one postdoctoral associate. Estimated funding per project will be \$180,000-210,000 per year, for three to four years. We expect this to result approximately five projects in two separate phases, depending upon the priority identified by the annual risk assessment planning. It is expected that per project expenses for established invasive species will be higher as compared to prevention strategies.

| Outcome | Completion Date |
|---|------------------------|
| 1. <i>Request for proposals released</i> | March 1, 2017 |
| 2. <i>Initial research projects selected and launched (est. 5 projects, ranging from 3-4 years each)</i> | June 30, 2017 |
| 3. <i>Research findings for projects completed</i> | May 31, 2023 |

Status as of January 31, 2017:

There has been no spending under this appropriation to-date. We are requesting the change in outcome completion dates to accommodate an RFP announcement this spring to better align with LCCMR’s FY 18 RFP.

Status as of July 31, 2017:

A Request for Proposals was issued in March 2017; 13 pre-proposals were received. All of the pre-proposals addressed at least one of the top 15 research species in each taxa (plant, insect, pathogen.) Pre-proposals are currently under internal review.

Status as of January 31, 2018:

The MITPPC is currently in the final stages of the research project deliberation phase. Two projects have workplans ready for LCCMR review; one project is in external review; and the remaining two are completing their workplan development. We anticipate that the five research projects to be amended into the overall MITPPC workplan within the next several weeks.

Status as of July 10, 2018:

This report will no longer provide a separate overview of Activity 1. Because the work plan has one activity, the activity summary is redundant with the overall project status and updates. This section will emphasize accomplishments of sub-projects.

Status as of January 31, 2019:
No longer provided (see above).

Status as of July 30, 2019:
No longer provided (see above).

Activity 1 Sub-Project Synopsis

Sub-project 1: Fungi in ash trees: towards protecting trees from emerald ash borer and new diseases

Project Manager: Robert Blanchette

Description: Fungi play an unclear role in the damage caused by emerald ash borer (EAB). EAB may move fungi that harm trees and contribute to tree decline. Other fungi may attack and kill EAB. Management of EAB to date has focused on the insect itself. This project is meant to find new alternatives to manage EAB by finding and using fungi as biological control agents and/or to keep infested trees healthy by identifying tree-disease-causing fungi. In the course of this project, researchers will also provide the first formal survey in Minnesota for *Hymenoscyphus fraxineus* a fungus that is devastating ash trees in Europe, as part of efforts for early detection of new invasive threats. The goals of this project are to: 1) identify the fungi associated with EAB from sampling hundreds of trees; 2) test canker causing fungi obtained from the galleries for their ability to contribute to dieback and decline of ash, evaluate the role of decay fungi found in the galleries for their potential to cause serious wood degradation and hazardous conditions in ash, and evaluate the detrimental role of canker and wood decay fungi entering EAB wounds in trees before being chemically treated to control the beetle and 3) identify and test entomopathogenic fungi found associated with beetles or galleries for their biocontrol potential.

Summary Budget Information

ENRTF Budget:

\$ 500,000

| Outcomes, Activity 1, Identify fungi associated with EAB and monitor their distribution | Completion Date |
|--|------------------------|
| 1. Assemble preliminary lists of fungi in Minnesota ash trees that are (a) associated with emerald ash borer (EAB) and might kill the insect; (b) associated with EAB and cause tree disease; and (c) not associated with EAB and cause decline diseases. | 12/31/2019 |
| 2. Assemble expanded lists of fungi in Minnesota ash trees that are (a) associated with emerald ash borer (EAB) and might kill the insect; (b) associated with EAB and cause tree disease; and (c) not associated with EAB and cause decline diseases. | 12/31/2020 |
| 3 Provide final list of fungi in Minnesota ash trees that are (a) associated with emerald ash borer (EAB) and might kill the insect; (b) associated with EAB and cause tree disease; and (c) not associated with EAB and cause decline diseases. | 12/31/2021 |
| 4. Assess distributions of fungi in relation to the distribution of EAB and other environmental conditions | 6/30/2022 |
| Outcomes, Activity 2, Identify fungi associated with EAB and monitor their distribution | |
| 1. Determine ability of fungi associated with emerald ash borer to cause disease in live trees | 9/31/2020 |
| 2. Determine the ability of fungi associated with emerald ash borer to rot wood | 12/31/2021 |
| Outcomes, Activity 3, Identify and test entomopathogenic fungi for their biocontrol potential of EAB | |
| 1. Determine ability of isolated fungi to infect and kill emerald ash borer in the laboratory. | 12/31/2020 |
| 2. Determine ability of fungi to kill emerald ash borer in the field | 12/31/2021 |
| 3. Identify the most effective approach for infecting emerald ash borer adults with fungi | 6/30/2022 |

Status as of July 10, 2018: Sub-project is in early phases of organization. No update is required per LCCMR instruction.

Status as of January 31, 2019:

Good progress has been made on all aspects of the project. Samples of ash infested with EAB have been obtained from over 50 sites throughout Minnesota for our studies to better understand the microorganisms associated with the beetle. Cultures have been obtained and we have identified three important groups of fungi residing in EAB larval galleries; canker causing fungi, pioneer species of wood decay fungi, and entomopathogens (pathogens of insects). This work is providing new information on the microbes associated with EAB and the biology and ecology of these organisms. In addition to isolations of beetle galleries, isolations from guts of EAB and frass (excrement) as well as ash bark have been made and cultures obtained. We have also completed the sequencing of the genomes for four fungal isolates from EAB galleries which we have identified to known entomopathogenic species (two *Beauveria* and two *Purpureocillium* isolates). The team has not encountered any obstacles during the investigations and work has exceeded expectations. Outreach activities have included a Midwestern presentation at the Upper Midwest Invasive Species Conference on the “Fungi associated with the Emerald Ash Borer: the role of fungi during ash mortality and finding effective biocontrol agents” (also see Dissemination).

Status as of July 31, 2019:

Good progress is being made on the project, outcome deadlines have been accomplished and research is on track. We have obtained a preliminary list of fungi associated with EAB and continue to expand the list as new identifications are made. From the total of 1,169 isolates, we have 280 that are potential canker causing fungi, 97 wood decay fungi and 94 entomopathogenic fungi. Phylogenetic analyses are being done on fungal groups of interest (decay, canker causing and new species) that need additional characterization. In additional studies, we have also identified fungal isolates from living ash bark and EAB frass. 120 seven foot ash trees (a donation from Schmidt Nursery, Oregon) are being planted in a University field plot for inoculations to test for pathogenicity of the canker forming fungi. Infested logs were placed in rearing chambers and emergence of adults has taken place. Scale up for obtaining more adult beetles is underway. The project team has secured additional support in the form of 500 Gb of free sequencing (~\$7k value) by the US Department of Energy Joint Genome Institute Community Science Program. This will allow a deeper understanding of the fungal and bacterial communities present in the ash-EAB system, including those which aren’t culturable. We are developing additional insect pathogenicity assays that are able to test multiple modes of potential biocontrol including both larval and adult parasitism and accounting for mortality as well as sub-lethal effects that may help suppress EAB populations.

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

Status as of July 31, 2022:

Status as of January 31, 2023:

Final Report Summary:

MITPPC Sub-project 2: Understanding the benefits and limitations of using goats for invasive plant control

Project Manager: Tiffany Wolf

Description: Common buckthorn, *Rhamnus cathartica*, is a common invasive shrub in many parts of Minnesota and is problematic for a number of reasons. Millions of dollars are spent annually in the state to control it. In many areas, labor costs or site accessibility limit the practicality of cut-treat methods of control. As a result, goats have been touted as a management alternative. These generalist grazers can be trained to eat buckthorn.

The long-term effectiveness of the approach has not been tested, nor have the impacts to native plants. In addition, placing goats in shrubby/forested landscapes may expose them to brain parasites, specifically *Parastrongyloides tenuis*. The parasites occur in snails and slugs (intermediate hosts) and can be eaten accidentally while goats graze on vegetation. Geese and other fowl are not susceptible to the parasite, so having fowl graze on snails and slugs may increase the safety of the site for goats. The intent of this research is to evaluate the effectiveness and sustainability of a buckthorn management alternative. The specific goals of this research is to 1) assess the efficacy of goat browsing for invasive species control, 2) determine the effects of goat browsing on native plant abundance and community composition, and 3) assess whether goose grazing can be utilized to lower the incidence of *P. tenuis* in goats by reducing gastropod abundance.

