M.L. 2017 Projects

MN Laws 2017, Chapter 96, Section 2 (beginning July 1, 2017)

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Subd. 03 Foundational Natural Resource Data and Information

County Geologic Atlases - Continuation

Subd. 03a $2,000,000 TF (FY2017)

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Appropriation Language
$2,000,000 in fiscal year 2017 is from the trust fund to the Board of Regents of the University of Minnesota, Minnesota Geological Survey, 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 A of county geologic atlases, which focuses on the properties and distribution of earth materials in order to define aquifer boundaries and the connection of aquifers to the land surface and surface water resources. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

Project due to be completed: 6/30/2020 Work Plan

Minnesota Wildflowers Online Botanical Reference - Phase II

Subd. 03e $270,000 TF (FY2018)

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Appropriation Language
$270,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with Minnesota Wildflowers Information to continue surveying and imaging plant species and publishing species profiles for a plant identification reference Web site available to the public and land managers. Images acquired and information compiled using these funds are for purposes of public information available on a Web site. If the organization is no longer able to maintain the Web site, the organization must work with the state and the University of Minnesota, Bell Museum of Natural History, to ensure

the materials remain publicly available on the Web. 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

Minnesota Wildflowers, an online field guide to the plants of Minnesota, was launched in 2007 by an amateur botanist who grew frustrated with the lack of information and quality imagery specific to Minnesota's flora. The task of systematically seeking out each species, photographing the identifying characteristics, describing each in non-technical terms, and publishing on the web was undertaken with the goal of becoming a comprehensive reference for all of Minnesota's 2100+ plants. The need for such a reference, especially targeted to non-botanists, has been evident by the number and type of users of the website, virtually anyone asking such questions as: What is that plant? Is it native or a weed? How to distinguish it from similar plants? These users include natural resource managers, restoration specialists, educators from elementary school through university level, citizen scientists, native plant advocates, gardeners and the general public. In 2014 when initial funding began, 799 species (mostly forbs) had been published and the average traffic during peak season was 2,000 visits and 10,000 web pages viewed per day. During the 6-year funding period ending June 2020, the 2-member team traveled 65,000 miles visiting locations in nearly every Minnesota county, photographing over 1500 plant species. This field work resulted in significantly increased coverage. As of June 30, 2020, 1734 species have been published, 82% of all Minnesota’s vascular plants, including trees/shrubs, grass-like plants, ferns and aquatics. Traffic has more than tripled with average 8,000 visits and 33,600 pages viewed per day during 2020 peak season, increases of 60% and 45% respectively over 2017 when the second round of funding began. This clearly shows the website is a valued resource and the more species covered, the more valuable it becomes.

PROJECT RESULTS USE AND DISSEMINATION

Usage of the website continues to grow; expectations are we will reach 1 million users in 2020. While word-of-mouth and Google searches are the source of much traffic, our web statistics show the single highest usage continues to come from the State of Minnesota, which includes multiple state agencies as well as the University of Minnesota. Our plant images are in high demand for other educational and outreach purposes, including interpretive signs, PowerPoint presentations and invasive species fact sheets, all of which promote the project via photo credits. Our field work puts us in contact with many state parks, nature centers and educational institutions across the state where we promote the project to their staff and visitors. During the past 3 years we collaborated with the Minnesota Landscape Arboretum on their native plant program, began discussions with the Minnesota Nursery and Landscape Association Foundation on contributing to their botany-related educational curriculum, manned a booth at the international Botany Conference in Rochester, had an interview on CCTV, and gave presentations about the project to Audubon, Wild Ones, and several other clubs and organizations. A marketing postcard was also developed and distributed to nature centers, educators, organizations and businesses across Minnesota.

Project Completed: 6/30/2020 **FINAL REPORT**

Drainage Records Modernization Cost Share - Phase II

Subd. 03g $540,000 TF (FY2018)

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Appropriation Language
$540,000 the first year is from the trust fund to the Board of Water and Soil Resources to facilitate statewide modernization of public drainage records under Minnesota Statutes, chapter 103E, and integrate new specifications into existing drainage records modernization guidelines through matching cost-share grants to drainage authorities. 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

Minnesota has an estimated 20,000 miles of Minnesota Statutes Chapter 103E public drainage ditches (Public Drainage Ditch Buffer Strip Study, Feb. 2006), and estimated thousands of miles of Chapter 103E public subsurface tile systems. Records for these public drainage systems are kept by the current 96 drainage authorities (a drainage authority (DA) can be a county, joint county board, or a Watershed district). The drainage system records are in various conditions, including deteriorating hard copy materials and scanned documents with limited electronic access.

Use of consistent GIS database capabilities are needed to advance local management of public drainage systems and to improve public access to statewide hydrographic data. Hydrographic data about the location, type (ditch or tile), dimensions and profiles of public drainage systems are often sought for watershed modeling and water planning but have not been easily accessible. Several hundred systems records containing several thousands of miles of open ditch and tile have been scanned, indexed, digitized and uploaded to local drainage databases and GIS layers as well as MnGeo Commons website. Many of the drainage authorities have completed this work for all systems in their jurisdiction, some have plans to continue their efforts until all systems are complete. A summary of the accomplishments from each grantee is in the attached spreadsheet.

