M.L. 2017 Project Abstract
For the Period Ending June 30, 2020

PROJECT TITLE: Tactical Invasive Plant Management Plan Development
PROJECT MANAGER: Monika Chandler
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WEBSITE: www.mda.state.mn.us/tactical-invasive-plant-management-plan and www.mda.state.mn.us/plants-insects/noxious-invasive-weed-program
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2017, Chp. 96, Sec. 2, Subd. 06e

APPROPRIATION AMOUNT: $ 296,000
AMOUNT SPENT: $ 295,677
AMOUNT REMAINING: $ 323

<u>**Sound bite of Project Outcomes and Results**</u>
To protect natural resources from damaging invasive plants and improve management outcomes, we developed a plan with regional management priorities and provided interactive tools to communicate best practices.

<u>**Overall Project Outcome and Results**</u>

A Tactical Invasive Management Plan was developed for 14 species to improve the coordination and efficacy of managing these species at state and local levels. This plan offers guidance to decision-makers for prioritizing invasive plant management activities. It is recognized that there are insufficient financial and personnel resources to control all invasive plant populations in Minnesota. The aim was to provide information in the form of invasive plant distribution modeling, prioritization maps based upon multiple criteria, identification and management timing guides, and tools for reporting invasive plants and tracking management activities. Decisions about which invasive plant infestations are controlled are made at all levels from federal to local, but the majority of decisions are made at the local level. We made these tools available by integrating them into MDA's webpages for the selected species. The plan document is also available on the web and can be downloaded and printed.

Fourteen species were selected for assessment because they are:

- Designated noxious weeds in Minnesota
- Not considered early detection within the state but may be considered early detection at a regional or local level.

The following species were selected: Canada thistle (*Cirsium arvense*), common/European buckthorn (*Rhamnus cathartica*), common tansy (*Tanacetum vulgare*), garlic mustard (*Alliaria petiolata*), glossy buckthorn (*Frangula alnus*), Japanese (*Polygonum cuspidatum*) and Bohemian (*Polygonum × bohemicum*) knotweeds, leafy spurge (*Euphorbia esula*), multiflora rose (*Rosa multiflora*), narrowleaf bittercress (*Cardamine impatiens*), plumeless thistle (*Carduus acanthoides*), purple loosestrife (*Lythrum salicaria*), spotted knapweed (*Centaurea stoebe*), and wild parsnip (*Pastinaca sativa*).

Training on this plan was provided to land managers. In person, regional workshops with a field tour were developed for this training scheduled for spring 2020. Sadly, the in-person workshops could not be held due to COVID 19. Instead, we developed an online course and held four, regional virtual workshops. The Tactical Invasive Management Plan online course was delivered to 146 individuals representing federal, state, county, municipal and tribal natural resource and agricultural agencies. Individuals also represented nonprofits, private companies, and academic institutions. The online course was approximately four hours in length and was

organized into eight different online modules to facilitate learning. Five videos that were recorded for the online course are also available as a YouTube playlist at
https://www.youtube.com/playlist?list=PLD3IcV9rnxDFZKFVVfTE698D83f1K7DY3
The workshops were held on 06/09/20 for the southwest (25 participants), 06/10/20 for the northwest (47 participants), 06/11/20 for the southeast and greater metro (38 participants) and 06/11/20 for the northeast (25 participants).

Project Results Use and Dissemination
We presented on topics related to this Tactical Plan at 3 field workshops, 2 field tours, 3 conference booths, 9 Noxious Weed Advisory Committee meetings, 6 County Agricultural Inspector meetings, 14 Cooperative Weed Management Area meetings and gave 38 presentations to a wide range of audiences.

Training to use this plan was provided to land managers. In person, regional workshops with a field tour were developed for this training scheduled for spring 2020. Sadly, the in-person workshops could not be held due to COVID 19. Instead, we developed an online course and held four, regional virtual workshops (135 participants). The Tactical Invasive Management Plan online course was delivered to 146 individuals representing federal, state, county, municipal and tribal natural resource and agricultural agencies. Individuals also represented nonprofits, private companies, and academic institutions. The online course was approximately four hours in length and was organized into eight different online modules to facilitate learning. Five videos that were recorded for the online course are also available as a YouTube playlist at
https://www.youtube.com/playlist?list=PLD3IcV9rnxDFZKFVVfTE698D83f1K7DY3

A peer-reviewed journal article highlighting the distribution modeling work has been published in the journal Scientific Reports. This paper describes the model distribution process and integrates it with future climate scenarios. The paper was led by Jason Reinhardt and co-authors:
> Reinhardt, J., M.B. Russell, S. Senay, W. Lazarus. 2020. Assessing the current and potential future distribution of four invasive forest plants in Minnesota, U.S.A. using mixed sources of data. Scientific Reports 10(1):12738. https://www.nature.com/articles/s41598-020-69539-1

Project dissemination will continue long after the project completion date. Materials developed for this project and the plan document are available on MDA's webpages. A draft of a peer-reviewed publication containing the multi-criteria decision results is complete and will be submitted. At the Upper Midwest Invasive Species Conference (11/02/20 – 11/06/20), an interactive poster on ISMTrack and a talk on the ISMTrack app will be presented. A presentation on the finalized Tactical Plan will be given to MDA's Noxious Weed Advisory Committee on 11/17/20.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2017 LCCMR Work Plan Final Report

Date of Submission: December 16, 2020

Final Report

Date of Work Plan Approval: June 7, 2017

Project Completion Date: June 30, 2020

Does this submission include an amendment request? No

PROJECT TITLE: Tactical Invasive Plant Management Plan Development

Project Manager: Monika Chandler

Organization: Minnesota Department of Agriculture

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Location: Statewide

Total ENRTF Project Budget:		**ENRTF Appropriation:**	**$296,000**
		Amount Spent:	**$295,677**
		Balance:	**$323**

Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 06e

Appropriation Language:
$296,000 the first year is from the trust fund to the commissioner of agriculture in cooperation with the Board of Regents of the University of Minnesota to develop regional priorities and an interagency action plan for invasive plant management to protect and promote habitat and native species. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Tactical Invasive Plant Mangement Plan Development

II. PROJECT STATEMENT:
Integrated planning for invasive plant management will facilitate protection of habitat and native species. Most invasive plant management decisions are made at the local level without the benefit of regional prioritization of targeted species and coordinated management across municipalities and counties. Existing plans produced by the National Invasive Species Council, Minnesota Invasive Species Advisory Council and Minnesota Department of Agriculture (MDA) outline prevention, early detection and rapid response, control and management, and restoration in general terms. None of these plans provides regional, species specific recommendations for invasive plant management that would inform state, county and municipal decision making.

We will analyze the current and predicted distributions of invasive plants and their economic impacts to inform priorities and management strategies. This has not been done before in Minnesota. A statewide invasive plant management plan with regional recommendations will be written. The plan will be available in interactive webpages and summarized in outreach materials. To educate about invasion fronts and priority species, regional workshops with field tours will be scheduled for Cooperative Weed Management Area (CWMA) partners and other land managers. Species selected for distribution and economics analyses are regulated, widespread and threaten managed landscapes and natural areas.

buckthorn	Japanese knotweed	narrowleaf bittercress	spotted knapweed
Canada thistle	leafy spurge	plumeless thistle	tansy
garlic mustard	multiflora rose	purple loosestrife	wild parsnip

Improved access for counties, townships and municipalities to shared invasive plant data and data management tools will result from this project. This will improve coordination of state and local management efforts.

Agencies and County Agricultural Inspectors are project partners. Invasive plant management roles are defined below.

- **Minnesota Department of Agriculture's (MDA) Noxious and Invasive Weed Program**

  MDA has a mandate to protect the environment, public health, public roads, crops, livestock, or other property in Minnesota from injurious plant species (Minnesota Statutes 18.75). The Noxious and Invasive Weed Program oversees the review and regulation of injurious plant species. It works closely with counties regarding the training and enforcement of the noxious weed law.

- **County Agricultural Inspectors (CAI)**

  Counties have noxious weed law enforcement responsibilities. All invasive plant species selected for this project are noxious weeds (regulated plants) so counties have a direct role in noxious and invasive plant management. Each county has a county agricultural inspector or county designated employee to oversee township and municipal weed law training and enforcement. Additionally, CAIs are important local contact persons within a county for state and federal agencies working on noxious and invasive plants. CAIs often have extensive knowledge about the local plant conditions, land ownership and history.

- **Minnesota Department of Natural Resources (DNR)**

  The mission of the Minnesota Department of Natural Resources (DNR) is to work with citizens to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life. Terrestrial invasive plants impact many of these goals and directly impact many of the lands that the DNR manages. The DNR is the regulatory authority for invasive aquatic plants and wild animals.

- **Minnesota Board of Water and Soil Resources (BWSR)**
  BWSR Coordinates the Cooperative Weed Management Area Grant Program that aids the establishment and management of local weed management organizations to manage invasive species across ownership boundaries within counties or multiple counties. These groups conduct a wide range of activities including outreach/education, mapping, management and monitoring. BWSR also conducts outreach on invasive species

management to guide the stewardship of conservation easements, pollinator plantings, stormwater management projects and wetland conservation and mitigation on private lands.

- **Minnesota Department of Transportation (MnDOT)**
It has long been recognized that road corridors are a pathway for invasive terrestrial plant species. In an effort to protect the natural resources of Minnesota, MnDOT manages road corridors across Minnesota to control and when possible eradicate noxious weed infestations by utilizing a variety of management tactics. MnDOT cooperates with state agencies, tribal groups, advisory boards, CWMAs, counties, townships and citizen groups on many levels to facilitate invasive species management on and off State controlled rights-of-way.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of November 30, 2017
We have begun our project. A contract with the University of Minnesota was executed. Then a subcontract with University of Georgia was executed. A researcher, Jason Reinhardt, was hired to work on Activity 2. Jason began his appointment with this project at the University of Minnesota-Department of Forest Resources as a Researcher 6 on October 30, 2017. Sufficient progress has been made with data entry into ISMTrack so we are beginning to develop data queries (Activity 3).

Project Status as of May 31, 2018
We continued to add capacity to this project with the hiring of Mari Hardel and Christina Basch as Noxious Weed Specialists at MDA. They both work half time on Activity 1 of this project. Initial distribution models have been developed for all species (Activity 2). These models will be refined. Data gaps will be addressed. A questionnaire is at final draft stage and will be distributed next month (Activity 2). The aim of the questionnaire is to learn about the knowledge level and costs of invasive plant management for both public and private landowners and managers. This will inform our outreach and the economic analysis. ISMTrack development continues (Activity 3). Progress and pitfalls are discussed at monthly meetings. We have focused on improving the usability of ISMTrack.

Project Status as of November 30, 2018
Knotweed data had been incomplete so approximately 500 infestations were documented since May 2018. Target plant distribution models are developed. The next step is to model future projections and dispersal/spread simulation. We are also looking at multi-pest modeling for co-occurring species. ISMTrack is now functional and basic queries were developed and will be refined. We are starting to develop the ISMTrack app scope.

Project Status as of May 31, 2019
We continue to work with counties on data sharing and management. Final tweaks of current distribution models is underway. An optimization model developed includes estimates of the benefits and costs of treating each weed, although more field trial results are needed before the results can be viewed with very much confidence. There is a lack of research about the costs, benefits and treatments efficacies. We continue to refine ISMTrack, have defined the app scope and begun app development.

Amendment Request Approved by LCCMR 06/25/19
We request to amend Activity 1 data management completion dates from 06/30/2018 to 06/30/2020. We continue to work with counties get their data into EDDMapS so that their data can be shared.

Project Status as of November 30, 2019
Components of this project such as distribution modeling, economic analysis, best management practices are ready to be tied together. Bringing them together is complicated yet we want our final products to be easy to understand and use. Reconciling this is our challenge for the remainder of the project.

Many people who are impacted by these invasive plants are hungry for knowledge about how to best manage them. Mari and our city of Duluth partners held a knotweed identification and management workshop that was packed with 53 participants. We look forward to our upcoming 6 workshops to interact with vegetation managers about regional priorities identified by this project.

Amendment Request March 4, 2020 and Amendment Approved by LCCMR March 27, 2020
We request to move $1,192 from Activity 3 Outreach materials printing to Activity 2 U of M Personnel to cover Activity 2 Personnel costs. These costs were slightly higher than anticipated. If additional funds are needed for materials printing, Extension will use non-project funds.

We request to move $3,000 from Activity 3 Graphic design for outreach materials to Activity 3 U of M Personnel. This will enable U of M to do the graphic design work inhouse. The capacity to do this work inhouse was not available at the time this work plan was developed.

Amendment Request September 30, 2020 and Amendment Approved by LCCMR November 24, 2020
If this amendment request is granted, budget numbers presented will be final. In response to COVID 19, we could not hold in person workshops and field tours as planned. Therefore, we could not use the bus rental and travel funds in Activity 3. We also did not print materials for in person workshops so did not use those funds. Instead we developed an online course with 8 modules including 5 videos. This required the modelers and economist in Activity 2 to develop their materials for an online course and record presentations.

We request to move $4,851 from Activity 3 to Activity 2 to cover increased personal costs for developing an online course and decreased workshop and field tour costs because we could not hold these workshops due to COVID 19.

