Final Abstract

Final Report Approved on January 6, 2025

M.L. 2020 Project Abstract

For the Period Ending June 30, 2024

Project Title: Conserving Black Terns And Forster's Terns In Minnesota

Project Manager: Annie Bracey

Affiliation: U of MN - Duluth - NRRI

Mailing Address: 5013 Miller Trunk Hwy

City/State/Zip: Duluth, MN 55811

Phone: (218) 788-2649

E-mail: brace005@d.umn.edu

Website: https://www.nrri.umn.edu/

Funding Source:

Fiscal Year:

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

Appropriation Amount: $198,000

Amount Spent: $198,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

We surveyed 67 wetlands and lakes across Minnesota to document Black and Forster's Terns nesting locations. We suggest future monitoring efforts focus on a few dozen locations where these species reliably occur in high abundance to obtain a meaningful index for detecting changes in breeding numbers across the state.

Overall Project Outcome and Results

Black Terns have experienced a loss of nearly 96% of the state population over 53 years and Forster’s Terns numbers in Minnesota have remained low (<1,000 nesting pairs) since the 1980s. These declines are hypothesized to be associated with loss of suitable nesting habitat and habitat degradation. To fill gaps in our knowledge about the breeding ecology of these species, we conducted a comprehensive assessment of their current and historical distribution and abundance in Minnesota.

We surveyed 67 waterbodies across Minnesota and collected drone imagery at a subset of sites. Black Terns were not observed at 10 of 29 sites where they were previously confirmed to breed and were not observed at 7 of 10 sites where they were historically recorded as breeding. Forster’s Terns were not observed at 5 of 15 sites where they were

previously confirmed to breed and were not observed at 12 of 21 sites where they were historically recorded as breeding. We were unable to confirm breeding of either species using drone imagery and therefore do not recommend this technique for large-scale monitoring efforts.

We suggest a targeted approach for future monitoring, focusing on locations where these species reliably occur in high abundance to obtain a meaningful index for detecting changes in breeding numbers across the state. Maintaining heterogeneity in both vegetation and water depths appears important to both species. We believe the ideal locations for both tern species are sites with the following features: no attachment to a shoreline; abundant floating vegetation present; a mixture of small openings and larger deeper water pockets for foraging. Notably, within our study sites, 67% of Black Terns were observed on state or federally protected lands compared to only 8% of Forster's Terns. Protection of important breeding sites will be key for maintaining both species.

Project Results Use and Dissemination

We received expert advice and worked directly with over 15 state, federal, and tribal agencies to conduct this research across the state. We have provided a final technical report to LCCMR, which describes the methodology used to conduct surveys as well as results and recommendations for future monitoring of these species in Minnesota. This report will be shared directly with all those who provided permits or advice. The final technical report is also available via the Natural Resources Research Institute's website. Results were presented at three conferences (2 local and one national) in 2022 and 2023.

Environment and Natural Resources Trust Fund

M.L. 2020 Approved Final Report

General Information

Date: January 8, 2025

ID Number: 2020-007

Staff Lead: Mike Campana

Project Title: Conserving Black Terns And Forster's Terns In Minnesota

Project Budget: $198,000

Project Manager Information

Name: Annie Bracey

Organization: U of MN - Duluth - NRRI

Office Telephone: (218) 788-2649

Email: brace005@d.umn.edu

Web Address: https://www.nrri.umn.edu/

Project Reporting

Final Report Approved: January 6, 2025

Reporting Status: Project Completed

Date of Last Action: January 6, 2025

Project Completion: June 30, 2024

Legal Information

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

Appropriation Language: $198,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute in Duluth to assess the distribution and breeding status of black tern and Forster's tern and to make conservation and restoration recommendations to improve the suitability of habitat for these two bird species in Minnesota.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: Black and Forster's tern populations have declined. Comprehensive assessment of distribution and breeding status will identify population limiting factors to inform best management practices and prioritize conservation and restoration.

