2023 Project Abstract
For the Period Ending June 30, 2023

PROJECT TITLE: Quantifying Benefits and Risks of Pollinator Habitat in Agricultural Landscapes

Project Manager: Daniel P Cariveau

Organization: University of Minnesota

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WEBSITE: https://beelab.umn.edu/cariveau-lab
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2017, Chp. 96, Sec. 2, Subd. 03n as extended M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 20

APPROPRIATION AMOUNT: $500,000
AMOUNT SPENT: $496,168
AMOUNT REMAINING: $3,832

Sound bite of Project Outcomes and Results

We installed 20 pollinator plantings in the Minnesota tallgrass prairie regions to study the effectiveness of restorations for conserving native bees. We collected nearly 25,000 native bee specimens from approximately 156 species. We found at least three new state records. We also organized a grower-led field day.

Overall Project Outcome and Results

We used these project funds in concert with federal funding (United States Department of Agriculture) to study the effectiveness of restorations for supporting native bees. Plots were typically in row crop agriculture prior to this study. We examined how the size and the location of the restoration (i.e., the amount of agriculture surrounding the restoration) influenced native bee abundance and richness. Previous studies on restorations have used sites planted by land management agencies prior to the research. This is problematic as researchers have little control over variables that could lead to confounding effects. We surveyed these plots for pollinators over four years. The summer of 2021 was limited due to COVID restrictions. We also examined plots to quantify the amount of the insecticide neonicotinoid in the soil and flowers. We collected and curated 24,657 native bee specimens which will soon be accessioned permanently into the University of Minnesota insect collection. The data associated with these specimens as well as other project data will be available to the citizens of Minnesota as peer-reviewed publications become available. We found that restorations were overall beneficial for native bees with abundance and species richness showing little effect of plot size or location. Further most sites did not have neonicotinoids in the soil and no flowers had a detectable level of this insecticide. Our results suggest that pollinator plantings benefit pollinators with small sites surrounded by agriculture providing similar benefits compared to larger restoration sites with little surrounding area in agriculture. This along with the low levels of neonicotinoids demonstrate the effectiveness of pollinator plantings for supporting native bees in Minnesota's tallgrass prairies.

Project Results Use and Dissemination

Each year we held outreach events for landowners as well as practitioners. These were focused on project updates and sharing our results. Our initial meetings were in person but had to move to Zoom with the COVID epidemic. On June 15, 2023, we held an in-person field day for project participants and the general public. This

field day began at the Nobles Soil and Water Conservation District in Worthington. We then visited a farm to highlight our work to landowners and the general public. We are continuing to work on peer-reviewed publications from the results of this work.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2017 LCCMR Work Plan Final Report

Date of Submission: Sep 27, 2024

Final Report

Date of Work Plan Approval: November 20, 2017

Project Completion Date: June 30, 2023

PROJECT TITLE: Quantifying Benefits and Risks of Pollinator Habitat in Agricultural Landscapes

Project Manager: Daniel P Cariveau

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Telephone Number: (612) 624-1254

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Location: Southwest Minnesota

Total ENRTF Project Budget:	**ENRTF Appropriation:**	**$500,000**
	Amount Spent:	**$496,168**
	Balance:	**$3,832**

Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 03n as extended M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 20

Appropriation Language:
$411,000 the first year and $89,000 the second year are from the trust fund to the Board of Regents of the University of Minnesota for pollinator research and outreach, including, but not limited to, science-based best practices and the identification and establishment of habitat beneficial to pollinators. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

Carryforward; Extension (d) The availability of the appropriation under Laws 2017, chapter 96, section 2, subdivision 3, paragraph (n), Pollinator Research and Outreach, is extended to June 30, 2023.

I. PROJECT TITLE: Quantifying Benefits and Risks of Pollinator Habitat in Agricultural Landscapes

II. PROJECT STATEMENT:

The funding we are requesting from Minnesota's Environmental and Natural Resources Trust Fund will allow us to addresses key questions about pollinator habitat.

- The ***first objective*** and the majority of these funds will be used to establish the large, randomized landscape-level experiment to determine how patch size, landscape context and seed mix influence pollinators and beneficial insects. This will lead to the creation of nearly 150 acres of pollinator habitat in corn and soybean growing areas of Minnesota. Using other funds, we will monitor plantings for pollinators and other beneficial insects (see below). This will be, to our knowledge, the most comprehensive and largest randomized, controlled landscape-scale experiment on pollinator plantings
- The ***second objective*** is to determine pesticide exposure risk across pollinator plantings. We will quantify the amount and types of pesticides in these plantings, beginning with the neonicotinoids, and expanding to other pesticides as funds allow. As we will have data on pollinators and other insects, we will be able to relate pesticide exposure to pollinator and beneficial insect communities.
- The ***third objective*** is to disseminate information and experiences to growers by conducting four grower-led field days. A subset of interested growers will help lead these field days as they will highlight their experiences, successes and set-backs with other growers. By having growers lead the content presented at field days, it will lead to greater adoption of and increased effectiveness of pollinator habitat plantings.

The ENRTF funding is an essential component of a large pollinator habitat study. In addition to this ENRTF request, we acquired $500,000 from the Minnesota Department of Agriculture (MDA), that will allow us to install separate plantings of honey bee habitat on different farms to quantify the benefits to honey bee survival and honey production. We also recently received a recommendation of full funding for a competitive national grant of approximately $700,000 in research funds from the United States Department of Agriculture's Agriculture and Food Research Initiative (USDA-AFRI). The USDA and MDA funds will allow us to monitor pollinator plantings.

The ENRTF funding in conjunction with USDA and MDA funds enables us to answer the following five questions:

1) How does the location and size pollinator habitat influence native bee communities, native bumble bee reproduction, honey production and honey bee survival? (USDA-AFRI & MDA)
2) How does the location and size pollinator habitat influence communities of predatory insects that prey upon crop pests such as soybean aphid? (USDA-AFRI)
3) How does the location and size pollinator habitat influence neonicotinoid exposure? (ENRTF)
4) What are costs, benefits and trade-offs of planting pollinator habitat of different sizes in different locations? (USDA-AFRI)
5) How can we most effectively implement pollinator habitat given different budget constraint scenarios? (USDA-AFRI)

WHY? There is a great need to protect and augment native pollinator populations in Minnesota, and increasing floral resources may be the most effective conservation method. Corn and soybean agriculture make up a large portion of the total land use in Minnesota. Increasing pollinator habitat in these agricultural areas offers some of the greatest opportunity for pollinator conservation. However, there are a number of knowledge gaps as to how to best enhance these agricultural landscapes to benefit pollinators.

- ***Where*** *is the best place to create new pollinator habitat?* Areas planted in pollinator habitat that are

surrounded by large amounts of agriculture may not hold remnant populations of native pollinators, and thus may not be helpful in conservation. Conversely, planting pollinator habitat in areas where there already are surrounding patches of natural habitat, such as old fields, roadsides and fallow fields, could greatly enhance communities of native pollinators that are harbored in these small but important natural areas. This study will help land managers prioritize where to place new pollinator habitat.

