

Final Abstract

Final Report Approved on December 3, 2024

M.L. 2020 Project Abstract

For the Period Ending June 30, 2024

Project Title: Expanding Minnesota Ecological Monitoring Network

Project Manager: Holly Bernardo

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Funding Source:

Fiscal Year:

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 03b

Appropriation Amount: \$800,000

Amount Spent: \$695,570

Amount Remaining: \$104,430

Sound bite of Project Outcomes and Results

In total, 226 monitoring plots were installed in The Ecological Monitoring Network (EMN). Substantial improvements were made to the EMN database, including enhanced security and connections to DNR's Natural Heritage Information System. Preliminary findings using all 412 plots are available online for land managers, conservation practitioners and decision makers.

Overall Project Outcome and Results

Until the formation of The Ecological Monitoring Network (EMN), most information on Minnesota's native plant communities came from single point in time surveys. Survey data are foundational to understanding native plant communities, but they do not provide information about change through time. The EMN will provide objective, statically rigorous, biodiversity data characterizing change in Minnesota's native prairies, forests and wetlands. Native systems provide ecosystem services such as recreation, timber, water filtration, pollinator habitat, flood protection, and carbon storage. Once resampling begins, the EMN can serve as an early warning system identifying stressors on those services, such as invasive species and extreme weather effects, and can inform decisions about best management and conservation of native habitats.

This appropriation supported:

- 1) Installing 226 monitoring plots, out of a project total of 412 (continued from ML16) and an estimated network total 550 (to be continued on ML23).
- 2) Documenting 20,718 trees, 14,202 saplings, and 43,930 herbaceous plants.
- 3) Submitting voucher specimens for 28 rare plant populations and 24 new County records.
- 4) Site-level reporting to landowners or administrators.
- 5) Security upgrades to the EMN database.
- 6) Integrating the EMN data within the Natural Heritage Information System.
- 7) Making project methods available online.
- 8) Developing a long-term resampling plan.

Lastly, initial findings were made available online. As of 2023, 45% of EMN plots are in upland forests, 27% in open wetlands, 15% in wetland forests and 12% in upland prairies. Overall, the EMN data show clear north-south differences. Forest EMN plots in southern Minnesota have higher browse pressure than northern plots. Southern prairie EMN plots have higher non-native species cover relative to northern prairie plots. This trend can also be seen in most other Ecological Systems. Invasive earthworm impacts are higher in mesic forests in southern Minnesota relative to northern Minnesota.

Project Results Use and Dissemination

With initial results available on the EMN webpage, linked in the attachments, information from the EMN is now reaching land managers, conservation practitioners and decision makers. That information will be expanded when the network is finalized, with each network resampling, and as we gather collaborators into the network. For example, we send detailed reports to EMN landowners. We have trained a multi-disciplinary DNR team on how to use EMN methods as part of long-term forest management monitoring. And we are currently collaborating with DNR zoologists to incorporate the EMN within the next 10-year revision of the State Wildlife Action Plan.



Environment and Natural Resources Trust Fund

M.L. 2020 Approved Final Report

General Information

Date: December 11, 2024

ID Number: 2020-023

Staff Lead: Tom Dietrich

Project Title: Expanding Minnesota Ecological Monitoring Network

Project Budget: \$800,000

Project Manager Information

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Project Reporting

Final Report Approved: December 3, 2024

Reporting Status: Project Completed

Date of Last Action: December 3, 2024

Project Completion: June 30, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 03b

Appropriation Language: \$800,000 the second year is from the trust fund to the commissioner of natural resources to improve conservation and management of Minnesota's native forests, wetlands, and grasslands by expanding the partially established long-term Ecological Monitoring Network that will provide critical knowledge of how ecosystem dynamics and conditions change through time.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: This project proposes to expand the Ecological Monitoring Network by establishing an additional 250 plots to inform the conservation and management of Minnesota's native forests, wetlands, and grasslands.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Most of the information collected on Minnesota's native plant communities was from surveys done at a single point in time. Invaluable as this data is, it was not collected for the purpose of repeatable or comparative analysis. While this information establishes a critical foundation for an understanding of the types and amounts of native plant communities we have and where they occur, it does not provide information about how plant communities change through time. The information collected by this project will provide objective, ground-based data collected systematically over time across many different ownerships and native plant communities from randomly selected, permanently marked plot locations, including from the metropolitan area. Our statistically designed protocols, which have been tested during the first phase of this project, are intended to provide detailed information on all plant species present at plot locations, from the ground layer to the canopy; something that other similar projects are not doing. In addition, information on bees and butterflies will also be collected at a limited number of plots that use these native plant communities.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