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

Black and Forster's terns are waterbirds that breed in freshwater wetlands with extensive emergent vegetation and open water, preferably located within large wetland complexes. These species have similar habitat preferences and can often be found nesting in the same wetlands. Populations of both species have declined significantly throughout their range in North America over the last 50 years. In Minnesota, Black Terns have experienced a large and statistically significant decline since 1966, decreasing an average of 5.8% per year for a loss of nearly 96% of the state population over 53 years. It has been suggested that the distribution and abundance of Forster's Terns has remained relatively unchanged in the state since the 1980s, although numbers remain low, likely <1,000 nesting pairs. For these reasons, both species are designated as Species in Greatest Conservation Need by the Minnesota Department of Natural Resources and Target Conservation Species by Audubon Minnesota. The main cause of population declines in Minnesota is hypothesized to be loss of suitable nesting habitat and habitat degradation due to invasive plants such as Phragmites, purple loosestrife, and hybrid cattail.

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.

Based on habitat preferences, suitable nesting habitat appears to exist in the state that is not currently being used by these species. Therefore, it is important to characterize changes associated with development, hydrology, and invasive species that have occurred in wetlands that have historically been used for breeding. Given the low site fidelity of Black Terns and the apparent lack of colonization of new sites by Forster's Terns, quantifying landscape changes associated with abandoned colonies in addition to identifying important characteristics of breeding colonies that have persisted over time will allow us to prioritize and develop recommendations for habitat restoration.
1) We will conduct a comprehensive assessment of the current and historical distribution and abundance of the Black Tern and Forster's Tern in Minnesota based on best available data.
2) We will classify habitat suitability and identify key habitat features associated with colony persistence, which will allow us to provide recommendations for best management practices and to prioritize conservation and restoration efforts.
3) We will develop systematic protocols for long-term monitoring of these species in the state.

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 develop long-term monitoring and conservation management plans for Black and Forster's Terns in Minnesota. It will identify management actions for land managers at both site-specific and landscape-level scales. Our results will help inform managers and land-owners about best practices for restoring nesting habitat for these species of conservation concern and will help identify where restoration efforts are most likely to be effective. We will share outcomes with land managers, state and federal government agencies, and non-profit organizations working to conserve these species.

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?

In the Future

Activities and Milestones

Activity 1: Data integration of historical and current breeding sites and wetland monitoring prioritization

Activity Budget: $36,740

Activity Description:
To develop a comprehensive assessment of potential priority wetland complexes, we will communicate with project partners to obtain historical and current breeding records for Black and Forster's terns in Minnesota. We will contact wildlife partners from MNDNR, MNBBA, Minnesota Ornithologists' Union, and Audubon Minnesota to obtain all relevant data and compile it into one geospatial database.

Activity Milestones:

Description	Approximate Completion Date
Obtain and merge data sources and integrate into the breeding colony geospatial database.	October 31, 2021
Identify priority wetlands to use as focal study sites.	May 31, 2022

Activity 2: Determine site quality and habitat characteristics of priority wetlands

Activity Budget: $131,860

Activity Description:
We will locate and inventory potential nesting areas to monitor the status of breeding colonies in priority wetlands. Monitoring will be conducted using a combination of in-person visits and drones, in areas that allow drone flights and where use of drones is logistically feasible. This activity will allow us to assess the feasibility of using drones as part of a long-term monitoring program for tern colonies across the state. We will measure hydrological features, collect water quality data, and develop an index of food availability to assess site-specific conditions. We will also characterize habitat associated with breeding colony locations in the wetlands along with features of individual nest locations. Specifically, we will assess habitat features associated with presence of both species relative to breeding status, including interspersion of hemi-marsh, water level control mechanisms, presence of invasive species, and land use around the wetlands using various geospatial data source (e.g., Global Surface Water dataset, USGS NLCD & Nonindigenous Aquatic Species databases). These data will allow us to determine characteristics of productive colonies, identify features that impact colony success, develop best practices for public land managers, and provide metrics for restoration and conservation initiatives.

Activity Milestones:

Description	Approximate Completion Date
Conduct tern monitoring at priority wetlands for two breeding seasons using in-person surveys and drones	August 31, 2023
Collect data to characterize site quality and habitat features at a subset of priority wetlands	August 31, 2023
Determine characteristics of productive colonies and identify limiting factors for breeding colonies across the state	December 31, 2023
Characterize wetlands used for breeding and analyze impacts of landscape changes on colony persistence	March 31, 2024

Activity 3: Identify priority wetland sites for restoration and develop long-term monitoring protocol for breeding tern colonies.