Summary Budget Information

ENRTF Budget:

\$ 445,533

| Outcomes, Activity 1, Use <i>Rhamnus cathartica</i> as a focal species to assess the benefits of goat browsing for invasive species control | Completion Date |
|--|------------------------|
| 1. Quantify effects of goat browsing with respect to both short-term (defoliation) and long-term (population growth rate) metrics. | 10/31/2021 |
| 2. Provide demographic data that can be used to target the most vulnerable life stages of <i>R. cathartica</i> . | 2/28/2022 |
| 3. Disseminate research findings to practitioners through University of Minnesota Extension and peer-reviewed scientific journals. | 2/28/2022 |
| 4. Provide information about the study, including research findings, to the general public and taxpayers through blog posts, social media, and formal journalism. | 2/28/2022 |
| Outcomes, Activity 2, Quantify the effect that goat browsing has on native plant species abundance and diversity | |
| 1. Determine the short-term and longer term effects of goat browsing on native plant abundance and community composition. | 2/28/2022 |
| 2. Disseminate research findings to practitioners through University of Minnesota Extension and peer-reviewed scientific journals. | 2/28/2022 |
| 3. Provide information about the study, including research findings, to the general public and taxpayers through blog posts, social media, and formal journalism. | 2/28/2022 |
| 4. Provide best management practices for practitioners to use when determining which sites are most conducive to management using goat browsing to be distributed through University of Minnesota Extension. | 2/28/2022 |
| Outcomes, Activity 3, Assess whether goose grazing can be utilized as a management strategy to lower the incidence of <i>P. tenuis</i> in goats | |
| 1. Describe <i>P. tenuis</i> prevalence in white tailed deer feces at multiple sites in southern Minnesota as an estimate of <i>P. tenuis</i> risk. | 10/30/2021 |
| 2. Estimate the change in gastropod abundance and diversity as a result of goose grazing. | 10/30/2021 |
| 3. Describe the impact of goose grazing on the incidence of <i>P. tenuis</i> in goats used for invasive plant control. | 2/28/2022 |
| 4. Contribute to the gastropod collections at the Bell Museum, which have gaps in coverage of terrestrial gastropod diversity. | 10/30/2021 |
| 5. Disseminate research findings to ungulate owners through University of Minnesota Extension. | 2/28/2022 |
| 6. Publish results in peer-reviewed scientific journals. | 2/28/2022 |

Status as of July 10, 2018: Sub-project is in early phases of organization. No update is required per LCCMR instruction.

Status as of January 31, 2019:

We embarked on our first field season this year, examining the effects of goat browsing on the invasive shrub common buckthorn and native plant community response. Preliminary results show that goats most heavily defoliate buckthorns of intermediate size, largely ignoring small plants and being unable to reach the canopies of buckthorns that are 4+ meters tall. Goats also killed a significant proportion of buckthorn germinants and seedlings through trampling. Additionally, when goats ate buckthorn berries, only a very small percentage of seeds passed through their digestive tracts intact.

We also prepared for experimental work next year that will examine whether co-grazing goats with ducks and geese reduces the exposure of the goats to a potentially deadly parasite, meningeal worm. This preparation included exploring which methods for gastropod and deer pellet collection would be most appropriate in assessing the level of meningeal worm infection risk on the landscape.

Preliminary results of our work have been disseminated through a poster presentation at the University of Minnesota, College of Veterinary Medicine's Points of Pride research symposium, as well as outreach presentations to the public and social media posts.

Status as of July 31, 2019:

Our major accomplishment over the winter was completing a study on viability of common buckthorn (*Rhamnus cathartica*) seeds following goat digestion. While stakeholders are enthusiastic about using goats for buckthorn control, there is concern about goats potentially spreading buckthorn through "endozoochory." Encouragingly, we found that only 2% of buckthorn seeds survived goat digestion, and of those 2%, only 11% were viable, compared to 63% viability in control (undigested) seeds. These numbers align with values from the scientific literature, where we found that seeds >4mm in length (buckthorn is ~5 mm) have low survival of goat digestion. Overall, it appears that goats present low risk for dispersing buckthorn seeds between sites. Our findings also provide a rule of thumb for other plant species based on seed length, an easy to measure characteristic. We will soon submit a manuscript on these results to a peer-reviewed journal with a large land manager audience. Other accomplishments include compiling data for a meta-analysis on the use of livestock for plant management, performing preliminary analyses of data from last field season, conducting late-winter deer pellet surveys, preparation of a land manager survey, setting up ducklings with 4H student rearers, and drawing blood from goats to examine their meningeal worm antibody levels. A minor obstacle is that the immunological test for meningeal worm exposure is still in development, so serum samples will be archived until the test is available. Finally, Dr. Marchetto presented on meningeal worm and our study to the UMN Vet School's small ruminant club.

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

Status as of July 31, 2022:

Status as of January 31, 2023:

Final Report Summary:

MITPPC Sub-project 3: Genetic Control of Invasive Insect Species: Phase I

Project Manager: Michael Smanski

Description: Spotted wing drosophila, *Drosophila suzukii*, is devastating small fruit producers in Minnesota. Growers are turning to the use of broad spectrum insecticides applied on a calendar basis to control the insect. The result has been a dramatic increase in insecticide use and an equally sharp rise in production costs. This research is meant to explore a revolutionary management alternative, genetic biocontrol. The project builds upon previous research that leverages the latest genetic tools to engineer 'species-like' barriers to reproduction. It is anticipated that this approach will offer a safe, robust, and easily scalable control method that directly addresses several challenges of sterile insect techniques (SITs). The goal of Phase I is to complete a proof of

concept in a closely related model insect, *Drosophila melanogaster*, and transition the technology to *D. suzukii*, and perform a genome-wide analysis of sequence diversity in invasive *D. suzukii* populations.

Summary Budget Information

ENRTF Budget:

\$ 296,655

| Outcomes, Activity 1, Proof of concept of engineering approach in the model insect, <i>D. melanogaster</i> | Completion Date |
|--|------------------------|
| 1 Completion and validation of <i>D. melanogaster</i> synthetic species | 3/30/2018 |
| 2 Completion and validation of <i>D. melanogaster</i> strains with female lethality and species like barriers to reproduction (= self-sorting incompatible male system [SSIMS]). | 6/30/2018 |
| 3 Testing the biocontrol insects in laboratory mating experiments to learn how effective the technology is in flies. | 3/31/2019 |
| Outcomes, Activity 2, Engineer SSIMS strains of invasive agricultural pest <i>D. suzukii</i> | |
| 1 Test the engineered <i>D. suzukii</i> in controlled laboratory mating experiments to learn if the applied insect biocontrol agent works as well as our model species. | 2/28/2020 |
| 2 Identification of additional target genes to make the technology more effective | 2/28/2020 |
| Outcomes, Activity 3, Assessment of genetic diversity in local seasonal populations of <i>D. suzukii</i> | |
| 1 We will demonstrate that new state-of-the-art genome sequencing technologies can provide high-quality data from a single animal. | 8/1/2018 |
| 2 Sequence the genomes of 20 wild-caught <i>D. suzukii</i> to learn the location of the identical regions that can be targeted by our technology to maximize its efficacy. | 8/30/2019 |

Status as of July 10, 2018: Sub-project is in early phases of organization. No update is required per LCCMR instruction.

Status as of January 31, 2019:

We have made significant progress towards developing a first-of-its-kind biocontrol approach to combat Spotted Wing Drosophila (SWD), using Sterile Male Accelerated Release Technology (SMART) flies. In the past 6 months, we have demonstrated that all of the engineered genetic components are functional in a closely related laboratory species of fruit fly. We have developed protocols for creating and rearing transgenic SWD. Lastly, we have performed an environmental analysis of the DNA sequence diversity in wild SWD. From this we have learned that early season flies from fruit farms located 100+ miles apart are similar genetically and could be controlled with the same engineered SMART flies. We are on schedule to meet our two year project goals.

Status as of July 31, 2019:

In the past 15 months, we have demonstrated that all of the engineered genetic components are functional in a closely related laboratory species of fruit fly (Activity 1). We are several weeks out from combining these together in a single strain (through controlled breeding) to create our first SMART fly. We have developed protocols for rearing SWD, collecting eggs, and performing recombinant DNA microinjections (Activity 2). We have not yet succeeded in making our first transgenic SWD, but we have reached out to experts in this area and have identified elements of our protocol that can be improved. Lastly, we have performed an environmental analysis of the DNA sequence diversity in wild SWD (Activity 3). From this we have learned that early season flies from fruit farms located 100+ miles apart are similar genetically and could be controlled with the same engineered SMART flies. We have also developed a method to obtain whole genome sequence data from a single fly. We will leverage this ability in the future to characterize any genetic resistance that we encounter during pre-field or field trials.