- ***What size*** *does a pollinator habitat need to be to be effective?* There are virtually no studies on how planting size influences native pollinators. It is critical to understand this as land managers could prioritize habitat placement depending on how much land is available. For example, if small pollinator plantings (e.g. 1 acre) provide little benefit, land managers might not prioritize planting such small patches. Further, effects of the pollinator plantings will be likely influenced by surrounding landscape. For example, a small pollinator patch surrounded by agriculture may provide little benefit compared a larger patch (e.g., 15 acres). Conversely, as bees are small bodied and able to disperse widely, small patches of habitat may be sufficient. More studies are need to understood how the surrounding landscape and size of planting interact to influence pollinator communities.
- ***Which groups*** *of beneficial insects might be enhanced through pollinator habitat, in addition to pollinators?* The adults of a number of native predatory insect species rely on flowers. These natural enemies can provide large benefits to agriculture as they feed their offspring crop pests such as soybean aphids. If pollinator habitat leads to an increase in these predatory species this may lead to a reduction in the amount of insecticides used.
- ***Does pesticide exposure*** *limit the effectiveness of pollinator plantings?* While agricultural landscapes may offer a number of opportunities to plant flowers, it may be that insecticide use negates the effectiveness of pollinator plantings by creating sinks that put pollinators at increased risk of pesticide exposure. Smaller plantings may have greater insecticide exposure risk. On the other hand, some studies have shown that increasing pollinator habitat can reduce the negative effects of pesticides by providing more uncontaminated floral resources. This is a critical but unanswered question.
- *Finally, how can we* ***maximize the return on investment****?* Pollinator habitat is becoming increasingly expensive. It is necessary to determine how to optimize pollinator habitat to maximize the cost-to-benefit ratio. Reducing economic costs of pollinator plantings while increasing their effectiveness is key to land owner adoption.

The key limitation to understanding these questions is that current studies on pollinator habitat have inadequate study designs and are not comprehensive. Nearly all pollinator habitat studies rely on plantings already established through existing conservation programs (e.g., CRP, or reconstructed prairies). The use of already established habitat violates a number of the tenants of strong experimental design. First, it does not allow for *randomization* in the placement of the habitat. Understandably, land managers design habitat programs where they assume it will be most effective, but this introduces bias. Second, *experimental control* is lacking. There is large variation in seed mixes, planting methods, and management techniques, which introduce noise into the study and make it difficult to determine processes and patterns. To overcome these shortcomings, ***we propose to conduct, to our knowledge, the most comprehensive and largest randomized, controlled landscape-scale experiment on pollinator plantings***.

OUTCOMES: Large, landscape-scale experiments are needed; however, they require extensive collaboration and coordination. The funds requested in concert with those from the MDA and USDA present a unique opportunity to accomplish this ambitious experiment. This study will provide highly robust recommendations for creating pollinator habitat that directly considers the economic cost. For example, we will be able to note the cost of different habitat plans and what benefits they provide for pollinators. Using our results, we will develop a decision support tool to help land managers and growers strategically develop and coordinate conservation

actions to benefit native pollinators and native predatory insects in agricultural areas in Minnesota. This tool optimizes effectiveness of pollinator plantings while explicitly considering economic costs. We will assess the risk of pesticide exposure in pollinator plantings. We expect that landowners will be interested in learning if their crop management affects their pollinator plantings. This could lead to a voluntary reduction in pesticide use. Further, we will disseminate these results to growers and land managers. Finally, we note here that this type of project is the gold standard for landscape studies. We have a number of collaborators interested in working with us to study a diverse array of topics such as disease transmission and pollinator nutrition.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of *June 2018***:** Our focus in the first year has involved outreach and obtaining sites for planting. Therefore, progress to date has been solely for Activity 1. Christina Herron-Sweet has taken the lead on project activities. Christina has a MSc in Ecology and has experience studying pollinators and interacting with landowners. In January 2018, we met with nearly 50 land managers and land owners to discuss this research project. This led to a high level of interest among a number if interested parties. Since that time, we have contacted nearly 100 landowners and have found almost all sites needed for this project. All sites have been visited. We have also purchased a native plant seed mix from Shooting Star Nursery. Currently, we are creating contracts for landowners for land rental fees. In addition, we are creating an RFP for installation of the sites. All contracts will be finalized by the December 2018 update. Planting will begin in late fall 2018.

Activities 2 and 3 will begin after planting of pollinator habitat. As noted above, the process of finding sites has led to extensive outreach and dissemination.

Project Status as of *March 2019:* The focus of this project has been selecting sites, designing and purchase seed mixes, seeding sites, and working with land owners. All but two sites have been seeded and we are preparing for our first summer of field collection. We will sample native bees, predators of crop pests, and flower communities. We will also collect preliminary data on pesticide residues in these sites. We continue to highlight this research in talks to scientists as well as the general public.

Project Status as of *June 2019***:** All sites have been selected and seeded. We are now sampling for pollinators and natural enemies of crop pollinators at these sites. Two or three sites will need to be reseeded as they did not establish well enough. We will complete a total of four sample rounds for the summer of 2019. We also began sampling for neonicotinoid residues at our sites. We have completed the first round of sampling and are currently sampling the second round. These will be sent out for analyses this coming winter. We have highlighted this research to the general public and Christina Herron-Sweet presented a poster of this research at the International Pollinator Conference at the University of California at Davis in July 2019.

Project Status as of *December 2019:* Our research plots successfully established and we have been working on maintaining plots. This has been primarily done through mowing. We also sampled all sites this summer for flowers, native bees, crop pests and insects that prey upon those pests. We are currently processing these data. We have scheduled a grower day this coming spring. The goal is to address any early problems and connect land owners so they can share their experiences. We continued to present at a number of local and national conferences.

Project Status as of *August 2020***:** Our project has experienced a number of delays due to COVID. The pandemic has hampered our ability to conduct work in the lab and we were not able to hire a large field crew due to restrictions on travel and housing. We do have a reduced crew (2 technicians.) Our main goal for this summer has been to maintain relationships with landowners and checking in and managing the research plots. We have been conducting management such as mowing for weed pressure when needed. We have been sampling bees at some plots to test new protocols. We will be sending out plant and soil samples for pesticide analysis this fall or winter. We were able to promote our work to scientists, landowners and the general public. In February, Christina Herron-Sweet presented our project to scientists at the annual Society for Range Management. Kiley

Friedrich conducted a number of presentations at Pheasant Fest in mid-February. In March, we held a meeting in Windom, MN for landowners and habitat restoration practitioners. This meeting was to update our progress, hear their feedback and any concerns.

Amendment Request: We request the following budget reallocations. All of the following reallocations occur within Activity 1. First, for installing the pollinator plots we purchased the seed mix that the restoration company used to plant the pollinator habitat and would like to reclassify seed mix as supplies. Therefore, we request to move the seed mix cost of $63,108 from Professional Services to Supplies in Activity 1. Second, we are conducting more management on these sites than we have originally anticipated and this has necessitated greater need for travel and salary. We request to move $15,000 more from Personal Services to Travel within Activity 1. To account for greater salary needs for site management, we request that we move $60,000 from the Land Rental Fees to the Salary Category. Specifically, we request that the crew leader position be funded at 100% for the three years instead of 75% for three years as originally budgeted. We also request to increase and the postdoctoral research associate to 25% in the second year of the position to from the original 20%. We have saved $60,000 from land rental fees as we have worked with a number of state agencies that do not require these payments.