For Activity 3, we request acceptance of a reduction of regional workshops from 6 to 4. This was because we moved to an online format due to COVID 19. We would have had better attendance at in person workshops so 6 would have made sense. In order to get enough participants to do breakout sessions for networking, we consolidated the participants into 4 workshops. We request eliminating field tours from our work plan because we could not hold them due to COVID 19. We created an online course and virtual workshops instead.

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IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Facilitate data sharing and write a statewide invasive plant management plan
Description: State agencies share invasive plant data in EDDMapS, an online database. Counties and municipalities would also benefit from data sharing but are not familiar with the reporting and data management tools available. Some have data on paper forms, in spreadsheets and in geodatabases. We will connect with all 87 counties, all CWMAs and large municipalities. If counties have data to share, we will prepare and upload these data into EDDMapS. Additionally, we will offer informal training and support for the use of EDDMapS and related apps. Work will be done by a Plant Health Specialist at MDA.

Risk assessment, distribution and economic information will be integrated with best management practices into a management plan with regional recommendations for each regulated species. Logic modeling to define impact and outcome indicators (success indicators) and scale will be utilized. Angela Gupta (Extension) will facilitate logic model development and Robert Venette (U of M) will be consulted.

Roger Becker (U of M), David Hanson Kenneth Graeve (MnDOT), Laura Van Riper (DNR) Dan Shaw (BWSR) and Monika Chandler (MDA) will be consulted about best management practices drawing from a number of sources including the Midwest Invasive Plant Control Database (https://mipncontroldatabase.wisc.edu/).

The plan will be written in plain language. All project partners will review the plan. Work will be done by a Plant Health Specialist at MDA.

Summary Budget Information for Activity 1:	**ENRTF Budget:** $ 106,000
	Amount Spent: $ 105,677
	Balance: $ 323

Outcome	Completion Date
1. Discuss data tools, availability and formats with all counties and large municipalities	06/30/2020
2. Accept data in multiple formats then prepare and bulk upload into EDDMapS	06/30/2020
3. Draft plan and send through review by project partners.	04/01/2020
4. Finalize plan and post on the MDA website.	06/30/2020

Activity 1 Status as of November 30, 2017:

MDA plans to combine part time work on this project with part time work on our Elimination of Target Invasive Plant Species project for full time positions in Duluth and Rochester. There would be no position on both projects in St. Paul. The rational for decentralizing these positions is house them in the northern and southern regions where they will be working. This will enable the positions to develop essential local partnerships. Once housing for these positions is secured, MDA will post the positions. Fortunately, DNR agreed to house the southern position at their office in Rochester at no charge to MDA. We are in the process of working out a no charge lease agreement for the space. Extension was asked to house the position in the interim and we await a response. The city of Duluth is considering housing the northern position at City Hall.

Monika Chandler demonstrated data management tools to Cooperative Weed Management Areas coordinators from Duluth and Lake County. Also, Shane Blair (primarily works on a Palmer amaranth project) began compiling best management practices and images of knotweed management. This information was presented to Duluth's city maintenance staff.

Activity 1 Status as of May 31, 2018:
Mari Hardel and Christina Basch were hired and are working out of office space provided by the city of Duluth and DNR in Rochester respectively. They are expanding MDA's capacity.

We held a training session on data management with Cooperative Weed Management Area coordinators from Anoka, Ramsey and Washington Counties.

We compiled identification tips and best management practices for knotweeds into a brochure that is available in print and on the web at the Midwest Invasive Plant Network which state agencies link to. Knotweeds are notoriously difficult to control. There is a lot of lore about controlling knotweeds and a lack of science based information. To develop these recommendations, a team of academic weed scientists and weed managers with extensive experience combined knowledge to produce straightforward guidelines. The public reporting knotweeds to MDA has expressed appreciation for these guidelines.

Activity 1 Status as of November 30, 2018:
This project has generated much interest in knotweeds. The public is increasingly reporting knotweeds and asking for management advice. In one instance, Japanese knotweed grew into a house basement in Red Wing (images available at https://photos.app.goo.gl/EOOvysZj0JbbmbRj2). DNR kindly agreed to use their grant funds for a CCM crew to treat the infestation.

Mari Hardel collected and sorted through data on knotweed locations in the greater Duluth area. This data was uploaded to the EDDMapS database and is displayed as "knotweed species (nonnative)". With this upload and increased attention on knotweeds, close to 500 new knotweed reports have been added to the EDDMapS database since May 31, 2018. Duluth has the highest density of knotweeds in the state.

A survey was created to gauge the knowledge of knotweeds within Minnesota. The online survey was open for the month of September 2018 and distributed widely across the state through multiple avenues to land managers and private landowners. Results were displayed at the Upper Midwest Invasive Species Conference via poster presentation. Briefly:
- 60% of those who completed the survey were familiar with Japanese knotweed (about 20% were familiar with giant and Bohemian knotweeds) and most people described knotweeds as a threat to native plants and a severe problem
- 81% think landowners should be required to prevent knotweeds from spreading
- 91% would manage knotweed on their property, but 85% feel there are insufficient resources to do so

- 70% are interested in resources such as education and workshops, coordinated efforts, shared tools and costs
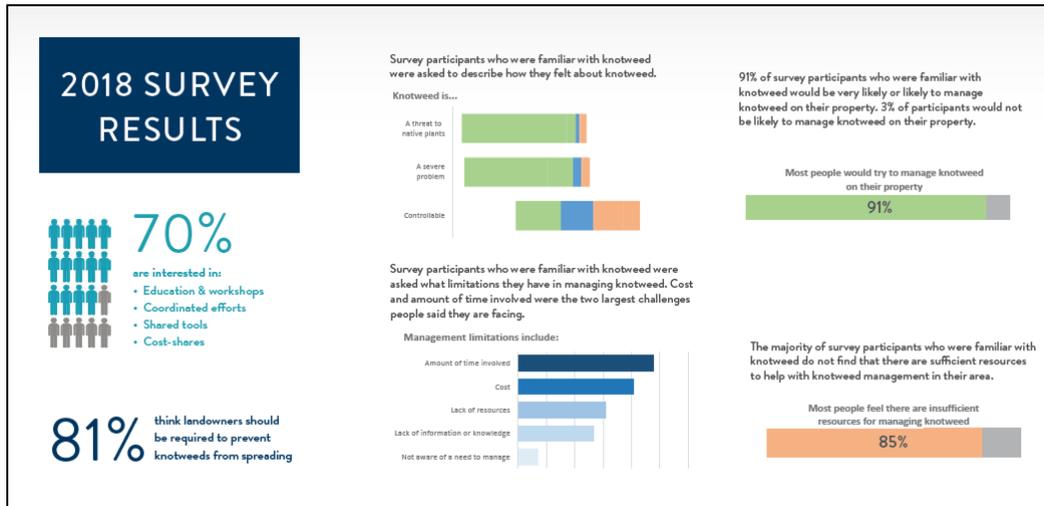
Figure 1: Summary of knotweed survey results

We are ramping up EDDMapS/ISMTrack trainings. The small group training format is hands on with tablets. All participants use ISMTrack and ask questions as they arise. Three County Agricultural Inspectors were trained on 11/27/18. Additional trainings will be scheduled throughout the winter and spring.

Activity 1 Status as of May 31, 2019:
We held 5 workshops on EDDMapS and ISMTrack conjunction with our Elimination of Target Invasive Plants Species project. Our aim is to train County Agricultural Inspectors first as a local resource for utilizing these data management tools. We continue to work with counties on data sharing.

Angela Gupta, UMN Extension, developed a prototype logic model for this project. Additional improvements with significant input from Rob Venette, USFS, to better incorporate SMART Goals: Specific, Measurable, Achievable, Relevant, Time-bound metrics are in process. This logic model incorporates Inputs, Outputs including Activities and Participation, plus Outcome Impacts organized into three categories: 1-2 years, 3-6 years and 7+ years. These Outcome - Impacts include outcomes and impacts of this project plus our proposed project **Tactical Invasive Plant Management Plan Development and Implementation.**

Program: Tactical Invasive Plant Management Plan Logic Model
Situation: Invasive plants are harming native species and habitat, reducing pasture and forestry productivity, and knotweeds have the potential to damage structures. Most invasive plant management decisions are made at the local level with limited information about invasive plant population levels, economic impacts and best management practices. Specific, site-level invasive plant management data is not available electronically so that it can be shared and inform research and decisions.
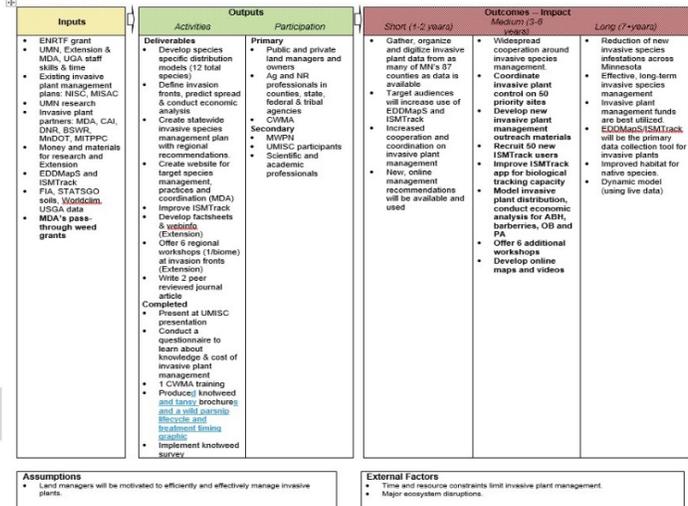
Activity 1 Status as of November 30, 2019

We held one workshops on EDDMapS and ISMTrack conjunction with our Elimination of Target Invasive Plants Species project. Our aim is to train County Agricultural Inspectors first as a local resource for utilizing these data management tools. We continue to work with counties on data sharing and will have metrics in the final report to show increased use of these tools by counties.

We have been compiling best management practices and materials such as videos that demonstrate these practices. We took high quality images of our subjects over the summer. The next step is to pull these and other resources together into a plan that is more visual than text based.

Final report summary September 30, 2020

A Tactical Invasive Plant Management Plan document was developed and is available at www.mda.state.mn.us/tactical-invasive-plant-management-plan. This plan offers guidance to decision-makers for prioritizing invasive plant management activities. The aim was to provide information in the form of invasive plant distribution modeling, prioritization maps based upon multiple criteria, identification and management timing guides, and tools for reporting invasive plants and tracking management activities. We made these tools available by integrating them into MDA's webpages for the selected species. Distribution modeling was added to the species webpage along with links to a lifecycle and treatment timing graphic and links to management prioritization modules. Management prioritization modules (created with ESRI Storymaps) guide the user through identification, distribution, prioritization. Understanding that most people would not read a text heavy document, we developed these materials to convey information graphically and be visually appealing.

Species	Species Webpage	Lifecycle and Treatment Timing Graphic	Management Prioritization
Canada thistle	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/canadathistle	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Canada%20Thistle%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/36840dcb78d746f0bc149e7ff2436630
Common buckthorn	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/commonbuckthorn	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Common%20Buckthorn%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/f8a5ec3171874338a4de93a92aab9d5c
Common tansy	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/commontansy	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Common%20Tansy%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/b93fbe435cf1439b9f1edaaa22fd4d2c

Species	Species Webpage	Lifecycle and Treatment Timing Graphic	Management Prioritization
Garlic mustard	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/garlicmustard	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Garlic%20Mustard%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/71346bdd57364eac933e73617cf665ca
Glossy buckthorn	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/glossybuckthorn	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Glossy%20Buckthorn%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/c9e60597617e4763b69c8a76789bba2f
Knotweeds	www.mda.state.mn.us/bohemian-knotweed www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/knotweed	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Knotweeds%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/cc0837ab73c64ad495ac62a0726f005f
Leafy spurge	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/leafyspurge	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Leafy%20Spurge%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/8afd936efb244b61abfec2b6fb5b95b5
Multiflora rose	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/multiflorarose	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Multiflora%20Rose%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/479e91c2346942088215aefe85bdfa55
Narrowleaf bittercress	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/bittercress	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Narrowleaf%20Bittercress%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/54994c00b9364b5fb02b2ff55999084e
Plumeless thistle	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/plumelessthistle	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Plumeless%20Thistle%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/ab776b379b004e5cb4d64bbbbac07ce0
Purple loosestrife	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/purpleloosestrife	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Purple%20Loosestrife%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/27c409a25ba4404395dd52db5116e13a
Spotted knapweed	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/spottedknapweed	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Spotted%20Knapweed%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/0065990c94f849f7b96a546342803c2f
Wild parsnip	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/wildparsnip	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Wild%20Parsnip%20new%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/30c23db120784ad092092a266c15450e

We finalized our logical model and can use it as a template for future projects.

Logic Model

Situation

    Invasive plants have negative economic, ecological, and human health impacts.

    Most invasive plant management decisions are made at the local level with limited economic information.

    Specific, site level invasive plant management data are not well organized or digitized.

Assumptions

    Natural resource managers will be motivated to efficiently and effectively manage invasive plants.

    Funding for invasive species work will continue.

External Factors

    Time and resource constraints impact invasive species managers.

    Climate change is causing shifts of host ranges and major ecosystem disruptions.

Consideration

    SMART goals were considered and implemented where deemed appropriate.

