M.L. 2013 Projects Completed in 2015-2016

MN Laws 2013, Chapter 52, Section 2 (beginning July 1, 2013)

For the next biennium (July 1, 2013 - June 30, 2015), approximately $33.8 million is available each fiscal year (Total = $67,620,000) for funding from the Environment and Natural Resources Trust Fund. In response to the 2013 Request for Proposal, 169 proposals requesting a total of approximately $155 million were received. Through a competitive, multi-step process 66 of these proposals, requesting a total of $73 million, were chosen to present to the LCCMR and 46 of those proposals, totaling $38.2 million (all FY 2014 funds and part of the FY 2015 funds), were chosen to receive a recommendation for funding to the 2013 MN Legislature. The Legislature adopted all 46 of these project recommendations and added one additional project. All 47 appropriations were signed into law by the Governor on 05/09/13. $29.6 million remains availble for LCCMR funding recommendations to the ML 2014 Legislature.

NOTE: For all projects, contact us to obtain the most up-to-date work programs for current projects (project updates are required twice each year) or the final reports of completed projects.

When available, we have provided links to web sites related to the project. The sites linked to this page are not created, maintained, or endorsed by the LCCMR office or the Minnesota Legislature.

Subd. 03 Natural Resource Data and Information

03a Minnesota Biological Survey

03b County Geologic Atlases - Part A

03d Updating the National Wetland Inventory for Minnesota - Phase IV

03e Conservation Easement Stewardship Program - Phase III

03f Harnessing Soudan Mine Microbes: Bioremediation, Bioenergy and Biocontrol - **RESEARCH**

03g Improved Rapid Forest Ecosystem and Habitat Inventory

03h Finding Disease Resistant Elm Trees in Minnesota - **RESEARCH**

03i Enhancing Timber Sale Program Environmental and Economic Sustainability

03j Enhancing Environmental and Economic Benefits of Woodland Grazing - **RESEARCH**

Subd. 04 Land, Habitat, Restoration, and Recreation

04a State Parks and State Trails Land Acquisition

04b Scientific and Natural Areas Restoration, Enhancement and Citizen Engagement

04c Native Prairie Stewardship and Prairie Bank Easement Acquisition

04d Metropolitan Conservation Corridors (MeCC) - Phase VII

04e Landscape Arboretum Acquisition Lake Tamarack

04f Conservation Program Technical Assistance

04g Moose Habitat Restoration in Northeastern Minnesota - **RESEARCH**

04h Bee Pollinator Habitat Enhancement

04j Preserving the Avon Hills Landscape - Phase II

04k Frogtown Farm and Park Acquisition

04l Restorations Evaluations

Subd. 05 Water Resources

05a Sustaining Lakes in a Changing Environment - Phase II - **RESEARCH**

05c Heron Lake Sediment and Phosphorus Reduction Implementation Projects

05d Southern Minnesota Lakes Restoration

05g Membranes for Wastewater-Generated Hydrogen and Clean Water - **RESEARCH**

05h Antibiotics in Minnesota Waters - Phase II - Mississippi River - **RESEARCH**

Subd. 06 Aquatic and Terrestrial Invasive Species

06a An Aquatic Invasive Species Research Center - **RESEARCH**

06b Detection and Monitoring of Asian Carp Populations

06d Elimination of Target Invasive Plant Species

06e Biological Control of Garlic Mustard - **RESEARCH**

06f Zebra Mussel Control Research and Evaluation in Minnesota Waters - **RESEARCH**

Subd. 07 Environmental Education

07a Minnesota Conservation Apprentice Academy

07b Youth Outdoors: Mississippi River Education and Employment Opportunities

Subd. 08 Administration and Contract Management

08b Contract Agreement Reimbursement

Funding Source:
Environment and Natural Resources Trust Fund (TF)

MN Laws 2013, Chapter 52, Section 2

Subd. 03 Natural Resource Data and Information

Minnesota Biological Survey
Subd. 03a $2,650,000 TF

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Appropriation Language
$2,650,000 the first year is from the trust fund to the commissioner of natural resources for continuation of the Minnesota biological survey to provide a foundation for conserving biological diversity by systematically collecting, interpreting, monitoring, and delivering data on plant and animal distribution and ecology, native plant communities, and functional landscapes.

Project Overview
The Minnesota Biological Survey (MBS) is an ongoing effort begun in 1987 by the Minnesota Department of Natural Resources (DNR) that is systematically surveying, county-by-county, the state's natural habitats. The effort identifies significant natural areas and collects and interprets data on the status, distribution, and ecology of plants, animals, and native plant communities throughout the state. To date, surveys have been completed in 81 of Minnesota's 87 counties and nearly 20,000 records of rare features have been recorded. MBS data is used by all levels of government in natural resource planning and use decisions, including prioritization of protection of park lands and scientific and natural areas. This appropriation will permit continuation of the survey in Lake, St. Louis, Clearwater, Beltrami, Lake of the Woods, and Koochiching counties. Additionally sites containing select native plant communities or select rare plant and animal populations will be monitored, conservation technical assistance will be provided, and interpretive products and publications will be developed to make the information useful to a variety of audiences.

OVERALL PROJECT OUTCOME AND RESULTS
The need to protect and manage functional ecological systems, including ecological processes and component organisms continues to accelerate with increased demands for land, water, and energy, continued habitat fragmentation, loss of species and genetic diversity, invasive species expansion, climate change, and other changing environmental conditions.

Since 1987 the Minnesota Biological Survey (MBS) has systematically collected, interpreted and delivered baseline data on the distribution and ecology of plants, animals, native plant communities, and functional landscapes. These data help prioritize actions to conserve and manage Minnesota's ecological systems and critical components of biological diversity.

Since July 2013, MBS contributed 1,326 new rare features records to the Rare Features Database, surveyed 72 lakes for rare plants and vegetation, and added 439 vegetation plots (releve) to the statewide database. Since 1987, MBS has added a total of 21,478 new rare feature records statewide; MBS botanists have documented 1,245 rare aquatic plants during targeted surveys of 1,983 lakes in 46 counties; MBS plant ecologists have contributed 5,392 of the 10,269 vegetation plot records in the DNR's releve database. Statewide 10,734 MBS sites of Biodiversity Significance and 83,913 polygons of native plant communities are now publically available on the Minnesota Geospatial Commons.

During this project period baseline surveys continued, focused in northern Minnesota (see map) within large functional landscapes of forests, peatlands, wetlands, and undeveloped lakes and streams. Highlights include helicopter-assisted field surveys of the most remote areas within northwest Minnesota's patterned peatlands, remote-access-only vegetation and botanical field surveys of the Border Lakes, and the discovery of a new state-record species of sedge, (Carex tincta), along with numerous other examples of new and expanded distribution data for native plant species.

MBS continued monitoring to measure the effectiveness of management and policy activities. For example, as part of DNR's forest certification high conservation value forest sites in southeastern

Minnesota have been targeted as monitoring sites with field survey efforts focused on detailed rare plant surveys. This work provided updates to existing data that is often more than 20 years old, set a foundation from which to more precisely track target species' populations through time, and improved the relevance of MBS data to monitoring needs.

PROJECT RESULTS USE AND DISSEMINATION

MBS data are stored primarily in the Division of Ecological and Water Resources information systems, which are increasingly linked to other databases in the MN DNR. For example, MBS, in collaboration with other DNR partners, developed and operationalized a DNR-wide native plant community GIS database that integrates native plant community mapping by all DNR Divisions. In addition, MBS procedures, updates, recent maps, and links to related data are presented on the DNR website. Many MBS GIS datasets are delivered to clients through the Minnesota Geospatial Commons. MBS regularly provides vegetation plot data from the releve database to researchers at academic institutions and other agencies and organizations. Non-public rare species data are available through agreements with the requesting agency and the DNR.

MBS publishes and distributes survey results in a variety of formats for various audiences. Many products are available on the DNR website, including GIS shape files of native plant communities and MBS sites, native plant community field guides, and guides to sampling techniques such as vegetation plot data collection using the releve method. MBS web pages are updated with new information and have links to associated resources: http://www.dnr.state.mn.us/eco/mcbs/index.html.

The DNR and Legislative libraries and other local information repositories (such as libraries within counties) have access to published products, including books, maps, reports, field guides and digital media. MBS has published several books and field guides and the publication of a natural history book based on MBS data collected in the northwestern prairie region and Red River Valley is underway. Based on local collaborator interest and the results of regional focus groups, this book will include a guide to selected natural areas of the region. A Minnesota publisher has agreed to publish this book.

Staff routinely make presentations that describe MBS methodologies and results to a wide range of audiences including county boards, local planning groups, citizen advisory groups, other biologists, land managers, and students. MBS staff provide local planners with ecological interpretations describing important sites of biodiversity identified during the Survey to assist with management plans. Staff lead or participate in technical workshops and field trips to exchange ideas on survey methodology and provide training in the application and interpretation of the data. For example, in 2014-15, MBS botanists and plant ecologists in collaboration with partners delivered nine field workshops to over 200 natural resource professionals. These field workshops focused on plant identification, native plant community classification, and how these skills can be used to inform management decisions.

Physical collections are deposited at Minnesota repositories, primarily at the University of Minnesota's J.F. Bell Museum of Natural History and at the Science Museum of Minnesota, St. Paul. As part of a larger network of museums and herbaria, these cooperators are essential to the documentation and sharing of MBS results. MBS and museum staff meet periodically to address curatorial, data management, and interpretive needs. During this project period, MBS deposited over 2,000 plant specimens to the Bell Museum Herbarium.

MBS also delivers data through an international organization, NatureServe, and also shares data with

cooperators at colleges and universities and with others in ecological regions where surveys are ongoing or completed.

Project completed: 6/30/2015

FINAL REPORT

County Geologic Atlases - Part A
Subd. 03b $1,200,000 TF

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Appropriation Language
$1,200,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to continue the acceleration of the production of county geologic atlases that define aquifer boundaries and the connection of aquifers to the land surface and surface water resources for the purpose of sustainable management of surface water and groundwater resources. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
The Minnesota County Geologic Atlas program is an ongoing effort begun in 1979 that is being conducted jointly by the University of Minnesota's Minnesota Geological Survey and the Minnesota Department of Natural Resources (DNR). This portion, called Part A and conducted by the Minnesota Geological Survey, collects geologic information to produce maps and databases that define aquifer boundaries and the connection of aquifers to the land surface and surface water resources. The information is used in planning and environmental protection efforts at all levels of government, by businesses, and by homeowners to ensure sound and sustainable planning, management, and protection of water resources used for drinking, agriculture, industry, and more. This appropriation will initiate Part A geologic atlases for three additional counties yet to be determined depending on county participation and other priorities.

OVERALL PROJECT OUTCOME AND RESULTS
The Minnesota Geological Survey maps sediment and rock because these materials control where water can enter the subsurface (recharge), where and how much water can reside in the ground (aquifers), where the water re-emerges (discharge), and at what rates this movement occurs. This information is essential to managing the quality of our water and the quantity that can be sustainably pumped. This project completed geologic atlases for Meeker, Redwood, and Kanabec counties, and contributed to ongoing atlas work in Brown, Wadena, Becker, and Hubbard counties. Information about the geology is gleaned from the records of domestic wells, and from drilling conducted for this project. In Meeker County we used 3,600 wells and 6 cores, in Redwood we used 1,900 wells and 10 cores, in Brown County we used 1,700 wells and 8 cores, in Wadena County we used 2,787 wells and 3 cores, in Becker

we used 8,887 wells and 5 cores, in Hubbard we are using 9,550 wells and 3 cores, and in Kanabec we used 4,055 wells and 7 cores. In all cases these are augmented with soil borings and geophysical surveys. From the data we created maps of the geology immediately beneath the soil; the aquifers within the glacial sediment; and the shape, elevation, and rock types of the bedrock surface. These maps and data support monitoring, wellhead protection, water appropriation, clean-ups, and water supply management.

In large portions of Redwood counties the glacial materials are relatively thin, and most of the bedrock types present do not provide much water. This makes the mapping of glacial sand bodies, which are potential aquifers, very important. In Becker, Hubbard, and Wadena counties the glacial deposits are the only viable water source. Irrigation is an important water use in those counties, and the atlas information will be useful in managing water for maximum benefit. In Meeker, Brown, and Kanabec counties, the glacial deposits vary in thickness, and the bedrock includes some formations that can serve as aquifers. In every county the database of well construction records we have compiled is an excellent indicator of which aquifers the population is currently relying on. Printed and digital versions of all these atlases will be delivered to LCCMR.

PROJECT RESULTS USE AND DISSEMINATION
The Minnesota County Geologic Atlas program is an ongoing effort begun in 1979 that is being conducted jointly by the University of Minnesota's Minnesota Geological Survey and the Minnesota Department of Natural Resources (DNR). This portion, called Part A and conducted by the Minnesota Geological Survey, collects geologic information to produce maps and databases that define aquifer boundaries and the connection of aquifers to the land surface and surface water resources. The information is used in planning and environmental protection efforts at all levels of government, by businesses, and by homeowners to ensure sound and sustainable planning, management, and protection of water resources used for drinking, agriculture, industry, and more. This appropriation will initiate Part A geologic atlases for three additional counties yet to be determined depending on county participation and other priorities.

Project due to be completed: 6/30/2016

FINAL REPORT (PDF)

Updating the National Wetland Inventory for Minnesota - Phase IV
Subd. 03d $1,000,000 TF

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Appropriation Language
$1,000,000 the first year is from the trust fund to the commissioner of natural resources to continue the update and enhancement of wetland inventory maps for Minnesota. This appropriation is available until

June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Over the past 100 years, about half of Minnesota's original 22 million acres of wetlands have been drained or filled. Some regions of the State have lost more than 90 percent of their original wetlands. The National Wetland Inventory, a program initiated in the 1970s, is an important tool used at all levels of government and by private industry, non-profit organizations, and private landowners for wetland regulation and management, land management and conservation planning, environmental impact assessment, and natural resource inventories. The data behind the National Wetlands Inventory for Minnesota is now considerably out-of-date and a multi-phase, multi-agency collaborative effort coordinated by the Minnesota Department of Natural Resources is underway to update the data for the whole state. This appropriation is being used to conduct the fourth of six phases of this effort, which involves wetlands maps for portions of Lake, Cook, and St. Louis counties in northeastern Minnesota. A completed wetlands inventory will help improve wetland protection and management.

OVERALL PROJECT OUTCOME AND RESULTS
Updating the National Wetland Inventory (NWI) is a key component of the State's strategy to ensure healthy wetlands and clean water for Minnesota. This effort is a multi-agency collaborative under leadership of the Minnesota Department of Natural Resources. These data are intended to replace the original 1980s NWI data. The NWI data provide a baseline for assessing the effectiveness of wetland policies and management actions. These data are used at all levels of government, as well as by private industry and non-profit organizations for wetland regulation and management, land use, conservation planning, environmental impact assessment, and natural resource inventories. The update project is being conducted in phases with data released for each region as it is finalized.

In this fourth phase of the overall effort, the DNR updated wetland inventory maps for 14,700 square miles in northeast Minnesota covering all of Lake, Cook, and St. Louis counties as well as portions of Carlton and Koochiching counties. The overall accuracy for wetland identification is 86%.

The updated NWI data was created in accordance with federal wetland mapping guidance. This update used spring aerial imagery acquired in 2009, summer imagery acquired in 2013, and lidar elevation data as well as other ancillary data. Quality assurance of the data included visual inspection, automated checks for attribute validity and consistency, as well as a formal accuracy assessment based on an independent field data. Further details on the methods employed can be found in the technical procedures document for this project located on the project website (http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html).

PROJECT RESULTS USE AND DISSEMINATION
All wetland map data and aerial imagery are available free of charge to the public. The data have been made available through the Minnesota Geospatial Commons (https://gisdata.mn.gov/) as well as through an online wetland viewer (http://www.dnr.state.mn.us/eco/wetlands/map.html). A copy of the data has also been provided to the US Fish and Wildlife Service for inclusion in the national wetland database.

Use of the NWI data is being promoted through a variety of channels. The DNR has given presentations about the NWI data at both the Minnesota Water Resources Conference and the Minnesota GIS/LIS Conference. The DNR and MnGeo have presented at the Minnesota GIS/LIS Conference regarding the availability of the spring aerial imagery. A press release has also been drafted for an expected

September release. A peer-reviewed journal article was published in the journal Wetlands based on the work from the previous NWI project phase and a book chapter has been prepared for an upcoming publication on wetland assessment.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Photo Interpertation Guide: For Updating The National Wetland Inventory In Minnesota (PDF)
Updating the National Wetland Inventory in Northest minnesota: Technical Documentation (PDF)

Conservation Easement Stewardship Program - Phase III
Subd. 03e $60,000 TF

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Appropriation Language
$200,000 the first year is from the trust fund to the commissioner of natural resources for the final phase to bring conservation easements held by the Department of Natural Resources up to minimum conservation standards, through monitoring, baseline data collection, and baseline report preparation.

Project Overview
The purchase of conservation easements - restrictions on land use that protect natural features while keeping land in private ownership - has proven to be an effective means to protect land at a lower initial cost than full state ownership. However, once an easement is purchased there are ongoing stewardship, monitoring, and enforcement responsibilities necessary to ensure the terms of the agreement between the easement holder and the landowner are met. Earlier efforts funded by the Environment and Natural Resources Trust Fund in 2008 and 2011 allowed the Minnesota Department of Natural Resources (DNR) to retroactively bring existing conservation easements up to minimum standards by developing a central inventory and management system of the conservation easements held by the DNR, along with a plan for how they would be administered into the future. This appropriation is the final phase of this effort allowing the DNR to continue and accelerate the implementation of the previously developed plan. Additionally, tools will be developed to enhance monitoring efficiency using remote sensing.

