Final Abstract

Final Report Approved on December 3, 2024

M.L. 2021 Project Abstract

For the Period Ending June 30, 2024

Project Title: A Biodiversity Checkup for Minnesota's Big Woods

Project Manager: Lee Frelich

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Website: https://cfans.umn.edu/

Funding Source:

Fiscal Year:

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

Appropriation Amount: $109,000

Amount Spent: $93,543

Amount Remaining: $15,457

Sound bite of Project Outcomes and Results

In the Big Woods Region of Minnesota, species richness of vascular plants and carbon accumulation are similar in second growth and old-growth sugar maple forests, indicating that second growth forests are currently healthy. However, jumping worm invasion is an emerging threat to diversity and productivity of Big Woods forests.

Overall Project Outcome and Results

Big Woods forests are dominated by sugar maple, American basswood and northern red oak, with smaller amounts of other species. Most of the Big Woods landscape in southeastern Minnesota has been converted to other land uses so that there is concern about the ecological health of the remnants. This project analyzed the ecological health of old-growth and second-growth Big Woods remnants from the perspectives of vascular plant diversity and carbon storage in tree biomass. The threats to conservation of Big Woods plants posed by jumping worms (Amynthas spp) invasion was also assessed.

Six pairs of second-growth (stand age 80-110 years with history of clearcutting) and old-growth (stand age >120 years) forests were chosen for comparison of plant species richness, and aboveground carbon was estimated in four of the

pairs. Plant diversity of three pairs of adjacent second-growth stands, with and without jumping worm infestations, was compared. However, note that all stands in the region are infested by European earthworms.

Second-growth and old-growth Big Woods forests have similar levels of plant diversity. Species richness was slightly higher in second-growth forest (7 species higher on an average hectare, 2.47-acre area) because some early-successional species are still present and second-growth forests have a few invasive species. Aboveground carbon estimates are also similar. Therefore, second-growth forests have made a good recovery towards old-growth conditions.

Jumping worm infestation significantly reduced plant diversity in two of the three paired stands, and jumping worms cause severe soil erosion on slopes, so that this invasion is a threat to Big Woods conservation. Overall, second-growth sugar maple forests are in good health and well on their way to full recovery to the same status as old growth, although all maple forests in southern Minnesota are threatened by the emerging jumping worm invasion.

Project Results Use and Dissemination

Two papers for peer-reviewed journals will result: (1) Plant species richness in Minnesota Big Woods as influenced by old-growth vs second-growth status and jumping worm invasion; (2) Carbon storage in second-growth mesic maple-basswood forests recovers to old-growth levels within ca 100 years.

Media appearances: Popular Science, Minnesota Conservation Volunteer, Northern Gardener Magazine, MPLS Star Tribune (3 times), KSTP TV, National Wildlife, Wandering Naturalist (Three Rivers Parks Podcast).

Presentations: 8 garden clubs, 3 Master Gardener clubs, MN Landscape Arboretum, Minnesota Native Plant Society, Botanical Club of Wisconsin, Riley Creek Watershed District, Chequamegon NF, Eastern Old-Growth Conference (NH, 2023).

Environment and Natural Resources Trust Fund

M.L. 2021 Approved Final Report

General Information

Date: December 19, 2024

ID Number: 2021-289

Staff Lead: Noah Fribley

Project Title: A Biodiversity Checkup for Minnesota's Big Woods

Project Budget: $109,000

Project Manager Information

Name: Lee Frelich

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Reporting

Final Report Approved: December 3, 2024

Reporting Status: Project Completed

Date of Last Action: December 3, 2024

Project Completion: June 30, 2024

Legal Information

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

Appropriation Language: $109,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to inform conservation strategies by comparing the historic and contemporary flora of Minnesota's Big Woods to determine if all species have survived in the small remaining remnants of that ecosystem.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: Compare the historic and contemporary flora of Minnesota's Big Woods to see whether all species are able to survive on a small fraction of the original area

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

Much time and money has been invested in preserving remnants of Big Woods (maple, basswood and oak forests), a landscape in southern Minnesota where most forests present at the time of European settlement were converted to other land uses. It is time for a checkup to see how biodiversity is faring in these small islands of native habitat, and to ask the question: can all species survive on a tiny fraction of the original landscape? Ecologists predict that loss of area will lead to loss of species, but that has not been tested with field data in Minnesota. It has been a century since the Big Woods were fragmented, so that the resulting impacts should be apparent by now. Although many scientific studies on the status of the Big Woods were published from the 1930s to the 1990s, there is surprisingly little information available on recent status. The question of whether forest biodiversity can coexist with agriculture over the long term is important because we need to know how well existing Big Woods remnants are serving as refuges for native biodiversity. Other projects have examined this coexistence question for highly fragmented prairies, however, we also need answers for forests.