Abbreviations

ENRTF	*Environment and Natural Resources Trust Fund*
MDA	*Minnesota Department of Agriculture*
UMN	*University of Minnesota*
UGA	*University of Georgia*
CAI	*County Agricultural Inspector*
DNR	*Department of Natural Resources*
BWSR	*Board of Water and Soil Resources*
MnDOT	*Minnesota Department of Transportation*
MITPPC	*Minnesota Invasive Terrestrial Plants and Pest Center*
EDDMapS	*Early Detection and Distribution Mapping System*
ISMTrack	*Invasive Species Management Tracking system*
FIA	*Forest Inventory Analysis*
STATSGO	*State Soil and Geographic Database*
UMISC	*Upper Midwest Invasive Species Conference*
CWMA	*Cooperative Weed Management Area*
MIPN	*Midwest Invasive Plant Network*

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2017 LCCMR Work Plan Final Report

INPUTS	OUTPUTS		OUTCOMES *(years after completion)*		
	Activities	**Participation**	**Short** (*1-2 years*)	**Medium** (*3-6 years*)	**Long** (*7+ years*)
▪ ENRTF grant funds for materials, research, and Extension ▪ MDA's pass-through weed grants ▪ UMN, Extension & MDA, UGA staff skills, time, research ▪ Existing state of Minnesota noxious weed risk assessments and management plans ▪ Invasive plant partners: MDA, CAI, DNR, BSWR, MnDOT, MITPPC ▪ EDDMapS including ISMTrack ▪ FIA, STATSGO soils, Worldclim, USGA data	▪ Develop 13 species-specific distribution models ▪ Define leading edges, predict spread, conduct economic analysis ▪ Create website for target species management, practices, coordination ▪ Develop outreach materials ▪ Write two peer reviewed journal article ▪ Present at UMISC 2018 ▪ Conduct questionnaire on knowledge & cost of invasive plant management ▪ Implement knotweed survey ▪ Produce knotweed brochure ▪ Improve ISMTrack ▪ Offer ISMTrack trainings ▪ Offer six regional workshops (1/biome) at invasion fronts ▪ Create statewide invasive species management plan with regional recommendations	▪ Primary ▪ Public and private land managers and landowners ▪ Agriculture and natural resource professionals in municipal, county, state, federal & tribal agencies ▪ CWMAs ▪ Secondary ▪ MIPN ▪ UMISC participants ▪ Scientific and academic professionals	▪ Gather, organize and digitize invasive plant data from as many of MN's 87 counties as data is available ▪ Primary participants will increase use of ISMTrack ▪ Increased statewide cooperation and coordination on invasive plant management ▪ New, online management recommendations will be available and used by participants	▪ Widespread cooperation around invasive species management ▪ Coordinate invasive plant control on 50 priority sites ▪ Develop new invasive plant management outreach materials ▪ Recruit new ISMTrack users ▪ Improve ISMTrack app for biological control capacity ▪ Develop online maps	▪ Reduction of new invasive species infestations across Minnesota ▪ Effective, long-term invasive species management ▪ ISMTrack/EDDMapS will be the primary data collection tool for invasive plants ▪ Improved habitat for native species ▪ Dynamic model (using live data)

ACTIVITY 2: Define invasion fronts, predict spread and conduct economic analysis

Description: We will analyze current and projected species distribution and density using a variety of datasets depicting the presence and abundance of invasive plants. In doing so, we will define invasion fronts by using data collected at various scales. The presence of invasive plant species will be acquired through EDDMapS (www.eddmaps.org) and Forest Inventory and Analysis invasive plant species databases (www.nrs.fs.fed.us/fia/maps/Invasive-maps/default.asp). We will create habitat suitability models for the invasive plants species listed through using maximum entropy (Maxent) species distribution models using three primary variables: (1) current presence and abundance of invasive plants, (2) land use category (e.g., forest agricultural land, or settlement), and (3) environmental parameters such climate variables and soil characteristics. Analyses of these data will predict invasive plant distribution throughout Minnesota based on suitable habitat. This work will be led by Dr. Matthew Russell (UMN Department of Forest Resources) with assistance from Dr. Senait Senay (UMN Department of Applied Economics) and will initiate in the summer of 2017. Collaborators with ongoing research projects funded through the Minnesota Invasive Terrestrial Plants and Pests Center will be consulted to ensure no duplication of work in this effort.

We will identify species-specific input parameters to conduct an economic analysis of each invasive plant species. This work will be led by Dr. Matthew Russell and conducted by a post-doc located in the UMN Department of Forest Resources and will be hired in 2017. A project collaboration team including Dr. William Lazarus (UMN Department of Applied Economics) and Dr. Roger Becker (UMN Department of Agronomy and Plant Genetics) will assist in the post-doc's analyses. Species-specific input parameters included in the modeling effort, in addition to management costs of invasive plants, will be identified and data will be delivered in tabular and spatial forms.

A series of economic models will be run on each invasive species by county. We will use the modeling results in combination with the identified species-specific parameters to determine the direct and indirect economic impacts of invasive plant species distribution and their management. This work will be led by Dr. William Lazarus (UMN Department of Applied Economics) with assistance from Brigid Tuck (UMN Extension) and will be completed by the spring of 2020.

Summary Budget Information for Activity 2:	**ENRTF Budget:**	**$ 136,343**
	Amount Spent:	**$ 136,343**
	Balance:	**$ -0**

Outcome	Completion Date
1. Analyze current and projected species distribution and density. Define invasion fronts.	07/01/2019
2. Develop species specific economic model input parameters.	07/01/2019
3. Run economic models and analyze results with a breakdown by county.	06/30/2020

Activity 2 Status as of November 30, 2017:

The University of Minnesota completed a search for a researcher to assist with the invasive plant modeling in fall 2017. Drs. Matthew Russell (UMN Department of Forest Resources), Senait Senay, and Bill Lazarus (UMN Department of Applied Economics) formed the search committee. Dr. Jason Reinhardt was hired on October 30, 2017 and has been exploring invasive plant distribution data sources, including EDDMapS and Forest Inventory and Analysis data. Although results are still very preliminary, Dr. Reinhardt has begun working with buckthorn as an invasive plant species in the modeling efforts.

We anticipate this work will be presented and shared in a number of outlets beginning in 2018. This includes a presentation at the Upper Midwest Invasive Species Conference in Rochester, MN (October 2018), in addition to several reports and at least two peer-reviewed publications.

Activity 2 Status as of May 31, 2018
Dr. Reinhardt has constructed a series of preliminary models for each invasive plant species in this study. Each model was constructed using plant location data from EDDMapS and the Forest Inventory and Analysis database, as well as environmental data from several other databases, including STATSGO soils, Worldclim, and the USGS , among others. Model refinement, tuning, and sensitivity analyses are in progress.

We have drafted a survey, to be distributed to private landowners and public land professionals, with the intent of gaining information regarding invasive weed management costs, currently used management approaches, concerns, and general context. The concerns and actions of different stakeholder groups, in addition to reported cost figures, will help inform the economic analysis component of this study and provide valuable context for data interpretation across analyses.

In addition to the survey, Drs. Lazarus and Reinhardt have begun an early collection of data and information regarding invasive weed management approaches, concerns, and costs.

Activity 2 Status as of November 30, 2018
An initial set of distribution models have been completed for each species in this study (see Figure 2.1 for an example). Model performance and outcomes have been summarized in a series of tables and maps. Additional modeling efforts are in progress – including general refinement and tuning, future projections, and dispersal/spread simulation.

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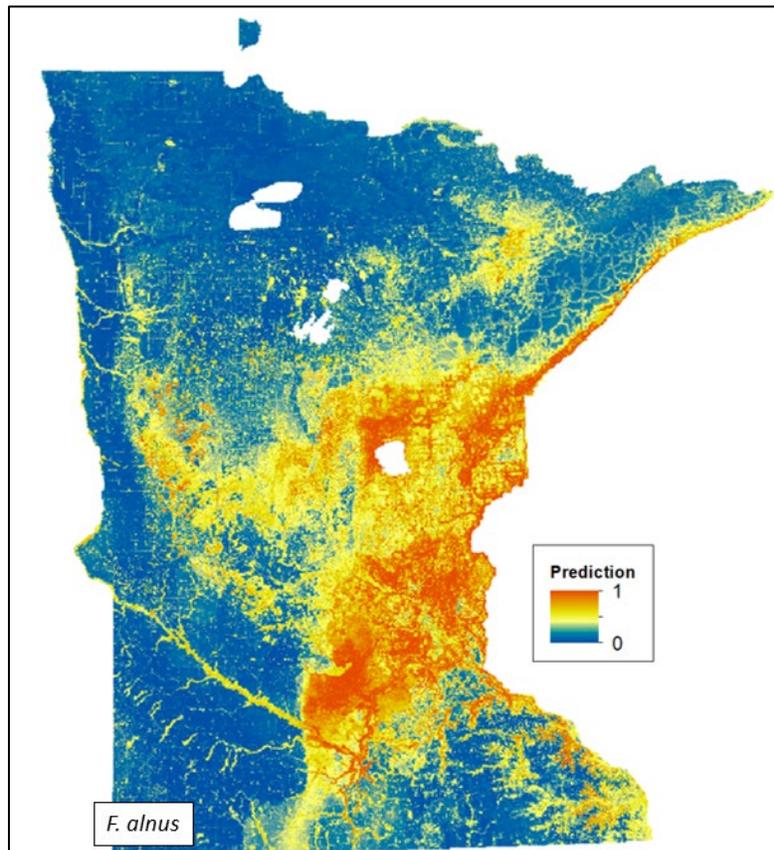
Figure 2.1. Distribution model output for glossy buckthorn (*Frangula alnus*). Mapped values range from 0 to 1, with 0 representing an extremely low likelihood of occurrence, and 1 representing a very high likelihood of occurrence. Such outputs have been produced for each species in the study.

The invasive plant survey described in the May 2018 update was distributed, completed by 249 respondents, and the results were analyzed by the project team. Information gathered includes overall concerns, species of greatest concern (Figure 2.2), limited cost estimates, and management approaches. Survey results have helped provide context for subsequent analyses as we have moved forward. The general top-level results of the survey are currently being drafted by Dr. Reinhardt into a University of Minnesota staff whitepaper, to be made freely available online.

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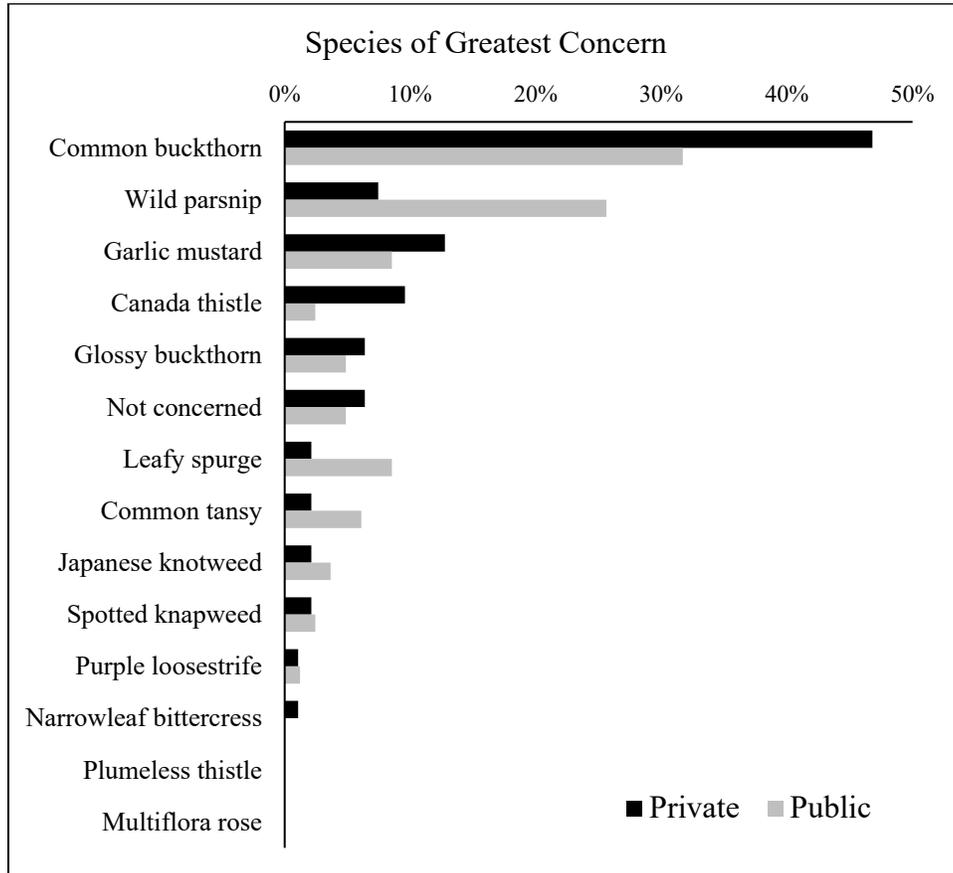
Figure 2.2. Species of greatest concern as reported by survey respondents. Results are broken down by respondent category: Private landowners (black) and public land professionals (gray).

