Final Abstract

Final Report Approved on February 7, 2025

M.L. 2021 Project Abstract

For the Period Ending June 30, 2024

Project Title: What's Bugging Minnesota's Insect-Eating Birds?

Project Manager: Alexis Grinde

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Funding Source:

Fiscal Year:

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

Appropriation Amount: $199,000

Amount Spent: $199,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

Grassland habitats promoted higher breeding success for Tree Swallows. Nestling diets were diverse (over 130 families of arthropods were detected) and varied across habitats, despite observed insect diversity being relatively constant. Overall, sites with grassland habitat had higher nestling growth rates, and a diverse bird breeding bird community.

Overall Project Outcome and Results

Aerial insectivores have experienced significant population declines in recent decades. The decline is often attributed to a combination of factors, including habitat loss, changes in land use, climate change, pesticide use, and reductions in the abundance and diversity of insect prey. Insect prey availability is critical for the survival and reproductive success of these birds, as it directly impacts their food resources. This study investigated the relationship between the availability of insect prey and breeding diet and dynamics of Tree Swallows (Tachycineta bicolor), a model species of aerial insectivores, across land-use intensities. Specifically, we assessed differences in breeding success, insect availability, growth rates, provisioning rates, and nestling diet across agriculturally dominated sites, grassland sites, and sites with both habitats. Overall, we monitored 95 occupied nest boxes, banded 74 adults, and obtained measurements on 508 nestlings. Our results showed that breeding season success was positively associated with NDVI ((measure of health and

density of vegetation) and in areas that had higher proportions of grassland at the landscape scale. Insect diversity and biomass was similar across treatments. We found that while provisioning rates did not differ between land-use types, growth rates were highest in sites with both agriculture and grassland habitats, suggesting higher quality prey items. Tree Swallow nestlings are fed a diverse diet that differed in composition across habitats: overall we detected 482 unique genera of arthropods from 130 families and 12 orders. Diptera, Coleoptera, and Lepidoptera were common prey items. The outcomes of this study provide baseline insights into the link between insect prey dynamics and the decline of aerial insectivores. Understanding these relationships is essential for developing conservation strategies aimed at conserving biodiversity and preserving ecosystem function.

Project Results Use and Dissemination

We held four multi-agency meetings to discuss private land conservation priorities, addressing key questions on where, why, and how to focus efforts. Formed working group with Minnesota Land Trust and USFWS to develop climate-forward conservation training. Developed resources and tools to address private landowner concerns, particularly the misconception that small parcels lack conservation impact, emphasizing our results demonstrates that small-scale efforts can significantly benefit insect and bird communities. We also developed "Enhancing Value of Agricultural and Grassland Ecosystems: Management Guidelines for Private Lands" (attached). Next, we will finalize eDNA and insect analyses and submit a manuscript for publication.

Environment and Natural Resources Trust Fund

M.L. 2021 Approved Final Report

General Information

Date: February 7, 2025

ID Number: 2021-032

Staff Lead: Mike Campana

Project Title: What's Bugging Minnesota's Insect-Eating Birds?

Project Budget: $199,000

Project Manager Information

Name: Alexis Grinde

Organization: U of MN - Duluth - NRRI

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Project Reporting

Final Report Approved: February 7, 2025

Reporting Status: Project Completed

Date of Last Action: February 7, 2025

Project Completion: June 30, 2024

Legal Information

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

Appropriation Language: $199,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute to examine the relationship between insect abundance, timing of insect availability, and breeding success for multiple bird species across land-use intensities to develop comprehensive guidelines to conserve bird and insect diversity.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: Examine the relationship between insect abundance, timing of insect availability and breeding success for multiple bird species across land-use intensities to develop comprehensive guidelines to conserve bird and insect diversity.

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

Declines in bird and insect abundance have been documented worldwide with recent reports providing sobering statistics: 29% of North American birds have been lost in the last 50 years and 50% of insect species worldwide are declining. Birds that specialize in eating flying insects such as nighthawks, swallows, and flycatchers, collectively known as aerial insectivores, have shown alarming population declines. Across North America, aerial insectivores have declined 32% since 1970. Populations of familiar and beloved bird species such as Common Nighthawks and Tree Swallows have dropped between 40% and 70%!