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.

The project will compare the historic and current number of plant species in the Big Woods, in total for the entire ecosystem, and for individual Big Woods remnants and per unit area. We examine plant species because they comprise a large proportion of all species, are the ecosystem base that supports soil health, pollinators, and all wildlife species. Historical records of plant occurrences in the Big Woods will be assembled from several sources. University herbarium records of plant collections done over the last ca 150 years are now digitized and available via electronic searches. Also available are publications in peer-reviewed journals, university students theses, MNDNR biological survey data, and many other species lists that were created over the last several decades when a given park or natural area was established. Current species lists will be assembled in the field by two graduate students. We will assess the extent to which premier Big Woods remnants (designated natural areas), remnants that had been logged, cleared, farmed and returned to forest, and remnants that have been invaded by jumping worms, function to preserve native plant communities.

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

The project will assess the status of biodiversity for the entire Big Woods ecosystem, and show whether the current system of reserves is adequate to protect all species. It is possible that scientist predictions of species loss in severely fragmented ecosystems are not valid and that our forest ecosystems are more resilient to change than many people think. The findings will provide guidance for managing natural areas in places like southern MN where remnants are sparse, and whether broad-brush strategies like having a certain number or a certain acreage of forest remnants works, versus having to track every species individually.

Project Location

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

Region(s): Central, Metro, SE,

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

Region(s): SE, Metro, Central,

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Gather all available historic records of plant species occurrences in the Big Woods

Activity Budget: $37,000

Activity Description:
These records will be assembled from university herbaria in the Midwest region, which contain millions of pressed plant specimens which can now be electronically searched, and are visible via high definition scans. Because these records go back 150 years, this will give us a picture of Big Woods plant diversity as it existed prior to European settlement. However, herbarium records also continue up to the present, so we can get a picture of continuing change. Other sources of data include species lists assembled by examinations of tracts of land by the MN Biological Survey over the last several decades, and species lists assembled when natural areas or state parks were established, as well as university student thesis projects that examined floras of individual tracts of land over the years. Records of all types will be assembled into a database by location, date, and species of every record of plant occurrence relevant to the project.

Activity Milestones:

Description	Approximate Completion Date
Establish historic plant data base	December 31, 2022
Gather all other records from various government agencies	June 30, 2024
Search peer-reviewed literature and university theses for historic plant occurrences	June 30, 2024
Search herbarium records from major universities for historic plant occurrences	June 30, 2024

Activity 2: Gather current data on plant species with two graduate students in the field

Activity Budget: $42,000

Activity Description:
This would be accomplished by visiting existing Big Woods remnants with different types of management history that we hypothesize will lead to different levels of persistence of the original plant diversity: old-growth remnants (never logged, areas which we think still have the same number of species per unit area that they had in the past), and second growth (areas that had tree cover removed by human activity at some point in their history) which we hypothesize will have progressively lower levels of plant diversity. This will include second growth forests that were logged and recovered, and second growth that was invaded by jumping worms. We expect that species present per unit area will be highest in old growth, second highest in second growth and lowest in second growth invaded by jumping worms. We will also assess the overall flora of the entire Big Woods region as one large geographical unit. This is a non-destructive project, no specimens will be taken. The needed information can be obtained by simple field observations by the project manager and graduate students.