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

Status as of July 31, 2022:

Status as of January 31, 2023:

Final Report Summary:

MITPPC Sub-project 4: Dwarf Mistletoe Detection and Management in Minnesota

Sub-Project Manager: Marcella Windmuller-Campione

Description: Dwarf mistletoe, *Arceuthobium americanum*, is a jack pine-killing, parasitic plant that does not yet occur in Minnesota but is as close as Manitoba. Once it becomes widespread in a stand, it is nearly impossible to control. However, given the relatively limited dispersal capacity of the plant, eradication seem highly feasible if infection can be detected early. This project is designed to assess the sensitivity of aerial detection methods to detect small infestations and to evaluate workable silvicultural methods to eradicate it. As the real species of interest does not occur in Minnesota, this project uses the closely related Eastern dwarf mistletoe, *A. pusillum*, as a surrogate to test the methods. The primary goal of the proposed project is to increase detection and management options for dwarf mistletoe. Specific objectives are to: 1) develop efficient and effective detection methods, 2) assess the effectiveness of current management policies and the cost of implementation, and 3) revamp a spatially based model of mistletoe spread and volume loss in dwarf mistletoe impacted forest systems

Summary Budget Information

ENRTF Budget:

\$ 455,606

| Outcomes, Activity 1, Develop efficient and effective detection methods for dwarf mistletoe | Completion Date |
|--|------------------------|
| 1. Identify and sample 40 black spruce stands prior to harvest | 6/30/2020 |
| 2. Protocol and efficiency rating for sampling <i>A. pusillum</i> developed | 1/31/2021 |
| 3. Analysis of type of vector of dwarf mistletoe analyzed | 4/30/2021 |
| 4. BHM (Bayesian Hierarchical Model) for mistletoe detection validated | 7/31/2021 |
| Outcomes, Activity 2, Assessment of <i>A. pusillum</i> treatment methods and their implementation effectiveness | |
| 1. Identify 30 black spruce stands | 9/30/2018 |
| 2. Forester and logger survey designed and administered | 6/30/2019 |
| 3. Field sampling of 30 sites completed | 9/30/2020 |
| 4. Data analyzed and shared from survey and field sampling | 12/31/2020 |
| Outcomes, Activity 3, Develop a detection and eradication plan for dwarf mistletoe in jack pine stands in Minnesota | |
| 1. Formation of <i>A. americanum</i> steering group composed of scientists, practitioners, and forest health specialists from Minnesota and Manitoba | 12/31/2018 |
| 2. Regular meeting of the steering group to aid in the development of the management plan | 11/30/2021 |
| 3. Management plan and risk map completed | 11/30/2021 |

Status as of July 10, 2018: Sub-project is in early phases of organization. No update is required per LCCMR instruction.

Status as of January 31, 2019:

The project has made progress in all three activities. Activity 1 highlights include the development, testing, and sampling using a ground-based sampling design for dwarf mistletoe on 11 different forest stands. This resulted in more than 3,000 tree samples! Preliminary results were presented at the National Society of American Foresters meeting in fall 2018. For Activity 2, sampling of pre-harvest black spruce stands is on-going. Currently seven stands have been sampled with additional sampling dependent on weather conditions. The second part of Activity 2 includes using a mix of interviews, focus groups, and surveys of loggers and foresters to understand

current knowledge and management of dwarf mistletoe. Ten interviews with loggers were completed. The use of interviews of loggers is a modification from the originally proposed mail survey due to concerns over survey fatigue with loggers as a result of being recently surveyed for other studies. The main accomplishment in Activity 3 is the re-establishment of the dwarf mistletoe network within the Great Lakes region both in the US and Canada. We have established contacts with natural resource managers in Manitoba. We are fortunate to have great working partnerships with state, private industrial, and county land management agencies. This has allowed us to stay on progress. The main limitation which is out of our control will be weather. If winters are mild, there will be reduced harvesting in black spruce stands. This may delay our ability to collect post-harvest data.

Status as of July 31, 2019:

Data from the first field season is actively being summarized. Preliminary results on the sampling design, structure, composition, and implications of different levels of eastern spruce dwarf mistletoe was presented at the Heart of the Continent Workshop in Duluth, MN which includes Minnesota and Canadian natural resource managers (Activity 1 & 3). Stands have been selected for sampling for summer 2019 to continue testing detection methods (Activity 1). Nine black spruce stands were sampled prior to harvest during the winter of 2018/19 (Activity 2). All in-person interview with loggers have been completed (n=10) and analysis is on-going. Three focus groups were conducted in Bemidji and Duluth with loggers (n=34). Initial feedback from the focus group includes interest in potential future presentations on dwarf mistletoe. Analysis is on-going. An online survey was developed and delivered to federal, state, county, industry, and tribal foresters (n=194). This was done in partnership with supervising staff in multiple agencies to try to ensure a greater response rate. After first wave, response rate is 41%. (Activity 2). Canadian scientists have expressed interest in discussing and collaborating on jack pine dwarf mistletoe (Activity 3).

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

Status as of July 31, 2022:

Status as of January 31, 2023:

Final Report Summary:

MITPPC Sub-project 5: Developing a spatially explicit bio-economic dispersal model to aid with the management of brown marmorated stink bug

Project manager: Senait Senay

Description: The brown marmorated stink bug, *Halyomorpha halys*, feeds on many economically important plants (e.g., apples, soybean, corn, and more than 300 other plant species). The insect was first detected in Minnesota in 2010, but it has not yet invaded everywhere. Previous research supported by MITPPC is meant to characterize where temperatures might allow the insect to build to large densities currently and under future weather conditions. This project builds on those efforts by developing tools to forecast where the species might move (i.e., disperse) next from centers where it is known to be established. These tools will also be used to measure the economic value of intensifying management efforts around these infested locations to slow spread and protect plants. This project supports MITPPC's goals to provide managers with better tools to know the future distribution of invasive pests and to evaluate the socioeconomic impacts of invasive species and their management alternatives. The specific objectives of this project are to 1) develop a high resolution, spatially explicit, agent-based dispersal model for *H. halys*, 2) develop a bio-economic modeling framework to assess economic resource vulnerability to the risk of *H. halys* invasion, and 3) measure the economic value of this new information by comparing how management effectiveness compares with and without this information.

| Outcomes, Activity 1, Develop a high resolution, spatially explicit, agent-based dispersal model for <i>H. halys</i> | Completion date |
|---|------------------------|
| 1. Dataset and documentation on local and long distance <i>H. halys</i> dispersal parameters from existing literature and data calibrated for Minnesota. | 10/30/2018 |
| 2. Harmonized gridded landscape layer representing the spatially heterogeneous pattern of <i>H. halys</i> survival generated from a spatial analysis of various <i>H. halys</i> suitability related geographic information. | 3/2/2019 |
| 3. High-resolution selectively recoded survival landscape dataset generated by employing high-resolution remotely sensed data to encode configuration of landscape features within urban and semi-rural high-suitability hotspot areas of the landscape data from output 2 above. | 7/30/2019 |
| 4. New flight distance data generated via a tethered-flight experiment. | 08/30/2020 |
| 5. Parallelized-MDiG and a spatially-explicit, Minnesota-wide <i>H. halys</i> dispersal model specification and simulation for years 2010-2050. | 12/31/2020 |
| Outcomes, Activity 2, Develop a bio-economic modeling framework to assess economic resource vulnerability to the risk of <i>H. halys</i> invasion | |
| 1. A spatially explicit compilation of data on the value of rural and urban resources susceptible to <i>H. halys</i> invasion risk, | 12/28/2018 |
| 2. Standardized data on the cost of various <i>H. halys</i> prevention, containment, and mitigation techniques. | 1/31/2019 |
| 3. Data on the impact of invasion produced from literature review and incorporated into the bio-economic modelling framework for undertaking risk analysis and determining efficient management trade-offs. | 11/30/2019 |
| 4. Modifications to the MDiG program so that it incorporates economic risk analysis and allows for multi-scenario modeling. | 12/30/2020 |
| 5. Generation of selected invasion-intervention scenarios, including efficient management scenarios that can be used to inform decision-makers choices regarding prevention, containment, and mitigation of <i>H. halys</i> invasion. | 3/28/2021 |
| Outcomes, Activity 3, Undertake a Value of Information (Vol) analysis by comparing the predicted resource outcomes of the proposed detailed <i>H. halys</i> invasion-intervention scenarios with results from less parametrized invasion and intervention scenarios | |
| 1. Full scale invasion-intervention scenario simulations from Activity 1 and 2 across the entire time (2010-2050) and spatial extent (Minnesota) of varying spatial resolution and model specifications. | 6/30/2021 |
| 2. Evaluate the value of information of selected modeling components to characterize the benefits gained from utilizing higher-resolution landscape information and incorporating complex dispersal assumptions in the modeling framework. | 8/25/2021 |
| 3. Results formatted and stored at the IAA platform GEMShare for easy access and further analysis. | 9/15/2021 |

Status as of July 10, 2018: No activity. This project has not yet been approved by LCCMR staff.

Status as of January 31, 2019:

Sub-project is in early phases of organization. No update is required per LCCMR instruction. Project was approved by LCCMR staff on August, 1, 2018.

Status as of July 30, 2019:

The project commenced in October 2018. We held a half-day project kick-off meeting on February 22, 2019. Project team members from UMN, MITPPC and collaborators from MDA and MNDOT attended the meeting.

