M.L. 2015 Projects

MN Laws 2015, Chapter 76, Section 2 (beginning July 1, 2015)

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Subd. 03 Foundational Natural Resource Data and Information

County Geologic Atlases - Part B

Subd. 03b $2,000,000 TF

Jim Berg
MN DNR
Ecological and Water Resources Division
Box 25, 500 Lafayette Rd N
St. Paul, MN 55155
Phone: (651) 259-5680
Email: jim.a.berg@state.mn.us
Web: http://www.mndnr.gov

Appropriation Language
$2,000,000 the first year is from the trust fund to the commissioner of natural resources to continue acceleration of the production of county geologic atlases for the purpose of sustainable management of surface water and groundwater resources. This appropriation is to complete Part B of county geologic atlases, which focuses on the properties and distribution of subsurface water found within geologic formations mapped in Part A in order to characterize the potential yield of aquifers and their sensitivity to contamination. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

County groundwater atlases (County Geologic Atlas, Part B) provide information about groundwater to help citizens and organizations improve sustainable management of groundwater resources. Delineated and mapped aquifers, recharge areas, and springsheds are essential information to help guide management decisions.

The county groundwater atlases describe the hydrogeologic setting, water levels, chemistry, pollution sensitivity, and groundwater use in a county. It includes selected hydrogeologic cross sections indicating groundwater flow direction, residence time within aquifers and groundwater-surface water interactions.

Completed county groundwater atlases that were partially funded by this funding include the counties listed below. Some key conclusions include:

Anoka and Sherburne, and Washington counties:
The surficial and upper two to four buried sand aquifers (Anoka; Sherburne and Washington, respectively) are relatively sensitive to pollution. The lower buried sand aquifers and the top of bedrock (Anoka and Sherburne) have large areas that generally appear to be well protected. Elevated chloride and nitrate concentrations in groundwater were found throughout these counties. Elevated concentrations of naturally occurring manganese were detected in more than half of the samples in Anoka and Sherburne.

Nicollet, Sibley, Renville, Wright, and Clay counties:
The pollution sensitivity ratings of the surficial and upper one to three buried sand aquifers (Nicollet,

Sibley, and Renville; Wright and Clay, respectively) are relatively sensitive to pollution. The deeper aquifers have mostly lower pollution sensitivity ratings across the interior of the counties with higher sensi¬tivity ratings in the Minnesota and Mississippi river valleys. Arsenic and manganese are naturally occurring elements of concern that are present in groundwater across these counties.

In Clay County, chemical analysis of groundwater samples indicates groundwater from buried aquifers in the western portion is some of the oldest and most isolated in the state. In Wright and Washington counties, chemical and other evidence shows lake and groundwater connections are common. Future atlases partially funded by this project include: Becker, Brown, Cass, Dodge, Hennepin, Houston, Hubbard, Isanti, Kanabec, Meeker, Morrison, Olmsted, Redwood, Wadena, and Winona counties.

PROJECT RESULTS USE AND DISSEMINATION

We created and presented educational workshops for all of the groundwater atlases that were completed during this funding period. Shorter presentations were also provided to the County Board of Commissioners for most of the completed Part B counties. Short presentations about the DNR part of the atlas program were made to county and other local staff during the completed Part A presentations. Other atlas related presentations included the Benton & Mille Lacs County SWCD, MPCA and non-atlas DNR staff, the Legislative Water Commission, and a state conference of township supervisors.

Technical articles for the Minnesota Groundwater Association (MGWA) for the completed atlases were published in issues of the MGWA newsletter (http://www.mgwa.org/news_letter/newsletter-back-issues/). Public notification of these completions was also provided to over 3000 subscribers through GovDelivery. Paper copies were sent out to the LCCMR Legislative Reference Library. Copies of the atlas are mailed to other interested stakeholders including USGS, local libraries, and state agencies.

Project Completed: 06/30/2018 **FINAL REPORT**

Reintroduction and Interpretation of Bison in Minnesota State Parks

Subd. 03h $600,000 TF

Edward Quinn
MN DNR
500 Lafayette Rd, Box 39
St. Paul, MN 55155
Phone: (651) 259-5594
Email: edward.quinn@state.mn.us
Web: http://www.dnr.state.mn.us/index.html

Appropriation Language
$600,000 the first year is from the trust fund to the commissioner of natural resources to preserve American bison by reintroducing bison to Minneopa State Park and provide interpretive learning opportunities at Blue Mounds and Minneopa State Parks. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

This project helps to preserve the genetics and population of American bison (Bison bison), a species classified as Near-Threatened by the International Union for the Conservation of Nature and provide more and better opportunities for the public to learn about bison and prairie ecosystems. Eleven bison were reintroduced to Minneopa State Park in the fall, 2015. That population has now grown to 20 and

will continue to expand until the population reaches about 40, the carrying capacity for the site. Annual Minneopa park attendance has increased approximately 70% since the bison were introduced. Further evidence of this increase is demonstrated by a 98% increase in annual permit sales compared to pre-reintroduction as well as a 66% increase in daily permit sales. Approximately 1,100 vehicles utilize the bison drive through in the park each week. Tours using the customized "safari" vehicle, which provides visitors with up-close opportunities to view bison and prairie at Blue Mounds State Park were initiated over Memorial Day weekend, 2018. Nearly 1,000 visitors had taken the tour through Labor Day with 98% saying they would recommend it to others. This project has received extraordinary amounts of publicity, from the initial stories posted about the re-introduction which were picked up by over 100 media outlets to continued TV and radio interviews and a MN Lottery spot that should start airing this fall.

PROJECT RESULTS USE AND DISSEMINATION

Information about this project has been shared through a variety of communication tools. Approximately 290,000 visitors to Minneopa are able to experience the bison and prairie ecosystems through interpretive programs, signage and radio broadcast. Another 65,000 visitors to Blue Mounds State Park learn about bison and prairies through programs and signage with approximately 1,000 annually able to participate in "safari" tours out into the prairie for close-ups looks at bison and the prairie ecosystem. Stories about the initial reintroduction at Minneopa were disseminated by over 100 media outlets across the country. The project continues to be highlighted in television and radio interviews. A MN Lottery spot was recently filmed as well as a commercial with Explore Minnesota tourism.

Project due to be completed: 06/30/2019 **FINAL REPORT**

Aquatic and Terrestrial Reptile Habitat

Subd. 03m $250,000 TF

Jennifer McGuire
University of St. Thomas
2115 Summit Ave
St. Paul, MN 55105
Phone: (651) 962-5221
Email: jtmcguire@stthomas.edu
Web: http://www.stthomas.edu/biology/research/biogeochemistry.html

Appropriation Language
$250,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the University of St. Thomas in cooperation with the Three Rivers Park District to analyze the aquatic and terrestrial habitat for certain reptile species in urban lakes and to make specific recommendations to protect and enhance the habitat. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Turtles are among the most threatened organisms in the world, with approximately 61% of the 356 modern species of turtles and tortoises listed as threatened, endangered, or already extinct. Little is known about how human alteration of habitats, including water chemistry in urban lakes, affects turtle behaviors. Human activities can lead to the addition of chemicals such as road salt and excess nutrients,

increased aquatic sediment, and altered water flow patterns. Understanding how these changes affect turtles is critical for appropriate planning to balance human and wildlife needs.