While the potential causes of population declines of aerial insectivores include changes in habitat and climate, their reliance on flying insects as an essential food source is likely a key driver. Timing of insect quantity and quality (i.e. high caloric value) throughout the breeding season are important; birds need insects high in fat at key times in the breeding season to produce more offspring. Shifts in timing of insect emergence and loss of insect diversity, abundance, and quality is expected to have cascading effects on food webs and impact ecosystem services (e.g., pollination), thus making the issue especially important for the conservation of Minnesota's 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.

Land-use intensification may be a major factor contributing to declines in insect abundance; however timing of high-quality food availability during the breeding season may influence breeding bird productivity more than insect abundance alone. This study will assess if land-use intensification affects insect abundance, timing of insect availability, and breeding success for multiple bird species.

Specifically, we will assess differences in insect availability across landscapes, ranging from agriculturally dominated to restored grassland prairies. We will then evaluate differences in breeding bird communities in relation to insect availability as well as measure nest and fledging success for two insect-dependent species, Tree Swallow and Eastern Bluebird. These species live in open habitats and while both rely on insects during the breeding season, Eastern Bluebird forage for insects in the vegetation layer whereas Tree Swallows forage for insects in the air. Focusing on these species will allow us to investigate many different types of insects that provide food for birds. Specific objectives include:

- Identify differences in overall insect abundance, diversity, and availability across land-use intensities.
- Assess relative importance of insect quantity and quality on breeding bird communities and focal species nesting and fledging success.
- Develop comprehensive guidelines for long-term conservation of Minnesota's biodiversity.

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?

Minnesota's bird and insect populations are in steep decline. There are no large-scale programs in place to monitor Minnesota's populations of insects or aerial insectivores. We know little about how these populations vary across landscapes and how they are affected by human land use. We will provide foundational information to assess the how land use effects insect and bird communities. This information is critical for the development of holistic, meaningful, and practical land management strategies and also to inform and prioritize conservation actions for the long-term preservation of Minnesota's biodiversity.

Project Location

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

Region(s): Central, NW, SW, NE,

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: Determine impacts of land-use and insect availability on breeding bird communities and document focal species productivity.

Activity Budget: $106,000

Activity Description:
We will identify 12 study areas across land-use intensities (i.e., intensive agriculture to restored prairie). At the study areas we will conduct point count surveys to document the composition of breeding bird communities. To measure nest and fledging success for two insect-dependent species, Tree Swallow and Eastern Bluebird, we will establish a grid of 16 nest boxes at each of the 12 study areas (n = 192) in the fall prior to the first field season. Nests will be monitored in-person during twice weekly visits during the breeding season and camera traps will be deployed at boxes occupied by focal species to document feeding activity, food items, and potential causes for nest failure and juvenile mortality (e.g., predation events). After eggs hatch, we will use a radio-frequency identification (RFID) system to monitor how often adults are feeding juveniles until young leave the nest. Lastly, we will measure weekly growth rates of nestlings and collect fecal samples for dietary analysis. We will use carbon and nitrogen stable isotopes to estimate lipid content and identify types of prey items eaten.

Outcome: Determine relationship between nestling survival and insect food provided by parents. Relate this to insect availability (Activity 2).

Activity Milestones:

Description	Approximate Completion Date
Identify 12 study areas across land-use intensities and deploy nest boxes.	November 30, 2021
Monitor nest fate and hatchling growth and survival.	August 31, 2023
Assess nestling diets using C:N stable isotopes.	October 31, 2023
Quantify breeding and feeding behavior with cameras and RFID technology.	October 31, 2023

Activity 2: Identify conservation priorities and strategies to mitigate loss of insect and bird diversity.