Researchers presented their proposed methods. There were Q & A sessions to address any concerns by stakeholders. The meeting created a common understanding among stakeholders about project outcomes. One data access pipeline is completed and two are under development. Out of the six major datasets that are required to build the Minnesota-wide BMSB survival likelihood data-layer, three are already developed. We collected preliminary empirical BMSB dispersal distance data through the flight experiment being undertaken at the UMN. We acquired and standardized four out of the eight datasets needed for modeling human mediated BMSB dispersal (Activity 1). Preliminary spatial data on prioritized crop hosts of BMSB is being processed. We have completed literature review on BMSB host plants of economic importance for Minnesota. Data on the cost of various BMSB treatment options is being compiled (Activity 2). To facilitate efficient comparisons of different invasion scenarios, developing an easily deployable version of the modelling platform is necessary. To that end, a Docker environment is being set up to containerize MDiG the individual based model that is used to build the dispersal platform (Activity 3).

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

MITPPC Sub-project 6: Management of Invasive Knotweeds

Sub-Project Manager: Alan Smith

Description:

Highly destructive knotweeds are beginning to invade Minnesota residential, industrial and natural areas. Their escape from cultivation is facilitated by hybridization and seed production, previously thought insignificant. Knotweeds are challenging to manage requiring several years of treatment. Their well-known resiliency triggers excessive and unnecessary herbicide applications and ecological disturbances during physical removal. Lack of species identification, carbohydrate use patterns and optimal herbicide use results in unnecessary environmental damage and spread to new sites. Knotweed taxonomy is confusing and confounded by frequent interspecific and intergeneric hybridization among the *Polygonaceae*. Knowing the genetic makeup and species composition of knotweed populations in Minnesota is crucial to its management because knotweed species respond differently to control measures. The lack of knowledge on Minnesota knotweed invasion is conspicuous and leading to an intractable knotweed invasion necessitating costly removal, loss of biodiversity, degradation to the environment and damage to property. Our goal is to provide essential information to understand and manage the knotweed invasion. Activity 1 will determine the genetic structure, species and extent of hybridization and introgression in knotweeds. These data provide essential information on knotweed composition and mode of spread in Minnesota. Activity 2 will determine herbicide sensitivity and potential resistance, measure key invasive phenotypes (reproductive strategy; sexual vs. clonal, biomass allocation and adventitious rooting efficiency) for a Genome-Wide Association Study (GWAS) of invasiveness. These data are fundamental to knotweed management, ultimately reducing further spread and economic and environmental damage by laying the groundwork to understand the evolution of knotweed invasiveness.

Summary Budget Information

ENRTF Budget:

\$ 579,670

| Outcomes, Activity 1 Determine the genetic structure, species composition, and extent of hybridization and introgression in knotweeds. | Completion Date |
|--|-----------------|
| 1. Sample knotweed populations (U.S., European, Native Japanese and other Polygonaceae members as likely sources of introgression), assessed by DArT-seq to determine the species of <i>Fallopia</i> and genetic composition in Minnesota populations. | 12/30/2020 |
| 2. Determine level of diversity through genetic structure analysis among and within populations and identify species or hybrids. | 10/31/2022 |

| | |
|--|------------|
| 3. Measure the level of interspecific and intergeneric introgressions within the Polygonaceae in Minnesota knotweed populations. | 10/31/2022 |
| Outcomes, Activity 2: Determine herbicide sensitivity and potential tolerance, measure key invasive phenotypes (reproductive strategy; sexual vs. clonal, biomass allocation and adventitious rooting efficiency) for recommending best management practices and a Genome-Wide Association Study of invasiveness. | |
| 1. Determine male and female fertility of individuals through morphological analysis, controlled crosses and measured seed set. | 12/31/2021 |
| 2. Characterize seed viability of wild-collected and controlled cross-produced seed, and seedbank dynamics of select Minnesota populations. | 11/31/2022 |
| 3. Determine asexual vs. sexual spread. | 10/31/2022 |
| 4. Optimize herbicide use and measure herbicide sensitivities. | 6/30/2023 |
| 5. Genome-Wide Association Study of genotype, genetic structure associated with intergeneric and interspecific introgressions vs. phenotypes associated with invasiveness (reproduction strategy, biomass allocation, carbohydrate distribution and herbicide sensitivities). | 8/31/2022 |
| 6. Characterize nonstructural storage carbohydrates and then determine their distribution in crowns and rhizomes, and seasonal fluctuations. | 6/30/2023 |
| 7. Recommend best practices for management integrating genotype and phenotype measurements. | 6/30/2023 |

Status as of July 31, 2019:

This sub-project was approved on April 2, 2019 and is in the early phases of organization. No update is required per LCCMR instruction.

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

Status as of July 31, 2022:

Status as of January 31, 2023:

Final Report Summary:

MITPPC Sub-project 7: Improved Detection and Future Management of Leafy Spurge and Common Tansy using Remote Sensing, Mechanistic Species Distribution Models, and Landscape Genomics

Sub-project managers: David Moller and Ryan Briscoe Runquist

Description: Predicting future range of invasive species is critical to management and control efforts. Species Distribution Models (SDMs) are developed to predict which geographic areas are under current risk of invasion and how distributions will expand or contract under climate change. Traditional SDMs are constructed only from environmental data and often underperform because they fail to account for how population demography and functional traits vary with environmental variables across geographic ranges. Here, we propose to develop mechanistic and process-based SDMs in order to provide fine-scale predictions of current and future distributions of two invasive species (leafy spurge and common tansy) that are widespread across much of the northern tier of the United States but considerably less common to the south. We will take a novel approach where we use remote sensing to gather demographic information on each species across MN. Publicly-available multi- and hyper-spectral satellite images will be analyzed to quantify abundance and population growth over the last 18 years. Those data will be used to develop process-based SDMs. We will also use manipulative controlled environmental experiments to assess population differentiation in ecologically-important traits across the region and determine critical thresholds that limit performance. Those data will be used to construct

mechanistic SDMs. Finally, we will use landscape genomics to assess fine-scale population structure and patterns of dispersal across the region using low-cost, high resolution sequence data. Together, these integrative datasets will provide detailed predictions of habitat under current and future climates and inform near- and long-term management strategies.

This project is co-funded with ML 2015, Ch. 76, Art. 2, Sec. 6a, with \$70,812 from ML 2015 and the balance of \$351,888 from ML 2016, Ch. 186, Art. 2, Sec. 6a.

| Summary Budget Information | ENRTF Budget (ML 2016, Ch. 186, Art. 2, Sec. 6a) \$351,188 | ENRTF Budget (ML 2015, Ch. 76, Art. 2, Sec. 6a): \$70,812 | Total \$422,000 |
|-----------------------------------|---|--|----------------------------|
|-----------------------------------|---|--|----------------------------|

| Outcomes, Activity 1 Remote sensing and machine learning to gather environmental, population, and demographic data | |
|--|------------------|
| 1. Gather remotely sensed environmental data from publicly-available sources | 12/13/2019 |
| 2. Develop classifier using DL and remotely-sensed data to detect leafy spurge | 12/31/2020 |
| 3. Gather demographic data on leafy spurge populations identified by classifier | 6/30/2021 |
| 4. Develop classifier using DL and remotely-sensed data to detect common tansy | 6/30/2021 |
| 5. Gather demographic data on common tansy populations identified by classifier | 12/31/2021 |
| 6. Validate classification model and demographic data through field surveys | 6/30/2022 |
| Outcomes, Activity 2: Common garden experiments to assess niche thresholds and trait differentiation among populations | |
| 1. Collect seeds for leafy spurge and common tansy from across range | 12/31/2019 |
| 2. Conduct growth chamber experiments on leafy spurge seeds at varying temperatures to assess germination niche | 6/30/2020 |
| 3. Conduct growth chamber experiments on leafy spurge juveniles at varying temperatures to assess first year emergence | 6/30/2021 |
| 4. Conduct growth chamber experiments on leafy spurge juveniles and adults at varying temperatures to assess relative growth rate, reproductive allocation, and biomass allocation (above- and below-ground) | 12/31/2021 |
| 5. Conduct growth chamber experiments on common tansy seeds at varying temperatures to assess germination niche | 6/30/2021 |
| 6. Conduct growth chamber experiments on common tansy juveniles at varying temperatures to assess first year emergence | 6/30/2021 |
| 7. Conduct growth chamber experiments on common tansy juveniles and adults at varying temperatures to assess relative growth rate, reproductive allocation, and biomass allocation (above- and below-ground) | 12/31/2021 |
| Outcomes, Activity 3 Build traditional mechanistic and process based distribution models | |
| 1. Build traditional SDMs (Maxent and Boosted Regression Trees) of leafy spurge | 12/31/2020 |
| 2. Build traditional SDMs (Maxent and Boosted Regression Trees) of common tansy | 12/31/2020 |
| 3. Build process-based SDMs of leafy spurge | 12/31/2021 |
| 4. Build process-based SDMs of common tansy | 6/30/2022 |
| 5. Build mechanistic SDMs of leafy spurge | 6/30/2022 |
| 6. Build mechanistic SDMs of common tansy | 6/30/2022 |
| Outcomes, Activity 4 Using landscape genomics to infer major dispersal pathways and sources of new infestations | |
| 1. Tissue collection and extraction | 12/31/2020 |
| 2. Enzyme optimization for sequencing | 6/30/2021 |
| 3. Sequencing and analysis of data within a spatial framework for leafy spurge | 12/31/2021 |
| 4. Sequencing and analysis of data within a spatial framework for common tansy | 6/30/2022 |

| | |
|---|-----------|
| 5. Final integrated report that summarizes current and future potential distributions of common tansy and leafy spurge complete | 9/30/2022 |
|---|-----------|

Status as of July 31, 2019:

This sub-project was approved on April 2, 2019 and is in the early phases of organization. No update is required per LCCMR instruction.