Beginning in the summer of 2015, our team of ecologists, water-quality specialists, wildlife managers and students, conducted research at an urban lake in Plymouth, MN (Medicine Lake) studying population dynamics of Painted Turtles (Chrysemys picta), Snapping Turtles (Chelydra serpentina), and Spiny Softshell Turtles (Apalone spinifera), three of the most widespread native turtle species in North America. We completed:

- Turtle trapping and telemetry of 314 turtles
- Genetic sampling to analyze population size and inbreeding
- Spatial and temporal analysis of lake sediment and water quality
- GIS analysis of turtle home range, habitat use, and water quality

These data were used to prepare recommendations (see final management report for details). Briefly, our data show it is important to protect and conserve diverse natural shorelines (with either sandy or vegetated habitat with locations for basking) to support diverse turtle communities. It is also important to balance human recreational needs with disturbance to basking or nesting sites, particularly for Spiny Softshell turtles that nested on the swimming beach. To maintain high genetic diversity and reduce inbreeding, aquatic connectivity between water bodies should be maintained and preserved. Finally, the impact of road salt should be limited via barriers, as our data show that these chemicals increased in the lake over the four year study, now reaching levels shown to produce aquatic toxicity and impaired food-web dynamics in other systems. Because dissolved salt is nearly impossible to remove from the water, limiting input BEFORE wildlife impacts are observed is critical.

PROJECT RESULTS USE AND DISSEMINATION

Although the work provided here was the subject of academic publications, student projects, and graduate theses (see work plan for additional details), the main results use and dissemination was in providing specific recommendations for future management of Medicine Lake and communicating those to Three River's Park District, the organization managing the lake (see final management plan).

We considered public engagement to be a very important aspect of this project. For social media outreach we created a Facebook page, Turtles of Medicine Lake, with over 150 organic followers. This page was updated with fun facts about the three species of turtles included in this project, relevant new research, and any other project updates that were appropriate. Additionally, we had media coverage from local news channels and local papers throughout the duration of the study. Eric Nelson from Channel 12 Local News and CCX Media filmed and aired a segment in July, 2016. Jeff Edmondson from Kare 11 covered all three years of the project and filmed and aired segments in August of 2016, 2017, and 2018. Sonya Goins from Channel 12 Local News and CCX Media came to the lake to film a segment covering the winter ice dive in March, 2018. And Lastly, Kristen Miller published an article in the Sun Post, also covering the winter ice dive in March, 2018. Bridging the gap between scientific research and the public is one of the most important aspects of science and we were successfully able to this for the Medicine Lake Urban Turtle Study.

Project Completed: 06/30/2019 **FINAL REPORT**

Subd. 04 Water Resources

Understanding Water Scarcity, Threats, and Values to Improve Management

Research Project

Subd. 04a $234,000 TF

Bonnie Keeler
U of MN
1954 Buford Ave
St. Paul, MN 55108
Phone: (612) 625-8905
Email: keeler@umn.edu
Web: http://z.umn.edu/keeler

Appropriation Language
$234,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to model and map statewide water scarcity and abundance; assess water-related risks to industry, municipalities, and ecosystems; and quantify the economic values of changes in water quality and quantity in order to inform long-term water sustainability strategies. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

We created high-resolution climate change projections for Minnesota using the best available techniques. State agencies, local governments, private sector engineers, and other climate data users will be able to build freely off the foundational data we have created to make plans that are more prudent for the future of Minnesota. To ensure our results were not sensitive to any one model or year, we averaged the results of five models and further averaged the results over four 20-year scenario periods, 1989-1999 historical, 2040-2059 moderate emissions, and 2080-2099 moderate and high emissions. This gives us confidence that observed changes are the result of long-term changes and not the weather on a single year or model.

The overall trend for the state found in previous global modeling is for a warmer at wetter future. Our work adds local nuance not possible in global models. We find that the timing of precipitation will change, with more precipitation in the spring and early summer, more intense rain events, and longer dry spells between events. The north shore region of the state had the most pronounced increase in both quantity and intensity of precipitation by the end of the century. Infrastructure in the region will have to contend with twice as much precipitation in May, already among the wettest months, and up to 50% more precipitation in the largest 5-day rainfall total in an average year. Corn and soy yields declined by as much as 25% in the majority of scenarios and regions. We also project up to 30 additional days with highs 95°F or hotter.

We also assessed if climate change and increased water withdrawals could lead to water scarcity in the state. We did not find evidence for broad-scale scarcity, but we do highlight watersheds that may consider shifting some of their withdrawals to surface water. We also note that further research is required to capture short-term depletion local effects of withdrawals on surface features.

PROJECT RESULTS USE AND DISSEMINATION

Due to the universal applicability of climate to humans and the environment, we invested extra effort in preparation for disseminating this work. We surveyed practitioners to identify the types of climate data that are most needed to make decisions and manage resources in the state. We have publicized this work in numerous presentations, including the Clean Water Council, the Department of Health, the

Department of Natural Resources and county level managers. We are also working to make much of the underlying data produced as a part of this research readily available to the public. Because the raw data is often challenging for non-specialists to work with, we invested considerable resources in interpreting the results in the accompanying final report.

For scientific audiences, in addition to the underlying data, we are planning three publications and at least one conference presentation based on this work. We already have plans to include these data in other research on irrigation trends and drinking water management in Minnesota.

Finally, as with most of our work, we will write a brief, accessible blog post to highlight and share this work with a broad audience. /p>

Project Completed: 06/30/2018 **FINAL REPORT**

Climate change projections for improved management of infrastructure, industry, and water resources in Minnesota

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Using Hydroacoustics to Monitor Sediment in Minnesota Rivers

Research Project

Subd. 04g $455,000 TF

Jeffrey R. Ziegeweid
U.S. Geological Survey
2280 Woodale Dr
Mounds View, MN 55112
Phone: (763) 783-3113
Email: jrziege@usgs.gov
Web: http://mn.water.usgs.gov/index.html

Appropriation Language
$455,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the United States Geological Survey to install hydroacoustic equipment on the lower Minnesota and Mississippi Rivers to improve measurement and monitoring accuracy for suspended sediment and enhance ongoing sediment reduction efforts by state, federal, and local agencies. This appropriation is not subject to Minnesota Statutes, section 116P.10. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Excessive sediment in rivers degrades water quality, reduces aquatic habitat, increases need for navigation channel dredging, reduces recreational opportunities, and transports harmful contaminants. Lake Pepin, a naturally-formed lake on the Mississippi River, is filling in with sediment at a rapid rate compared to conditions prior to European settlement, and 85-90 percent of the sediment depositing in Lake Pepin comes from the heavily-cultivated Minnesota River Basin. However, we lack detailed spatial information within the watershed to focus sediment-reduction efforts. Therefore, the U.S. Geological Survey (USGS) began a project funded by the Environment and Natural Resources Trust Fund to better understand sources and sinks of sediment in the watershed upstream of Lake Pepin, which includes the Minnesota, St. Croix, and upper Mississippi Rivers. We sampled nine stream locations and developed surrogate relations between newly installed, continuous hydroacoustic sensors and collected suspended sediment samples. Data from this study allows determination of sediment loads for streams in the study

area that are more accurate and at a higher spatial resolution of sampling sites than prior monitoring efforts. Higher gradient river reaches in upstream portions of the study area were consistent sources of sediment. Low gradient areas near river confluences were consistent sinks of sediment, storing more sediment in floodplain or lake environments than was input from upstream. In contrast, mid gradient areas were dynamic, generating sediment load in some conditions but storing sediment in other conditions. Channelized river reaches, latitudinal precipitation patterns, and inputs from sediment-laden tributaries in the southern part of the watershed likely contributed to fluctuating sediment dynamics in mid-gradient areas. The spatial density of continuous sediment monitors was critical to understanding the source/sink dynamics of sediment in the study area. Results of this study may help resource-management agencies target sediment-reduction efforts at areas within the watershed that act as sediment sources.

PROJECT RESULTS USE AND DISSEMINATION

Results of this project will be disseminated in a number of ways. First, suspended sediment data collected at hydroacoustic streamgages in the study area are publicly available on the U.S. Geological Survey (USGS) National Water Information System (NWIS) data portal (https://waterdata.usgs.gov/mn/nwis/sw). Second, real-time suspended sediment data has been made available through the USGS National Real-Time Water Quality website (https://nrtwq.usgs.gov/) for the Minnesota River at Fort Snelling State Park, Minn. (USGS streamgage 05330920), and real-time suspended sediment data will be added for a subset of project streamgages in the near future. Finally, project results will be summarized in a USGS Scientific Investigations Report (Groten and others, in review – draft files attached) that will be publicly-available for dissemination after official publication.

