Final Abstract

Final Report Approved on December 4, 2025

M.L. 2022 Project Abstract

For the Period Ending June 30, 2025

Project Title: Enhancing Natural Resource Conservation through Species Distribution Modeling

Project Manager: Holly Bernardo

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Funding Source:

Fiscal Year:

Legal Citation: M.L. 2022, Chp. 94, Sec. 2, Subd. 03b

Appropriation Amount: $200,000

Amount Spent: $124,954

Amount Remaining: $75,046

Sound bite of Project Outcomes and Results

Species distribution models (SDMs) are data-driven maps identifying high-likelihood potentially suitable habitat for rare species. 109 SDMs were created for rare plant species. 17 are published and in use informing the environmental review process. All are improving field surveys, with 67 new rare species occurrences discovered through their use.

Overall Project Outcome and Results

The first step to conserving and protecting Minnesota's rare species is knowing where they are. When rare species have not been surveyed, it is difficult for environmental review and conservation planners to assess the likelihood of a rare species or its habitat being present to best mitigate environmental impacts. Despite decades of surveys, our data documenting rare species' occurrences are incomplete.

For that reason, we created a new tool to support the conservation and protection of rare plant species in Minnesota. Species distribution models (SDMs) are data-driven maps that identify high-likelihood potentially suitable habitat for a specific rare species. These maps are non-public data, but will become a standard tool for environmental review and have a wide variety of potential uses for conservation planning.

For this project:

- SDMs were completed for 109 rare plant species,
- 17 SDMs were published for internal use through the DNRs NHIS,
- All SDMs have an accompanying report with full details about its creation,
- 344 validation field surveys were completed for 23 species,
- 67 new rare species occurrences were discovered,
- A method for integrating numerous metrics related to quality was created, resulting in a confidence level assigned to each SDM, and
- A user manual detailing the SDM modelling and confidence assignment methods was created to support proper uses of SDMs in the DNR.

The published SDMs are already in use by DNR staff. For example, they are informing the environmental review process and improving the efficiency of field surveys for rare species. Thanks to this appropriation, the uses of SDMs in support conserving and protecting Minnesota's rare species will continue to grow. This project launched an ongoing body of work to create and refine SDMs until this tool is available for as many rare species in Minnesota as possible.

Project Results Use and Dissemination

The results of species distribution models are considered non-public data. SDMs for 17 species have been published to DNRs Natural Heritage Information System. It is expected that 10 more will be finalized and made available per year. Each SDM has an individual species report detailing how it was created linked directly within the map product. A user manual detailing the SDM modelling and confidence assignment methods was created to support proper uses of SDMs in the DNR. And, a short educational workshop to introduce the SDM method and considerations for their use internally was presented.

Environment and Natural Resources Trust Fund

M.L. 2022 Approved Final Report

General Information

Date: December 5, 2025

ID Number: 2022-048

Staff Lead: Tiffany Schaufler

Project Title: Enhancing Natural Resource Conservation through Species Distribution Modeling

Project Budget: $200,000

Project Manager Information

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Project Reporting

Final Report Approved: December 4, 2025

Reporting Status: Project Completed

Date of Last Action: December 4, 2025

Project Completion: June 30, 2025

Legal Information

Legal Citation: M.L. 2022, Chp. 94, Sec. 2, Subd. 03b

Appropriation Language: $200,000 the second year is from the trust fund to the commissioner of natural resources to create distribution models for rare species in Minnesota to provide new tools for natural areas conservation.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: Create Species Distribution Models (SDMs) for rare species in Minnesota to provide new tools for natural areas conservation and rare species surveys.

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

To help conserve Minnesota's native flora and fauna, conservation planners, environmental impact reviewers, land managers and landowners have to know where the plants and animals are—especially rare species that are in danger of vanishing from the state.