OVERALL PROJECT OUTCOME AND RESULTS
This was the last phase of a three-phase project to establish procedures and tools to effectively monitor conservation easements held by the DNR. One project goal was to monitor and create baseline reports for 75 existing conservation easements-actual attainment was 85 easements. As detailed in the Phase III Supplemental Report, additional goals were to investigate the use of image processing software coupled with LiDAR and current imagery to improve the efficiency of conservation easement stewardship. Two areas were explored: 1) can these tools be used to accurately redraw stream centerlines after changes in stream courses; and 2) can remote sensing tools be written to automatically identify possible violations

of easement terms? DNR trout stream easement boundaries are typically 66' from stream centerlines and move with stream course changes. It is essential to have accurate maps of easement boundaries for monitoring, but it is time consuming to edit boundaries manually. Staff created a novel approach to generate stream centerlines from LiDAR and adjust them with imagery where stream course changes had occurred. Tests of a 15km stream section demonstrated the accuracy and usefulness of this approach. Manual effort of 90 minutes to digitize the stream section was reduced to 11 minutes. In the second problem area, staff utilized eCognition image analysis software to classify land cover in easement corridors utilizing imagery with three levels of resolution and LiDAR and identify objects/conditions that could be easement violations. Staff concluded that to effectively monitor easements remotely would require image resolution no coarser than 6" and LiDAR that had been acquired at the same time. Possible violations identified in this fashion still need on-site verification, but this technique can highlight areas of concern and reduce on-site visit time. Tools developed in this project have potential application for statewide riparian buffer mapping and monitoring.

PROJECT RESULTS USE AND DISSEMINATION
Results for Activity 1 of the project are being assembled in a fashion where they can be presented to personnel in Fish and Wildlife who are responsible for the maintenance of the stream centerline GIS layers for possible broader application. In addition, a presentation is being planned for BWSR and DNR personnel involved in mapping the public waters and ditches as part of the new 50 foot buffer legislation. There is potential for applying both the centerline and land cover techniques developed for this project to buffer mapping and monitoring.

Results for Activity 2, using tools developed in project phases I and II to visit 75 additional easements for the purposes of collecting baseline property information and creating those reports, was disseminated primarily to DNR management for the purposes of directing monitor efforts. One update was generated for the Conservation Easement Stewardship User Manual during the project for staff training use. During the project, wild and scenic river easement baseline property reports were signed and mailed to fee title owners of the properties.

Periodic project updates and preliminary results were presented to the Conservation Easement Stewardship committee for the purposes of gathering additional direction from that group during the project. A conservation easement stewardship cost calculator was disseminated to DNR fiscal staff. Information about the calculator was presented to the LCCMR on June 25, 2015.

Project completed: 6/30/2015

FINAL REPORT

Harnessing Soudan Mine Microbes: Bioremediation, Bioenergy and Biocontrol
Subd. 03f $838,000 TF

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RESEARCH

Appropriation Language
$838,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to continue the characterization of unique microbes discovered in the Soudan Underground Mine State Park that have potential applications for metal remediation in water resources, microbial electrofuels, and biocontrol of white-nose bat syndrome. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
The Soudan Iron Mine near Ely, Minnesota is no longer an active mine and is now part of a state park, as well as the home to a state-of-the-art physics laboratory at the bottom of the mine. The mine has also been discovered to contain an extreme environment in the form of an ancient and very salty brine bubbling up from a half-mile below the Earth's surface through holes drilled when the mine was active. Strange microorganisms - part of an ecosystem never before characterized by science - have been found living in the brine. Scientists from the University of Minnesota will use this appropriation to continue to study this unique ecosystem and its organisms and build upon findings from a previous Environment and Natural Resources Trust Fund supported effort to explore potential applications of using the microorganisms living there for removing metals from mine waters, producing biofuels, and developing a biocontrol for White-Nose Syndrome, which is decimating bat populations around the country.

OVERALL PROJECT OUTCOME AND RESULTS
The Soudan Iron Mine in Minnesota provides direct access to microbes with special adaptations that can be harnessed for biotechnology. We conducted research to harness these microbes to approach some of the most critical environmental challenges in Minnesota:

Metal Bioremediation:
Our goal was to explore the native fungi living in the mine. These fungi live in extremely harsh and variable chemical conditions, including high metal concentrations in water. Because the Soudan Iron Mine fungi have adapted to the conditions in the mine, they might possess properties that we can use for cleaning up metal-contaminated water. When we use plants or microorganisms (like fungi) to remove metals from water, it is termed bioremediation. We investigated mine fungi that thrive in heavily contaminated waters with metals such as copper, cobalt, zinc, nickel, and mercury. We isolated 1014 different strains of fungi representing 140 different taxa, including novel species. We screened 60 fungal isolates and discovered that several species accumulate metals within their living biomass. These findings confirmed that: (1) many Soudan Iron Mine fungal isolates have promising metal removal characteristics in solid and liquid growth conditions; (2) the amount of metal removed from water was similar between natural and lab specimens; and (3) metal binding can be reversed in some cases. These results can be used to develop a suite of bioremediation strategies using fungi as passive sorbent materials or in living self-regenerating bioreactor.

Electrosynthesis Project:
We characterized and developed methods for understanding two bacterial isolates from the Soudan Mine: Marinobacter subterrani and Desulfuromonas soudanensis. D. soudanensis is capable of producing electricity and dissolving rust in high salt concentrations, making it a very unusual organism. We sequenced and characterized its genome to better understand how electricity production works at

high salt concentrations, a process that could be important for future applications in microbial bioremediation and desalination. We are currently in the process of developing a genetic system in D. soudanensis to further our understanding of how it generates electricity in high salt conditions. M. subterrani is a model for the study of metal precipitation, a process that, if better understood, could allow us to feed electricity directly into bacteria. These bacteria could then be engineered to produce desired products using electricity. Given the complexities of this biological process, we are still an early stage of understanding the fundamental pathway that enables metal precipitation. Our students working on these two projects have presented their work at national and international meetings and have produced 2 peer reviewed scientific manuscripts on their work as well.

White Nose Bat Syndrome Biological Control:
White Nose Syndrome is a devastating bat disease causing catastrophic economic and biodiversity losses throughout the US. Our primary goal was to identify microbes that inhibit the fungal pathogen, Pseudogymnoascus destructans that could eventually be developed as a treatment in caves and mines. As part of this biocontrol strategy, we collected and screened new microbes from the Soudan Mine. In total, 32/121 fungal strains and 60/262 bacterial isolates inhibited growth of P. destructans. Analysis of active strains provided us with a picture of which types of inhibitory microbes may be found in various mine locations, which may help future screening and discovery efforts. With this library of nearly 100 antifungal strains, we are poised to move forward into phase II, which will involve testing the ability of each active strain to inhibit P. destructans on specific substrates both in the lab and in the environment. An additional outcome is that a subset of at least 50 strains had activity against human pathogens and these will be further explored in a separate project.

PROJECT RESULTS USE AND DISSEMINATION
Information, discoveries, approaches and questions from our project have been used and disseminated in a number of different ways: Presentations about individual projects have been given to school groups, college students, local community groups and at professional scientific conferences (see examples, below). Several components of this project were completed and shared as peer-reviewed scientific manuscripts. Some of the fundamental scientific discoveries have been used to further develop and expand new ideas that were not a part of the original research plan. These new ideas and hypotheses have been incorporated into new grant proposals, resulting in successful new funding at both the state and federal levels (including several new LCCMR proposals that build directly on initial research accomplished in this period as Phase II projects). Some additional uses include the screening of these new, diverse microbial libraries against other targets, including human infectious disease pathogens. For example, several of the bacterial strains that showed no activity against the fungal bat pathogen did exhibit inhibition of human yeast pathogens. These strains will be further studied to purify and identify the active components for potential development as human therapeutics.

Project completed: 6/30/2016

FINAL REPORT (PDF)

Improved Rapid Forest Ecosystem and Habitat Inventory
Subd. 03g $262,000 TF

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Appropriation Language
$262,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to evaluate a new approach to forest inventory, based on statewide forest inventory and analysis (FIA) data.

Project Overview
Minnesota has 15.9 million acres of forest land managed by a variety of county, state and federal agencies, and private landowners for timber production, wildlife habitat, and ecological considerations. Forest managers rely on inventory data to make effective planning and management decisions. Because forests are continually changing through natural and human processes, forest inventory data is periodically updated. However, doing so is an expensive and time-consuming endeavor and, as a result, much of Minnesota's forest inventory data is currently out of date. This appropriation is being used by scientists at the University of Minnesota to evaluate an innovative approach to forest inventory using existing statewide Forest Inventory and Analysis (FIA) data that could help reduce costs, expedite future updates, and improve overall usability.

OVERALL PROJECT OUTCOME AND RESULTS
Forests cover one-third of Minnesota and contain 15.9 million acres of timberland managed in large part by county, state and federal agencies and private landowners. Of this, 53% is public. DNR forest stand inventory records alone include nearly 200,000 stands. Stand inventories are central to the management of these lands. But forests change rapidly (e.g., 14% of field plots change cover type within 5 years) and stands can shift from sapling to old forest stage in 2-4 score years. Thus inventories need updating, but such efforts have fallen far behind. Why? They are costly (say $6 per acre, $3 for field plots, $3 for mapping) and can total millions of dollars statewide. Consequently these data are typically insufficient and out of date.

The project questioned existing inventories and explored new ideas, methodology and tools to dramatically reduce costs and to expand ecological and habitat detail. The findings below will foster inventories with greater frequency, timeliness and detail:

1. A major use of inventories is in forest planning (harvest scheduling), but results indicate such analyses do not require large numbers of field plots.
2. Forest yield estimates, essential to planning, likewise do not require large numbers of field plots-nearby and past inventories can satisfy much of this data need.
3. Data mining analyses indicate numerous ecological variables can be imputed to inventory stands from data already available such as physiographic class, soil maps, location, and tree species present. Results show moderate to high accuracy for native plant community class (NPC) estimation.
4. Habitat suitability models have been refined and packaged for PC use. This enables local to large area habitat characterization for 150+ wildlife species across past, present and projected inventories.
5. Based on the above findings, cost effective alternative inventory designs are now available to fit diverse situations. These can reduce field plot costs to half or less.

6.

PROJECT RESULTS USE AND DISSEMINATION

1. Workshops, training, software tools and publications are already underway to foster implementation among DNR and county participants and other landowners. Some these will be offered through the Sustainable Forests Education Cooperative (SFEC) from the University's Cloquet Forestry Center. These workshops will cover developing local yield tables, the use of efficient judgment (located) plots, and choosing your inventory design from among alternatives. Lidar workshops have already been held. We are also making the data mining and habitat imputation capability available as software for PCs. Further details on project findings and tools and their implementation will be made available as University of Minnesota Forestry Research Notes at www.forestry.umn.edu and on the Interagency Information Cooperative website at iic.umn.edu.
2. The project manager and staff have presented project progress and various results at several meetings of participating professionals and agencies (e.g., the Minnesota Forest Resources Partnership). These communications have focused on inventory design. This includes advising on the development of a DNR Forestry led implementation proposal directed to the LCCMR. Staff has also been working with DNR Forestry on the implementation of ecological imputation findings. A report on parts of this work has been accepted for presentation at the 2015 National Convention of the Society of American Foresters in Baton Rouge, LA in November.
3. Combinations of Lidar, spectral imagery and automated cover type mapping software explored in the project are are coming soon and will likely reduce mapping costs to half or less.
4. It is anticipated that these project findings will be examined and implemented by most project participants.
5. The subject of this LCCMR project is an increasingly common and internationally important topic. Many states and countries are faced with similar inventory cost and effectiveness problems. Thus publications and methods developed from this project will likely spur further study by others well beyond Minnesota.

Project completed: 6/30/2015

FINAL REPORT

Finding Disease Resistant Elm Trees in Minnesota
Subd. 03h $200,000 TF

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RESEARCH

Appropriation Language
$200,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to

evaluate and identify native Minnesota elms resistant to Dutch elm disease to assist with limiting the susceptibility of the state's elms to Dutch elm disease. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview

Elms were once a very widespread tree in Minnesota and amongst the most common and popular in urban landscapes due to their size, shading capability, and tolerance of pollution and other stresses. Over the past five decades, though, Dutch elm disease, an exotic and invasive pathogen, has killed millions of elms throughout the state. However, scientists at the University of Minnesota have observed that some elms have survived the disease and appear to have special characteristics that make them resistant to Dutch elm disease. This appropriation is being used to identify, propagate, and evaluate native Minnesota elms resistant to Dutch elm disease to assist with limiting the susceptibility of the state's remaining elms to Dutch elm disease and possibly lay the foundation for re-introductions of the tree in the future.

OVERALL PROJECT OUTCOME AND RESULTS

Dutch elm disease is caused by an exotic invasive fungus (Ophiostoma novo-ulmi) that was introduced into Minnesota in the 1960's. Since that time the disease has killed millions of elms in urban and forested landscapes across the state. Although most American elms have no resistance to this pathogen, some continue to survive the disease and remain healthy in locations where all other elms have died. To determine if these trees have some tolerance to the disease or just escaped infection, we collected and inoculated a group of selected elms from across Minnesota. These trees were found from surveys with the help of city officials and the general public and they are from metropolitan and rural areas throughout the state. Accomplishments included:

1. Twenty-five trees were selected for testing during the first phase of the project.
2. All trees were successfully propagated to produce clones.
3. Successful inoculation methods were developed.
4. Clones were screened in greenhouse and field for resistance.
5. 600 trees representing different native elm selections have been planted in the elm research nursery at the University of Minnesota for continued testing and evaluation.
6. Over 50 additional selections have been identified and are available for propagation for the future.

Results indicate that there is a range of elm genotypes that vary in their tolerance to Dutch elm disease. We are continuing our efforts to find the highest degree of resistance among different genotypes so more Minnesota-hardy elms can be added to our urban and rural landscapes. New elm selections will provide the much needed diversity in these important native species and will provide more options for replanting in communities devastated by the emerald ash borer and other exotic pests and diseases. A Phase II elm project which began on July 1, 2016 with funds from the Minnesota Environment and Natural Resource Trust Fund will allow the testing of more elms, study the mechanisms of resistance found in the trees and continue to field test our selections to ensure trees with the greatest resistance and best growth characteristics are available for planting by the people of Minnesota.

PROJECT RESULTS USE AND DISSEMINATION

Over the duration of this project many presentations, magazine articles, and scientific publications have been completed providing information about the project to a large audience of stakeholders including the arborists, nursery managers, foresters, researchers and the general public. We have received a great

deal of feedback from the public supporting this project to find hardy Minnesota elms that are resistant to Dutch elm disease. With this information we are closer to our goal of introducing more Minnesota native elms back to our urban and rural landscape. Since the 1960's, Minnesota has lost millions of elms to this disease, changing the landscape. The results from our investigations show that there is hope to obtain resistant elms that are native to Minnesota and these will provide benefits to the environment and people of Minnesota.

Project completed: 6/30/2016

FINAL REPORT (PDF)

Enhancing Timber Sale Program Environmental and Economic Sustainability
Subd. 03i $336,000 TF

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Appropriation Language
$336,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to evaluate the impacts of timber payment methods on postharvest forest ecological conditions and net revenue generated from public timber sale programs. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Minnesota has 9.5 million acres of public forest lands that play an important role in sustaining Minnesota's environment and economy. The policies and programs used by public timber sale programs can impact post-harvest ecological conditions and have pronounced effects on the composition, structure, and productivity of the forest in the future. Additionally, timber harvesting revenues play an important role in economic activity, employment, and tax revenue. Currently, timber on public lands is sold in of two ways: pay based on volume harvested and pay based on appraised volume available for harvest, regardless of the actual harvest. Scientists at the University of Minnesota are using this appropriation to evaluate how timber payment methods impact post-harvest forest ecological conditions, net revenue generated from public timber sale programs, and barriers perceived by forest managers and loggers. This information will help gauge economic and ecological tradeoffs between the two methods in order to maximize future forest productivity, wildlife habitat, and biodiversity.

OVERALL PROJECT OUTCOME AND RESULTS
The method used by a timber sale program to collect payment for timber sold was perceived by land managers and others to have a substantial impact on post-harvest ecological conditions and net timber sale revenue. The two payment methods used are consumer scale (scale) and lump sum. Under the scale method, the buyer only pays for timber that has been harvested and scaled by a qualified scaler.

With this method, the seller tracks harvested volume using scale tickets which require administrative time to process. The lump sum method requires the buyer to pay a fixed amount for the timber, regardless of the timber volume actually harvested.

Our study goals were to evaluate how the two timber payment methods: a) impact post-harvest ecological conditions; b) impact the cost-effectiveness within Minnesota's public timber sale programs; and c) are perceived by natural resource managers and loggers. To accomplish these study goals, we collected data from post-harvest sites, reviewed agency records, conducted a field economic experiment using a timber sale auction, conducted time studies, administered a mail survey, and conducted interviews and focus groups.

We found that the perceptions of ecological and economic impacts of timber payment method often exceed actual impact. Timber payment method did not impact post-harvest ecological conditions, gross stumpage revenue or stumpage price bids. Numerous factors (e.g., pre-harvest operator conditions, operator) had a greater impact on post-harvest ecological conditions than payment method. A strong biomass market could increase utilization and thus post-harvest ecological conditions under a lump sum method. The impact of using the consumer scale method on net timber sale revenue is less than one percent of the timber sale's value. Logging business owners participating in the study ranked timber payment method lower in importance than other factors when bidding on a sale. As each payment method has its strengths and weaknesses (see table below), agencies need the flexibility to select the approach which best meet their needs.

Summary of factors favoring use of scale and lump sum payment methods.