Results of this project have been presented to other agencies, including the U.S. Army Corps of Engineers, the National Weather Service, and the Lower Minnesota River Watershed District; funding through the Environment and Natural Resources Trust Fund has been acknowledged during every presentation given. Furthermore, USGS scientists involved in this project have discussed ways to integrate results of the project into existing cooperative efforts between the USGS and the Minnesota Department of Natural Resources, and the Minnesota Pollution Control Agency (MPCA). Finally, the project chief has been actively involved in discussions with the Upper Mississippi River Basin Association, the Mississippi River Cities and Towns Initiative, and the USGS Midwest Regional Office about ways to integrate project hydroacoustic streamgages into larger regional efforts to improve the health of the Mississippi River.

The results of this study may help the MPCA evaluate progress towards sediment reduction goals for Lake Pepin. For locations that were consistent sources of sediment throughout the study, implementation of best management practices (BMPs) on the landscape may reduce amounts of sediment entering the Minnesota River. However, locations that can change between sources and sinks for sediment likely indicate temporary storage in the Minnesota River and delayed transport to the Mississippi River. The timing and magnitude of in-channel sediment transport in these locations varies substantially with changes in weather and streamflow. Without continuous monitoring of sediment in these dynamic locations, the effects of in-channel sediment transport would be difficult to quantify, complicating efforts to evaluate long-term progress towards sediment reduction goals.

Project Completed: 06/30/2019 **FINAL REPORT**

Study Area Map

Assessment of Irrigation Efficiencies in Benton County

Subd. 04h $431,000 TF

Gerry Maciej
Benton Soil and Water Conservation District
14 Second Ave W
Foley, MN 56329
Phone: (320) 968-5300 x3
Email: gerry@soilandwater.org
Web: http://www.soilandwater.org

Appropriation Language
$431,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with Benton Soil and Water Conservation District to develop and implement a decision support system to increase irrigation efficiencies and provide outreach on irrigation best management practices. Software developed with this appropriation must be available in the public domain. Project efforts should be coordinated with the Department of Natural Resources. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Several areas in Minnesota exist where groundwater use exceeds sustainable levels or is approaching a sustainability threshold. One those areas is Little Rock Creek in Benton and Morrison Counties. The overall goal of this project was to provide new tools and expertise to overcome sustainability issues in Little Rock Creek and provide these tools to others facing similar sustainability problems throughout many parts of Minnesota. This project successfully created an online, mobile-friendly, Conservation Irrigation Decision Support System and Irrigation Scheduling Assistant that increases irrigation efficiencies and confidence in irrigation water management. The major outcomes and results from this project include:

1. **Real-Time Conservation Irrigation Decision Support System (CIDSS):** Three DNR monitoring stations on Little Rock Creek were upgraded with satellite telemetry equipment. The CIDSS illustrates real-time graphs of Little Rock Creek's stream flow and temperature along with their associated environmental thresholds. Conservation Irrigation Tips were developed for short- and long-term conservation measures that allows irrigators to make condition appropriate irrigation decisions.
2. **Increasing Irrigation Efficiency:** An online, mobile-friendly irrigation scheduling assistant was created. Input was taken from a local stakeholder group to integrate GIS-based NEXAD daily rainfall estimates into the scheduler that improves field-by-field reliability. We had successful adoption of irrigation water management in the project area. Over the past four growing seasons, irrigation management was practiced on 9,728 acres. In 2018, the software was expanded to a 5-county area of East Ottertail instance, and has been used on 139 fields covering 27,258 acres.
3. **Improving Soil Health:** Technicians provided expertise to producers on soil health practices to increase soil organic matter, conserve soil moisture, and to improve nutrient cycling on the sandy irrigated soils, as well as, reducing wind and soil erosion. A total of 454 acres of soil health practices have been implemented within the project area.

PROJECT RESULTS USE AND DISSEMINATION

This project was able to educate many people about new up-to-date irrigation water management tools. The irrigation scheduling tool and CIDSS for the Little Rock Creek Groundwater Area is available online at

http://ima.respec.com/. The East Ottertail instance that include the 5-county expanded areas of Hubbard, Becker, Wadena, Ottertail and Todd Counties is also available online at http://ima.respec.com/ The project's new online irrigation management scheduler is highlighted on local SWCD's websites, such as www.soilandwater.org and http://www.eotswcd.org/irrigation-scheduler/. A online demo trial of the irrigation scheduler is available to the public to try and to see what the tool has to offer. Promotional banners of the Irrigation Management Assistance were made for the local SWCD's where the current software is offered. Weather station and evapotranspiration data is available at www.agweathernetwork.com. Water flow and stream temperature for Little Rock Creek is currently available to the irrigators using the scheduling assistant within Little Rock Creek Groundwater Area.

Project Completed: 06/30/2019 **FINAL REPORT**

Benton AG: Newspaper Article
Minnesota Irrigator: Newspaper Article

Subd. 06 Aquatic and Terrestrial Invasive Species

Minnesota Invasive Terrestrial Plants and Pests Center

Research Project

Sec. 6a $5,000,000 TF

Sub-Project 07: Tools to Distinguish Native from Exotic Reed Canary Grass - $248,848 TF

Neil O. Anderson
U of M - Department of Horticultural Science
286 Alderman Hall
1970 Folwell Avenue
St Paul, MN 55108
Phone: (612) 624-6701
Email: ander044@umn.edu

OVERALL PROJECT OUTCOME AND RESULTS

The goal of this project was to use molecular markers to determine native vs. exotic reed canary grass status in various locations across Minnesota growing along rivers (Des Moines, Minnesota, Mississippi, Red, Roseau, St. Croix), in fields, as commercially-grown cultivars (forage, ornamental), and preserved historic specimens in herbaria (<1940, presumed native) and a corollary set of samples from rivers in the Czech Republic as exotic comparisons (Activity 1); along MN transportation corridors (highways) existing during the 1920s-1930s (Dust Bowl era) and Minnesota lakes (Bush, Cedar, Como, Phalen, Mille Lacs, Minnetonka, Square, White Bear) and Central Park (Activity 2). Due to Covid-19 travel restrictions, we were unable to get permission to collect along additional lakes. The number of plants analyzed totaled 3,430 (Activities 1,2). Plant DNA was extracted from each sample to determine genomic markers of short DNA sequences (2,889 highly differentiated single nucleotide polymorphisms, SNPs, out of 16,902 total markers) to distinguish native vs. exotic status. Genetic analysis of reed canarygrass showed that river populations are native Minnesota or North American types. Herbarium samples as well those from a native, unplowed field (Roseau, MN) were genetically similar to wild collections from five MN rivers; forage cultivars in commercial fields (Roseau, MN) and along the Roseau River formed a separate group.

The exotic central European populations were distinctly different from all native MN groups. Most variation is within (98.8%), rather than among (1.2%), populations, suggesting little divergence and a high level of shared genetic markers. Across the state, Minnesota rivers had 2-32 genetic variants present, some of which were shared among rivers. Thus, the majority of MN reed canarygrass, while invasive, is native in origin and not exotic (European). Thus, based on this study, all of MN reed canarygrass is native; Tribal and State managers may choose to preserve this species.

PROJECT RESULTS USE AND DISSEMINATION

How has the information from this project been used and/or disseminated?

Dissemination of native vs. exotic status of all Phalaris results from Activity 1 has been reported on the Department of Horticultural Science website (http://horticulture.umn.edu), that of the PIs (http://horticulture.umn.edu/directory/faculty/neil-oanderson), as well as in all PIs/co-PIs Experts at umn.edu links (https://experts.umn.edu/). As many as 11 abstracts were published in national and international meetings, along with corollary public posters sessions or seminar talks to varied audiences of academics, land managers, students, and/or the public-at-large. We have kept State and Tribal Land Managers informed on the native status of MN reed canarygrass and have initiated discussions on approaches to managing this native species yet invasive. The investment by the state on control measures for this invasive grass warrant careful consideration of best management approaches to maintaining the native genetic diversity yet not encouraging the invasive spread of this grass into managed areas. Results were also communicated to the scientific community in peer-reviewed journal articles.