DNR biologists have been conducting field surveys to document where rare species remain in Minnesota. Yet, our information is incomplete. First, we cannot get to all potential locations for every species, and second, we do not have good information for many species on the extent of other unsearched locations where those species also likely reside. As a result:

1.   For sites where rare species have not been surveyed, environmental review and conservation planners have no way of predicting the likelihood of a rare species being present, or of identifying other suitable habitat for a given rare species for mitigating environmental impacts.

2.   Rare species field surveys can be hit-or-miss when surveyors are uncertain about how likely a species will occur in a given location – this makes surveys expensive and inefficient.

3.   Public and private demand for DNR rare species data and expertise exceeds our staff capacities resulting in lost opportunities to protect biodiversity.

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.

This project will address the above issues by developing Species Distribution Models (SDMs) for Minnesota rare species. The project will use: (1) GIS modeling software to integrate known rare species locations with GIS data layers (e.g. LiDAR, climatology, soils, LandSat, and land-use data) to generate predictive habitat suitability maps for a given species, (2) test model predictions by conducting field surveys, and (3) refine the models' predictive success by integrating the new field data back to the model. The final product will include a tested and refined process for modeling species distributions in Minnesota and data-driven maps that identify locations that have the highest likelihood of supporting a specific rare species in Minnesota. For projects undergoing environmental review that lack previous surveys, these maps will become one of the standard tools used for determining the likelihood of a rare species being present and for targeting field surveys.

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?

This project will:
1. Increase our ability to locate suitable habitat in decisions to require field surveys or mitigate environmental impacts in regulatory processes.
2. Increase precision in decisions, such as state listing decisions, by providing data-driven estimates of a species' viability, vulnerability and available suitable habitat.
3. Increase the sharing of knowledge about rare species distributions and habitats by synthesizing an immense amount of subject matter expertise that currently resides inside the heads of a few biologists.
4. Increase the effectiveness of rare species field surveys by identifying and ranking unsurveyed locations where rare species are likely to occur.

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 and In the Future

Activities and Milestones

Activity 1: Develop Species Distribution Models

Activity Budget: $50,000

Activity Description:
Assemble and meet with a technical team of collaborators within and outside the DNR to develop model applications, data inputs and modeling protocols. Consult with other organizations that have experience with SDM, including NatureServe (an international network of conservation science organizations). Identify target species to model that have at least 10 known locations. Assemble SDM software and other tools. Assemble continuous coverage GIS data layers (LiDAR, climatology, soils, LandSat, land-use). Run SDM models on at least 100 rare plant species (and a similar number of rare animal species with federal funding for which these LCCMR dollars are a match). Convene the technical team to review model outputs. Refine and rerun models.

Activity Milestones:

Description	Approximate Completion Date
A technical team identifies target species, model applications, needs, parameters and protocol	September 30, 2022
SDM models are completed for at least 100 species	February 28, 2023
SDM model outputs are reviewed by technical team and protocol adjustments identified	March 31, 2023
Models are refined and rerun based on technical team reviews.	April 30, 2023

Activity 2: Test Model Predictions by Conducting Field Surveys

Activity Budget: $120,000

Activity Description:
Field surveys guided by SDM outputs are conducted in the 2023 and 2024 field seasons. For each field season, a minimum of 10 new SDM-generated locations will be surveyed for at least 10 species (i.e.>100 field survey locations). Results are compiled into the DNR's Natural Heritage Information System databases including the Observation Database and the Rare Features Database.

Activity Milestones:

Description	Approximate Completion Date
At least 10 SDM-identified locations for at least 10 species are surveyed by field staff in 2023 field season	September 30, 2023
2023 field season data are compiled into databases	December 31, 2023
At least 10 SDM-identified locations for at least 10 species are surveyed by field staff in 2024 field season	September 30, 2024
2024 field season data are compiled into databases	December 31, 2024

Activity 3: Refine Models by Integrating New Field Data

Activity Budget: $30,000

Activity Description:
Refine the models' predictive success by integrating new data back in the models and rerunning the models. Apply standard evaluation methods to assess model results. Incorporate validated models in DNR data delivery sites that are available for use by a wide range of people inside and outside the DNR, including environmental review biologists and contractors licensed to access rare species data.