Amendment Approved by LCCMR 3/28/2022.

Project Status as of *December 2021:* All plots are planted, and we are managing them for weeds and flowers. This is being done in concert with land owners. In the summer of 2021, we employed ten field technicians to collect data on flower communities, native bee communities, bumble bee colony health and natural enemies of crop pests. In total, we recorded over 110 species of blooming plants in these plots. We have identified all bees collected from 2019 and 2020. We collected individual 8,920 bee specimens across these two years. a total of 111 different species. COVID-19 greatly limited our ability to collect data in summer 2020 and only 322 total bee specimens were collected during that summer. In 2019 and 2020, we conducted sweep net sampling for insects that are predators in crop pests. We collected and processed a total of 4,700 specimens of predatory insects. We have prepared the samples for noenicitinoid analysis and will be getting results from these collections by the next report. Finally, we held a remote land owner meeting in the spring of 2021 and are planning a larger field day for land owners and land managers.

Project Status as of *June 2022***:** We have made a lot of progress in the project. In summer 2021, we were able to have to have a full field season. All bees have been processed but we are awaiting final identifications. In total, we collected 10,700 individual specimens. In total, we have collected approximately 20,000 specimens. We still have one more year of data collection. Early analysis suggests that seed mix type does not influence native bee abundance or species richness (number of species). This finding is important as it may be the case that cheaper seed mixes support native bees as well as more expensive mixes. We will continue to analyze native bee community dynamics and including 2021 and 2022 data will allow us to investigate temporal patterns of restoration. We conducted a preliminary trial of bumble bee colony dynamics. This research took place at four sites (two different seed mix types). The data are quite preliminary however it seems that the number of queens and workers were higher near more expensive and diverse seed mixes. We are currently conducting a larger study on bumble bee colony dynamics (summer 2022). We have now sampled 21 sites for natural enemies of crop pests. We have processed data from 30 sites. This included 19,946 pest specimens and 6,367 predatory specimens. Early results suggest that plots surrounded by high agriculture have more predators and fewer pests. The less expensive seed mix has more predators as well as more pests. The samples are currently being processed by the United States Department of Agriculture's National Science Laboratory. We have also held one landowner outreach day since our last update. We are currently collecting data in our final field season.

Project Status as of *December 2022:* We completed a summer of sampling for native bees at the high diversity seed mixes. We collected approximately 6,000 specimens. In total we, have collected approximately 25,000 native bee specimens of approximately 160 species, at least two of these species are new records to state of

Minnesota. We collected a total of 8 bumble bee species. One species, the American bumble bee (*Bombus pensylvanicus*) was the most common bumble bee and is categorized as Vulnerable but the International Union of the Conservation of Nature. The fourth most common bumble bee, the golden northern bumble bee (*B. fervidus*), is also listed as Vulnerable by the IUCN. We are finished processing our natural enemy specimens. We currently have about 30,000 insects counted. We are finalizing the data entry and cleaning. We have received our samples of soil and flower neonicotinoids. We had generally low quantity of neonicotinoids in the soil and none in the flower samples. We are finalizing the cleaning and organizing of a complex data set.

Amendment Approved by LCCMR 08/04/2023

Amendment Request: We had higher than anticipated labor needs and are requesting we move $47,324 to personnel. We would like to move funds from three sources. First, we used other funds and used crew leader time to manage plots in collaboration with landowners. Therefore, we saved $8,753, of these funds and request that they be moved to be moved to personnel. Second, we also used other funds and saved on travel expenses. Therefore, we request $8,975 for travel to moved to personnel. Third, we saved $29,596 on pesticide sampling as the cost was lower and the first quite large batch of pesticide samples had almost no detectable neonicitinoid presence.

We are also requesting some moving $3,368 to lab supplies as we needed to purchase native bumble bee colonies due to challenges of pathogens and mortality in wild caught bumble bees. We request moving funds from the following three sources. First, while used most of our funds for leases, we were able to spend $1,956 less than we had predicted and request to move these funds. Second, we are planning on outreach event this month and one of the landowner has allowed us to use their land for the event are thus able to save $624.

Overall Project Outcomes and Results:

We used these project funds in concert with federal funding (United States Department of Agriculture) to study the effectiveness of restorations for supporting native bees. Plots were typically in row crop agriculture prior to this study. We examined how the size and the location of the restoration (i.e., the amount of agriculture surrounding the restoration) influenced native bee abundance and richness. Previous studies on restorations have used sites planted by land management agencies prior to the research. This is problematic as researchers have little control over variables that could lead to confounding effects. We surveyed these plots for pollinators over four years. The summer of 2021 was limited due to COVID restrictions. We also examined plots to quantify the amount of the insecticide neonicotinoid in the soil and flowers. We collected and curated 24,657 native bee specimens which will soon be accessioned permanently into the University of Minnesota insect collection. The data associated with these specimens as well as other project data will be available to the citizens of Minnesota as peer-reviewed publications become available. We found that restorations were overall beneficial for native bees with abundance and species richness showing little effect of plot size or location. Further most sites did not have neonicotinoids in the soil and no flowers had a detectable level of this insecticide. Our results suggest that pollinator plantings benefit pollinators with small sites surrounded by agriculture providing similar benefits compared to larger restoration sites with little surrounding area in agriculture. This along with the low levels of neonicotinoids demonstrate the effectiveness of pollinator plantings for supporting native bees in Minnesota's tallgrass prairies.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Implement nine different-sized pollinator habitat plantings in two landscape types

Description: ENRTF funds will be used to plant the native floral habitat. We will implement two main experimental treatments to test the effect of this habitat on native pollinators. First, we will install native floral

plantings that range in size from 1 to 15 acres. Each size class will increase by 1.75 acres for a total of 9 size classes (1, 2.75, 4.5, 5.75…15 acres). Second, these size classes will be replicated across two landscape types: 1) High agriculture (<1% of 1500m surrounding the planting will be natural/semi-natural habitat) and 2) Moderate agriculture (10-20% of 1500m surrounding the planting will be in natural/semi-natural habitat). This results in a total of 18 plantings (9 in each landscape type) for a total of 144 acres. All s will contain locally-sourced native plants that meet requirements of NRCS CP42 pollinator mixes. We note here that we are using funds from the MDA to plant honey bee habitat, which contains a mixture of native and non-invasive, non-native floral species. We will use the same experimental design. We expect some native bees to forage on the honey bee habitat and some honey bees to forage on the native habitat.

We are focusing on southeastern Minnesota for two reasons. First, this research depends on having locations with high agricultural land use (<1% in natural/semi-natural habitat) and we are confident we can locate sites for plantings that meet this research objective. Second, we will focus on a specific region to minimize variation that can occur across regions (e.g., soil and moisture conditions) and can sometimes mask treatment effects. Finally, we emphasize that these plantings are experimental treatments and not conservation-focused restorations. While they will benefit native insects, the goal of placement and installation is to address specific hypotheses that researchers have not been able to test to date.