Factors favoring scale method	Factors favoring lump sum method
1) Less administrative time and accuracy needed to estimate sale volume	1) Less time needed to administer active timber sale and to process paperwork and other related documents
2) Appraisal staff have low probability of accurately estimating sale volume and value	2) Facilitates simultaneously administering several timber sales
3) Timber sales with a high percentage of low value timber and/or where operating costs are expected to be high	3) Fewer personnel required for timber sale
4) More woody material may be retained on-site for wildlife purposes	4) High utilization can facilitate manual reforestation efforts
5) Salvage timber sales	5) Timber sale has uniform characteristics (e.g., pine plantation)

PROJECT RESULTS USE AND DISSEMINATION

Project cooperator meetings were conducted annually to discuss upcoming areas of focus, data and methods, and to present results to date. Semi-annual project summary reports submitted to LCCMR were shared with all project cooperators. During the March 24, 2016 project cooperator meeting in Willow River, final results from all project components were presented during a highly interactive session and four one-page fact sheets were distributed. Participants at that March 2016 meeting were so interested in the study results that they suggested and helped arrange additional presentations to the Minnesota Association of County Land Commissioners (June 9, 2016) and the Minnesota Forest Resources Partnership (June 23, 2016). Additional project outreach included a meeting with the DNR

Forest Operations and Management Section in 2014, four papers and presentations at the Council on Forest Engineering annual meetings in 2014 and 2015, a seminar presented during the 2015 International Symposium for Society and Resource Management, three seminars to University of Minnesota graduate students and faculty, and a poster presented during the 2015 Society of American Foresters Annual Meeting. Three graduate students completed M.S. theses on their work in this project. Two University of Minnesota, Department of Forest Resources Staff Papers were produced. Everyone who participated in the Activity 2 mail survey was sent an electronic summary letter with instructions for how to receive the full report. At least two manuscripts are being prepared for peer-review journals and will be submitted after project completion.

Project completed: 6/30/2016

FINAL REPORT (PDF)

Enhancing Environmental and Economic Benefits of Woodland Grazing
Subd. 03j $190,000 TF

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RESEARCH

Appropriation Language
$190,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to evaluate management options for woodlands used for grazing to improve ecological and economic benefits. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Over 527,000 acres of unmanaged woodlands are being used for livestock grazing throughout Minnesota. Managing these grazed woodlands based on the use of best management practices can provide environmental and economic opportunities, including improved water quality, maximized forage production, and higher-quality timber. The best management practices involved are commonly used in other parts of the country with other types of ecosystems, but have not been widely adopted in Minnesota due to a lack of knowledge and experience with implementing them within the ecosystems of Minnesota. This appropriation is being used by scientists at the University of Minnesota to evaluate and demonstrate how to effectively adapt and implement these best management practices for improved woodland grazing for use in Minnesota.

OVERALL PROJECT OUTCOME AND RESULTS
Over 527,000 acres of unmanaged woodlands are being used for livestock grazing throughout Minnesota. Managing these grazed woodlands based on the use of best management practices can

provide environmental and economic opportunities, including improved water quality, maximized forage production, and higher-quality timber. The best management practices involved are commonly used in other parts of the country with other types of ecosystems, but have not been widely adopted in Minnesota due to a lack of knowledge and experience with implementing them within the ecosystems of Minnesota. This appropriation is being used by scientists at the University of Minnesota to evaluate and demonstrate how to effectively adapt and implement these best management practices for improved woodland grazing for use in Minnesota.

PROJECT RESULTS USE AND DISSEMINATION

Over 527,000 acres of unmanaged woodlands are being used for livestock grazing throughout Minnesota. Managing these grazed woodlands based on the use of best management practices can provide environmental and economic opportunities, including improved water quality, maximized forage production, and higher-quality timber. The best management practices involved are commonly used in other parts of the country with other types of ecosystems, but have not been widely adopted in Minnesota due to a lack of knowledge and experience with implementing them within the ecosystems of Minnesota. This appropriation is being used by scientists at the University of Minnesota to evaluate and demonstrate how to effectively adapt and implement these best management practices for improved woodland grazing for use in Minnesota.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Silvopasture: Establishment and Management Principles for Northern Hardwood Forests in Minnesota and the North Central United States (PDF)

Subd. 04 Land, Habitat, Restoration and Recreation

State Parks and State Trails Land Acquisition
Subd. 04a $1,000,000 TF

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Appropriation Language
$1,000,000 the first year is from the trust fund to the commissioner of natural resources to acquire 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, 2016, by which time the project must be completed and final products delivered.

Project Overview

Minnesota's extensive state park and trail system, the second oldest in the country, is currently comprised of a total of 76 state parks and recreation areas and 13 state trails scattered throughout the state. Some of Minnesota's state parks and trails have privately owned lands within the designated park boundaries or trail corridors. Purchase of these lands from willing landowners for addition to the state park and trail system makes them permanently available for public recreation and enjoyment and facilitates more efficient management. Additional benefits include preserving contiguous wildlife corridors, facilitating preservation and restoration of native plant communities and cultural resources, reducing impacts of future development, and providing riparian buffers along wetlands, creeks, and lakes. The Minnesota Department of Natural Resources is using this appropriation to fund the acquisition of approximately 245 acres to add to the state park and trail system, which includes:

- 50 acres for Great River Bluffs State Park in Winona County
- 115 acres for Cuyuna Country State Recreation Area in Crow County
- 80 acres for the Mill Towns State Trail in Rice County

OVERALL PROJECT OUTCOME AND RESULTS
Minnesota Environment and Natural Resources Trust Fund funding resulted in the Department of Natural Resources acquiring approximately 103 acres of land within the statutory boundaries of two Minnesota State Parks and one Minnesota State Trail.

- Acquired approximately 29 acres in Frontenac State Park comprised Lowland forested wetlands with a small stream and exposed dolomite bluff face partially covered with a mix of native prairie and some upland trees.
- Acquired approximately 8 acres of an entire island located within the new Lake Vermilion-Soudan Underground Mine State Park. This acquisition preserves unique island habitat, viewshed and enhances outdoor recreation opportunities such as canoe campsite and a new day use area.
- Partially funded the acquisition of approximately 66 acres of land for Mill Towns State Trail to preserve and protect ~6 miles of a former railroad corridor for future development of the legislatively authorized trail that will eventually connect cities of Faribault and Dundas.

PROJECT RESULTS USE AND DISSEMINATION
These project results and dissemination have been communicated through updated state park and state trail maps reflecting state managed land instead of private in-holdings, and are identified as public land open to be used and enjoyed by all visitors.

A news release promoting the recent acquisition for the Mill Towns State Trail is scheduled for July 2016, and credits Minnesota Environment and Natural Resources Trust Fund as a partial funding source.

Signage at the above listed locations lists ENRTF as a funding source for these State Parks or State Trails.

Project completed: 6/30/2016

FINAL REPORT (PDF)

Scientific and Natural Areas Restoration, Enhancement and Citizen Engagement
Subd. 04b $1,500,000 TF

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Appropriation Language
$1,500,000 the first year is from the trust fund to the commissioner of natural resources to conserve sites of biodiversity significance by restoring and enhancing lands established as scientific and natural areas as provided in Minnesota Statutes, section 86A.05, subdivision 5, and providing volunteer engagement and outreach. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Minnesota's Scientific and Natural Areas (SNA) Program is an effort to preserve and perpetuate the state's ecological diversity and ensure that no single rare feature is lost from any region of the state. This includes landforms, fossil remains, plant and animal communities, rare and endangered species, and other unique biotic or geological features. These sites play an important role in scientific study, public education, and outdoor recreation. The Minnesota Department of Natural Resources is using this appropriation to conduct restoration and enhancement activities on approximately 1,600 acres in existing SNAs and to increase citizen and student knowledge and skills pertaining to ecological restoration and biodiversity conservation through engagement with SNAs.

OVERALL PROJECT OUTCOME AND RESULTS
Habitat restoration and enhancement actions increased the quality of habitat on more than 1500 acres of designated Scientific and Natural Areas (SNAs) through achieving: restoration of about 235 acres at 4 SNAs; woody invasive species control on 371 acres at 49 SNAs, herbaceous invasive species treatment on 266 acres at 44 SNAs, and installation of invasive species control boot brush kiosks at 5 SNAs; about 26 miles of burn breaks at 24 SNAs and completion of 720 acres of prescribed burns at 25 SNAs and 141 acres of prescribed haying at 7 SNAs; and site development work (e.g. entry and boundary signs, new gates, and site cleanup) at over 50 SNAs. Conservation Corps Minnesota was involved in 42 of these projects. Adaptive Management Plans have been completed for 19 SNAs. Ecological monitoring has been completed at 7 SNAs; including monitoring of snakes at an SNA which is yielding new information that will inform natural resource management work.

The public's and youth involvement in SNAs and their knowledge and skills about biodiversity conservation has significantly increased through the SNA Outreach Initiative in its second phase through this appropriation. As of September 2015: the SNA Facebook page reached over 34,000 people with over 1500 likes of the page and the quarterly SNA e-newsletter Nature Notes reached over 3,250 subscribers. From January 2014 through June 2015, about 170 SNA events were held involving over 1550 people and volunteer site stewards were helping monitor and care for 128 or 80% of SNAs. The statewide color map locating all SNAs was updated and 5000 copies of this second addition were printed.

PROJECT RESULTS USE AND DISSEMINATION

Dissemination is primarily achieved through the upgraded SNA webpage on the DNR website: http://www.mndnr.gov/snas and through other electronic/social media which are linked through this webpage. With support through this funding, the SNA Facebook page was launched in February 2014; the SNA Facebook page has achieved over 1,500 page likes and total monthly reach of over 34,000 by March 2015. The 11th (Winter 2014) issue of the Nature Notes e-newsletter was delivered to over 3,250 subscribers. The statewide color map locating all SNAs (with directions to all sites and ENRTF acknowledgement on the back) was updated and 5000 copies of this second addition were printed and nearly all have been distributed.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Restoration Evaluations (PDF)
Outreach (PDF)

Native Prairie Stewardship and Prairie Bank Easement Acquisition
Subd. 04c $750,000 TF

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Appropriation Language
$750,000 the first year is from the trust fund to the commissioner of natural resources to acquire native prairie bank easements, prepare baseline property assessments, restore and enhance native prairie sites, and provide technical assistance to landowners. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Prior to European settlement more than 18 million acres of prairie covered Minnesota. Today less than 1% of that native prairie remains, and about half of those remaining acres are in private landownership without any formal protection currently in place. Through this appropriation the Minnesota Department of Natural Resources will work with private landowners of high quality native prairie sites to protect remaining native prairie using a variety of tools. Approximately 200 acres are expected to be permanently protected through Native Prairie Bank conservation easements. A variety of restoration and enhancement activities will be implemented on a total of about 690 acres. Additionally, education and technical assistance will be provided to interested landowners to help them improve the management and stewardship of native prairie sites they own.

OVERALL PROJECT OUTCOME AND RESULTS
Native Prairie Bank (NPB) conservation easements were acquired on 330 acres thereby permanently protecting valuable native prairie. Specifically, 3 easements were acquired in part with this appropriation located in Wilkin, Traverse and Big Stone Counties (194 acres pro-rated to this

appropriation). In total, 12 baseline property reports were written through this appropriation (including 2 of the 3 newly acquired easement baselines). In addition to baseline reports, 16 existing Native Prairie Bank easements were monitored and data entered into the Department of Natural Resource (DNR)'s Conservation Easement Monitoring database.

Restoration and enhancement activities were completed on a total of over 850 acres exceeding the project's target acreage. Specific accomplishments are 18 prescribed burns on 702 acres, 4 prairie reconstructions on 6 acres, and 21 invasive species control projects on 147 acres; 9 of these 43 projects involved Conservation Corps Minnesota (CCM) crews. Boundary signing has been completed on 5 NPB easements.

Through this appropriation, 9 different events were held aimed at getting prairie stewardship information to landowners. NPB staff also worked with all 10 Prairie Conservation Plan Local Technical Teams to insure that landowners being approached by other practitioners are made aware of their prairie stewardship options such as Native Prairie Bank that are available through the Scientific and Natural Area (SNA) Program. Prairie specialists engaged 70+ different priority prairie landowners one-on-one to discuss prairie protection and management options for their property. One landowner received a comprehensive Prairie Stewardship plan.

PROJECT RESULTS USE AND DISSEMINATION
Native Prairie Tax Exemption brochures were updated and printed to aid in prairie outreach, encourage prairie preservation and improve prairie stewardship of native prairie acres that may not be protected long-term by other means. A .pdf copy of this brochure is included with the final report and a paper copy can be made available upon request. A total of 3000 Prairie Tax Exemption brochures were printed, 1000 of which were paid for through this appropriation.

Additionally, included with the final report is an article written about a landowner technical assistance success story. This article was written to promote the technical assistance available to private land prairie landowners through this appropriation and encourage pro-active prairie land management. An abbreviated version of this story was shared in the SNA Nature Notes which is published quarterly and distributed to over 3,250 subscribers. One Prairie Stewardship Plan was completed and is being followed by the landowner.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Restoration Evaluations (PDF)

Metropolitan Conservation Corridors (MeCC) - Phase VII
Subd. 04d $2,000,000 TF

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Appropriation Language

$2,000,000 the first year is from the trust fund for the acceleration of agency programs and cooperative agreements. Of this appropriation, $10,000 is to the commissioner of natural resources for agency programs and $1,990,000 is to the commissioner of natural resources for agreements as follows: $304,000 with Friends of the Mississippi River; $368,000 with Dakota County; $208,000 with Great River Greening; $310,000 with Minnesota Land Trust; $400,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $400,000 with the Trust for Public Land for planning, restoring, and protecting priority natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through contracted services, technical assistance, conservation easements, and fee title acquisition. 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 for the purchase of habitable residential structures, unless expressly approved in the work plan. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work plan. Lands that would require payments in lieu of taxes under Minnesota Statutes, section 97A.061 or 477A.12, shall not be acquired with money from this appropriation. Up to $54,000 is for use by Minnesota Land Trust in a monitoring and enforcement fund as approved in the work plan and subject to subdivision 16. An entity that acquires a conservation easement with appropriations from the trust fund must have a long-term stewardship plan for the easement and a fund established for monitoring and enforcing the agreement. Money appropriated from the trust fund for easement acquisition may be used to establish a monitoring, management, and enforcement fund as approved in the work plan. An annual financial report is required for any monitoring, management, and enforcement fund established, including expenditures from the fund. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

OVERALL PROJECT OVERVIEW

Though many parts of the Twin Cities metropolitan area are urbanized, there are also has large areas of natural lands that continue to serve as important habitat for fish, wildlife, and plant communities. However, pressure on these remaining lands continues to intensify as population and development pressures increase. This appropriation represents the seventh phase of an ongoing effort by a partnership of state and non-profit organizations, called the Metro Conservation Corridors (MeCC) partnership, to conduct strategic and coordinated land protection, restoration, and enhancement activities that build connections between remaining high quality natural areas in the greater Twin Cities metropolitan area and ensures their benefits are available for future generations. Efforts will strengthen and protect biodiversity; improve water quality in lakes, rivers, and streams; and improve connectivity and access to outdoor recreation. This phase involves six partners and is expected to result in the permanent protection of more than 260 acres and the restoration and enhancement of more than 260 acres. Organizations involved in this phase include Dakota County, Friends of the Mississippi River, Great River Greening, Minnesota Land Trust, MN Valley National Wildlife Refuge Trust, and Trust for Public Land.

Individual Partner Project Overviews

- *1.1/1.2: Coordination and Mapping - Minnesota Land Trust ($20,000)*
  The Minnesota Land Trust provides coordination, mapping, and data management for the Metropolitan Conservation Corridors partnership. Funds are being used to coordinate the partnership, guide strategic outreach and implementation efforts, manage project data, and provide reporting and mapping of accomplishments.
- *2.1 & 3.4: Protect, Restore and Enhance Significant Watershed Habitat - Friends of the Mississippi River ($304,000)*
  Friends of the Mississippi is using this appropriation to permanently protect six acres through fee title acquisition for addition to Fish Creek Natural Area near Maplewood, MN, and to restore and enhance approximately 134 acres of permanently protected prairie, savanna, wetland, and forest habitat in Dakota, Washington, Ramsey, and Hennepin counties. Specific restoration and enhancement activities will include updating management plans, soil preparation, prescribed burning, native vegetation installation, woody encroachment removal, and invasive species control.
- *2.3: Restoring Our Lands and Waters - Great River Greening ($208,000)*
  These funds will enable Great River Greening to restore approximately 90 acres of permanently protected forests, savanna, prairie, and wetland habitat and 0.18 miles of shoreland habitat while engaging hundreds of volunteers in the stewardship of the Metropolitan area's remaining natural areas. Specific activities include invasive species control, seeding/planting, prescribed burning, and other associated activities.
- *2.6 & 3.7: Dakota County Lakeshore and Riparian Protection - Dakota County ($368,000)*
  Through this appropriation Dakota County plans to permanently protect approximately 27 acres of shoreland and contiguous upland in the Marcott Lakes area of Inver Grove Heights by securing a conservation easement from willing landowner. For all acres protected, natural resource management plans will be prepared to ensure their long term stewardship. Additionally, restoration and enhancement activities are expected to occur on approximately 40 acres.
- *3.1: 2013 TPLs Critical Land Protection Program - Trust for Public Land ($400,000)*
  The Trust for Public Land is using this appropriation to purchase approximately 24 acres of land and 0.2 miles of shoreline with high ecological value and then convey the land to state or local governments for long-term stewardship and protection. Lands being considered for permanent protection in this round of funding include an areas around the Rum River in Anoka County, Lindstrom Natural Area in Chisago County, and Carnelian Creek and Keystone Woods area in Washington County.
- *3.2: Protect Signifcant Habitat by Acquiring Conservation Easements - Minnesota Land Trust ($300,000)*
  With this appropriation, the Minnesota Land Trust plans to protect 100 acres of high quality forest, prairie, wetland, or shoreline habitat by securing permanent conservation easements and dedicating funds for their perpetual monitoring, management, and enforcement. Lands being considered for permanent protection in this round of funding are located in Chisago, Goodhue, Hennepin, Isanti, and Washington counties.
- *3.3: Priority Expansion of Minnesota Valley National Wildlife Refuge - Minnesota Valley National Wildlife Refuge Trust Inc. ($400,000)*
  The Minnesota Valley National Wildlife Refuge Trust is using this appropriation to purchase a total of approximately 100 acres of land and donated to the U.S. Fish and Wildlife Service to expand the Minnesota Valley National Wildlife Refuge. Many benefits are anticipated from this

project, including improved habitat connectivity, protection of native species, improved water quality in the Minnesota River, and increased public access to natural lands for activities such as hiking, hunting, and fishing. Restoration and management plans will be completed for all acquired lands.