Activity Budget: $33,000

Activity Description:
Findings from Activities 1 and 2 will be integrated to determine if insect and breeding bird communities vary across a gradient of land-use intensity and determine the extent to which availability and quality of food affects breeding success. We will develop comprehensive guidelines that outline how agricultural land use intensity can influence food web dynamics and ultimately productivity which is necessary to maintain Minnesota's biodiversity and to conserve it for future generations. Combining tracking technologies (RFID and stable isotopes) with traditional survey techniques (nest monitoring and insect collection) will produce a robust dataset that will provide a comprehensive picture of how land use influences food web dynamics. Findings from this study will provide the foundational data needed to provide evidence-based guidance on how land use practices can best serve both people and native wildlife species. We will provide our findings to land use managers, agricultural extension agents and others who influence land use practices.

Outcomes: 1) Determine if influence of land-use intensity on insect abundance, timing of insect availability, and breeding success for multiple bird species. 2) Develop guidelines for long-term conservation of Minnesota's biodiversity.

Activity Milestones:

Description	Approximate Completion Date
Provide guidelines to agricultural extension educators and land use managers and agencies.	June 30, 2024
Development of conservation guidelines and priority actions.	June 30, 2024
Quantify impacts of timing of availability of high-quality insects on focal species productivity.	June 30, 2024

Activity 3: Assess impacts of land-use intensity on insect abundance and composition.

Activity Budget: $60,000

Activity Description:
We will conduct insect surveys twice weekly during the breeding bird season (mid-May-June). Four 50 m insect survey plots will be established in each study area (n= 48), and will be randomly placed to ensure complete and unbiased sampling. Plant dwelling insects will be sampled by sweep netting along three of the virtual borders of the survey plots (150 m transect). Flying insects will be sampled using flight-interception traps that will be placed in a sub-set of survey plots. We will calculate size-specific abundance by sorting Insects into size categories that we will count, dry and weigh to estimate size-specific biomass available to feed bird nestlings. We will assess insect diversity in a subset of samples. A subset of samples from each biweekly sampling period will be analyzed for fat content to assess nutritional quality and document the timing and availability of high-quality prey items for birds. Together, these data will allow us to quantify differences in insect total abundance (quantity) and changes in insect composition (quality) throughout the breeding season across land-use intensities.

Outcome: Determine how various land uses affect insect quantity, quality and availability for supporting bird nestlings during breeding season.

Activity Milestones:

Description	Approximate Completion Date
Conduct insect surveys from mid-May to June in 2022 and 2023 breeding seasons.	August 31, 2021
Quantify impact of land-use on insect abundance, composition, and timing of availability.	May 31, 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 how land-use affects insect and bird communities, this is the first critical step in developing comprehensive guidelines for long-term conservation of Minnesota's overall biodiversity. We will use the data collected to provide guidance on how land-use practices can best serve both people and native wildlife species. We will distribute our findings to land-use managers, agricultural extension agents and others who manage lands and influence land-use practices. The findings will be distributed to stakeholders and will be made available through the Internet as a Natural Resources Research Institute report. In addition, we expect several manuscripts 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. All reports and publications from this project will be made available via the Natural Resources Research Institute website. 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?
There is growing concern among scientists that insects, including pollinators such as bees, butterflies and moths, are in steep decline in many areas of the world, which may not only lead to a global biodiversity crisis but also an economic agricultural crisis due to lack of pollinators. This study will provide critical information needed for assessing the impacts of human land use on insects and bird communities and help to identify practical land management strategies for conserving Minnesota's biodiversity. Our results will provide information that land managers can use to promote land management that conserves Minnesota's insects and birds.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Conserving Minnesota's Forest Birds of Management Concern	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 03g	$500,000
Mapping Avian Movement in Minnesota	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 03h	$200,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Research technicians		Bird monitoring, behavior analysis, and insect identification (CS)			24.1%	0.9		$58,730	-	-
Graduate Research Assistants		Two Summer GRA appointments to assist with data collection and analysis.			16.6%	0.4		$11,760	-	-
Research Scientists		Project management, data collect, and analysis (P&A)			26.7%	0.48		$37,865	-	-
Alexis Grinde, Wildlife Ecologist		Principal investigator; Project management and coordination.			33.5%	0.15		$18,754	-	-
Research Technician		Insect sample processing and data management			24.24%	0.02		$10,000	-	-
Research technicians (undergraduate student)		Bird monitoring, behavior analysis, and insect identification			0%	0.01		$500	-	-
Research Technician (temp/casual)		Bird monitoring, behavior analysis, and insect identification			7.6%	0.01		$500	-	-
							Sub Total	**$138,109**	**$138,109**	**-**
Contracts and Services										
University of Minnesota Genomics Center	Internal services or fees (uncommon)	Isotope samples; 3 samples of feces and food availability during each breeding season. Total= $9045 Fecal samples.				0.01		$15,997	$15,997	-
							Sub Total	**$15,997**	**$15,997**	**-**
Equipment, Tools, and Supplies										
	Tools and Supplies	Diet analysis	We estimate there will be 120 active nests each year, and will collect samples 3 times per year for 2 years					$7,100	$7,100	-