Activity Budget: $29,400

Activity Description:

To increase the availability of suitable breeding habitat for Black and Forster's terns in the state we will use the landscape model developed in Activity 2 to identify wetland sites that are most likely to sustain breeding tern colonies. We will use the information from Activity 2 to develop site-specific restoration plans that would increase the probability of colony persistence. We will use the monitoring data collected in Activity 2 to develop best practices for restoration and long-term monitoring of breeding Black and Forster's tern colonies in Minnesota.

Activity Milestones:

Description	Approximate Completion Date
Identify priority sites for restoration and develop site specific restoration plans.	June 30, 2024
Determine viability of using drones for monitoring and develop protocol for long-term monitoring	June 30, 2024

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.
This project will provide foundational information necessary to assess the habitat characteristics that are important for breeding colonies of Black Terns and Forster's Terns in Minnesota. We will use the data collected to identify population limiting factors associated with habitat suitability, provide guidance on best management practices that will help to prioritize conservation and restoration efforts. We will distribute our findings to the Minnesota Department of Natural Resources and Audubon Minnesota as well as suggested protocols we develop for long-term monitoring of these species. The findings will be distributed to stakeholders and will be made available via the Natural Resources Research Institute website. In addition, we expect at least one manuscript to be written and submitted for publication in peer-reviewed journals. Results will also be disseminated through webinars and through local, regional, and national conferences. We will acknowledge the ENTRF funding in publications, signage, and other public communications and outreach related to work associated with the project using the trust fund logo or inclusion of language attributing support from the trust fund as appropriate.

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?
This project builds on several current and previous LCCMR funded projects including the “Minnesota Breeding Bird Atlas” (NRRI/Audubon Minnesota), “Implementing Conservation Plans for Avian Species of Concern” (Audubon Minnesota), and “Creating a Statewide Wetland Bird Survey” (Audubon Minnesota). Our breeding colony monitoring protocol and restoration guide will be distributed to land mangers throughout the state. Additional funding will be needed to continue long-term monitoring of breeding terns; we will seek additional funds from available state and federal resources to ensure the long-term conservation of these imperiled species.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Principal Investigator		Project management and coordination.			26%	0.39		$38,932	-	-
Co-Investigators		Provide advice and guidance on project implementation, analyses, and interpretation.			26%	0.03		$5,646	-	-
Research Scientists		Assist with project design, data collection and analysis.			24%	0.3		$21,975	-	-
Research Assistant/Field Technician		Assist with data collection.			8%	0.3		$10,311	-	-
Graduate Student (MS)		Lead field data collection and analysis.			46%	0.75		$61,482	-	-
Undergraduate Researcher		Undergraduate Research Technician assisting with field work			0%	0.32		$10,000	-	-
							Sub Total	**$148,346**	**$148,346**	**-**
Contracts and Services										
							Sub Total	**-**	**-**	**-**
Equipment, Tools, and Supplies										
	Tools and Supplies	Wildlife monitoring and hydrology equipment	Includes remote cameras (e.g., trail cameras) to monitor colony status, pressure transducers for monitoring water levels, misc. supplies for data collection (e.g., batteries, waders, SD cards)					$10,188	$10,188	-
	Equipment	Rechargeable batteries for drones	Additional set of batteries and charger for the drones to extend flight times.					$1,100	$1,100	-
	Equipment	Drone camera attachment	Mount to attach the camera to the drone.					$199	$199	-

	Tools and Supplies	Supplies for building aquatic insect traps	Supplies needed to construct aquatic insect traps to sample food available at the nine focal sites. Supplies include mesh, plastic bottles, pvc, polyethylene foam, hardware, glue, etc.					$2,500	$2,500	-
							Sub Total	**$13,987**	**$13,987**	**-**
Capital Expenditures										
							Sub Total	**-**	**-**	**-**
Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
	Miles/ Meals/ Lodging	Year 1: Miles (8,000 x $0.585 per mile), Meals ($45/day x 30 days x 2 people (bird crew) and $45/day x 6 days x 2 people (fish crew))), Lodging ($100/night x 30 nights x 2 people (bird crew) and $100/night x 6 nights x 2 people (fish crew). Year 2: Miles (10,500 x $0.585 per mile), Meals ($59/day x 36 days x 2 people (bird crew) and $59/day x 8 days x 2 people (fish crew))), Lodging ($100/night x 36 nights x 2 people (bird crew) and $100/night x 8 nights x 2 people (fish crew).	Funds required to travel to field sites and conduct fieldwork					$35,667	$35,667	-
							Sub Total	**$35,667**	**$35,667**	**-**
Travel Outside Minnesota										
							Sub Total	**-**	**-**	**-**
Printing and Publication										