OVERALL PROJECT OUTCOME AND RESULTS

Metro Conservation Corridors partners continued their work to accelerate protection and restoration of high-quality natural lands within the greater Twin Cities Metropolitan Area. Six partner organizations participated - Minnesota Land Trust, Friends of the Mississippi River, Dakota County, Great River Greening, Trust for Public Land, and Minnesota Valley National Wildlife Trust. Minnesota Valley National Wildlife Trust received a 1-year extension to their grant and will report their final outcomes separately. Three specific areas of activity were pursued:

1. **Partnership Coordination, Mapping, and Database Management:** An upgrade to the MeCC web-based project database was completed and the MeCC corridor map was revised and posted for public use. Partners met quarterly to review project accomplishments, share information, and to strategically plan and coordinate conservation activities.

2. **Restore and Enhance Significant Habitat:** Partners restored/enhanced 364.5 acres of habitat (282.6 acres through ENRTF) and 0.42 miles of shoreline (0.35 miles ENRTF), exceeding overall proposed outcomes in both areas and leveraging an additional $342,658. Despite the Partnership achieving its collective goals, Dakota County fell short of its habitat restoration/enhancement goal by 75%, returning $17,000 (42%) of its funding for this activity. A landowner with whom they expected to work instead opted to enroll in CRP, ultimately restoring habitat and receiving a payment.

Partner	Proposed (Habitat/Shoreline)	Accomplished Habitat/Shoreline (ENRTF)	Accomplished Habitat/Shoreline (Other)	Expenditures (ENRTF / Other)
Friends of the Mississippi River	134 acres/0 miles	135.5 acres/0 miles	0.0 acres/0 miles	$142,000/$4,546
Great River Greening	90 acres/0.18 miles	137 acres/0.35 miles	73 acres/0.07 miles	$184,270/$315,178
Dakota County	40 acres/0 miles	10.1 acres/0 miles	8.9 acres/0 miles	$22,808/$22,935
Totals	**264 acres/0.18 miles**	**282.6 acres/0.35 miles**	**81.9 acres/0.07 miles**	**$349,078/$342,658**

3. **Acquire Significant Habitat:** Partners protected 308 acres of land (189 acres ENRTF) and 2.5 miles of shoreline (1.25 miles ENRTF) through fee and conservation easement acquisition. This exceeded proposed outcomes for shoreline protection by 625% (0.2 miles proposed vs 1.25 miles achieved), but fell short in acres protected by 28% (189 acres achieved vs 262 proposed). The $1,053,216 from ENRTF leveraged $3,373,183 through other sources.

Two partners turned back funding:

- Minnesota Land Trust was unable to complete an easement due to financial considerations or tax implications of easements on the part of landowners. $251,388 (84% of grant) was returned.

- akota County exceeded its proposed protection goals, but turned back $132,196 (40% of its grant for protection) due to setbacks with two landowners.

The amount of funding returned to the State (33% of total appropriation for protection) is proportional to the shortfall in ENRTF acres protected (28% below goal).

PROJECT RESULTS USE AND DISSEMINATION

Partners publicized accomplishments through a diverse array of press releases, organization newsletters and the internet. Additionally, the MeCC Partnership maintains an interactive public web map that shows the locations of MeCC projects over time. This web map can be directly accessed at: http://www.dnr.state.mn.us/maps/MeCC/mapper.html.

Project completed: 6/30/2016

FINAL REPORT (PDF)

ABSTRACTS AND FINAL REPORTS OF INDIVIDUAL PARTNER PROJECTS (Click project # to go to listing for that project)

- **1.1/1.2** - MeCC VII - Coordination and Mapping - Minnesota Land Trust ($20,000)
- **2.1/3.4** - MeCC VII - Protect, Restore and Enhance Significant Watershed Habitat - Friends of the Mississippi River - Friends of the Mississippi River ($304,000)
- **2.3** - MeCC VII - Restoring Our Lands and Waters - Great River Greening ($208,000)
- **2.6/3.7** - MeCC VII - Dakota County Lakeshore and Riparian Protection - Dakota County ($368,000)
- **3.1** - MeCC VII - 2013 TPL's Critical Land Protection Program - Trust for Public Land ($400,000)
- **3.2** - MeCC VII - Protect Significant Habitat by Acquiring Conservation Easements - Minnesota Land Trust ($300,000)
- **2.6/3.3** - MeCC VI - Priority Expansion and Restoration MN Valley NW Refuge - Minnesota Valley National Wildlife Refuge Trust, Inc. ($400,000)

1.1/1.2 FINAL REPORT - MeCC VII - Coordination and Mapping - Minnesota Land Trust ($20,000)

Project Outcome and Results

In this seventh phase of the Metro Conservation Corridors the partners met quarterly to review project accomplishments, share information related to each respective partner's conservation work across the MeCC program area, and to strategically plan and coordinate conservation activities.

The MeCC web-based project database upgrade work was completed by the DNR during Spring 2016 and made available for partner review, planning, and coordination purposes. Based on partner feedback, the web-based map was revised and was posted for public use which was made available for use in June 2016. The web-based map for public use can be accessed on the DNR's website.

Project Results Use And Dissemination

The MeCC Partnership maintains an interactive public web map that shows the locations of MeCC projects over time. This web map can be directly accessed at: http://www.dnr.state.mn.us/maps/MeCC/mapper.html, while the web-based project database can be accessed by authorized partners at:https://webapps15.dnr.state.mn.us/mecc/.

Project completed: 6/30/2016

2.1/3.4 FINAL REPORT - Metro Conservation Corridors (MeCC) Phase VII-Friends of the Mississippi River. Protect, Restore and Enhance Significant Watershed Habitat - Friends of the Mississippi River ($304,000)

Project Outcome and Results

FMR had three goals for this project: Increase the amount of native habitat, enhance the quality of existing habitat and acquire and permanently protect habitat along the Mississippi River in Maplewood. To approach the first two goals we committed to restoring 10 acres of prairie and enhancing 54-acres of prairie, 10-acres of savanna and 60 acres of forest/woodland for a total of 134 acres improved. We accomplished the goals through the following projects:

- Gelhar-Emrick (Ravenna Township): A 6-acre unit at this property was restored to prairie.
- Pine Bend Bluffs SNA (Inver Grove Heights): A restored prairie and two native bluff prairies were managed for invasive weeds by spot-spraying and burning. Total prairie enhanced: 39
- Old Mill Park (Hastings): This project resulted in 10 acres of enhanced oak savanna.
- Ravenna Block (Ravenna Township): A total of 5 acres of a previously installed prairie was managed for the initial two-year establishment period (mowing, spot-treat weeds). 34 acres of forest were managed for invasive woody plants (cut and stump-treat, fall foliar treatment).
- Spring Lake Park Reserve (Rosemount): Prairie was installed in a 17.5-acre old field.
  Heritage Village Park (Inver Grove Heights) : We controlled invasive weeds and seeded native prairie/savanna species on 2 acres of woodland and 7 acres of savanna.
- Mississippi River Gorge (Minneapolis): 7 acres of woodland were enhanced by controlling invasive woody plants.
- Gateway North Open Space Area (Cottage Grove): 6 acres if woodland were enhanced by controlling woody invasive species.
- River Oaks Park (Cottage Grove): Controlled woody and herbaceous plants on an acre each of prairie and woodland.

Project totals: 23.5 acres of prairie installed/restored and 45 acres of existing prairie, 17 acres of savanna and 50 acres of forest/woodland were enhanced for a total of 135.5 acres of habitat improved. The third goal was accomplished by acquiring 6 acres of bluffland habitat in the Fish Creek Natural area, Maplewood.

Project Results Use And Dissemination

Information about this project was disseminated in several ways. FMR published articles about the site specific projects in our traditional newsletter and in our electronic newsletter. Articles could also be found on our website. An article about the Fish Creek acquisition appeared in the St. Paul Pioneer Press and in the Minneapolis Star Tribune. We often organize volunteer events for our project sites and we share information with our participants.

Project completed: 6/30/2016

2.3 FINAL REPORT - MeCC VII - Restoring Our Lands and Waters - Great River Greening ($208,000)

Project Outcome and Results

Along with partners and volunteers, Greening undertook restoration projects to reduce habitat fragmentation, enhance habitat quality, reconnect habitat corridors, and build connections with local communities. Habitats included prairie, oak savanna, woodland, wetland, and riparian. Significantly exceeding all of our goals, we:

1. restored/enhanced 141 acres of upland habitat and an additional 77 acres with leveraged non-state funds for a total of 218 acres,
2. restored/enhanced 0.35 mile of shoreland habitat and an additional 0.08 mile using leveraged non-state funds for a total of 0.42 miles ,

3. engaged over 1750 (>500 youth) volunteers in meaningful parts of these projects
4. leveraged $315,178 in non-state funds

Table 1: Summary of Deliverables by Parcel

Parcel Name	City	County	Acres	Shoreline (mi)	Volunteers
Trout Brook Nature Preserve	St. Paul	Ramsey	7		882
Long Pond Elk Ranch II	Princeton	Sherburne	3		-
Doyle-Kennefick Regional Park	Elko	Scott	10		142
Katherine Abbott Park I	Mahtomedi	Washington	19		313
Wild & Scenic Rivers II - Rum	Cambridge	Isanti	1	0.15	-
Pilot Knob Hill III	Mendota Heights	Dakota	1		24
Cedar Creek Conservation Area	Oak Grove	Anoka	67		-
Central Corridor II and III	Woodbury / Cottage Grove	Washington	6		337
Spring Lake Regional Park III	Cedar Lake Twsp	Scott	20		-
Arcola Mills Maintenance	May Township	Washington	-		-
Cedar Lake Farm Regional Park	New Prague	Scott	3	0.20	-
Dodge Nature Center Lilly Preserve	Mendota Heights	Dakota	4		63
TOTALS			**141**	**0.35**	**1,761**

Sites hosted five documented rare species (2 plants, 3 vertebrates), and three native plant communities with biodiversity of statewide significance.

We restored and de-fragmented habitat in ecological corridors, and at several ecological cores. Restorations protected water quality along the Mississippi River and the Rum River and its watershed.

Volunteers planted over 4,500 trees/shrubs and 5,600 forb/grass plugs, and received presentations from a Greening ecologist as part of their workday.

Project Results Use And Dissemination

Volunteer event descriptions acknowledging Trust Fund contributions and qualitative results were emailed to Greening's e-subscribers in July 2013, Feb 2014, July 2014, February 2015, July 2015, and

spring 2016 in advance of our spring and fall volunteer event seasons. Over the course of the grants, the number of subscribers increased from approximately 5,000 to about 6,500. Information about the Metro Conservation Corridors is on our website in the Initiatives and Volunteer Events sections at http://www.greatrivergreening.org/. Over the course of the grant, the visits to the Greening website increased from over 1,200 to over 1,500 visits per month. Seven press articles disseminated information about the projects. Greening is in active partnership with landowners, other land managers, service providers, conservation peers, and volunteers resulting in a dynamic and timely exchange of information and results.

Project completed: 6/30/2016

2.1/3.4 FINAL REPORT - MeCC7: Dakota County Lakeshore and Riparian Protection - Dakota County ($368,000)

Project Outcome and Results

The project goal was to acquire permanent conservation easements or land along rivers, streams, and undeveloped lakeshore in Dakota County; prepare Natural Resource Management Plans (NRMPs) for conservation easements; and restore/enhance protected land. The project scope encompassed some of the best natural resource features found in the metropolitan region. A sound fiscal and ecological conservation approach was taken, while attempting to balance the interests, rights and responsibilities of private landowners, with public concerns about water, wildlife habitat, outdoor recreation, and climate change.

In November 2011, Dakota County adopted a comprehensive Land Conservation Vision that includes establishing permanent vegetative buffers along all rivers, streams and undeveloped lakeshore, and protecting quality natural areas. The County's land conservation programs targeted specific areas in the County and mailings were issued to determine landowner interest. Program applications were reviewed and evaluated using County Board-approved criteria; and top-ranking projects were considered for permanent protection. Appraisals were conducted for recommended projects. NRMPs and baseline Property Reports were prepared for projects where landowners accepted purchase offers; and landowners agreed to cash or in-kind restoration and management contributions. Restoration projects were also completed on existing easement and fee title properties.

The project goals were to acquire an estimated five permanent conservation easements and one fee title property, totaling 235 acres, and restoring/enhancing 40 acres of protected land. In spite of significant County efforts, a wide variety of issues prevented projects from being completed. Landowner inflated value expectations, lack of family agreement to move forward, and inability to make timely decisions delayed and derailed projects. Subsequently, the County didn't meet its acquisition goals, but exceeded its restoration goals, and overall, accomplished the following:

Project Name	Acres	Miles of Shoreline	Ecological Significance	Activity Description	ENRTF Cost
Cemstone	61.7	1.7	Designated trout stream area on Vermillion River	Fee title acquisition	$104,932
Ruppe	17.2	0.5	Chub Creek riparian area	Easement acquisition	$25,450
Schweich	20.7	0.3	Chub Creek riparian area/upland	Easement acquisition	$60,400

Cemstone	19	1.7	Designated trout stream riparian area/upland	Initial site preparation, seeding and first phase restoration of formerly cultivated and disturbed areas	$4,845
Malecha	27	0.9	Wetland restoration	Wetland berm construction and initial seeding	$6,000
Ruppe	NA	0.5	Chub Creek riparian area	Natural Resource Management Plan (NRMP) completed	$5,625
Schweich	15	0.3	Chub Creek riparian area, and formerly cultivated upland area	NRMP completed and buffer seeded	$4,238 (NRMP only)

Project Results Use And Dissemination

Information about the specific projects funded through this State appropriation is integrated with information about the County's comprehensive land conservation efforts that were initiated in 1998, with a farmland and natural areas protection plan partially funded by the Environment and Natural Resources Trust Fund. Implementation of the initial plan and subsequent revisions resulted in the permanent protection of 11,244 acres of natural areas and agricultural land and over 51 miles of shoreland outside of the regional park and greenway system. This project informed and improved internal and external County land conservation practices, procedures and policies. County staff has provided numerous local, regional and national presentations about how Dakota County has developed and implemented its successful programs. Information has appeared on TV and radio, as well as metropolitan newspapers and residential newsletters. Information can also be found on the County's web site at: https://www.co.dakota.mn.us/Environment/LandConservation/Pages/default.aspx.

Project completed: 6/30/2016

3.2 FINAL REPORT - MeCC VII - 3.2 - Protect Significant Habitat by Acquiring Conservation Easements - Minnesota Land Trust ($300,000)

Project Outcome and Results

In this seventh phase of the Metro Conservation Corridors, the Minnesota Land Trust (Land Trust) sought to protect 100 acres of critical habitat through conservation easements within designated Metro conservation corridors. To facilitate this outcome, the Land Trust implemented an RFP process (a revision of the MMAPLE framework developed for the ENRTF-funded Avon Hills program in Stearns County) to solicit bids from interested landowners within areas of high biological value targeted for the program. A framework for scoring and prioritizing bids was developed for the Metro Corridors program that placed emphasis on a set of ecological criteria (size of habitat to be protected, condition of the habitat, ecological/protection context within which the parcel lies, and threat) and cost. Along with their proposal for inclusion into the program, landowners identified the funding level necessary for their participation.

The Land Trust utilized an array of strategies to effectively target landowners within priority areas,

ranging from direct mail to face-to-face meetings and web-based methods (Facebook and web postings). Anoka and Washington Conservation Districts were contracted to engage local landowners within priority areas. Anoka Conservation District (ACD) sent 17 mailings out to landowners of high priority properties within the Rum River Watershed. Washington Conservation District utilized both GIS-generated mail merge and direct contact to reach 100 landowners. The Land Trust also sent out targeted mailings to 26 landowners of property meeting criteria for the program elsewhere in the Metro.

Twelve bids were received and ranked relative to the established criteria; three projects were identified as highest priority for the program. These landowners were engaged in easement negotiations but eventually declined to continue forward due to financial considerations, specifically low appraised land values (relative to landowner expectations/desires) and tax implications for the landowner. As a result, no conservation easements were procured through this grant.

Project Results Use And Dissemination
The Land Trust developed partnerships with local conservation partners (Anoka and Washington Conservation Districts) to conduct targeted landowner outreach in priority geographies to identify interested landowners. Outreach materials, including program fact sheets and application materials, were developed and shared with local partners and or were direct-mailed to landowners by the Land Trust. In addition, the Land Trust marketed the easement program and RFP process through social media and on its web site. Over 140 landowners were reached via direct mail or through face-to-face meetings, and an unknown number of individuals were reached through our web-based media. Though no easements were completed from which to disseminate results, the time invested in outreach through local partnerships provides a strong foundation from which to continue protection efforts in the Conservation Corridors area.

Project completed: 6/30/2016

Landscape Arboretum Acquisition Lake Tamarack
Subd. 04e $2,000,000 TF

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Appropriation Language
$2,000,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to acquire land surrounding Lake Tamarack in Carver County as part of the acquisition of approximately 80 acres. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
The University of Minnesota's Landscape Arboretum is the largest and most diverse horticultural site in

Minnesota. It features gardens and natural areas representative of Minnesota and the upper-Midwest that can be explored using several miles of trails. Additionally it conducts fruit and plant breeding research to develop cultivars that have particular desired characteristics, such as cold hardiness or disease resistance. The arboretum has a long-term goal of protecting the entire watershed of which it is a part. This appropriation is being used by the arboretum to acquire approximately 80 acres of land surrounding Lake Tamarack in Carver County, which will protect a variety of habitat types and 1,300 feet of shoreline in an area threatened by development. This new portion of the arboretum will have free public access and provide additional land for future research that may pertain to restoration ecology, crop production, bio-energy, or wildlife habitat.