Our goal is to place the native pollinator plantings on permanently or long-term protected (e.g. Minnesota CREP, Reinvest in Minnesota, WMAs, CRP, etc.) lands. This will help ensure that the conservation benefits of these practices continue past the life of the project. Second, this will reduce the cost, as ***we will not pay rental fees on land that is currently enrolled in conservation programs***. However, at the majority of plantings, we may have to pay land rental fees. The ability to pay rental fees increases the number of sites available for plantings and thus it is an essential tool to ensure that we can adequately implement our experimental design. If we are able to reduce rental fees requested in Activity 1, we will work with LCCMR staff to redirect the funds to sample for pesticides beyond neonicotinoids (As described in Activity 2). Finally, to determine price of rental fees, we will use county-level CRP rental rates.

We will begin sampling plant communities, native bees, bumble bee reproduction, predatory insects of crop pests, and honey bee survival and honey production in the spring of 2019 following protocols outlined in the USDA-NIFA grant proposal. Sampling will take place for four years after planting. We note that the sampling and decision tool development for Outcomes 4 & 5 are not directly funded through ENRTF. We have listed them here as we are requesting ENRTF funds to implement the plantings. Using these data, we will create a decision support tool with Eric Lonsdorf – Institute on the Environment, University of Minnesota. While this tool will be developed using USDA funds, we will make it available to growers and conservation practitioners involved in this study as well as throughout the state of Minnesota.

Finally, while we already have generated a great amount of interest among growers and landowners, we highlight here potential alternatives if we are not able to get enough sites for plantings. First, we will prioritize planting of the 18 high-diversity, locally-sourced pollinator plantings (as requested by this ENRTF) over the honey bee habitat plantings (from MDA funding). This is because native plantings will take longer to establish. Second, if we are still unable to acquire 18 sites for plantings, we will reduce the number of size classes in the middle of distribution. This will allow us to test the extremes in size classes (small vs. large) and would still provide valuable information.

Summary Budget Information for Activity 1:

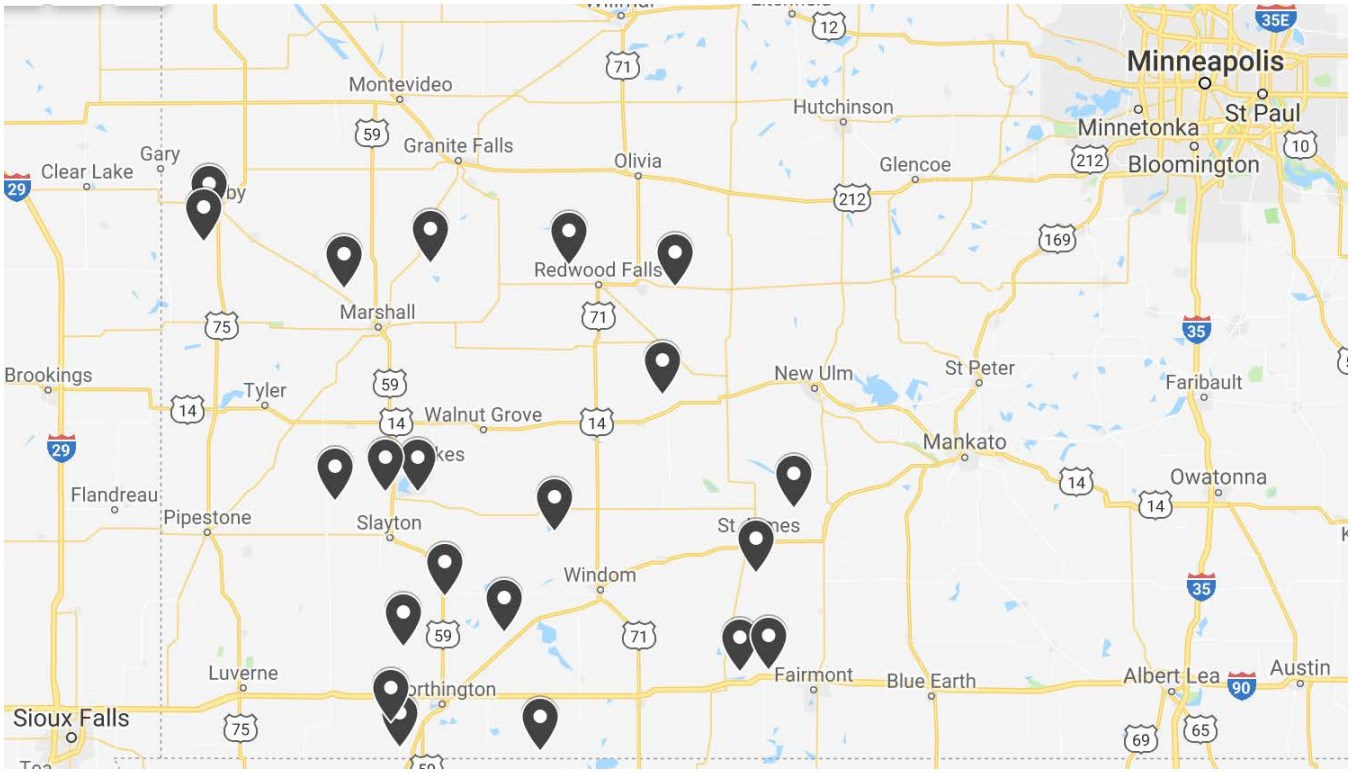
ENRTF Budget: $ 338,770
Amount Spent: $ 338,780
Balance: $ 0

Outcome	Completion Date
1. Find 18 sites for plantings in southeast Minnesota, set-up contracts for 18 plantings.	November 2018
2. Plant 18 sites in high diversity, locally-sourced native seed mix	November 2018
3. Mow and spray plots to control for invasive plants	July 2019-2022

4. Quantify effect of plantings on native bee diversity, bumble bee reproduction, abundance of predatory insects of crop pests, and honey production and honey bee survival. (USDA-AFRI & MDA funding)	Summers 2019-2022
5. Using data from outcome #4 above**,** develop decision support tool to create pollinator planting strategy that maximizes benefits to pollinators and other beneficial insects given budget constraints. (USDA funding).	Summer 2022

Activity 1 Status as of *June 2018***:** In January 2018, we met with nearly 50 land managers and land owners to discuss this research project. This led to a high level of interest among a number if interested parties. Since that time, we have contacted nearly 100 landowners and have found almost all sites needed for this project. All sites have been visited. We have also purchased a native plant seed mix from Shooting Star Nursery. Currently, we are creating contracts for landowners for land rental fees. In addition, we are creating an RFP for installation of the sites. All contracts will be finalized by the December 2018 update. Planting will begin in late fall 2018.

Activity 1 Status as of *March 2019:* We have selected a total of 20 sites and 116 acres for seeding for native bee habitat (see Map below). A total of 11 private land owners are involved in this project. As of December, all but two sites have been seeded. The seed mix used for these sites are attached. We have hired a full field crew for the summer of 2019 and will begin sampling plant communities, bees and natural enemies (using other funds). We will also be surveying plots to assess management needs such as controlling invasive plants and mowing.



Map of pollinator habitat sites

Activity 1 Status as of *June 2019***:** All sites have been selected and seeded. We are now sampling for pollinators and natural enemies of crop pollinators at these sites. Two or three sites will need to be reseeded as they did not establish well enough. We will complete a total of four sample rounds for the summer of 2019.