Information from the resurvey of these established monitoring plots can serve as an early warning system about the effects of invasive species, extreme weather effects, land use changes, and other stressors on native vegetation. Informed decisions about how to best manage and conserve native habitats rely on detailed vegetation data collected from these kinds of monitoring plots, something that is currently not available. This project will build on work begun by the Minnesota Biological Survey Program (MBS) with 2016 ENRTF funding to design a monitoring program to track status and trends in Minnesota's prairies, forests and wetlands, including additional metropolitan natural area plots. With the help of many collaborators, methods were developed and tested, and the first 100 of 600 monitoring plots were installed to begin building the Ecological Monitoring Network. This network of plots is designed to be available to others conducting ecological and related research in Minnesota. Already, collaborators at the University of Minnesota are sampling lichens and mosses on a subset of these plots, and efforts to attract additional collaborators will continue. The goal of this project is to provide detailed data on the health of Minnesota's native habitats in a variety of formats.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

The data gathered on vegetation and other metrics from monitoring plots in this network will be available to natural resource agencies, organizations, landowners, and the public. Examples of results from this project that could inform management and conservation decisions include the effects of warming temperatures on plant communities, effects of increased flooding on wetlands, impacts from earthworms and other invasives on forests, and documenting changes in dominant canopy trees in forests. We will install a minimum 250 plots to help reach the minimum number of plots needed to provide scientific, repeatable statewide data and deliver project results in several formats.

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project

Activities and Milestones

Activity 1: Complete Installation of 250 New Plots

Activity Budget: \$750,000

Activity Description:

Install 250 new plots to the existing network of 125 plots established in the ML16 project. Data will be collected on all plant species, and depending on the vegetation type of each plot, variables such as deer browse, coarse woody debris, water chemistry, and grassland structure will be collected. A new database will be developed and added to the existing Natural Heritage Information System, so that data will be more easily accessible to the public. Data collected will be entered into the database at the end of each field season. Plant collections will be processed and delivered to the UMN for accession in permanent collections.

Activity Milestones:

Description	Approximate Completion Date
Database developed and incorporated into the Natural Heritage Information System	April 30, 2023
Data collected at 250 newly established monitoring plots (80-85 plots each summer)	September 30, 2023
Data entered into the Ecological Monitoring Network Database	April 30, 2024
Specimen preparation and delivery of specimens to museum collections	June 30, 2024

Activity 2: Data Distribution, Education and Outreach

Activity Budget: \$50,000

Activity Description:

Results will be published on the DNR Ecological Monitoring Network website. Report forms including Individual site data will be sent to the owners or managers of the land where each site is located. A written report summarizing all of the collected data will be available on the website. Presentations to nonprofit organizations, natural resource managers, and universities will be made to inform audiences of monitoring results and recruit other researchers to use the network.

Activity Milestones:

Description	Approximate Completion Date
Annual summary reports distributed to landowners or managers after each field season	February 28, 2024
Descriptions of the project's methods, initial findings posted on project website	June 30, 2024
Conduct public outreach and technical guidance activities.	June 30, 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Division of Forestry	MN DNR	Help with initial project objectives, providing help with land access, staffing in the field.	No
Division of Parks and Trails	MN DNR	Help with initial project objectives and study design, providing help with land access, staffing in the field.	No
Division of Fish and Wildlife	MN DNR	Help with initial project objectives and study design, providing help with land access, staffing in the field.	No
The Nature Conservancy	The Nature Conservancy	Help with initial project objectives and study design, providing help with land access, staffing in the field, potential collaboration with additional research at plots on their land.	No
College of Food, Agricultural and Natural Resource Sciences	University of Minnesota	Staff, primarily within the Department of Forest Resources helped with original study design and objectives. We see potential for future research or statistical analysis collaboration on monitoring plots. Data collection on lichens and mosses has already begun at a select number of our plots by U of MN researchers.	No
U.S. Fish & Wildlife Service	Department of the Interior	Helped with initial study design and objectives, assistance with land access and permits, potential future partner for additional research on plots placed on their land.	No
U.S. Forest Service	Department of Agriculture	Helped with initial study design and objectives, assistance with land access and permits, potential collaborator on future additional research on plots within their ownership.	No