Activity Milestones:

Description	Approximate Completion Date
New data are incorporated into models and models are rerun	February 28, 2025
Technical team evaluates model results and identifies improvements	March 31, 2025
Outputs from validated models are made available for use	June 30, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Regan Smyth	NatureServe	Guidance on tools and procedures developed for species distribution modeling.	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.
MBS data are stored primarily in the DNR Natural Heritage Information System. SDMs will become one of the standard Natural Heritage Information System (NHIS) data delivery products that are provided by the Minnesota DNR through the same means as rare species data and information. MBS often delivers data in response to requests from researchers at academic institutions, government agencies, and other organizations. 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 native and rare species, ecological communities, and sites of biodiversity significance to assist with management plans.

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?
Once built, tested and refined, SDMs will become one of the standard Natural Heritage Information System (NHIS) data delivery products that are provided by the Minnesota DNR through the same means as rare species data and information. The SDMs will be trained over time to improve their predictions through the input of new field survey data and advancements in the related datasets. Ongoing financial support for SDMs will be covered by program funding.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Natural Resource Specialist - Plant Ecologist		Create, refine and evaluate SDM models; field survey SDM-identified locations		X	30%	1.5	X	$151,023	-	-
Natural Resource Specialist - Plant Ecologist		Conduct field surveys to SDM-identified locations			30%	0.2		$25,000	-	-
							Sub Total	$176,023	$106,054	$69,969
Contracts and Services										
							Sub Total	-	-	-
Equipment, Tools, and Supplies										
							Sub Total	-	-	-
Capital Expenditures										
							Sub Total	-	-	-
Acquisitions and Stewardship										
							Sub Total	-	-	-
Travel In Minnesota										
	Miles/ Meals/ Lodging	Travel for one 1-2-person 2 field seasons to sample approximately 20 sites, approximately 10,000 miles. Vehicles ($5,900), lodging ($2,700), and meals	Fleet, lodging, meal expenses while in travel status for field surveys.					$10,000	$4,923	$5,077

		($1,400) in accordance with the Commissioner's Plan.								
							Sub Total	$10,000	$4,923	$5,077
Travel Outside Minnesota										
-							Sub Total	-	-	-
Printing and Publication										
							Sub Total	-	-	-
Other Expenses										
		DNR Direct & Necessary	DNR's direct and necessary costs pay for activities that are directly related to and necessary for accomplishing appropriated projects. HR Support (~$2,829), Safety Support (~$438), Financial Support (~$2,371), Communication Support (~$1,311), IT Support (~$6,019), and Planning Support (~$1,008).					$13,977	$13,977	-
-							Sub Total	$13,977	$13,977	-
							Grand Total	$200,000	$124,954	$75,046

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Personnel - Natural Resource Specialist - Plant Ecologist		Create, refine and evaluate SDM models; field survey SDM-identified locations	Classified position **Classified :** The position being classified was originally hired entirely to support this and previous ENRTF projects. However, the positions' longevity (>3 years) and now mix of funding no longer qualifies for the State's LCCMR unclassified exemption. The positions' unique skills and expertise are required to successfully complete this ENRTF project. The positions' funding over the course of the grant will not change, there is not another source of funding to replace the ENRTF funding for this position at this time; thus, ENRTF funds will not be replacing or decreasing the amount of non ENRTF sources of funds spent on the position during the project period. When the project period ends, the positions' ENTRF funding will end, and the ENTRF approved complement of the agency reduced accordingly.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
In-Kind	State Heritage Enhancement	In kind funds for 0.25 FTE (existing classified NR Specialist SR and Research Scientist 2) for 2 years; DNR GIS/IT professional services.	Secured	$65,000	$65,000	-
Cash	State mitigation dollars	Funds earmarked for SDM for goblin fern (Botrychium mormo).	Secured	$50,000	$30,012	$19,988
In-Kind	General Fund	0.1 FTE for Project management, supervision, administrative support	Secured	$20,000	$20,000	-
			State Sub Total	**$135,000**	**$115,012**	**$19,988**
Non-State						
In-Kind	Federal State Wildlife Grant	LCCMR dollars would be State match to Federal dollars; Federal dollars used for animal SDMs	Secured	$130,000	-	$130,000
			Non State Sub Total	**$130,000**	**-**	**$130,000**
			Funds Total	**$265,000**	**$115,012**	**$149,988**

