2016 Project Abstract
For the Period Ending June 30, 2020

PROJECT TITLE: Elimination of Target Invasive Plant Species – Phase II

PROJECT MANAGER: Monika Chandler, MDA, and Angela Gupta, UMN Extension
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WEBSITE: https://www.mda.state.mn.us/plants-insects/noxious-invasive-weed-program
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2016, Chp. 186, Sec. 2, Subd. 06e

APPROPRIATION AMOUNT: $511,000 to MDA and $239,000 to UMN
AMOUNT SPENT: $ 511,000 (depended on rebudget) and $237,061
AMOUNT REMAINING: $ 0 and $1,939

Sound bite of Project Outcomes and Results
We educated about, found, documented and managed highly damaging invasive plant populations before they spread statewide. We also initiated a response to Palmer amaranth in conservation plantings that was continued by the project Palmer Amaranth Detection and Control. Mitigating these invasive plant threats protected Minnesota forests, grasslands and riparian areas.

Overall Project Outcome and Results
The goal was to eliminate highly damaging target invasive plants before they became widespread by 1) training people to identify and report invasive plants, 2) survey, coordinate control and monitor target plants, 3) control target plants and 4) implement the invasive species management database system from Phase 1. Targeted plants that cause severe ecological harm include black swallow-wort, dalmatian toadflax, cutleaf and common teasels, Grecian foxglove, Japanese hops, brown and meadow knapweeds, Oriental bittersweet and Palmer amaranth.

University of Minnesota Extension led the education and outreach efforts outlined in the dissemination section. The drone team transitioned from research to survey work by testing several different types of drones, cameras, weather conditions and self-produced and commercial post-processing software. We determined that surveying for Oriental bittersweet is best done with sturdy quadcopter drones and a high quality camera on mild winter days after leaf drop but with snow on the ground so the red fruit is most visible. High quality, stitched-together and geo-coded maps can now be produced in post processing and inform accurate eradication efforts.

The Minnesota Department of Agriculture (MDA) and Conservation Corps Minnesota (CCM) led invasive plant management. MDA led survey, invasive plant report follow up, monitoring and coordinated control with landowners and partners. CCM led the control effort with 157 unique crew members working on this project.

Plant Name	New Infestation Reports*	New Infestation Acres Reported	Acres Treated**
Black swallow-wort	5	5	9
Dalmatian toadflax	no new reports	0	828
Common teasel	6	1	302
Cutleaf teasel	99	65	1,832
Grecian foxglove	119	47	1,368
Japanese hops	202	85	8,171
Brown/meadow knapweeds	343	351	97
Oriental bittersweet	203	2,937	1,462
Total	**977**	**3,490**	**14,070**

*New infestation reports were recorded during the project period. We continued control work on infestations identified during our Phase 1 project (2013-2016).

**Acres were spot treated because the invasive plants were scattered within some large areas. Many infestations were treated in multiple years and the acreage of each treatment was recorded and included in the total.

This project enabled us to find, document and manage infestations before they spread. We also initiated a response to Palmer amaranth in conservation plantings that was continued by the project Palmer Amaranth Detection and Control. Mitigating these invasive plant threats protected Minnesota forests, grasslands and riparian areas.

Project Results Use and Dissemination

University of Minnesota Extension led the education and outreach funded specifically by this project. Reaching 1,108 people via 11 workshops, field tours and public and professional presentations. Developed two national award winning videos: Planning invasive species events: Tips for working with volunteers and Planning invasive species events: Working with a natural resources professional. Created 14 innovative educational materials including: 3D-printed models of Palmer amaranth, Japanese hops and Grecian foxglove; pull-up banners for Palmer amaranth and giant hogweed; and identification kits available at the public library for Palmer amaranth, wild parsnip and Oriental bittersweet. Produced two new educational handouts and printed and distributed about 10,875 educational materials.

In addition, the University of Minnesota and Minnesota Department of Agriculture (MDA) team members won numerous national, regional and state awards for effort including this project, from across an impressively wide spectrum of content areas. There were 13 media pieces about project activities; 13 presentations or booths reaching 5,137 gardeners, tribal youth, Extension volunteers and others; and 30 presentations or posters at 14 different professional conferences representing a broad spectrum of expertise reaching almost 1,000 natural resource or invasive species professionals. Two professional, peer reviewed articles were published that reference this work. MDA organized and led 6 field tours, gave 43 presentations, provided project updates at 32 meetings, authored 14 articles, sent an annual report to stakeholders and trained Conservation Corps Minnesota crew members at multiple workshops each year.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2019 ENRTF Final Report (Main Document)

Date of Report: August 15, 2020

Date of Next Status Update Report: **Final Report**

Date of Work Plan Approval: June 7, 2016

Project Completion Date: June 30, 2020

PROJECT TITLE: Elimination of Target Invasive Plant Species – Phase II

Project Manager: Angela Gupta

Organization: University of Minnesota Extension

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Web Address: https://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/targetplants

Location: Statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$239,000**
	Amount Spent:	**$237,061**
	Balance:	**$1,939**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06e2

Appropriation Language:
$750,000 the second year is from the trust fund. Of this amount, $511,000 is to the commissioner of agriculture and $239,000 is to the Board of Regents of the University of Minnesota to train volunteers and professionals to find, control, and monitor targeted newly emergent invasive plant species. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2019 ENRTF Final Report (Main Document)

I. PROJECT TITLE: Elimination of Target Invasive Plant Species - Phase 2

II. PROJECT STATEMENT: Eliminating highly damaging target invasive plant species before they become widespread prevents ecological and economic damage. Currently, these species have limited distributions in Minnesota. It is feasible to control them before they proliferate by continuing the strategic effort initiated in Phase 1. To date, we trained 521 people to identify target invasives, surveyed over 10,000 acres, initiated control on 450 acres and are developing an invasive species management database system with broad applicability for terrestrial and aquatic invasives. We will continue these activities in Phase 2. In addition, we will expand our training capacity by developing online training, test whether a drone will increase survey efficiency and add to the target species list.

Target Invasive Plant List: Species include but are not limited to the following. They are listed in order of feasibility to eradicate based upon their abundance and distribution. All target species are prohibited noxious and invasive weeds on the eradicate list (Minnesota Statutes, Section 18.78) providing a legal backing.

1. **Black swallow-wort** is a milkweed vine that overgrows other vegetation. Small infestations have been reported in Hennepin and Ramsey Counties and are being controlled. (New in Phase 2)
2. **Dalmatian toadflax** forms dense stands in grasslands and reduces biodiversity, wildlife habitat, and livestock production. Infestations in the Halma and Lutsen areas are reduced but not eliminated yet.
3. **Cutleaf and common teasels** overtakes grasslands and riparian areas reducing species diversity and wildlife habitat. There are scattered infestations in southeastern Minnesota. (Common teasel is new in Phase 2)
4. **Grecian foxglove** is highly toxic to humans, wildlife, and livestock. It also displaces native plants. As of spring 2015, most infestations are in Washington County.
5. **Japanese hops** are annual vines that grow so rapidly that they smother other plants. There is an extensive infestation along the Root River and a small infestation on the Mississippi.
6. **Brown and meadow knapweeds** are spreading across meadows in northern Minnesota. (New in Phase 2)
7. **Oriental bittersweet** is a woody vine that is destroying swaths of forest in Red Wing and Winona by girdling and breaking the trees then covering and shading the remains so that little else grows.
8. **Palmer amaranth** is an annual plant native to the arid southwestern United States and northwestern Mexico. It has spread to the southeastern and Midwestern US and become problematic. It grows very quickly to heights reaching 10 feet. It also produces massive amount of seed. These qualities give it a competitive advantage against row crops and native vegetation plantings. During the battle against Palmer amaranth, this plant developed resistance to multiple classes of herbicides. Palmer amaranth now causes extensive losses where it is abundant including in corn and soybeans. (Added in an approved amendment in Phase 2)

Our long-term goal is to eradicate these problematic species from Minnesota to protect forest and grassland habitats. All of the invasive plants listed harm natural areas and degrade wildlife habitat.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of November 30, 2016:
We hired Dawn Littleton, the new Extension Invasive Plant Program Coordinator, purchased two tablets and data, started training on ISMTrack, tried one unmanned aerial vehicle launch and completed several presentations at professional conferences about this project.

Amendment Request November 30, 2016:
We request the addition of Palmer amaranth, *Amaranthus palmeri S. Watson*, to the Target Invasive Plant List above. This will allow us to explicitly include Palmer amaranth in the workshops and training opportunities already included in this project. We are not asking for a budget amendment.

Project Status as of May 31, 2017:
During this project period we completed 3 weed identification trainings reaching 183 natural resource professionals; engaged 100s of volunteers, citizens and other natural resource professionals at 8 programs with our 3D printed weed models, and updated and printed various educational materials. On March 23, 2017 we launched 4 unmanned aerial vehicle (UAV or drones) flights at Memorial Park in Red Wing, MN and learned a great deal about camera quality, type and size of UAV and which aspects of equipment and data processing to improve as we continue to survey for Oriental bittersweet. Extension trained 220 pesticide applicators on ISMTrack invasive species management tracking software, established a naming convention for ISMTrack private properties to be respectful of homeowner privacy, and purchased 18 more tablets for use by Extension and Conservation Corps Minnesota (CCM) while using ISMTrack. This work was disseminated in 8 media articles, 2 academic/professional presentations, and in 8 presentations to natural resource professionals, volunteers or citizens reaching 514 individuals.

Amendment Request 7/5/17
We are adding one month of AmeriCorps volunteer time to work on video production ($1,650); this money was allocated for the Project Coordinator but she didn't start until November so we're hoping to back-fill some of her work and salary to complete this activity.
Approved 7/6/17

Project Status as of November 30, 2017:
Our long-term, dedicated, innovative and collaborative network is even more effective and efficient in controlling prohibited species through our continued work. Our network of natural resource professionals, volunteers, landowners and others are increasingly engaged and informed as we create new partners (e.g. American Public Works Association of MN). Since our report last May, we have spoken to over 450 community members interested in learning about invasive species and trained over 200 pesticide applicators seeking their license. Our web presence is growing as we have developed or improved three online materials for poison hemlock and Oriental bittersweet viewed thousands of times in a few short months and reviewed very positively by UMN Natural Resources faculty. We have presented at four national and international conferences. Our new audiences include the Regional Parks and Trails Commission and Prairie Island Indian Community. We have realized this work has enabled our extensive network in Minnesota to become a national leader and budding world leaders via our holistic and synergistic methods. There is still much to be done but thank you for the funding that enables Minnesota the opportunity to be a world leader in collaborative invasive species early detection and management!

Project Status as of May 31, 2018:
ETIPS 2 MDA, UMN, CCM staff visit UMN Aerospace Lab after a team's meeting in May:

I start this Project Status report with a team photo, because without this great team this project would not be getting done! Please note this pictures includes University, MDA and CCM staff. A strong collaboration even in trying times!

Since our last report in November Extension and the UMN, with the help of the above project team, has: completed 2 Weed 'Em Out workshops (96 participants); participated in 7 additional presentations to 435 community members; printed 500 more educational resources; developed 2 new 3D invasive plant models plus 2 new large educational invasive plant identification banners; tested and started developing new UAS software for drone image assessment; and had 1 media article.

Amendment Request 5/31/18:
Do to serious unplanned health issues Extension's Invasive Plants Coordinator has only been able to work about half of her full time position since last September. Unfortunately this situation is likely to continue for the foreseeable future. The good news is the whole Elimination of Target Invasive Plant Species – Phase II team, including Extension, the MDA and CCM, are on target to finish all grant deliverables on time and within budget; however that accomplishment is do to incredible team commitment, extra (unpaid) hours by team leaders and this, and possible future, amendment requests.

This Amendment Request is to:

1. Move $45,000 from the Extension's Invasive Plants Program Coordinator salary to a new contract for service budget item, in Extension's budget, to enable CCM to continue their eradication and survey work (Activity 3 on the MDA budget). Additionally, Extension will take on some CCM management tasks

related to the $45,000 CCM contract, and the MDA will take some of the Activity 4 ISMTrack training duties, previously done by Extension. We are not requesting a budget change in the total amount; only a change in work team responsibilities and budget allocation as we accommodate the health issues of Extension's Program Coordinator.