							Sub Total	**-**	**-**	**-**
Other Expenses										
							Sub Total	**-**	**-**	**-**
							Grand Total	**$198,000**	**$198,000**	**-**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
			State Sub Total	**-**	**-**	**-**
Non-State						
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	$86,965	$86,965	-
			Non State Sub Total	**$86,965**	**$86,965**	**-**
			Funds Total	**$86,965**	**$86,965**	**-**

Attachments

Required Attachments

Visual Component

File: 911edc31-a68.docx

Alternate Text for Visual Component

Black Tern and Forster's Tern are pictured in flight. Maps of the distribution of the species in the state, typical wetland habitats and a shallow nest with three eggs on a floating mat of vegetation are also pictured. Text reads: We will conduct a comprehensive assessment of the current and historical status and distribution of Black Tern and Forster's Tern. Determining site quality and habitat characteristics of breeding colonies will allow us to create best management practices and priorit...

Supplemental Attachments

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

Title	File
ENRTF Background Check Certification Form	ceb20c13-c63.pdf
Figure 1	10ac5c8a-5f1.pdf
Approved Research Addendum	69f29822-844.pdf
December 2022 Presentation of Preliminary Results	7b239e31-971.pdf
Conserving Black Terns and Forster's Terns in Minnesota Final Report	148b1d0f-633.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

We updated the years and altered the budget to reflect changes in salaries and supply costs which align with the recommended funding amount. This adjustment resulted in $1,000 less than the amount in the proposal.

In regards to the LCCMR comments:

For comment 1152 'Budget': We itemized the drone set-up into drones, camera, and rechargeable batteries as individual pieces of equipment and added more details about each item and the costs to clarify the expected equipment needs.

For comment 1153 'Dissemination': We added the ENTRF acknowledgements in the dissemination section.

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 UMN Policy on travel 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?

Yes, Sponsored Projects Administration

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	• Attachments • Activities and Milestones	I am requesting to move Activity 1 Milestone 2: 'Characterize wetlands used for breeding and analyze impacts of landscape changes on colony persistence' to Milestone 4 under Activity 2 to better align with workflow and data analyses.	June 7, 2022	Yes	June 7, 2022
2	Amendment Request	• Budget • Budget - Capital, Equipment, Tools, and Supplies • Budget - Personnel • Budget - Travel and Conferences • Budget - Non-ENRTF Funds Contributed	We had an undergraduate working on the project for field work. Supply costs were more than anticipated due to supply chain issues. Our graduate student candidate went with a different program due to the 1 year delay in the legislature (grad search will continue). Travel expenses have been much higher due to challenges accessing sites (fluctuations in water levels) leading to more site visits, and increased costs due to inflation.	November 21, 2022	Yes	November 21, 2022

Status Update Reporting

Final Status Update August 14, 2024

Date Submitted: December 9, 2024

Date Approved: December 10, 2024

Overall Update
A total of 706 Black Terns and 520 Forster's Terns were documented at 67 waterbodies surveyed in 2022 and 2023. Changes in surface water occurrence was associated with both species. However, there were no significant differences in local- or landscape-scale variables between historical and current breeding sites for Black Terns but there were for Forster's Terns. The use of drones to identify nesting terns was challenging, however, by using the drone imagery to classify habitat features, we were able to document how classification varies based on image type (i.e. high-resolution imagery vs. satellite imagery). We found 25 nests during the study, 20 Black Tern nests and 7 Forster's Terns nests. Of these nests, 84% occurred in cattail or some mix of cattails and other vegetation types. Hydrology was variable across focal sites and can help managers determine whether managing for these species is appropriate. We documented 153 aquatic insect taxa from emergent traps and dip net sampling and 26 prey fish species and describe how daily biomass of aquatic insects varied by habitat type. We recommend a targeted approach to monitoring both species in Minnesota focusing on the most abundant and persistent locations for both species.