PROJECT RESULTS USE AND DISSEMINATION

All grantee organizations and hydrography data can be found at the Minnesota Geospatial Commons public website. This link provides one location to find all the individual datasets. It lets people find the GIS data from which maps could be made, but there are no ready-made maps. In addition, all organizations have updated and posted easily accessible information on their organizational website and a link has been provided on the BWSR Drainage Records Modernization webpage. This has advanced local drainage records preservation and use for enhanced drainage system management and provided hydrographic data about these drainage systems in the statewide GIS database.

Project Completed: 6/30/2020 **FINAL REPORT**

Groundwater Contamination Mapping

Subd. 03h $400,000 TF (FY2018)

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Appropriation Language
$400,000 the first year is from the trust fund to the commissioner of the Pollution Control Agency to develop a Web-based interactive map of groundwater contamination to improve protection of groundwater resources for drinking water. 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

In Minnesota 75% of the drinking water comes from groundwater, a source that is generally out of sight and out of mind. Minnesota properties that were once home to dry cleaners, metal plating shops, manufacturing plants and other industrial facilities in many cases have contaminated our groundwater from spills and leaks of hazardous chemicals. Frequently the contamination spreads off the property creating an area of groundwater contamination. When there has been contamination often costly treatment systems are needed to make the water suitable for use.

Information about the areas of groundwater contamination were contained in individual MPCA Superfund Program project files. The project was developed to expand access to information about groundwater contamination to improve protection of groundwater resources.

This project developed the Minnesota Groundwater Contamination Atlas. The Atlas maps areas of groundwater contamination concern and tells the contamination story in a way that is understandable to the general public and is meaningful for technical users. The Atlas also makes it easy for the public to download contamination testing results from individual wells. The Atlas establishes a public communication platform that can be expanded beyond the 92 superfund sites that were included in this project.

The project extracted well information from project files and loaded it into a state enterprise database,13,605 wells and loaded 3,700 groundwater contamination test results were loaded into the database. The data was used to map 92 contamination source areas and 60 distinct groundwater contamination areas of concern. For each source areas a contamination site story tells how the contamination happened, what the contaminants are, what cleanup work has been done, what additional cleanup work is planned, where drinking water in the area comes from, who to contact with questions and if there is related contamination in soil, sediments and underground vapor. A project development webpage and stakeholder group were utilized to help shape scope and format of the map contamination story elements of the Atlas.

PROJECT RESULTS USE AND DISSEMINATION

A project webpage was used to provide project development updates and solicit stakeholder feedback as project elements were developed. The webpage invited interested parties to subscribe to the GovDelivery email distribution list for the project. The GovDelivery list currently includes 832 subscribers. Outreach during the project also include presentation at professional conferences and stakeholder meetings. A recorded presentation of the project presentation at that 2019 Minnesota Groundwater Association (MGWA) Fall Conference “No Longer ‘out of Sight, Out of Mind- Making Groundwater Science Visible to Citizens and Clients” is available on the MGWA website.

Launch of the Minnesota Groundwater Contamination Atlas was communicated through the project Gov Delivery distribution list as well as MPCA social media platforms. As of August 3rd the Minnesota Groundwater Atlas website has been visited by 1,162 non-MPCA users.

Project Completed: 6/30/2020 **FINAL REPORT**

Moose Calf Surveys and Monitoring

Subd. 03j $348,000 TF (FY2018)

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Appropriation Language
$348,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to assess the use of unmanned aerial vehicles in natural resource monitoring of moose populations and changes in ecosystems.

Project due to be completed: 6/30/2019 **Work Plan**

Subd. 04 Water Resources

Assessment of Household Chemicals and Herbicides in Rivers and Lakes

Research Project

Subd. 04a $236,000 TF (FY2018)

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Appropriation Language
$236,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to quantify environmental levels of household chemical and herbicide ingredients in rivers and lakes and assess their potential to form toxic by-products.

OVERALL PROJECT OUTCOME AND RESULTS

Quaternary ammonium compound (QACs) are ingredients in personal care products, fabric softeners, disinfectants, and herbicides. QACs, which are biologically active molecules, are unintentionally and intentionally released into the environment. QACs kill bacteria and may affect microbial communities in wastewater treatment and algal communities in surface waters. In this study, the levels of QACs in the effluent from 12 wastewater treatment plants were determined. Plants with more advanced treatment processes had lower levels of QACs. Sediment samples in a lake demonstrated potential inputs from both municipal wastewater effluent and agricultural sources for QACs. In sediment cores taken from lakes, two distinct trends over time were observed. In lakes with large watersheds and mixed domestic

and industrial wastewater sources, peak concentrations of QACs were found at depths corresponding to deposition in the 1980s and decreases after this time are attributed to improved wastewater treatment and source control. In a smaller lake with predominantly domestic wastewater inputs, concentrations of QACs increased slowly over time. In surface waters, QACs were found to degrade by reaction with reactive species (hydroxyl radicals) generated by sunlight and by microbial processes. Even with these loss processes, QACs likely persist from days to weeks in the water, leading to their deposition in the sediments. QACs were found to form low levels of a carcinogenic class of compounds (nitrosamines) when reacted with a drinking water disinfectant (chloramine), but this would be of greatest concern in wastewater potable reuse scenarios. The overall results of the work indicate that QACs are being released by wastewater treatment plants. Once in the environment, degradation by bacteria and by sunlight can occur in surface waters, but accumulation in sediments, where the QACs are persistent, is likely the main removal process. During the wastewater disinfection process QACs can form a carcinogen, but QACs are not as important as other chemicals known to form nitrosamines. The findings allow more robust assessment of potential impacts of QACs and insight into wastewater treatment processes that lead to removal, which is important given the increasing use of QACs during the COVID-19 pandemic.