Subproject 07 Completed: 06/30/2020 **FINAL ABSTRACT**

Sub-Project 12: Developing Robust Identification Assays for Amaranthus Palmeri in Seed Mixture - $208,230 TF

Don Wyse
U of M - Department of Agronomy and Plant Genetics
411 Borlaug Hall
1991 Upper Buford Crescent
St Paul, MN 55108
Phone: (612) 625-7064
Email: wysex001@umn.edu
Web: https://agronomy.cfans.umn.edu/department-directory/donald-l-wyse

OVERALL PROJECT OUTCOME AND RESULTS

Palmer Amaranth is an aggressive and prolific weed species that poses a major ecological and economic risk to growers in the state of Minnesota. Closely related to other pigweed species, Palmer has a far more severe impact on agricultural row cropping systems. Early identification of Palmer Amaranth is critical, as it has developed resistance to some of the most widely used herbicides; ALS-inhibitors, PPO-inhibitors, and glyphosate. Visual identification of Palmer Amaranth against other pigweed species is difficult, which has led to the use of genetic testing becoming the standard for identifying Palmer.

To address this emerging challenge we collected at team of weed science experts from the University of Minnesota, Colorado State University and the Minnesota Department of Agriculture. This team developed an improved genetic test to maximize the robustness and reliability of Palmer Amaranth identification for both individual plants and bulk seed screenings. To achieve this, our team collected

Pigweed samples across the United States as well as Mexico, South America and Africa. We extracted DNA samples from a total of 24 populations of Palmer amaranth and 42 non-Palmer pigweeds, resulting in DNA from over 2,000 individual plants. We sequenced more than 800 of these samples through the University of Minnesota Genomic center to search for genetic differences between Palmer and the other species. These differences served as a target for developing a set of genetic markers that can be used for species identification. Once developed the genetic markers were tested against 1,250 pigweed samples to assess their performance.

The final result is a highly reliable test for (>99.7% accuracy) for detecting Palmer Amaranth, both for individual plants and pools of seed. This test will be an important tool for Palmer control for Minnesota growers, crop consultants, and other agronomic specialists. The test is expected to be commercially available in 2020.

PROJECT RESULTS USE AND DISSEMINATION

This project resulted in the development of a robust, highly accurate and easy to use assay for the identification of Palmer Amaranth against other pigweed species. This assay is commercially viable, and a patent was filed for the two markers developed solely at UMN on March 27th, 2020 (Patent #63,000,946). Collaborators at Colorado State University has stated their interest in licensing the tests and offering them as part of a comprehensive Pigweed seed testing service.

This project has also resulted in the creation of a large body of genetic sequence data for Pigweeds assembled from across a wide geographic range. This data will be a valuable resource for future work on Palmer Amaranth and related pigweed species, and will be made publically available through NCBI.

Subproject 12 Completed: 06/30/2020 **FINAL ABSTRACT**

Emerald Ash Borer Ecological/Hydrological Impacts - Phase 2

Research Project

Subd. 06b $400,000 TF

Anthony D'Amato
U of MN
1530 N Cleveland Ave
St Paul, MN 55108
Phone: (612) 625-3733
Email: damato@umn.edu
Web: http://www.forestry.umn.edu/silviclab/index.htm

Appropriation Language
$400,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to assess the potential impacts of emerald ash borer on Minnesota black ash forests and quantify potential impacts on native forest vegetation, invasive species spread, and hydrology. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

The Emerald Ash Borer (EAB) has been decimating ash trees throughout the Lake States and is currently on the doorstep of the vast acreages of black ash in northern Minnesota. There are over one billion black ash trees in the state and loss of this species is expected to have significant cultural and ecological impacts across the region. This project was a continuation of the Ecological and Hydrological Impacts of

Emerald Ash Borer project that received ENRTF funding in 2010 and was designed to increase our understanding of the vulnerability of northern Minnesota forests to EAB and develop appropriate strategies for increasing the resilience of these critical habitats to the impacts of this introduced insect. Results from this project indicate that loss of black ash will have significant impacts on the hydrology of these areas with overstory mortality resulting in an increased duration of flooding. These impacts are likely to be greatest in swamps occupying depressional or transitional hydrogeomorphic settings. Examination of 32 black ash wetlands across northern Minnesota indicated a region-wide lack of species capable of replacing black ash following EAB and point to an urgent need for active silvicultural intervention to establish non-host tree species in these wetlands. To this end, we monitoring survival of seedlings planted as potential replacement species over a nine-year period and found that the highest surviving species were American elm, swamp white oak, Manchurian ash, and hackberry. Another species showing promise is balsam poplar, which is readily planted from cuttings and may provide an operationally efficient strategy for establishing non-ash tree species in areas threatened by EAB. Collectively, this work has helped identify both the black ash wetlands most vulnerable to EAB impacts, as well as the forest conservation strategies most effective at mitigating these impacts.

PROJECT RESULTS USE AND DISSEMINATION

The results of this project have been shared on numerous occasions with resource professionals, policy makers, citizens, and scientists over the past five years in efforts to inform forest conservation decisions regarding the impacts of emerald ash borer on black ash forests in Minnesota. These dissemination activities have included the development of case studies within the Great Lakes Silviculture Prescription Library highlighting key outcomes of this work. In addition, we have shared the results from this project with private forest landowners, and county, state, tribal and federal natural resource managers on numerous occasions, including through two Sustainable Forestry Education Cooperative webinars (September 15, 2015 and October 17, 2017) and presentations at the Upper Midwest Great Lakes Landscape Conservation Cooperative North Woods Work Group meeting at Sault St. Marie, MI June 28, 2016, and the Society of American Foresters National Convention in Madison, WI on November 3, 2016. The results of this work have also been shared directly with the Silviculture Program Coordinator for the Minnesota DNR to discuss ways in which the findings from this project can inform black ash management guidelines for the state of Minnesota (February 16, 2017). We co-organized the workshop, “Science and Management of Ash Forests after EAB” in Duluth, MN July 25-27, 2017 where results from this project related to hydrology and understory vegetation and associated management strategies were presented to over 200 resource managers, policy makers, and scientists from across MN, MI, WI and the northeastern US. Results of this project related to management strategies for minimizing emerald ash borer impacts were presented as part of the National Silviculture Workshop in Bemidji, MN May 21-23, 2019. This included a field tour for natural resource managers to the sites established under Phase I of this project with representation from the Minnesota DNR, several MN County Land Departments, Chippewa National Forest, Superior National Forest, Division of Resource Management for the Leech Lake Band of Ojibwe, as well as foresters and scientists from across the US. The results of this project related to potential replacement species for planting to sustain the functioning of black ash wetlands following EAB were shared as part of a webinar “Integrating Assisted Migration into Adaptation Strategies for Northeastern Forests.” This webinar is part of the Northern Institute of Applied Climate Science Forest Webinar series, with over 120 forest managers viewing the webinar, which is now archived online on YouTube. Finally, the project PI has served on the Minnesota DNR black ash management guideline committee since the inception of this project and has shared project results to influence the current recommendations for managing MN black ash forests in the face of EAB.

Publications resulting from this work are available for download from the USFS Treesearch website. Additional publications from this work that are currently in development will also be posted on this site and shared with LCCMR staff for dissemination.