Activity 1
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 2
Milestone 1:We conducted tern monitoring at 67 wetlands and lakes across Minnesota in 2022 & 2023. In-person surveys were conducted at all sites and drone flights were conducted at 14 sites. Milestone 2: We collected additional data at 18 'focal sites', nine in each year, documenting water-level fluctuations and assessing food availability. We also collected information on dominant habitat features at each focal site. Milestone 3 & 4: Black Tern abundance was positively associated with the amount of emergent vegetation and surface water level changes. Surface water level changes also varied between historical and currently active Forster's Tern breeding sites. Limiting factors are likely the amount of wetlands and water surrounding their breeding colonies.
'In October 2023 update' we stated that 79 wetlands were surveyed. However, 12 of those 79 wetlands were sites that were surveyed in both years (2022-2023), therefore, the total number of sites surveyed during this project was 67 when accounting for site revisits and not 79.
(This activity marked as complete as of this status update)

Activity 3
Based on our study, we recommend a targeted approach to monitoring and managing these species in Minnesota. Identifying several dozen locations where these species occur in high abundance and where they persistently nest would be key. Prioritizing monitoring these selected sites biannually using 10-minute surveys would likely provide a meaningful index for changes in breeding numbers across the state. Focusing on sites where both species are known to nest should also be a priority. Any management actions aimed at attracting these species or maintaining them should consider whether local site conditions are appropriate and can feasibly be maintained. Maintaining heterogeneity in both vegetation and water depths seem to be important to both species. Ideally, locations that are not attached to the shoreline, where floating vegetation and a mixture of small openings and larger deeper water pockets for foraging are available is key. It is not recommended to manage for these species in locations prone to extreme water-level fluctuations or large waterbodies where exposure to wind and storm events could lead to extensive nest failure. At this time, we do not recommend use of drones for long-term monitoring of either species due to logistical constraints (see

final report for details).
(This activity marked as complete as of this status update)

Dissemination
We will distribute our findings to the Minnesota Department of Natural Resources and Audubon Minnesota as well as suggest a protocol for long-term monitoring of these species. These findings will be distributed to stakeholders who provided access to the wetlands and lakes included in this study. We have completed a technical report which provides details of the study and its findings which we will also be made available via the Natural Resources Research Institute website. We will provide any wildlife managers that are interested in obtaining the raw data (e.g., bird counts, fish or invertebrate data, hydrology, etc.) for the sites they manage by request. We will also be presenting these findings at a national conference in January 2025.

We are not currently planning to pursue publication in a peer-reviewed journal. If we do decide to do so, we will attach any publications resulting from this project on the attachments page in the LCCMR portal. The final technical report is now included as an attachment.

Status Update Reporting

Status Update April 1, 2024

Date Submitted: December 9, 2024

Date Approved: December 10, 2024

Overall Update
We have compiled and quality controlled all of the data collected on this project since our last update. Data is currently being summarized and analyzed for the final report. This includes identifying management actions based on our habitat and food availability assessments. Once all data has been formally analyzed we will be able to complete the recommendations for future long-term monitoring efforts for these species in Minnesota as well as provide this information to all project partners and collaborators.

Activity 1
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 2
Since our last update we have compiled and error checked all data. We are now finalizing the spatial data layers, including drone and satellite image classification for our sites. Milestones 1 & 2 are complete and milestones 3 & 4 will be completed by the end of May 2024.

Activity 3
Activity 3 will be completed only after activity two has been completed. We are finalizing our drone imagery classifications and comparing those to satellite-derived imagery to provide information about use of drones for monitoring these species. This is expected to be completed at the end of May 2024.

Dissemination
We do not have any new dissemination activities to report since our last update. The majority of this will happen once the project is completed in June 2024.

Status Update Reporting

Status Update October 1, 2023

Date Submitted: October 2, 2023

Date Approved: December 15, 2023

Overall Update
Our anticipated outcome is to identify which environmental factors influence colony persistence for Black and Forster's Terns in Minnesota and to use that information to identify which management activities would likely be most effective in maintaining colony sites in Minnesota. Additionally we plan to use this information to provide recommendations about how these species should be monitored long-term. We have surveyed 79 wetlands across Minnesota in 2021 and 2022, collected in-depth data at 18 of those sites including deploying well loggers to document changes in water levels throughout the breeding season and collected samples of aquatic insects and fish where feasible. Additionally, we collected drone imagery at 9 of those 18 sites. These data will be analyzed and summarized in the coming months to inform our overall outcomes.