Attachments

Required Attachments
Visual Component

File: 2548c54d-ac0.pdf

Alternate Text for Visual Component

Graphic illustration of a species distribution model for blanket flower....

Supplemental Attachments

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

Title	File
Background Check Certification Form	cb8e36f6-12e.pdf
SDM Status Table	2dc0f897-c51.pdf
SHM User Manual	5ecd9f61-d19.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

A new reporting schedule was requested. Additions were made to the Dissemination page as instructed. An error in the project managers contact information was corrected. And, information was added to the travel budget justification as requested.

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?
> Yes

Does the organization have a fiscal agent for this project?
> No

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements
> N/A

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	• Budget - Personnel	The position being classified was originally hired entirely to support this and previous ENRTF projects. However, the positions' longevity (>3 years) and now mix of funding no longer qualifies the positions for the State's LCCMR unclassified exemption. The personnel lines were modified to represent the split between the single classified staff member on this project (1st line) and the unclassified staff serving as field assistance to this project (2nd line).	June 30, 2023	Yes	June 30, 2023

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: November 10, 2025

Date Approved: November 13, 2025

Overall Update

Report updates are through June 30, 2025.

Activity 1 was previously marked complete. 109 species distribution models created under this appropriation. Activity 2 is now complete, with a total of 344 surveys completed under this appropriation.

Much of this reporting period was devoted to readying models for dissemination. In total, 17 species distribution models have been made available through the DNRs Natural Heritage Information System (NHIS). Two species are State listed as endangered, eight as threatened and the remaining as special concern. Two species also have Federal level protection. Model quality has been a critical concern. A major accomplishment during this period was developing a system for integrating the quality metrics we assessed into a single confidence level, giving users an easy way to understand proper uses and limitations of each model.

While 17 is a fraction of the 109 created, this appropriation was intended to support the start-up of what will become an ongoing body of work create more and continuing refining existing models. Our goal is to target approximately 10 species a year for the further field work or other refinements needed to ensure the model meets our quality standards prior to adding that model to NHIS.

Activity 1

This activity was previously marked complete.

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

Activity 2

Data processing from the 2024 field season is complete. Additional field surveys for slender milk-vetch were conducted in Spring 2025 in collaboration with the MN PlantWatch program. The collaboration with MN PlantWatch allowed for more extensive searches. The results from 2024 surveys led us to believe this species may be experiencing rapid decline. In 2024, nine previously known locations were chosen for re-survey based on the model results. Slender milk-vetch was not relocated at seven of those and the population size has severely declined since the last survey in one. In 2025, 13 previously known locations were re-surveyed. Slender milk-vetch was not relocated at seven, and the population size had severely declined at three. Together we found loss or substantial decline of this species at 18 of the 22 sites resurveyed. This activity is complete

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

Activity 3

Much of this reporting period was spent evaluating model results and output for dissemination. All field survey data from 2023 and 2024 were processed and used to update those species' models. Model quality has been a critical concern throughout this project. The technical team developed a system for integrating numerous metrics related to quality into a single 'high,' 'medium,' or 'low' confidence level, to give users a quick and easy way to understand the proper uses and limitations of each model. That tool is one component of a technical manual currently being drafted to support users in many ways, from basic interpretation of the results to evaluating the many nuisances important for determining appropriate uses.