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

All of the information on the web page for this project will be continually updated, including revised brochures, revisions to the Standard Operating Procedures, and

information from data analyses. The web site address is:

<https://www.dnr.state.mn.us/mbs/ecologicalmonitoring/index.html>

Reports summarizing data collected in each plot will continue to be sent to the respective landowner or land manager for each plot following each field season. PowerPoint presentations will be revised and presented at a number of venues to make natural resource managers, scientists, and the general public aware of project outcomes and its long term importance.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

The DNR is actively developing long-term cooperative funding for sustaining this Ecological Monitoring Network over

time. Resampling plots will take considerably less time and resources compared to initial installation, and will be incorporated into the work of the DNR MBS Program.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Statewide Monitoring Network for Changing Habitats in Minnesota	M.L. 2016, Chp. 186, Sec. 2, Subd. 03d	\$500,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount	\$ Amount Spent	\$ Amount Remaining
Personnel										
Plant Ecologist/Botanists		Field and Data Leads			28%	2.25		\$240,000	-	-
Plant Ecologist/Botanist		Field and Data Specialist			27%	4.5		\$247,500	-	-
Data/Specimen Manager		Data specialist			27%	0.03		\$8,000	-	-
Information Outreach Specialist		Data delivery and outreach manager			30%	0.03		\$8,000	-	-
Interns		Field assistants			0%	2.25		\$70,200	-	-
							Sub Total	\$573,700	\$489,422	\$84,278
Contracts and Services										
Contracts with Biologists for plot sampling	Subaward	Contracting with a field botanist(s) with advanced plant identification skills to install plots and/or support MBS staff for Milestone 2 under Activity 1				0.6		\$42,000	\$39,016	\$2,984
							Sub Total	\$42,000	\$39,016	\$2,984
Equipment, Tools, and Supplies										
	Equipment	Field equipment will be reused from previous projects to the extent possible. Additional supplies needed include meter tapes, waterproof notebooks, insect/tick repellent, safety vests; plot marking supplies such as rebar, magnets and magnetized nails, witness tree tags; measuring tools such as tree calipers, rulers, water chemistry meters and calibration supplies, pvc pipes for marking plots in wetlands, compasses, GPS receivers; plant,	Supplies needed for three 3-person crews for three field seasons to collect data and permanently mark 500 monitoring plots					\$18,000	\$15,837	\$2,163

		insect, soil specimen collecting and preservation supplies.								
							Sub Total	\$18,000	\$15,837	\$2,163
Capital Expenditures										
							Sub Total	-	-	-
Acquisitions and Stewardship										
							Sub Total	-	-	-
Travel In Minnesota										
	Miles/ Meals/ Lodging	Travel for three 3-person crews for 1.5 field seasons to install and sample monitoring plots; 225 field days, 36,000 miles. Vehicles (\$19,000), lodging (\$76,838), and meals (\$2,500) in accordance with the Commissioner's Plan.	Each team will require one vehicle (3 total) for the summer to access plots across the state; Each team will need access to lodging/hotels while in transit during the week; and reimbursement for meals while in transit.					\$105,838	\$90,833	\$15,005
							Sub Total	\$105,838	\$90,833	\$15,005
Travel Outside Minnesota										
							Sub Total	-	-	-
Printing and Publication										
							Sub Total	-	-	-
Other Expenses										
		Direct and necessary costs to cover HR support (\$13,908), Safety Support (\$2,517), Financial Support (\$8,429), Communication Support (\$1,388), IT Support (\$33,082), and Planning Support (\$1,138).	These funds are needed to pay other DNR personnel for things like HR and IT.	X				\$60,462	\$60,462	-
							Sub Total	\$60,462	\$60,462	-

							Grand Total	\$800,000	\$695,570	\$104,430
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Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Other Expenses		Direct and necessary costs to cover HR support (\$13,908), Safety Support (\$2,517), Financial Support (\$8,429), Communication Support (\$1,388), IT Support (\$33,082), and Planning Support (\$1,138).	Direct and necessary costs reflect the amounts directly related to and necessary for accomplishing the project outcomes that would not exist but for the receipt of the appropriation.