2. A smaller budget Amendment Request is to move $2,211 from Activity 4 to Activity 1 "materials for training" to support additional printing of the Minnesota Noxious Weeds book, a key educational material for Weed 'Em Out workshops. Activity 4 deliverables are well-in-hand and unlikely to require the $2,211 money we'd like to move.

It's possible Extension will need, at the end of the project period, a no-cost extension. During which we'll keep the Program Coordinator on, at reduced hours allowable by her doctor and the budget, to continue the project until her salary is exhausted.
Approve 6/14/2018

Project Status as of November 30, 2018:
Since our last report UMN Extension has produced a Palmer amaranth identification kit that can be checked-out from any public library in the state, completed two online videos about how to lead, organize and host invasive species removal events, and taught a 2 day Invasive Species Instructor Training in Mankato. Our unmanned aerial vehicle (UAV) work has benefited from similar work related to Palmer amaranth and applied that new information to test and improve the capabilities of our survey system and is learning how to efficiently use a new UAV (drone). This reporting period had many dissemination opportunities including a new invasive species field guide produced by the UMN Extension; successful applications of new 360/virtual reality glasses videos for Oriental bittersweet education; a large and well visited augmented reality display in the 4-H building at the MN State Fair; 6 professional presentations at the Upper Midwest Invasive Species Conference (UMISC) that touched on this work; the launch of a new program, EmpowerU, to help citizens engage decision makers in invasive species management; and last, but certainly well deserved, several members of this project team won the Team Achievement Award from the Minnesota Invasive Species Advisory Council at UMISC for their great work in early detection and rapid response in SE Minnesota.

Project Status as of December 21, 2018:
Amendment Request (12/21/18): Amendment Approved by LCCMR 1/15/19.
Activity 1 bus rental in Mankato was more expensive than anticipated. We were able to partner closely with the MN Master Naturalist program to reduce materials spending by tapping into donated materials from Play Clean Go and the Master Naturalist Foundation. This budget amendment moved $700 from Activity 1 Materials to cover the unexpectedly high Activity 1 Bus rental.

Project Status as of May 31, 2019:
I'm delighted to report our educational video series was a national Gold Award from the Association of Natural Resource Extension Educators. While we're on target to reach grant deliverables the extensive and severe medical issues of key staff has necessitated a request for a no-cost one year extension and another budget related amendment request. Extension and project partners completed 2 additional Weed 'em Out workshops (104 participants), one intended field training (moved indoors because of flooding) to 6 master volunteers, and the 4 remaining library kits are almost complete.

Amendment Request as of May 31, 2019: Amendment Request signed into law 5/31/19
We request to amend completion dates from 06/30/2019 to 06/30/2020. Final payment for the high quality videos was $3,000 more than expected. I request permission to use money currently allocated to Program Coordinator staff salary (unused because of medical issues) to cover that expense. In addition, I request

permission to transfer the anticipated unused Program Coordinator staff salary of $13,786, after the position ends on June 30, 2019 to increase the CCM Contract by that amount: $13,786.

Project Status as of November 30, 2019:
I'm delighted to note that the dissemination of this report includes six awards for materials, ideas or people for work associated with this project! In addition our UAS (unmanned aerial system) has transitioned from research to Oriental bittersweet survey work that precedes eradication efforts. In addition the final 4 noxious weed library identification kits are in the library system via the Rochester public library.

Amendment Request as of November 30, 2019: Amendment Approved by LCCMR 01/22/20
As we continue to finish this project and because of the major health issues of the project coordinator hired to do much of Extension's work, I'm requesting one final rebudget. Dawn Littleton completed her tenure with Extension on June 30 and the dust has settled on the remainder of her intended salary and the final estimated costs to compete all the grant deliverables.

Activity 1:
I am requesting a rebudget to actually reflect Dawn's actually paid salary, slightly less than expected display materials expenses, and increased expenses for workshop materials to cover a new printing of the MN Noxious Weed book that will reflect new changes in the MN Noxious Weed Law for 2020 and a tiny adjustment to travel.

Activity 2:
I'm requesting a slight increase in Curt Olson's salary so he can continue to work on Oriental bittersweet drone surveys during this unexpected 4th year of the project this money is left from Dawn's unused salary because of her unexpected medical issue.

Activity 3:
With the final salary payment to Dawn and the team decision to have Curt work more on this project during the winter 2019-2020, we're requesting a slight decrease, $3,708, in the new CCM crew time for a new contract of $10,078. This will complete the original salary that was intended, at the grant initiation for Dawn, Extension's program coordinator, but couldn't be spent because of her medical issues.

Activity 4:
We're requesting a $499 overall reduction to reflect the final expenses for Extension's work on this activity because MDA partners took over this task in a reallocation of Dawn's work in the November 2018 Work Plan Report.

Amendment Request April 3, 2020
In response to COVID 19 social distancing guidelines and Governor Walz' Stay at Home order, we request to reassign 6 CCM field specialists from invasive plant control to aerial image analysis. This work can be done safely from home and will further project progress. This would increase the scope of work that CCM does.

Tens of thousands of aerial images of Oriental bittersweet infestations were collected with drone flights. An automated process for image analysis to find Oriental bittersweet has not been invented yet. By having the field specialists review and mark Oriental bittersweet on images, we gain their analysis. We also gain data about analysis patterns that may inform machine learning/artificial intelligence development for future image analysis.

There is no budget amendment request; the budget will remain the same.

Overall Project Outcomes and Results:
For consistence this abstract is the same as the MDA's because this was a joint project.

Amendment request: For the Period Ending June 30, 2020, we request a small budget revision, moving $358 from Activity 2: Personnel to increase Activity 1: Professional/Technical/Service Contracts by $60 and Activity 1: Equipment/Tools/Supplies by $298.

Amendment Approved by LCCMR 10/27/2020

2016 Project Abstract

Sound bite of Project Outcomes and Results

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University of Minnesota Extension led the education and outreach efforts outlined in the dissemination section. The drone team transitioned from research to survey work by testing several different types of drones, cameras, weather conditions and self-produced and commercial post-processing software. We determined that surveying for Oriental bittersweet is best done with sturdy quadcopter drones and a high quality camera on mild winter days after leaf drop but with snow on the ground so the red fruit is most visible. High quality, stitched-together and geo-coded maps can now be produced in post processing and inform accurate eradication efforts.

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IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Train People to Identify and Report Target Invasive Species
Description: University of Minnesota (U of M) will train professionals, volunteers and impacted landowners to prevent, identify, report, monitor and manage target species. The U of M Extension will deliver educational trainings to:

A. Natural resource professionals to identify terrestrial invasive species of special concern and native plant species that could be confused with these invasives (2 workshops per year),
B. Natural resource professionals and volunteers will conduct target invasive species surveys (2 surveys/workshops),
C. Minnesota Master Naturalist Instructor Training - a weekend-long training and field tour dedicated specifically to terrestrial invasive species of special concern, their prevention, identification, reporting, monitoring and management to incorporate this information into Master Naturalist volunteer trainings across the state. (1 event),
D. Develop supportive, online training and outreach materials for Invasive Blitz volunteers (Master Naturalist and other master volunteers that lead invasive species removal activities in their community). This will include a video with volunteer management considerations like training volunteers, risk assessments and recruiting and maintaining active volunteers.

We will create 5 high quality traveling learning material kits about target invasive species that can be checked-out by natural resource professionals and volunteers.

This work will be done across the state. An effort will be made to find free workshop locations. It may be necessary to charge workshop participants a registration fee to cover room rental (if free room is not available) and food costs for all day and weekend workshops. Registration fees would go to Extension. In the event that workshop registration received exceeds workshop costs, Extension will use these funds for outreach for Environmental and Natural Resources Trust Fund projects. Training partners include the University of Minnesota, Extension, Minnesota Departments of Agriculture, Natural Resources and Transportations, and various local partners.

Summary Budget Information for Activity 1:

ENRTF Budget:	**$150,268**
Amount Spent:	**$150,186**
ENRTF Balance:	**$82**

Outcome	Completion Date
1. 9 Statewide training sessions/workshops/field trainings conducted and evaluated	06/10/2020
2. Develop online training and outreach materials that are publicly available	06/10/2019
3. Create high quality display materials and 5 invasive plant learning kits for check out by educators (schools, nature centers, master gardeners, etc.) and agency staff for outreach	06/10/2020

Activity Status as of November 30, 2016:

- Hired Dawn Littleton, Extension Invasive Plants Program Coordinator. She started on November 1. Dawn has been a dedicated invasive species volunteer for years through the Master Naturalist program and a co-founder of the Friends of Indian Heights Park in Rochester. She's also worked with Dakota and other Native American peoples through her extensive volunteering at Indian Heights. She's following her passion and shifting careers to invasive plants from her former position as Head of Public Services at the Mayo Clinic Libraries where she's been a librarian and supervisor. She has a PhD in Work, Community, and Family Education from the UMN.
- Have started exploring options to get invasive plant display/educational materials into the UMN Library system including 3D models for their collections and circulation.

Activity Status as of May 31, 2017:

- Conducted 3 Weed 'Em Out workshops in Virginia (3/29/17), Morris (4/18/17) and Baxter (5/3/17) to 183 natural resource professionals and road maintenance professionals.
- Printed: 400 copies of the 2017 Minnesota Noxious Weeds booklet from MnDOT.
- Printed: 2,000 MDA Arrest the Pest stickers after updating with GLEDN app contact information.

- Printed: 7,000 MDA Oriental Bittersweet brochures after updating with new web address.
- 3D print materials development: project partners are working to develop new mixed media educational displays. Current 3D weed models were used at 8 different events statewide to engage managers, volunteers and citizens in MN Noxious Weed education. This is in addition to the workshops above.

Activity Status as of November 30, 2017:

- Because of audience demand, printed 500 additional copies of the 2017 Minnesota Noxious Weeds booklet from MnDOT with Minnesota Department of Agriculture funds ($4,175).
- Olmsted County Fair Conservation Building booth entitled **"ID or Report Minnesota's BAD Plants"** viewed by ~200 fair visitors.
- **Weed 'Em Out workshop**, trained about 80 CCM and Nature Conservancy staff (Red Wing, 6-12-17)
- UMN Extension Education booth at the Stewards of Hope/People of Hope trail opening celebration viewed by ~75 attendees and Master Naturalists (Rochester, 8-2-17)
- UMN Extension **Terrestrial Invasive Species Education** booth for "Starry Trek" AIS Day viewed by ~25 attendees (Winona, 8-5-17)
- Toured Prairie Island Indian Community with Gabe Miller, Prairie Island's Environmental Program Manager, to see success and challenges of managing invasives on a reservation (Prairie Island 8-4-17)
- Presented to the American Public Works Association Minnesota Chapter, **"Minnesota's Noxious Plants and their Look-A-Likes"** ~60 in attendance (Brooklyn Center, 11-16-17)
- Presented to the American Public Works Association Fall Expo **"Minnesota's Noxious Plants and their Look-A-Likes"** ~35 in attendance (St. Cloud, 10-5-17)
- **"Parks and Invasive Plants"** presented at the Greater Minnesota Parks & Trails Association Annual Meeting Association ~45 in attendance (Little Falls, 10-18-17)
- Prepared 35 CCM members using hands-on demos and practice to distinguish Oriental bittersweet from other vines immediately prior to CCM Red Wing and Winona eradication work (August and September)
- Working with the UMN Center for Agriculture, Food and Natural Resources Business Development Coordinator in developing a system to create, sell and market multi-media models for invasive species identification education. Expect to have 3D models of invasive species for sale in January 2018. From those models we're also developing 3D digital images for invasive species education. These educational outreach materials are being developed, expanded and enhanced through connections with Extension's Communication team and the U's Advanced Imaging Service for Objects and Spaces (AISOS) lab as our network members learn the possibilities of new technologies for target invasive species detection and eradication.
- Established dedicated email: InvasiveEd@umn.edu for learners and instructors and furthered collaboration with invasive species specialists for creation of learning materials.