			from each nest = $6236 Food availability. We will collect insect samples from each study area 3 times per year for 2 years = $864							
	Tools and Supplies	Nest box monitoring equipment	RFID receivers ($120 ea.) and tags and cameras ($100 ea.) used to monitor nest box activity (Calculated at a total of $220 per nest box for 24 nest boxes)= $5280					$5,280	$5,280	-
	Tools and Supplies	Insect sampling equipment	Flight intercept traps (2 per study area), nets for vegetation sampling, and collection analysis vials.					$6,014	$6,014	-
							Sub Total	**$18,394**	**$18,394**	**-**
Capital Expenditures										
							Sub Total	**-**	**-**	**-**
Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
	Miles/ Meals/ Lodging	Travel associated with fieldwork	Travel for fieldwork, including mileage, lodging, and per diem for field technicians and researchers. Travel is largely associated with nest box monitoring and insect collection and lodging during the 2022 and 2023 field seasons.					$26,500	$26,500	-
							Sub Total	**$26,500**	**$26,500**	**-**
Travel Outside Minnesota										

							Sub Total	**-**	**-**	**-**
Printing and Publication										
							Sub Total	**-**	**-**	**-**
Other Expenses										
							Sub Total	**-**	**-**	**-**
							Grand Total	**$199,000**	**$199,000**	**-**

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	$109,450	$109,450	-
			Non State Sub Total	**$109,450**	**$109,450**	**-**
			Funds Total	**$109,450**	**$109,450**	**-**

Attachments

Required Attachments

Visual Component

File: b7988957-693.pdf

Alternate Text for Visual Component

Title reads "What's "bugging" Minnesota's insect-eating birds?". Two pictures of birds flying frame the text. Text reads "Bird and insect populations are declining worldwide. Aerial insectivore populations have declined 32% Flying insect abundance has declined 75% Knowledge Gap: Land-use intensification may be a major factor contributing to declines in insect abundance; however timing of insect availability may influence breeding bird productivity more than insect abundance alone." Below is ...

Supplemental Attachments

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

Title	File
Sponsored Projects Authorization Letter	3b5c4934-57d.pdf
Research Addendum (revised)	c4e4faec-c40.docx
Background Check Certification Form	464e6bb1-155.pdf
Study area	1335d85e-25b.jpe
Insect sampling	d8478987-3c1.jpe
Management Guidelines	16826e6a-41e.pdf

Media Links

Title	Link
Birds, bugs and climate change: Is erratic weather affecting bird nutrition?	https://www.mprnews.org/story/2023/07/03/birds-bugs-and-climate-change?utm_campaign=20230630_AM_Edition_Newsletter&utm_medium=email&utm_source=sfmc_&utm_content=
'Bugs 'n Birds' study underscores importance of insects	https://nrri.umn.edu/news/birds-n-bugs2

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

I changed the "S" in the title to lowercase.