Non ENRTF Funds

Category	Specific Source	Use	Status	\$ Amount	\$ Amount Spent	\$ Amount Remaining
State						
Cash	Heritage Enhancement Fund	Funds the Research Scientist/Coordinator Lead for the project.	Secured	\$104,000	\$104,000	-
Cash	General Fund dollars	Supervision, project oversight, guidance	Secured	\$100,000	\$100,000	-
Cash	Reinvest In Minnesota	Lump sum to support all EMN work and MBS Biometrician	Secured	\$250,000	\$250,000	-
			State Sub Total	\$454,000	\$454,000	-
Non-State						
			Non State Sub Total	-	-	-
			Funds Total	\$454,000	\$454,000	-

Attachments

Required Attachments

Visual Component

File: [319a5965-026.pdf](#)

Alternate Text for Visual Component

Statewide map showing the location of plots already established with ML 2016 and 2020 Appropriations, a summary of ML 2020 accomplishments, and a QR code link to the EMN website....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
2021 ENTRF Background Check Certification Form FINAL	001cc2d9-73e.pdf
2022 EMN A Tool to Understand Climate Change	98f1b6cd-b6e.pdf
2020 EMN ML20 Proposal Visual	97604b66-ddf.pdf
2024 EMN ML20 Completion	1c94caf1-66c.pdf
Approved Work Plan Graphic	223dc5a7-b80.pdf

Media Links

Title	Link
Ecological Monitoring Network Webpage	https://www.dnr.state.mn.us/mbs/ecologicalmonitoring/index.html

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Amended budget from original proposed amount to recommended amount of \$800,000. We will also be including additional prairie plots and metro plots as well as ensuring that under-represented counties statewide also have 1 or more plots for the upcoming funding cycle, per LCCMR staff contingencies. Also, reduced the amount of proposed plots for the funding cycle from 500 to 250 to reflect reduced budget plan.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the Commissioner's Plan applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

No

Does the organization have a fiscal agent for this project?

No

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	<ul style="list-style-type: none"> • Budget • Project Collaborators - Project Manager Info • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Travel and Conferences • Attachments 	Within Professional/Technical/Service Contracts, change the focus from 'MN. IT service level agreements for project database and website development' to 'Contracts with Biologists for plot sampling.' We have greater need for this funding to support plot installation. Database work can be supported through other contributing funding sources. Funds were moved from personnel and travel (equally) to increase contracts to \$80,000.	April 22, 2022	Yes	May 4, 2022
2	Amendment Request	<ul style="list-style-type: none"> • Budget • Budget - Non-ENRTF Funds Contributed • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences 	A projection of supply costs shows additional (\$8,000) funds will be needed. Contract funds decreased to balance. Two contributing fund that were not secured were removed. Reduce the contribution from Heritage Enhancement by \$200,000 due to the resignation of the EMN Coordinator. Added \$250,000 State contribution from the Reinvest in Minnesota fund for a lump sum reported previously and the addition of the MBS Biometrician's work.	March 7, 2023	Yes	March 10, 2023
3	Amendment Request	<ul style="list-style-type: none"> • Budget - Professional / Technical Contracts • Budget - Travel and Conferences 	Travel expenses were higher than expected due to additional field staff, mostly increasing lodging and meal costs. As well as an agency wide increase in fleet costs associated with the use of State vehicles. This project's next grant (ML2023) can provide support for further professional contracts if additional funds are needed. Thus project-wide deliverables should not be impacted by this reduction of contract funding.	January 12, 2024	Yes	January 16, 2024

Status Update Reporting

Final Status Update August 14, 2024

Date Submitted: November 18, 2024

Date Approved: December 2, 2024

Overall Update

Work on the EMN will continue under the ML 2023 continuation grant. A total of 25 plots were installed on this appropriation during this reporting period, bringing the project total to 412. Of those, a total of 226 were supported on this appropriation. The goal of 250 plots was not met mostly due to less contractor and seasonal staff capacity than anticipated. However, seasonal hiring and contracting were completely successful this reporting period. Full capacity allowed us to complete two particularly time-consuming groups of plots. One in the Boundary Waters Canoe Area, the other on Red Lake Nation. This also contributed to fewer plots installed than typical in a field season.