PROJECT RESULTS USE AND DISSEMINATION

Three papers were published: 1) the detection of QACs in wastewater and sediment (the paper and data set are available online); 2) Photolysis of QACs; and 3) Potential environmental impacts of elevated QAC usage during the COVID-19 pandemic (available online through ACS Publications< or PubMed Central). A public lecture that incorporated data for the project was also given at the U of MN, and it is available on YouTube.

Project Completed: 6/30/2019 **FINAL REPORT**

Assessment of Water Quality for Reuse

Subd. 04f $148,000 TF (FY2018)

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Appropriation Language
$148,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to collect and analyze pathogen data for evaluation of water reuse in order to maximize water reuse and protect groundwater and surface water quality.

OVERALL PROJECT OUTCOME AND RESULTS

Reusing water will reduce demands on groundwater aquifers and improve surface water quality. However, public perception of health risks associated with microbiological contaminants remains a key barrier to the expansion of water reuse. The goal of this project is to maximize the potential of water reuse in Minnesota by eliminating barriers to water reuse implementation. In this project, water quality of 25 water reuse systems around Minnesota was assessed by quantifying potential human pathogens. At each reuse facility, water samples were collected at the source and when available at the distribution

site such as an irrigation tap. When treatment steps were in place, water samples were also collected before and after the treatment. Samples were collected more than once for some reuse facilities. As a result, 90 water samples were collected from the 25 sites. Bacterial and viral pathogens in these water samples were quantified using a high-throughput method. Most of the water samples did not contain detectable levels of pathogens. Some pre-treatment wastewater samples, contained potential human pathogens such as norovirus. Based on a preliminary quantitative microbial risk assessment (QMRA) for norovirus, the risk for illness and infection is considerable for these samples. However, advanced water treatment removed these pathogens to the levels considered low risk of infection and illness for reuse. Due to the complexity of QMRA analyses and the variability of the results, the risk assessment is only done for norovirus. Potential health risks associated with pathogens other than norovirus should be analyzed in the future.

PROJECT RESULTS USE AND DISSEMINATION

This project has produced two presentations: one at the EPA's webinar on "Water Reuse and Reclaimed Water" and one at a national conference (Association of Environmental Engineering and Science Professors [AEESP] Conference). Two publications are being prepared: one as a peer-review journal publication and one as a white paper published from Minnesota Department of Health. These publications will be freely available to the public.

The outcomes of this research have been used to expand our water reuse research. MN Stormwater Research Council has provided additional funding to continue and expand the water reuse research. In addition, the outcome obtained in this project will be shared with other state and federal agencies (EPA, MPCA, etc.) as well as private sectors to establish safe water reuse in MN and other states.

Project Completed: 6/30/2019 **FINAL REPORT**

Identification of Chemicals of Emerging Concern in Minnesota Fish

Research Project

Subd. 04g $400,000 TF (FY2018)

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Appropriation Language
$400,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Grand Portage Band of Lake Superior Chippewa to identify chemicals of emerging concern and metals in fish, water, and sediments from approximately 30 water bodies in northeastern Minnesota used for subsistence harvest and recreation. 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

This is the first study to comprehensively analyze a large suite of Chemicals of Emerging Concern (CECs) across the three media of fish tissues, water, and sediment in a broad geographic extent in northern Minnesota. CEC's are pharmaceuticals and personal care products that can linger in the environment

and have been shown to affect behavioral and reproductive health of aquatic life. This study was focused on fish species and water bodies used for subsistence by the Grand Portage Band of Chippewa and recreational users of northeastern Minnesota. We described the spatial distribution of CEC occurrences in 25 Minnesota lakes and in Lake Superior. We consider our most important findings to be the number of detections and the classes of CECs that were detected. We found 117 CECs across all media types with 101 found in water samples, 67 in sediments, and 35 in fish tissues. The pharmaceutical classes that were most frequently detected included hormones (100% of sites), DEET insect repellent (100% of sites), antidepressants (80% of sites), and antimicrobials (80% of sites). These results were derived from surface water samples, sediment samples, and fish samples of walleye/yellow perch in inland lakes and lake trout/cisco from Lake Superior. We also related measures of fish health and parasite loading to CECs and land use. Our findings are consistent with early literature on CECs in Minnesota lakes that studied water samples only. We used Aquatic Toxicity Profiles (ATPs) to identify those chemicals that may pose risks to aquatic life. ATPs provide an overview of chemical-specific information such as acute toxicity, endocrine activity, physicochemical properties, and occurrence information in the aquatic environment. We found that even in undeveloped sites that had a fewer number of total contaminants, they often had a high percentage of high priority contaminants. More work is needed to determine the effects of CECs on aquatic life.

PROJECT RESULTS USE AND DISSEMINATION

A video was developed from this project and posted to YouTube. There were three radio broadcasts on this work, WTIP, Grand Marais in 2016, WTIP, Grand Marais in 2017, and Minnesota Public Radio (MPR) in 2020. Various online and paper media outlets reported on this work as well including: The Circle (Part One and Part Two of their two-part series), The Minnesota Daily, University of Minnesota College of Veterinary Medicine News, Medium, City Pages, and the Grand Rapids Herald Review.