Dr. Senay has undertaken a multi-peril weed risk analysis based on Dr. Reinhardt's individual distribution models for the 13 weeds covered under this project. The outcome of this analysis is a weed co-occurrence map and a multi-peril weed occurrence risk index, which indicate the likelihood of presence of multiple weeds and the severity of the risk by location respectively. These outcomes can be used in upcoming economic analyses to prioritize various locations based on their multi-weed risk severity and also to optimize treatments for locations that are likely to have multiple weeds.

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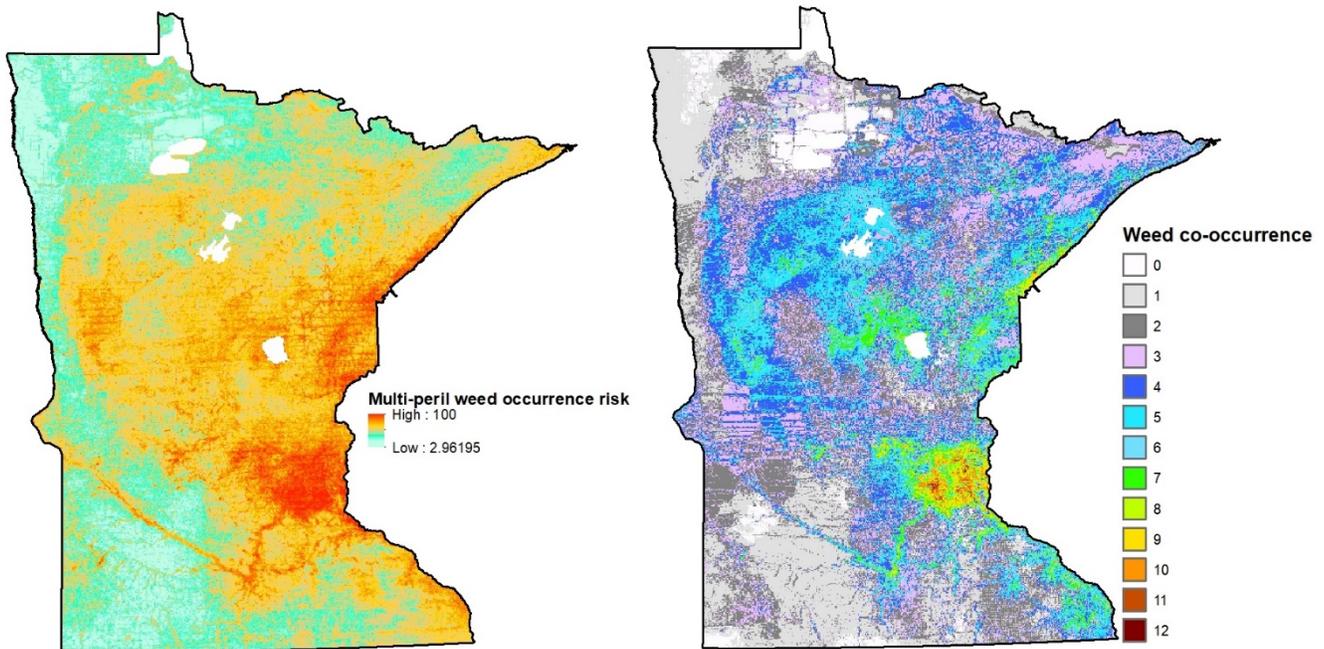
Figure 2.3 multi-peril weed occurrence risk map showing the combined risk from weed co-occurrence as well as the likelihood of occurrence of each individual weed (map on the left). Weed count map showing how many of the 13 weeds are likely to co-occur in Minnesota based on a presence/absence cut-off calculated out of the spatially relative risk severity value generated for the 13 individual weeds (map on the right).

Preliminary cost estimates for chemical and mechanical treatments of the listed weeds have been compiled. Historical data on timelines and costs involved in the development of biocontrols for purple loosestrife and garlic mustard (still under development) in Minnesota were summarized. Literature was reviewed for data on impacts of the listed weeds that can be quantified in economic terms.

A limitation of the economic analysis is that for some of the listed weeds, recent treatments appear to be motivated mainly by factors such as aesthetics that are not readily quantifiable in economic terms. In other cases there are techniques (such as hedonic models of willingness to pay, and surveys of park visitor travel costs) that have been used to value environmental changes similar to invasive weeds, but applying those techniques to the listed weeds in Minnesota is beyond the scope of this project.

A draft economic optimization model has been developed in an Excel spreadsheet. The model selects the treatment that maximizes the net benefit per acre at a given location based on the land use, the presence or density of each weed, and the costs of alternative treatments available for each weed. One way the model could be used is to do the calculations for each of a sample of locations from Dr. Reinhardt's distribution models of likely presence and density of weeds as described in the May 2018 progress report.

Activity 2 Status as of May 31, 2019:
The literature review on impacts of the listed weeds and benefits of treatment was revised and expanded. A separate document describing the organization and use of the spreadsheet optimization model along with suggestions for future research on impacts was prepared. A detailed analysis of the labor and travel costs for treating Japanese knotweeds based on ISMtrack data was created in a spreadsheet and documented. The

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optimization model was revised and the interface simplified to make it more user-friendly for possible use by local decision makers. The optimization model now includes estimates of the benefits and costs of treating each weed, although more field trial results are needed before the results can be viewed with very much confidence.
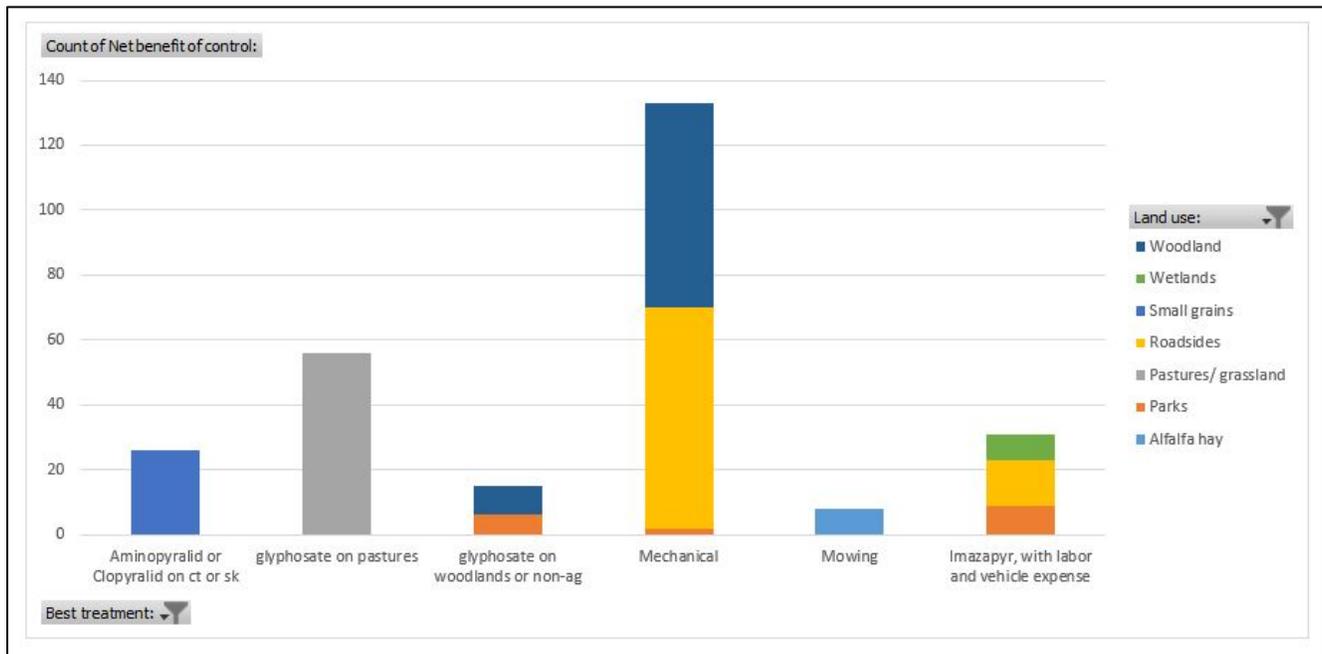
Example optimization output showing counts of the weed treatments with the greatest net benefit on each of 1,000 randomly-selected points in the state, by land use at each point. Points with no treatment are not shown.

Final tweaks and refinements of the distribution models is underway with feedback from the entire Tactical Plan project group, and discussion has begun regarding the optimal distribution format for the results.

The invasive plant survey described in the May and November 2018 updates has been published as a University of Minnesota Staff whitepaper and is available online at:
https://www.forestry.umn.edu/sites/forestry.umn.edu/files/russell_survey_staffpaper_final.pdf and can be found on the Staff Paper Series page at: https://www.forestry.umn.edu/our-department/publications/staff-paper-series. The survey summarizes information from questions we posed to landowners and public land professionals regarding invasive weed management costs, approaches, concerns, and other topics.

Activity 2 Status as of November 30, 2019
The distribution models have been completed with feedback from the Tactical Plan project group. The primary model outputs are available online in raster (GIS) or png form on the U of M data repository, at https://conservancy.umn.edu/handle/11299/208549. Discussions have begun regarding the creation of an interactive ArcGIS Online map using these data products.

A feature was added to the optimization model to allow a user to indicate a budget that is available for weed treatments (most likely less than required to treat all areas with positive net benefits), after which the model displays a chart with the breakdown of treated sites by land use and weed, and shows the gross benefit and the net benefit of treating that group of sites (see below).

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Count of Most damaging weed:

Sites treated with 26% of required funds

Most damaging weed:
- Japanese knotweed
- Spotted knapweed
- Wild parsnip
- Garlic mustard
- Buckthorn -euro

- Leafy spurge
- Narrowleaf bittercress
- Multiflora rose
- Plumeless thistle
- Buckthorn -glossy

Land use:

Move slider to adjust treatment budget constraint.		
Funds required to treat entire area:	$1,316	million/year
Minimum required for any treatment	$0	million/year
Budget selected:	$342	million/year	26% of req
Points treated with avail funds	167	
Cost:	$336	million/year
Gross benefit:	$1,486	million/year
Net benefit:	$1,150	million/year

The optimization model was also modified slightly to focus on the question of how much of available resources should be directed at infestations near the edges of infested areas where there is high potential to spread to new areas vs. infestations in areas that are already heavily infested. Out of 1,000 randomly-selected points, many have the potential to spread but only a few of the spread destinations are in land uses where the weeds would do damage (see graph below). Note that good data on damages is lacking for wild parsnip and Japanese knotweed.

Also, while the distribution models show infestations of Canada thistle on soybean and wheat acreages, a review of herbicide recommendations suggests that Canada thistle is not a high priority weed at present on those crops because apparently herbicide treatments recommended for other weeds do an adequate job of controlling Canada thistle at the same time without additional cost directly related to this weed. Consequently, the model now does not include a net benefit calculation for Canada thistle infestations on soybean and wheat acreages.

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Number of points with dispersal values, total and those with damages (net benefits from treatment)
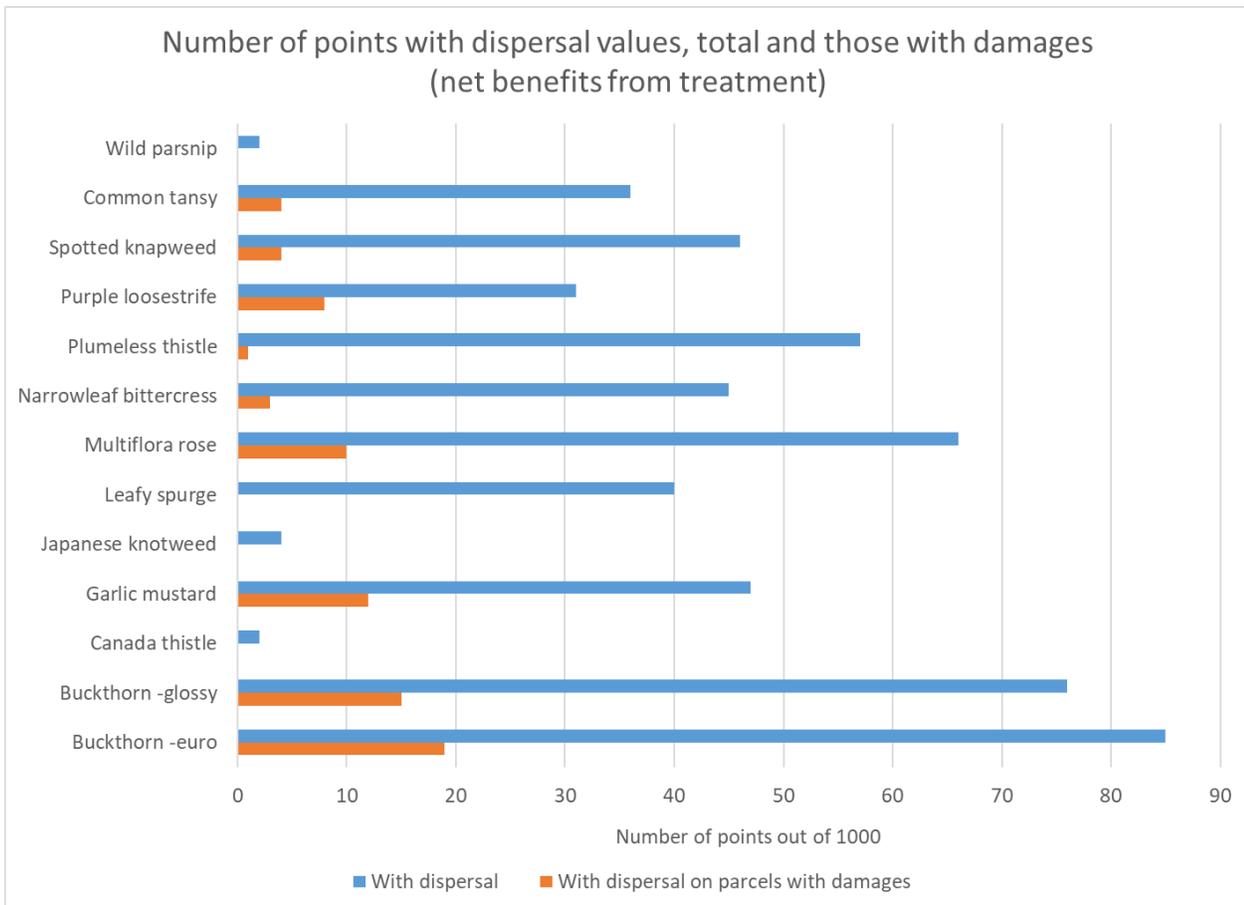
To tie the distribution modeling, economic analysis, and other relevant concerns together, we have begun exploring the use of multi-criteria decision analysis (MCDA) for use in a statewide prioritization for each species. The objective of the prioritization would be to identify priority areas for management for each species in order to minimize future impacts.