Activity Status as of May 31, 2018:

- Conducted 2 Weed 'Em Out workshops in Duluth (3/27/28) and in Chaska (4/4/18) for 96 natural resource professionals and road maintenance professionals.
- Extension's Program Coordinator presented Houston County Invasive Plants and their look-alikes (2/13/18) in collaboration with Mike Cruse, Extension Educator in SE Minnesota with 30 attendees.
- Printed 500 copies of the new 2018 DOT Minnesota Noxious Weeds book. This printing included poison hemlock and Japanese barberry updates.
- Developed 2 new 3D printed Palmer amaranth models of the rosette and flower.
- Developed 2 new educational, large, pull-up banners of Palmer amaranth and giant hogweed.
- Project partners and Three Rivers Park District staff presented about these and other invasive species at CCM training to ~ 120 members and staff.
- In progress:
    - The two day, August 9-10, 2018, Instructor institute entitled *FORTIFY: Actions, Knowledge, Habitat* has been finalized through Minnesota Master Naturalists Instructor Training at the Floyd Roberts Jr. Pavilion in Mankato, Minnesota where expert speakers and practitioners explain invasion ecology and best practices for reporting and managing Minnesota's invasive species.

- Several inspirational true stories of volunteer successes related to invasive plant management videos and educational invasive species removal videos of volunteer leaders are in production for Outcome 2. Develop online training and outreach materials that are publicly available.
- Palmer amaranth library check-out kits and testing display model materials for the highest quality durability. Rochester Public Library (RPL) staff is eager to host a grant-based Palmer Amaranth educational kit. Per their recommendations, the kit will consist of two parts - a large tough RPL bag to fit the hard case for the samples as well as the paper/canvas products. This bag is typical for the kits they provide regularly and has the needed pocket for shipping and handling paperwork.

Activity Status as of November 30, 2018:

- Palmer amaranth identification kit (library catalog title: *Palmer amaranth (Amaranthus palmeri) kit*) completed and now available through the public library system. This identification kit can be checked-out, via interlibrary loan, from any library in the state. This is one of the "high quality display materials and 5 invasive plant learning kits" mentioned in Activity 1, D.
  - Dawn Littleton, Extension's Terrestrial Invasive Plant Program Coordinator, hired on this project, presented about this Palmer amaranth library kit at the Upper Midwest Invasive Species Conference in Rochester, MN October 15-18 tp ~38 Natural Resource professionals. The peer reviewed presentation was titled Novel Outreach: *Library Distributed Training Kits for Prohibited Plant Identification*.
- Complete two educational videos to support: *Planning invasive species events: Tips for working with volunteers* https://youtu.be/5rB4zjQwbQQ (90 views as of 11-29-18 published on 11-2-18) and *Planning invasive species events: Working with a natural resources professional* https://youtu.be/CJNsD-1KVnc (44 views as of 11-29-18 published on 11-2-18). These are Activity 1, A deliverables to "develop supportive, online training and outreach materials for Invasive Blitz volunteers…that are publicly available."
- Completed Activity 1, C, "Minnesota Master Naturalist Instructor Training - a weekend-long training and field tour dedicated specifically to terrestrial invasive species of special concern, their prevention, identification, reporting, monitoring and management to incorporate this information into Master Naturalist volunteer trainings across the state." August 9-10 Extension Natural Resources hosted the Invasive Species Instructor Institute in Mankato, MN. Twenty dedicated invasive species volunteers and professional participated in a 2-day workshop including 2 field tours and topics including: invasion ecology, identification of selected invasives, teaching strategies, tools for species observation (iNaturalist) and reporting (EDDMaps), and field trips to several locations with invasive plants present and where management actions have removed invasive plants. 95% of participants agreed or strongly agreed that they have a deeper understanding of the subject matter as a result of the session and 90% agreed or strongly agreed have situations in which they can use what they learned in the session.

Activity Status as of May 31, 2019:

- Award Winner! The 2-part video series, *Planning invasive species events: Tips for working with volunteers* https://youtu.be/5rB4zjQwbQQ and *Planning invasive species events: Working with a natural resources professional* https://youtu.be/CJNsD-1KVnc, won the 2019 National Gold Award in the TV, VIDEO category for the National Association of Natural Resources Extension Professionals.
- Completed 2 more Weed 'Em Out workshops in Mankato (4-30-19) and Bemidji (5-2-19) for a total of 104 road side mowers and similar professionals as part of Activity 1. Ordered additional MN DoT Noxious Weed books for workshop participants.
- Hosted an Invasive Plant ID and survey workshop at in Rochester, relocated and moved indoors because

of severe water at Whitewater State Park for anglers and master volunteers as required in Activity 2. Six master volunteers attended.
- Continue work for on time completion of the remaining four library kits (1 more Palmer amaranth, 2 wild parsnips and 1 Oriental bittersweet).
- The latest Palmer seedling model was 3D printed. A stronger resin was used but unfortunately, it has a low melting point which proved problematic. The new seedling design will be printed with the formerly used resin that has a higher melting point.

Activity Status as of November 30, 2019:
- Four additional library kits are now in the public library system: 1 additional Palmer amaranth identification kit; 2 wild parsnip identification kits; and Oriental bittersweet identification kit. These identification kits can be checked-out, via interlibrary loan, from any library in the state. This completes Activity 1, D deliverables.

Final Report Summary:
During the last reporting period we printed 475 2020 Noxious Weed books and began distributing them. We also purchased one kayak for CCM crew members to survey Japanese hops and other targeted species. Renting a kayak at specific places along various rivers is troublesome and not reliable. This kayak will allow crew members to access rivers more efficiently.

We achieved all grant deliverables for a total impact reaching about 1,108 people via 11 activities including workshops, field tours and public and professional presentations. The videos we developed: Planning invasive species events: Tips for working with volunteers and Planning invasive species events: Working with a natural resources professional won a national gold award from the Association of Natural Resource Extension Professionals and have been viewed by about 450 individuals. We printed and distributed about 10,875 noxious weed educational publications. We developed 14 innovative new educational materials including 2 pull-up banners one each for Palmer amaranth and giant hogweed, 5 library identification kits for Oriental bittersweet (1), Palmer amaranth (2) and wild parsnip (2) and developed scientifically accurate 3D printed models for Palmer amaranth (3 models), Japanese hops (2 models) and Grecian foxglove (2 models).

ACTIVITY 2: Survey, Coordinate Control and Monitor
Description:
Part A (MDA)
Minnesota Department of Agriculture (MDA) will verify reports, survey potentially infested areas and delineate infestations. Conservation Corps Minnesota (CCM) will participate in large area surveys. Presence/absence data for all target species will be collected along assigned survey routes. Surveys will be done in collaboration with agency partners when practical.

MDA will contract with the St. Croix River Association (SCRA) for survey along the St. Croix River main stream and Brown's Creek, a designated trout stream. The St. Croix watershed is a high priority conservation area where Oriental bittersweet and Grecian foxglove have been found. SCRA will monitor approximately 130 river miles by boat. Highest risk areas will be surveyed multiple times and seasons to have the best chance of seeing each target species at its most visible stage. For example, Grecian foxglove is most visible in the summer and Oriental bittersweet in the fall. We will engage SCRA staff, National Park Service partners and volunteers in survey and outreach efforts.

All survey data will be entered into EDDMapS (www.eddmaps.org). MDA will contract and coordinate with CCM and landowners for target species control. This will include writing agreements with landowners where CCM

will do control work. Agreements will specify that landowners will monitor the site to prevent reinfestation for at least three years after the control work is completed. The coordinator will train the landowners how to identify and monitor for the species and report any reinfestation issues that arise.

Part B (U of M)
The U of M Unmanned Aerial Vehicle Lab will test its drone fleet with the goal of increasing survey efficiency. Tests will determine best available sensor, concept of operations, and post processing requirements outlined below. We are working with the Federal Aviation Administration on regulatory requirements before we can legally fly outside of our permitted area (currently only covers Umore park in Rosemount, MN.)

Sensor
Every sensor has trade offs in terms of cost, size, weight, resolution, speed, type of data sensed, etc. Often the required sensor drives the choice of aerial platform. We will select the sensors with the best chance of producing useful data for detecting invasive species from the air. The best sensor might not be a camera. If it is a camera we need to determine if our objective is the highest resolution possible, or is it more important to capture a certain band(s) of the visible spectrum.

Concept of Operations
Depending on the aircraft and the sensor choices the time of day and lighting may be an important consideration. We may need to consider sunny versus overcast conditions and the best season(s) for detecting specific invasive species. We need to think through optimal routes and patterns for data collection. The type of sensor chose may drive the choice of altitude and limit the amount of area that can be covered. If significant terrain is involved, that could complicate flight planning. Is the best vantage point straight down from above (nadir view) or is an oblique view better, or even a side view from below the tree tops?

Post Processing Requirements
Will the data be reviewed manually? Are there computer algorithms that could be leveraged to highlight areas of concern in the data (i.e. some sort of threshold or blob detection?) What characteristics in the data would indicate a target invasive species is detected? For the longer term, we will evaluate economic factors including the cost to image an area versus the likelihood or reliability of spotting invasive plants.

Summary Budget Information for Activity 2 Part B:

ENRTF Budget:	**$ 24,245**
Amount Spent:	**$23,396**
ENRTF Balance:	**$1,513**

Outcome	Completion Date
1. Drones will be tested for survey capability. Testing will determine the appropriate sensor, calculate the impact of variable light conditions and chart the optimal flying pattern.	03/01/2018
2. Surveys are conducted and infestations are documented	05/30/2019
3. Treated sites are monitored to determine whether additional control is needed	06/10/2019

Activity Status as of November 30, 2016:
Part B (U of M) – see MDA report for Part A
Status for Part B: Field tested one UAS (Unmanned Aerial System) in September but experienced major technical difficulties. Are working on improvements and have another scouting/possible test flight scheduled for December.

Activity Status as of May 31, 2017:
Part B (U of M) – see MDA report for Part A

Photo of Memorial Park, Red Wing, MN taken from Flight 4's fixed-wing UAV.

- On March 23, 2017 flew 4 survey missions at Memorial Park, Red Wing, MN.
  - Flight 1: Quadcopter, aborted due to battery issue.
  - Flight 2: Quadcopter, captured 193 images with a 4-lens multispectral camera (772 total images.)
  - Flight 3: Quadcopter, captured 202 images with a 4-lens multispectral camera (808 total images.)
  - Flight 4: Fixed-wing Unmanned Aerial Vehicle (UAV) aborted about 4 minutes into the flight due to winds aloft in excess of 25 knots (kts). The UAV was landed safely under manual pilot control.
- Weather conditions at the time of the survey flights were extremely windy and overcast. This adversely impacted image quality by increasing motion blur and smearing.
- Lessons learned:
  - The quadcopter successfully operates in higher wind conditions compared to the fixed wing aircraft. (Specific vehicles have specific ranges of useful operating conditions.)
  - Drones can operate safely in less than ideal conditions, but the risk of a mishap increases with worsening conditions; also image quality is adversely affected.
  - Ideally winds aloft would be < 20 kts, relatively low turbulence, with sunny skies.
  - The 4-lens multispectral camera tested on the quadcopter is fairly low resolution, slow shutter speed, and produces images with a lot of unwanted artifacts. These images require substantial

post processing before they can be used.
    - Initial inspection of the additional image channels (each with filters that let through specific wavelengths of light) didn't show any promise for identifying Oriental bittersweet.
    - It appears we will have better success with improved lens optics, faster shutter speeds, and a higher resolution CMOS sensor.
- To address the camera/imager quality needs, we have purchased a Sony A6000 digital mirrorless camera with 20mm fixed focal length lens. We also purchased a remote trigger with precise GPS geotagger to interface with the UAV autopilot.
- A system has been designed and built to mount the new (and larger) camera on the fixed wing UAV.
- We invited media to the drone flight which resulted in several media reports : Eagle's-eye view: Using drones to spot invasive plants; Researchers test drones to spot invasive plants in Minnesota; and A Drone's Eye View of Oriental Bittersweet, *The Forestry Source*, May 2017.

Activity Status as of November 30, 2017:

This picture was taken by a camera mounted on the U's UAS vehicle for the Weed 'Em Out training in Sorin's Bluff Park, Red Wing. This shows CCM and Nature Conservancy participants and instructors using ETIPS Phase 2 purchased tablet computers to practice ISMTrack data entry.