Project Completed: 6/30/2020 **FINAL REPORT**

Techniques for Water Storage Estimates in Central Minnesota

Subd. 04h $250,000 TF (FY2018)

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Appropriation Language
$250,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to improve water storage estimates in groundwater, soil moisture, streams, lakes, and wetlands through integration of satellite monitoring and ground-based measurements in central Minnesota. 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

Our freshwater resources reside in surface water bodies (ponds, wetlands, lakes, streams/rivers) and subsurface water reservoirs (soil and groundwater aquifers). Management of these freshwater

resources has always been a challenge because we do not have a good idea of how much water is stored in these various entities. The objective of this project was to improve the methods for real-time quantification of the amount of water stored in these entities using existing ground-based measurement networks as well as satellite data. The study region stretched from St. Paul to Moorhead, and encompassed 17 HUC-8 watersheds. The study region has an area of about 53,000 km3. We collected archived ground-based measurements including streamflows, observation wells, and lake levels for the period 2002-2015. We also acquired satellite data from the GRACE (Gravity Recovery and Climate Experiment), SMOS/SMAP, and Landsat satellites. The GRACE satellite provides data on the total water stored in the earth. The spatial resolution of the data used in this study was 100 km by 100 km. The SMOS/SMAP satellites provide a measure of the surface soil moisture over areas of about 36 km by 36 km. The Landsat satellite provides visual images at a scale of 30 m, and can be used for measuring the surface area of individual lakes; this surface area data can be used to estimate the volume of water stored in a given lake at a given moment in time. The project demonstrated that the variation in total water storage can be monitored by the GRACE satellite, and variations in lake storage can be monitored by the Landsat satellite. For the period 2002-2015 the estimates of time-averaged water storage is 1,500 km3 for groundwater in the Quaternary (surficial) aquifer, 15 km3 for lakes, 20 km3 for soil moisture, and 1.5 km3 for wetlands. The GRACE satellite became inoperable in late 2017, far exceeding the original planned life for the satellite. However, in May 2018 a new satellite, GRACE-FO (GRACE-Follow On) was launched and it now is providing the same information about total water storage. One of the outcomes of this project is a new research activity to test the utility of water storage information gained from the GRACE-FO satellite to forecast flooding and hydrological droughts in Minnesota.

PROJECT RESULTS USE AND DISSEMINATION

The project results have been presented at a number of different forums including the Minnesota Water Resources Conference (October 2019), the Water Resource Sciences Graduate Seminar at the University of Minnesota (September 2019), and the Western Regional Project 4188 Meeting in Las Vegas (January 2020). Two MSc theses were completed based on the work in the project, and the work of two Ph.D. students got started (one to finish in December 2020 and the other to finish in December 2021) based on work in the project.

A methodology for quantifying the volume of water in a lake based on the surface area of a lake was adapted from previous work and was tested during this project for the project study region. This tested methodology was then used in a separate LCCMR funded project in which the volumes of lakes across the State of Minnesota were estimated. This objective of this other project was to use remote sensing to quantify the water quality of lakes and the lake volume estimates were needed to examine lake processes affecting lake water quality.

A methodology was developed for quantifying the volume of water stored in the Quaternary aquifer spanning across the study region. The methodology uses observation well data and lake level data to map the water table across the region. This methodology will be shared with the MNDNR, but also it will also now be used in some immediate future research to assess the water table mapping in quantifying the forecasting of floods, and possibly in forecasting hydrologic droughts.

Project Completed: 6/30/2020 **FINAL REPORT**

Subd. 05 Environmental Education

Expanding Raptor Center Online Education

Subd. 05d $270,000 TF (FY2018)

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Appropriation Language
$270,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota, Raptor Center, to provide environmental education for approximately 15,000 middle-school students and 600 teachers, combining classroom learning and outdoor experiences with technology, scientific investigation of birds, and conservation projects. This appropriation is available until June 30, 2022, by which time the project must be completed and final products delivered.

OVERALL PROJECT OUTCOME AND RESULTS

If Minnesota students are to grow into adults who are capable of making meaningful contributions to conservation, both they and their teachers need effective tools to foster meaningful outdoor experiences. This project expanded Raptor Center Online Education to give both teachers and students those much-needed tools with a goal of facilitating experiential outdoor learning and inspiring conservation mind-sets.

The major project objectives were to expand a current education program (Raptor Lab) to support students in conducting an investigation, provide teachers with demonstrations on how to use the learning module, and bring in environmental education experts to teach teachers skills and techniques to facilitate meaningful outdoor learning experiences for their students.

We partnered with University of Minnesota Extension and Learning Technologies Media Lab to build an interactive environment for students, based on a proven curriculum developed by Extension, Driven to Discover. We created a web-based interactive version titled “Outdoor Investigator.” Outdoor Investigator is six-part educational tool engaging students, step-by-step, though the scientific method to complete an outdoor investigation.