Activity Milestones:

Description	Approximate Completion Date
Choose sites with varied human disturbance and jumping worm invasion to include in plant survey	March 31, 2022
Carry out surveys field surveys of plants with two graduate students	October 31, 2022

Activity 3: Analyze the status of Big Woods native plant diversity and disseminate the results

Activity Budget: $30,000

Activity Description:

Here we will use the data on plant occurrences to test the hypotheses that the current flora is as species rich today as it was historically, and the impacts of jumping worm invasion on the big woods flora. We will also identify species that were historically present that cannot be found today, also at the site and regional scales. It is possible that some species are no longer present but that new species (including native and invasive species) have moved in, so it is important to look for differences in the flora as well as the total number of species. Another important analysis is to identify species that are declining or increasing in number of occurrences across the landscape. These may fall into groups, for example studies in northern MN, WI and MI have shown that grasses and other grass-like plants have been increasing while other groups like native orchids and Trillium species are declining. Finally, we will examine whether the flora is becoming more homogeneous, with a small group of species adapted to fragmented conditions and other changes in the contemporary environment becoming more common.

Activity Milestones:

Description	Approximate Completion Date
Two graduate student theses	June 30, 2023
Dissemination via public lectures, media appearances and peer-reviewed publications	June 30, 2024
Analyze historic and current plant data	June 30, 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Scott Milburn (representing the organization as board president)	Minnesota Native Plant Society	Organize the involvement of 10-12 society members who will help survey plant diversity in Minnesota's Big Woods (maple-basswood-oak forests) as described in the proposal.	Yes

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.
Results of the study will be disseminated to scientists within the University of MN system, and at other universities in the region, to MN Department of Natural Resources and county staff who manage natural areas, parks, and state forests within the study region, and to non-profit environmental organizations (e.g. Nature Conservancy) through extensive connections that already exist, or that come to light as the project proceeds. The forms for dissemination will include peer-reviewed, published papers, a recorded presentation with powerpoint slides available online, and in person presentation by the Project Manager Frelich and/or graduate student will be available on request.

The findings will be useful as a checkup of the overall health of the natural areas within the Big Woods, and whether they are accomplishing their goal to maintain all of the species over time, or whether there are concerns about the existing reserve system. The findings will also provide a documented baseline for future studies of change in Big Woods natural areas, and for assessing goals of restoration efforts with respect to plat species or species groups that are in need of restoration or protection.

All data on historic and current floras will be uploaded to the Data Repository of U of MN (DRUM), where it will be maintained and accessible to researchers and natural resources managers as a baseline for future studies and assessments of biodiversity in Minnesota Big Woods forests.

Frelich has had very productive, long-term relationships with many reporters at radio stations and newspapers in southeastern Minnesota, and will disseminate the results to the public through as many media appearances as possible.

ENTRF will be acknowledged in all dissemination efforts.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?
This project is a logical progression adding onto 26 years of previous research in Big Woods forests by the project manager. Other proposals for supplemental funding from within and outside of the University of Minnesota and donations from private individuals will be pursued to continue this line of research. This future funding would be used for the next step after the project proposed here, namely to learn how to restore Big Woods remnants to their full level of biodiversity on small tracts of land so the plant-pollinator complex essential to human wellbeing can be restored in southern Minnesota.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Graduate student		Lead field work, andalyze data, write papers			52%	0.8		$62,000	-	-
Lee Frelich		Project manager			27%	0.48		$40,000	-	-
							Sub Total	**$102,000**	**$92,535**	**$9,465**
Contracts and Services										
							Sub Total	**-**	**-**	**-**
Equipment, Tools, and Supplies										
	Tools and Supplies	Field equipment including 2 GPS units, 2 lasers for distance measurements, 2 notebooks	Recording locations where plants are identified, recording and measuring surrounding habitat characteristics					$1,000	-	$1,000
							Sub Total	**$1,000**	**-**	**$1,000**
Capital Expenditures										
							Sub Total	**-**	**-**	**-**
Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
	Miles/ Meals/ Lodging	Travel by project manager and graduate student to field sites in southeast and central MN from St.Paul Campus	Visit Big Woods remnants to evaluate current number of plant species					$3,000	$1,008	$1,992
							Sub Total	**$3,000**	**$1,008**	**$1,992**

Travel Outside Minnesota										
							Sub Total	**-**	**-**	**-**
Printing and Publication										
	Publication	Publish two peer reviewed papers based on this project	Dissemination of results of the project					$3,000	-	$3,000
							Sub Total	**$3,000**	**-**	**$3,000**
Other Expenses										
							Sub Total	**-**	**-**	**-**
							Grand Total	**$109,000**	**$93,543**	**$15,457**