Final report summary September 30, 2020
A peer-reviewed journal article highlighting the distribution modeling work has been published in the journal Scientific Reports. This paper describes the model distribution process and integrates it with future climate scenarios. The paper was led by Jason Reinhardt and co-authors:

> Reinhardt, J., M.B. Russell, S. Senay, W. Lazarus. 2020. Assessing the current and potential future distribution of four invasive forest plants in Minnesota, U.S.A. using mixed sources of data. Scientific Reports 10(1):12738. https://www.nature.com/articles/s41598-020-69539-1

Matt Russell presented the distribution modeling work at the Chippewa National Forest-MN Department of Forest Resources Forest Health Workshop on Feb. 4, 2020 in Walker, MN to an audience of forest and natural resource professionals. The title was "Mapping invasive plants across Minnesota (And what managers are doing about them)".

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The work on multi-criteria decision analysis (MCDA) has identified priority areas for invasive plant management using a variety of sources. Prioritizations included data from (1) the distribution estimates from the mapping efforts, (2) known report density from EDDMaps and Forest Inventory and Analysis data, (3) proximity to areas of conservation interest, (4) proximity to trails, and (5) estimated economic benefit of treatment as indicated from the economic analyses. Each criteria included in the MCDA was compared in a pairwise fashion, with a group of 10 natural resource professionals, scientists, and experts ranking the relative importance of each criteria in each pairwise comparison. These individuals represented the University of Minnesota, Minnesota Department of Agriculture, and Minnesota Department of Natural Resources.

The following figure shows the prioritization maps for (A) common buckthorn, (B) garlic mustard, (C) knotweeds, (D) glossy buckthorn, and (E) multiflora rose:
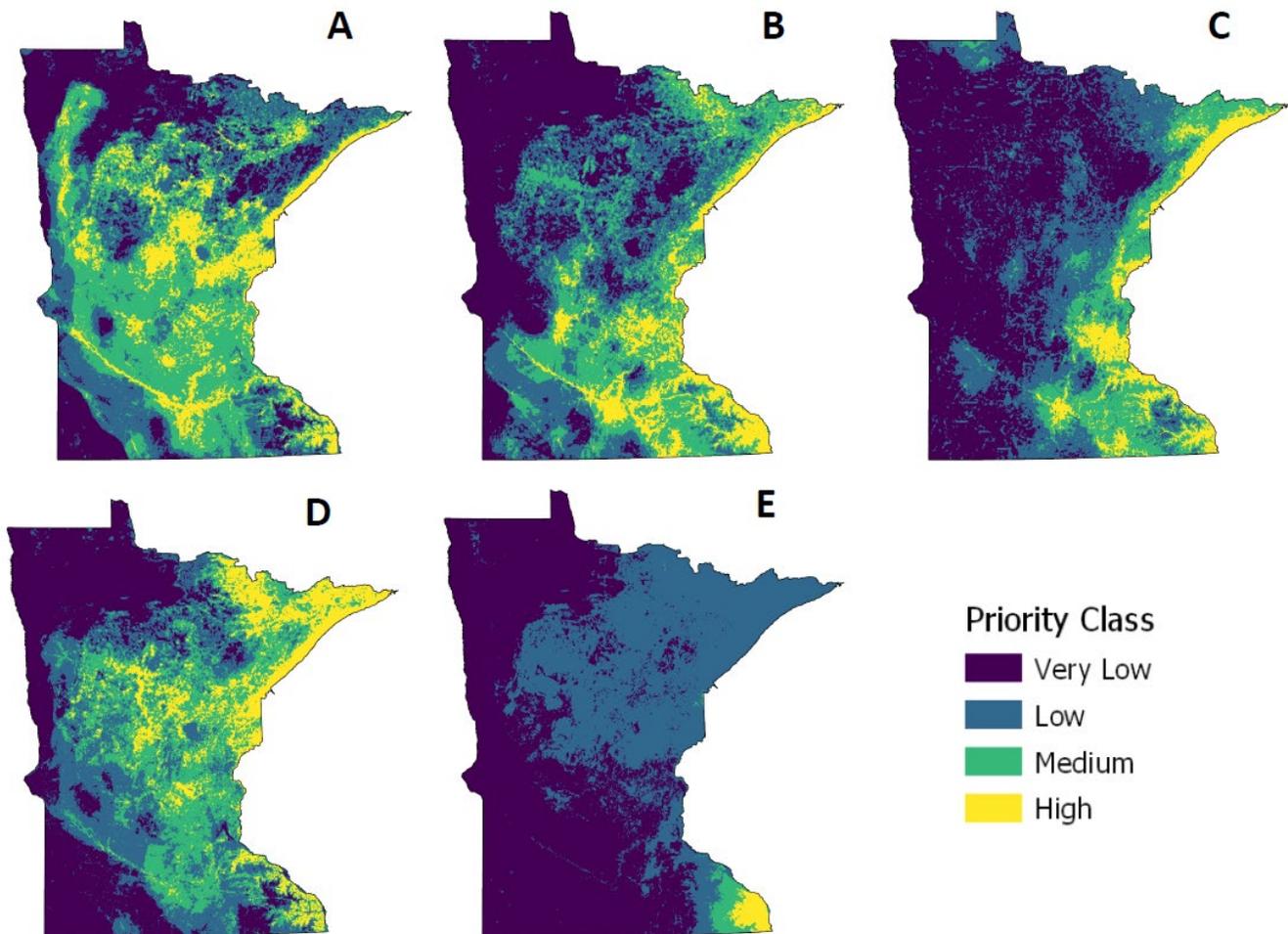
We have also used the results from the MCDA to prioritize invasive plant management across different ecosystem provinces, as indicated in the table below. For example, our results indicate the highest priority for invasive plant management of glossy buckthorn in the Laurentian mixed forest province and lowest priority for managing this species in the tallgrass aspen parklands:

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Table: Distribution of priority classes across Minnesota Ecological Classification System (ECS) Provinces for each species. Priority classes correspond as: very low = 1, low = 2, medium = 3, high = 4.

ECS Province	Area (km²)	Common buckthorn	Glossy buckthorn	Garlic mustard	Multiflora rose	Knotweeds
Eastern Broadleaf Forest	47932	2.88 ± 0.78	2.59 ± 0.80	2.86 ± 0.92	1.65 ± 0.81	2.46 ± 1.05
Laurentian Mixed Forest	93804	2.38 ± 1.03	2.63 ± 1.06	2.04 ± 0.92	1.76 ± 0.43	1.84 ± 0.90
Prairie Parkland Province	65095	2.3 ± 0.91	1.57 ± 0.68	1.85 ± 0.93	1.02 ± 0.13	1.36 ± 0.63
Tallgrass Aspen Parklands	11751	1.81 ± 0.99	1.03 ± 0.16	1.03 ± 0.16	1.02 ± 0.14	1.16 ± 0.38

A draft of a peer-reviewed publication containing the MCDA results is complete and it will be submitted before September 30, 2020.

ACTIVITY 3: Develop user-friendly educational materials and communicate the plan and develop an app for evaluating invasive plant management outcomes
Description: The MDA will develop webpages to communicate species management objectives, practices, and coordination. These webpages will be housed on MDA's Noxious and Invasive Weed Program's website (www.mda.state.mn.us/weedcontrol). Monika Chandler will oversee development of these webpages. Maps of the suitable habitat produced in Activity 2 will be a core component displayed in these webpages. Intended audiences are agricultural and natural resource professionals working in county, state, federal, and tribal agencies.

We will translate the statewide invasive plant management plan to the field and foster cooperation by holding six regional workshops with field tours to see invasion fronts and high priority infestations. These workshops will be sponsored by UMN Extension (Angela Gupta and Matthew Russell). Target regions for these workshops, offered in 2019 and 2020, will be at least one in each of Minnesota's four biomes spanning agricultural and forest land uses. In addition, outreach materials (e.g., fact sheets and invasive plant management summaries) will be created and distributed by UMN Extension using both printed and web resources though UMN Extension's webpage (http://www.extension.umn.edu/) and MyMinnesotaWoods (http://www.myminnesotawoods.umn.edu/).

ISMTrack, an invasive species management tracking system, was developed in the *Elimination of Target Invasive Plants* LCCMR project. ISMTrack is a cloud based software system to help land managers track invasive species management across sites and over time. ISMTrack is integrated with EDDMapS, an invasive species inventory, mapping and tracking system. ISMTrack can be used to track many invasive species management activities including: staffing, treatment method, travel time, volunteer or crew hours, weather conditions, completion dates and other critical information. Data can be shared, downloaded and analyzed to increase efficiency and improve invasive species management by a team and across organizations.

We will improve work flow processes and add query and reporting features to analyze and summarize changes in infestation size and density over time. Finally, we will create an app that works consistently offline on a mobile device. This will allow land managers access records of what has been done at a site. This will inform decisions in the field. Work will be contracted through Extension.

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Summary Budget Information for Activity 3:   ENRTF Budget: $ 53,657
                                                        Amount Spent: $ 53,657
                                                        Balance: $ 0

Outcome	Completion Date
1. Define and develop outreach materials	05/30/2020
2. <u>Develop an online class and</u> hold ~~6~~ 4 regional <u>virtual</u> workshops ~~with field tours~~	06/30/2020

Activity 3 Status as of November 30, 2017:
We continued to develop ISMTrack, an invasive species management tracking system. Improvements to polygon drawing/editing functionality, observation mapping and image handling have made data entry easier. There are now a large number of records enabling us to begin to develop queries. The first query we are working on is summing area treated.

Activity 3 Status as of May 31, 2018:
We are discussing means of disseminating distribution models on the web that would be sustainable beyond this project. Once difficulty is that land use and other information change. We are exploring ways to feed in the latest information. This is challenging because we are dependent on federal agencies to share these data dynamically.

For ISMTrack, focus has been on increasing the usability of ISMTrack. We can now navigate between and search observations, sites and management activities more effectively. This has facilitated bringing on new users. An update meeting was held February 13, 2018 with Chuck Bargeron (developer with University of Georgia), current users (Extension and MDA) and future users (DNR and MnDOT). This included people working with both aquatic and terrestrial invasives. We discussed current status and defined future direction.

Activity 3 Status as of November 30, 2018:
For ISMTrack, we hold monthly web meetings with the developer to maintain steady progress. Big changes include improving pesticide reporting and developing queries. Pesticide reporting was refined to improve ease and accuracy of pesticide use recording. Existing records were updated to the new reporting format. Initial queries have been developed (see screenshot below). We plan to use the queries for two months and note suggested improvements. Once improvements are made, we will work on the user interface design.

MDA is requiring that weed management done with MDA noxious weed grant funds be recorded in ISMTrack. This will allow MDA to see exactly what work was done where and to easily summarize data. Christina, Mari and Monika (MDA) are available to help grant recipients with recording in ISMTrack.

Activity 3 Status as of May 31, 2019:
We wrestled with how to create a plan that is not text heavy because most land managers do not have the time to read long text documents. It is easiest to design the plan first for the web then consider ways to have a paper format of the plan available for those without web access. We mocked up interactive webpages for wild parsnip to guide users through decision-making. We will utilize available images and videos for these pages but see the need for many more instructional videos about invasive plant management. We are developing graphics to synthesize complex information into easy to understand visuals. Below is a wild parsnip lifecycle and treatment timing graphic to show which activities should be done at specific parsnip developmental stages. Design and printing costs for this graphic were covered by MDA general funds. We plan to develop similar graphics for other species.