Activity 1 Status as of *December 2019:* All sites are installed and we have been overseeing maintenance on these sites. This mainly involves mowing and checking for plant establishment. All sites were sampled this past

summer (2019) for insects and flowers. We collected approximately 8,000 specimens of wild bees. They are currently being sorted and will be identified late winter 2020. We used sweep nets to collect a number of samples of crop pests and insects that prey upon those pests. We are in the process of counting and identifying these specimens and currently have identified 2400 of 26 different groups. We look forward to presenting summaries of these results in the next report.

Activity 1 Status as of *August 2020***:** All of the plots have been planted. We have continued to maintain relationships with landowners. We have been visiting plots to evaluate weed pressure and determine management needs. We have been collecting some data on plants and bees to test protocols. However, we were not able to hire a large field crew and therefore have not been able to collect data in the manner we had hoped. We have a number of bees that have yet to be identified from summer 2019. We are just returning to the lab to finalize these identifications this fall and winter.

Activity 1 Status as of *December 2021:* All plots are planted, and we are managing them for weeds and flowers. This is being done in concert with land owners. In the summer of 2021, we employed ten field technicians to collect data on flower communities, native bee communities, bumble bee colony health and natural enemies of crop pests. In total, we recorded over 110 species of blooming plants in these plots. We have identified all bees collected from 2019 and 2020. We collected individual 8,920 bee specimens across these two years. a total of 111 different species. COVID-19 greatly limited our ability to collect data in summer 2020 and only 322 total bee specimens were collected during that summer. In 2019 and 2020, we conducted sweep net sampling for insects that are predators in crop pests. We collected and processed a total of 4,700 specimens of predatory insects.

Activity 1 Status as of *June 2022***:** In summer 2021, we were able to have to have a full field season. All bees have been processed but we are awaiting final identifications. In total, we collected 10,700 individual specimens. In total, we have collected approximately 20,000 specimens. We still have one more year of data collection. Early analysis suggests that seed mix type does not influence native bee abundance or species richness (number of species). This finding is important as it may be the case that cheaper seed mixes support native bees as well as more expensive mixes. We will continue to analyze native bee community dynamics and including 2021 and 2022 data will allow us to investigate temporal patterns of restoration. We conducted a preliminary trial of bumble bee colony dynamics. This research took place at four sites (two different seed mix types). The data are quite preliminary however it seems that the number of queens and workers were higher near more expensive and diverse seed mixes. We are currently conducting a larger study on bumble bee colony dynamics (summer 2022). We have now sampled 21 sites for natural enemies of crop pests. We have processed data from 30 sites. This included 19,946 pest specimens and 6,367 predatory specimens. Early results suggest that plots surrounded by high agriculture have more predators and fewer pests. The less expensive seed mix has more predators as well as more pests. The next step in this process will be to analyze pests and predators based on specific groups. We have also been sampling vegetation. In 2019 and 2021, we took data on over 7,000 1 x 1 meter quadrats. The most abundant native plants were *Achillea millefolium, Helianthus maximilani, Verbena stricta, Rudbeckia hirta, Heliopsis helianthoides, Ratibida pinnata, Ratibida columnifera, Solidago canadensis, Monarda fistulosa,* and *Verbena hastata*. We will use these data to analyze the success of the pollinator plantings and determine whether native bees are preferring certain plant species above the abundance in the plots.

Activity 1 Status as of *December 2022:* We have just finalized all data entry and nearly done with data cleaning. This is a highly complex data set including data on native bee specimens, bumble bee colony success, vegetation, flower surveys, soil and flower neonicotinoid quantity, natural enemies of crop pests, and herbivorous insects including crop pests. We have finished collecting native bees and vegetation data. In total we collected approximately 25,000 specimens of 160 species. We collected at least two new state records. We collected bees using bee bowls and hand netting. Hand netting allows for the use These specimens were collected off nearly 80 species of flowers. The most visited flowers were Maximilian sunflower (*Helianthus maximiliani*), golden alexander (*Zizia aurea*), prairie coneflower (*Ratibida pinnata*), lance-leaved coreopsis (*Coreopsis lanceolata*), and bee balm (*Monarda fistulosa*). We recorded over 140 species of blooming plants in the floral counts. Based on

quadrat number, the five most common native blooming flowers were yarrow (*Achillea millefolium*), hoary vervain (*Verbena stricta*), black-eyed susan (*Rudbeckia hirta*), Maximilian sunflower (*Helianthus maximiliani*), and false sunflower (*Heliopsis helianthoides*). We have collected and cataloged over 30,000 insect specimens from our sweep net samples. Emma Dombrow presented the preliminary results of this work at the national Entomological Society of America meeting in Vancouver, BC. Emma found that there were more herbivorous and predatory insects in the low diversity seed mix as compared to the high seed diversity mix. However, there was no evidence that either herbivores or predators spilled over into soybean fields. We also examined aphid abundance in soybean fields next to pollinator plantings. Early results suggest there was a trend for lower aphid abundance near the edge of the pollinator plantings.

Activity 1 Final Report Summary: We installed 20 pollinator plantings using a high-diversity pollinator seed mix. These plots were sampled for native bees in 2019, 2020, and 2022. We had limited sampling in 2021 due to restrictions associated with the COVID-19 pandemic. We collected 24,657 specimens and approximately 165 species. This is a high number of specimens and is a much larger dataset than most studies on native bee community ecology. We also conducted sweep net surveys for crop pests and their natural enemies in the plantings and nearby soybean fields. We counted, identified, and classified 36,146 specimens. Overall, we found that planting size and location had little effect on native bee community metrics or natural enemies. We are continuing to analyze these data to better understand how these restorations in the tallgrass prairie impact native bees and other insects.

ACTIVITY 2: Quantify neonicotinoid residues in nectar at 28 pollinator plantings

Description: Pesticide use, and in particular, insecticides can have large negative effects on native bees and other beneficial insects. This has led to a major concern for placing pollinator habitat in agricultural areas. The risk to pollinators occurs primarily when the insecticide moves off the target crop to nearby wildflowers. The movement can be through the soil, as has been demonstrated for neonicotinoid seed-treated crops, where only 5-10% of the seed treatment moves into the plant and the remainder moves into soil. Depending on the organic content of the soil and amount of sunlight the neonicotinoids may or may not be “bioavailable” meaning able to move into nearby flowering plants. Movement also can be through aerial drift; for example, when neonicotinoid treated seeds are planted in spring the dust may blow off the seeds onto nearby flowers in bloom at that time of year. Aerial drift also can occur throughout the growing season when other pesticides (insecticides and fungicides) are applied to control crop pests, such as soybean aphids, or when herbicides are applied to control weeds. Herbicides do not directly affect pollinators and beneficial insects, but they do pose a risk to pollinator habitat itself.

It is important to study the conditions in Minnesota in which pesticide movement presents the greatest risk. For example, the size of pollinator planting may influence the degree to which pesticides reach the flowers along the edge or in the interior of the planting. We predict that pesticide amount and the number of pesticides found in the interior will be much less in larger plantings compared small plantings, in which case, the future recommendations would be to plant pollinator habitats of a particular size, and to plant a buffer of a non-flowering plant such as grass between the crop and the pollinator habitat.