OVERALL PROJECT OUTCOME AND RESULTS

The University of Minnesota Landscape Arboretum purchased the property at 400 Arboretum Boulevard, Victoria, (previously known as the Kerber Farm or Lano Burau Property), effective Friday, November 1, 2013. The property consists of 78.13 acres in Carver County. This is the final property purchase identified in the Arboretum's 1995 Boundaries Plan. Over 300 acres have been added to the Arboretum during the last 18 years.

The property is north of State Highway 5 and directly adjacent to the Horticultural Research Center. The property contains native forest, wetlands, tillable land, and 1,300 feet of lakeshore on Lake Tamarack. Current structures on the property will be evaluated for condition and safety and some will likely be retained for unheated storage while others may be demolished.

The property will be used in the future for research; protection of wildlife, wetlands and water quality; protection of big woods, oak savanna and upland meadow; and educational and public low impact recreational purposes. Research uses have not been determined and roads, fencing, and irrigation will be installed in the 10 acre area designated for research. Some of the current soybean fields could also be used for alternative crop, forage crop, or restoration research projects, and the Arboretum is considering partners from across the University of Minnesota or other conservation and natural resources groups.

Funding for this purchase was provided by the Environment and Natural Resources Trust Fund (ENRTF) - recommended by the Legislative Citizens Commission for Minnesota Resources (LCCMR), the Lessard Sams Outdoor Heritage Council (LSOHC) and the Minnesota Landscape Arboretum Foundation. Because we received LCCMR and LSOHC funding to purchase the property, the Arboretum will provide FREE public access. The University of Minnesota is charging the City of Victoria $1 for the 50 year Use License Agreement for the Trail that crosses the Lake Tamarack Property and $1 for the Use License Agreement for Temporary Construction Access for this trail. There are no fees beyond the $2 for the entire trail including the sections that do not cross the Lake Tamarack Property. Finally, the Arboretum will work over the next several months to develop public access policies and install signage.

PROJECT RESULTS USE AND DISSEMINATION

The acquisition was successfully publicized by the Arboretum with a press release issued on November 11, 2013 and was also covered in the Arboretum E-News with 10,000 subscribers. It was then covered in the local media:

- U to expand arboretum with 78-acre purchase, Minnesota Daily, January 28, 2013
- U Arboretum expands base in Chanhassen by 78 acres, Star Tribune, November 12, 2013
- Minnesota Landscape Arboretum grows by 78 acres, Finance & Commerce, November 13, 2013

- Minnesota Landscape Arboretum Grows By 78 Acres, WCCO-CBS News Online, November 13, 2013

Project completed: 6/30/2014

FINAL REPORT

Conservation Program Technical Assistance
Subd. 04f $3,000,000 TF

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Appropriation Language
$3,000,000 the first year is from the trust fund to the Board of Water and Soil Resources to continue providing grants to soil and water conservation districts and other units of local and state government for the employment of staff to reenroll expiring lands into programs for conservation purposes. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Enrollment of private lands in conservation programs can provide important natural resource and other public benefits by taking the lands out of production so that they can provide various wildlife, water quality, and ecological benefits. This appropriation is enabling the Minnesota Board of Soil and Water Resources to continue to provide grants to local soil and water conservation districts for employment of technical staff to assist private landowners in implementing conservation programs. This effort is expected to assist with the enrollment, retention, and management of 170,000 private acres of grasslands, wetlands, and forests in federal and state conservation programs, particularly in areas expected to lose enrollments in the Conservation Reserve Program (CRP).

OVERALL PROJECT OUTCOME AND RESULTS
During this project a total of 42,474 private landowner contacts were made resulting in 8,235 contracts on 160,258 acres of land positively impacted (restored, enhanced or managed) with grassland and wetland programs. A contact is defined as a personal interaction between the Farm Bill Assistance Partnership (FBAP) staffer and a landowner. It may be a phone conversation discussing program benefits and opportunities, office visit to review plan documents or an in-field visit to stake out a practice. In order for a contract to be completed it takes several contacts to move a landowner through the process, once again demonstrating the value of these positions.

Program	CCRP *	CCRP *	CCRP *	CCRP *	General	Other local, state and federal **

Type	Filter Strips	Riparian Buffers	Wetlands	Windbreaks	**General CRP** Gen. Erosion and water quality	**CRP and CCRP** Mgt. Activities to sustain site	Various conservation concerns	Total
Contracts	2,002	355	1,829	510	237	1,180	2,122	8,235
Acres	14,044	4,235	71,265	1,335	3,817	22,091	43,471	160,258

89,544 acres of this total were critical wetland and riparian CRP contracts and this exceeded our goal of 80,000 acres. With this project, targeted local outreach, enrollment and implementation has occurred which directly led to the project accomplishments.

The primary environmental benefits tied to the land use conversion from row crops to perennial vegetation due to CRP and other programs, includes the reduction of sediment and nutrient pollutants to water bodies as well as increased habitat for resident and migratory species.

The new Federal Farm Bill reduced the national CRP acreage limit and drastically curtailed General CRP sign-ups and encouraged more focused Continuous CRP (CCRP). This allowed local staff hired through this project to assist landowners who wanted to focus on CCRP, management of existing CRP contracts to optimize the environmental benefits as well as other programs to reach the goals of this project. Due to these facts local staff were still able to accomplish 94% of the overall acreage goal for the project (160,258 acres compared to 170,000 goal).

This project is built upon the framework of a multi partner group called the Farm Bill Assistance Partnership (FBAP) created in 2002 to accelerate private lands conservation program implementation. Emphasis is on the maximum use of federal and state conservation programs to retain and restore grasslands and wetlands on private lands primarily in the agricultural region of MN. At the core of the project is the hiring of Soil and Water Conservation District (SWCD) or Pheasants Forever (PF) staff to engage and lead landowners through conservation practice enrollment and implementation. At the close of this project there were 47 counties participating with 30.40 full time staff equivalents hired (18 SWCD and 12 PF employees housed in SWCD offices).

This $3M ENTRF funded project was leveraged with $873,737 of local and non ENTRF funds to bring the grand total for the project to nearly $3.9M.

PROJECT RESULTS USE AND DISSEMINATION

The work of this project, past, present and future is tracked as part of the MN Conservation Lands Summary. This document is the only accounting of our collective private and public conservation estate here in MN. As CRP comes and goes and as we add permanently protected lands it is imperative that we have a foundation of our conservation estate. This report is updated annually and is posted on the BWSR web site at http://www.bwsr.state.mn.us/easements/CLS%20Statewide%20Summary%20August%2013%202015.pdf.

The Farm Bill Assistance Partnership has been a model for local-state-federal agency and NGO

cooperation and has been used for other conservation related acceleration projects. At the local level biologists utilize past successes and future goals to provide widespread and one-on-one outreach to landowners in their covered areas.

Project completed: 6/30/2016

FINAL REPORT (PDF)

Moose Habitat Restoration in Northeastern Minnesota
Subd. 04g $200,000 TF

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RESEARCH

Appropriation Language
$200,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute to develop best practices guidelines for creating moose foraging habitat efficiently and cost-effectively. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Moose, one of Minnesota's most iconic wildlife species, are dying at increasingly higher rates in Minnesota and there is uncertainty as to why. Estimates suggest the population declined 35 percent just between 2012 to 2013, and projections suggest moose could be nearly gone from the state by 2020 if this trend is not halted and, ideally, reversed. Scientists at the University of Minnesota are using this appropriation to identify appropriate management and habitat needs and the sorts of actions that can be implemented to help slow or prevent continued population declines amongst Minnesota's moose populations. The project is a continuation and expansion of work completed and underway by two other past Environment and Natural Resources Trust Fund supported projects on determining the cause for the increasing mortality.

Project due to be completed: 6/30/2016

Work Plan (PDF)

Bee Pollinator Habitat Enhancement
Subd. 04h $200,000 TF

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Appropriation Language
$200,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to assess the potential to supplement traditional turf grass by providing critical floral plant resources to enhance bee pollinator habitat. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Bees play a key role in ecosystem function and in agriculture, including more than one hundred U.S. crops that either need or benefit from pollinators. However, bee pollinators are in dramatic decline in Minnesota and throughout the country. One of the potential causes appears to be a scarcity of bee-friendly flowers, particularly in urban areas, which is leading to nutritional deficiencies, chronic exposure to pesticides, and debilitating diseases and parasites. Scientists at the University of Minnesota are using this appropriation to assess options that can be broadly implemented in urban areas to enhance bee pollinator habitat and counteract declining populations and bee health. The effort will examine ways to supplement traditional turfgrass landscapes, particularly in areas that primarily serve an aesthetic purpose, with flowering plants that can provide increased nutrition and less potential exposure to pesticides.

OVERALL PROJECT OUTCOME AND RESULTS
Our goal was to develop an innovative way of helping bee pollinators by enhancing turf areas with native flowering plants. Planting "bee lawns" could help reduce intensive inputs (pesticides and fertilizers) and provide low-growing floral areas, which would beautify Minnesota and provide a creative model for a simple yet effective way to help pollinators and protect our natural resources. First, we identified turf grasses that are well suited to incorporating flowering plants. We found that hard fescue, Festuca brevipila, like other fine leafed fescues, demonstrates drought tolerance, slow vertical growth rate, and excellent winter hardiness making it suitable for a lower-input lawn species. Next, we found that native floral species, Prunella vulgaris spp. lanceolata and Astragalus crassicarpus established well in hard fescue, with Prunella establishing better in loamy soil and Astragalus in sandy soil. We also found that Symphyotrichum lateriflorum (native calico aster) would bloom at a low height under light mowing pressure, making it a third native species for incorporation into turf. These experiments were important first steps in identifying native plants to diversify lawns that are both attractive to pollinators and can withstand mowing pressure. To assist homeowners in establishing flowers in their own existing home lawns, we subjected turf areas in two locations to scalping and/ or aeration and then seeded them with native flowers. The flowers established at higher rates at the location that used minimal turfgrass management (infrequent mowing and no fertilizer use) compared to the more intensively managed site. This latter finding indicates that flowering lawns will do best with lower inputs, which will contribute to more sustainable landscapes that are beneficial to pollinators. Ian Lane, graduate student that conducted this work, defended his Master's degree in May 2016.

PROJECT RESULTS USE AND DISSEMINATION
This project reached a broad audience with research-based information about bee lawns. Professional

audiences have been reached through articles in trade journals. Hobbyist audiences have been reached through presentations at local, regional, and national meetings. Scientific audiences have been engaged through departmental seminars and national scientific meetings. Ian Lane, graduate student, will produce at least three peer-reviewed publications from this project. Most importantly, the general public has been reached in a number ways: we hosted five field days, 3,000 copies of a new brochure on Bee Lawns were distributed, and a new page on the Bee Lab website at the University of Minnesota was developed with information on planting and maintenance of Bee Lawns: https://www.beelab.umn.edu/ A pdf copy of the brochure and evaluations from attendees of the 2016 field day are included as an Addendum to this report.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Bee Lawn Brochure (PDF)
Bee Lawn Info (PDF)

Preserving the Avon Hills Landscape - Phase II
Subd. 04j $772,000 TF

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Appropriation Language
$772,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with Saint John's University in cooperation with the Minnesota Land Trust to secure permanent conservation easements on high quality habitat in Stearns County, prepare conservation management plans, and provide public outreach. A list of proposed easement acquisitions must be provided as part of the required work plan. Up to $80,000 is for use by Minnesota Land Trust in a monitoring and enforcement fund as approved in the work plan and subject to subdivision 16. An entity that acquires a conservation easement with appropriations from the trust fund must have a long-term stewardship plan for the easement and a fund established for monitoring and enforcing the agreement. Money appropriated from the trust fund for easement acquisition may be used to establish a monitoring, management, and enforcement fund as approved in the work plan. An annual financial report is required for any monitoring, management, and enforcement fund established, including expenditures from the fund. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
The Avon Hills area is a unique 65,000-acre glacial moraine landscape located in Stearns County just west of St. Cloud. It has been identified as having statewide ecological significance and includes the highest concentration of native plant communities in the county - including oak and maple-basswood forests, tamarack and mixed-hardwood swamps, and wet meadows - and several rare plants and animal

species, including American ginseng, cerulean warbler, red-shouldered hawk, and Blanding's turtle. This appropriation is being used by the St. John's Arboretum at St. John's University to secure permanent protection, via conservation easements, for an additional 350-550 acres of high quality habitat in the Avon Hills area, prepare conservation management plans for the easement lands, and provide public outreach on the significance of the Avon Hills landscape and options for its protection. St. John's Arboretum previously used a 2008 Environment and Natural Resources Trust Fund appropriation to permanently protect more than 1,000 acres in the area.

OVERALL PROJECT OUTCOME AND RESULTS
Conservation easements to permanently protect private land from development are the main goal of this project located in the Avon Hills 10 miles west of St. Cloud, MN. We tested a reverse bidding system termed the MN Multi-faceted Approach for Prioritizing Land Easements (MMAPLE) to rank submitted easement locations. MMAPLE ranks proposed easements by comparing the land's inherent ecological features to the cost per acre for the easement, thereby focusing on the best value. Land which has many inherent ecological values receives a higher score. Conversely, landowners who bid a higher price per acre for the easement receive a lower score.

The MMAPLE process resulted in seven bids for easements. Pursuit of easements was discontinued with five of these landowners due to concerns with future tax implications, or land use restrictions imposed by the easement itself. In this regard, MMAPLE proved effective as a ranking tool in identifying the next highest-scoring eligible landowner within the candidate pool; this enable the Land Trust to move quickly in engaging the landowner. MMAPLE also proved its ability to efficiently leverage the grant funding under this phase of the project; both easement acquisitions were bargain sales by the landowners. On the first easement acquisition of 170 acres, the easement was purchased for $126,100 below its full market value; the second easement of 61 acres was purchased for $67,800 below its full market value. Total appraised value of the two purchased easements was $635,300, with the grant providing $441,400 towards acquisition; donated value of these bargain sales amounted to $193,900.

The grant also funded outreach and education to increase landowner awareness of easements and land protection as well overall conservation. Landowner conferences held at Saint John's University were the main vehicle for this outreach with 559 total attendees.

PROJECT RESULTS USE AND DISSEMINATION
The Land Trust shared news of the easement acquisitions on both the Avon Hills (Riesner) and (Dwyer) parcels on its website and Facebook page. MMAPLE was also featured as a new model for acquiring conservation easements in the Fall 2015 publication of the academic journal, Natural Resources & Environment. The MMAPLE model was being advocated for use in other grants by advisors and staff of the LCCMR and other funders such as the Lessard-Sams Outdoor Heritage Council.

Project completed: 6/30/2016

FINAL REPORT (PDF)

Frogtown Farm and Park Acquisition
Subd. 04k $1,500,000 TF

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The Trust for Public Land

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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 Trust for Public Land to acquire a portion of 12 acres for Frogtown Farm and Park to be established as a St. Paul city park.

Project Overview
The Frogtown area of St. Paul is a culturally diverse, low-income neighborhood having less green space per child than any other neighborhood in the city and was recently identified as an area in need of a new park. This appropriation is being used by The Trust for Public Land, in partnership with the City of St. Paul, to acquire a portion of twelve acres of a currently vacant space in the area to establish the multi-purpose Frogtown Farm and Park. The vision for the space is to provide a safe space for neighborhood children to experience nature and families to recreate while simultaneously acting as a demonstration urban farm for community members to learn about growing food locally as a vehicle for advancing self-sufficiency, environmental stewardship, healthy living, and community collaboration.

OVERALL PROJECT OUTCOME AND RESULTS
On December 4, 2013, The Trust for Public Land acquired +/- 13 acres from the Wilder Foundation and conveyed it to the City of Saint Paul. The land will be used to create Frogtown Farm and Park - a much-needed public green space for this culturally diverse, low-income neighborhood. The new Frogtown Farm and Park will include a six-acre urban demonstration farm, a recreation area, and a nature sanctuary that preserves a grove of large mature oak trees. When complete, this urban park will be the site of a variety of activities demonstrating green and sustainable inner-city living and providing exceptional educational opportunities.

The land was purchased for $2,200,000. Of that, $1,498,000 was from the Environment and Natural Resources Trust Fund and $702,000 was from the City of St. Paul.

Creation of this public park and demonstration farm will advance environmental and social justice, and strengthen residents' self-sufficiency, environmental stewardship, healthy living and community collaboration. The project furthers the LCCMR Six-Year Strategic Plan in multiple ways including: protecting important land resources (especially the oak grove), supporting research and demonstration projects of natural resources, supporting community based conservation, encouraging outdoor recreation, and promoting public education and dissemination of information about natural resources (for both students and community residents).

The City of Saint Paul has put the project out to bid, and construction is expected to begin on the initial park and farm improvements in the summer of 2015.

PROJECT RESULTS USE AND DISSEMINATION
This project is highlighted on The Trust for Public Land's website at: http://www.tpl.org/our-work/parks-for-people/frogtown-park-and-farm

The Trust for Public Land also issued a press release with the City of Saint Paul:
http://www.tpl.org/media-room/frogtown-park-deal-finalized

There have also been a number of news stories covering this project:

- http://www.minnpost.com/political-agenda/2013/12/deal-finalized-new-park-st-pauls-frogtown-neighborhood
- http://www.twincities.com/stpaul/ci_24654416/st-pauls-frogtown-park-and-urban-farm-set
- http://kstp.com/news/stories/S3296801.shtml?cat=1

FINAL REPORT

Project completed: 6/30/2015

Restoration Evaluations
Subd. 04l $200,000 Transfer from M.L. 2009, Chp. 143, Sec. 2 ,Subd. 8b as amended by M.L. 2011, First Special Session, Chp. 2, Art. 3, Sec. 2, Subd. 18, Para. A, Clause 8

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Appropriation Language
$200,000 from Laws 2009, chapter 143, section 2, subdivision 8, paragraph (b), Legislative-Citizen Commission on Minnesota Resources, as amended by Laws 2011, First Special Session, chapter 2, article 3, section 2, subdivision 18, paragraph (a), clause (8), is transferred to the Board of Regents of the University of Minnesota for evaluation of lands restored using money from the trust fund. The lands to be evaluated shall be identified and prioritized in consultation with the Legislative-Citizen Commission on Minnesota Resources.