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	• Budget • Other • Budget - Personnel • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences	Requesting a travel increase due to the increase in costs for hotels due to availability, the increase number of sites visited, and changes in travel due to the weather. We're requesting a Research Technician to be opened because of their expertise in insect sample processing. We were able to reduce the P&A time because the technicians have expertise in insect processing and therefore the effort for P&A staff to train was not needed.	May 15, 2023	Yes	May 18, 2023
2	Amendment Request	• Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies	Requesting to rebudget the diet analysis cost because it was originally budgeted under supplies only, but the cost should have been split between supplies and services. The justification remains the same, except for an increase in costs. We were able to offset costs by reducing P&A personnel time because of the increase efficiency of work. Requesting undergrad and temp/casual lines to be opened because this job class may be needed during field season.	June 1, 2023	Yes	June 2, 2023
3	Amendment Request	• Budget • Other • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Non-ENRTF Funds Contributed	Increased travel was related to the timing of the nesting birds and logistics traveling between sites. Birds were nesting at the same time across study sites, therefore two additional teams out in the field during the peak of the breeding season. This was necessary to collect the data but the result was an increase in travel costs related to additional vehicles, mileage,	December 21, 2023	Yes	December 29, 2023

			hotel, and per diem. Increased services due to higher rates than was quoted.			
4	Completion Date	Previous Completion Date: 06/30/2024 New Completion Date: 12/31/2024	LCCMR administrative workaround for final update.	August 13, 2024	Yes	August 13, 2024
5	Completion Date	Previous Completion Date: 12/31/2024 New Completion Date: 06/30/2024	LCCMR staff administrative workaround for final update.	August 13, 2024	Yes	August 13, 2024

Status Update Reporting

Final Status Update August 14, 2024

Date Submitted: January 6, 2025

Date Approved: January 7, 2025

Overall Update

We assessed differences in breeding success, insect availability, growth rates, provisioning rates, and nestling diet across agriculturally dominated sites, grassland sites, and sites with both habitats. Our results showed that breeding season success was positively associated with NDVI and in areas that had higher proportions of grassland at the landscape scale. Insect diversity and biomass was similar across treatments and tended to be lower in grassland habitats compared to agricultural and mixed treatments, although the difference was not statistically significant. We found that while provisioning rates did not differ between land-use types, growth rates were highest in sites with both agriculture and grassland habitats, suggesting higher quality prey items. Tree Swallow nestlings are fed a diverse diet that differed in composition across habitats: overall we detected 482 unique genera of arthropods from 130 families and 12 orders. Diptera, Coleoptera, and Lepidoptera were common prey items. Our results showed that if nesting sites are available, agricultural lands provide adequate abundance and diversity of insects that contribute to the successful Tree Swallow breeding, however agricultural treatments did not provide habitat to many grassland-dependent species and do not serve as a feasible alternative compared to the ecological value provided by grassland habitats.

Activity 1

A total of 57 bird species and 1065 individuals were detected at the study sites in the 2022 and 2023 breeding seasons. Thirteen species designated as (SGCN) were detected during these surveys. Out of 165 individual SGCN detections, 55% occurred in grassland treatments, 39% in mixed treatments, and 5% in agricultural treatments. Overall, we monitored 95 occupied nest boxes, banded 74 adults, and obtained measurements on 508 nestlings. Our results showed that breeding season success was positively associated with NDVI (measure of health and density of vegetation) and in areas that had higher proportions of grassland at the landscape scale. Insect diversity and biomass was similar across treatments and tended to be lower in grassland habitats compared to agricultural and mixed treatments, although the difference was not statistically significant. We found that while provisioning rates did not differ between land-use types, growth rates were highest in sites with both agriculture and grassland habitats, suggesting higher quality prey items. Tree Swallow nestlings are fed a diverse diet that differed in composition across habitats: overall we detected 482 unique genera of arthropods from 130 families and 12 orders. Diptera, Coleoptera, and Lepidoptera were common prey items.
(This activity marked as complete as of this status update)

Activity 2

Our results showed minimal differences between land-use treatments, but provided evidence that suggests grassland habitats provide multiple benefits in terms of breeding season productivity and biodiversity. The findings of this study offer foundational insights into the connection between land-use, insect prey availability, and the decline of aerial insectivores. Agricultural landscapes that are managed with biodiversity in mind can increase benefits for birds. For example, maintaining and promoting native plants in hedgerows and buffer strips; maintaining or creating small wetlands, ponds, or shallow water areas, and retaining or establishing shelterbelts and woodlots will help to provide habitat features that support a variety of insects and bird species. Crop rotations that include forages such as alfalfa, which can mimic native grasslands and cover crops will help to enhance soil health and increase insect abundance and diversity. Moreover, minimizing the use of chemical pesticides and herbicides by employing Integrated Pest Management will reduce the direct and indirect harm to breeding birds by minimizing the loss of insects. Conserving and restoring large patches of grassland should continue to be a priority, however increasing the overall amount of grassland

available, even in relatively small patches, will provide benefits for biodiversity conservation.
(This activity marked as complete as of this status update)