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

Status as of July 31, 2022:

Status as of January 31, 2023:

Final Report Summary:

MITPPC Sub-project 8: Using Plants to Control Buckthorn: an Expanded Approach

Sub-project manager: Peter Reich

Description: European buckthorn (*Rhamnus cathartica*) is an invader of woodlands throughout eastern North America. Current control methods are costly and offer little-to-no long-term benefit due to rapid buckthorn recolonization after removal. Preliminary results from ongoing experiments around Minneapolis/Saint Paul established under the MITPPC-funded Cover It Up! project suggest that densely revegetating woodlands can reduce buckthorn recolonization by blocking at least 96% of incoming light. Within the two year duration of those experiments, this level of shading was achieved using dense, costly plantings of native shrubs. It remains unclear whether other planting treatments or lower-cost seeding treatments can achieve this level of shading and associated buckthorn suppression, and under which contexts revegetation will most effectively suppress buckthorn. Here, we propose to leverage and expand on Cover It Up! to discover how revegetation can synergize with other management practices to help suppress buckthorn over longer time frames, at lower cost, and more widely through the state. Activity 1 extends the aforementioned experiments to evaluate the ability of slow-growing native perennial plants (still immature after two years) to suppress buckthorn and examine how herbicide, deer and fire management may interact with revegetation to strengthen buckthorn suppression. Activity 2 investigates new methods to cost-effectively establish dense, suppressive shrub cover from seed, in comparison with traditional low-density bare-root plantings. Activity 3 expands the experimental network to citizen scientists, to evaluate the performance of revegetation seed mixtures in diverse environments across Minnesota. If effective, the revegetation treatments designed and tested here can serve as a template for managers throughout Minnesota, potentially resulting in significant cost and labor savings and improving the health of woodlands by excluding invaders, reducing herbicide applications, and increasing forest understory plant diversity.

Summary Budget Information

ENRTF Budget:

\$ 560,000

| | |
|---|------------|
| Outcomes, Activity 1 Revegetating after buckthorn removal as a component of integrated management strategies to suppress re-invasion over the long term | |
| 1. Characterize and relate fuel loads, fire behavior, and buckthorn performance | 12/31/2021 |
| 2. Herbicide applications | 9/1/2021 |
| 3. Annual censuses of performance of buckthorn, planted species, and other native plants | 10/1/2022 |
| 4. Statistical analyses and publication-ready manuscripts | 12/31/2022 |
| Outcomes, Activity 2. Scaling up shrub revegetation using cost-effective direct seeding and low-density planting. | |
| 1. Sites identified and pre-seeding and seeding treatments imposed | 12/1/2019 |

| | |
|---|------------|
| 2. Census performance of buckthorn, seeded species, and other native plants | 10/1/2022 |
| 3. Statistical analyses and publication-ready manuscripts | 12/31/2022 |
| Outcome, Activity 3 Exploring revegetation efficacy in diverse Minnesota environments | |
| 1. Develop web portal for volunteer data submission and associated website | 6/1/2020 |
| 2. Participants are registered and have received training and experimental supplies | 6/1/2020 |
| 3. Participant submission of data complete | 10/1/2022 |
| 4. Statistical analyses and publication-ready manuscript completed | 12/31/2022 |

Status as of July 31, 2019:

This sub-project was approved on April 2, 2019 and is in the early phases of organization. No update is required per LCCMR instruction.

Status as of January 31, 2020:

Status as of July 31, 2020:

Status as of January 31, 2021:

Status as of July 31, 2021:

Status as of January 31, 2022:

Status as of July 31, 2022:

Status as of January 31, 2023:

Final Report Summary:

IV. DISSEMINATION:

Description:

Findings will be shared with agencies and citizen groups so that public information and decision making is based on the best available science. Updates on progress and research results will be disseminated through University of Minnesota, College of Food, Agricultural, and Natural Resource Sciences, and College of Biological Sciences via websites, social media, and publications. Media releases will also be used when warranted. Additionally, findings will be presented at local and national conferences and via peer-reviewed publication and student theses.

Status as of January 31, 2017:

There has been no activity under this appropriation to-date.

Status as of July 31, 2017:

There has been no activity under this appropriation to-date.

Status as of January 31, 2018: For a description of dissemination by the MITPPC on the ML 2014, 2015, and 2016 appropriations may be accessed in the ML 2014 workplan.

Status as of July 10, 2018: For a description of dissemination by the MITPPC on the ML 2014, 2015, and 2016 appropriations may be accessed in the ML 2014 workplan.

Status as of January 31, 2019:

The following presentations were made by sub-project research teams funded under this appropriation:

(Sub-project 1)

- Held, B.W., A.J. Cotton, K.E. Bushley and R.A. Blanchette. 2018. Fungi associated with the Emerald Ash Borer: the role of fungi during ash mortality and finding effective biocontrol agents. Proceedings of Upper Midwest Invasive Species Conference, October 15-18, Rochester, MN.

(Sub-project 2)

- Meet and greet with the goats at Indian Mounds park in St. Paul (June 16, 2018): Presented information about our project to members of the public during event organized by St. Paul Parks and Recreation.

- University of Minnesota College of Veterinary Medicine Points of Pride presentation (Oct. 10, 2018): Presented a poster with preliminary results from our first field season.
- Tech Savvy at St. Cloud State (Oct. 27, 2018): Presented information about parasite transmission, including that of meningeal worm, to junior high girls using live outreach snails. The event included activities that simulated parasite transmission under different scenarios.
- Informational meeting at Dakota County Extension office for 4-H members (Nov. 13, 2018): Informed 4-H members about our project and recruited help with raising our poultry for the coming field season.

(Sub-project 3)

- “Three Healthtech Teams Win Big at Sixth Walleye Tank” Rochester Rising.
<http://rochesterrising.org/main/three-healthtech-teams-win-big-at-sixth-walleye-tank>
- “U of M biologists ‘hard-wiring’ male sterility in mosquitoes to lower the risk of Zika” MinnPost.
<https://www.minnpost.com/twin-cities-business/2018/08/u-m-biologists-hard-wiring-male-sterility-mosquitoes-lower-risk-zika/>

(Sub-project 4)

- Contact with all collaborators on the project to inform them of the successful project award (April 2018) and to begin reaching out about sites, surveys, and the collaboration network. Contact include
 - State: MN DNR & MLEP
 - Private Industrial: UPM Blandin & Molpus
 - County: Itasca, Koochiching, and St. Louis County
- Presentations
 - Skay, R., Windmuller-Campione, M., Anderson, B., & Russell, M. (2018). *Black Spruce Alternative Silviculture Methods and Dwarf Mistletoe In Minnesota*. SAF National Convention. October 5th, 2018. Portland, OR. **** **Funding to attend conference not through MITPPC**
 - Skay, R. (2018). *Black Spruce Alternative Silviculture Methods and Dwarf Mistletoe In Minnesota*. Natural Resources Science and Management Graduate Student Seminar. October 24th, 2018. St. Paul, MN.
 - Windmuller-Campione, M. (2018). *Status of Current Silvicultural Collaboration with MN DNR*. MN DNR Annual Winter Silviculture Meeting. December 12th, 2019. Cloquet, MN. (Invited presentation).
- Social Media Post
 - One Instagram post on the Silva Lab Instagram page about sampling (<https://www.instagram.com/p/Bq0apxAh1Kq/>)

Status as of July 31, 2019:

(Sub-project 1)

- No activity during this reporting period.

(Sub-project 2)

Presentations:

- Dr. Marchetto presented on meningeal worm and to the UMN Vet School’s small ruminant club. She also presented information about our study to the public at the Germanic American Institute’s German Days on June 8. We worked with 4H families to rear our ducklings.
- Dr. Marchetto gave feedback for the Science of Agriculture Challenge to a group of students at the Dakota County Extension doing a project on backyard chickens.

Publications:

- A manuscript about the effects of goat digestion on common buckthorn seed recovery and viability has been submitted to the Natural Areas Journal.