Once Outdoor Investigator was completed, The Raptor Center, Extension, Eagle Bluff and Wolf Ridge worked together to design and develop teacher demonstrations. Demonstrations explored each section of Outdoor Investigator, the technology and functionality of the online environment, integrated outdoor teaching techniques, and expanded Teacher Toolbox with extra materials and resources. Three model conservation projects were also created and included in the Teacher Toolbox to guide teachers in the process of conducting a Citizen Science-based outdoor investigation.

Over the course of the 2018 – 2019 school year demonstrations were provided to 520 teachers in 28 counties throughout Minnesota. These teachers will serve an estimated population of 15,000 to 25,000 students. Minnesotans will benefit from this work when as many as 25,000 children a year, throughout the state of Minnesota, engage in authentic and meaningful learning experiences in their local environment to inspire our next generation of scientists and future conservationists.

PROJECT RESULTS USE AND DISSEMINATION

Throughout the two year grant period we have been intensively disseminating Outdoor Investigator in a number of venues where we would be interacting directly with teachers. We presented and/or

exhibited at numerous conferences, such as Minnesota Education Academy Conference (MEA), the Minnesota Science Teachers Association Conference, Sci/Math and Ignite After school conference, the Agriculture Teachers Tech Conference, Minnesota Association of Agricultural Educators, the Conference of Middle and High School Principles, Minnesota's Grand Challenges Conference at the University of Minnesota, the Minnesota Department of Natural Resources Forest School Program Conference, the 3M Visiting Wizards Teacher's Workshop (hosted by 3M), Bell Museum's Educator's Open House, Prior Lake Teacher Development Workshop, University of Minnesota Extension Driven to Discover Teacher Training, and the Minnesota Field Trip Fair.

During these exhibits we had printed materials to highlight the main components of Outdoor Investigator, a computer for teachers to see and interact with the Raptor Lab and Outdoor Investigator, and forms to capture teacher information to contact them directly with information to access the website and to communicate important information about upcoming Teacher Demonstrations.

Project Completed: 6/30/2019 **FINAL REPORT**

Increasing Residential Environmental Learning Center Opportunities

Subd. 05g $130,000 TF (FY2018)

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Appropriation Language
$130,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Audubon Center of the North Woods to provide scholarship opportunities for a minimum of 1,000 students that are not currently served through other residential environmental education learning centers. 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

Today's students are increasingly being left out of nature learning experiences with children today spending far less time outdoors than any other generation in human history. For students that are low on the socio-economic spectrum, this is compounded as there are typically no outdoor areas near where they live, or adults who spend time with them in natural areas. Many schools do not have the financial resources to make environmental field trips possible. Additional factors impeding their participation are the cultural and language barriers increasingly seen with immigrant populations. Parents do not understand what the experience is, and are wary of sending their child away on an overnight field trip. Students coming from low economic families cannot afford to pay the student fee, or buy winter outerwear or a sleeping bag for use in the dormitory. We as a society have a responsibility to foster environmentally literate citizens from all backgrounds and it starts with our children. They will make the decisions for our society's future.

We wanted to engage with the diverse and changing demographics of MN's schools through this project by offering scholarships to financially strained schools to attend Osprey Wilds Environmental Learning

Center for environmental learning experiences. This project's goal was to make residential environmental learning experiences more accessible by: 1) providing a minimum of 1,000 K-12 scholarships to Minnesota students for residential programming at Osprey Wilds Environmental Learning Center, 2) purchasing outerwear (snow pants, coats, hats, mittens, scarves, winter boots) to lend out to K-12 students when attending to keep them comfortable and safe, 3) translating all K-12 trip forms into Spanish, Hmong, and Somali.

Through this project, we were actually able to provide 1,254 K-12 scholarships to Minnesota K-12 students, exceeding our goal of 1,000 student learning experiences with this project.

PROJECT RESULTS USE AND DISSEMINATION

The ongoing results of this project have been shared through our newsletters, our annual reports and social media accounts. Through these platforms, we have updated our constituents on the goals of the program, and the number of participants served. Some of our newsletters and annual reports are available online including: the Spring/Summer 2018 Newsletter, the Spring/Summer 2019 Newsletter, and the Fiscal Year 2019 Annual Report.

Project Completed: 6/30/2020 **FINAL REPORT**

Subd. 06 Aquatic and Terrestrial Invasive Species

Adapting Stream Barriers to Remove Common Carp

Subd. 06d $301,000 TF (FY2018)

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Appropriation Language
$301,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to conduct field tests at existing barrier sites and laboratory experiments to adapt a technology to remove common carp from streams during carp spawning migrations in Minnesota.

OVERALL PROJECT OUTCOME AND RESULTS

As a result of this project, we developed a new technology for managing the invasive common carp that is currently being commercialized by the University of Minnesota. The technology is easy to implement in various field conditions, requires minimum site engineering, and can be operated by a crew of two, which substantially reduces labor costs. This project started by testing whether the Whooshh system developed for migrating salmon might be adopted for common carp removal during spring migrations. Over the course of two field seasons we determined that the Whoosh technology is not easily adaptable for carp management because it requires that carp voluntarily swim into the Whooshh through a system of fish ladders, which proved problematic. However, we developed an alternative technology that appears to be effective and practical. Our technology is comprised of a low-voltage fish guidance system (available commercially) that guides the migrating carp into a large fenced in enclosure along the bank constructed using PVC pipes that slide into the stream bottom via horizontal support beams, a system of additional low-voltage electrodes placed inside the enclosure that can be activated as needed to crowd

the carp and then briefly immobilize them, and a system of partially-submersed conveyers that collect the immobilized carp and carry them on land. All elements of this technology were rigorously tested over two field seasons using over a 1,000 carp marked with electronic micro-tags. The entire system was then successfully tested in summer 2019 and spring 2020. The technology appears to be ready for management implementations. In addition to its applications for managing common carp throughout Minnesota, the technology we developed might be also applicable for managing other invasive fish, including the bighead and the silver carp that are advancing up the Mississippi and St. Croix rivers.