Project Completed: 06/30/2020 **FINAL REPORT**

Biological Control of Canada Thistle - RESEARCH

Research Project

Subd. 06c $300,000 TF

Roger Becker
U of MN
411 Borlaug Hall, 1991 Upper Buford Cir
St. Paul, MN 55108
Phone: (612) 625-5753
Email: becke003@umn.edu
Web: http://appliedweeds.cfans.umn.edu/

Appropriation Language
$300,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to develop a biological control for Canada thistle, an invasive plant species in Minnesota. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Canada thistle is a serious threat to natural and managed ecosystems in Minnesota. In 1998, the Canada thistle biocontrol stem-mining weevil Hadroplontus litura was introduced into a limited area in Minnesota with a resulting decline in Canada thistle populations. Although showing a preference for Canada thistle, initial host range testing of H. litura revealed that it attacked other native thistles. Before continuing biocontrol efforts with additional H. litura releases in Minnesota, we wanted to clarify whether H. litura would attack thistles native to Minnesota. The two objectives of our research were: 1.) determine whether H. litura could feed, oviposit and complete development on native thistles, and 2.) determine the phenology of native thistles in relation to Canada thistle. In no-choice tests, female H. litura accepted all native thistle species for oviposition and was able to complete development to the adult stage on swamp, field, tall, Flodman's and wavy-leaved thistle. In Hill's and the federally threatened Pitcher's thistle, no adults were found in development tests. However, since more than half of Hill's and Pitcher's thistle plants died during the course of the experiment and it is unclear whether the plants died as a result of H. litura attack or other causes. Delayed spring emergence on native thistles could temporally escape H. litura oviposition and afford some protection from H. litura. However, all tested native thistles could be attacked because they have shoots present when H. litura eggs are laid in the spring. In conclusion, we recommend that tests should be conducted in open field conditions to document the ecological host range of H. litura prior to the continued released of H. litura as a biocontrol agent of Canada thistle in Minnesota.

PROJECT RESULTS USE AND DISSEMINATION

The following materials were disseminated and produced:

- Becker, R.L. 2017. Update included as part of a broader presentation: Overview of Canada Thistle (Cirsium arvense) Management in Minnesota. Iowa Invasive Species Conference. Honey Creek Resort at Rathbun Lake, Moravia, Iowa. March 28 - 29, 2017
- Becker, R. 2018. Update included as part of a broader presentation: Canada thistle in Minnesota Prairies: Now you see it, now you don't. Webinar hosted by MIPN. International audience (Canada and US). 70 participants. Invited talk, of on 4 in a series. Feb 13 2018. Available online https://www.mipn.org/proceedings/restoration-webinar-series/
- Katovich, E., R. Becker, M. Marek-Spartz. 2018. Host Specificity of Hadroplontus litura on native Cirsium Species. Proc. North Central Weed Science Soc. Hyatt Regency, Milwaukee, WI. Dec. 3–6, 2018. Poster (35)
- Katovich ES, RL Becker, M Marek-Spartz, M Chandler, L Van Riper. 2016. Biological Control of Canada Thistle. UMISC. LaCrosse WI Oct 17-19. Poster.
- Marek-Spartz, M., E. Katovich, R. Becker, M. Chandler, and L. Van Riper. 2018. Biological Control of Canada Thistle: Host Range of Hadroplontus Litura on Native Cirsium spp. Presentation at the Upper Midwest Invasive Species Conference. Rochester Convention Center, Rochester MN. Oct. 15-18, 2018.

Project Completed: 06/30/2019 **FINAL REPORT**

Preventing a New Disease of Pines in Minnesota

Research Project

Subd. 06d $371,000 TF

Robert Blanchette
U of MN
1991 Upper Buford Cir, 495 Borlaug Hall
St. Paul, MN 55108
Phone: (612) 625-0202
Email: robertb@umn.edu
Web: http://forestpathology.cfans.umn.edu/default.htm

Appropriation Language
$371,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to establish early detection for heterobasidion, an invasive root rot fungus, and develop efforts to prevent its spread and reduce its impact. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

A new invasive tree disease called Heterobasidion root disease is a serious threat to Minnesota's red and white pines as well as other conifers. It is considered the most economically important disease of pines throughout the Northern temperate regions. In recent years, the pathogen has moved through Wisconsin and is now found on red pine in southeastern Minnesota. New molecular methods to identify the pathogen were developed and are being used to successfully identify the pathogen from field samples. Monitoring disease progression has been initiated and spores of the pathogen appear to be moving into new areas. Finding this disease early is essential so that control procedures can be initiated to limit the spread of this disease. Control methods for Minnesota have been evaluated and

management guidelines were developed in collaboration with the Minnesota Department of Natural Resources. A series of videos on the biology and control of this disease as well as information on our research activities to find biocontrol agents were developed. These educational materials are being widely used by foresters and landowners in Minnesota as well as in other states. Although some control options are available, research was carried out to identify the possibility of new biocontrol methods that could be used. Native fungi that are antagonistic to the pathogen were tested for their potential use as biological control agents. Several were found to be effective and are ready for field testing. This work has helped to limit the spread of this pathogen in Minnesota and has provided new information on potential future biological control methods. The detection protocols that were developed have been found to be very effective for monitoring this pathogen and can now be adapted and used to survey for other invasive forest pathogens that may affect Minnesota's trees.

PROJECT RESULTS USE AND DISSEMINATION

To disseminate important information obtained from the project we developed four videos that explain the identification, biology and management options for Heterobasidion root disease.

- https://www.youtube.com/watch?v=IRO8eLmHqn0
- https://www.youtube.com/watch?v=4woY5IC40RA
- https://www.youtube.com/watch?v=1_B6g45OGWU
- https://www.youtube.com/watch?v=Y7-jU5LzOgA

These videos provide resource managers and the public with needed information to identify the disease and the most current options for control. Collaboration with the Minnesota Department of Natural Resources in making these outreach materials has resulted in their widespread use and they have become an important resource for limiting the spread of this new invasive disease in Minnesota. Other scientific publications from project results are in the process of being published these include:

- Surveys Results for *Heterobasidion irregulare* in Minnesota
- Fungal community analysis of red pine stumps in managed stands across Minnesota
- Antagonistic interactions between basidiomycete fungi and *Heterobasidion irregulare*

Project Completed: 06/30/2019 **FINAL REPORT**

Subd. 07 Air Quality, Climate Change, and Renewable Energy

Renewable and Sustainable Fertilizers Produced Locally

Research Project

Subd. 07a $1,000,000 TF

Alon McCormick
U of MN
421 Southeast Washington Ave
Minneapolis, MN 55455
Phone: (612) 625-1822
Email: mccormic@umn.edu
Web: http://www.cems.umn.edu

Appropriation Language
$1,000,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Morris West Central Research and Outreach Center and Twin Cities Campus to develop and demonstrate new technologies aimed at enabling renewable and sustainable production of ammonia for fertilizer in a localized manner. This appropriation is subject to Minnesota Statutes, section 116P.10. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Activity 1 demonstrated that UMN absorbent technology can pave the way to making ammonia sustainably for the farm, using renewable energy and with producing no greenhouse gas emission. This would reduce the environmental impact of Minnesota farms while also providing relief from stringent seasonal demand for ammonia. Numerous engineering and technoeconomic analysis publications and presentations - assisted also by the US Department of Energy ARPA-E - laid the foundation to develop intellectual property and seek potential future partners. For Minnesota farms, it is next most promising to focus on designing a single integrated reactor-separator module, safer and more efficient than to date, able to produce cheaper ammonia at the farm scale. We will next to seek support to pursue this direction to benefit the Minnesota environment.

Activity 2 explored plasma-generated ammonia and nitrates, showing potential for use in hydroponic irrigation streams providing on-demand fertilizer.

Activity 3 technoeconomic and policy analysis examined appropriate siting and planning of distributed ammonia production for the Minnesota agriculture, establishing important case studies that frame the challenge for the future. Data used was from WCROC's existing wind-to-ammonia facility, demonstrating nationally and internationally the important of this nation-leading benchmark, and drawing interest in possible use of WCROC for a future US Department of Energy demonstration.