We will begin by sampling residues of only neonicotinoids in flowers within the pollinator plantings. The laboratory we will use to analyze the residues (USDA-AMS National Science Laboratory in Gastonia, North Carolina; the lab used by researchers nationally) can quantify neonicontinoid residues down to (1.5 ppb). We will sample for 7 neonicotinoids: Acetamiprid, Clothianidin, Dinotefuran, Flonicamid, Imidacloprid, Thiacloprid, and Thiamethoxam. They have another assay that quantifies a broad spectrum of 170 pesticides (insecticides, fungicides and herbicides) but the limit of detection of the neonicontinoids in this second assay is much higher, and thus not as sensitive. We will collect additional flower samples for the second, broad spectrum residue assay and keep in the -80C freezer until funds are available to analyze them.

We will sample from 14 plantings that will be planted in native floral habitat created from this from ENRTF proposal and from 14 plantings that will be planted in honey bee habitat created from MDA funding. As noted above, we are installing an additional 18 plantings based on floral preferences of honey bees. We are

sampling these honey bee plantings as these will also be used by native bees. We are sampling 14 plantings of each type (total 28) instead of 18 plantings from each planting type (total 36) due to the expense of residue testing. This number of plantings should provide enough statistical power answer our questions. However, if planting installation costs are less than predicted, we will work with LCCMR staff to expand the scope and sample more plantings. At each planting, we will take one soil sample. This will provide background information on the potential residue already in the soil before planting. As flowers bloom, we will sample residues in flowers on 14 plantings that are sampled on the native bee-focused plantings as well as on 14 plantings of the honey bee-focused plantings. All sampling will take place on Anise hyssop (*Agastache foeniculum*) that will be planted in both types of plantings because it is highly attractive to native bees and honey bees. We will collect 3mg of floral material (minimum amount needed by the USDA laboratory). Within each plot, we will compare the neonicotinoid residue in flowers along the edges to those in the interior. We expect the larger plots will have less residue in interior of the plantings compared to smaller plots. We expect plantings to be of similar shape but we will also record distance from edge to interior and use this distance as predictor in our statistical models. We will sample at three different bloom periods: early, peak and late. As we will have data on pollinator and other insects, we will be able to relate pesticide exposure to pollinator and insect communities.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 141,089
Amount Spent: $ 139,866
Balance: $ 1,223

Outcome	Completion Date
1. Sample Anise hyssop at 28 pollinator plantings. Sample 2 samples for 3 rounds during bloom.	September 2020
2. Send samples to USDA lab for neonicotinoid analysis	November 2020
3. Analyze pesticide residue data for 7 different neonicotinoids. Compare residue amount at edge and center of pollinator plantings	April 2021
4. Relate pollinator success metrics (see activity 1 above) to pesticide exposure.	December 2022
5. Integrate pesticide risk assessment to decision support tool and other management recommendations.	December 2022

Activity 2 Status as of *June 2018***:** This research will not start until the second year of bloom.

Activity 2 Status as of *March 2019:* While the main data collection period will be in the second year, we will collect some preliminary data on this in the summer of 2019.

Activity 2 Status as of *June 2019***:** We began sampling for neonicotinoid residues at our sites. We have completed the first round of sampling and are currently sampling the second round. We collected samples from the center of the plot as well as the center. For our second round, we collected soil samples at similar locations as the first round. We have also collected plant samples at select sites. These will be sent out for analyses this coming winter.

Activity 2 Status as of *December 2019:* We collected material from plots in the summer of 2019. We are currently determining how many samples we will be sending for analysis.

Activity 2 Status as of *August 2020***:** We have only recently been able to reenter the lab due to COVID. We collected soil samples and floral tissue of Black-Eyed Susan (*Rudbeckia hirta*). All material remains in the Cariveau Native Bee Lab in a -80C freezer. We expect to be able to send out these for analysis this fall or early winter.

Activity 2 Status as of *December 2021:* We have prepared the samples and will be getting results from these collections by the next report.

Activity 2 Status as of *June 2022***:** The samples are currently being processed by the United States Department of Agriculture's National Science Laboratory.

Activity 2 Status as of December 2022*:* We have received our samples of soil and flower for neonicotinoid analysis. In total, we processed samples 47 samples. We tested for seven types of neonicotinoids (Acetamiprid, Clothianidin, and Dinotefuran, Flonicamid, Imidacloprid, Thiacloprid, and Thiamethoxam) with only Clothianidin having detectable levels in the soil. Of these soil samples 59% had no or only a trace of Clothianidin. The average amount of Clothianidin in the soil samples was 8.78 ppb. The maximum level in the soil was 33 ppb. We tested for differences in edge vs. center of the pollinator planting. We did not find a difference with 8.8 ppb $\pm$ 3.7 SEM and 8.7 ppb $\pm$ 2.8 SEM in the center and edge of the plots respectively. These soil samples were taken in 2019 and the plots were in soybean or corn production in the summer of 2018. Therefore, we expect the amount would be reduced in subsequent years. There were no detectable levels of neonicotinoids in the flower heads of Black-eyed Susan (*Rudbecki hirta*). These results suggest that while some neonicotinoids may remain in the soil, there is no uptake from this flower – a flower commonly visited by native pollinators. However, we caution that this is one flower species and future research should examine other species of flowers, particularly those commonly visited by native pollinators. We are continuing to conduct more detailed analyses for the final report and publications.

Activity 2 Final Report Summary: Overall, we found low or no neonicotinoids in the soil at our sites. This is promising as it suggests that pollinator plantings can be beneficial in areas of agricultural production. Most importantly we found no evidence of neonicotinoids in the flowers. This is where bees would come into contact with the insecticide therefore, this absence further illustrates that the risk associated with this insecticide may not be a large concern as it relates to pollinators and restorations in agricultural areas. We caution that other insecticides (e.g., pyrethroids) were not studied and these may have large effects on native bees and other insects.

ACTIVITY 3: Conduct four grower-led field days to share experiences installing and managing pollinator habitat plantings.

Description: To disseminate information and share experiences among growers, we will hold a total of four field days in two different years. These field days will focus on growers that participated in the experiment and will allow them to share their experiences with other growers. This peer to peer sharing is critical as other growers have greater knowledge of the concerns, opportunities and impediments to installing pollinator habitat. The field days will be held at pollinator plantings used in the experiment. We will also invite beekeepers and conservation practitioners.

Summary Budget Information for Activity 3:

ENRTF Budget: $ 20,141
Amount Spent: $ 17,533
Balance: $ 2,608

Outcome	Completion Date
1. Recruit 5 to 8 growers in Southwest Minnesota to present at field days.	January 2022
2. Print out outreach materials and develop decision support tool.	April 2022
3. Advertise field days at local meetings and in grower newsletters.	February 2022
4. Hold 2 field days in 2021 and 2022 at cooperating farms (total of 4 field days).	August 2022 & May 2023

Activity 3 Status as of *June 2018***:** This activity will not start until the final two years of the project.

Activity 3 Status as of *March 2018:* This activity will not start until the final two years of the project.