PROJECT RESULTS USE AND DISSEMINATION

The main results if a new technology for managing common carp described above. The technology is currently being commercialized by the University of Minnesota. In addition, our efforts to disseminate the results of this work include one manuscript published in peer-reviewed literature that described our early tests of the electric guidance system, another manuscript that describes the entire system and its performance during spring migrations of 2018 – 2020 that is currently in preparation, two TV interviews for local stations, three press articles including one in the New York Times, four regional or national conferences, four MAISRC presentations or publications.

Project Completed: 6/30/2020 **FINAL REPORT**

Tactical Invasive Plant Management Plan Development

Subd. 06e $296,000 TF (FY2018)

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

OVERALL PROJECT OUTCOME AND RESULTS

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

Fourteen species were selected for assessment because they are designated noxious weeds in Minnesota and not considered early detection within the state but may be considered early detection at a regional or local level. The following species were selected: Canada thistle (Cirsium arvense), common/European buckthorn (Rhamnus cathartica), common tansy (Tanacetum vulgare), garlic mustard (Alliaria petiolata), glossy buckthorn (Frangula alnus), Japanese (Polygonum cuspidatum) and Bohemian (Polygonum × bohemicum) knotweeds, leafy spurge (Euphorbia esula), multiflora rose (Rosa multiflora), narrowleaf bittercress (Cardamine impatiens), plumeless thistle (Carduus acanthoides), purple loosestrife (Lythrum salicaria), spotted knapweed (Centaurea stoebe), and wild parsnip (Pastinaca sativa).

Training on this plan was provided to land managers. In person, regional workshops with a field tour were developed for this training scheduled for spring 2020. Sadly, the in-person workshops could not be held due to COVID 19. Instead, we developed an online course and held four, regional virtual workshops. The Tactical Invasive Management Plan online course was delivered to 146 individuals representing federal, state, county, municipal and tribal natural resource and agricultural agencies. Individuals also represented nonprofits, private companies, and academic institutions. The online course was approximately four hours in length and was organized into eight different online modules to facilitate learning. Five videos were recorded for the online course and are available as a YouTube playlist. The workshops were held on 06/09/20 for the southwest (25 participants), 06/10/20 for the northwest (47 participants), 06/11/20 for the southeast and greater metro (38 participants) and 06/11/20 for the northeast (25 participants).

PROJECT RESULTS USE AND DISSEMINATION

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

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

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

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

Project Completed: 6/30/2020 **FINAL REPORT**

Maximize Value of Water Impoundments to Wildlife

Subd. 06f $195,000 TF (FY2018)

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Appropriation Language
$195,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the National Audubon Society, Minnesota office, to control invasive hybrid cattails in water impoundments to improve habitat quality for migrating and breeding birds. 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 Agassiz Valley Impoundment, located near Warren, MN, is a 2,560-acre impoundment with a gated water storage area of 6,840 acre-feet that is managed by the Middle-Snake Tamarc-Rivers Watershed District (District). The primary purpose of this impoundment, like the many others across Minnesota, is for floodwater storage, however, they serve many other secondary functions including important wildlife habitat for migrating and breeding species. Due to their primary purpose, impoundments normally follow a hydrologic regime that includes water-level drawdown during the summer months to increase the impoundment's holding capacity for the fall and following spring. This draw down cycle can stimulate the germination of emergent wetland species, especially the non-native hybrid cattail that can form dense monocultures which crowd out native species and degrade habitat quality. Audubon Minnesota and the District collaborated on a project to test the effectiveness of a cattail management regime and the corresponding bird use throughout the treatment cycle. From 2017-2020, Audubon used a three-phase management approach that included conservative herbicide application, structural biomass reduction, and water management in an attempt to control and reduce the hybrid cattail population. Furthermore, Audubon acquired high-resolution orthophotography in 2019 and 2020 from drone flights to further delineate cattail populations and to allow for precise treatment. From 2017 to 2019, the normalized vegetation difference index decreased in 78% of vegetation points within the treatment area, indicating that the management regime was effective in areas that were able to be inundated. Avian response showed promising results; species diversity initially declined the first year following mechanical treatment (2018) but rebounded in 2019 and 2020 with respective increases of 27% and 41% when compared to the pre-treatment numbers in 2017.

This management regime shows promise as a long-term strategy to improve the habitat quality of impoundments across Minnesota while still allowing them to serve their primary purpose of flood mitigation. Hybrid cattail reduction in impoundments benefits the longevity of the impoundment, and thus, the surrounding Minnesotans depending on it for floodwater mitigation.