Activity 3
Over the two-year duration of the project, we captured over 10,000 individual insects from 10 orders via aerial traps and sweep netting across site and landscape composition. In 2022, the aerial traps captured roughly double the number of insects as in 2023 (n = 4,950 vs n =2,403 individuals for 2022 and 2023, respectively) whereas abundance via sweep netting was roughly equal across both years (n = 2,963 vs n = 2,709 individuals for 2022 and 2023, respectively). Insect order abundance and richness had similar patterns across treatments and study areas for both aerial traps and sweep netting. Aerial traps represented flying insects with both richness and abundance dominated by the order Coleoptera followed by Diptera across all treatments and study areas in 2022 and 2023. In 2023, Hemiptera richness was greater compared to 2022 in aerial traps, for 2022, abundance was dominated by Coleoptera, and in the central and north study areas dominated by Diptera. In 2023, insect abundance was Coleoptera across study areas and treatments with the exception of central agriculture and mixed treatments. We intend to continue taxonomic identification to the family level to better understand diversity patterns and dynamics across land-use intensities.
(This activity marked as complete as of this status update)

Dissemination
In fall 2024, we had four meetings with staff from multiple agencies to provide an overview of the results from this project with a focus on continued opportunities for conservation and restoration on private lands; agencies in attendance included MNDNR, NRCS, UMN, USFWS, The Nature Conservancy, Minnesota Zoo, American Bird Conservancy, and Minnesota Land Trust. We formed a working group with Minnesota Land Trust and the private lands division of the USFWS to develop tools and trainings for biologists to identify conservation priorities and determine the need for tools and information that will increase impact of outreach and engagement of private land owners. One piece of feedback that has often given is that private landowners often think that their land parcel isn't "big enough" to make a difference, we hope that our results provide data that will help increase engagement and by making small-scale differences can have large impacts on insect and bird communities. Please see attachment of "Enhancing Value of Agricultural and Grassland Ecosystems: Management Guidelines for Private Lands" document we developed. We are finalizing the eDNA and insect analyses and plan to submit the manuscript in February 2025. We will attach the manuscript, once it is accepted.

Additional Status Update Reporting

Additional Status Update August 14, 2024

Date Submitted: July 1, 2024

Date Approved: August 13, 2024

Overall Update
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2024.

Activity 1
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2024.

Activity 2
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2024.

Activity 3
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2024.

Dissemination
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2024.

Status Update Reporting

Status Update June 1, 2024

Date Submitted: July 1, 2024

Date Approved: August 13, 2024

Overall Update
We have completed the following activities during this reporting period 1.) We completed nest box models, RFID analysis, and dietary analysis. 2.) we completed insect identification of samples collected in 2023 and have run preliminary models related to diversity and treatments, and 3.) extracted NDVI at multiple buffers to use in landscape analysis for provisioning rates and insect diversity.

Activity 1
We have analyzed the point count surveys from 2022 and 2023 to document the composition of breeding bird communities between sites and treatments. We completed the preliminary nest success and growth rate models and are currently using NDVI to determine potential differences between sites, year, and treatments. Due to the lack of difference in isotopic differences between treatments in our preliminary assessment, we focused our dietary analysis on using metabarcoding from fecal material to assess nestling diet. Our results show that diversity diet was higher in 2023 and tended to be greater in grassland sites, diptera was the most common and diverse order in nestling diets followed by coleoptera and lepidoptera.

Activity 2
We have started writing the final report and are currently working on finalizing the models and results.