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	Unrecovered indirect costs @52.6% of direct costs.	Costs incurred by organization for institutional activity including utilities, building maintenance, clerical salaries, and general supplies	Secured	$57,336	$16,665	$40,671
			Non State Sub Total	**$57,336**	**$16,665**	**$40,671**
			Funds Total	**$57,336**	**$16,665**	**$40,671**

Attachments

Required Attachments

Visual Component

File: 7e340c32-cb9.pdf

Alternate Text for Visual Component

Map of Minnesota showing the project area, and major questions to be answered if the project is funded. Can all species survive on a small fraction of the original area? How many Big Woods remnants still retain their original lushness of species composition, retain a small component of species including only those adapted to fragmented habitats or have major species loss and 'biological desert' conditions?...

Supplemental Attachments

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

Title	File
Letter of support from MN Native Plant Society	779e690b-ce9.pdf
Peer review research addendum Frelich 2021 289	ffe31554-6c9.docx
Background check certification	8b34640b-034.pdf
Louis Goodall presentation LCCMR Big Woods Project	b596f5b4-2e1.pdf
Nick Partington presentation LCCMR Big woods	e80c1c97-e6f.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

There are no substantive changes between the proposal and the work plan

Additional Acknowledgements and Conditions:

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

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

N/A

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

Yes, I understand the 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	• Activities and Milestones	Need a longer time line (December 31 2022 rather than March 31 2022) to finish the gathering and analysis of historical data for the four milestones in activity 1. Reason: The historical data set likely needs to be revisited in light of the field data being collected during summer 2022.	May 31, 2022	Yes	June 2, 2022
2	Amendment Request	• Narrative • Budget - Professional / Technical Contracts • Activities and Milestones • Budget - Personnel	Need a longer timeline to gather some of the records in activity 1. Other changes are due to taking into account the jumping worm invasion that was unexpectedly found in the big woods, which requires more graduate student work. This can be accommodated by moving $12,000 in funding from Native Plant Society collaboration to graduate student support (also the Native Plant Society collaboration did not work out as expected).	December 1, 2022	Yes	December 5, 2022
3	Amendment Request	• Activities and Milestones • Budget - Capital, Equipment, Tools, and Supplies	I have requested to move the due dates for Milestones in Activities 1 and 3 to June 30, 2024, this will allow these activities, which had been disrupted by Covid when the project started, to be fully completed, and to match the actual appropriation date which ends June 30, 2024.	June 1, 2023	Yes	June 12, 2023

Status Update Reporting

Final Status Update August 14, 2024

Date Submitted: August 14, 2024

Date Approved: December 2, 2024

Overall Update
The overall goal was to compare plant diversity of old-growth and second-growth Big Woods (maple, basswood and red oak dominated forests in eastern and southeastern MN). We accomplished this by carrying out detailed surveys plant species in 6 pairs (12 stands total) of old-growth (stands >120 years old, never logged) and second growth (stands 80-110 years old that were clearcut). Part way through the project we also discovered that jumping worm invasion was starting to impact the Big Woods in MN, and requested a change (which was approved by LCCMR staff) in activities to assess the impacts of the invasive earthworm of Asian origin on plant diversity. We were able compare three pairs of second-growth stands that are adjacent to each other and with/without jumping worm infestation (6 stands total). We are in the process of preparing two papers for publication on these topics.

Activity 1
Comparison of the historic plant species richness data to our current stands proved to have endless possibilities. Therefore, we decided to take the subset of all records of plant occurrence in the same forest type (MN DNR classification of Southern Mesic maple-basswood forest) and counties (Carver, Hennepin, Wabasha, Winona and Wright) as our study sites. This creates a master species list that is readily comparable to our 12 study sites, and this will be included in the paper that we plan to submit to a peer-reviewed journal during late 2024.
(This activity marked as complete as of this status update)

Activity 2
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 3
This portion of the project was completed by 2 masters students, and we have combined their individual data sets into one data set, and have written early drafts of the 2 papers (comparisons of old growth and second growth, and jumping worm infested versus not infested). Louis Goodall's (one of the M.S. students) presentation pdf is attached to this report with the preliminary results, and published papers will be posted when available.