(Sub-project 3)

Presentations:

- This work was presented as part of the Data Needs Assessment for Self-Limiting Genetic Biocontrol Workshop at the National Academy of Sciences in May 2019.
- It was also presented at the MN DNA Workshop on Genetic Biocontrol in June 2019.
- A staff member (soon to be PhD student) Nate Feltman presented a poster on this research at the Genome Writer's Guild Conference in June 2019.

(Sub-project 4)

Presentations:

- [Workshop: Dwarf Mistletoe on Black Spruce: Practical Management Options](#). Held on Wednesday May 15, 2019 in International Falls, MN. Sponsored by the Sustainable Forests Education Cooperative and Minnesota Logger Education Program. 39 attendees of loggers and natural resource professionals. Several members of this project team provided presentations, including F. Baker and M. Russell. Photos of the workshop [can be found here](#).
- Windmuller-Campione, M., Skay, R., Russell, M., (2019). Influence of eastern spruce dwarf mistletoe on structure and composition of black spruce forests in northern Minnesota. Hearts of the Continent's Science Symposium. Duluth, MN. April, 4th 2019.
- Baker, F. (2019). Dwarf mistletoe fun facts. Project Fact Sheet.

(Sub-project 5)

Presentations:

- *Senait D. Senay presented the proposed BMSB dispersal platform on the IAA 4.0 GEMS meeting (<https://agroinformatics.org/>) on May 29, 2019.*

- (Sub-project 6)
No activity during this reporting period.

(Sub-project 7)

- No activity during this reporting period.

(Sub-project 8)

- No activity during this reporting period.

Status as of January 30, 2020

Status as of July 31, 2020

Status as of January 30, 2021

Status as of July 31, 2021

Status as of January 30, 2022

Status as of July 31, 2022:

Status as of January 31, 2023:

Final Report Summary:

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than \$5,000: 0

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 10.5 FTE

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 0

B. Other Funds:

| SOURCE OF AND USE OF OTHER FUNDS | Amount Proposed | Amount Spent | Status and Timeframe |
|---|-----------------|--------------|----------------------|
| Other Non-State \$ To Be Applied To Project During Project Period: | | | |
| | \$ | \$ | |
| Other State \$ To Be Applied To Project During Project Period: | | | |
| UMN Indirect Recovery Rate @52% | \$ 1,950,000 | \$ | |
| ML 2014 Chapter 312, Article 12, Section 8 (general fund) | \$3,400,000 | \$1,152,502 | 6/30/2022 |
| Past and Current ENRTF Appropriation: | | | |
| M.L. 2014, Ch. 312, Art. 12, Section 8 (ENRTF) | \$1,460,000 | \$1,199,842 | 6/30/2022 |
| M.L. 2015, Ch. 76, Sec. 2, Subd. 6a (ENRTF) | \$5,000,000 | \$806,528 | 6/30/2023 |
| Other Funding History: | | | |
| N/A | \$ | \$ | |

VI. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

| Name | Title | Affiliation | Role |
|------|-------|-------------|------|
| | | | |

B. Partners NOT receiving ENRTF funding

| Name | Title | Affiliation | Role |
|------|-------|-------------|------|
| | | | |

VII. PROJECT STRATEGY:

A. Project Partners:

Project Partners (not receiving funds):

- USDA Forest Service Northern Research Station
- Minnesota Department of Agriculture
- Minnesota Department of Natural Resources
- Minnesota Forest Resource Council
- Agencies and organizations involved in invasive species outreach programs so public information is based on the best available science.

- Networks of citizen scientists could be an important part of implementing early detection programs and monitoring the effectiveness of control efforts.

This will be updated in more detail once the priorities for research are established.

B. Project Impact and Long-term Strategy:

The Center's ultimate goal is to eliminate, reduce, mitigate or prevent the introduction, expansion or damage done by terrestrial invasive species in Minnesota. Metrics of success include: threat awareness, response efficiency, control effectiveness, non-target species protection, and mitigation strategies. Ancillary goals include: workforce development, citizen engagement, focused research strategies, improved response time to emerging threats, and improved coordination of efforts.

Success will depend on the ability to marshal multi-disciplinary teams in timely and prioritized ways to deliver results. Funding provided will be used to support additional multi-disciplinary research teams. With adequate funding, the Center's efforts are expected to result in numerous, effective prevention and control methods within an eight year time frame for a significant portion of the species upon which we will focus.

IX. VISUAL COMPONENT or MAP(S): See attached

X. RESEARCH ADDENDUM: A research addendum was developed after a panel of researchers from the University of Minnesota provided competitive reviews of the pre-proposals under this appropriation. 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 addendums were modified as necessary in response to comments received during the peer-review process. The final documents provide a technically detailed description of the research to be completed under this sub-project work plan. The research addendums are on file with the Minnesota Invasive Terrestrial Plant and Pest Center.

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than January 31 and July 31 each year (every six months). A final report and associated products will be submitted between June 30 and August 15, 2023.

Environment and Natural Resources Trust Fund

Minnesota Invasive Terrestrial Pests and Plants Center-- Sub Project List

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Project Manager: Robert Venette

Project Title: Minnesota Invasive Terrestrial Plants and Pests Center – Phase III

Organization: Regents of the University of Minnesota

College/Department/Division: College of Food, Agricultural, and Natural Resources Sciences

Project Budget: \$3,750,000

Project Length and Completion Date: 7 years; June 30, 2023

Current Date: July 23, 2019

| Sub Project # | Sub-Project Title | Species |
|----------------------|--|---|
| reserve | | |
| 1 | Sub-project 1 Fungi in ash trees: towards protecting trees from emerald ash borer and new diseases | Emerald ash borer & challara disease of ash |
| 2 | Sub-project 2 Understanding the benefits and limitations of using goats for invasive plant control | Buckthorn |
| 3 | Sub-project 3 Genetic control of invasive insect species: Phase I | Spotted wing drosophila |
| 4 | Sub-project 4 Dwarf mistletoe detection and management in Minnesota | Dwarf mistletoe |
| 5 | Sub-project 5 Developing spatially explicit bio-economic dispersal model to aid with the management of brown marmorated stink bug | Brown marmorated stink bug |
| 6 | Sub-project 6 Management of invasive knotweeds | Japanese, giant, and bohemian knowtweeds |
| 7 | Sub-project 7 Building mechanistic and process based species distribution models for common tansy and leafy spurge: from landscapes to genomes* | Common tansy and leafy spurge |
| 8 | Sub-project 8: Using plants to control buckthorn: an expanded approach | Common buckthorn |
| Notes: | *This project is co-funded with ML 2015, Ch. 76, Art. 2, Sec. 6a, with \$70,812 from ML 2015 and the balance of \$351,888 from ML 2016, Ch. 186, Art. 2, Sec. 6a (total project allocation = \$422,000). This table only summarizes expenditures made through ML 2016, Ch. 186, Sec. 2, Subd. 6a | |



| Sub-Project Manager | LCCMR Approval Date | Budget | Amount Spent | Balance | Status (select from dropdown menu) |
|---------------------------------------|----------------------------|--------------------|---------------------|--------------------|--|
| Robert Blanchette | 2/1/2018 | \$500,000 | \$146,378 | \$353,622 | In Progress |
| Tiffany Wolf | 2/19/2018 | \$445,533 | \$133,456 | \$312,077 | In Progress |
| Michael Smanski | 2/28/2018 | \$296,655 | \$116,590 | \$180,065 | In Progress |
| Marcella Windmuller-Campione | 4/19/2018 | \$455,606 | \$100,252 | \$355,354 | In Progress |
| Senait Senay & Terrance Hurley | 8/6/2018 | \$561,348 | \$71,325 | \$490,023 | In Progress |
| Alan Smith | | \$579,670 | \$0 | \$579,670 | In Progress |
| David Moeller & Ryan Briscoe Runquist | | \$351,188 | \$0 | \$351,188 | In Progress |
| Peter Reich | | \$560,000 | \$0 | \$560,000 | In Progress |
| | | \$3,750,000 | \$568,001 | \$3,181,999 | |

**Environment and Natural Resources Trust Fund
M.L. 2016 Budget Spreadsheet- Minnesota Invasive Terrestrial Pests and Plants
Center**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Sub-Project Title: Sub-project 1 Fungi in Ash Trees: towards protecting trees from emerald ash borer and new diseases