PROJECT RESULTS USE AND DISSEMINATION

Site documentation through photos occurred 2018-2020 during the growing season, especially concentrating on times with significant water level changes like spring flooding or coinciding with other management actions. A selection of those photos are included in the final report. Audubon Minnesota created a project webpage highlighting the work we are doing at the Agassiz Valley Impoundment. A

summer update on progress was posted to the project webpage mid-June E-news updates about the project went out to over 25,000 Audubon Minnesota e-newsletter subscribers over the course of the project.

We have also posted updates about the project to Audubon's social media platforms. Audubon has reached out to the Watershed District about adding a segment to the Agassiz Valley Impoundment Page about this project and they are open to it so we will continue to work on website additions to their webpage. Dissemination of the summary fact sheet on the project to area watershed districts is underway along with updates on the culmination of the project in our next e-newsletter and on social media. Our project webpage will also be updated with more photos and project summary information.

Recommendations and Ways to Improve Wildlife Habitat in Impoundments:

- A three-phased approach was most effective in treating and controlling hybrid cattail. The areas that experienced prolonged control were areas that could be inundated during prime cattail germination periods.
- Winter mowing was an effective method to reducing the standing dead cattail structure when fire is not an option.
- Follow up herbicide treatments are likely to be necessary if the area experiences a dry period during the growing season allowing hybrid cattail to germinate.
- Managing invasive non-native species and noxious weeds on the dikes through herbicide use or spot mowing allows delayed overall mowing or haying to occur to benefit ground nesting birds and reduce population sinks.
- Plan new impoundments with habitat management in mind.

Project Completed: 6/30/2020 **FINAL REPORT**

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

Promoting Conservation Biocontrol of Beneficial Insects

Research Project

Subd. 08b $400,000 TF (FY2018)

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Appropriation Language
$400,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to research integrated pest management strategies, including insecticide alternatives, and overwintering habitat sites to conserve beneficial insects, including bees, butterflies, and predator insects. The integrated pest management strategies will be used to develop best management practices to increase pollinator and beneficial insect diversity and abundance in various restored habitats. 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

Research investigated the best insecticides to conserve beneficial insects that can be used in green space. The new bee friendly insecticide chlorotraniliprole was highly toxic to butterflies and should not be used near butterfly habitat. Chlorotraniliprole did not kill bumblebees at 4 ppm, however Monarch butterfly larvae were killed at 0.2 ppm, while Painted lady butterfly larvae were killed at 0.03 ppm and adults were killed at 0.05 ppm chlorotraniliprole. This new and highly popular bee friendly insecticide is not butterfly friendly.

In contrast, the neonicotinoid insecticide chlothianidin that was commonly used as a seed treatment and foliar applied insecticide in agriculture, is highly toxic to bees, but not butterflies. Monarch butterfly larvae were killed at 4 ppm clothianidin, while Painted lady butterflies were killed at 96 ppm clothianidin, and adults were killed at 13 ppm clothianidin. At 20 ppb clothianidin bumblebees colonies had reduced nest weight and brood production. Bumblebees are more sensitive to the neonicotinoid clothianidin (40 ppb lethal dose, 20 ppb sublethal dose) compared to two species of butterfly (4, 96 ppm lethal dose).

Pesticide residue on wildflowers near potato fields showed that 100% of 36 samples tested contained at least 2 and up to 15 different pesticides. Research on pesticide residue on flowers near corn fields showed that of 40% of 32 samples tested contained only 1 pesticide and it was atrazine. Pesticide residue was highest on wildflowers near potatoes and demonstrates the need for buffer strips.

Beetle banks are 4 ft piles of mulch that were created at 3 park sites in Washington County. At a citizen science field day, beetle banks were found to a mean of 131 insects compared to control plots with 1 insect. Research on reed nests as habitat for native stem nesting bees showed that there were 236 occupied reeds or 95% of the nests were occupied. Both beetle banks and stem nests increased insect abundance and are cultural methods to increase insect numbers.

PROJECT RESULTS USE AND DISSEMINATION

The grant produced 8 new outreach bulletins, 1 new poster, and research results which are presented at a new website. These outreach bulletins are attached to the work plan.

Our lab has provided 4 workshops per year and 28 talks per year to professionals and consumers on issues related to the grant's research. The bulletins, poster, and research summaries were handed out at outreach events. After 2020 we will continue to use these bulletins at outreach events to educate consumers on IPM programs to protect bees, butterflies, and beneficial insects, such as the parasitoids of the emerald ash borer.

Project Completed: 6/30/2020 **FINAL REPORT**

Subd. 09 Land Acquisition, Habitat and Recreation

Minnesota State Parks and State Trails Land Acquisition

Subd. 09c $1,500,000 TF (FY2018)

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Appropriation Language
$1,500,000 the first year is from the trust fund to the commissioner of natural resources to acquire approximately 373 acres from willing sellers for authorized state trails and critical parcels within the statutory boundaries of state parks. State park land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards, as determined by the commissioner of natural resources. A list of proposed acquisitions must be provided as part of the required work plan. 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

Minnesota Environment and Natural Resources Trust Fund funding resulted in the Department of Natural Resources acquiring approximately 373 acres of land within the statutory boundaries of four Minnesota State Parks.