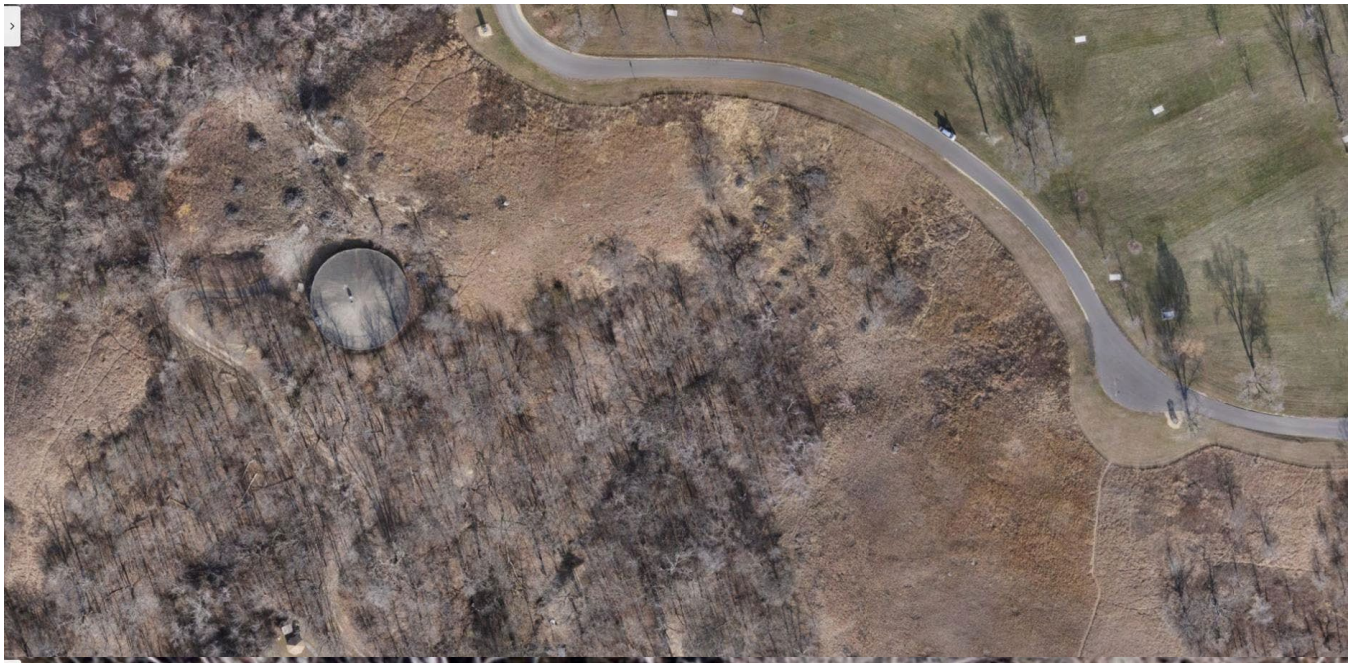
- We tested the integrated Sony a6000 digital mirrorless 24 megapixel camera in the aerial survey system. This camera provides a higher quality imager and lens compared to most quadcopter-based mapping systems. It yields improved resolution, detail and color quality.
- In Red Wing (6-12-17) we flew a demonstration flight for a weed identification training class. The captured images (sample shown above) were used to construct a 3D model of the hill top area in a park that is a focus of our Oriental bittersweet eradication work.

- On September 27, 2017 we flew two Palmer Amaranth survey flights in Yellow Medicine county and two flights in Lyon county. These flights helped refine our procedures and led to improvements in camera setup, camera triggering, lens choice and survey patterns. This was done for our Palmer amaranth detection project but has useful implications for this project.
- On October 11, 2017 we flew three survey flights over invaded areas of Nebraska and Iowa for our Palmer amaranth detection project. These flights over actual invaded areas continued improvement of our survey processes and camera setup.
- We developed a survey planning and mapping tool that works with our aircraft's autopilot. This software can now be used to create a database of survey areas, and then transmit those areas to the flying aircraft which generates an optimal survey pattern for current wind conditions, camera field of view, and desired image overlap.
- On November 29, 2017 we flew 3 survey flights at Memorial Park in Red Wing. The flights covered approximately 120 acres and yielded 2500 high resolution images. In the later fall and winter months the leaves are off most of the trees, but the oriental bittersweet berries are still on the vine. These berries have a distinct reddish/orange color and contrast clearly against the dull winter colors. Examining the raw aerial images showed that concentrations of oriental bittersweet were clearly visible throughout the park.
- Rochester Extension ETIPS 2 staff surveyed Northern Heights Park with Rochester City Forester for effectiveness of last year's treatment of Oriental bittersweet. Several plants survived last year's treatment and the City Forester will retreat. (Rochester, 6-8-17)

Activity Status as of May 31, 2018:

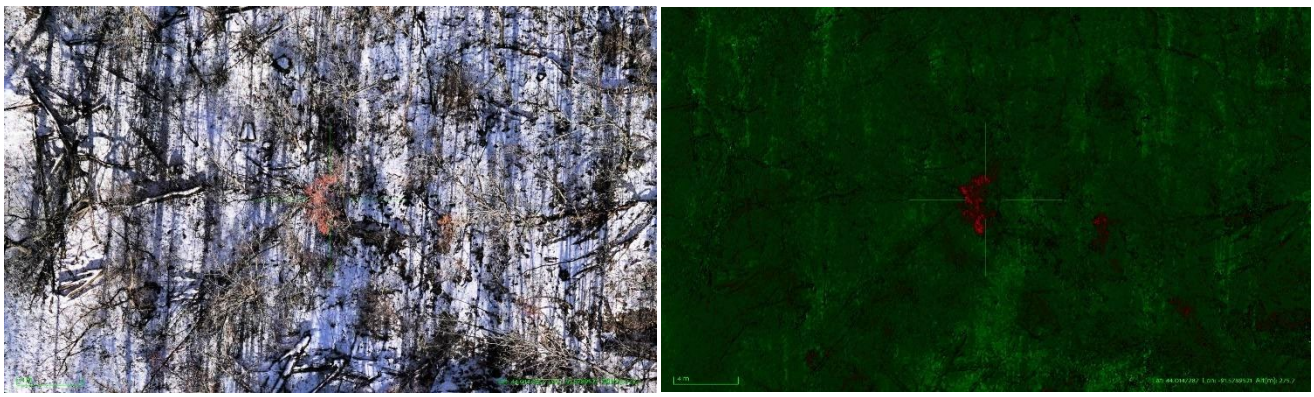
- Improved ground station and airborne flight control software for generating more optimal survey patterns.
- UAV flight control: optimize 180 turn direction (at the end of each survey transact) to minimize wasting time turning around and flying the next transact. Turning up wind saves substantial time and energy over turning down wind and helps fly more complete and accurate survey patterns.
- Pix4d mapping software processed Red Wing's Memorial Park survey imagery to create detailed maps of the park. Pix4d takes all the individual images collected during the flight and fits them together in a single unified map. This map can be explored online and shared with project contributors. Pix4d will generate a 2D orthophoto as well as a detailed 3D surface map. This software was purchased for the Palmer Amaranth Detection and Eradication project but is also helping this related project.
- The Oriental bittersweet survey late November 2017 covered 237 acres of the park. In total, 2,626 images were captured over 3 flights. This imagery yielded a final map resolution of approximately 1 cm per pixel.
- Continued work on in-house tools to enable more detailed inspection and analysis of the survey imagery compared to what the available commercial tools offer.

First image below: Stitched together picture of Memorial Park.
Second image below: Zoomed in detail, from first pictures, that shows Oriental bittersweet fruit.



Activity Status as of November 30, 2018:
This summer we continued to test and improve the capabilities of our survey system. We greatly improved the reliability and safety of our auto-launch system, and made further refinements to our auto-landing system. Drone Deploy software, purchased with other funds, has been used to help with data post processing: image stitching, mapping, and locating areas of interest from the imagery. We also completed assembly of a new survey aircraft that has improved payload capacity, endurance, and more stable flight characteristics.

Activity Status as of May 31, 2019:



Natural and enhanced image of Oriental bittersweet survey in Winona.

This winter and spring we flew oriental bittersweet surveys near Winona, Elm Creek Park Preserve, and Hay Creek. We determined that oriental bittersweet surveys can be conducted throughout the winter season with diminishing returns once March arrives and the weather begins to warm up. Surveys can begin as soon as the leaves drop in the fall, but the ideal conditions for best results is with a layer of snow on the ground. This helps hide fallen leaves and other plants at ground level and creates the best visual contrast with the colorful berries.

The trade off with surveying primarily during the winter season is that here in Minnesota we can get long stretches of unflyable weather. Concerns include excessive cold, excessive wind, snow (and rain), fog and freezing fog.

In January we purchased a DJI Phantom 4 Pro v2.0 with a Sentera multispectral camera. The Sentera camera images 5 distinct bands of the color spectrum: near infrared, red edge, red, green, and blue. The bands are carefully filtered to minimize any bleed through between neighboring bands. The DJI system is capable of vertical take off and landing and can operate in more constrained areas compared to our fixed wing system. However it has much shorter flight times, covers a smaller area, and the cameras and images are lower quality compared to our larger fixed wing unmanned aircraft system.

Through the winter we optimized our fixed wing route following algorithms and improved our camera triggering system. We continue to refine our in-house mapping and analysis software. This winter we created a graphical visualizer that displays all the original aerial images precisely fitted and scaled together as a nearly seamless map. This preserves all the detail and resolution of the original images (because we are drawing the original images), makes all the images (i.e. all the overlapping perspectives) for any point of interest available for viewing, and presents all of this as an intuitive ortho map.

We anticipate the tools, techniques, experience, and software developed through this project will continue to be improved upon, and continue to be used for future invasive projects as well as other related university research.

Activity Status as of November 30, 2019:
Collaborative and complementary work from the Palmer amaranth project, also funded by LCCMR and in conjunction with the same MDA team, is helping to further refine the flight and post-flight data processing for the Oriental bittersweet survey work in this project.

I'm delighted to report that we've successfully transitioned from primarily testing drones for research to deploying this technology to survey for Oriental bittersweet in the field so Oriental bittersweet can be better managed MDA and CCM crews. The research worked and is being deployed on the ground!

Final Report Summary:

During the final reporting period, the team:

- Completed several Oriental bittersweet survey drone flights, with local invasive species managers, in Red Wing in and around Hay Creek.
- Completed several drone survey flights around Spring Grove to inform CCM crew Oriental bittersweet management. See photo immediately below. The image is a mosaic of the drone images from this survey overlaid with ground-truthed Oriental bittersweet points, to refine ground truth and drone survey methods.
- Improved in-house post processing software to better handle heavily forested areas and significant terrain. In addition to improving final map presentation tools and the annotation system.
- Built and connected images to the Zooniverse online people-powered citizen science platform to work on Oriental bittersweet drone photo review using CCM crew members during the COVID-19 stay-at-home order. See the MDA's 2020-07-31 Noxious Weed Detection Eradication WP for more details of this work.

Photo by Curtis Olson, UMN, composite drone images of steep terrain in southeaster Minnesota after post processing via software Curt developed with ground truthed Oriental bittersweet points overlayed.

During the course of meeting all the grant deliverables project team members transitions from flying drones for research to using them for Oriental bittersweet surveys over tricky terrain on mild winter days to inform CCM crew eradication efforts. We tested various sizes and styles of fixed-wing and quadcopter drones and discovered that quadcopters work best for this work but there's constant tension between size, maneuverability and

payload (camera) capacity. Several different sizes and types of cameras and lenses were tested, including light and wave characteristics and coupled with seasonal influences like leaves and snow. It became clear that mild winter days worked best because the drones and cameras work, most leaves are gone and white snow creates visual contrast to orange and red Oriental bittersweet berries. These conditions led to the best images that will then be reviewed by humans. (Wave length variation did not prove helpful.)

Curt Olson developed a post processing software system and improved it throughout the project while also comparing it to several commercial post processing software products. An example of his work is the immediately above photo which is created by several different drone surveys' thousands of images stitched together to create an interactive, highly detailed and GPS specific map that is overlaid with ground-truthed Oriental bittersweet reports.