Activity 4 explored the question of whether hydrochar might be used to help prevent runoff of ammonia and nitrates from fields (in partnership with Prof. Ken Valentas' project).

PROJECT RESULTS USE AND DISSEMINATION

Engineering publications that laid the foundation for intellectual property development. Presentations at major meetings (national and international ammonia and fertilizer meetings) and state, national and international meetings arranged with the UMN Office of Technology Commercialization, to pursue contacts and plans with prospective partners.

Workshops with possible Minnesota stakeholders convened by co-PI Steve Kelley (formerly UMN Humphrey School of Public Affairs; now, though, Minnesota Commerce Commissioner) to learn and address needs of farmers and local utilities.

News features and science outreach to help get the message out and stimulate further inquiries and discussion Website logging progress and literature resources as they grow from the team's work: (https://wcroc.cfans.umn.edu/research-programs/renewable-energy/ammonia)

Project Completed: 06/30/2019 **FINAL REPORT**

Subd. 08 Methods to Protect, Restore, and Enhance Land, Water, and Habitat

MSU Moorhead Science Center Restoration & Monitoring

Subd. 08g $527,000 TF

Brian Wisenden
Moorhead State University
1104 Seventh Ave S
Moorhead, MN 56563
Phone: (701) 212-5801
Email: wisenden@mnstate.edu
Web: http://web.mnstate.edu/wisenden

Appropriation Language
$527,000 the first year is from the trust fund to the Board of Trustees of the Minnesota State Colleges and Universities system for Minnesota State University Moorhead in cooperation with the Department of Natural Resources to restore and monitor 160 acres of prairie and riparian habitat and develop and disseminate monitoring protocols. This appropriation is contingent upon the donation of a 60-acre parcel to Minnesota State University Moorhead from the Minnesota State University Moorhead Alumni Foundation and is available until June 30, 2020, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

The Bluestem Prairie is Minnesota's largest remnant tall grass prairie (6700 acres) comprising lands owned by The Nature Conservancy, Department of Natural Resources and Minnesota State University Moorhead. This project set out to achieve three goals: (1) acquire additional 189 acres of land contiguous with the complex, 100 acres of which were abandoned agricultural field and 89 acres comprised 60 acres of golf course fairways and 29 acres of riparian terrace forest, (2) collaborate with the MN DNR to restore 160 acres of land to tall grass prairie habitat, and (3) engage faculty and students at Minnesota state University Moorhead to monitor changes in the prairie community before, during and after restoration, to enrich undergraduate curricula, develop capacity for personnel interested in restoration biology, and develop and disseminate monitoring protocols for application to future restoration projects. In the five years since June 2015, we have successfully transferred ownership of the 189 acres of land to Minnesota State University Moorhead, restored 160 acres to tall grass prairie community and engaged 10 MSUM faculty, dozens of research students and many hundreds of undergraduates in concepts and practical skills in conservation ecology. This work has resulted in establishment of a customized GIS database at the site, active and ongoing field projects on microbial ecology, small mammal monitoring, comparison of C3 and C4 plant responses, and establishment of a nutrient network site. The results of these projects have been presented at local and regional meetings in the subdisciplines of faculty principle investigators. In addition, the ENTRF-funded prairie restoration project increased interest in the MSUM Regional Science Center as a regional research site for the study of prairie ecology from faculty at North Dakota State University, several of whom have now established long term research projects at the site.

PROJECT RESULTS USE AND DISSEMINATION

Dissemination of project outcomes have been those presented by project faculty and their research groups at meetings of their respective professional communities in geosciences, ecology and management conferences. Dissemination of overall project description, outcomes and application to undergraduate pedagogy is forthcoming. Plans for final paper preparation were delayed by the covid-19 pandemic.

Project Completed: 06/30/2020 **FINAL REPORT**

Improving Community Forests Through Citizen Engagement

Subd. 08h $800,000 TF

Ken Holman
MN DNR
500 Lafayette Rd N
St. Paul, MN 55155
Phone: (651) 259-5269
Email: ken.holman@state.mn.us
Web: http://www.dnr.state.mn.us

Appropriation Language
$800,000 the first year is from the trust fund to the commissioner of natural resources to design and pilot a program, including grants to communities, to mobilize citizen volunteers to protect, improve, and maintain local forests in communities around the state. Participation is open to any municipality in the state and participating municipalities will be selected through a competitive proposal process that will include representation from both metropolitan and nonmetropolitan areas of the state. Trees planted using this appropriation must be species that are native to Minnesota. A participating municipality must provide a match of not less than 25 percent, up to half of which may be in the form of in-kind support. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Many communities are not prepared to adequately address declining canopy in Minnesota's community forests. Without action, community forests in Minnesota will continue to decline, impacting air, water, public health, and the natural environment. This project is a model to protect and improve Minnesota's community forests.

Environment and Natural Resources Trust Funds assisted 20 (Ada, Aitkin, Arlington, Austin, Duluth, Ely, Fridley, Grand Marais, Hermantown, Hill City, Hutchinson, Mankato, Maple Grove, Marshall, North Saint Paul, Rochester, Saint James, Saint Paul, Shakopee, Winona) communities through engaging citizens in their community forest. Communities expended a total $437,035.98 in grant funds provided by Environment and Natural Resources Trust Fund, Minnesota Department of Natural Resources, and the United States Forest Service's Great Lakes Restoration Initiative. Communities utilized funds to purchase tools for volunteers to engage with their community forest, such as pruning shears for small tree pruning and binoculars to monitor for emerald ash borer. Communities also used funds to reforest areas of their communities planting 5,631 trees. These trees, maintained by volunteers for the next five years will intercept 1,328,922 gallons of stormwater and reduce 580,016 pounds of carbon dioxide from the atmosphere. Communities worked with partners to implement citizen engagement plans by hosting volunteer planting events, utilizing citizens for small tree pruning, monitoring the health of community trees, and conducting community tree inventory garnering a total of 10,518 volunteer hours.

PROJECT RESULTS USE AND DISSEMINATION

Volunteer engagement training manuals (Appendix B, Appendix C), developed by the University of Minnesota, are tailored to meet the unique community forestry needs of individual communities. These training manuals will continue to be utilized as we expand our community forestry volunteer engagement.

Communities and partners utilized social media, community flyering, a television segment, presenting to community volunteer organizations, and newspaper articles to garner volunteer support and promote community accomplishments. Communities have been provided individual accomplishment and impact reports (Appendix A) to share with their citizens and their community leaders. Project impacts are in the process of being incorporated as accomplishments into the Minnesota Forest Action Plan.

In addition to conducting outreach to garner citizen volunteers and promote project impacts, communities have utilized outreach to provide education about community forests to encourage the care of trees.

Project Completed: 06/30/2018 **FINAL REPORT**

Minnesota Tree Steward
Minnesota Citizen Pruner

Subd. 09 Land Acquisition for Habitat and Recreation

Metropolitan Regional Park System Land Acquisition Phase 4

Subd. 09b $1,000,000 TF

Emmett Mullin
Metropolitan Council
390 N Robert St
St. Paul, MN 55101
Phone: (651) 602-1360
Email: emmett.mullin@metc.state.mn.us
Web: http://www.metrocouncil.org/Parks.aspx

Appropriation Language
$1,000,000 the first year is from the trust fund to the Metropolitan Council for grants to acquire at least 133 acres of lands within the approved park unit boundaries of the metropolitan regional park system. This appropriation may not be used to purchase habitable residential structures. A list of proposed fee title and easement acquisitions must be provided as part of the required work plan. This appropriation must be matched by at least 40 percent of nonstate money that must be committed by December 31, 2015, or the appropriation cancels. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

The Metropolitan Council works with the Regional Park Implementing Agencies to protect critical lands and provide recreational opportunities for the Regional Parks System. This $1,000,000 ENRTF project was matched with $666,000 in Council funds and $555,000 in local Agency funds to purchase three properties for the Regional Parks System.