Considerable time was spent by the project-led developing a long-term re-sampling strategy for the EMN. Briefly, long-term resampling will be conducted on a ten-year rotation, with an eight-year sampling period and a two-year analysis and reporting period. The MBS biometrician ran simulation analyses to determine there is no impact of varying plot order during re-sampling. Plots will be clustered based on location for re-sampling.

Initial findings using plots completed through 2023 are now available on the EMN website. A handout highlighting final grant accomplishments is attached to this report.

Activity 1

Milestone 1. Previously reported complete.

Milestone 2. Much of this reporting period was spent preparing for 2024 field work, such as reviewing candidate plot locations, obtaining landowner permissions, and coordinating trip logistics such as crew lodging. Seasonal employee hiring was successful, adding three staff to field crews for 2024 to support plot installation. A large contract was renewed, and several small contracts were awarded for field botanists with advanced plant identification skills to assist installing plots. Most contract work was supported on the ML23 continuation grant.

A total of 25 plots were installed on this appropriation during this reporting period. Successful hiring and contracting allowed us to complete a particularly time consuming and difficult group of plots in the Boundary Waters Canoe Area. Over 50 plant specimens were collected, including three rare species and numerous County records.

Milestones 3 & 4. Post-2024 field season data processing, reporting and specimen preparation will be supported by the ML23 continuation grant. Data processing and delivery for all previous years has been completed.

(This activity marked as complete as of this status update)

Activity 2

Milestone 1. Annual landowner and land administrator reporting is complete on this appropriation. Post-field season work for 2024 will be supported by the ML23 continuation grant.

Milestone 2. Initial findings using plots completed through 2023 are now available on the EMN website. As of 2023, 45% of EMN plots are location in upland forests, 27% in open wetlands, 15% in wetland forests and 12% in upland prairies. Overall, the EMN data show clear north-south differences. Heavy browsing by herbivores, such as white-tailed deer, can negatively impact forest vegetation. Forest EMN plots in southern Minnesota appear to be experiencing consistently higher browse pressure than plots in northern Minnesota. Big-toothed aspen experiences the highest browse pressure relative to all woody species overall. Southern prairie EMN plots have higher non-native species cover relative to prairie plots in northern Minnesota. This trend can be seen to a lesser degree in most other Ecological Systems. Prairie EMN plots also have higher non-native species cover relative to forest plots, likely driven by two species, Kentucky bluegrass and smooth brome. Lastly, Invasive earthworm impacts are higher in mesic forests in southern Minnesota relative to northern Minnesota.

Milestone3. See Dissemination update.

(This activity marked as complete as of this status update)

Dissemination

The project-lead served as a technical expert training a multi-disciplinary DNR team on how to use EMN methods as part of long-term forest management monitoring. The project lead continues to engage with a group of zoologist colleagues developing future collaborations. The project lead also explored and recommended the use of NatureServe's Ecological Integrity Assessments as a compliment for landscape-scale analyses using EMN data. The EMN crew engaged in outreach with several groups by inviting internal and external colleagues to join for a day of plot installation. One notable event was volunteers from Winona State University joining plot installation, giving the EMN crew the opportunity to teach them about the EMN.

A handout highlighting final grant accomplishments is attached to this report.

Status Update Reporting

Status Update April 1, 2024

Date Submitted: March 16, 2024

Date Approved: April 10, 2024

Overall Update

Accomplishments and expenses reported as of February 29th, 2024. A total of 77 plots were installed during the 2023 field season, 46 during this reporting period. The project total is now 387 plots. A major upgrade to the EMN database was completed this reporting period. The EMN data are now more secure and compatible with other components of the NHIS, completing Milestone 1 of Activity 1. An improvement in efficiency was gained with the ability to automate landowner report creation within the new database. Substantial work was completed toward Activity 2 Milestone 2. Analyses and initial findings from the network are being created for dissemination on the project website. Information will be provided on: the extent of deer browse, invasive earthworms, and invasive plant species, the coverage of course-woody-debris at plots, and several figures documenting canopy tree composition. The EMN project lead pursued several avenues for outreach and dissemination with internal and external entities. As well as provided technical guidance related to the use of the EMN method to both internal and external entities. Field season planning is currently underway, including an exciting opportunity to collaborate with Red Lake Nation to install EMN plots on their land.