ACTIVITY 3: Control Target Species

Description: MDA will contract with CCM for trained and equipped field crews to control target invasive species on an estimated 660 acres (75 ac Dalmatian toadflax, 5 ac teasels, 130 ac Grecian foxglove, 50 ac Japanese hops, 150 ac meadow and brown knapweeds, and 250 ac Oriental bittersweet). CCM crews trained in identification and control of target species will conduct control work starting with known infestations of Oriental bittersweet and continuing with control of other target species. Large infestations of Oriental bittersweet will be controlled using basal bark and/or cut-stump treatment with a systemic triclopyr based herbicide in basal oil which is specific to broadleaf plants and will reduce potential impact on non-target species. Smaller infestations of young plants or infestations in sensitive areas that prohibit use of herbicides will be controlled by hand or mechanical pulling with a focus on removing and properly disposing of all plant parts including all roots and fruit to prevent re-sprouting and/or seeding. Timing of control will focus on late fall and winter when non-target species are dormant to reduce impacts on desirable species. Control of additional target species will involve mechanical and chemical control methods following established best management practices for each species based on size and location of infestations.

Amendment Request:

Activity Status as of May 31, 2018:

Extension will manage the $45,000 contract in our amendment request to increase funding for control work by CCM. MDA will work with Extension and coordinate the control work with landowners and CCM.
Approved 6/14/2018

Summary Budget Information for Activity 3:	**ENRTF Budget:**	**$ 55,078**
	Amount Spent:	**$54,734**
	ENRTF Balance:	**$344**

Outcome	Completion Date
1. Acres treated are documented	06/30/2019

Activity Status: See MDA report for activity status.

Activity Status as of November 30, 2018:

Elimination of target invasive plant species activities in SE Minnesota. Surveying and treating by CCM. Detailed reporting on activity provided in the MDA report.

Activity Status as of November 30, 2019:

Extension managed a contract with CCM, at the direction of MDA partners (see their report for details of CCM crew activities). Extension is proposing a rebudget request to further contract with CCM to use much of the remaining program coordinator salary that was unable to be used because of serious medical issue that arose and prevented her from working as expected.

Final Report Summary:
During the final reporting period for this project Extension managed a contract with CCM, at the direction of MDA partners (see their report for details of CCM crew activities) that also included work Zooniverse to look for Oriental bittersweet infestations.

Activity 3 is an excellent of project team member's dedication to success and teamwork. The designated staff hired for this project by Extension experienced a major medical issue part way through the project which significantly reduced her ability to work. That reduction in salary led to an increase in funds that were reallocated, via budget request, to CCM to do more on the ground eradication work. The ability of team members from Extension and the Minnesota Department of Agriculture to work collaborative and flexibly to problem solve enabled us to complete and far exceed exceptions in Activity 3. For a detailed summary of CCM's efforts please see the MDA's report.

ACTIVITY 4: Implement Invasive Species Management Database System from Phase 1
Description: In the field, CCM will use tablets with a database system developed in Phase 1 to collect data on target invasive species control treatments and monitor infestation changes. This platform will enable us to communicate across organizations and efficiently summarize activities and outcomes. Extension will train agencies and other organizations to utilize this system.

A. Purchase 20 tablet computers; 10 for Extension trainings for database system users and 10 for CCM crews to use while managing and monitoring on target invasive species,
B. Natural resource manager database system trainings (using the tablets, 2 per year).

Amendment Request:
Activity Status as of May 31, 2018:
MDA will take on some of the few remaining duties mentioned above,+ predominately the natural resource manager database system field trainings.
Approved 6/14/2018

Summary Budget Information for Activity 4:	**ENRTF Budget:**	**$ 6,910**
	Amount Spent:	**$6,910**
	ENRTF Balance:	**$0**

Outcome	Completion Date
1. 6 training workshops will be conducted for vegetation managers	05/30/2020
2. Tablets and software will be utilized for data collection in the field	06/10/2020
3. Summary reports of activities and outcomes will be run	06/10/2020

Activity Status as of November 30, 2016:

- Invasive Species Management (ISMTrack) an hour and 40 minute training for about 30 natural resource professionals was also presented at the Upper Midwest Invasive Species Conference on October, 19, 2016.
- Bought 2 tablets plus data; working on data plans with CCM.
- Scheduled to teach ISMTrack at 8 Minnesota Pesticide Information and Education workshops in 2017 and

2018.

Activity Status as of May 31, 2017:

- **Pesticide Information and Education Course for Minnesota** for 220 pesticide applicators seeking their license Detroit Lakes Holiday Inn (1/31/17) and Alexandria (2/2/17).
- **ISMTrack** - Data assistance for site names
  A portal of county based parcel identification numbers to aid site name creation while keeping some privacy for a home. Site name for homes will rely on county assessor' Parcel Identification number. Portal for Minnesota counties: https://sites.google.com/umn.edu/pins
- **Hardware/cellular support for CCM crews**
  To enable the goal "Implement Invasive Species Management Database System" to develop invasive species apps (GLEDN, EDDMapS and ISMTrack) we piloted the 2 tablets to monitor the emerging Palmer amaranth population in western Minnesota prairies. The new concern about Palmer amaranth and the context in which the tablets were tested were reported in the December 28 *Star Tribune* article "Superweed introduced to Minnesota with conservation seed mix." The pilot received positive reviews for functionality. Eighteen more tablets and cases were purchased for the use by Extension Invasive Plant Program Coordinator and the Conservation Corps of Minnesota and Iowa (CCM). Cellular data for ten grant purchased tablets is provided by the existing CCM Verizon plan. Data for the other 10 tablets will purchased as needed.
- Upcoming activities: Conservation Corps MN volunteer training for ISMTrack and Noxious Weed identification, June 12, Red Wing, MN and ISMTrack will be used in another UMN Research and Extension project to track soybean aphids use of buckthorn.

Activity Status as of November 30, 2017:

- Key staff in the Rochester DNR/CCM/Quarry Hill Park offices adopted ISMTrack for management data.
- SWCD (Soil, Water, Conservation District) in Lake County was trained to use ISMTrack.
- CCM crews are using 10 ETIPS 2 grant-purchased tablets that are connected via CCM's Verizon accounts to track invasive species management.

Activity Status as of May 31, 2018:

- Extension ETIPS 2 staff joined the MDA and ISMTrack development staff in St. Paul (2/13/18) for working group meeting to learn current status of ISMTrack, discuss future development and to address issues including data entry and management for herbicide rates, drawing polygons, site definitions, non-ISMtrack usage and feasibility of drawing site polygons over large areas.
- MDA has assumed responsibility for training people to utilize ISMTrack. CCM members were introduced to ISMTrack as part of their general training on February 22, 2018. MDA will work one on one with CCM crew leaders as they begin to utilize ISMTrack. On April 16, 2018 there was a training session for Anoka, Ramsey and Washington CWMAs and the St. Croix River Association in Arden Hills.

Activity Status as of November 30, 2018:

See the MDA report. MDA's May 2018 work plan amendment request was approved on 06/14/18. Since then, MDA has been doing this work.

Activity Status as of May 31, 2019:

See the MDA report. MDA's May 2018 work plan amendment request was approved on 06/14/18. Since then, MDA has been doing this work.

Activity Status as of November 30, 2019:
See the MDA report. MDA's May 2018 work plan amendment request was approved on 06/14/18. Since then, MDA has been doing this work.

Final Report Summary:
See the MDA report. MDA's May 2018 work plan amendment request was approved on 06/14/18. Since then, MDA has been doing this work.

Extension completed 4 workshops to 250 professionals and purchased 20 tablets to test ISMTrack on and eventually enable CCM crews to use ISMTrack to record eradication efforts. After Extension's staff member's medical issues began MDA took over the remaining work in this section. Please see their Final Report for specific details. I'm incredibly grateful for this team's dedication to success and the group effort that went into making sure all grant deliveries were met. This required tireless work from the MDA and flexibility from LCCMR staff. Thank you everyone!

V. DISSEMINATION:
Description: We will communicate about target invasive plant species with the public, natural resource professionals, County Agricultural Inspectors, highway and other road crew employees, and Cooperative Weed Management Areas. The web will be used for communication at www.mda.state.mn.us/en/plants/pestmanagement/weedcontrol/targetplants.aspx and www.myminnesotawoods.umn.edu/ (this location may shift as we develop additional online training, outreach materials and target audiences). Communication with the public will be via workshops, news media (print, television, and radio), online and via social media such as YouTube, Facebook, Twitter and Pinterest. We will communicate updates at County Agricultural Inspector meetings and in trade publications such as "The Scoop" published by the Minnesota Nursery Landscape Association. We expect to present this project during at least one peer-reviewed professional conference such as the Association of Natural Resource Extension Professionals Conference or the Upper Midwest Invasive Species Conference (both biannual conferences).

Status as of November 30, 2016:
Upper Midwest Invasive Species Conference (UMISC):
Work from this project was highlighted in three different formats at the UMISC in LaCrosse, WI from October 16-19, 2016.

- Extension Using Mobile Technology, 3D Printing & UAVs to Battle Invasive Species was presented by Angela Gupta (additional authors: Monika Chandler & Curtis Olson) to about 35 natural resource professionals.
- Master Naturalist Making a Difference: Volunteer Impact Analysis by Christian Wood, an AmeriCorps Volunteer hired under the Elimination of Target Invasive Plant Species Phase 1 (additional authors: Angela Gupta & Andrea Lorek Strauss), was presented.
- Invasive Species Management (ISMTrack) An hour and forty minutes training for approximately 30 natural resource professionals was also presented.

Board of Water and Soil Resources Academy

- Tools and Techniques for Effective invasive Plant Management was presented by Monika Chandler and Michael Reichenbach to 60 soil and water conservationists. We covered reporting invasive species with the Great Lakes Early Detection Network (GLEDN) using ISMTrack.

Society of American Foresters (SAF) National Convention:
Work from this project was highlighted in one presentation at the SAF Convention in Madison, WI from November 1-5, 2016.

- **Extension Forestry Using Mobile Technology, 3D Printing, and UAVS to Battle Invasive Species** was

presented by Angela Gupta to about 38 foresters and other natural resource professionals.

Status as of May 31, 2017:

Image: Citizen Scientists Influencing Forest Invasive Species Management in Minnesota UMN Extension presentation

- **Noxious Weed Identification – What am I looking for? Oriental Bittersweet and Japanese hops** Winona, (3/22/17) 22 city and council officials.
- **Coming to a Prairie Near You** - sponsored by Prairie Smoke of Minnesota, Chatfield (2/26/17), 36 attendees.
- **Oriental Bittersweet and its Look-alikes** - sponsored by Friends of the Bluffs in Red Wing (3-21/17), 53

attendees.

- **Weed 'Em Out workshops** in Virginia (3/29/17), Morris (4/18/17) and Baxter (5/3/17) to 183 natural resource professionals and road maintenance professionals.
- **Pesticide Information and Education Course for Minnesota** for 220 pesticide applicators seeking their license Detroit Lakes Holiday Inn (1/31/17) and Alexandria (2/2/17).