Project Overview
Ecological restorations aim to aid the recovery of native ecosystems that have been degraded or lost. However, very seldom are restorations evaluated past the initial implementation phase to determine whether the efforts achieved their goals and the funds spent were a strategic conservation investment. Monitoring and evaluation of restorations can teach what works and what does not in order to advance restoration practices and increase the likelihood of success for future projects. The Environment and Natural Resources Trust Fund has funded restoration activities on hundreds of thousands of acres since its inception. The University of Minnesota is using this appropriation to evaluate the outcomes and effectiveness of some of those restoration efforts in order to inform and improve future land restoration techniques and best practices and future state investments in restoration activities.

OVERALL PROJECT OUTCOME AND RESULTS

In 2013 LCCMR requested an evaluation of ENRTF restorations, from 1990-2010, to assess ecological outcomes of past projects, to determine factors tied to successful outcomes, and to develop evaluation criteria for proposed and completed projects. Our evaluation was based on information gathered from LCCMR files (450 projects), project manager files (78 projects), project manager interviews (59 projects) and field surveys (59 projects). Project managers were interviewed to gain insight into restoration process and organizational capacity to implement restorations. To quantify the extent of ecological recovery of each site we calculated: 1) proportion of plant species considered part of the potential natural vegetation following DNR Native Plant Community manuals (%PNV) and 2) an index of abundances of invasive species (CISA). These two parameters were used to classify ecological condition as high, medium or low quality. High quality restorations were those with greater than average %PNV and lower than average CISA; low quality restorations have the opposite scores, i.e., lower than average %PNV and higher than average CISA. 32% of projects evaluated were deemed high quality and 27% low quality. Using contingency analysis, we screened a variety of factors related to site history, organizational capacity, and type of ecosystem to determine which have the greatest potential to predict post-restoration ecological condition. This analysis found that starting condition, type of ecosystem, and an organization's internal capacity have the strongest effect on restoration outcome. Restorations of highly altered sites are much riskier than those undertaken on remnant natural areas, and so are less likely to result in high quality outcomes. Restorations of forests are riskier than prairie or wetland restoration. Common problems hindering restoration teams' capacity to keep their ecological restoration projects on track are inadequate staffing and expertise, insufficient funds, incomplete records, and leadership change: Evaluation guidelines, monitoring protocols, planning tool documents are included with the final report.

PROJECT RESULTS USE AND DISSEMINATION

The results of this project have been (or will be) disseminated in several ways:

1. A summary report (i.e., Restoration Evaluation Guidelines) that outlines the key findings of the evaluation has been developed. The guidelines will be posted on the Ecological Restoration Practitioners network and website (https://cceevents.umn.edu/restoring-minnesota).
2. Two webinars summarizing key elements of restoration project planning and recordkeeping were hosted in winter 2016. The webinar "Planning to Avoid Pitfalls: The Key to Restoration Success", with guests Dan Shaw from the Board of Water and Soil Resources and Wiley Buck from Great River Greening was hosted on February 23, 2016. The webinar "Learning by Doing: Why Restoration Records Matter" with guests Mark Cleveland from the Department of Natural Resources and Karen Schik from Friends of the Mississippi River was hosted on March 29, 2016. The target audience for the webinars were the project managers as well as other restoration professionals. Each webinar was viewed by approximately 55 professionals. The webinars began with a summary of the results of the restoration evaluation presented as an introduction and context for each topic. The invited expert guests for each webinar presented the perspectives of a state agency and a non-profit engaged in ecological restoration respectively. The webinars are archived on the Ecological Restoration Practitioners website (https://cceevents.umn.edu/restoring-minnesota). In partnership with the DNR, we offered a webinar to agency staff in November 2014.
3. Presentations describing the evaluation process and preliminary findings were made at 3 professional meetings: the Eighth SER Midwest Great Lakes Chapter meeting in Bloomington, IN in April 2016, the Society for Ecological Restoration 6th World Conference on Ecological

Restoration in Manchester England in August 2015, and the Seventh SER Midwest Great Lakes Chapter meeting in Glencoe, IL in March 2015.

4. The results of the restoration evaluation will be summarized and submitted for publication in at least two peer-reviewed journals.
5. Content in the Site Assessment and Monitoring courses of the online Ecological Restoration Training Consortium will be reviewed and updated to reflect recommendations and best practices developed as outcomes of the restoration evaluation project.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Guidelines (PDF)
Restoration Planning Tool (MS Excel
Vegetation Monitoring Protocol Part 1 (PDF)
Vegetation Monitoring Protocol Part 2 (MS Excel)

Subd. 05 Water Resources

Sustaining Lakes in a Changing Environment - Phase II
Subd. 05a $1,200,000 TF

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RESEARCH

Appropriation Language
$1,200,000 the first year is from the trust fund to the commissioner of natural resources in cooperation with the United States Geological Survey, the University of Minnesota, and the University of St. Thomas to continue development and implementation of monitoring, modeling, and reporting protocols for Minnesota lakes to be used in water and fisheries management. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Minnesota's environment is changing in response to a variety of stressors - including population growth, residential development, industry, agriculture, invasive species, and climate change - and the state's iconic lakes, and the goods and services they provide (e.g., fishing and water recreation), are an important part of what's being impacted. To manage effectively for these changes it is important to understand how the state's many lakes respond to these stressors. This includes knowing baseline habitat conditions, observing long-term changes to the baseline, and developing models that can forecast the risks posed and expected impacts of various stressors. In 2009 the Minnesota Department of Natural Resources (DNR) began an ambitious long-term monitoring effort of 24 "sentinel" lakes

throughout the state specifically identified to represent the breath of basic conditions (e.g., water chemistry, habitat conditions, fishery types, surrounding ecosystem types) present in Minnesota's most common aquatic environments. The DNR is using this appropriation to continue and expand on that effort to develop and implement improved monitoring, modeling, and reporting protocols that will provide timely information on lake trends, reduce uncertainty about potential causes, and guide conservation approaches for improving water quality, reversing problematic trends, and preventing further degradation into the future.

OVERALL PROJECT OUTCOME AND RESULTS

Phase 2 of the Sentinel Lakes Long-Term Monitoring Program comprised a wide variety of monitoring and research activities on the 25 Sentinel Lakes selected to provide representation of Minnesotass major lake-types. During 2013-2016, the Sentinel Lakes Program continued to integrate the activities of key, collaborative agencies and partners (e.g. DNR, MPCA, USGS, and universities) which focus on determining the effects of large-scale ecological stressors (e.g., eutrophication, invasive species, and climate changes) on lake ecosystems. Highlights include:

- Detailed summaries of fish and aquatic plant sampling activities were prepared to guide future data analyses and monitoring activities.
- High-resolution water column temperature and dissolved oxygen tracking reveals progression of oxythermal-habitat changes for important fish species in Elk Lake.
- Continuation of specialized sampling of Cisco population in 3 Sentinel Lakes further enhanced our understanding of the relationships between Cisco and climate change and the presence of invasive species.
- Evaluations of biological indicators of lake status including pupal skins of aquatic midges, and White Sucker biology. Results indicate aquatic fly composition reflects lake nutrient status, while assessing White Sucker biology proved difficult. At least 141 species of midge were detected.
- A detailed report of phytoplankton and zooplankton composition, seasonal cycling, and interactions in 13 Sentinel Lakes was completed.
- Food web research conducted to understand impacts of zebra mussels finds that lake biota (insects and fish) shifted to alternative food sources.
- Long-term water quality and baseline aquatic plant surveys at Shaokotan Lake detected a major shift in 2015 from algae-dominance to clear water, aquatic plant-dominance due to watershed restoration and BMP implementation.
- New biophysical lake models were developed Pearl and Madison lakes, while previous models were used to simulate impacts of future climate conditions in Elk and Trout lakes. Surface water temperatures increase dramatically under future climate scenarios and oxygen depletion dynamics differed between lakes.

PROJECT RESULTS USE AND DISSEMINATION

The information gathered during the second phase of Sentinel Lakes sampling continues to provide insights useful to lake managers. The continued ability to collect water quality, zooplankton, fisheries, aquatic vegetation, and land use data over consecutive years from a set suite of lakes has added to the strong foundation of long-term monitoring that was established during the first phase of the project (2009 to 2013). Refining metrics and more fully developing our understanding of how they react to specific ecological stressors will continue to assist managers faced with developing management strategies and practices in lakes. The value to fisheries and lake managers is perhaps most evident in the Department of Natural Resource's commitment to hire and fund a full-time Sentinel Lakes coordinator position. That internally funded position was filled in May of 2016 and will provide project continuity going forward.

As was the case in Phase 1 we again included partner institutions with different areas of expertise, thus the project was able to gain valuable insights into 1) how lake systems in agricultural zones function (USGS), 2) how Chironomid (midge) populations may serve as important indicators of trophic status (University of Minnesota), and 3) how stable isotope analysis can lead to fuller understanding of the effects invasive species such as zebra mussels have on lake food webs (University of St. Thomas). The techniques developed by partners as well as their final results should provide valuable tools and information for some time to come. Continued, consecutive, sampling of Cisco populations has not only furthered our understanding of their population dynamics and their vulnerability to climate change and invasive species but has also added to the development of specific methods for monitoring this important climate- and land-use sensitive species in lakes across the state.

Finally, the project has become an excellent training tool for undergraduates, graduate students, and professionals. More than a dozen undergraduates have been able to gain valuable field experience and mentoring from research staff over the course of the project. The project has also served as a valuable entry point into fisheries for early-career professionals.

Much of the focus of disseminating information gathered during the project has been focused on a scientific audience but with an emphasis on making that information relevant to lake and fisheries managers. To that end, all collaborators past and present were invited to attend and present their findings at a Sentinel Lakes Summit which was held in Brainerd in 2015. Over 50 managers from DNR and PCA attended the event. A similar event is being planned for 2017. Additionally, a number of manuscripts covering a wide variety of topics are currently being prepared for submission to peer-reviewed publications. Already a number of presentations have been made at national, regional, and state-level professional meetings.

For general audiences the Department of Natural Resources maintains a series of Sentinel Lakes-related pages on their website (http://www.dnr.state.mn.us/fisheries/slice/index.html) and the Pollution Control Agency hosts Sentinel Lake Assessment reports on their website (https://www.pca.state.mn.us/water/sentinel-lakes).

Project completed: 6/30/2016

FINAL REPORT (PDF)
Phytoplankton Report (PDF)
Algal Community Dynamics Report (PDF)

Heron Lake Sediment and Phosphorus Reduction Implementation Projects
Subd. 05c $122,000 TF

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Appropriation Language
$122,000 the first year is from the trust fund to the Board of Water and Soil Resources for an agreement with the Heron Lake Watershed District for public outreach and installation and monitoring of water quality improvement projects. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Once known for its clean water, fertile soil, and healthy habitat, in more recent times the Heron Lake Watershed in southwestern Minnesota has been heavily impacted by pollution from intensive agriculture, feedlots, non-compliant septic systems, and urban stormwater runoff. The Heron Lake Watershed District is using this appropriation for public outreach and installation and monitoring of water quality improvement projects aimed at reducing sediment and nutrient loading for the benefit of public health, recreation, and wildlife habitat.

OVERALL PROJECT OUTCOME AND RESULTS
The Heron Lake watershed, approximately 472 square miles, is located within portions of Nobles, Jackson, Murray, and Cottonwood Counties in southwestern Minnesota. Heron Lake, a public water of the State of Minnesota, is impaired for phosphorus. Decreasing the amount of phosphorus and sediment entering Heron Lake would be valuable for reducing water pollution. The Heron Lake Watershed District Watershed Management Plan and county water plans recognize on-the-ground projects as the most effective way to address phosphorus and sediment.

Funding from the Minnesota Environment and Natural Resources Trust Fund was used to install projects in Nobles, Jackson, and Murray Counties. They included a biodetention basin, multiple water and sediment control basins, a bioretention basin, and a streambank stabilization. The purpose of these projects was to reduce sediment and nutrient loads into streams and lakes. The projects affected more than 300 acres and have an estimated reduction rate of 620 pounds of phosphorus and 575 tons of sediment per year. The grant dollars covered 75 percent of the project costs, with the landowner paying 25 percent.

Funds were also used to gather water samples at three sites in the watershed - Jack Creek, Okabena Creek, and the Heron Lake Outlet. The water samples were analyzed and compared to data gathered since 1996. The Jack Creek and Okabena Creek sampling sites decreased in phosphorus. Okabena Creek showed an increase. All sites showed a reduction in sediment.

Plans were made to visit three project sites in April of 2016. A newsletter summarizing the grant activities and promoting the project site tour was distributed to approximately 3,500 watershed residents, agency personnel, and legislators. Attending the event were eleven members of the general public, one Board of Water and Soil Resources staff, two news reporters, two Heron Lake Watershed District board members and three employees.

PROJECT RESULTS USE AND DISSEMINATION
Over the course of the grant period, information about the grant was presented at many meetings and events. Each year annual reports contained a project summary. The grant activities were summarized in a newsletter which was distributed to approximately 3,500 watershed residents, agency personnel, and legislators. In addition, reporters published articles regarding the project site tour in the Daily Globe, Tri County News, and Fulda Free Press.

Project completed: 6/30/2016

FIANL REPORT (PDF)
Project Brochure (PDF)

Southern Minnesota Lakes Restoration
Subd. 05d $463,000 TF

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Appropriation Language
$463,000 the first year is from the trust fund to the Board of Water and Soil Resources for an agreement with Le Sueur County to install shoreland and agricultural best management practices to improve water quality for up to 14 lakes in a tri-county area in southern Minnesota. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Lakes and streams located in Blue Earth, Le Sueur, and Waseca Counties provide important public benefits such as hydrologic storage, economic and recreational opportunities, and regional water quality improvement. However, several of the lakes and streams have been listed as impaired because of excess nutrients and sediment from runoff. Le Sueur County is using this appropriation to install shoreland and agricultural best management practices such as wetland enhancements, infiltration basins, stream restoration, and native plantings to improve the water quality of up to 11 lakes in the region.

OVERALL PROJECT OUTCOME AND RESULTS
The Grant consisted of 14 projects spread out in a region that covered Le Sueur, Blue Earth and Waseca Counties and provided environmental benefits to a number of different bodies of water.

In Blue Earth County, one project on Madison Lake was completed.

1. Bray Park Ravine Stabilization was a highly visible project that provided reductions of 30.3 T/yr. TSS, 30.3 T/yr. Soil and 34.8 lbs./yr. Phosphorus from entering Madison Lake.

In Waseca County, two shoreline projects were completed on Clear Lake.

1. Clear Lake Park Shoreline Restoration resulted in the reduction of TSS by 37.13 T/yr., Soil by 37.13 T/yr. and Phosphorus by 31.56 lbs./yr.
2. Kanewischer Shoreline Restoration provided reductions of 11.55 T/yr. TSS, 11.55 T/yr. Soil and 9.82 lbs./yr. Phosphorus. In Le Sueur County, eleven projects were constructed.

Five projects total were completed in the City of Waterville and resulted in reduced pollutant loads to a number of different waterbodies. A stream shoreline stabilization project and two retention areas were

constructed along White Water Creek which directly flows into Upper Sakatah Lake. Two large stormwater projects were completed near the City's water tower that discharges to the Cannon River directly before it enters Upper Sakatah Lake.

1. Lions Park retention project reduced TSS by 110.08 T/yr., Soil by 127.05 T/yr. and Phosphorus by 126.59 lbs./yr.
2. Mini Park restoration resulted in reductions of 42.0 T/yr. TSS, 42.0 T/yr. Soil and 48.3 lbs./yr. Phosphorus.
3. Streambank work and retention project at the WEM School District Bus Garage resulted in the reduction of 55.04 T/yr. TSS, 63.53 T/yr. Soil and 63.29 lbs./yr.
4. Water Tower A & B Reduced TSS by 1.36 T/yr. (72% Removal Efficiency), Soil by 1.36 T/yr. (72% Removal Efficiency) and Phosphorus by 2.35 lbs./yr. (11% Removal Efficiency). Water Tower Area (due to their high level of interconnection, reduction numbers for both Water Tower Area and Water Tower A & B are combined.

Six additional projects were done throughout Le Sueur County. Including wetland enhancements were completed at two Waterfowl Production Areas (WPA). These projects created enhanced areas for waterfowl as well as providing pollutant reductions.

1. Vail Ravine Stabilization resulted in reduction loads of 31.43 T/yr. TSS, 31.73 T/yr. Soil and 89.10 lbs./yr. Phosphorus from Upper Sakatah Lake.
2. The Rain Garden located at Lake Washington County Park removes 35.0 T/yr. TSS, 35.0 T/yr. Soil and 40.25 lbs./yr. Phosphorus from stormwater runoff before it ultimately reaches Lake Washington.
3. The Elysian City Park Shoreline Restoration Project on Lake Francis resulted in reductions of 19.620T/yr. TSS, 17.0 T/yr. Soil and 19.62 lbs./yr. Phosphorus.
4. The Koppelman Ravine Stabilization provided reductions of 76.5 T/yr. TSS, 153.0 T/yr. Soil and 76.5 lbs./yr. Phosphorus from entering Lake Jefferson.
5. The Pruess WPA resulted in reductions of 31.43 T/yr. TSS, 31.43 T/yr. Soil and 47.14 lbs./yr. Phosphorus.
6. Rice Lake WPA enhancements reduced loads by 59.40 T/yr. TSS, 59.40 T/yr. Soil and 89.10 lbs./yr. Phosphorus.