In total, 17 species distribution models were made available through the DNRs Natural Heritage Information System. The end-product mimics the structure and symbology of the DNR's Natural Heritage Review package. The attribute table includes confidence ranks and other important information for use. It also links directly to an individual species report, providing many more details about how each model was created. Model results are non-public data. Model output can

be made available upon request to users with the appropriate non-public data use agreements.
(This activity marked as complete as of this status update)

Dissemination

Seventeen species distribution models were made available through the DNRs NHIS. Two species are State listed endangered, eight threatened and the remaining special concern. Two also have Federal level protection. Two models performed with 'high' confidence across all our quality metrics(dwarf trout lily and clasping milkweed). A 'high' confidence model can be used to support a wide variety of conservation actions. Nine models performed at 'medium' confidence and six at 'low' confidence. 'Low' confidence models are still quality products that can guide conservation actions. However, they are most appropriately used as an indication that more information might be useful about a specific species prior to taking an action.

Work to create and distribute materials and guidance to support appropriate uses of this data product is ongoing. The initial release of the first 17 models will serve as a testing phase, during which we intend to evaluate users understanding and needs as they apply models to various types of DNR work. We will then tailor support materials accordingly. Our goal is to target approximately 10 species a year for the further field work or other refinements needed to ensure models meet our quality standards prior to adding them to NHIS.

Status Update Reporting

Status Update April 1, 2025

Date Submitted: March 24, 2025

Date Approved: May 27, 2025

Overall Update

Budget updates are through end of February 2025. Accomplishments updates are through end of March 2025. Activity 1 is now complete, with a total of 109 species distribution models created. Activity 2 field goals have been met, with 344 surveys complete, and data processing ongoing. A few small additional field objectives are being considered for Spring 2025. Most of this reporting period was spent developing the final SDM product structure, tools and resources for their appropriate use, and an first educational workshop for potential users with the DNRs Division of Ecological and Water Resources. The SDM product will be available internally to DNR staff trained in the use of non-public data. There will be an accompanying user manual detailing how SDMs are created, explaining the components of the models and guiding and appropriate uses. And, each species will have an individual report available to users with further information specific to its model. We anticipate only a handful of the 109 models will be ready for dissemination by the end of this appropriation.

Activity 1

The technical team completed one model using a Habitat Suitability Index. They concluded this would be a good avenue to pursue in the future to create species distribution models for data-poor species. They configured an already-made tool in ArcGIS Pro to complete this process and included these methods within the resources being created to document our modeling processes, and explain model results and uses. However, no additional models using this method will be created during this appropriation grant due to time constraints. This activity is now complete with the creation of a total of 109 species distribution models; 108 models via traditional inductive methods and one via the Habitat Suitability Index deductive method.
(This activity marked as complete as of this status update)

Activity 2

All plant specimens collected under this appropriation (total of 110) have been processed and are ready for accessioning into the Bell Museum Herbarium. Other data processing from the 2024 field season is still ongoing. The project total of 344 survey well exceeds the originally planned accomplishments. Additional field work in early Spring 2025 might be planned for early spring flowering species model validation or follow up visits to previous survey locations where needed.

Activity 3

Much of the time during this reporting period was devoted to making outputs from the models available for use. First, the technical team consulted with the DNR NHIS team and concluded that species distribution models should be considered non-public data. With that decision, the project-led began working with DNR Information Technology staff to create the structure of the final SDM product. Briefly, the product will mimic the structure and symbology of the DNR's Natural Heritage Review package within the NHIS. The project-led has also spent considerable time drafting two key resources for SDM users. One, individual species reports detailing how each model was created, which will be available directly from the map product. And two, an in-depth user manual that includes details on the overall methods used, guidance on interpretation of the model results, information about the factors that affect model credibility and suggested uses of the models. We anticipate only a handful of the 109 models will be ready for dissemination by the end of this appropriation.

Dissemination

Most dissemination activities for the models will occur after the map products are available for use. However, an opportunity presented itself to incorporate SDM results for Rubus stipulatus into a newly drafted recovery plan for that species. The project-led has provided content and technical guidance to the team drafting that recovery plan for incorporating this species SMD information, as well as general guidance for how these models might be incorporated into future recovery plans for other species.