Presentations to professional audiences

- Gupta, A. (2017). **MN's First Detectors: Past, Present and Future**. Minnesota Shade Tree Advisor Committee Forum. St. Paul, MN. (Audience: ~30 arborist and urban tree care professionals. 1/19/17
- Gupta, A. & Littleton, D. (2017). **Citizen Scientists Influencing Forest Invasive Species Management in Minnesota**. Poster for Citizen Science Association Conference. St. Paul, MN. 5/18-21/17. (Image above)

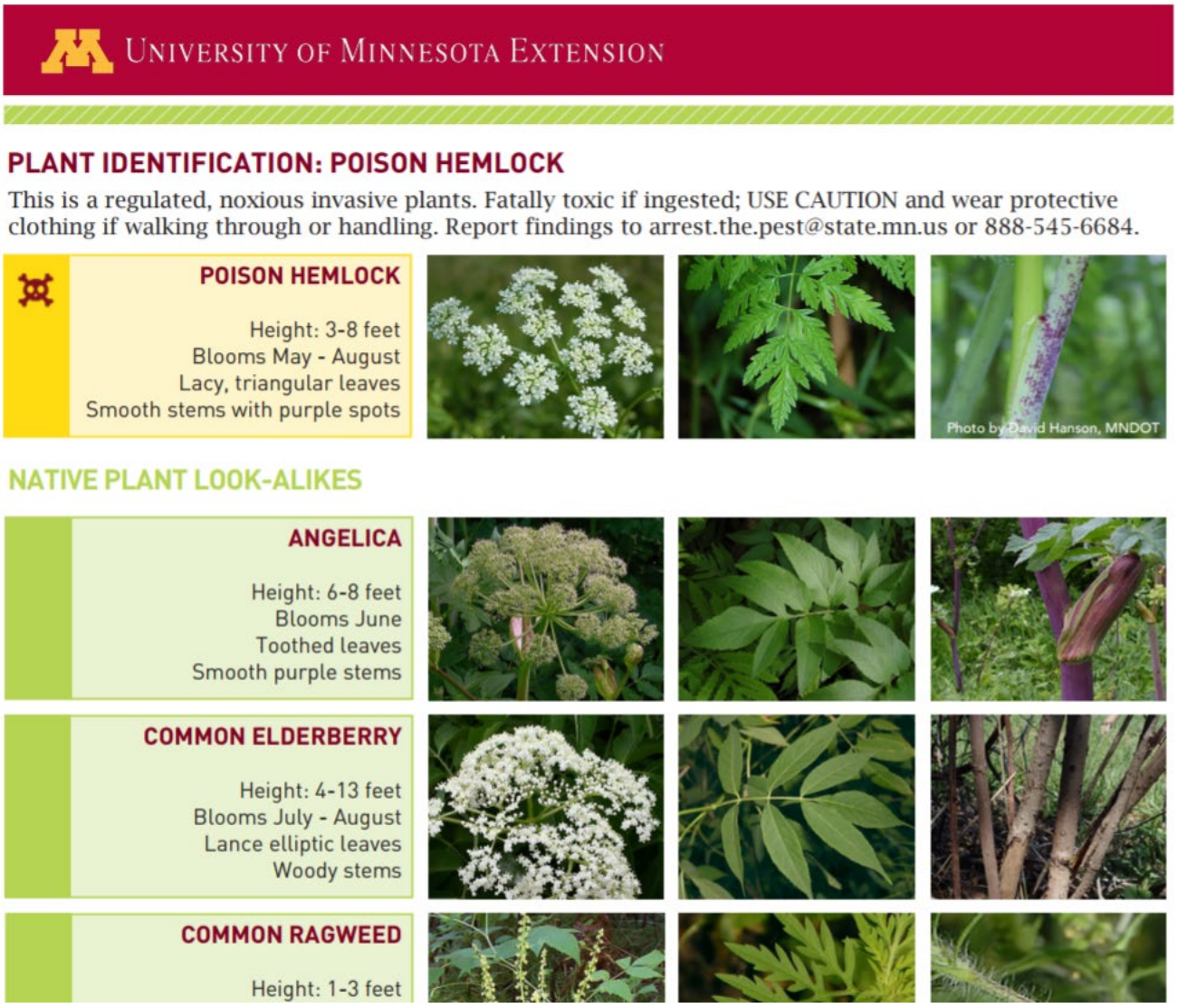
Media Coverage

- Superweed introduced to Minnesota with conservation seed mix. *Star Tribune.* December 28, 2016
- 2017 Invasive Species Calendar January's photo acknowledges CCM youth pulling Grecian foxglove at Afton State Park. Minnesota Invasive Species Advisory Council
- "Help Eradicate Dangerous Plants from Minnesota" *Technology Exchange (*Minnesota Local Technical Assistance Program) newsletter (expected publication June 2017)
- Red Wing Republican Eagle: Eagle's-eye view: Using drones to spot invasive plants
- A Drone's eye view of Oriental bittersweet. Society of American Foresters. *The Forestry Source,* 2017 22(5):5
- "Drones spot invasive plants" *University of Minnesota Extension Quarterly Report- Southeast Region* 2017 (1):3
- "Invasive species education goes statewide" *University of Minnesota Extension Quarterly Report-Southeast Region* 2017 (1):5
- Drones can spot invasive Oriental bittersweet vine: MyMinnesotaWoods: Researchers test drones to spot invasive plants in Minnesota, Extension highlights, University of Minnesota Extension - Quarterly Reports
- My Minnesota Woods's Facebook page 228 people reached as of 5/10/17.

Status as of November 30, 2017:

Since the last report, it has become evident that ENRTF funding (and Phase 1 funding) has strengthened and created connections with local and statewide invasive species partners. This was realized when Angela Gupta (Project PI) presented at the International Union of Forest Research Organizations (IUFRO) 125th Anniversary Congress in Freiburg, Germany. While attending sessions it became clear that Minnesota's collaborative, committed and innovative invasive species partnerships create an extensive network of professionals, volunteers and citizens that identify, report, manage and educate on invasive species. These systems and networks shine on the international stage. Our ETIPS 2 funds not only support our critical connections but also provide evidence that Minnesota is already doing invasive species work in every area recommended for global impact. Specifically, this Minnesota network is working strategically across organizational boundaries to tackle invasive species. Our network utilizes professionals, volunteers, regulatory updates and new technologies to achieve reduction and elimination of prohibited species in Minnesota. Our network, rich in passion and dedicated professionals, produces unforeseen advantages in knowledge sharing and project management. Our network's effectiveness was viewed favorably when Extension staff was awarded *Empowering citizens to engage resource managers to minimize the impact of invasive species on forests and across ecosystems*, ($115,000) from USDA National Institute of Food and Agriculture (with A. Gupta as PI). This USDA project is interwoven with the successes and partnerships created through ENRTF funds. Thank you for your support and enabling us to achieve this level of coordination and integration.

- Gupta, A. (2017). Beware of Oriental Bittersweet in Holiday Decorations. *Women Owning Woodlands* post updated and revised.
- Creation and dissemination of Poison Hemlock page on UMN Extension website
- Creation and dissemination of UMN Extension's Poison Hemlock's Look Alike factsheet (excerpt below)



http://www.myminnesotawoods.umn.edu/wp-content/uploads/2017/06/Poison-Hemlock-Lookalikes-3-types.pdf

- Met with Olmsted County Waste to Energy Facility (OCWE) staff to address poison hemlock plants adjacent to finished compost and the DM&E railroad track. In response to our concerns, OCWE staff ran an article entitled **"Poison Hemlock Spreads Throughout Area"** in their environmental resources community newsletter (August)
- 10 grant-funded tablets used for White Earth Reservation education summer camp (45 youth) including outreach on target terrestrial species (July).
- Introductory meeting with American Public Works Association Minnesota Chapter President to arrange for invasives species presentations at upcoming professional meetings. (6-19-17)
- MN Local & Tribal Assistance Program (LTAP) Technology newsletter "Help eradicate dangerous plants

from Minnesota". (June)

Presentations, Papers and Posters to professional audiences

- Gupta, A. Chandler, M., Wood, C. & Littleton, D. (2017). E**mpowering volunteers in early detection and management of forest invasive species using 3D printed models, online tracking systems and UAVs** (Abstract, pg 175). International Union of Forest Research Organizations (IUFRO) 125th Anniversary Congress, Freiburg, Germany. (Audience: ~55 international natural resource professionals). Gupta presentee. (This conference trip was paid for by several other funds and scholarships, not by ENRTF. $2,208)
- Gupta, A., Rager, A., Weber, M., Larkin, D. & Littleton, D. (2017). Let's Chat: Extension and invasive species. UMN Extension Program Conference. Brooklyn Park, MN. (Audience: ~36 Extension professionals). Gupta was the co-facilitator and co-organizer.
- Littleton, D., & Gupta, A. (2017). Citizen Scientists Influencing Forest Invasive Species Management in Minnesota. UMN Extension Program Conference, Brooklyn Park, MN. Poster presented.
- Presented "MN Invasive Plants: Mapping, Reporting and Tracking" at the **Pesticide Information and Education Course for Minnesota** for applicators seeking their license ~ 210 attendees (Mankato, 11/7/17)

Staff Updates:

- A. Gupta, RREA (Renewable Resource Extension Act) Focus Funds: Empowering citizens to engage resource managers to minimize the impact of invasive species on forests and across ecosystems. Received $115,000 from the USDA National Institute of Food and Agriculture. Gupta is the PI leading the effort to work with 4 additional states on flipped classroom, normative messaging approach to empower citizens to engage decision makers over 2 years. As of 11-28-17 about 50% of states applied to work with us on this project!
- Angie Gupta and Dawn Littleton begin planning for the MISAC/NAISMA Joint meeting invasive species tours planned for October 15-18 2018
- Christian Wood, formerly an AmeriCorps volunteer partially supported by Phase 1 of this project, will start as a full time permanent employee at UMN Extension as a Web Developer! This is very exciting news for Extension and a great continuation of Christian's promising career.
- Extension Program Coordinator attended Minnesota Invasive Species Advisory Council (MISAC) meeting
- Angela Gupta is the 2017 MISAC chair.

Status as of May 31, 2018:

- Update poison hemlock website: http://www.myminnesotawoods.umn.edu/poisonhemlock/
- Presented on Synergies of Invasive Species work in Minnesota in Winona (1/16/18) for ~ 35 engaged residents.
- Staffed an Extension booth about invasive species, including ETIPS 2 species, at Saint John's University in Collegeville (2/10/18) for ~100 attendees.
- Provided Q and A assistance, 3D-print models and other resources for target invasive plants at Wabasha County Forestry Day (2/9/18).
- Conducted 2 Forest Pest First Detector workshops, which includes Oriental bittersweet: Andover (2/28/18) and Mankato (3/21/18) for 21 natural resource volunteers and professionals.
- Presented (~14) and staffed a booth at the Gathering Partners Conference in Brainard (5/19/18) to some of the ~200 Extension natural resource audiences including volunteers.
- The team was contacted by
    - Khem So of USFWS in Oregon in April to access ISMTrack to aid development of a national standard for management action tracking at National Wildlife Refuges. He is interested in

seeing what/how the system tracks treatments.
- Corey Engle of Prairie Restorations - A statewide commercial retailer/wholesaler of prairie plants and restoration services requested access to ISMTrack for use in managing invasives.

Media

- Torching Noxious Weeds. By Shane Blair, http://www.pinecitymn.com/news/torching-noxious-weeds/article_1a7da684-02ab-11e8-9075-cbe5773d40ec.html

Presentations, Papers and Posters to professional audiences

- Presented at the Association of Natural Resource Extension Professionals (ANREP) national conference in Biloxi, MS in May.
- Presented at the CitSci Symposium, a professional gathering o ~115, in Andover (12/1/17), that includes some of this work.

Staff Updates

- October 2018 MISAC/NAISMA Joint Meeting programming and tours have been finalized with dates, times and maps.
- UMN Extension Dean Durgen received updates on ETIPS 2 during her visit to the Rochester Extension office (5/10/18).
- Olmsted County Waste to Energy Facility (OCWE) staff met to address poison hemlock plants adjacent to finished compost and the DM&E railroad track. Follow-up management to eradicate poison hemlock from the site and prevent spread happened in the fall, early spring and continues. OCWE reached out the Minnesota Pollution Control Agency (MPCA) to temporarily move the yard waste compost windrows on the adjacent farm field property that is currently owned by the County (formerly Minnesota DNR Area District Office). Poison hemlock has sparked additional conversations with MPCA about invasive plant disposal.