PROJECT RESULTS USE AND DISSEMINATION
Information about the projects has been discussed at numerous city, county and lake association meetings. Information on the projects and the grant are posted on Le Sueur County's website and has been submitted to local papers for publication. The City of Waterville will be sending out an informational insert in upcoming water bills. A science teacher at the Waterville public school utilizes the rain garden for his classes. Articles have been published in the Waterville paper about the different projects being constructed. The City also is in the planning stages to hold an on-site open house celebration for the City Water Tower Projects.
Project completed: 6/30/2016

FINAL REPORT (PDF)

Membranes for Wastewater-Generated Hydrogen and Clean Water
Subd. 05g $246,000 TF

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RESEARCH

Appropriation Language

$246,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to develop, optimize, and test membranes made of thin film polymers embedded with selected bacteria to generate clean water and energy in the form of hydrogen from wastewater. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview

Waste streams often contain unutilized resources that if properly extracted or otherwise utilized could be used to provide additional sources of renewable energy or other benefits. Wastewater is one of the primary candidate waste streams because of its nutrient content and researchers have been developing technologies such as microbial fuel cells and algal-based biofuel production in order make use of these nutrients. Researchers at the University of Minnesota are using this appropriation to develop, test, and optimize another new technology that can be used to extract energy from wastewater, specifically a polymer membrane embedded with select bacteria that could be used to simultaneously improve wastewater treatment while generating renewable energy in the form of hydrogen. If effective the technology is likely to be scalable with broad application potential for use with any biodegradable liquid waste stream.

OVERALL PROJECT OUTCOME AND RESULTS

In this project we developed a technology that could extract energy from wastewater: a polymer film containing bacteria that generate hydrogen (a clean energy source) while cleaning the wastewater. The system also contained a mesh of small, permeable tubes ("fibers") for efficient hydrogen collection. A finding of this study was that the wastewater treated needed to be high strength to generate adequate quantities of hydrogen. This type of high strength wastewater is produced by food and sugar beet processing facilities, and dairies, among other industries, and is plentiful throughout Minnesota. This technology efficiently produced and collected hydrogen in the laboratory with synthetic wastewater and wastewater from a dairy and a sugar beet processor. When used with vacuum gas collection, the exit gas was approximately 51% hydrogen, which is suitable for use in a fuel cell or for direct combustion. The system was also deployed at a pilot-scale at a brewery and was able to produce and collect hydrogen from the brewery wastewater. After further optimization for ease of scale-up and manufacture, the composite membrane system could allow the extraction of high-quality energy from wastewater while also saving industries on their treatment fees and reducing the need for expensive centralized treatment. In fact, based on our (un-optimized) results, the hydrogen generated in the Metro area would yield approximately $82,000/yr through electricity generation. This same assumption yields over $312,000/yr from the sugar beet industry in the state through electricity generation. This does not include the cost savings associated with reduced treatment fees, which for two Metro area processors alone exceeds $1,000,000/year/company. A patent application was submitted on this

technology and has been approved; the University of Minnesota is exploring commercialization and licensing options. A peer-reviewed manuscript was published from this work and has been submitted to the LCCMR.

PROJECT RESULTS USE AND DISSEMINATION

Information from this project has been shared with several large water technology companies in Minnesota who may have the interest and capability to assist in optimizing and eventually deploying this technology for large-scale energy production from wastewater. Information from this project has also been shared with personnel from the Metropolitan Council Environmental Services, who treat the high strength wastewater of many large food- and beverage-processing plants, the sugar beet industry, and the brewery at which the pilot study was performed. As stated above, a peer-reviewed manuscript was published from this work and has been submitted to the LCCMR. Multiple presentations about the research have been given at both regional and national/international conferences. Additional funding has been obtained from the Minnesota Department of Commerce to study and improve the scalability and manufacturability of the technology and optimize it for deployment.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Journal Article (PDF)

Antibiotics in Minnesota Waters - Phase II - Mississippi River
Subd. 05h $203,000 TF

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RESEARCH

Appropriation Language

$203,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the University of St. Thomas to measure antibiotic concentrations and antibiotic resistance levels and assess the contributions of farm runoff and wastewater treatment in a portion of the Mississippi River. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview

The occurrences of contaminants including antibiotics, other pharmaceuticals, and personal care products in the environment have gained increasing attention in recent years because of their potential health and ecological impacts. However, serious gaps remain in our understanding of these contaminants and the significance of the threats they may pose, such as to drinking water. Through this appropriation scientists at the University of St. Thomas, Gustavus Adolphus College, and the University of Minnesota will continue work focused on the threats posed by antibiotics to understand which antibiotics are of the most concern - for example, because of their potential to increase antibiotic

resistance - and to delineate their urban and rural sources. The first phase focused on antibiotics in the Minnesota River and this phase will focus on the Mississippi River. Findings will help develop strategies to manage threats and minimize future impacts posed by antibiotics to human and ecological health.

OVERALL PROJECT OUTCOME AND RESULTS

This project was Phase 2 of a two-part ENRTF-funded study designed to examine the significance of antibiotics and antibiotic resistance in Minnesota surface waters. Both phases of the study analyzed the following:

- Antibiotic concentrations. Cutting-edge analytical techniques were developed to measure antibiotics at concentrations as low as parts per trillion.
- Antibiotic resistance genes. Quantitative polymerase chain reaction (qPCR) was used to quantify several antibiotic resistance genes.
- Antibiotic-resistant bacteria. Culture-based techniques were used to compare ability of bacteria from various sites to grow in the presence of elevated concentrations of antibiotics.

Phase 1, which ended in 2013, focused on a portion of the Minnesota River basin. The results showed that municipal wastewater treatment plants were a significant source of antibiotics, resistance genes, and antibiotic-resistant bacteria; elevated levels of all three were found in waters impacted by wastewater treatment plant effluent. These findings motivated Phase 2, where the focus shifted to surface waters that serve as drinking water sources and tap water samples and therefore a more direct potential connection to human health impacts. Based on the results of Phase 1, we decided to focus primarily on antibiotics used in human rather than agricultural medicine.

Phase 2 initially focused on the Mississippi River, including St. Cloud, Minneapolis, and St. Paul. Discussions with the Drinking Water Protection section of the Minnesota Department of Health about sites potentially impacted by wastewater led us to expand our study to Ely (Burntside Lake), Grand Marais (Lake Superior), Moorhead (Red River) and Burnsville (Kramer quarry). In general, no measurable antibiotic concentrations, no elevated levels of antibiotic-resistant bacteria, and no antibiotic resistance genes were found in drinking water sources. Development of a new membrane filtration technique allowed us to find antibiotic resistance genes in tap water samples at extremely low levels; the importance of these exceptionally low levels with respect to human health is unclear.

PROJECT RESULTS USE AND DISSEMINATION

Four St. Thomas undergraduate students have presented this work at American Chemical Society national meetings; two in 2014, one in 2015, and one in 2016. Dwight Stoll (Gustavus Adolphus) presented at the Quality Assurance meeting of Region 6 of the Environmental Protection Agency in Fall 2015. Kris Wammer (St. Thomas) has presented this work at two national meetings; the Fall 2015 Society of Environmental Toxicology and Chemistry meeting in Salt Lake City, and the Fall 2016 ACS meeting in Philadelphia. A manuscript detailing the findings from this work is also currently in preparation. In addition, we have in the past and will continue to engage relevant personnel at the state level, in particular from state agencies such as MDH, through meetings and formal talks. The MN One Health Antibiotic Stewardship Collaborative, which both Tim LaPara and Kris Wammer participate in, will help facilitate continued interactions with Minnesota stakeholders.

Project completed: 6/30/2016

FINAL REPORT (PDF)

Subd. 06 Aquatic and Terrestrial Invasive Species

An Aquatic Invasive Species Research Center
Subd. 06a $8,700,000 TF

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RESEARCH

Appropriation Language
$4,350,000 the first year and $4,350,000 the second year are from the trust fund to the Board of Regents of the University of Minnesota to develop and support an aquatic invasive species (AIS) research center at the University of Minnesota that will develop new techniques to control aquatic invasive species including Asian carp, zebra mussels, and plant species. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

Project Overview
Aquatic invasive species pose critical ecological and economic challenges for the entire state and beyond. They can cause irreparable harm to fisheries and aquatic habitat as well as damage to infrastructure. The problems posed by aquatic invasive species continue to grow as existing infestations expand and new exotic species arrive, most of which are poorly understood. New ideas and approaches are needed to develop real solutions. In 2012 the Minnesota Legislature provided the University of Minnesota with $3,800,000 ($2,000,000 from the Environment and Natural Resources Trust Fund; $1,800,000 from the Clean Water Fund) to launch a new, first-of-its-kind research center specifically focused on developing and implementing solutions to control aquatic invasive species. This appropriation provides this new center with additional initial operating funds for conducting research aimed at slowing the spread, reducing, controlling, and/or eradicating aquatic invasive species including Asian carp, zebra mussels, Eurasian watermilfoil, and more. Proven tools and techniques developed at the center are intended to be implemented statewide.

Project due to be completed: 6/30/2019

Work Plan (PDF)

Detection and Monitoring of Asian Carp Populations
Subd. 06b $540,000 TF

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Appropriation Language
$540,000 the first year is from the trust fund to the commissioner of natural resources to accelerate a search and monitoring program directly targeting Asian carp to be used in the development of potential control strategies.

Project Overview
Asian carp pose a real and serious threat to Minnesota's aquatic ecosystems. While there are a few instances of individual carp being found in Minnesota waters, including the Mississippi and St. Croix Rivers, it is not presently believed that there are significant established populations in the state. In order to quickly and effectively respond to threats posed by Asian carp in the future, though, detailed information about the fish themselves is needed. The DNR is using this appropriation to establish an aggressive search and monitoring program directly targeting Asian carp to determine existing distribution and abundance, measure current reproductive success, and evaluate impacts on native fish populations. The information will inform rapid response efforts aimed at control and removal of Asian carp as they emerge.

OVERALL PROJECT OUTCOME AND RESULTS
Invasive Carp, especially Bighead Carp and Silver Carp, pose an imminent and serious threat to Minnesota's aquatic ecosystems. From the 2013 appropriation, the MN DNR was able to appoint three non-classified positions to monitor and remove Invasive Carp from Minnesota waters, assist with environmental DNA collection, and collect groundbreaking native species biological data to determine the effects to native species if Invasive Carp become established. As a result, the MN DNR has established and developed the state's Invasive Carp management, monitoring, and detection program including all life stages. The program collected data from 255,750 feet of contracted commercial gill net, 18 commercial seines, 55,800 feet of gill net, 168 hours electrofishing, 422 larval samples, 622 hoop net and 223 fyke net sampling nights.

We would prefer to catch no Invasive Carp, however it is irresponsible not to be prepared. From the funding, the program caught 7 Invasive Carp via contract commercial fishing, 1 Bighead Carp from targeted sampling, and process an additional 5 Invasive Carp caught by other commercial fishermen and anglers. Sampling has also allowed researchers to determine areas to target from an increased understanding of their biology, associations with native species, and catch records. Specifically, Lower Grey Cloud Slough and the King plant on the St. Croix River were identified as target areas after more than one fish was captured. The program has implemented processing protocols and gained the ability to work-up fish in-house including ageing, determining sex and maturity, and collect all structures necessary for microchemistry analysis. The results can be accessed from the MN DNR 2012 - 2015 Invasive Carp Sampling Reports.

The project furthers the LCCMR Six-Year Strategic Plan in multiple ways including: protecting important water resources, management of invasive species, supporting research of natural resources, and promoting public education and dissemination of information about natural resources.

PROJECT RESULTS USE AND DISSEMINATION

Project plans and results have been disseminated through annual MN DNR reports including, In addition, results have been presented at numerous conferences and meetings including Minnesota's American Fisheries Society annual meetings, the Midwest Fish and Wildlife Conference, U.S. Fish and Wildlife annual meetings, and many others.

This project is highlighted on the MN DNR website at: http://www.dnr.state.mn.us/invasive-carp/index.html

The project is described in the:

- Minnesota Invasive Carp Action Plan, online at: http://files.dnr.state.mn.us/natural_resources/invasives/carp-action-plan-draft.pdf
- The First Annual Report to Congress: Summary of Activities and Expenditures to Manage the Threat of [Invasive] Carp in the Upper Mississippi and Ohio River Basins, June 2012 to June 2014, online at: https://www.fws.gov/midwest/fisheries/asian-carp/WRRDA2015.pdf

Project completed: 6/30/2016

FINAL REPORT (PDF)

Elimination of Target Invasive Plant Species
Subd. 06d $350,000 TF

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Appropriation Language
$350,000 the first year is from the trust fund to the commissioner of agriculture to train volunteers and professionals to find, control, and monitor targeted newly emergent invasive species. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
New invasive plant species continue to emerge in Minnesota and will pose ongoing threats to Minnesota's economy, ecology, and environment if able to spread across the state. It is cheapest, easiest, and least harmful to find and control small populations of invasive plants before they become widespread. The Minnesota Department of Agriculture is using this appropriation to increase the state's flexibility and rapid response to newly emergent terrestrial invasive plant species by training professionals and volunteers to find, control, and monitor certain invasive plants that presently exist only as small, isolated populations in the state. Targeted species include Dalmatian toadflax (NW MN), cutleaf teasel (various isolated areas of state), Japanese hops (SW MN), Oriental bittersweet (Areas along St. Croix and Mississippi Rivers), and Grecian foxglove (Washington County).

OVERALL PROJECT OUTCOME AND RESULTS

The goals of the Elimination of Target Invasive Plants species were 1) Train volunteers and professionals to find target species; 2) Control these species before they spread; and 3) Monitor to prevent reinfestation. Target species are invasive plants that cause severe ecological harm. There are localized infestations of these plants and controlling them will prevent them from becoming widespread. Target species include Dalmatian toadflax, cutleaf teasel, Japanese hops, Oriental bittersweet and Grecian foxglove. We completed Phase 1 of this project and will expand the effort in Phase 2.

University of Minnesota Extension led education and outreach. A total of 34 workshops educated 772 people about target plants. Invasive Blitz was a workshop with 12 sessions across the state that trained volunteers to organize and conduct invasive species removal events. Volunteers reported 434 service events with management activities that impacted 9,582 acres in 30 counties.

Minnesota Department of Agriculture led survey and project coordination. A total of 1,542 road miles and 125 river and trail miles were surveyed with a multitude of volunteers and agency partners. Distribution data for target species can be accessed at http://www.eddmaps.org/. Coordination with private landowners and crew leaders was necessary. An agreement was written with each private landowner where crews worked to ensure clarity about expectations and activities. We wrote agreements with 162 landowners.

Conservation Corps Minnesota led the effort to control target invasives. There were 144 unique and 194 total (some returning members) crew members who worked on this project. Together, they treated 1,360 acres of target invasives.

This project was about eradicating plants, but people were key to success. Project achievements were due to the involvement of hundreds of volunteers, landowners, crew members and state and local partners. Engaging people has vital for long-term success.

PROJECT RESULTS USE AND DISSEMINATION

In addition to 34 workshops with 772 participants, there were 4 field tours, 10 presentations, 8 articles, 3 media events and mailings to hundreds of private landowners. Weed of the Month articles were run in local papers throughout the state. Overall, this dissemination reached thousands of Minnesotans.

Other Extension materials created to support this work, often funded with other grant and internal Extension funds including those generated from participant fees from workshops sponsored by the this project include:

- Oriental Bittersweet Fact Sheet (Extension produced)
- Bittersweet ID for Crafters (short version) (Joint funded: Extension & ENRTF)
- Bittersweet ID for Crafters (long version) (Joint funded: Extension & ENRTF)
- Defeating a Killer Vine: Oriental bittersweet (Farm Bill funded, via MDA)
- Going Rogue: The Story of Japanese Barberry (Farm Bill funded, via MDA)
- Keep a Lookout for New Invasive Plants in Minnesota flyer (MDA funded)
- Five 3D printed invasive plant models of Grecian foxglove (2), Japanese hops (2) and black swallow-wort (1) were produced (Farm Bill funded via MDA). To our knowledge, this is the first time 3D printing has been used to generate invasive plant models. This work is being received very well in by natural resource professionals.

If the live links to videos do not work, please go to the University of Minnesota Extension YouTube channel.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Prioritizing Invasive Plant Control Report (PDF)
Invasive Species Management Matrix (PDF)
Invasive Species Project Planning Worksheet (PDF)

Biological Control of Garlic Mustard
Subd. 06e $140,000 TF

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RESEARCH

Appropriation Language
$140,000 the first year is from the trust fund to the commissioner of natural resources in cooperation with the University of Minnesota to continue the implementation of biological control for invasive garlic mustard plants. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Garlic mustard is a non-native, invasive plant species that is severely threatening native plant communities and degrading wildlife habitat in forest and riparian zones throughout the state. The plant is considered the highest priority species for development of long-term management solutions such as biological control, which involves using natural enemies of a non-native species from its native region to control or reduce the impact of the species in the areas where they are invasive. Introducing one non-native species to control another, though, is something that must be done with care so that the introduction does not have unintended consequences. This appropriation is enabling the Minnesota Department of Natural Resources and the University of Minnesota to continue ongoing research and evaluation of biological control options for garlic mustard. With this phase the aim is to be able to release multiple biological control inserts and monitor their effectiveness.