Activity 3 Status as of *June 2019***:** This activity will not start until the final two years of the project.

Activity 3 Status as of *December 2019:* While were originally planning on waiting until the final two years, we have decided to set-up a winter meeting for spring 2020. This is important as we wanted to connect landowners after the first year of the project to address any problems early. We felt this was a good opportunity to have landowners share early successes and challenges. We have set the date for March 3, 2020 in Windom. All invitations have been sent to landowners and other interested parties. We have also begun planning for the meeting.

Activity 3 Status as of *August 2020***:** On March 3, we conducted a grower field day. This meeting took place in Windom, MN at the United States Fish and Wildlife Service office. We invited landowners as well as practitioners involved in habitat restoration. Approximately 30 people were in attendance. Christina Herron-Sweet, Kiley Friedrich, Dr. Katie Lee, Dr. Marla Spivak and I attended as well. We all presented updates on the project and asked for feedback.

Activity 3 Status as of *December 2021:* We have completed one grower/land owner outreach event since this last update. As it was during the COVID pandemic it was an online event. We plan to hold the larger field day in spring 2023.

Activity 3 Status as of *June 2022***:** We held a landowner outreach event in the spring of 2022. Dr. Cariveau gave an extension presentation on the results of this study at the University of Minnesota's Research and Outreach Station in Lamberton, MN and gave a talk to scientists at Iowa State University.

Activity 3 Status as of *December 2022:* We are planning our final land owner event for June 2023. This event will involve a presentation and field visit to a participant enrolled in the study. We will also be highlighting this work in upcoming outreach and extension presentations.

Activity 3 Final Report Summary: Each year we held outreach events for landowners as well as practitioners. These were focused on project updates and sharing our results. Our initial meetings were in person but had to move to Zoom with the COVID epidemic. On June 15, 2023, we held an in-person field day for project participants and the general public. This field day began at the Nobles Soil and Water Conservation District in Worthington. We then visited a farm to highlight our work to landowners and the general public. We are continuing to work on peer-reviewed publications from the results of this work.

V. DISSEMINATION:

Description: The success of this project relies upon finding growers that are interested in planting pollinator habitat. Our goal is to locate a total of 18 plantings for native, locally-sourced pollinator plantings. An individual landowner may have more than one planting. However, plantings need to be separated by at least 1500 yards. To find growers, we will attend grower meetings, provide presentations and write for newsletters. This is outreach is needed to find locations but will also serve as outreach for the purposes of promoting pollinator habitat. Further, once we have results, we are dedicated to disseminating our results and informing management. We have explicitly budgeted for dissemination and details are in Activity 3 (see above). Further, the Bee Lab at the University of Minnesota is dedicated to extension and outreach. We work with the Bee Squad and Elaine Evans, an Assistant Professor of Extension, is focused on disseminating results of native bee conservation. This will include talks, seminars, and extension materials. These handouts will be available for future outreach and extension opportunities. Further, PI Cariveau and CO-PI Spivak give multiple outreach talks and interviews each year. The results of this study will be shared through these and other programs. Finally, we are developing a decision support tool to optimize the effectiveness of pollinator plantings for a given budget. This tool will be available on our website for growers and conservation practitioners.

Dissemination Status as of *June 2018***:** In January 2018, we met with nearly 50 landowners and land managers in Windom, MN. The purpose of this meeting was to introduce our project and generate interest. This was highly successful, and we have talked to nearly 100 landowners and land managers. While we only are using approximately 40 sites, we have already made much progress in disseminating this work and highlighting the importance of the ENRTF as a funding source. In November 2018, D. Cariveau is giving an invited presentation on this project at the Entomological Society of America Annual Meeting in November 2018.

Dissemination Status as of *March 2019:* Dan Cariveau has presented on this in a number of different settings. He presented this study at the Ecological Society of America national meeting in Vancouver, BC. In addition, he highlighted this work at an invited seminar at the University of Manitoba. He has also presented this work to general audiences including at University of Minnesota Arboretum's Pollinator symposium (~200 attendees) in September 2018 and the State of the Bees event in Bloomington Minnesota (~450 attendees).

Dissemination Status as of *June 2019***:** Since March, Dr. Cariveau was on a panel and highlighted this research. Christina Herron-Sweet presented a poster of this work at the International Pollinator Conference at the University of Davis in July 2019. This conference was attended a few hundred pollinator biologists. Attendees included scientists from a number of countries including Australia, England, Brazil, France, and Sweden.

Dissemination Status as of *December 2019:* We have presented a number of conferences. Katie Lee (postdoc) has presented her work at three national conferences. She has also presented at two local outreach events. Kiley Friedrich (staff) presented Perennial Farm Gathering Conference with other 200 people in attendance. In Kiley and Christina Herron-Sweet (staff) presented at two local, southwest Minnesota events. In total, we estimate that we reached approximately 570 audience members.

Dissemination Status as of *August 2020***:** In addition to the grower meeting in March, Christina Herron-Sweet presented our research at the annual meeting for the Society of Rangeland Management in Denver, Colorado. No ENRTF funds were used for this out-of-state travel. Approximately 30 people were in attendance. Kiley Friedrich presented twice at Pheasant Fest in mid-February. Overall, Kiley reached a few hundred individuals.

Dissemination Status as of *December 2021:* We held a landowner outreach event in the spring of 2021. This was done remotely with numerous land owners. Overall, outreach activities have been a bit reduced due to COVID. However, we are starting this coming year. For example, Dr. Cariveau will presenting the results of this work at an extension event for Master Gardeners in April 2022 and the results will be highlighted at a talk Dr. Cariveau is giving at Iowa State University (no LCCMR funds will be used for travel to Iowa).

Dissemination Status as of *June 2022***:** We held a landowner outreach event in the spring of 2022. Dr. Cariveau gave an extension presentation on the results of this study at the University of Minnesota's Research and Outreach Station in Lamberton, MN and gave a talk to scientists at Iowa State University. In November, three members of the Cariveau Lab (D. Cariveau, I. Lane, and E. Dombrow) will be traveling to the Entomological Society of America in Vancouver, British Columbia to present the results of this research to colleagues. This is the premier international meeting in our field.

Dissemination Status as of *December 2022:* We presented the preliminary findings at five different outreach events in the Twin Cities metro area. These talks reached approximately 200 people. In addition, Emma Dombrow and Dan Cariveau presented talks at the Entomological Society of America meeting in Vancouver, British Columbia.

Dissemination Final Report Summary: We used this research in numerous public outreach talks throughout Minnesota. In each presentation we highlighted the importance of ENRTF support for this and other work. As noted above, we held a field day in southwest Minnesota. This was open to the public with presentations at the

Nobles Soil and Water Conservation District in Worthington and a visit to a private landowner's site used in this research.