Status as of November 30, 2018:

Media

Angela Gupta and others developed augmented reality (AR) displays for MN State Fair 4-H Building for: boot brush and garlic mustard and wild parsnip; egg mass and gypsy moth; firewood and emerald ash borer; trap and zebra mussels; silver carp; rusty crawfish; and boat and invasive species prevention. We used the Zappar app to create 7 different augmented reality pieces. UMN Extension estimates that “One in five people who attend the state fair visit the 4-H Building. That's more than 320,000 in 12 days!” Zappar app analytics captured 3804 zaps total (ranging from the boot brush with 664 zaps to zebra mussel with 333 zaps). Display was staffed by 4-H. Gupta helped developed emerald ash borer, gypsy moth and boot brush AR displays with UMN Printing Services AR expertise. Online article and video: Invasive Species AR Exhibit at the MN State Fair, http://news.printing.umn.edu/invasive-species-augmented-reality-exhibit-at-the-mn-state-fair/

UMN Extension IT and communications staff worked with Angela Gupta to develop 360 images of Oriental bittersweet and buckthorn for virtual reality glasses for educational use, https://extension.umn.edu/invasive-species/invasive-species-360-degree-images This tool was used for the first time while teaching Oriental bittersweet at the Upper Midwest Invasive Species Conference during a special identification workshop and they worked really well.

- Coyle, D., **Gupta, A**., Ambourn, A. (2018) Know the Problem: Tips to Identifying Invasive Forest and Range Pests. Upper Midwest Invasive Species Conference, Rochester, MN. (Audience: ~20 Natural Resource professionals) Gupta was a workshop session presenter.

Presentations, Papers and Posters to professional audiences

UMN Extension Invasive Species Community of Practices created a new invasive species field guide, including all the early detection plants in this project. The field guide, *By Land and By Sea*, was self-funded by Extension. For this project Extension created and crowd sources a new invasive species photo library for UMN Extension education and sales.

UMN Extension invasive species programming currently uses a flipped classroom educational approach for much of its teaching. This approach was developed over many years and in part because of experiences in the Weed 'em Out training funded by this project. The September issue of the peer reviewed publication Journal of Extension was dedicated to innovation and Angela was a co-author on the Flipping the Classroom to Train Citizen Scientists in Invasive Species Detection and Response paper.

- Larkin, D., Weber, M., Galatowitch, S., Gupta, A., & Rager, A. (2018) Flipping the Classroom to Train Citizen Scientists in Invasive Species Detection and Response. *Journal of Extension*. https://joe.org/joe/2018september/tt1.php Blind-Juried or Refereed Publication.
- Gupta, A., Weber, M., Larkin, D., Rager, A. (2018) Flipped classroom: What are they and how can I use them? Upper Midwest Invasive Species Conference, Rochester, MN. (Audience: ~32 Natural Resource professionals)

Another project Angela Gupta is primary investigator on is the EmpowerU: Empowering Citizens to Engage Decision Makers in Invasive Species Management. This is a national project with federal funding support from the Renewable Resources Extension Act. The first local and train the trainer workshop was held in on October 13 and 15 in Rochester, MN for 27 Extension professionals and invasive species volunteers and landowners. This is a flipped classroom curriculum with 8 one-hour online modules followed by a one day in-person training. Participants finish the course with an engagement plan. Several participants included species in this project in their engage plans.

- Kallestad, B., Gupta, A. (2018) EmpowerU: Invasive Species. Rochester, MN. (Audience: 27 natural resources volunteers, woodland owners, Extension professionals both local and national). Gupta co-organized the event and is primary investigator on the whole project. 100% of 19 respondents reported: a deeper understanding of how to engage with decision makers, have a situation in which they can use what was learned and will follow the important steps to prepare for civic engagement.
- Kallestad, B. & Gupta, A. (2018) Empowering Citizens to Engage Resource Managers and Decision Makers. Upper Midwest Invasive Species Conference, Rochester, MN. (Audience: ~37 Natural Resource professionals)
- Gupta, A. & Kallestad, B. (2018) Empowering citizens to engage resource managers to minimize the impact of invasive species on forests and across ecosystems. Poster. Association of Natural Resource Extension Professionals (ANREP) National Conference. Biloxi, MS. (Audience: Extension natural resource professionals)

Dawn Littleton presented on the new Palmer amaranth library kit launched through this project and was able to present about the kit at the Upper Midwest Invasive Species Conference (UMISC) in Rochester, MN.

- Littleton, D. & Gupta, A. (2018) Novel Outreach: Library Distributed Training Kits for Prohibited Plant Identification. Upper Midwest Invasive Species Conference, Rochester, MN. (Audience: ~38 Natural Resource professionals) Gupta collaborated on the project and presentation.

Also presented at UMISC was this project about including noxious weed education in pesticide applicator trainings.

- Wyatt, G., Gupta, A. & Herzfeld, D. (2018) Incorporating Noxious Weeds and Invasive Species Lessons into Pesticide Trainings. Upper Midwest Invasive Species Conference, Rochester, MN. (Audience: ~45 Natural Resource professionals) Gupta collaborated on the project.

Staff Updates
Team Achievement Award – Minnesota Invasive Species Advisory Council, Carol Mortensen Invasive Species Management Award. Upper Midwest Invasive Species Conference. Rochester, MN. This award was given to several members of this team for their effort in invasive species early detection and rapid response in SE Minnesota.

Dawn Littleton had another major survey at the end of October and is out on medical leave during her recovery. We believe the surgery went well and will be working with human resources and her medical team during her recovery. As was agreed in the May 2018 project rebudget her unused salary will support additional CCM field work and MDA has taking over most of what remained of Extension's ISMTrack deliverables.

Status as of May 31, 2019:
Presentations, Papers and Posters to professional audiences

- Gupta, A. (2019) Augmented Reality, Virtual Reality & 3D-Printed Models: New Tools for Education & Engagement. MN Society of American Forester & MN Wildlife Society Chapter Conference, Duluth, MN.
- Gupta, A., Flory, J., Hardel, M., Sagor, E. & Zamora, D. (2019) Workshop #1: Identification of Terrestrial Invasive Species. MN Society of American Forester & MN Wildlife Society Chapter Conference, Duluth, MN.
- Gupta, A, Ambourn, A, Mutschler, K, & Schwingle, B. (2019) Forest Pest First Detector workshop. St. Cloud, MN.
- Dawn Littleton, project staff, hosted an educational booth at the 4th Annual Best Practices for Pollinators Summit in St. Anthony. About 300 participants attended the event.
- Littleton, D. (2019) Palmer amaranth Library Kit, Giant Hogweed, and Palmer amaranth banners presentation at Prairie Smoke Spring Meeting, Chatfield, MN.
- Black swallowwort, 3D print model and new educational poster on display at the Rochester Public Library, March 26-April 22.
- Gardening Day at Heinz Center had approximately 300 participants and new materials were a hit.
- Gupta, A. (2019) Augmented Reality, Virtual Reality & 3D-Printed Models: New Tools for Education & Engagement Lunch & Learn. UMN Department of Forestry, St. Paul, MN.
- Gupta, A & Weber, M. (2019) Bringing science to life through immersive imagery and 3-D modeling. Waste to Worth conference, Minneapolis, MN.

Staff Updates
Dawn Littleton, project staff, is back-up to full time employment after a long medical related work reduction.

Media

- Anne Morse, Winona County Agricultural Inspector, lined up great outreach about the drone flights for oriental bittersweet detection. She issued a media release and there was interest in the story.
  - Winona Daily News - Winona County gets more help in fight against Oriental bittersweet

- KWNO Oriental Bittersweet Battle
- Greg Taylor interviewed Curt and Shane. To listen to the interview, click the link below CURT OLSON AND SHANE BLAIR U OF M MN DEPT OF AG .mp3
- News 800 - Winona County receives assistance to combat invasive plant
- Fox 47 - Researchers use drone technology to find Oriental bittersweet in Winona County

Activity Status as of November 30, 2019:
Presentations, Papers and Posters

- The UMN Bell Museum of Natural History is hosting a traveling exhibit called Wicked Plants, during Saturday, October 5 of the opening weekend MN Master Naturalist volunteers staffed a UMN Extension booth with many of the noxious weed materials developed through this project on display, including the giant hogweed and Palmer amaranth banners, all 4 invasive plant 3D models, and lots of additional educational materials.
- Holland, A., Tuck, B., Gupta, A., Mamedov, S., Weber, M., & Weisenhorn, J. (2019) Rethinking "teaching" in Extension. UMN Extension Program Conference. Duluth MN. (Audience: ~ 40 UMN Extension professionals). Gupta, served on the panel and discussed lessons learned during this project.
- Gupta, A., Weber, M., & Holland, A. (2019) Implementing engaging technology in Extension programming: AR, VR and more. UMN Extension Program Conference. Duluth MN. (Audience: ~25 UMN Extension professionals). Gupta represented aspects of this project on the panel.
- Gupta, A. Kasten, K., Olson, C. & Wright, D. (2019) Panel Discussion: Drones and citizen science: opportunities and challenges. CitSciMN 2019 Symposium. St. Paul, MN. (Audience: ~19 citizen scientist professionals). Gupta organized and Gupta and Olson served on the panel discussing what we've learned from this project.
- Gupta, A. Blinn, C., & Peterson, R. (2019) MLEP: Introduction to Invasive Species. Cloquet, MN. (Audience: 20 MN loggers). Gupta co-developed the agenda, taught the introduction, leafy spurge, Japanese knotweed, common tansy and reed canary grass sections, and facilitated the discussions. Many materials, display items and messages were borrowed from this project.
- Gupta, A. Blinn, C., & Peterson, R. (2019) MLEP: Introduction to Invasive Species. Palisade, MN. (Audience: 8 MN loggers). Gupta co-developed the agenda, taught the introduction, leafy spurge, Japanese knotweed, common tansy and reed canary grass sections, and facilitated the discussions. Many materials, display items and messages were borrowed from this project.
- Gupta, A. (2019) Technologies for Education and Outreach: Augmented Reality, 360 Images and Virtual Reality, 3D Printing, and Crowdsourcing Project Funds and Media. International Union of Forest Research Organizations (IUFRO). Duluth, MN. (Audience: ~20 international foresters). Gupta developed and presented the presentation, some of the materials were from work done during this project.
- Gupta, A. & Reichenbach, M.R. (2019) New Tools for Education and Engagement around invasive species using augmented reality, virtual reality and 3-D printed models. Minnesota Agricultural Inspectors Association Annual Meeting, Baudett, MN. (Audience: 45 participants). Reichenbach presented, Gupta co-developed content, much of the content was borrowed from this project.
- During the MN State Fair this year, the Palmer amaranth banner, developed and used for this project, was on display in the 4-H building as part of the augmented reality invasive species display. (To learn more about this award winning project please view this 2018 video: https://youtu.be/9L8cIMo6DuQ) We improved and expanded the display in 2019 and added augmented reality to the Palmer amaranth

banner (see Zappar app code below that looks like lightening, if you download the Zappar app to a smart device you can see the augmented realty content). During the Minnesota State Fair, a total of 3,356 zaps (scans) were recorded in the exhibit for a total of 31 hours of time spent exploring within the AR scenes across the 12 State Fair days.

Staff Updates & Staff Awards

- Dawn Littleton ended her tenure with UMN Extension, as anticipated, on June 30. Monika Chandler and the MDA team on this project have been WONDERFUL throughout Dawn's medical and work trials.
- **AWARD**: I'm delighted to report that Monika Chandler received the Minnesota Epsilon Sigma Phi Pi Chapter Friend of Extension award this year for her dedicated, professional and lasting contributions to Extension's invasive species programming. Please join me in congratulating Monika!
- **AWARD**: I, Angela Gupta, won the Visionary Leadership Award from the Minnesota Epsilon Sigma Phi Pi Chapter, in part because of work done on this project.

Media & Program Awards

- **AWARD**: Exhibit Award for Invasive Species Augmented Reality. National Association of Extension 4-H Agents Professional Communicator Award. Team members: Margo Bowerman, Bradley Rugg, Angela Gupta, Megan Weber, Lisa Anderson, & Jalil Shabazz. This included the Palmer amaranth augmented reality piece.
- **AWARD**: Exhibit for Invasive Species Augmented Reality. North Central Region-National Association of Extension 4-H Agents Professional Communicator Award Team members: Margo Bowerman, Bradley Rugg, Angela Gupta, Megan Weber, Lisa Anderson, Jalil Shabazz. This included the Palmer amaranth augmented reality piece.
- **AWARD:** Exhibit for Invasive Species Augmented Reality. Minnesota Association of Extension 4-H Youth Development Professional Communicator Award. Team members: Margo Bowerman, Bradley Rugg, Angela Gupta, Megan Weber, Lisa Anderson, Jalil Shabazz. This included the Palmer amaranth augmented reality piece.
- **AWARD:** Book, National Award winner (top 4 in the country) - "By Land and By Sea" (Invasive Species of Minnesota). The National Association of Agricultural Agents (NACAA) communications awards. 2019 Annual Conference. Fort Wayne, IN. Gupta collaborator. This included all the Noxious Weed eradicate invasive plants.
- Media: Black swallow-wort: http://www.lillienews.com/articles/2019/09/27/noxious-plant-taking-root-oakdale-washington-county
- Media: Black swallow-wort: https://www.messagemedia.co/aitkin/outdoors/home_garden/report-and-remove-black-swallow-wort-plant/article_e6fde7e6-e553-11e9-9c3c-47a1df7a90e7.html
- Early American Life magazine, Volume 50, No. 5. October 2019. Itchy Organic reader writing in column, with answer about Oriental bittersweet derived from this project.