The technical team also developed and will present (on March 26th) a short educational workshop to introduce the SDM method and considerations for their use internally. This is the first of what will likely be a series of similar presentations to provide the support that will be needed to use SDMs appropriately. This first event is primarily educational, targeted at a broad audience and done prior to the product being available to stress the message that users will need time to learn how to use this tool, and that resources and support will be available to them.

Status Update Reporting

Status Update October 1, 2024

Date Submitted: September 18, 2024

Date Approved: October 4, 2024

Overall Update

Accomplishments and budget reported through August 27, 2024.

Much of this reporting period was spent preparing for and conducting field surveys. Except three additional model refinements were completed prior to the field season for Astragalus missiouriensis, Xanthisima spinulosa, and Cypripedium arietinum. And, work continued exploring other methods to create models for data-poor species. The technical team decided to pursue a Habitat Suitability Index method.

A total of 158 sites (unique location by species combinations) were surveyed in 2024, bringing the project total to 344. A total of 10 species were targeted for surveys in 2024, bringing the project total to 23. This well surpasses our original goal of 10 locations for 10 species (100 unique location by species combinations) per field season. Twenty-four new Element Occurrences of rare plants species were documented in 2024, bringing the project total to 67, across all targeted and incidentally found species.

The technical team has begun to design the final product format, incorporating elements related to compliance with non-public data requirements and accurate interpretation of model results.

Activity 1

The technical team decided to pursue a Habitat Suitability Index method to create species distribution models for data-poor species. One of these models was created for Aristida longespica. This model is in review by the technical team, which will help determine whether this approach is worth continuing.

Activity 2

A field data collection application was developed prior to the 2023 field season to reduce data entry time and errors and streamline incorporating data into the NHIS. That application was refined and improved for the 2024 field season.

Ten species were selected for field survey in 2024 (Antenaria parvifolia, Astragalus flexuosus, Astragalus missouriensis, Lomatium orientale, Solidago mollis, Synthyris bullii, Trillium nivale, Xanthisma spinulosum, Viola lanceolata, and Trichophorum clintonii). A total of 125 sites were surveyed across all ten species, and 17 new populations were documented. In addition, 33 new sites were surveyed for species that had been primarily targeted in 2023 (Rubus fullerii, Rubus semisetosus, Rubus stipulatus, Rubus multifer, Aristida tuberculosa, and Xyris torta). Two new populations were discovered among those species. Lastly, populations for six other rare plant species (Carex annectens, Cypripedium candidum, Dalea candida var. oligophylla, Gymnocladus dioicus, Juglans cinerea, and Phlox maculata) were discovered incidentally in 2024. Across all species found, 27 new Element Occurrences were documented in 2024.

Activity 3

Three species' models were refined during this reporting period, Astragalus missiouriensis, Xanthisima spinulosa, and Cypripedium arietinum.

The technical team has begun to design the format for the final distributed product. Compliance with non-public data requirements and accurate interpretation of model results have been key topics in these discussions. We expect the final product will be an interpretation of the model results rather than the original output to account for these concerns. At this time, we anticipate that only the highest quality, easiest to interpret model results will be made available through the Natural Heritage Information System by the completion of the grant. Likely a subset of the species that were targeted for field surveys.

Dissemination

No activity during this period. The final product format will inform the creation of a dissemination plan that will likely include both educational and outreach components due to the depth of explanation that will be required to support appropriate use of the information by a broad range of audiences.

Status Update Reporting

Status Update April 1, 2024

Date Submitted: March 22, 2024

Date Approved: May 10, 2024

Overall Update

Accomplishments and budget reported through February 27, 2024. The original Milestones for Activity 1 are considered complete. However, the technical team is still exploring other methods to create models for data-poor species. If that is successful, that work would generally support Activity 1 goals. Field surveys under Activity 2 for 2023 exceeded expectations. A total of 19 rare species were documented across 186 sites. A total of 43 new Element Occurrences were discovered. All 2023 field data have been processed and submitted. Model refinement and review under Activity 3 continues and creating field data collection goals for 2024 has just gotten underway.