Washington County acquired a 4.5-acre property for Big Marine Park Reserve and a 102-acre property for St. Croix Bluffs Regional Park with partial funding from this project. These properties contain critical habitats including wetlands, hardwoods, mixed forest, open meadow, and oak savanna. St. Croix Bluffs Regional Park previously protected 3,800 feet of St. Croix River shoreline. With the addition of this 102-acre parcel, the park now protects 5,000 contiguous feet of St. Croix River shoreline. Three Rivers Park District acquired a 16-acre property for the Kingswood Special Recreation Feature with funding from this

project. This acquisition protected 850 feet of shoreline on Little Long Lake, one of the few untouched, pristine lakes left in the metropolitan area.

Acquiring these properties permanently protects critical natural resources while providing additional recreational opportunities for the region. All properties funded are inholdings or parcels that are included in master plan-approved park boundaries. The Regional Park Implementing Agencies work only with willing landowners when acquiring lands with ENRTF, and they focus on acquiring lands with high natural resources and habitat value that are at risk of being developed.

PROJECT RESULTS USE AND DISSEMINATION

The Regional Park Implementing Agencies include the ENRTF sign/logo when they install visitor signs for these new park lands. The Agencies acknowledge ENRTF on their websites when appropriate, such as the Three Rivers Park District Kingswood Special Recreation Feature website funding section. In addition, the Metropolitan Council and the Regional Park Implementing Agencies acknowledge ENRTF for any media releases about the acquisitions.

Project Completed: 06/30/2020 **FINAL REPORT**

SNA Acquisition, Restoration, Enhancement and Public Engagement

Subd. 09c $4,000,000 TF

Ann Pierce
MN DNR
500 Lafayette Rd, Box 25
St. Paul, MN 55155
Phone: (651) 259-5119
Email: ann.pierce@state.mn.us
Web: https://www.dnr.state.mn.us/snas/index.html

Appropriation Language
$4,000,000 the first year is from the trust fund to the commissioner of natural resources to acquire at least 350 acres of lands with high-quality native plant communities and rare features to be established as scientific and natural areas as provided in Minnesota Statutes, section 86A.05, subdivision 5, restore and improve at least 550 acres of scientific and natural areas, and provide technical assistance and outreach. A list of proposed acquisitions must be provided as part of the required work plan. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards, as determined by the commissioner of natural resources. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Through this appropriation, 519.3 acres were permanently protected as state Scientific and Natural Areas (SNAs). Protected through these parcels are a variety of Minnesota's most unique intact ecosystems that house many of Minnesota's state threatened and special concern species (see the parcel list for specific site details). Proactive landowner outreach took place in 12 strategically prioritized areas, 7 SNA conservation easements were monitored and the SNA Strategic Land Protection Plan gap analysis was refined to identify exceptional plant communities/species that still need protection for SNA to reach its goal of ensuring that Minnesota's natural heritage is not lost from any ecological region of the state.

Habitat restoration and enhancement activities took place across the state on SNAs. Activities included 45 acres of habitat restoration (see restoration evaluations included with final report), 772 acres of invasive species control, 332 acres of woody control, 652 acres of prescribed burning, 102 acres of prescribed haying, site development work at 51 SNAs, completion of 11 Adaptive management Plans and ecological monitoring at 49 SNAs and 1 proposed SNA. Knowledge gained through monitoring will enable managers to improve management of SNAs for the Species in Greatest Conservation Need, state special concern and state/federally threatened and endangered species that call these habitats home.

Outreach activities through this appropriation brought the SNA Facebook page to nearly 5000 page likes and the total monthly reach, for example, in April 2018 was 72,730. The SNA Flickr social media channel facilitated sharing of high quality photos with 67 members sharing over 991 photos. Five "Nature Notes" e-newsletters were delivered reaching over 5,673 subscribers. From March 1, 2017 through February 2018, 99 events were held involving over 990 people. As of June 2018, there were 149 SNA Site Stewards. These stewards submit reports on their observations and assist with management tasks.

PROJECT RESULTS USE AND DISSEMINATION

The SNA website was updated throughout this appropriation as needed, including listings of new volunteer events. Information on SNAs and activities through this appropriation were posted on the SNA Facebook page which achieved nearly 5,000 page likes. Included with this final report is an SNA Facebook Metrics Report from April-June 2018. The SNA Flickr social media channel was used to encourage high quality photo sharing with 58 members sharing 991 photos. Five Nature Notes e-newsletters were delivered during this timeframe reaching over 5,673 subscribers.

Project Completed: 06/30/2019 **FINAL REPORT**

Native Prairie Stewardship and Prairie Bank Easement Acquisition

Subd. 09d $3,325,000 TF

Judy Schulte
MN DNR
1241 East Bridge Street
Redwood Falls, MN 56283
Phone: (507) 637-6016
Email: judy.schulte@state.mn.us
Web: http://www.dnr.state.mn.us

Appropriation Language
$3,325,000 the first year is from the trust fund to the commissioner of natural resources to acquire native prairie bank easements on at least 675 acres, prepare baseline property assessments, restore and enhance at least 1,000 acres of native prairie sites, and provide technical assistance to landowners. Of this amount, up to $135,000 must be deposited in a conservation easement stewardship account. Deposits into the conservation easement stewardship account must be made upon closing on conservation easements or at a time otherwise approved in the work plan. A list of proposed easement acquisitions must be provided as part of the required work plan. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Through this appropriation, 1,107 acres of high quality dry hill, mesic and wet prairies, which house state and federally threatened species, state special concerns species, multiple Species in Greatest Conservation Need and a wide variety of pollinators, were permanently protected through 12 Native Prairie Bank conservation easements (see attached parcel list for more details). Protection efforts, through this appropriation and other Native Prairie Bank appropriations, preserve some of the best remaining native prairie in the state for current and future MN Citizens benefit. These remaining native prairies function at a significantly higher level and provide habitat to more species of insects, birds, reptiles and mammals than reconstructed/restored prairie. Additionally, 12 Baseline Property Reports and 22 monitoring events were completed through this appropriation. Stewardship funds for the 12 closed Native Prairie Bank easements were enrolled into the Conservation Easement Stewardship Account and 3 appraisals were conducted as an easement valuation best management practice.

A total of 221 acres of invasive species control and 909 acres of prescribed burns were completed to improve prairie quality throughout the prairie region of the state. Adaptive Management Monitoring was completed on 14 Native Prairie Banks and specific research was conducted to evaluate the impact of grazing on secretive marsh birds. Knowledge gained through this monitoring and research will help landowners, DNR land managers and partner agencies improve the management of native prairie and wetlands.

DNR Prairie Specialists participated in 7 outreach events, providing prairie protection, restoration and enhancement education. DNR Prairie Specialists also engaged 163 different priority prairie landowners to discuss protection and management options for their property. Ten Prairie Stewardship Plans were written by contractors, approved by DNR Prairie Specialist and provided to the landowners.

PROJECT RESULTS USE AND DISSEMINATION

Ten Prairie Stewardship Plans were written by contractors, approved by SNA Prairie Specialists and provided to landowners. These plans will help guide native prairie landowner's enhancement activities for well over a decade. All outreach activities completed as part of this appropriation had the ENTRF logo present on any documentation or displays.

Attached is the *Waterbird Response to Conservation Grazing in Western Minnesota Tallgrass Prairies* summary of the research conducted through this appropriation to assess impacts of grazing on waterfowl and other wetland and grassland birds. The results of this study will be distributed to members of the conservation community in several ways. Agency and conservation organization staff hold a grazing webinar at the end of every other summer with DNR hosting and covering these results this year. Marissa, the grad student who took lead on this research had a poster at the recent MN Wildlife Society meetings and we will encourage her and/or her graduate advisor Dr Todd Arnold to present the final results at this year's meeting. Last, the information will be shared among Prairie Conservation Plan partners this fall. The information will be useful to DNR and USFWS staff as we continue to write new grazing plans and modify existing plans. As with any good research project, the results of this study point to additional questions that agency staff and researchers can address in the coming years.