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WILD PARSNIP
Pastinaca sativa
Lifecycle and Treatment Timing
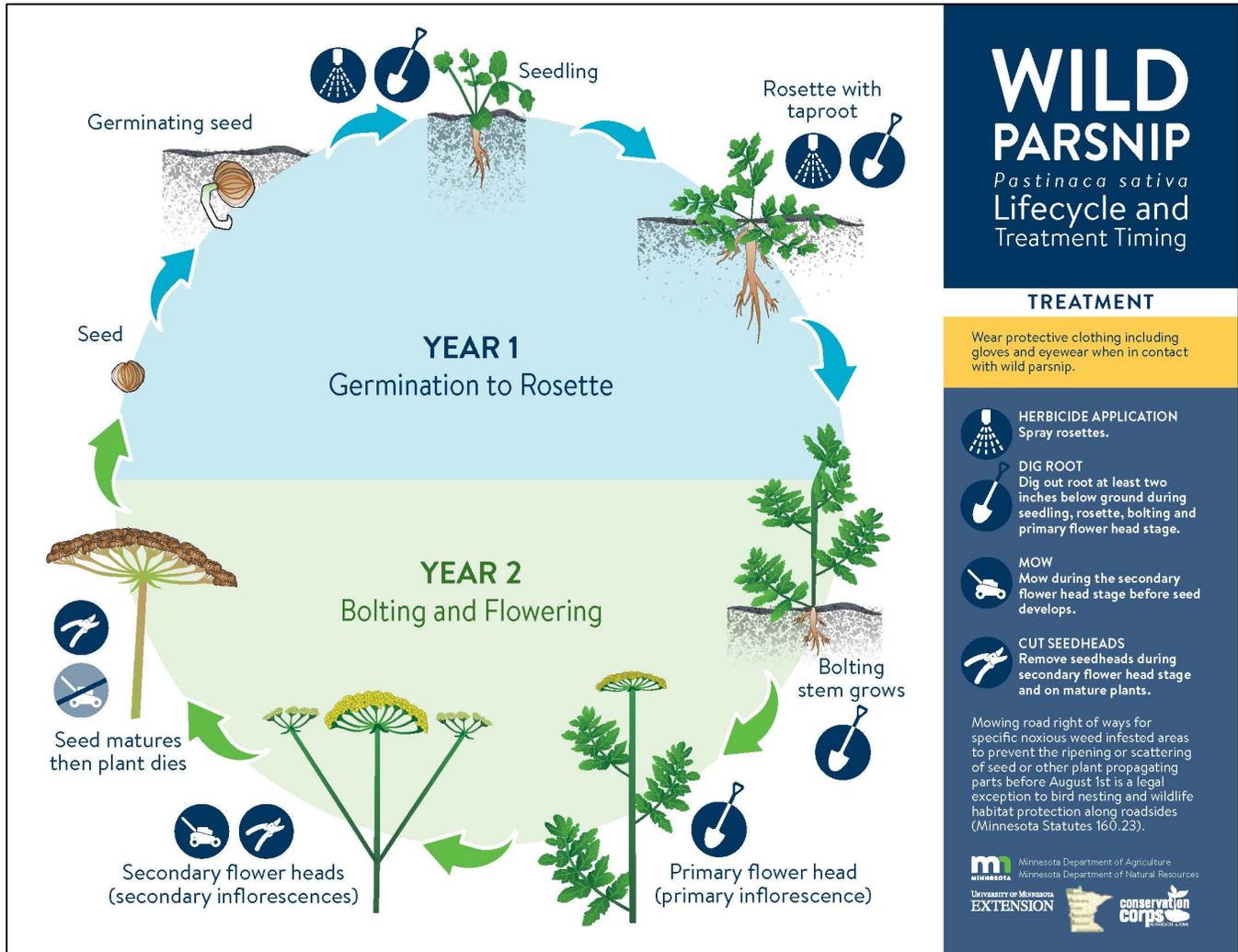
ISMTrack development continues with improved queries although we still have some issues to work through. We are also focused on user permissions at User, Site Manager and Administrator levels and which levels should be able to view and edit data. Will still have usability improvements to make and need an API (Application Programming Interface) for downloading data from ISMTrack. Scoping for an app is completed and initial development has begun. We will begin field testing the app this summer.

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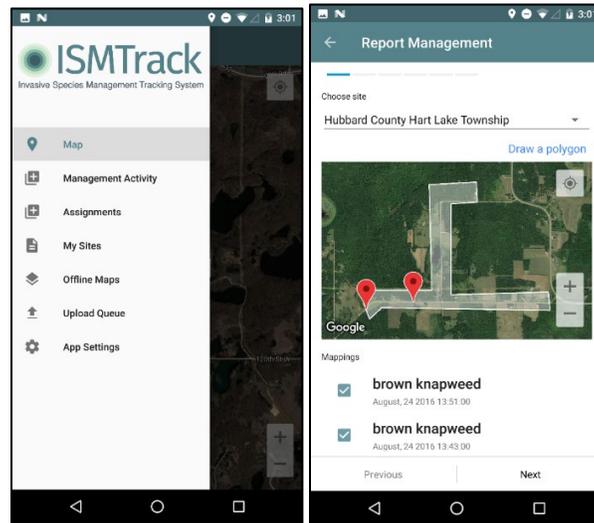
Activity 3 Status as of November 30, 2019:
We will create additional lifecycle graphics with treatment timing for groups of species including woody invasives (common and glossy buckthorns and multiflora rose), herbaceous perennials (Canada thistle, leafy spurge, purple loosestrife, spotted knapweed and tansy), knotweeds, and biennials (garlic mustard, wild parsnip, narrowleaf bittercress and plumeless thistle).

We began workshop planning and aim to conduct all 6 workshops by the end of May.

Select Conservation Corps Minnesota field specialists and crew leaders have been field testing the ISMTrack app. They are completing work faster because they can easily find where work had been done before when revisiting a previously treated site. The app helps them with herbicide calculations which saves time and reduces the chances for error. It is faster to record treatments with the app than on paper and images are included with the record. This is all very positive but there are improvements to make such as adding budget string fields, additional detail recording options for management activities, and improving usability. An android version of this app was developed first. Once we no longer have significant changes to the android version, then an Apple version will be developed.

Final report summary September 30, 2020
We created numerous materials for this project that will be used in multiple ways. A lifecycle and treatment timing graphic was developed for each species. The graphics were posted on the Midwestern Invasive Plant Network (MIPN) site (mipn.org/control) and were shared in the MIPN fall newsletter (mailchi.mp/1b1729e1813a/mipn-fall-2020-newsletter). Posting on the MIPN website allows us to maintain version control while enabling others to link to them so they are used broadly in the Midwest. We also developed interactive maps (ESRI Storymaps) that guide the user through the invasive plant management prioritization process for each species. Links to these interactive maps were added to each species webpage.

Training on this plan was provided to land managers. In person, regional workshops with a field tour were developed for this training scheduled for spring 2020. Sadly, the in-person workshops could not be held due to COVID 19. Instead, we developed an online course and held four, regional virtual workshops. The Tactical Invasive Management Plan online course was delivered to 146 individuals representing federal, state, county,

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municipal and tribal natural resource and agricultural agencies. Individuals also represented nonprofits, private companies, and academic institutions. The online course was approximately four hours in length and was organized into eight different online modules to facilitate learning. Five videos that were recorded for the online course are also available as a YouTube playlist at
https://www.youtube.com/playlist?list=PLD3IcV9rnxDFZKFVVfTE698D83f1K7DY3
The workshops were held on 06/09/20 for the southwest (25 participants), 06/10/20 for the northwest (47 participants), 06/11/20 for the southeast and greater metro (38 participants) and 06/11/20 for the northeast (25 participants).

Conservation Corps Minnesota consistently utilized ISMTrack for our Elimination of Target Invasive Plants project. We were pleased with how well this tool facilitated revisiting sites for follow up treatments. At the Upper Midwest Invasive Species Conference this fall, Christina Basch will present ISMTrack's role in facilitating management. There are currently 147 ISMTrack users. That number will continue to increase.

V. DISSEMINATION:
Description: We will communicate about plan development with the public, CWMAs, land managers, and researchers. Webpages will be developed for communication. Communication with the public will be via news media (print, television, and radio) and social media such as Facebook and Twitter. Updates and findings will be presented at a University of Minnesota seminar, the 2018 Upper Midwest Invasive Species Conference, and other meetings (LCCMR funding will not be used for meetings).

Status as of November 30, 2017:
- Chandler, M. Spotted knapweed management field workshop for the Meeker County Cooperative Weed Management Area on July 26, 2017 at the Casey Lake Waterfowl Production Area.
- Chandler, M. presented Compost and Weeds at the Minnesota Composting Council's Yard Waste Site Operator Training on August 16, 2017 in Maple Grove.
- A project update was given to MDA's Noxious Weed Advisory Committee on September 7, 2017 in Arden Hills.
- Chandler, M. presented about knotweeds on the 2017 Minnesota Invasive Species Advisory Council field tour on September 12, 2017 in Duluth.
- Chandler, M. presented Parks and Invasive Plants at the Greater Minnesota Parks & Trails annual meeting on October 18, 2017 in Little Falls.
- Chandler M. and M. Reichenbach presented Minnesota Invasive Plants: Mapping, Reporting and Tracking at the Minnesota Pesticide Information and Education workshops November 7-9, 2017 in Mankato, Brooklyn Center and Grand Rapids.
- Reichenbach, M. and M. Russell instructed Master Woodland Owners (University of Minnesota Extension program) on the use of herbicides for controlling weeds and invasive plants during a workshop held on Nov. 11, 2017 at the UMN St. Paul Campus, St. Paul, MN.
- Chandler, M. discussed invasive weeds and regional priorities at roundtable portion of the Minnesota Association of Townships annual meeting on November 17, 2017 in Rochester.
- Chandler, M. presented about the noxious weed listing process and knotweeds to city of Duluth maintenance workers and separately to the Duluth Collaborative Invasive Species Management Area on November 28, 2017 in Duluth.

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Status as of May 31, 2018:
- A project update was given to MDA's Noxious Weed Advisory Committee on February 18th and May 24th 2018 in Arden Hills. Jason Reinhardt presented an overview of distribution modeling and the upcoming questionnaire at the May 24th meeting.
- Chandler, M. presented biological control and invasive plant early detection at the new County Agricultural Inspector training on February 20, 2018 in St. Cloud.

Status as of November 30, 2018:
- Hardel, M. discussed invasive plants with participants at a Mini Outdoor Recreation Summit sponsored by REI in Duluth on June 28, 2018.
- Chandler, M. presented "Invasive Species Data Management" about EDDMapS including ISMTrack at the annual Minnesota Association of County Agricultural Inspectors Short Course in Waite Park on July 18, 2018.
- Hardel, M. and S. Blair presented on knotweed identification and management and the use of mapping tools on August 9, 2018 at the Duluth CISMA Knotweed Workshop.
- Hardel, M. presented to the Duluth Invaders volunteer group at their annual meeting about mapping tools including EDDMapS and the GLEDN app.
- Justen, E. presented about weed law, Japanese hops and wild parsnip at a Fillmore County roadside vegetation workshop in Preston on August 28, 2018.
- Hardel, M. wrote an article for MDA's Weed of the Month article series for September. The article is at https://content.govdelivery.com/accounts/MNMDA/bulletins/2093399 and was distributed to numerous media outlets in outstate Minnesota.
- Chandler, M. presented about wild parsnip identification and management to city of Duluth, St. Louis County and several private company staff members in advance of a development project in a heavily infested area on September 5, 2018.
- The Duluth News Tribune published the article "If you've got Japanese knotweed in your yard, now the time to spray" on September 16, 2018 (http://www.duluthnewstribune.com/news/science-and-nature/4500155-if-youve-got-japanese-knotweed-your-yard-now-time-spray). Mari Hardel and city of Duluth staff were interviewed for this article.
- Chandler, M. gave a project update to MDA's Noxious Weed Advisory Committee on September 25, 2018.
- Mike Reichenbach, Matt Russell, and Mari Hardel led a Master Woodland Owner field tour (University of Minnesota Extension program) that included the identification and management of invasive plants held on September 29 ,2018 at the Audubon Center of the North Woods, Sandstone, MN.
- Jason Reinhardt presented a talk entitled "Employing Distribution Modeling and Multi-Species Prioritization to Inform Regional Invasive Plant Management" at the Upper Midwest Invasive Species Conference in Rochester MN on October. 16, 2018.
- Hardel, M., M. Chandler, J. Flory and L. Seele presented a poster titled "Gearing Up for Knotweed Management in Duluth Minnesota" at the Upper Midwest Invasive Species Conference in Rochester from October 15-18, 2018.
- Hardel, M. hosted a round table session at the Minnesota Association of Townships conference in Duluth on November 16, 2018 and communicated about collaboration among various parties within the state in regards to invasive plant management.