Activity 1

Milestone 1. The EMN database was migrated from a Microsoft Access platform to an ArcGIS-based SDE platform. This involved quite a bit coordination with Information Technology staff and data checking for accuracy and completeness. This new format will make the EMN data more secure and compatible with other components of the NHIS. This Milestone is complete.

Milestone 2. A total of 46 plots were installed within this reporting period, including 7 in the prairie region. Two notable highlights were discovering a rich black spruce and cedar peatland housing several unique orchid species in Roseau County, and a beautiful example of a hill/bluff prairie transitioning into oak savannah in Ottertail County.

Field season planning for 2024 has begun, including evaluating potential plots, creating the field schedule, supply purchasing and intern hiring. One unique element of field planning this year is a collaboration with Red Lake Nation to install EMN plots on their land, to be supported on the ML23 continuation.

Milestone 3. Data processing and quality control checks are complete for data collected in 2023.

Milestone 4. All plant specimens collected within EMN plots have been processed for submission to the Bell Herbarium. The 2023 specimens include several County records.

Activity 2

Milestone 1. With the change in database platform, a new landowner report template was created via an automatic script within the database. This new automation was a great improvement in efficiency to the annual process of disseminating data and plot summaries to landowners and land administrators. All landowner reports for plots installed in 2023 have been delivered. This Milestone is complete.

Milestone 2. Several figures and maps showing preliminary results for most EMN methods have been created. The MBS biometrician has reviewed and approved the summarization methods used to create them. They are currently being formatted for posting on the EMN project website. Preliminary results include information on: the extent of deer browse, invasive earthworms, and invasive plant species, the coverage of course-woody-debris at plots, and several figures documenting canopy tree composition.

Milestone 3. The EMN project lead advised a group from the Nature Conservancy on how the EMN method may be appropriately applied to one of their new research projects. The EMN project lead is currently advising an internal group

of colleagues on how to best collect and analyze data from a long-term forest management monitoring project that is using the EMN method.

Dissemination

The EMN project lead has been engaged with a group of zoologist colleagues in the DNR discussing several potential collaborations with the EMN and contributions of EMN data within the next 10-year revision of the State Wildlife Action Plan. For example, there have been discussions about how EMN data could inform native bird habitat metrics and inform bird species monitoring practices.

The EMN project lead reached out to a research lab at the University of MN studying silviculture practices, particularly assisted migration of tree species. They discussed using EMN data as natural reference condition data for comparison to the lab's long-term experimental tree communities. EMN provided preliminary information about the plot network for their consideration, and they developed plans for future discussions.

Members of the EMN crew delivered an update presentation at the annual MBS report out event. Also see Activity 2 Milestone 3.

Status Update Reporting

Status Update October 1, 2023

Date Submitted: October 24, 2023

Date Approved: October 24, 2023

Overall Update

Accomplishments reported as of June 30, 2023. Much of this reporting period was spent finalizing 2022 data and planning for plot installation in summer 2023. An additional 31 plots were installed by June 2023. The total to date is 341, with 155 of those having been supported by this appropriation.

The MBS biometrician completed a power analysis using data from the first 310 EMN plots. This preliminary analysis concluded that 500 plots is sufficient to fully monitor plant communities across the entire State of MN. The minimum number of plots needed per plant community type varies considerably depending on the analysis performed and metric of interest. The power analysis was able to show that even as few as ten plots per community type can provide basic information about change through time, with long-term, continued resampling. Based on the distribution of plots among plant communities thus far, we expect to need to exceed 500 plots by up to 50 plots in order to target under sampled community types. These revised goals will not impact the work completed under this appropriation. They were accounted for in the final work plan of the EMN ML23 continuation appropriation.

Activity 1

Milestone 1. Improvements were made to the EMN data collection application.

Milestone 2. A good portion of this reporting period was devoted to planning and performing summer 2023 field work. Planning for field work includes an initial GIS site review for the presence of a Native Plant Community, determining potential access routes to the plot location, obtaining landowner permission for plot installation and site access, grouping plots and crews into weekly schedules, and then planning the logistics of travel, supplies, etc. needed to complete the work. Over 100 potential sites were reviewed for summer 2023.

A total of 31 plots were completed in May and June of 2023, including eight more plots in the metro area. One notable highlight was the discovery a new Ginseng population with hundreds of individuals and no signs of being impacted by foraging.

Milestone 4. A total of 98 additional plant specimens associated with EMN plots were submitted to the Bell Herbarium.