Sub-Project Manager: Robert Blanchette

Organization: University of Minnesota

M.L. 2016 ENRTF Appropriation: \$500,000

Project Length and Completion Date: 4 Years, June 30, 2022

Date of Report: July 23, 2019



| ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET | TOTAL BUDGET | AMOUNT SPENT | TOTAL BALANCE |
|---|---------------------|---------------------|----------------------|
| BUDGET ITEM | | | |
| Personnel (Wages and Benefits) | \$442,529 | \$129,871 | \$312,658 |
| PhD graduate student: \$42,518 (56% salary, 8% benefits; 36% tuition); 0.5 FTE per year for 3.5 years | | | |
| Research Scientist: \$24,202 12 weeks salary for each year (75% salary, 25% benefits) 0.17 FTE per year for 4 years | | | |
| Postdoctoral Research Associate, \$57,636 (82% salary, 12% benefits) 1 FTE for 3.5 years | | | |
| Undergraduate Students, \$8,000 (100% salary) .23 FTE for 4 years | | | |
| Professional Services | | | |
| Molecular sequencing and greenhouse space fees | \$20,871 | \$7,106 | \$13,765 |
| Equipment/Tools/Supplies | | | |
| Culture media for growing microorganism, such as molecular primers, probes and reagents, petri dishes. Materials for laboratory and field biocontrol studies, such as containers for EAB infected logs, screen, funnel traps, biocontrol beetle contamination chambers, biocontrol tree bands, etc. | \$27,000 | \$8,273 | \$18,727 |
| Travel expenses in Minnesota | | | |
| \$2,400 per year for vehicle travel costs to collect samples from EAB infected areas in Minnesota | \$9,600 | \$1,128 | \$8,472 |
| Other | | | |
| COLUMN TOTAL | \$500,000 | \$146,378 | \$353,622 |

**Environment and Natural Resources Trust Fund
M.L. 2016 Budget Spreadsheet- Minnesota Invasive Terrestrial Pests and Plants
Center**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Sub-Project Title: Sub-project 2 Understanding the benefits and limitations of using goats for invasive plant control

Sub-Project Manager: Tiffany Wolf

Organization: University of Minnesota

M.L. 2016 ENRTF Budget: \$445,533

Sub-Project Length and Completion Date: 4 Years, June 30, 2022

Date of Report: July 23, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET

| BUDGET ITEM |
|--|
| Personnel (Wages and Benefits) |
| Assistant Professor Larkin, Faculty investigator: \$25,100 (75% salary, 25% benefits) summer salary; 3.8% FTE each year for 4 years |
| Post-doc: \$236,771 (82% salary, 18% benefits); 100% FTE each year for 4 years |
| Graduate Research Assistant: \$25,000 (58% salary, 42% benefits); 25% FTE each year for 2 years |
| Graduate Research Assistant: \$85,597 (55% salary, 45% benefits); 50% FTE each year for 2 years. |
| Laboratory technician: \$10,020 (79% salary, 21% benefits); 30% FTE for 1 year. |
| Undergraduate research assistants: \$22,400 (100% salary); 560 hours @ \$10/hour per year for four years. 27% FTE per year for 4 years. |
| Professional/Technical/Service Contracts |
| Rental of 56 goats to graze a site over four field seasons on UMN land, such as the Rosemount Research and Outreach Center, in order to have the greatest long term access to the field site. Other sites will be located on land of Goat Dispatch customers at no cost. |
| Research software for data management and analysis (Fulcrum Custom Subscription) |
| Equipment/Tools/Supplies |
| Experimental supplies - goat fencing, field stakes, flagging, yard sticks, gloves, and related items & Sample collection consumables - vials, research grade ethanol, vinyl gloves, forceps, and related items |
| Laboratory testing- The largest expense is for immunological testing to quantify <i>P. tenuis</i> incidence in goats, a new technique not yet optimized for mass production, which will cost \$8,400 a year. |
| Travel expenses in Minnesota |
| Vehicle rental/gas/mileage, trailer rental for goose transportation between field sites. These expenses are necessary for project investigators, staff, and students to be able to make multiple trips each year from the U of M's St. Paul campus to field sites throughout southern Minnesota. Travel expenses will comply with U of M travel policies |
| COLUMN TOTAL |



| Budget | AMOUNT SPENT | TOTAL BALANCE |
|------------------|-------------------------|--------------------------|
| \$399,432 | \$122,918 | \$276,514 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| \$12,400 | \$4,663 | \$7,737 |
| \$1,056 | \$310 | \$746 |
| | | |
| \$4,245 | \$1,217 | \$3,028 |
| \$18,400 | \$2,295 | \$16,105 |
| | | |
| \$10,000 | \$2,053 | \$7,947 |
| \$445,533 | \$133,456 | \$312,077 |

**Environment and Natural Resources Trust Fund
M.L. 2016 Budget Spreadsheet- Minnesota Invasive Terrestrial Pests and Plants
Center**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Sub-Project Title: Sub-project 3 Genetic Control of Invasive Insect Species: Phase I

Sub-Project Manager: Michael Smanski

Organization: University of Minnesota

M.L. 2016 ENRTF Budget: \$296,655

Sub-Project Length and Completion Date: 2.5 years, June 30, 2020

Date of Report: July 23, 2019



| ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET | TOTAL BUDGET | AMOUNT SPENT | TOTAL BALANCE |
|--|---------------------|---------------------|----------------------|
| BUDGET ITEM | | | |
| Personnel (Wages and Benefits) | \$235,655 | \$93,591 | \$142,064 |
| Maciej Maselko, postdoc: \$150,588 (75% salary, 25% benefits); 100% FTE each year for 2 years | | | |
| Graduate Student, \$85,067 (60% salary, 40% benefits); 50% FTE each year for 2 years | | | |
| Professional/Technical/Service Contracts | | | |
| <i>Core facilities (DNA sequencing costs)</i> | \$20,000 | \$8,957 | \$11,043 |
| Equipment/Tools/Supplies | | | |
| <i>Lab/Field Supplies, such as plasmid extraction kits, PCR strib tubes, parafilm, RNA extraction kits, DNA aliquos, eppendorf tubes</i> | \$40,000 | \$13,959 | \$26,041 |
| Printing | | | |
| <i>Publication costs</i> | \$1,000 | \$83 | \$917 |
| COLUMN TOTAL | \$296,655 | \$116,590 | \$180,065 |

Environment and Natural Resources Trust Fund
M.L. 2016 Budget Spreadsheet- Minnesota Invasive Terrestrial Pests and Plants
Center

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Sub-Project Title: Sub-project 4 Dwarf Mistletoe Detection and Management in Minnesota

Sub-Project Manager: Marcella Windmuller-Campione

Organization: University of Minnesota

M.L. 2016 ENRTF Budget: \$455,506

Sub-Project Length and Completion Date: 3.5 years: December 31, 2021

Date of Report: July 23, 2019



| ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET | TOTAL BUDGET | AMOUNT SPENT | TOTAL BALANCE |
|--|---------------------|---------------------|----------------------|
| BUDGET ITEM | | | |
| Personnel (Wages and Benefits) | \$367,746 | \$89,288 | \$278,458 |
| M. Windmuller-Campione, project manager: \$23,766 (75% salary, 25% benefits) summer salary; 4% FTE each year for 4 years. | | | |
| M. Russell, Project investigator: \$24,452 (75% salary, 25% benefits) summer salary, 4% FTE each year for 4 years | | | |
| 3 graduate research assistants: \$268,104 (52% salary, 48% benefits during academic year, 85% salary and 15% benefits during summer); Each position 50% FTE each year for 2 years (total FTEs 3.0) | | | |
| 3 undergraduate research assistants: \$51,424 (100% salary, 0% benefits summer, 92% salary 8% benefit academic year), Each position 20% FTE for 3 years (total FTE 0.6) | | | |
| Equipment/Tools/Supplies | | | |
| Mail Survey | \$2,500 | \$0 | \$2,500 |
| Field equipment | \$1,500 | \$0 | \$1,500 |
| Computers for PhD Student and MS student - computers are a necessary expense for the development of sampling locations and design on GIS software and the analysis of data collected in the field for Objective 1 and Objective 2. Computers will be used solely for project-related work. Computers will be cleaned of data and programs and returned to MITPPC after the completion of the project. | \$1,500 | \$1,399 | \$101 |
| Travel expenses in Minnesota | | | |
| Travel to the multiple research sites multiple times each year to collect data related for Activity 1 and 2. We estimate over 5000 miles traveled each year due to remote site location, long distances between sites, and many of the project team members being based in the Twin Cities with sites located in northern Minnesota. Travel expenses includes lodging and meal allowance for graduate students, research associates, and field technicians | \$66,060 | \$9,565 | \$56,495 |
| Rental time in airplane for sampling of dwarf mistletoe | \$10,000 | \$0 | \$10,000 |
| In state conference travel and registration | \$1,500 | \$0 | \$1,500 |
| Unmanned aircraft work | \$4,800 | \$0 | \$4,800 |
| COLUMN TOTAL | \$455,606 | \$100,252 | \$355,354 |

Environment and Natural Resources Trust Fund
M.L. 2016 Budget Spreadsheet- Minnesota Invasive Terrestrial Pests and Plants
Center

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Project Managers: Senait Senay & Terrance Hurley

Sub-Project Title: Sub-project 5 Developing Spatially Explicit Bio-economic Dispersal Model to Aid with the Management of Brown Marmorated Stink Bug