Status as of May 31, 2019:

- Chandler, M. provided an update to the Minnesota Association of County Agricultural Inspectors Board on December 12, 2018 in St. Paul (14 participants).
- Chandler, M. gave project updates to MDA's Noxious Weed Advisory Committee on December 19, 2018 in Arden Hills and on February 27, 2019 in Roseville (23 and 25 participants respectively).
- Hardel M. presented about the Noxious Weed Law and target species in the Northeast Minnesota region at the Duluth Cooperative Invasive Species Management Area meeting on January 8, 2019 (15 participants) and discussed target species at meetings on March 26 and May 14, 2019 (14 and 12 participants, respectively).
- Basch, C., M. Chandler and S. Blair gave updates at the southeastern region County Agricultural Inspectors meeting on January 9, 2019 (15 participants).
- Basch, C. and E. Justen attended the Washington County CWMA Meeting. Christina talked about plans for bittersweet, Grecian foxglove and teasel eradication work on January 10, 2019 in Oakdale.
- Hardel, M. gave updates at the County Agricultural Inspector northeastern region meetings on January 10, 2019 and March 14, 2019 in Ogilvie.
- Russell, M. presented a talk titled "Perspectives and strategies for managing current forest health threats: Insights from a 2017 state-wide survey of land management agencies" on February 5, 2019 at the Chippewa National Forest's Forest Health Workshop in Walker, MN.
- Chandler, M. presented early detection and rapid response to target species at new county agricultural inspector training on February 12, 2019 (14 participants).
- Justen, E. provided noxious weed training to new CCM members on February 21, 2019 in Annandale (38 participants).
- Basch, C., M. Chandler and S. Blair trained new CCM in southern Minnesota to identify target species followed by Extension training on safe herbicide use on February 28, 2019 at Whitewater State Park (17 participants).
- Hardel, M. trained new CCM in northeastern Minnesota to identify target species on March 1, 2019 in Duluth (20 participants).
- Gupta, A. and M. Hardel trained workshop participants to identify target plants at a joint Society of American Foresters and Wildlife Society conference on February 21, 2019 in Duluth (20 participants).
- Basch, C. presented target plant identification and reporting at the Dakota County/Township meeting on March 5, 2019 in Farmington (25 afternoon session and 7 evening session participants).
- Basch, C. and M. Chandler presented about Japanese hops, poison hemlock and knotweeds to the Water Resources Advisory Committee on March 6, 2019 in Rochester (13 participants).
- Hardel, M. discussed target species status and management at the Cook County Invasive Team meeting in Grand Marais on March 6, 2019 (10 participants)
- Hardel, M. and M. Chandler provided an update at a northeastern region invasive species meeting on March 13, 2019 in Duluth (14 participants).
- Chandler, M. gave a presentation titled "Woody Invasive Plant Detection and Management Update" at the Shade Tree Short Course on March 19 and 20, 2019 in Roseville (12 and 23 participants respectively).
- Basch, C. presented on bittersweet, barberry and burning bush at the St. Croix River Association Forestry Conference March 28-29, 2019 in Siren, WI (35 participants).
- Basch, C. presented about target species at the Houston County/Township meeting on April 2, 2019 in Caledonia (22 participants).
- Basch, C. presented about Japanese hops and poison hemlock to landowners within infestation areas in Houston and Rushford on April 4, 2019 (5 and 15 participants respectively).

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- Chandler, M. presented a webinar titled "An update on invasive plants in Minnesota forests" as part of the Sustainable Forests Education Cooperative and UMN Extension Forestry Webinar Series on April 16, 2019 (45 participants). A recording is available at https://www.youtube.com/watch?v=yVamE7cefuY
- Hardel, M. discussed knapweeds and wild parsnip at the Koochiching Cooperative Weed Management Area meeting on April 17, 2019 in International Falls (17 participants).
- Chandler, M. discussed target species status and future management at the Ramsey County Cooperative Weed Management Area meeting on April 17, 2019 in Shoreview (9 participants).
- Basch, C. discussed target species management with the Wright Cooperative Weed Management Area meeting on April 17, 2019 (26 participants).
- Basch, C. discussed target species management at the Wabasha Cooperative Weed Management Area meeting on April 23, 2019 (27 participants).
- Hardel, M. presented about hybridizing target species at the Gathering Partners of Natural Resources conference on May 19, 2019 in Willmar (14 participants).
- We participated in spring 2019 MnDOT district meetings including weed identification training and weed management discussions at the following locations: Bemidji (4/24), Detroit Lakes (4/25), Arden Hills (5/10), Mankato (5/13), Rochester (5/15) and Duluth (5/30).

Status as of November 30, 2019
- Hardel, M. presented discussed wild parsnip identification at the Duluth CISMA's Parsnip Workshop in Duluth on July 9, 2019.
- Basch, C. provided updates at a Dakota County CWMA (Cooperative Weed Management Area) Steering Committee meeting on July 16, 2019. (20 participants)
- Hardel, M. presented identification information and control recommendations to the Itasca County Local Weed Inspectors on August 1, 2019. (30 participants)
- Hardel, M. assisted in the planning of and presented at the Duluth CISMA's Knotweed Workshop in Duluth on August 8, 2019. (53 participants)
- Chandler, M. provided updates at a Ramsey CWMA meeting on August 21, 2019. (10 participants)
- Hardel, M. gave project updates at the District 2 County Ag Inspector meeting on September 12, 2019 in Ogilvie.
- Chandler, M. provided project updates at MDA's Noxious Weed Advisory Committee on September 17, 2019 and November 21, 2019 in Arden Hills. (20 and 21 participants respectively)
- Hardel, M. attended the Duluth CISMA partner meetings on September 24, and October 12, 2019 in Duluth.
- Chandler, M. gave a project update at the Anoka CWMA meeting on September 24, 2019 in Andover. (24 participants)
- Basch, C. provided updates at a District 3 County Ag Inspector meeting on September 25, 2019.
- Hardel, M. participated in the Minnesota Department of Transportation district 1 vegetation team meeting in Virginia on October 10, 2019.
- Hardel, M. participated in a District 1 County Ag Inspector meeting on October 24, 2019 in Mahnomen.
- Hardel, M. gave a presentation on target species identification, reporting and management to environmentally focused local units of government at the 2019 BWSR Academy at Breezy Point Resort on October 29, 2019. (55 participants).
- Basch, C. provided updates at a District 4 County Ag Inspector meeting on November 6, 2019. (19 participants)

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- Basch, C. guest lectured about invasive plants at St. Cloud State University on 11/26/19. (3 participants)

Media
Mari Hardel is housed by the city of Duluth and was involved with the outreach below.
- City of Duluth Educates Community on Invasive Knotweed Plant
  https://www.fox21online.com/2019/06/03/city-of-duluth-educates-community-on-invasive-knotweed-plant/ (06/03/19)
- City of Duluth Mobilizing Public to Fight Invasive Species https://www.wdio.com/news/wild-parsnip-invasive-species-duluth-water-front-trail/5417655/ (07/09/19)

Final Report Summary:
We presented on topics related to this Tactical Plan at 3 field workshops, 2 field tours, 3 conference booths, 9 Noxious Weed Advisory Committee meetings, 6 County Agricultural Inspector meetings, 14 Cooperative Weed Management Area meetings and gave 38 presentations to a wide range of audiences.

Training to use this plan was provided to land managers. In person, regional workshops with a field tour were developed for this training scheduled for spring 2020. Sadly, the in-person workshops could not be held due to COVID 19. Instead, we developed an online course and held four, regional virtual workshops (135 participants). The Tactical Invasive Management Plan online course was delivered to 146 individuals representing federal, state, county, municipal and tribal natural resource and agricultural agencies. Individuals also represented nonprofits, private companies, and academic institutions. The online course was approximately four hours in length and was organized into eight different online modules to facilitate learning. Five videos that were recorded for the online course are also available as a YouTube playlist at
https://www.youtube.com/playlist?list=PLD3IcV9rnxDFZKFVVfTE698D83f1K7DY3

A peer-reviewed journal article highlighting the distribution modeling work has been published in the journal Scientific Reports. This paper describes the model distribution process and integrates it with future climate scenarios. The paper was led by Jason Reinhardt and co-authors:
Reinhardt, J., M.B. Russell, S. Senay, W. Lazarus. 2020. Assessing the current and potential future distribution of four invasive forest plants in Minnesota, U.S.A. using mixed sources of data. Scientific Reports 10(1):12738. https://www.nature.com/articles/s41598-020-69539-1

A peer reviewed journal article on multi-criteria invasive plant modeling. The paper was led by Jason Reinhardt and co-authors.
Reinhardt, J., M.B. Russell and W. Lazarus. 2020. Prioritizing Invasive Forest Plant Management Using Multi-Criteria Decision Analysis in Minnesota, USA. Forests https://www.mdpi.com/1999-4907/11/11/1213

At the Upper Midwest Invasive Species Conference (11/02/20 – 11/06/20), an interactive poster on ISMTrack and a talk on the ISMTrack app were presented. A presentation on the finalized Tactical Plan was given to MDA's Noxious Weed Advisory Committee on 11/17/20. Project dissemination will continue long after the project completion date. Materials developed for this project and the plan document are available on MDA's webpages.

VI. PROJECT BUDGET SUMMARY:
A. Preliminary ENRTF Budget Overview:
***This section represents an overview of the preliminary budget at the start of the project. It will be reconciled with actual expenditures at the time of the final report.**

Budget Category	$ Amount	Overview Explanation
MDA Personnel:	$ 102,000	One 3 year 50% time Plant Health Specialist 2 estimated salary $34,000/yr plus fringe benefits @ 50% for Activities 1 and 3 invasive plant data sharing and plan writing
MDA Travel Expenses in MN:	$ 4,000	Travel for Activity 1 for Plant Health Specialist and project manager. Mileage $2,400, lodging $1,000; meals $600
Contract with U of M	$ 190,000	
U of M Personnel:	$ 130,300	One year Research Associate (postdoc) salary $57,761/yr and fringe @ 22.4% for Activity 2 economic analysis; One 10% time Research Associate salary $6,900 and 33% fringe for 1 year for Activity 2 invasive plant distribution modeling; Two faculty one month summer salary $9,000 plus fringe 17% @ for 2 years for Activity 2 economic analysis and 3 years for invasive plant distribution modeling and outreach
U of M Professional/Technical/Service Contracts:	$ 53,000	Contract to UMN to build capacity of ISMTrack (Invasive Species Management Tracking System) to evaluate management activity outcomes ($10,000/year for 3 years) and to create an app that can work offline ($20,000) graphic design for outreach materials ($3,000)
U of M Printing:	$ 2,700	U of M outreach materials and printing
U of M Travel Expenses in MN:	$ 1,600	Meals ($35/workshop and field tour) and mileage ($200/workshop and field tour) for U of M instructors for 6 workshops = $1,410 and 4 overnight lodging ($550) for Activity 4 outreach workshops and field tours
U of M Other:	$ 2,400	Six regional field tours of invasion fronts and priority species for land managers. Anticipated attendance is 50 per regional tour = 300 total. Bus rental estimated $400/tour
TOTAL ENRTF BUDGET:	**$ 296,000**	

Explanation of Use of Classified Staff: NA

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 1.5

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

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Contract with U of M = 1.54
U of M Subcontract: 1,100 hours/2080 = 0.53
Total = 2.07

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$	$	
State			
MDA: Computing/software, GIS and data management, and project management for 3 years ($15,000) U of M: One Extension Educator and 2 faculty for 2 weeks/year for 3 years ($36,200)	$ 51,200	$ 51,200	
TOTAL OTHER FUNDS:	**$ 51,200**	**$ 51,200**	

VII. PROJECT STRATEGY:
A. Project Partners:
Partners receiving ENRTF funding

- Monika Chandler, Research Scientist (Invasive Species Specialist), MDA, $106,100, will oversee data sharing with counties and municipalities, writing a statewide management plan, creating webpages for communicating the plan and providing overall project coordination.

University of Minnesota, $190,732

- Matthew Russell, Assistant Professor, with assistance from Senait Senay, Research Associate, and Roger Becker, Professor, will conduct invasive plant distribution analysis and predictive modelling. Matthew Russell will be the project leader for U of M. Roger Becker will also provide expertise with best management practices.
- William Lazarus, Professor, and Brigid Tuck, Researcher 5, will conduct an economic analayasis of the invasive plant species listed for this project.
- Angela Gupta, Extension Professor, with Matthew Russell will lead the development of educational materials and plan communication.

Partners NOT receiving ENRTF funding
The following persons will provide technical expertise and review the invasive plant management plan.

- Trent McCorkle, Rice County Agricultural Inspector, Minnesota Association of County Agricultural Inspectors
- Laura Van Riper, Terrestrial Invasive Species Coordinator, DNR
- Kenneth Graeve, Roadside Vegetation Manager, MnDOT
- David Hanson, Roadside Vegetation Manager, MnDOT
- Daniel Shaw, Senior Ecologist/Vegetation Specialist, BWSR
- Robert Venette, Minnesota Invasive Terrestrial Plants Pest Center Director, U of M
- James Calkins, Government Relations, Minnesota Nursery Landscape Association

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B. Project Impact and Long-term Strategy:
State and local partners jointly developed this proposal and will create an invasive plant management plan that is workable. CWMAs are an excellent vehicle for implementation. If there is a need, we would submit a future proposal to develop cohesive regional strategies and timelines with the CWMA program. After the plan is implemented, we anticipate more efficient and coordinated control of priority species. This will result in better protection of habitat and native species from invasive plants. We also anticipate that research and mapping needs will be identified. The plan framework will be valid for at least 10 years. The plan will be a dynamic document online with embedded live maps of invasion fronts to show changes based upon new invasive plant reports over coming years. Project partners will review the plan every five years. Ideally, the invasive plant distribution predictions and economic analysis would be updated every decade if funding permitted.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
Elimination of Target Invasive Plant Species Phase 1 project $350,000 from ENRTF, 33,993 MDA general fund for salary, $50,000 MDA in-kind and $35,000 U of M in-kind. This project was early detection and rapid response to emerging invasive plants. The focus on widespread species in proposed project is different.	07/01/2013 – 06/30/2016	$ 468,933
Elimination of Target Invasive Plant Species Phase 2 project is recommended for funding $750,000 from ENRTF and $92,050 in-kind ($30,000 MDA, $20,830 CCM, $22.500 St. Croix River Assoc. and $18,700). The focus on widespread species in proposed project is different.	07/01/2016 – 06/30/2016	$ 842,030
		$ 1,310,963

VIII. REPORTING REQUIREMENTS:
- The project is for 3 years, will begin on 07/01/2017, and end on 06/30/2020.
- Periodic project status update reports will be submitted November 30 and May 31 of each year.
- A final report and associated products will be submitted between June 30 and August 15, 2020.