Activity 2

Milestone 1. Landowner reports from the 2022 field season have been disseminated.

Milestone 2. The EMN working team began planning for a preliminary report on EMN's methods and initial findings. The powers analysis completed during this reporting period will be included.

Milestone 3. The new EMN lead staff member participated in discussions to implement EMN-style methods in natural origin red pine habitats to monitoring the impacts of timber management.

Dissemination

The EMN lead and Project Manager hosted new members of DNR's Division of Ecological and Water Resources leadership for a field day. It was a great opportunity to share EMNs goals and accomplishments, and gain support for EMNs long-term future. Also see Activity 2 Milestone 3.

Status Update Reporting

Status Update April 1, 2023

Date Submitted: March 7, 2023

Date Approved: March 10, 2023

Overall Update

Accomplishments reported as of December 31, 2022. An additional 63 plots were installed between July and December 2022, exceeding expectations for 93 plots installed in the summer of 2022. The total to-date is 310.

The EMN Coordinator resigned from MBS in December 2022. Some coordinator duties were split among non-grant funded staff, the grant project manager and the MBS biometrician, but most have been assigned to a grant-funded field and data lead.

Due to past struggles hiring seasonal botanists, we combined several MBS efforts to support three new year-round temporary field and data specialist positions. These positions will be supported by this appropriation for approximately 1/3 of each year completing field data collection and data processing.

The MBS biometrician began a power analysis project. Using data from the first 310 plots, this project will:

1. calculate the total number of plots needed for a statistically robust, statewide monitoring network (confirming or modifying the 600-plot estimate originally calculated during project design), and
2. calculate the minimum number of plots needed per habitat to perform smaller, system specific analyses.

A budget amendment is requested to support additional supplies needed, and account for changes to the source and amounts of contributing funds.

Activity 1

1. An improvement was made with the EMN database such that most portions of landowner reports are automatically generated and exported from the database.
2. A total of 63 plots across 35 Counties were installed between July and December 2022. Twenty-five of those were installed across 16 Counties within the Prairie Parkland Province. To-date, 43 plots are installed within Upland Prairie systems Statewide.

An exciting discovery of the field season was at an EMN plot documenting a high-quality Black Ash / Yellow Birch Wet Forest. A very large and expansive area was discovered that contained populations of three *Botrychium* (moonwort) species; *B. tenebrosum* (State Special Concern), *B. matricariifolium*, and *B. angustisegmentum* (State Threatened).

3. Data entry and QA/QC procedures for this field season's data are complete.
4. A total of 68 plant specimens associated with EMN plots were collected, pressed, labeled and are ready for submission to the Bell Herbarium. This included *Juglans cinerea* (State Endangered) and *Arisaema dracontium* (State Special Concern) and a total of 10 county records.

Activity 2

1. Landowner reports for this season's plots have been generated and are in the processes of being disseminated.
2. The full description of the EMN methods has been made accessible and is now available to the public on this page of the DNR website: <https://www.dnr.state.mn.us/mbs/ecologicalmonitoring/index.html#text-1-4>.
3. The EMN crew presented at an annual report out event hosted by MBS, including internal presenters as well participants from the DNR's Scientific and Natural Areas and Nongame programs. Over 300 internal and external stakeholder's and partners attended the virtual event.

The EMN lead engaged in more detailed technical guidance with representatives of Pine County on the conservation value of protecting a site containing rare *Botrychium* species.

Dissemination

See Activity 2 Milestone 3.

Status Update Reporting

Status Update October 1, 2022

Date Submitted: September 23, 2022

Date Approved: October 14, 2022

Overall Update

Accomplishments reported as of June 30, 2022. Shortly before the end of this reporting period, the EMN project received a one-time lump sum of \$184,000 of internal funding. These funds primarily contributed by supporting the 2022 contracts with biologists for plot sampling and back correcting and supporting most staff salary and travel between July 1, 2021 and June 30, 2022. Thus, our current budget update shows less spending than the April 1, 2022 report. Should another amendment be required, this new support will be documented as a contributing fund.

The EMN Coordinator returned from an extended leave of absence during this reporting period. Two interns and one seasonal botanist were hired to assist with the summer 2022 field season. Our original goal was to hire three seasonal botanists. Progress on plot installation was only minimally impacted by this lack of seasonable hiring as we were able to enlist help from other MBS Plant Ecologist/Botanists on staff to serve in an EMN field specialist role. In total, 30 plots were installed during this reporting period, bringing the statewide total to 247.