- Acquired 80 acres in Maplewood State Park. This acquisition is located within the southeast portion of the state park, which contains a large contiguous tract of maple basswood hardwood forest over a rolling topography. This forest is similar to what is known to exist at the time of European settlement of the area. This undisturbed/undeveloped forest is important nesting habitat for neo-tropical forest songbirds.
- Acquired 153 acres in Sibley State Park. This property affords park visitors approaching along TH71 a glimpse of Minnesota's original prairie landscape with rolling grasslands and wetlands. Recreational trail users on this parcel will have views of the transitions from prairie to savanna to woodlands. This parcel will also provide a route for the Glacial Lakes State Trail connection to Sibley State Park.
- Acquired 30 acres in Minneopa State Park. This acquisition helps in protecting cultural resources, provide for sustainable wildlife habitat and new hiking, bird watching and facilitate interpretive programming opportunities. It is located adjacent to existing DNR ownership along the Minnesota River which will connect ~164 acres of publically owned, DNR managed land, and contributes to the consolidated management efforts to maintain and restore native vegetation as well as buffer for Minnesota River and protection of river watershed.
- Acquired 158 acres in Frontenac State Park. This land improves the park's ability to preserve and buffer natural resources, wildlife habitat and view sheds. This parcel also has a stunning overlook and incredible birding opportunities for unique trail hiking experiences.

PROJECT RESULTS USE AND DISSEMINATION

Maplewood and Sibley acquisitions dissemination have been communicated through updated state park maps reflecting state managed land and are identified as public land open to be used and enjoyed by all visitors. Now, that an acquisition consultant has been appointed, dissemination will continue for the rest of the acquired parcels.

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

Minnesota State Trails Acquisition, Development and Enhancement

Subd. 09d $1,038,000 TF (FY2017 - $999,000 / FY2018 - $39,000)

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Appropriation Language
$999,000 in fiscal year 2017 and $39,000 the first year are from the trust fund to the commissioner of natural resources for state trail acquisition, development, and enhancement in southern Minnesota. A proposed list of trail projects on authorized state trails must be provided as part of the required work plan. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

Project due to be completed: 06/30/2020 **Work Plan**

Leech Lake Acquisition

Subd. 09f $1,500,000 TF (FY2018)

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Appropriation Language
$1,500,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Leech Lake Band of Ojibwe to acquire approximately 45 acres, including 0.67 miles of shoreline of high-quality aquatic and wildlife habitat at the historic meeting place between Henry Schoolcraft and the Anishinabe people. The land must be open to public use including hunting and fishing. The band must provide a commitment that land will not be put in a federal trust through the Bureau of Indian Affairs.

Project due to be completed: 08/30/2019 **Work Plan**

Land Acquisition for Voyageurs National Park Crane Lake Visitors Center

Subd. 09i $950,000 TF (FY2018)

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Appropriation Language
$950,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the town of Crane Lake, in partnership with Voyageurs National Park and the Department of Natural Resources, to acquire approximately 30 acres to be used for a visitor center and campground. Income generated by the campground may be used to support the facility.

OVERALL PROJECT OUTCOME AND RESULTS

The Township of Crane Lake received a $950,000 grant from the ENRTF to acquire an approximately 30 acre former resort site on the shores of Crane Lake to work in partnership with an adjacent DNR 7 acre site to build an entrance point to Voyageurs National Park that will include a National Park Service Visitors Center, boat ramp, docks, beach, campground, restrooms, and educational and community space. The Township of Crane Lake has purchased the property and will be working with their partners to begin the design and development phases of their development. The total cost of the parcel was $982,000 with $950,000 coming from the ENRTF and the Township providing $32,000 in their own funds.

PROJECT RESULTS USE AND DISSEMINATION

During the process of planning, land sale negotiations, and securing the former Borderland Resort site, the Township of Crane Lake has been posting progress on their website, updating local newspapers, working with local tourism offices, area chambers of commerce and working very closely with their partners including the DNR and Park Service. The Township will continue to disseminate information through the same media through the planning, design and construction phases of the overall development.

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

Subd. 10 Administration

Contract Agreement Reimbursement

Subd. 10a $135,000 TF (FY2018)

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Appropriation Language
$135,000 the first year is from the trust fund to the commissioner of natural resources, at the direction of the Legislative-Citizen Commission on Minnesota Resources, for expenses incurred for contract agreement reimbursement for the agreements specified in this section. The commissioner shall provide documentation to the Legislative-Citizen Commission on Minnesota Resources on the expenditure of these funds.

OVERALL PROJECT OUTCOME AND RESULTS

This appropriation was used to support the ENRTF contract management program, which ensured that ENRTF grantees expended grant funds in compliance with state law, session law, approved work plans, and Office of Grants Management grants policies.

The DNR Grants Unit managed 67 grants active in FY 2017. In FY 2018, the Grants Unit managed 71 active grants. Between 7/1/2016 when the services began and 06/30/2018 when they ended, the DNR Grants Unit:

- Made 359 reimbursements to grantees totaling $13,053,825.58
- Prepared and executed 21 ML 2017 grant agreements
- Published 6 editions of the quarterly newsletter for all grantees
- Billed 350 hours at the FY 2017 professional services rate of $63.00/hr
- Billed 1,534 hours at the FY 2018 professional services rate of $63.00/hr
- Monitored all grants in compliance with Office of Grants Management policies.

PROJECT RESULTS USE AND DISSEMINATION

Project personnel were in frequent contact with appropriation recipients and LCCMR staff. Information was disseminated through manuals, training sessions, orientations, meetings, memos, letters, emails, newsletter, and phone.

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