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IX. VISUAL COMPONENT or MAP(S):

Tactical Invasive Plant Management Plan Development

Integrate best management practices

Define invasion fronts, predict spread and economic analysis

Outreach and education

State and local data sharing

Prioritize and Plan Invasive Plant Management

Build capability to evaluate management outcomes

Common Buckthorn Reports

Legend

County

Buckthorn Reported

Report Density

0 - 99
100 - 230
231 - 380
381 - 550
551 - 800
801 - 1,120
1,121 - 1,470
1,471 - 1,831
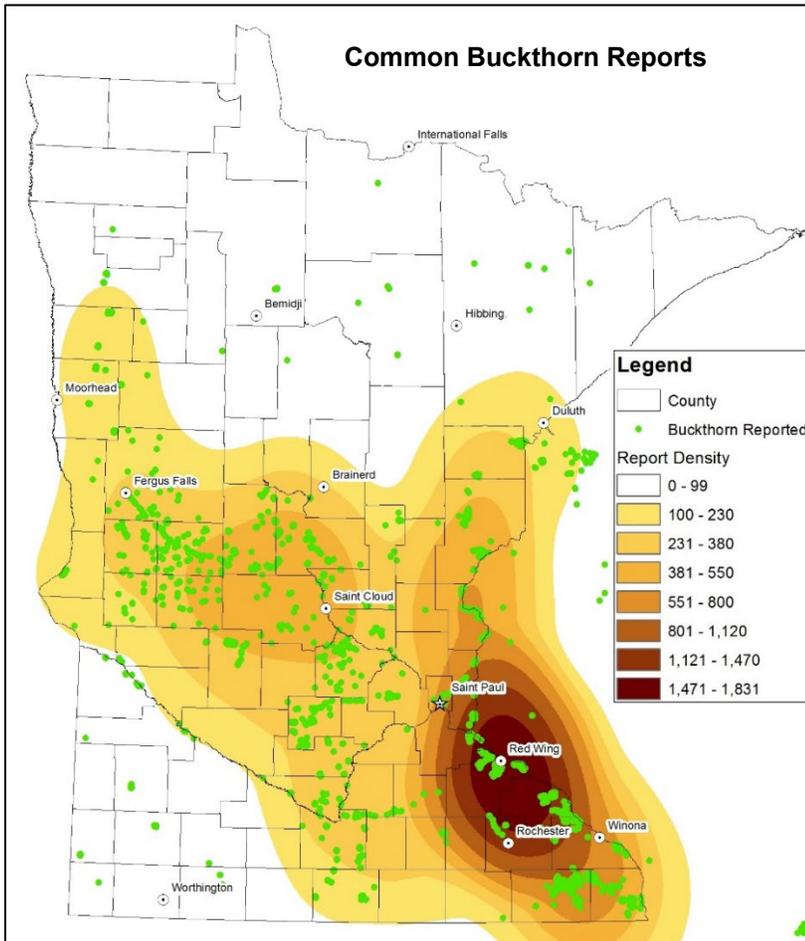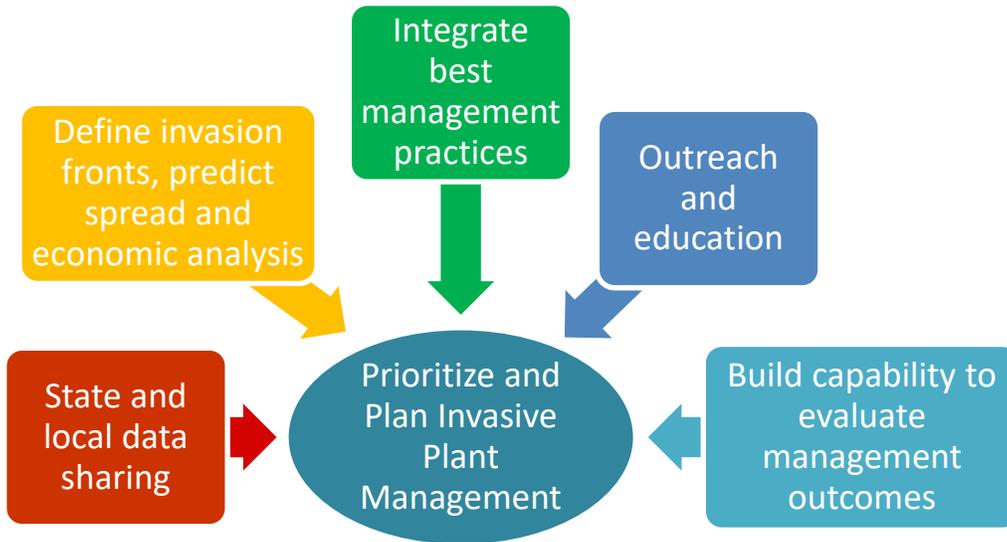
This heat map of common buckthorn reports shows it is abundant in some areas of the state, but is an early detection target in northern and southwestern Minnesota.

We aim to predict the spread of buckthorn and other species based upon habitat suitability and do an economic analysis to inform decision making about priorities.

Buckthorn fruit with seed

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Environment and Natural Resources Trust Fund
M.L. 2017 Project Budget

Project Title: Tactical Invasive Plant Management Plan Development
Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 6e
Project Manager: Monika Chandler
Organization: Minnesota Department of Agriculture
M.L. 2017 ENRTF Appropriation: $ 296,000
Project Length and Completion Date: 3 Years, June 30, 2020
Date of Report: September 30, 2020

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget 11/24/20	Amount Spent	Activity 2 Balance	Activity 3 Budget 11/24/20	Amount Spent	Activity 3 Balance	TOTAL BUDGET 11/24/20	TOTAL BALANCE
BUDGET ITEM	*Data management & plan development*										
Personnel (Wages and Benefits)	$102,000	$101,777	$223							$102,000	$223
Two 2.5 year 25% time Plant Health Specialist estimated salary $34,000/yr plus fringe benefits @ 50% for Activity 1 invasive plant data sharing and plan writing											
Travel expenses in Minnesota											
Travel for Activity 1 for Plant Health Specialist and project manager. Milage $2,400, lodging $4,500; meals $4,300	$4,000	$3,900	$100							$4,000	$100
Professional/Technical/Service Contracts											
Contract with U of M total is $ 190,000											
U of M Personnel (Wages and Benefits)				$136,343	$136,343	$0	$2,958	$2,958	$0	$139,301	$0
Research Associate salary for 1.25 years at $57,761/yr and fringe @ 22.4% for Activity 2 economic analysis											
One 10% time Rearch Associate salary $6,900 and 33% fringe for 1 year for Activity 2 invasive plant distribution modeling											
One faculty one month summer salary $9,000 plus fringe 17% @ for 3 years for invasive plant distribution modeling and outreach											
One part-time Natural Resources Program Coordinator for 12.5% time for four months to develop outreach materials											
U of M Subcontract											
Activity 3: Build ISMTrack (Invasive Species Management Tracking System) capacity to evaluate management outcomes ($10,000/year for 3 years) and create an app ($20,000)							$50,000	$50,000	$0	$50,000	$0
U of M Printing											
Outreach materials printing							$78	$78	$0	$78	$0
U of M Travel expenses in Minnesota											
Meals ($35/workshop and field tour) and mileage ($200/workshop and field tour) for U of M instructors for 6 workshops = $1,410 and 4 overnight lodging ($550)							$621	$621	$0	$621	$0
U of M Other											
Six regional field tours of invasion fronts and priority species for land managers. Anticipated attendance is 50 per regional tour = 300 total. Bus rental estimated $400/tour							$0	$0	$0	$0	$0
COLUMN TOTAL	**$106,000**	**$105,677**	**$323**	**$136,343**	**$136,343**	**$0**	**$53,657**	**$53,657**	**$0**	**$296,000**	**$323**

List of Project Materials Developed

PROJECT TITLE: Tactical Invasive Plant Management Plan Development
PROJECT MANAGER: Monika Chandler
AFFILIATION: Minnesota Department of Agriculture
MAILING ADDRESS: 625 Robert St. N.
CITY/STATE/ZIP: St. Paul, MN 55114
PHONE: 612-327-3857 (mobile), 651-201-6537 (office)
E-MAIL: monika.chandler@state.mn.us
WEBSITE: www.mda.state.mn.us/tactical-invasive-plant-management-plan and www.mda.state.mn.us/plants-insects/noxious-invasive-weed-program
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2017, Chp. 96, Sec. 2, Subd. 06e

A Tactical Invasive Management Plan was developed for 14 species to improve the coordination and efficacy of managing these species at state and local levels. Materials developed for this plan were integrated into Minnesota Department of Agriculture (MDA) webpages. Species webpage urls are included below with urls for Lifecycle and Treatment Timing Graphics and interactive Management Prioritization maps. The Lifecycle and Treatment Timing Graphics and Management Prioritization maps were developed for this project. The graphics and maps were developed for this project.

Species	Species Webpage	Lifecycle and Treatment Timing Graphic	Management Prioritization
Canada thistle	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/canadathistle	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Canada%20Thistle%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/36840dcb78d746f0bc149e7ff2436630
Common buckthorn	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/commonbuckthorn	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Common%20Buckthorn%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/f8a5ec3171874338a4de93a92aab9d5c
Common tansy	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/commontansy	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Common%20Tansy%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/b93fbe435cf1439b9f1edaaa22fd4d2c
Garlic mustard	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/garlicmustard	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Garlic%20Mustard%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/71346bdd57364eac933e73617cf665ca
Glossy buckthorn	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/glossybuckthorn	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Glossy%20Buckthorn%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/c9e60597617e4763b69c8a76789bba2f
Knotweeds	www.mda.state.mn.us/bohemian-knotweed www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/knotweed	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Knotweeds%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/cc0837ab73c64ad495ac62a0726f005f
Leafy spurge	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/leafyspurge	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Leafy%20Spurge%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/8afd936efb244b61abfec2b6fb5b95b5
Multiflora rose	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/multiflorarose	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Multiflora%20Rose%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/479e91c2346942088215aefe85bdfa55
Narrowleaf bittercress	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/bittercress	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Narrowleaf%20Bittercress%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/54994c00b9364b5fb02b2ff55999084e

Species	Species Webpage	Lifecycle and Treatment Timing Graphic	Management Prioritization
Plumeless thistle	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/plumelessthistle	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Plumeless%20Thistle%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/ab776b379b004e5cb4d64bbbbac07ce0
Purple loosestrife	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/purpleloosestrife	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Purple%20Loosestrife%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/27c409a25ba4404395dd52db5116e13a
Spotted knapweed	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/spottedknapweed	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Spotted%20Knapweed%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/0065990c94f849f7b96a546342803c2f
Wild parsnip	www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/wildparsnip	bugwoodcloud.org/mura/mipn/assets/File/Educational%20Resources/Wild%20Parsnip%20new%208_5x11%20(locked).pdf	storymaps.arcgis.com/stories/30c23db120784ad092092a266c15450e

A peer-reviewed journal article highlighting the distribution modeling was published in the journal Scientific Reports. This paper describes the model distribution process and integrates it with future climate scenarios. The paper was led by Jason Reinhardt and co-authors:

> Reinhardt, J., M.B. Russell, S. Senay, W. Lazarus. 2020. Assessing the current and potential future distribution of four invasive forest plants in Minnesota, U.S.A. using mixed sources of data. Scientific Reports 10(1):12738. https://www.nature.com/articles/s41598-020-69539-1

A peer reviewed journal article on multi-criteria invasive plant modeling. The paper was led by Jason Reinhardt and co-authors.

> Reinhardt, J., M.B. Russell and W. Lazarus. 2020. Prioritizing Invasive Forest Plant Management Using Multi-Criteria Decision Analysis in Minnesota, USA. Forests https://www.mdpi.com/1999-4907/11/11/1213

An invasive plant survey summarizing information from questions we posed to landowners and public land professionals regarding invasive weed management costs, approaches, concerns, and other topics published as a University of Minnesota Staff whitepaper and is available online at:
https://www.forestry.umn.edu/sites/forestry.umn.edu/files/russell_survey_staffpaper_final.pdf.

We created an online course to train professionals about the Tactical Plan. A University of Minnesota account and an invitation are needed to access the course. Five videos that were recorded for this online course are also available as a YouTube playlist at
https://www.youtube.com/playlist?list=PLD3IcV9rnxDFZKFVVfTE698D83f1K7DY3

A poster titled Gearing up for Knotweed Management in Duluth Minnesota by M. Hardel, J. Flory and L. Seele was presented at the Upper Midwest Invasive Species Conference in 2018. The poster file is attached.