Activity 1

1. No activity in this period.
2. Much of the work preparing for plot installment was completed during this period. Those activities included: selecting plot locations, obtaining landowner permission or permits, hiring seasonal staff and creating their on-boarding and training schedules, purchasing supplies, and writing and processing professional service contracts for plot installment. A total of 30 EMN plots across 17 Counties were installed during this reporting period, bringing the total to date to 247. Five plots were installed directly in the Twin Cities metro, with another four in counties peripheral to the metro. Total by County list: Anoka (1), Benton (1), Goodhue (1), Hennepin (2), Isanti (2), Lake (1), Lake of the Woods (3), Le Sueur (1), McLeod (1), Morrison (1), Olmsted (1), Pine (2), Pope (1), Ramsey (1), St. Louis (8), Waseca (2), and Washington (1).
A few plot highlights: discovered a new population of *Arisaema dracontium* (Green Dragon), a species of special concern, and documented a high-quality floodplain terrace community.
3. Data are collected digitally via tablet devices and are entered and securely stored in the EMN database daily.
4. Specimens are collected as needed during field work and stored safely for processing after the field season.

Activity 2

1. No activity in this period.
2. The final technical revisions of the EMN Standard Operating Procedures (methods), for both the full and abridged versions, were completed.
3. No activity in this period.

Dissemination

No activity in this period.

Status Update Reporting

Status Update April 1, 2022

Date Submitted: April 22, 2022

Date Approved: May 4, 2022

Overall Update

Work started on this work plan on July 1, 2021. Much of this work plan is a continuation of the ML16 ENRTF Ecological Monitoring Network (EMN) work plan. Field related milestones were less than expected due to continued COVID-related restrictions and precautions. Also, the EMN Coordinator took an extended leave of absence during this period. Therefore, other milestones, particularly outreach and website updates, were also less than expected. Improvements were made to the EMN Access database that will streamline data entry, quality control and extraction. The EMN network contained 186 plots at the start of this grant on July 1, 2022. The difference from the 125 noted on the work plan is largely the plots completed after the submission date of this proposal supported by the ML16 EMN grant. But, a few of those plots were installed with other funding in-between EMN ENRTF grants. Thirty-one plots were added to the network after July 1, 2022 and supported by this funding. There are now 217 total EMN plots installed statewide. Data collected in 2021 have been entered and quality checked, and all landowner reports have been distributed. Lastly, planning for next season's plot installation and data collection is well underway.

Activity 1

1. Database development focused on improving data entry, quality assurance and control tasks, and data extraction from a Microsoft Access database created to house EMN data. Additional features were added to the Access database. Incorporating EMN plot data into the Natural Heritage Information System (NHIS) database has not begun. However, submitting data collected via EMN to preexisting NHIS databases, such as rare species records, is done routinely as part of normal data management.
2. A total of 31 EMN plots across 19 Counties were installed during this reporting period, bringing the total to date to 217. These field related milestones were less than expected due to continued COVID-related restrictions and precautions.
By Count list: Itasca (6), St. Louis (4), Polk (3), Cass (2), Aitkin (2), Lincoln (1), Jackson (1), Mahnomen (1), Clearwater (1), Renville (1), Lyon (1), Becker (1), Otter Tail (1), Swift (1), Carlton (1), Big Stone (1), Pope (1), Douglas (1), and Hubbard (1).
3. All data collected to date have been entered in the EMN database, and all quality assurance and control tasks are complete.
4. All specimens collected to date have been labeled and prepared for accession to the herbarium at the Bell Museum.

Activity 2

1. Work to distribute annual reports from data collected during the summer of 2021 is complete. Examples of land managers or administrators include: DNR Forestry, DNR Wildlife, DNR Parks, Superior National Forest, Chippewa National Forest, and County government.
2. No activity in this period.
3. Two PowerPoint presentations were given, one internal one external, to create awareness of the EMN project and provide summarized results from the summer of 2021. A Facebook post about EMN was created and disseminated in collaboration with DNRs' SNA program.

Dissemination

Progress toward our Data Dissemination is proceeding as planned and up to date. See Activity 2 for details.