The results show good news that the second-growth stands are in good ecological health and are progressing towards similar conditions as old growth. The second growth has slightly more species, but that includes a few early-successional species that are still present, and a few invasive species not present in old growth. The final analysis will include the comparison with historic flora of the Big Woods from the same counties as our study sites as described under activity 1 above and we anticipate a reduced species richness (even in the old growth) due to impacts of European earthworm invasion, excessive deer populations, and reduced area of Big Woods forest. Our data indicates the Jumping worm invasion has a further negative impact on plant species richness.
(This activity marked as complete as of this status update)

Dissemination
We are in the process of preparing 2 papers for publication in peer-reviewed journals, one on old-growth and second-growth comparisons, and the other on jumping worm infested versus non-infested comparisons, of plant diversity. We should be submitting these for peer review within the next few months after the end date of the LCCMR project. In addition, we have had good success with presenting preliminary results via public lectures and the news media. Since

the previous progress report, we have the following items for the first half of 2024:

Presentations:
January 11. Botanical club of Wisconsin.
June 11. Men's and Women's Garden Club of Minneapolis.
June 20. Lake Harriet Environmental Council.

News media:
March 1. KTOE Radio (Mankato, MN), Lisa Kaye.
May 1. Wandering naturalist, Angela Grill, Secrets of the soil—jumping worms, Podcast by Three Rivers Park District.
July 3. Minnesota Outdoor News, Tori McCormick, "New law in Minnesota targets invasive 'jumping' worms"

These have concentrated on the jumping worm impacts, while the second-growth and old-growth comparison analyses are just being finished during summer 2024, so that the dissemination of those results will occur after the end date of the LCCMR project.

Status Update Reporting

Status Update December 1, 2023

Date Submitted: December 1, 2023

Date Approved: January 22, 2024

Overall Update
Field work has been completed to compare plant diversity in old growth and second growth big woods forests and to compare plant diversity in forests that infested/not infested with jumping worms (most importantly two masters theses completed prior to 6/30/2023). These these contain preliminary analyses and we are combining the data for an overall analysis to be completed during winter 2023-2024, and two manuscripts to be submitted for publication in peer-reviewed journals by 6/30-2024 (One on old and second growth comparisons and one on jumping worm/no jumping worm comparisons).

Activity 1
Continuing to gather records and search the literature (M2, M3 and M4, which will likely lead to updates in M1, the data base) are part of the manuscript writing process described in the overall update above.

Activity 2
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 3
M1 (media and public presentations) has been in progress, with presentations and podcasts to gardening groups and other non-profit organizations, as well as classroom lectures at the University of Minnesota, listed below under Dissemination update. News media outreach will occur as we finish writing the manuscripts, and will continue after the LCCMR project is finished. M2--the these were previously completed. M3--analyzing the data is in progress as part of writing the manuscripts for publication.

Dissemination
Presentations since the last report:
June 25. Water garden society of MN. Topic: jumping worms.

Sept. 15 Classroom lecture on invasive earthworms, UMN (ESPM 3612W/SOIL 5611 Soil and Environmental Biology)

Sept. 22, Presentation on invasive earthworms at the Eastern Old-Growth Conference, Lake Winnepesaukee, NH

Nov. 13. The No-Till Growers Podcast Network, Mimi Casteel. Jumping Worms and Other Invasive Worm Species in Forested & Agricultural Lands with Dr. Lee Frelich. https://podcasts.apple.com/us/podcast/jumping-worms-and-other-invasive-worm-species-in/id1441886206?i=1000634603077

Oct. 31 Classroom lecture at UMN on invasive earthworms, (ESPM 3015/5015. Invasive plants and animals).

Three additional presentation are scheduled for December 2023-April 2024.