Sub-Project Budget: \$569,268

Sub-Project Length and Completion Date: 4 years, June 30, 2022

Date of Report: July 23, 2019



| ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET | TOTAL BUDGET | AMOUNT SPENT | TOTAL BALANCE |
|--|---------------------|---------------------|----------------------|
| BUDGET ITEM | | | |
| Personnel (Wages and Benefits) | \$547,628 | \$69,320 | \$478,308 |
| Terrance Hurley, Co-Project Manager: \$57,684 (75% salary; 25% benefits) 5.77% FTE (partial summer salary) each year for 4 years | | | |
| Post-doc in Applied Economics: \$66,750 (75% salary; 25% fringe); 100% FTE for 1 year. | | | |
| Graduate Research Assistant in Entomology: \$80,000 (54% salary; 25% fringe); 100% FTE each year for 2 years | | | |
| Researcher: \$70,361 (75% salary; 25% fringe); 15% FTE per year for 4 years | | | |
| Post doc with International AgrolInformatics Alliance: \$135,169 (75% salary; 25% fringe); 100% FTE each year for 2 years | | | |
| Programmer with International AgrolInformatics Alliance: \$132,569 (75% salary; 25% fringe); 65% FTE each year for 2 years | | | |
| Senior Software Engineer with International AgrolInformatics Alliance: \$5,095 (75% salary; 25% fringe); 2% FTE each year over 2 yrs | | | |
| Equipment/Tools/Supplies | | | |
| \$3,500 for ERDAS IMAGINE image analysis software, \$4,000 for 2 laptops with monitors and docking station (2 @ \$2000 each). This research project is computer intensive and requires capabilities beyond normal office desktops. Software and computers will be used solely for this project and will be transferred to MITPPC upon project completion for future use. | \$7,500 | \$2,005 | \$5,495 |
| Printing | | | |
| Publication costs for four original research articles | \$4,000 | \$0 | \$4,000 |
| Travel expenses in Minnesota | | | |
| Travel to share results and receive feedback from stakeholder groups within the state. Travel is for up to three trips (estimated @ \$290 / trip) and may include presentations to technical experts. | \$870 | \$0 | \$870 |
| Other | | | |
| Travel: \$1,350 for one traveller to present results and receive project feedback at an out-of-state technical conference | \$1,350 | \$0 | \$1,350 |
| COLUMN TOTAL | \$561,348 | \$71,325 | \$490,023 |

**Environment and Natural Resources Trust Fund
M.L. 2016 Budget Spreadsheet- Minnesota Invasive Terrestrial Pests and Plants
Center**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Project Managers: Alan Smith

Sub-Project Title: Sub-project 6 Management of Invasive Knotweeds

Sub-Project Budget: \$579,670

Sub-Project Length and Completion Date: 4 years, June 30, 2023

Date of Report: July 23, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET

| BUDGET ITEM |
|--|
| Personnel (Wages and Benefits) |
| Graduate students \$ 25,498 (47.5% salary, 17.7% fringe; 35% tuition) .5 FTE for 2.5 yrs |
| Undergraduate student: \$33,000 (100% salary) .25 FTE during school year; 1 FTE summer for 4 years |
| Civil service: \$44,219 (72.8% salary, 27.2% fringe) .5 FTE for 4 years |
| Equipment/Tools/Supplies |
| GPS device, field and greenhouse supplies, microscopy supplies |
| Printing |
| Publication costs for four research articles |
| Travel expenses in Minnesota |
| Travel to collect knotweed samples |
| Other |
| Greenhouse fees, field space, soil testing |
| COLUMN TOTAL |



**ENVIRONMENT
AND NATURAL RESOURCES
TRUST FUND**

| TOTAL BUDGET | AMOUNT SPENT | TOTAL BALANCE |
|-------------------------|-------------------------|--------------------------|
| | | |
| \$425,481 | \$0 | \$425,481 |
| | | |
| | | |
| | | |
| | | |
| \$62,096 | \$0 | \$62,096 |
| | | |
| \$4,000 | \$0 | \$4,000 |
| | | |
| \$29,525 | \$0 | \$29,525 |
| | | |
| \$58,568 | \$0 | \$58,568 |
| \$579,670 | \$0 | \$579,670 |

**Environment and Natural Resources Trust Fund
M.L. 2016 Budget Spreadsheet- Minnesota Invasive Terrestrial Pests and Plants
Center**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Project Managers: David Moeller and Ryan Briscoe Runquist

Sub-Project Title: Sub-project 7: Building mechanistic and process based species distribution models for common tansy and leafy spurge: from landscapes to genomes

Sub-Project Budget: \$422,000

Sub-Project Length and Completion Date: 3 years, June 30, 2022

Date of Report: July 23, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET

| |
|---|
| BUDGET ITEM |
| Personnel (Wages and Benefits) |
| David Moeller, Project Manager: \$39,835 (74% salary, 26% fringe) .03% FTE (partial summer salary) for 3 yrs |
| Ryan Briscoe Runquist, Researcher: \$248,879 (65.8% salary, 34.2% fringe) 1 FTE for 4 yrs. |
| Graduate student: \$58,669 (68.3% salary, 17.7% benefits, 14% tuition) 0.5 FTE for four semesters (2 academic years) |
| Undergraduates: \$27,322 (40 hrs/wk for 13 wks @ \$13.13-\$13.43/hr; 0% fringe) for 4 years |
| Professional services |
| Lab services for DNA sequencing/growth chamber fees |
| Equipment/Tools/Supplies 6295 |
| Supplies for seed collection, growth chamber experiments, plant processing from experiments |
| computer software for remotely-sensed data & GIS analysis; genomic analysis |
| Printing |
| publications' costs for journal articles |
| Travel |
| Out of state travel to present at conferences |
| In-state travel (\$3,000/yr) |
| COLUMN TOTAL |



Funding for this sub-project is split with ML 2015 Ch. 76, Art. 2, Sec. 6

| TOTAL BUDGET | AMOUNT SPENT | TOTAL BALANCE |
|------------------|--------------|------------------|
| \$303,893 | \$0 | \$303,893 |
| | | |
| | | |
| | | |
| | | |
| \$27,500 | \$0 | \$27,500 |
| | | |
| \$1,795 | \$0 | \$1,795 |
| \$4,500 | \$0 | \$4,500 |
| | | |
| \$4,500 | \$0 | \$4,500 |
| | | |
| \$3,000 | \$0 | \$3,000 |
| \$6,000 | \$0 | \$6,000 |
| \$351,188 | \$0 | \$351,188 |

| TOTAL BUDGET | AMOUNT SPENT | TOTAL BALANCE |
|-----------------|--------------|-----------------|
| \$70,812 | \$0 | \$70,812 |
| | | |
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| | | |
| | | |
| | | |
| \$70,812 | \$0 | \$70,812 |

6a

revised remove this line item \$58,669 and move to ML 2015

lower this line item by \$12,143 & move to ML 2015

Total: \$70,812

**Environment and Natural Resources Trust Fund
M.L. 2016 Budget Spreadsheet- Minnesota Invasive Terrestrial Pests and Plants
Center**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06a

Project Managers: Peter Reich

Sub-Project Title: Sub-project 8 Using Plants to Control Buckthorn: an Expanded Approach

Sub-Project Budget: \$560,000

Sub-Project Length and Completion Date: 4 years, December 31, 2022

Date of Report: July 23, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET

| |
|--|
| BUDGET ITEM |
| Personnel (Wages and Benefits) |
| 2 Post-doctoral associates: \$321,103 (78.6%salary, 21.4% fringe) 2 FTE, 1 for 9 mos, 1 for 6 month/yr for 4 yrs. |
| 2 undergraduates: \$60,224 (100% salary) @12/hr * 1,254 hrs/yr for 4 yrs |
| 1 civil service technician: \$106, 432 (78% salary, 22% fringe) 0.75 FTE for 4 yrs. |
| 1 temp casual: \$16,221 (92.3% salary; 7.7% fringe) 0.5 FTE for 1 yr |
| Contracts |
| Contractor to supply and apply bud inhibitor herbicide at research plots |
| Equipment/Tools/Supplies |
| Field supplies, fencing, tools, seeds, plants, equipment to measure light availability, maintenance of equipment to measure light availability |
| Travel expenses in Minnesota |
| In-state travel to field and training sites and UMISC conference, including mileage on personal vehicles |
| COLUMN TOTAL |



| TOTAL BUDGET | AMOUNT SPENT | TOTAL BALANCE |
|------------------|--------------|------------------|
| \$504,000 | \$0 | \$504,000 |
| | | |
| | | |
| | | |
| | | |
| \$27,000 | \$0 | \$27,000 |
| | | |
| \$15,000 | \$0 | \$15,000 |
| | | |
| \$14,000 | \$0 | \$14,000 |
| \$560,000 | \$0 | \$560,000 |