Activity 1
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 2
We have surveyed 79 wetlands over two breeding seasons and documented the status of breeding activity for both species at each wetland/lake. At 18 sites we collected in-depth measurements to assess how water-levels fluctuate across the breeding season and assessed food availability using passive sampling techniques to estimate abundance of aquatic emergent insects at each site and fish at each site, where it was feasible. We will identify the aquatic insects and summarize food availability at each site for both insects and fish. Now that field data collection is complete we will complete data entry and incorporate geospatial data into the analyses to identify which environmental features influence colony stability which will then help to develop BMPs. Activity 2 is 50% complete.

Activity 3
Activity 3 cannot be completed until Activity 2 is complete. We anticipate Activity 2 will be complete by March 2023.

Dissemination
There are no current updates to report on dissemination activities occurring since the last report. We have been in discussion with individuals with the non-game program at Minnesota DNR about how our survey methods could align with their five year colonial waterbird surveys in the state. In terms of other methods of dissemination, because the project analyses are primarily occurring in the coming months, we anticipate there being many upcoming opportunities for us to share our results in the coming year.

Status Update Reporting

Status Update April 1, 2023

Date Submitted: March 30, 2023

Date Approved: April 13, 2023

Overall Update

To date, our primary focus has been on collecting, summarizing, and analyzing the data collected during the first year of the study. This includes quantifying and summarizing the fish and aquatic insect samples at the nine focal sites as well as summarizing the bird survey data and habitat data collected at 33 waterbodies in 2022. We are currently focused on planning and coordinating the second season of fieldwork, which will begin in June 2023 and include 36 additional survey locations. The logistics of conducting these surveys across the state requires many permit requests to access and conduct research on state, federal, tribal, and public lands, including National Wildlife Refuges, and Wildlife Management Areas. This has required substantial effort and we have received permission to conduct our surveys at all of the non-public lands in 2023. Permission to conduct drone flights was not granted on federal lands but we have been given permission to conduct them on 12 of the 18 focal sites we have for this study. These flights will occur during the 2023 field season.

Activity 1

This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 2

Milestone 1: In 2022, we conducted surveys at 33 waterbodies in MN. Both species were detected in 17 of the 33 locations. Black Terns were detected in 64% of sites previously confirmed to be breeding locations, in 40% of sites listed as possible breeding locations, and in 50% of historically active nesting locations (Figure 1). Forster's Terns were detected in 83% of sites previously confirmed as breeding locations, in 25% of sites listed as possible breeding locations, and in 38% of sites listed as historically active (Figure 2).
Milestone 2: In 2022, data were collected at nine 'focal sites'. This included hydrology measurements, fish and aquatic insect sampling. A total of 72 insect samples and 63 fish samples were collected. Identification and summarization of the insect samples is underway. Twenty-three fish species and 12,244 individuals were counted across the nine sites. Fish density per site was calculated using only suitable prey items (i.e. non-benthic and <100 m length).

In 2023, 36 additional waterbodies will be surveyed, nine of which will be focal sites. Drone imagery will be collected at 12 of 18 focal sites.

Activity 3

Milestones 1 and 2 will be completed after all of the data collected (including drone imagery) have been collected and processed/analyzed.

Dissemination

In 2022 and 2023, we disseminated preliminary results of our study at three conferences. This included one national conference 1) The Waterbird Society annual meeting (October 2022) and two local conferences: 2) Minnesota Ornithologists' Union annual paper session (December 2022) and 3) the University of Minnesota Duluth 'University for Seinors' research seminar series (February 2023). We intend to have a meeting with Minnesota Department of Natural Resources, non-game program in 2024 to discuss our results and describe suggestions for long-term monitoring of these species in the state based on our findings. We will also likely present our results at additional local and national conferences in 2023- 2024.

Status Update Reporting

Status Update October 1, 2022

Date Submitted: October 3, 2022

Date Approved: November 21, 2022

Overall Update
We have completed our first of two field seasons documenting current occupancy of wetlands which have historically and/or recently been used by one or both tern species during the breeding season. We have identified important wetlands on state, federal, and public lands that were included in the first survey season. The managers of many of the wetlands surveyed in 2022 were extremely interested in participating in the study as well as being provided the results at the end of this project. We have also collected in depth habitat information and food availability at a subset of sites which will be used to inform managers of the conditions associated with long-term occupancy. Because both species are listed as state or federally important by different agencies, there is great interest in the results of our study which will ultimately provide management recommendations aimed at conserving these species in the state.