Grant spending has been less than anticipated. This is largely a result of 10 of the 13 species targeted for field surveys being eligible for support by State Mitigation funds. Field work in 2024 will be mostly grant supported.

Dissemination activities have been largely paused as we work to determine the best way to present and explain model output, and the best tools for users to appropriately interpret model results. We expect full dissemination of project results to be delayed due to this extra need for caution and supporting materials.

Activity 1

The technical team has been exploring new protocols to create models for species that do not have enough data to model with our current methods. It is too early to know if these methods can be appropriately applied and whether we will increase the number of species modeled beyond the original 108 already completed.

All other review and revision of current models will be reported within Activity 3.

Activity 2

An additional 96 sites were surveyed during this reporting period, bringing the 2023 season total to 186. Most areas surveyed had the potential to house more than one target species. This is why more sites (unique location by species combinations) were able to be surveyed than the original goal.

An additional six target species were surveyed during this reporting period (Rubus fullerii, Rubus semisetosus, Rubus stipulatus, Rubus multifer, Aristida tuberculosa, and Xyris torta). All these species' surveys were supported by contributing funds (State Mitigation).

Also, six other rare plant species were incidentally found during 2023 (Hieracium longipilum, Triplasis purpurea, Cyperus accuminatus, Antennaria parvifolia, Helianthemum canadense, and Chamaecrista fasciculata).

Together, across all 19 targeted and incidentally discovered species, an additional 26 new Element Occurrences were recorded, bringing the 2023 seasonal total to 43. Thirty-three of those new records were of targeted species for which data can be used to continue model refinement. An additional 10 Element Occurrences were previously known, bringing the 2023 season total to 12 updated records.

Activity 3

All data collected in 2023 has been processed and submitted for inclusion in the Natural Heritage Information System, where they will be available for further model refinements. Four species' models were refined with new data during this

reporting period. One more species' model (Trillium nivale) was reviewed and refined as a target for field surveys in 2024. Other model reviews to identify 2024 field targets are currently underway.

The technical team has been exploring additional model building protocols for incorporating negative data into current models. Where these methods are appropriate, they could greatly improve model results.

The technical team identified model improvements through incorporating additional climate data, more precise soil data, and by creating a new spatial dataset measuring the distance from a known location to the nearest wetland.

Dissemination

The project team has found that it is easy to misinterpret species distribution model output, and common even within technically trained audiences. Methods are being developed to convert the highly technical raster-based model output into an easier to interpret shapefile for broader dissemination. Discussions have also begun to determine the type of supporting metadata and depth of explanation that will be required to support appropriate use of these models by a broad range of audiences. At the moment, we expect full dissemination of project results to be delayed due to this extra need for caution and supporting materials for intended users.

Status Update Reporting

Status Update October 1, 2023

Date Submitted: September 6, 2023

Date Approved: October 23, 2023

Overall Update

Accomplishments reported through June 30, 2023 to match financial reporting through the end of the State fiscal year. We exceeded our goal of 100 SDMs, completing models for an extra eight species. We are on track to exceed our first field season goals, with 13 species identified for field work (3 more than expected). Seven species were surveyed during this reporting period across a total of90 of the total 100 promised sites, with still more time to go in the field season. The technical completed development of field validation methods but has been otherwise inactive while the focus of work has been on preparing for and conducting field work.

Activity 1

We conducted a review to determine how many terrestrial State-Listed plant species have enough Element Occurrence data to construct SDMs models. As of the time of that review, only 108 species had sufficient records available to the DNR. Thus, we completed draft models for an additional 50 SDMs, completing all 108 plant species with sufficient data. Fourteen are State-listed endangered (END) plant species, 40 are Threatened species (THR), and 54 are special concern (SPC) species. Technical reviews of the SDMs were completed for 20 of those species determine to be the best candidates for field validation. Refined versions of four SDMs were created are considered complete. Further review and revision of models will continue after field work is completed for 2023.