Activity 3
We collected insect samples in 2023 using the same protocols established in 2022. We sorted and identified the 2023 insects to order and size class, based on preferred prey items for Tree Swallows. We have completed preliminary analysis and are in the process of identifying analytical methods to compare results of fecal samples and insect samples. We have completed preliminary models to assess insect diversity between collection methods and across treatments. In 2023 there was a significant negative correlation between NDVI (less vegetation) and insect richness. We are continuing to build the final models for the final report.

Dissemination
We did not complete dissemination activities during this time of the project.

Status Update Reporting

Status Update December 1, 2023

Date Submitted: December 21, 2023

Date Approved: December 29, 2023

Overall Update
We have completed all field work associated with this project, completed data QA/QC, and are currently conducting preliminary analysis. Specifically, 1.) 2023 field work included nest box monitoring in the three study areas, measuring chicks and collecting feces, banding adults and deploying RFID tags to assess provisioning rates, and insect collection using aerial traps and nets. We also conducted point counts. Data has been entered and error checked, 2.) We extracted DNA from the 2023 fledgling feces samples and they will be sent to the genomics center, 3.) 2023 insect samples are currently being processed, 4.) Preliminary analyses are currently underway.

Activity 1
In 2023 we conducted point count surveys for the second year to document the composition of breeding bird communities. At total of 72 nest boxes (~50%) were used (one or more eggs were layed) by Tree Swallows in the 2023 breeding season, compared to 56 boxes (~39%) in the 2022 season. As in 2022, no Eastern Bluebirds were detected on our study sites in 2023. Of these, 69 (95%) had one or more eggs that hatched and of these 68 nests successfully raised nestlings to fledging age. We banded a total of 39 adult Tree Swallows and deployed RFID units on 25 nest boxes, these data are currently being processed to determine provisioning rates of adults. We completed extracting DNA from the feces collected in 2023 and will send it to the genomics center this spring to determine which insects are present in the feces. After completing preliminary analyses we have determined that there is not a fine enough resolution in the isotopic signals to be a useful method for analysis and the fecal DNA is providing a better assessment of diet that can be directly tied to the insect samples.

Activity 2
Limited activities have been completed at this stage of the project. However, we are on track to complete the work outlined in this section.

Activity 3
We collected insect samples in 2023 using the same protocols established in 2022. We are in the process of sorting and identifying the 2023 insects to order and size class, based on preferred prey items for Tree Swallows. We have completed preliminary analysis and are in the process of identifying analytical methods to compare results of fecal samples and insect samples.

Dissemination
Research was featured in story by Minnesota Public Radio.
https://mail.google.com/mail/u/0/#search/from%3Ajbrenema%40d.umn.edu+%22Grinde%22/FMfcgzGtvsVkDHPVzhkSlCKWVjptBcXw

Status Update Reporting

Status Update June 1, 2023

Date Submitted: May 15, 2023

Date Approved: May 18, 2023

Overall Update
We have completed the following activities during this reporting period 1.) We extracted DNA from fledgling feces and sent samples to the genomics center to assess important food items for fledglings and determine if food items differ across treatment areas, 2.) Completed processing and identification of insect samples collected during the 2022 field season, 3.) Prepared maintenance on nest boxes and field equipment and have started monitoring sites for breeding activity for the upcoming 2023 field season.

Activity 1
During this reporting period we have completed preliminary analyses of the 2022 data and are preparing for the 2023 field season. Specifically, this spring we completed the DNA extraction from fledgling feces (n = 73 samples). DNA was extracted from nestling fecal samples using Qiagen DNeasy® PowerSoil Pro kit , amplification was completed using ANML primers appended with Nextera adapters and was confirmed by running a subsample and visualizing with UV light. We used ANML primers to target the arthropod mitochondrial cytochrome c oxidase I (COI) gene. Primary PCR products and negative controls were sent to the University of Minnesota Genomics Center for indexing PCR and were then sequenced on the MiSeq Illumina platform. These data will be summarized after this field season. In April, we completed seasonal maintenance on the nest boxes at all three study sites, have prepared the RFID technology in preparation for deployment, and have started monitoring the study sites for breeding activity. As of May 8, 2023 Tree Swallows were in the nest building stage in the southern site and had not returned to the central and northern sites, we have not seen bluebirds yet this year.