Project Completed: 06/30/2019 **FINAL REPORT**

DNR Paper: Waterbird response to conservation grazing in western Minnesota tallgrass prairies

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Metropolitan Conservation Corridors Phase VIII - Strategic Lands Protection

Subd. 09f $750,000 TF

Robert McGillivray
The Trust for Public Land
2610 University Ave W, Ste 300
St. Paul, MN 55114
Phone: (651) 999-5307
Email: Bob.McGillivray@tpl.org
Web: https://www.tpl.org/our-work/minnesota

Appropriation Language
$750,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with The Trust for Public Land for Phase VIII of the Metro Conservation Corridors partnership to acquire in fee at least 35 acres of high-quality priority state and local natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties. A list of proposed acquisitions must be provided as part of the required work plan. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards, as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work plan. This appropriation may not be used to purchase habitable residential structures, unless expressly approved in the work plan. A list of fee title acquisitions must be provided as part of the required work plan. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Located only 30 miles northeast of the Twin Cities in Washington County, Crystal Spring Scientific and Natural Area (SNA) offers the region's 3.3 million residents a close-to-home opportunity to experience unique flora and fauna and beautiful views of the National Wild and Scenic St. Croix River. Acquired and created with help from The Trust for Public Land in 2015, the original 38-acre, state-owned SNA encompasses significant biodiversity, thriving communities of native plants, and habitat for several rare species of birds and plants. The SNA's dramatic geologic features include a scenic waterfall, steep rocky cliffs, a winding cold-water stream, thick old forests, and panoramic views of the National Wild and Scenic St. Croix River.

Utilizing the M.L. 2015 ENRTF MeCC appropriation, The Trust for Public Land acquired an additional 20.98 acres which it conveyed to the Minnesota DNR on October 24, 2018 as an addition to the Crystal Spring SNA. The Crystal Spring SNA Addition North property provides significantly safer public access to the SNA, and the land contains high quality native plant communities and several rare species of birds and plants.

Due to the funding provided by the Environment and Natural Resources Trust Fund as recommended by the Legislative Citizen Commission on Minnesota Resources, and the Reinvest in Minnesota Program (RIM), the 68 acre Crystal Spring SNA is permanently protected and available for all Minnesotans to enjoy.

PROJECT RESULTS USE AND DISSEMINATION
A TPL project website has been created for the Crystal Spring SNA project.

Project Completed: 06/30/2019 **FINAL REPORT**

Metro Conservation Corridors Phase VIII - Priority Expansion of Minnesota Valley National Wildlife Refuge

Subd. 09g $500,000 TF

Deborah Loon
Minnesota Valley National Wildlife Refuge Trust Inc
3815 East American Boulevard
Bloomington, MN 55425
Phone: (612) 801-1935
Email: dloon@mnvalleytrust.org
Web: http://www.mnvalleytrust.org

Appropriation Language
$500,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Minnesota Valley National Wildlife Refuge Trust, Inc. for Phase VIII of the Metro Conservation Corridors partnership to acquire in fee at least 100 acres of priority habitat for the Minnesota Valley National Wildlife Refuge in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties. A list of proposed acquisitions must be provided as part of the required work plan. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards. Expenditures are limited to the identified project corridor areas as defined in the work plan. This appropriation may not be used to purchase habitable residential structures, unless expressly approved in the work plan. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

Minnesota Valley Trust was unable to bring any of the potential acquisitions to completion by the grant deadline. Over the course of this grant, we worked with eight landowners interested in considering the sale of their land to us for the Minnesota Valley National Wildlife Refuge (MVNWR). All were priority parcels delineated by the US Fish and Wildlife Service.

- Minnesota Valley Trust completed fee title acquisition on three parcels for the Rapids Lake Unit of the MVNWR. We could not use this ENRTF grant because all three included buildings. Outdoor Heritage Fund (OHF) grants helped acquire two of the properties, along with private funds. The third was acquired with private funds as leverage to the OHF grant.
- The landowner with property in the San Francisco Unit of the MVNWR was not satisfied with the appraised value and unwilling to continue discussions at that time. We anticipate we will be able to resume discussions in the future.
- Minnesota Valley Trust is working with four landowners who expressed interest in possible sales to us for the Jessenland Unit of the Minnesota Valley National Wildlife Refuge. Extended flooding this year has delayed completion of two appraisals. The appraised values on the other two properties were lower than the sellers would consider at this time. Minnesota Valley Trust will continue working with these landowners.

The market is mixed for the various properties we have been pursuing. We were able to close on the properties with buildings, as they can be sMold for residential development and their values have recovered since the recession. But the properties in the floodplain of the Minnesota River have not recovered after dropping in value during the recession. Those landowners are unwilling to sell at the depressed values.

Because we could not complete any acquisitions, Minnesota Valley Trust is returning these grant funds to the ENRTF.

Project Completed: 06/30/2018 **FINAL REPORT**

Subd. 10 Emerging Issues Account

Sub-Project 03: Deer Movement Related to Potential CWD Prion Transmission - $449,557 TF

Christopher S. Jennelle
MN DNR
5463 West Broadway Ave
Forest Lake, MN 55025
Phone: (651) 539-3310
Email: christopher.jennelle@state.mn.us
Web: http://www.dnr.state.mn.us/index.html

OVERALL PROJECT OUTCOME AND RESULTS

We quantified dispersal and migratory movements of wild white-tailed deer (Odocoileus virginianus) in southeastern Minnesota that are relevant to understanding the potential spread of chronic wasting disease (CWD). After detection of CWD in fall 2016 in Fillmore County, we sought to determine potential pathways of CWD spread on the landscape via wild deer movements and estimate general causes of deer mortality in southeastern Minnesota. Since March 2018, we captured and fitted GPS collars to 226 deer and continue to monitor 72 animals. The main causes of mortality were hunting and vehicle collision in the yearling to 3-year-old deer composing our sample, which underscores the importance of harvest management as a valuable tool to control CWD in southeastern Minnesota. Average annual survival for females and males was 0.73 and 0.54, respectively, and these low survival estimates likely reflect effective liberalized harvest regulations within the study area to manage CWD.

We found that 26% of females and 43% of males dispersed between their natal and adult home range, and surprisingly 15% of females and 6% of males underwent seasonal migration between summer and winter ranges. The average dispersal distance for females and males was 20.0 km and 22.8 km, respectively, while that for migratory females and males was 12.8 km and 17.7 km, respectively. We also observed extreme dispersal distances of 116 km and 97 km, respectively, for a female and male. Both sexes tended to disperse westward, although a pattern was unclear for migratory animals. Deer were more likely to avoid agricultural landscape during dispersal and migration, although we did not observe consistent habitat characteristics along movement paths. The southwest to northwest trajectory of dispersal movements underscores increased risk of CWD spread to the Minnesota interior. This information will be vital for prioritizing and guiding CWD management efforts in and around southeastern Minnesota.

PROJECT RESULTS USE AND DISSEMINATION

Over the course of this project, we have had 23 articles, interviews, or media reports pertaining to this study. MNDNR staff have given at least 14 professional presentations regarding this study to state, federal, and University audiences. We have also created a dedicated webpage devoted to providing background and updates to this study. We have outreached to over 250 private landowners in southeastern Minnesota as part of the process of obtaining permission to access private property for deer capture and GPS-collaring efforts. We have provided regular updates and interactive maps to participating landowners, interested citizens, and hunters who have submitted harvested collared deer to us. We are in the process now of creating an interactive map of select study deer to go live on our webpage that will allow the public to better engage with the amazing movement data we have collected

thus far. We have written three DNR agency reports of this project thus far, and are in the process of writing manuscripts for publication. We will continue to collect data for deer with active GPS collars, and we intend to collar about 45 additional deer in early 2021 as a final cohort for this study.

Subproject 03 completed: 06/30/2020 **FINAL ABSTRACT**