VI. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview:

***This section represents an overview of the preliminary budget at the start of the project. It will be reconciled with actual expenditures at the time of the final report.**

Budget Category	$ Amount	Overview Explanation
Personnel:	$157,652	• Crew Leader 75% FTE at $40,000 base +26.2% fringe + 2% COLA for 3 years (Activities 1, 2 & 3) – manage site selection, grower outreach and contacts, collect pesticide residue
	$73,089	• Postdoc: 100% FTE at $47,500 base + $13,192 fringe for 1 year; 20% in Y2; Activities 1 & 2 – grower outreach, collect pesticide residue samples, manage and analyze data, write scientific manuscripts
Professional/Technical/Service Contracts:	$110,000	• Site prep, seed mix, planting, mowing and weed control, contract administration (Estimate subject to change through bidding process)
	$100,000	• Land rental fees for 100 acres at ~$200 per acre for 5 years. Estimated with goal to use CRP or already protected land. ***If we use already protected land, we will *not* pay rental fees. If we find an adequate amount of protected lands and thus have funds remaining in this category, we will work with LCCMR staff to redirect funds to expand scope of Activity 2. To determine rental fees, we will use county-level CRP rental rates.**
	$38,808	• Pesticide residue analysis will be conducted by the United States Department of Agriculture's National Science Laboratory in Gastonia, NC. ($198 per sample 7 samples at 28 sites)
	$1000	• Outreach event, tent rental, audio equipment rental about $500 per year.

Equipment/Tools/Supplies:	$500	• Supplies include cooler, vials for pesticide residue samples.
Printing	$3,000	• Printing for outreach events with a focus on grower field days. $1500 per year
Travel Expenses in MN:	$15,951	• Travel will be to select plantings, sample native bees and collect pesticide residues.
TOTAL ENRTF BUDGET:	**$500,000**	

Explanation of Use of Classified Staff: N/A

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 3.45

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF: 2

Appropriation:

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state: United States Department of Agriculture: Agriculture and Food Research Initiative "Ecology and economics of pollinator habitat: Using a landscape-scale experiment to determine cost-effective restoration strategies for beneficial insects" Proposal #2017–06466; Cariveau PI (Spivak Co-PI) – ***Funding Allocation in Process***	$999,803 ($699,862 for research; $299,941 for indirect costs to UMN)	$967,323	These funds will be used to 1) sample native bee communities, 2) measure reproductive success of bumble bees, 3) sample predatory insects of crop pests in pollinator plantings as well as nearby soybean fields, 4) measure honey bee survival and honey production, 5) determine costs, analyze benefits and trade-offs, and conduct decision analysis of various budget constraint scenarios.
State			
Minnesota Department of Agriculture – M.L. 2017, Chp. 88, Sec. 2, Subd. 02(d)	$500,000	$500,000	These funds will be used to install habitat that targets honey bees (i.e. primarily stands of mass blooming flowers.) Purchase, manage and sample honey bees.
TOTAL OTHER FUNDS:	**$1,499,803**	**$618,918**	

VII. PROJECT STRATEGY:

A. Project Partners:

Partners receiving ENRTF funding

- *Dan Cariveau, Assistant Professor, Department of Entomology, University of Minnesota (Principle Investigator)* will oversee all project details and provide reports. He will be responsible for all project reports, supervising crew leader and postdoc and all project management.

Partners NOT receiving ENRTF funding

- *Marla Spivak, Professor, Department of Entomology, University of Minnesota. Co-Principle Investigator* will help with project management, grower outreach and provide scientific advice.

B. Project Impact and Long-term Strategy: This project will be, to our knowledge, the largest landscape-scale experiment on pollinator habtitat. This will provide the most robust and rigorous information in regards to the size and placement for pollinator plantings. Further, it will begin to address how planting size and location influence pesticide risk. This will provide concrete management recommendations to help land managers make important decisions regarding how and where to use limited funds to create pollinator habitat.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
ENRTF Award to D. Cariveau "Data Driven Pollinator Conservation Strategies in Tallgrass Prairies" Sampling of tallgrass prairie remnants and restorations for native bees. We are also conducting pollination studies. M.L. 2016, Chp. 186, Sec. 2, Subd. 03a	June 2016-June 2019	$520,000
ENRTF award to M. Spivak in 2014, "Enhancing Pollinator Landscapes" M.L. 2014, Chp. 226, Sec. 2, Subd. 06a Covers D. Cariveau's 9-month academic year salary	August 2015 – June 2019	$329,000
ENRTF Award to Pheasants Forever "Minnesota Bee and Beneficial Species Habitat Restoration" (Cariveau Co-PI) M.L. 2017, Chp. 96, Sec. 2, Subd. 08g	June 2017-June 2021	$206,537 to Cariveau ($732,000 total)

VIII. REPORTING REQUIREMENTS:

- **The project is for 5 years, will begin on 12/15/2017, and end on 06/30/2023.**
- **Periodic project status update reports will be submitted** *June 15* **and** *December 15* **of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2023**.

IX. VISUAL COMPONENT or MAP(S):

Environment and Natural Resources Trust Fund
M.L. 2017 Project Budget

Project Title: Quantifying Benefits and Risks of Pollinator Habitat in Agricultural Landscapes
Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 03n as extended M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 20
Project Manager: Daniel P Cariveau
Organization: University of Minnesota
M.L. 2017 ENRTF Appropriation: $500,000
Project Length and Completion Date: June 30, 2023
Date of Report: September 27, 2024

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget Amount	Amount Spent	Activity 1 Balance	Activity 2 Budget Amount	Amount Spent	Activity 2 Balance	Activity 3 Budget Amount	Amount Spent	Activity 3 Balance	Revised Total Budget
BUDGET ITEM										
Personnel (Wages and Benefits)	$199,423	$199,423	$0	$122,877	$121,654	$1,223	$15,765	$15,765	$0	$338,065
Crew Leader 100% FTE at $40,000 base +26.2% fringe + 2% COLA for 3 years (Activities 1, 2 & 3)										
Postdoc: 100% FTE at $47,500 base + $13,192 fringe for 1 year; 25% in Y2; Activities 1 & 2										
Professional/Technical/Service Contracts										
Site prep, planting, mowing and weed control, contract adminstration (Estimate subject to change through bidding process) $110,000	$23,139	$23,139	$0							$23,139
Land rental fees for 100 acres at ~$200 per acre for 5 years $100,000 total	$38,044	$38,044	$0							$38,044
Pesticide Residue Analysis (~$198 per sample, 6 samples per site (2 samples over three rounds) at 28 sites, plus one soil sample per site)				$9,212	$9,212	$0				$9,212
Outreach event, tent rental, audio equipment rental about $500 per year. see printing below for other associated costs with Activity 3							$376	$376	$0	$376
Supplies										
*Tubes for pesticide residue samples (~1$ each, coolers for transporting samples, seed mix for pollinator plantings , **native bumble bee colonies***	$65,688	$65,688	$0	$500	$500	$0				$66,188
Printing										
Educational and Outreach Materials: e.g., signs, brochures, handouts, pubs, press releases, fact sheets, estimated $1,500/ year for 2 years							$3,000	$392	$2,608	$3,000
Travel expenses in Minnesota										
Travel and lodging for selecting sites and collecting pesticide residue samples per the University of Minnesota's travel and lodging rates.	$12,476	$12,476	$0	$8,500	$8,500	$0	$1,000	$1,000	$0	$21,976
COLUMN TOTAL	**$338,770**	**$338,770**	**$0**	**$141,089**	**$139,866**	**$1,223**	**$20,141**	**$17,533**	**$2,608**	**$500,000**