OVERALL PROJECT OUTCOME AND RESULTS
This project advanced the goal of having effective biological control insects for garlic mustard (Alliaria petiolata). Host-specificity testing focused on the potential biocontrol insects Ceutorhynchus scrobicollis (a crown feeding weevil) and C. constrictus (a seed-feeding weevil). Monitoring garlic mustard populations in Minnesota provided information on garlic mustard populations in the absence of biocontrol. C. scrobicollis host specificity testing was completed for 15 plant species. Based on these

results, C. scrobicollis has the host specificity to be a successful biocontrol agent of garlic mustard. The researchers wrote a petition for release which summarizes the 18 years of C. scrobicollis host specificity testing. The petition was submitted to the USDA-APHIS Technical Advisory Group in June 2016. Rearing protocols, release methods, and biocontrol manuals were developed for C. scrobicollis. C. constrictus host specificity testing was completed for 19 plant species. The results show that C. constrictus continues to show the host specificity to be a successful biocontrol agent for garlic mustard. Approximately 30 more species need to be tested and then a petition for release of C. constrictus can be submitted to the USDA. Garlic mustard is a biennial and long-term monitoring shows that its populations can fluctuate widely from year to year. When the plots were established in 2005 and 2006, garlic mustard was present in 100% of the plots. Garlic mustard is still present in 88% of the plots as of June 2016. Garlic mustard is currently experiencing very little herbivory in Minnesota with an average amount of leaf removed due to herbivory ranging from 0.6 to 4.5% in 2014 - 2016. It is expected that after biological control release, garlic mustard cover and density will decrease and shoot heights and silique production of individual plants will decrease as well.

PROJECT RESULTS USE AND DISSEMINATION

- Dr. Jeanie Katovich and Dr. Roger Becker presented a poster on this project at the Upper Midwest Invasive Species Conference in Duluth, MN held October 20-22, 2014.
- Dr. Jeanie Katovich gave a presentation on the project to the "Invasive Plant Management" class at the University of Minnesota - Twin Cities during the spring 2015 and 2016 semesters.
- Dr. Roger Becker gave a presentation titled "Petition to release Ceutorhynchus scrobicollis for biological control of garlic mustard (Alliaria petiolata)" at the 2015 Midwest Invasive Plant Network Invasive Plant Symposium (part of the North Central Weed Science Society annual meeting) in Indianapolis, IN on December 9, 2015.
- Dr. Jeanie Katovich gave a presentation on the project to Northeast Region US Forest Service researchers and staff at a meeting in Roseville, MN on March, 3, 2016.
- Dr. Jeanie Katovich presented the host-specificity data for Ceutorhynchus scrobicollis to the USDA APHIS Technical Advisory Group at their annual meeting in Greenbelt Maryland on April 6, 2016.
- Monitoring data has been shared with a consortium of researchers led by Dr. Bernd Blossey of Cornell University. This group will work together to produce a peer-reviewed publication on the results of garlic mustard monitoring plots in the Midwest and Northeast regions of the United States. The paper is currently being written.
- Dr. Laura Van Riper will give the presentation "Perspectives on Garlic Mustard Biocontrol in the Midwest" at the Upper Midwest Invasive Species Conference in La Crosse, WI held October 17-19, 2016.
- The petition for release for C. scrobicollis was submitted to the USDA APHIS Technical Advisory Group.
- Title: A Petition for the Introduction, Experimental Release and Open-Field Release of the Root-Mining Weevil Ceutorhynchus scrobicollis (Coleoptera: Curculionidae) for the Biological Control of Alliaria petiolata (Garlic Mustard) in North America.
- Authors: Laura Van Riper, Esther Gerber, Hariet L. Hinz, Ghislaine Cortat, Elizabeth Katovich, Roger Becker, Mary Marek-Spartz
- Date submitted: June 21, 2016

Project completed: 6/30/2016

FINAL REPORT (PDF)

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Zebra Mussel Control Research and Evaluation in Minnesota Waters
Subd. 06f $600,000 TF

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RESEARCH

Appropriation Language
$600,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the United States Geological Survey, Upper Midwest Environmental Sciences Center, to assess the ecological impacts of a commercially available molluscicide formulation on the reproduction and development of native fish, as well as impacts on larval aquatic insect survival, and to evaluate the effectiveness of these treatment options for detection and control of zebra mussels. The United States Geologic Survey is not subject to the requirements in Minnesota Statutes, section 116P.10. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
Zebra mussels are an aquatic species that are invasive in Minnesota and severely threaten native fish and other aquatic species by disrupting food webs and damaging spawning habitat. Their range continues to expand within Minnesota lakes and rivers, where they are spread through the transporting of water, vegetation, or equipment from an infested water body. Once established zebra mussels are very difficult to control and there is an immediate need for safe and effective control measures to reduce their impacts in the state. Scientists at the United States Geological Survey are using this appropriation to assess the ecological impacts of a commercially available mollusicide formulation (Zequanox) showing some promise for the control of zebra mussels. Findings will be used to determine the extent to which this product can and should be used in Minnesota waters and, if so, to optimize treatment protocols and techniques to maximize zebra mussel control while minimizing undesirable impacts.

OVERALL PROJECT OUTCOME AND RESULTS
Zebra mussels (Dreissena polymorpha) continue to rapidly expand their range within Minnesota's lakes and rivers disrupting aquatic food webs, threaten native species, and damage infrastructure. Zequanox©, which contains killed cells of Pseudomonas fluorescens as the active ingredient, is a potential tool for controlling dreissenid mussels (zebra and quagga mussels D. rostriformis bugensis. The project goals were to determine the safety and efficacy of Zequanox for controlling zebra mussels and to evaluate the use of molecular tools to inform control efforts. Project studies are summarized in supplemental attachments with the final report.

The Zequanox non-target animal impacts database was expanded by evaluating the exposure-related impacts on three life stages of fathead minnow (Pimephales promelas), and on the survival of adult scuds (Gammarus lacustris) and mayfly nymphs (Hexagenia sp.) after applications were conducted in outdoor 1,000-L mesocosm tanks. No significant treatment related impacts were observed in survival of invertebrates or fathead minnows or in hatchability and growth of fathead minnows.

Detailed maps were prepared for portions of Lake Le Homme Dieu and Maple Lake (Douglas County), which had different zebra mussel infestation levels. Maps of depth, substrate hardness, and submerged aquatic vegetation (SAV) depth and biovolume were generated using side-scanning sonar and parallel sonar data transects were collected and processed into component data categories. Processed sonar data and resulting maps are available on the vendor's cloud-based server network and could be combined with new or existing data to generate additional mapping products. Sonar data were used to generate a geospatial database of map characteristics in ArcGIS, and spatial analyses of the data were used to generate additional map products in ArcMap. Conversion to ArcGIS allowed for spatial analysis and sharing in GIS format. Zebra mussel populations were correlated with depth and substrate and submerged aquatic vegetation was found to be an important component of zebra mussel habitat in shallow areas in Lake Le Homme Dieu.

The use of environmental DNA to detect and identify application locations for Zequanox that might have the greatest impact on zebra mussel populations was also evaluated. The use of eDNA could assist management agencies to identify infestations, however, eDNA was found to not be effective for targeting control efforts.

Methods to apply Zequanox under the surface were first evaluated in controlled laboratory and pond-scaled mesocosm studies and further evaluated in 27-m2 enclosures placed in Robinson's Bay (Lake Minnetonka, MN). Whole water column and subsurface applications were evaluated by comparing zebra mussel mortality and biomass reduction between treated and control groups. Approximately 73 and 56% of the zebra mussels in contained samples were killed in the highest whole water column and subsurface Zequanox applications, respectively, and the similarly the adhering zebra mussel biomass was reduced ~79 and 57%, respectively.

Overall, we found that Zequanox has the potential to be used as a management tool for zebra mussels in quiescent water environments, however, Zequanox is not likely to be effective for eradication of zebra mussels in an open water environment. Additionally, eDNA may have utility as a tool for the detection of zebra mussels in a waterbody but it is not an effective tool for determining the biomass of zebra mussels present or for prioritizing the location of zebra control efforts.

PROJECT RESULTS USE AND DISSEMINATION

Three oral presentations describing study methods and results were prepared and disseminated at professional scientific meetings including the Upper Midwest Invasive Species Conference and the Annual Conference of the International Association of Great Lake Research. One webinar entitled "The potential use of eDNA to guide site selection for zebra mussel control treatments" was presented during a USGS hosted Environmental DNA Webinar Series. One peer-reviewed manuscript entitled "Safety of the molluscicide Zequanox© to nontarget macroinvertebrates Gammarus lacustris (Amphipoda: Gammaridae) and Hexagenia spp. (Ephemeroptera: Ephemeridae)" was prepared and published online on June 23, 2016 in the Management of Biological Invasions and is included as a supplemental attachment to the project final report. Five peer-reviewed reports that summarize study methods and

results were prepared and are supplemental attachments to the project final report.

A model was developed for selecting the proper concentration (w/v) of Zequanox to be used in stocks prepared for subsurface applications waters between 7 and 22°C. This prediction model is described in supplemental attachments with the final report.

Molecular markers for the detection of zebra mussels were found to be highly specific to zebra mussels. A water sampling protocol was also developed to improve the probability of detecting zebra mussels. The use of environmental DNA (eDNA) did correlate with zebra mussel biomass. Zebra mussel DNA did accumulate in depositional areas. This suggests that our zebra mussel eDNA assay could assist management agencies to identify infestations, but not inform control efforts. The molecular markers, sampling protocol and depositional areas are described in supplemental attachments with the final report.

Project completed: 6/30/2016

FINAL REPORT (PDF)
Safety of Molluscicide to Nontarget Macroinvertebrates (PDF)
Effects of Spray-Dried Pseudomonas fluorescens on Flathead Minnow (PDF)
Mapping Lakes to Charecterize Substrate Hardness and Vegetated Habitat (PDF)
Environmental DNA Mapping of Zebra Mussel (PDF)
Development of Targeted Delivery Techniques for Zequanox (PDF)
Controlling Zebra Mussels Within Lake Minnetonka Enclosures (PDF)
Response to CO2 Exposure in a Freshwater Mussel (PDF)

Subd. 07 Environmental Education

Minnesota Conservation Apprentice Academy
Subd. 07a $186,000 TF

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Appropriation Language
$186,000 the first year is from the trust fund to the Board of Water and Soil Resources in cooperation with the Conservation Corps Minnesota to continue a program to train and mentor future conservation professionals by providing apprenticeship service opportunities with soil and water conservation districts.

Project Overview
Many of the most experienced conservation practitioners at local soil and water conservation districts throughout the state are nearing retirement, and with their departure will go much of their practical,

on-the-ground knowledge, experience, and skills. Meanwhile, college students seeking to be the next generation of conservation practitioners have knowledge of emerging technologies and other innovations that can improve and contribute to current conservation efforts. Through this appropriation the Minnesota Board of Soil and Water Resources will work with the Minnesota Conservation Corps to continue a program that places students in apprenticeship positions with county soil and water conservation district offices throughout the state. This unique program provides an opportunity for interns to gain valuable in-the-field experience from current practitioners while sharing their knowledge with those practitioners about the newest ideas and solutions for meeting today's natural resource challenges.

OVERALL PROJECT OUTCOME AND RESULTS

Familiarizing future conservation leaders with Minnesota's various land-use practices, water and soil resources, plant and animal habitats, and landowner concerns is needed to maintain the capacity of local organizations to deliver conservation on the ground. Many of the conservation districts' most experienced conservation professionals and practitioners are nearing retirement age but due to budget constraints will not be replaced until they have left employment. Consequently, Minnesota is missing a great opportunity to transfer professional knowledge and experience to the next generation.

While university graduates with conservation-related degrees are knowledgeable in technology, theory, and research methods, their practical, on-the-ground skills need development. Communicating with landowners and adjusting designs for field nuances are vital to the success of conservation projects and best learned alongside seasoned professionals. In turn, apprentices bring knowledge of emerging technologies to improve the quality and productivity of conservation efforts.

This program funded the placement of 37 conservation apprentices in 35 SWCDs in 2014. During this time, the apprentices stabilized erosion on 7 million square feet of slopes, planted 28,001 plants, trees, shrubs and seedlings, maintained 3.5 million square feet of restored areas, collected 2,465 water samples, spent 2,110 Hours collecting data and mapping using GPS and GIS, and impacted 1,265 people through environmental education and outreach.

This program has benefits to both students and conservation districts. 100% of apprentices indicated they felt more prepared to work in the conservation industry as a result of the program and would recommend it to others. 96% of the Districts were satisfied with the work their apprentices completed, and 100% indicate they would participate in the program again. Managers also indicated that the work conducted by the apprentices increased the amount of conservation practices delivered by their districts during the program period.

This was the third grant awarded to the Apprentice Academy through LCCMR. Grant one addressed the cohorts working during the summers of 2011 and 2012. The state government shutdown of 2011 produced a small balance in the 2010 grant that was used to fund additional positions in 2012 and 2013; this in turn allowed a small balance the second grant (M.L. 2011) to fund additional positions in the this, the M.L. 2013, Chp. 52, Sec. 2, Subd. 07a plan, and carried funding into the early portion of 2014.

PROJECT RESULTS USE AND DISSEMINATION

Information from the project has been disseminated through reports to LCCMR, press releases by BWSR, local press releases by SWCDs, and through the Conservation Corps newsletter, website and annual report. Information was used to recruit apprentices and increase awareness of the project.

Communication and outreach activities include the aforementioned reports, press releases, and electronic newsletters. Additionally, BWSR and Conservation Corps staff conducted outreach to SWCDs to find optimal matches between districts and apprentices. Through the course of their work, the apprentices conducted significant outreach to land owners and residents in topics ranging from easement protection, to water quality education, to plant biodiversity.

Project completed: 6/30/2015

FINAL REPORT

Youth Outdoors: Mississippi River Education and Employment Opportunities
Subd. 07b $450,000 TF

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Appropriation Language
$450,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with Wilderness Inquiry to provide outdoor education, recreation, and youth employment on the Mississippi River from Grand Rapids to St. Cloud, the Twin Cities, Hastings, and Red Wing. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

Project Overview
There has been a sharp decline in participation in outdoor recreation and education amongst youth, particularly in urban areas. Some argue that youth who have meaningful outdoor education experiences are more likely to become engaged in environmental stewardship and invested in outdoor resources as adults. Wilderness Inquiry - in partnership with state and federal agencies, non-profits, and local school districts - is using this appropriation to expand an environmental education and recreation program that provides youth with hands-on educational and recreational experiences of the Mississippi River. Funds enable the program to offer canoe experiences to an additional 6,000 youth and to expand the types of experiences provided to include overnight camping, aquatic sampling and monitoring, and conservation-related internships. The program is also expanding geographically to serve additional communities in the Twin Cities and outstate, including Grand Rapids, St. Cloud, Hastings, and Red Wing.

OVERALL PROJECT OUTCOME AND RESULTS
Youth in Minnesota and across the country are spending less time outdoors than ever before. Minnesota is home to beautiful wilderness areas and our youth are missing out on opportunities to experience it. The goal of the Youth Outdoors project is to bring more youth outside to experience the wilderness -- urban and remote -- and gain a new appreciation for their environment and community through guided outdoor experiences.

Between July 1, 2013 and September 1, 2015 Wilderness Inquiry (WI) engaged 12,000 youth in outdoor programming. More than 11,000 youth joined WI for an introductory outdoor day experience and more than 830 youth participated in an overnight camping experience. Additionally, 31 youth were employed as interns with job responsibilities including supporting participants, leading educational stations, and creating new activities. On single day events, youth canoed, fished, hiked, explored, and collected data from lakes and rivers for hands-on water quality tests. Youth worked in teams to paddle 24-foot Voyageur canoes on urban waterways such as the Mississippi and Minnesota Rivers and Minneapolis Chain of Lakes as well as remote lakes and rivers across the state such as Voyageurs National Park and Lake Itasca. Outdoor Educators, with the support of partner organizations, facilitated activities to engage students with each other and the outdoors. On overnight camping experiences, youth set up tents, built fires, and cooked outside. We reached out to schools, formalized district partnerships, and engaged a variety of groups to offer these experiential and educational opportunities.

The University of Minnesota's Center for Applied Research and Educational Improvement (CAREI) collected data from the project as part of a 5-year plan to evaluate the program outcomes. We are continuing our relationship with CAREI to determine best practice and next steps. By engaging thousands of Minnesota youth in the outdoor educational experiences, we are energizing the next generation of environmental stewards.

PROJECT RESULTS USE AND DISSEMINATION
We disseminated information about the project and its outcomes through a variety of media including our website, social media networks, quarterly newsletter, partner website, and news sources. We have shared our educational resources with schools in an effort to support the continued engagement of their students in the outdoors. Our program has been highlighted in a number of local newspapers.

Project completed: 6/30/2015

FINAL REPORT

Subd. 08 Administration and Contract Management

Contract Management
Subd. 08b $135,000 TF

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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.

Project Overview
Appropriations to non-state entities must be made through a formal contract with a state entity that manages all of the funds for the project on a reimbursement basis. This appropriation to Minnesota's Department of Natural Resources (DNR) funds the expenses incurred by the DNR in contracting, contract management, and expense re-imbursement for most of the Environment and Natural Resources Trust Fund appropriations made to non-state entities, including both new projects funded during the biennium and existing projects funded in previous bienniums.

OVERALL PROJECT OUTCOME AND RESULTS
This appropriation, in conjunction with Outdoor Heritage Fund appropriations, was used to support the contract management program, which ensured ENRTF funds were expended in compliance with state law, session law, approved work plans, and Office of Grants Management grants policies.

Services provided under this appropriation included the following:

- Contract Management Services
    - Prepared grant agreements and amendments
    - Encumbered/Unencumbered Funds
    - Executed Use of Funds Agreements
    - Advanced funds for land acquisition (if approved)
    - Communicated regularly with LCCMR staff and grant recipients
    - Contract management documentation, including file management
- Training and Communications
    - Trained recipients on state grant requirements
    - Worked with recipients to ensure grantees understood the state's reimbursement procedures and requirements
    - Provided ongoing technical assistance/guidance to recipients
- Reimbursement Services
    - Reviewed reimbursement requests
    - Arranged for prompt payment once expenses were verified eligible for reimbursement
    - Detailed accounting by pass-through appropriation for each grant recipient
- Fiscal, Audit, and Close-out Services
    - Financial reconciliation
    - Financial reporting
    - Contract management reporting (fund balance/expenditures)
    - Examined or audited records of recipients
    - Worked with recipients to successful close out of grants
    - Worked closely with and responded to requests from the Office of the Legislative Auditor

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.

FINAL REPORT

Project completed: 6/30/2015