Final Report Summary:

Project Results Use and Dissemination

University of Minnesota Extension led the education and outreach funded specifically by this project. Reaching 1,108 people via 11 workshops, field tours and public and professional presentations. Developed two national award winning videos: Planning invasive species events: Tips for working with volunteers and Planning invasive species events: Working with a natural resources professional. Created 14 innovative educational materials including: 3D-printed models of Palmer amaranth, Japanese hops and Grecian foxglove; pull-up banners for Palmer amaranth and giant hogweed; and identification kits available at the public library for Palmer amaranth, wild parsnip and Oriental bittersweet. Produced two new educational handouts and printed and distributed about 10,875 educational materials.

In addition, the University of Minnesota and Minnesota Department of Agriculture (MDA) team members won numerous national, regional and state awards for effort including this project, from across an impressively wide spectrum of content areas. There were 13 media pieces about project activities; 13 presentations or booths reaching 5,137 gardeners, tribal youth, Extension volunteers and others; and 30 presentations or posters at 14 different professional conferences representing a broad spectrum of expertise reaching almost 1,000 natural resource or invasive species professionals. Two professional, peer reviewed articles were published that reference this work. MDA organized and led 6 field tours, gave 43 presentations, provided project updates at 32 meetings, authored 14 articles, sent an annual report to stakeholders and trained Conservation Corps Minnesota crew members at multiple workshops each year.

Final Report Summary:
During this final reporting period Angela Gupta presented a one hour online presentation titled: Citizen science solving invasive species issues through early detection and management to 41 international foresters, mostly Canadians, through the Canada Institute of Forestry webinar series.

During the 4 years of this project, coming on the heels three years of work for Phase 1, it has had many long-lasting and national impacts demonstrated most clearly in the scope and scale of awards project team members have been included in, that, in part or whole, were possible because of this work. The videos produce for this project won the Gold award from the national Association of Natural Resource Extension Professionals. Monika Chandler won the Friend of Extension work from Minnesota Epsilon Sigma Phi (ESP) Pi Chapter, a National Extension fraternity. She was then nominated for a national ESP award. Angela Gupta was part of teams that won invasive species awards, including work or products developed through this project, from the National 4-H Association, National Association of Extension Agriculture Agents, and Angela won the Visionary Leadership Award from the MN ESP chapter. Several project team members were included in the Team Achievement Award presented at the Upper Midwest Invasive Species Conference in 2018.

In addition to winning awards, during the four years of this project, two peer reviewed articles have been published that include work from this project. There have been 13 media pieces from national to local outlets. Two new educational publications for Minnesotans were produced. Thirteen presentations or booths to various natural resource audiences reached 5,137 gardeners, tribal youth, prairie enthusiasts, Minnesota Master Naturalists, local decision makers, and many others. Team members presented three professional conference posters and 27 professional presentations at 14 different conferences, reaching almost 1,000 natural resource and invasive species professionals!

VI. PROJECT BUDGET SUMMARY:
A. ENRTF Budget Overview:

Budget Category	Amount	Overview Explanation
Personnel:	$ 126,759	Program coordinator and UAV scientist

Professional/Technical/Service Contracts:	$ 79,449	For video development and creation of quality display materials. Amendment request includes CCM invasive plant management work.
Equipment/Tools/Supplies:	$ 23,515	
Travel Expenses in MN:	$ 8,177	
Other: Bus rental	$ 1,100	
TOTAL ENRTF BUDGET:	**$ 239,000**	

Explanation of Use of Classified Staff: NA

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

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:
One 3 year full time Program Coordinator = 3 FTE; amendment request for health reasons, about 1 year full FTE; about 2 years of ½ FTE.
One single year 25% graduate student = 0.25 FTE
Total = 3.25 FTE; amendment request, new total: 2.25 FTE.

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF
Total FTEs = estimated 250 hours worked by contractors/2080 = 0.12 FTE; amendment request: ~1.12 FTE.

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
Extension will work to procure an additional $40,000 to support work related to this project from non-state funding sources (likely Federal, $35,000 and private, $5000).	$ 40,000	$5,300	Extension income funding for ISMTrack development and food for Weed 'em Out workshops.
Extension self-funded from program income	$9,609	$9,609	Printing of the new invasive species field guide By Land and By Sea.
Master Naturalist Foundation donation funds	$3,613	$3,613	Master Naturalist Instructor Institute on Invasive Species programming.
Federal Renewable Resource Extension Act funding	$115,000	$69,221	EmpowerU project funds that will likely impact these species.
State			
In-kind Services During Project Period: U of M: One Extension Educator at 10% time for 3 years ($18,700) Printing (MDA general funds $4,175)	$ 18,700	$18,700	Grant implementation including hiring Dawn and working on invasive plant program development.
TOTAL OTHER FUNDS:	**$ 186,922**	**$106,440**	

A. Project Partners:

Receiving funds: Angela Gupta (U of M) will lead the educational components. Brian Taylor (U of M) will lead the survey drone test. Monika Chandler (MDA) will lead survey, coordination of target species control with CCM and follow up monitoring. Brian Miller (CCM) will lead target species control activities. All organizations will provide in-kind equipment, facilities, and GIS/technical support.

Not receiving funds: We will draw from Extension's existing statewide base of volunteers which totals over 102,000 active, trained volunteers. We will collaborate with DNR and Mn/DOT, other federal and state agencies, counties, municipalities, and private landowners.

B. Project Impact and Long-term Strategy:

Preventing highly destructive invasive plant species from spreading throughout the state has an enormous impact. All of the selected species would become widespread without intervention. They would overtake habitats and be prohibitively costly to control on a large scale. Controlling these target species across property lines protects the investment by agencies such as Mn/DOT on their lands. Eradication is defined as target species absence for six years after the last seed was produced. Therefore, eradication must be achieved in a long-term effort and ongoing monitoring is critical. ENRTF funds will be leveraged for (1) Extension funding for online training development cost not included in this proposal and (2) federal funding for volunteer training.

Project partners are working closely with other agencies and land management organizations to optimize and integrate the use of the invasive species management software into invasive species work across the state in a variety of landscape. A comprehensive management inventory should help optimize management impacts while reducing costs.

Continued engagement and empowerment of trained volunteers to identify, detect, survey, monitor and manage invasive species as both immediate and long-term impacts. These volunteers are actively training others and management invasive species while also influencing local policies and action. Sustain engagement and additional outreach should continue to grow citizen understanding and action.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
LCCMR Elimination of Target Invasive Plant Species (Phase 1) project $350,000 from ENRTF of which $135,000 was for MDA and $150,000 was for CCM and $65,000 UMN Extension. In-kind was $85,000 of which $20,000 was from MDA and $30, 000 from CCM.	07/01/2013-06/30/2015 LCCMR In-kind Total	 $ 285,000 $ 50,000 $ 335,000
DNR received $60,000 for early detection and rapid response invasive plant management. These funds were used for CCM crews to survey for and control some of our joint target plant species such as Japanese hops, cutleaf teasel and Oriental bittersweet.	2014 - 2015	$ 60,000
Winona Soil Water Conservation District received $15,000 from the Board of Water and Soil Resources to work on target invasive plant control and site restoration in Winona County	2014 - 2016	$ 15,000
Minnesota Department of Agriculture funded printing of 5,000 updated Department of Transportation Noxious Week booklets used in extensive training for ETIPS 2 audiences	June 2017	$4,125
UMN Extension supplied and was awarded travel scholarships for Angela Gupta to attend the IUFRO 125th Anniversary Congress in Freiburg, Germany. She presented on information including this project.	September 2017	$2,208

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS: NA

IX. VISUAL COMPONENT or MAP(S):

Conservation Corps controlling Oriental bittersweet in Red Wing

Oriental bittersweet vines overwhelming and killing trees in Red Wing

Unmanned Aerial Vehicle Lab students will test a drone for survey

Training people to identify and report target species.

X. RESEARCH ADDENDUM: NA

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than November 30, 2016, May 31, 2017, November 30, 2017, May 31, 2018, November 30, 2018, June 2019, December 2019. A final report and associated products will be submitted between June 30 and August 15, 2020.

Environment and Natural Resources Trust Fund
M.L. 2016 Final Project Budget

Project Title: Elimination of Target Invasive Plant Species – Phase II
Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 06e2
Project Manager: Angela Gupta
Organization: University of Minnesota
M.L. 2016 ENRTF Appropriation: $ 239,000
Project Length and Completion Date: 3 Years, June 30, 2019
Date of Report: 10/27/2020

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activty 1 Final Revised Budget	Amount Spent 6/30/2020
BUDGET ITEM		
Personnel (Wages and Benefits)	$102,156	$102,156
Program Coordinator: ~~$161,350~~ $102,156 (73% salary, 27% benefits); 100% FTE each year for 3 years		
AmeriCorps Volunteer - includes 1 month AmeriCorps time for video production: $1,650		
UAV Scientist: ~~$22,700~~ $24,603 (66% salary, 34% benefits); 16% FTE for 1 Year		
Professional/Technical/Service Contracts		
Develop video for online training for Activity 1	$13,000	$13,000
Quality display materials and 5 invasive plant learning kits for check out by educators (schools, nature centers, master gardeners, etc.) and agency staff for outreach	$11,432	$11,432
CCM Contract		
Equipment/Tools/Supplies		
Materials for trainings and volunteer surveys (identification guides and survey equipment such as safety vests)	$17,001	$17,001
Tablets (20 @ $400 each) for field data collection for Activity 4 for with 10 tablets for Extension training sessions and Extension will provide 10 tablets to Conservation Corps. Tablet purchase is an exception to enable field use of a sophisticated database system.		
Supplies for Activity 2 survey drone test (will use existing U of M drone fleet and sensors)		
Travel expenses in Minnesota		
Travel for program coordination, U of M instructors and drone tests. Milage $5,624; lodging $1,300; meals $1,775	$5,579	$5,497
Other		
Bus rental for in-depth field training of 40 Master Naturalist instructors	$1,100	$1,100
COLUMN TOTAL	**$150,268**	**$150,186**

Activity 1 Balance 6/30/2020	Activity 2 Final Revised	Amount Spent 6/30/2020	Activity 2 Balance 6/30/2020	Revised Activity 3 Budget 1-22-2020	Amount Spent 6/30/2020
$0	$24,245	$23,396	$849		
$0					
$0					
				$55,078	$54,734
$0					
	$1,000	$712	$288		
$82	$1,500	$1,125	$375		
$0					
$82	**$26,745**	**$25,232**	**$1,513**	**$55,078**	**$54,734**
$82			$1,513		

Activity 3 Balance 6/30/2020	Activity 4 Budget 1/22/2020	Amount Spent 6/30/2020	Activity 4 Balance 6/30/2020	Revised TOTAL BUDGET 6/30/2020	TOTAL BALANCE 6/30/2020	Revised TOTAL BALANCE
				$126,401	$850	$850
				$13,000	$0	$0
				$11,432	$0	$0
$344				$55,078	$344	$344
				$17,001	$0	$0
	$5,812	$5,812	$0	$5,812	$0	$0
				$1,000	$288	$288
	$1,098	$1,098	$0	$8,177	$457	$457
				$1,100	$0	$0
$344	**$6,910**	**$6,910**	**$0**	**$239,000**	**$1,939**	**$1,939**
$344			$0		$1,939	

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