Activity 1
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 2
We identified 36 wetlands to survey for nesting terns in 2022 and were able to survey 33. Habitat surveys and in-person bird surveys occurred at each of these 33 sites. At each of the 9 focal sites (i.e. subset of priority wetlands where we conducted more in-depth surveys) we measured changes in water level using HOBO transducers, collected insects using floating aquatic insect traps and macroinvertebrates using dip nets and ponar grabs and fish using a beach seine. We were unable to conduct drone-assisted surveys in 2022, due to supply chain issues, the drone camera we custom ordered was delayed and did not arrive until the breeding season was over in late-July. We plan to conduct drone flights at 6 of the focal 9 wetlands identified in 2022 during the 2023 field season. Therefore, we completed the first of two years of data collection related to milestone # 1 and 2. Milestones # 3 and 4 will occur post 2023 field season when all data has been collected. We will then use that data to assess habitat features associated with occupancy as well as additional geospatial data sources to describe important site-specific and landscape level features for each species.

Activity 3
We do not have progress to report on Activity 3 as it is dependent on Activity 2 being completed.

Dissemination
Many of the 36 wetlands we included in monitoring in 2022 occurred on federal (e.g. National Wildlife Refuges), state (e.g. Wildlife Management Areas, and public lands (e.g. State Parks). Therefore, in obtaining permits to access and utilize these sites for our study we spoke with managers, all of whom were excited about this study and interested in participating and being provided results from this study. One or both species are listed as federally or state important species and so knowing more about them on the lands they manage is a priority. They were also able to provide us with important information about historical use and access. We anticipate many additional connections will be made as we start site selection for 2023 this winter. We will be giving an oral presentation at a Black Tern Symposium hosted by The Waterbird Society in October, 2022 to discuss the project design and preliminary results. We will acknowledge the ENTRF funding and logo in the presentation. We anticipate other opportunities to disseminate information about this project in the next year.

Status Update Reporting

Status Update April 1, 2022

Date Submitted: June 7, 2022

Date Approved: June 7, 2022

Overall Update

We have completed Activity 1 which was to develop a comprehensive assessment of potential priority wetland complexes which were determined to be either historical and current breeding sites of Black and Forster's terns in Minnesota or potential breeding sites. Activity Milestones 1 & 3 have been completed. I requested an amendment to move Activity 1 Milestone 2 to Activity 2 to better align with work flow and analyses.

* We identified 100 candidate wetland locations across the state to include in the study. We also identified 36 sites to survey in 2022 and focal sites where more intensive data collection will occur (Figure 1).
* We are in the process of obtaining all necessary state and federal permits to access wetland sites and conduct research.

Activity 1

To compile this resource, we integrated data obtained from the Minnesota Department of Natural Resources which contained both historical and recent breeding records, as well as current records from the Minnesota Breeding Bird Atlas and eBird, which documents bird distribution and abundance data through spatially explicit checklists collected by birdwatchers globally and which is managed by Cornell Lab of Ornithology.

We uploaded data to ArcMap to filter the data. Data filtering processes were unique to each dataset as they had unique formatting and data inputs. We created new columns that would be shared by all datasets and included information about breeding status and removed any observations that were collected outside of the breeding season (this only applied to eBird records). We then estimated distance to the nearest waterbody (within 500 m radius) and each waterbody was given a unique ID. We then combined each data source by the common field (i.e. waterbody ID) and manually entered lake names where absent. We then inspected remaining bird points that were >500m from a waterbody, to identify most likely waterbody association, if not listed in database notes, or left it NA if not reasonably close to water.

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

Activity 2

We have begun to prepare for the field season including obtaining permission to access state and federal lands and to collect biological samples from Minnesota waters. We have also completed permitting requests for handling fish (Institutional Animal Care and Use Committee [IACUC]) and leaving pressure transducers and aquatic emergent insect traps at our focal sites. Data collection associated with 'Activity 2' will begin in May 2022. This will align with Activity 2 Milestones 1 & 2.

Activity 3

There is no progress to report on Activity 3 since it's completion is contingent on Activities 1 & 2 being completed.

Dissemination

Dissemination of our results will primarily occur at the end of the project. However, we will provide site-specific data to state and federal entities that request it in tern for surveying wetlands that fall within managed lands.