Activity 2
Limited activities have been completed at this stage of the project.

Activity 3
We completed processing and identifying insect samples (n= 45) collected during the 2022 field season. We sorted insect samples and identified individuals to order and separated by size class, based on preferred prey items for Tree Swallows. We are in the process of entering these data and preparing the data for analyses. We will use the information from the eDNA to identify insect groups that are important food items for fledglings and plan to send these groups for isotope analysis after the 2023 field season. In preparation for the 2023 field season, we performed maintenance on the insect traps.

Dissemination
We have not completed dissemination activities at this point of the project.

Status Update Reporting

Status Update December 1, 2022

Date Submitted: December 22, 2022

Date Approved: December 28, 2022

Overall Update
We completed our first field season for the project in June and July 2022. Work included nest box monitoring in the three study areas, measuring chicks and collecting feces, banding adults and deploying RFID tags to assess provisioning rates, and insect collection using aerial traps and nets. We also conducted point counts at the study sites to characterize bird communities. Data from the 2022 field season has been entered and error checked and feces and insect samples are currently being processed.

Activity 1
In the 2022 field season we conducted point count surveys to document the composition of breeding bird communities. At total of 56 nest boxes (~39%) were used (one or more eggs were layed) by Tree Swallows in the 2022 breeding season, no Eastern Bluebirds were detected on our study sites in 2022. Of these, 42 (75%) had one or more eggs that hatched and of these 37 nests successfully raised nestlings to fledging age (88%). We banded a total of 35 adult Tree Swallows and deployed RFID units on 23 nest boxes, these data will be used to determine provisioning rates of adults. Additionally, we were able to get growth data and feces samples from nestlings from 25 nests. We are currently extracting DNA from the feces and plan to send it to the genomics center this spring to determine which insects are present in the feces.

Activity 2
We have not completed tasks associated with this final activity at this stage of the study, however we are on track for being able to achieve the outcomes.

Activity 3
We conducted insect surveys two times during the breeding bird season using flight-interception traps and sweep nets at each of study areas. These samples are currently being sorted and identified to order.

Dissemination
We have not had any dissemination of our results at this point of the study.

Status Update Reporting

Status Update June 1, 2022

Date Submitted: July 12, 2022

Date Approved: July 13, 2022

Overall Update
Work completed as of June 1, 2022 has focused the following activities: 1.) identifying study areas across land-use intensities, 2.) we established nest box grids in the study sites (n= 144), 3.) we have been monitoring nests since the end of April and we have high box occupancy in all study sites.

Activity 1
We identified and established nest box grids at three study areas across the western MN this year (south, central and north; see attached file: "study area"). Potential study areas were identified using data from the MN Breeding Bird Atlas (mnbirdatlas.org) to identify areas with high densities of our focal species. Once the areas were identified we looked for sites that had core areas (160 acres) and landscape composition (640 acres) with greater than 75% of the habitat treatments (high intensity agriculture, mixed land-use, and grassland). We chose sites within each study area that similar conditions such as development and water features to minimize confounding factors that could influence bird and insect use. We currently have agreements with 15 private land owners to conduct the study on their properties in 2022 and 2023. Due to late winter snow and spring flooding we were not able to access the fourth study area to deploy the nest boxes this year. We may add the fourth study area next year if needed. We have built RFID units and developed methods for monitoring and adults.

Activity 2
Limited work has been completed associated with this activity.

Activity 3
We established insect survey methods for sweep netting to target insects on vegetation and built flying insect traps that will passively collect flying insects over time. The sweep net samples will be conducted three times throughout the breeding season, at each site there will be three 30 m sweep net transects that will occur between the nest boxes. The aerial insects will be sampled using an sampler that consists of a PVC tripod, a clear panel array, a funnel, and Nalgene bottle filled with propylene glycol as a preservative (see attached picture "Insect sampling"). Aerial trap samples will be collected three times throughout the duration of the breeding season. All insect samples will be processed fall and winter 2022.

Dissemination
We are just beginning to collect data for this project, thus there has been no dissemination of information at this point of the project.