Activity 2

Survey plans were created for thirteen of the 20 reviewed species, which are the current targets for field work in Summer 2023. The survey planning process is, first, identify top priority sites for each species. Next, extract habitat patches within each site with the highest likelihood of occurrence predicted from the model. And last, plan the logistics for on the ground surveys, for instance, creating survey routes that maximize the number of those habitat patches that can be visited while on site.

Seven species were surveyed during this reporting period (Synthris bullii, Erythronium propullans, Gaylussacia baccata, Hudsonia tomentosa, Nuttallanthus canadensis, Polygala cruciata, Viola lanceolata). Of those, four were supported by contributing funds (State Mitigation). In total, 90 sites were surveyed among the seven species, averaging 12.8 sites per species. Seventeen new Element Occurrences were found, and four known locations were updated.

Activity 3

No activity is possible on these milestones until newly collected data are entered and available for analyses.

Dissemination

No activity. Dissemination efforts will begin when completed models and newly collected data are available for reporting and presentations.

Status Update Reporting

Status Update April 1, 2023

Date Submitted: March 14, 2023

Date Approved: March 21, 2023

Overall Update

Accomplishments reported through February 28, 2023. Work continued at the technical team level, model building began, and models are just beginning to be evaluated for field survey priorities.

The project manager used the list of 100 prioritized species to add refinement and specificity to the use of State Mitigation funds contributing to this work. A total of up to $64,000 were approved for use toward this project to build, review and field test models for at least 12 species. This change will be reflected in the budget should an amendment be required for other reasons.

Activity 1

The technical team has largely completed their literature review, method development and detailed assessment of model applications, needs, parameters and protocols. This team has moved into an advisory role to the main staff member responsible for completing the models. It also continues to be active developing procedures for field testing. Fifty-eight SDMs have been completed in draft form. Method development took longer than anticipated. The technical team extensively reviewed early models created. As expected, that lead to protocol adjustments resulting in those early models being fairly time intensive. However, many of the data needed have now been compiled and we anticipate completing all 100 models by April. Further review of models will be prioritized to those models being used to guide field surveys during the summer of 2023.

The technical team has concluded that review, refinement and re-running models is best done as an iterative process that includes data from field testing where available. We now feel a completion date of June 30, 2025 is more realistic for the last milestone in Activity 1. Or, this milestone is more better considered a task within Activity 3 milestones, and not a stand-alone milestone at all.

Activity 2

Early reviews have been done to start to identify which species and locations will be prioritized for field surveys.

Activity 3

No Activity

Dissemination

No Activity

Status Update Reporting

Status Update October 1, 2022

Date Submitted: September 23, 2022

Date Approved: October 7, 2022

Overall Update

Accomplishments reported through September 15, 2022. All work thus far has contributed to Activity 1 at the project management and technical team level. Focused work creating distributions models for individual species will begin, as planned, in October 2022 after the technical team finishes assembling all resources (e.g. modelling script) needed and identifies target species. Thus, no funds have been spent by staff supported by this appropriation to complete and evaluate individual species models as of this reporting date. In-Kind contributing funds have been expended by technical team members.

The major accomplishment for this reporting period is the completion of the targeted species list by the technical team. One Hundred Endangered, Threatened or Special Concern plant species have been identified and prioritized for modelling in this project.

Activity 1

An internal technical team has been assembled including DNR staff with expertise in the rare flora and fauna of Minnesota, study design and analysis, computer programming, advanced biostatistics, and statistical modeling. That team has reviewed SDM literature and methods, begun to assemble the SDM software and GIS resources that will be needed, and drafted the computer code to execute the SDM models. The technical team has also identified 100 target Endangered, Threatened or Special Concern plant species as priority for modeling in this project.

Activity 2

No activity.

Activity 3

No activity.

Dissemination

No activity.