Status Update Reporting

Status Update June 1, 2023

Date Submitted: June 1, 2023

Date Approved: June 12, 2023

Overall Update
The biggest item--completing of two M.S. theses that compare plant diversity in second growth and old-growth Big Woods forests, is complete (Activity 2 and a big part of Activity 3). This includes 10 Big woods sites, five pairs of second growth and old growth sites, and three pairs of jumping worm infested and non-infested stands (pursuant to an amendment to the project, due to the discovery that jumping worm invasion is an important factor in the Big Woods which was not known when the original LCCMR proposal was written). Combining the two theses into a single analysis and writing two peer-reviewed papers (Activity 3), comparing second growth to, old growth, and comparing jumping worms with no jumping worms, and comparing current diversity to historical diversity (Activity 1), will be the focus of the work for the rest of 2023. Major dissemination (also part of Activity 3) can occur later in 2023 when the papers have been written.

Activity 1
We have almost completed assembly of the data on plant occurrences in the Big Woods. The herbarium and published literature have been searched (Milestones 3 and 4), however, we do not have all of the MN DNR records yet (Milestone 2), so we can't claim that the database (Milestone 1) is complete. We will continue work on this for the remainder of 2023.

Activity 2
The field surveys were done at 10 sites (5 pairs of sites, 5 second growth and 5 old growth), and completed as of October 2022 (milestone 1). Field surveys of 3 paired sites (with and without jumping worms) were also completed as of October 2022. The work was carried out by two graduate students, Louis Goodall (M.S. completed January 2022), and Nick Partington (M.S. defense scheduled June 1, 2023). The project was carried out by 2 graduate students over three field seasons due to disruption caused by Covid in 2020-2021, effectively making the project take a year longer than expected when the proposal was written.
(This activity marked as complete as of this status update)

Activity 3
Milestone 2 (2 M.S. graduate student these) is complete, whereas Milestone 1 (dissemination) and Milestone 3 (analyze the combined field and historical data) are not complete. Analyses of the combined data from the 2 M.S. theses will continue for the remainder of 2023 to produce two peer-reviewed papers. Preliminary results (paper #1 for Milestone 3, historical data will be worked into this paper) indicate that second growth Big Woods forests have high plant species richness (when comparing the same land area), probably because some early successional species are still present in stands 80-100 years old, as compared to much older old growth. In addition, the second-growth stands have a few more invasive species than old-growth stands. Jumping worms (paper #2 for Milestone 3) reduce plant diversity (comparing all second growth stands, no old growth stands are known to be infested), by a few to as much as 30 species in the paired comparison of nearby infested and non-infested stands--these analyses are preliminary and will be continued for the rest of 2023.

Dissemination
We have disseminated the preliminary results via discussions to small numbers of forest managers at the MNDNR, Three Rivers Parks, and University of MN Landscape Arboretum. However, it is too early to disseminate more widely to the

pubic via news media and to a wider group of forest mangers, since we need to write the papers and get them peer-reviewed first. This is what we will work on for the rest of 2023, so that more wide spread dissemination can occur.

Status Update Reporting

Status Update December 1, 2022

Date Submitted: December 1, 2022

Date Approved: December 5, 2022

Overall Update
With the help of two graduate students, we have completed field work (during 2021 and 2022) comparing the flora of second growth and old growth big woods forests. We also have data on a new impact on the big woods flora from the recent jumping worm invasion. Analyses of the data are underway, and when these analyses are complete we will be able to compare current flora with historical data on big woods forests, followed by dissemination of the results.

Activity 1
Activity 1 is almost complete. The literature and herbarium searches are complete (milestones 3 and 4), while the government sources of information will be obtained during early 2023 (milestone 2), so that we can bring all information together during early 2023 (milestone 1). This is slightly slower than our original schedule (to finish in December 2022), mostly because the field work for activity 2 turned out to be larger and more involved than anticipated for reasons explained below.

Activity 2
There are two important changes to this activity, compared to the original proposal. Milestones 1 and 2 were completed as envisioned--we chose 6 pairs of old growth and second growth big woods forests and completed field work in October 2022. The first change is a new factor affecting the big woods flora that was discovered during the project--the impacts of jumping worm invasion. This previously unknown factor is so important that we changed the design to include comparisons of flora at two pairs of sites with and without jumping worm invasion (preliminary analyses show a 25-30% reduction in number of native plant species on jumping worm sites). This led to much greater effort for graduate student work than anticipated. The second change involves milestone 3, the proposed collaboration with MN Native Plant Society (MNNPS) members. The collaboration with MNNPS mentioned in the June 2022 update did not develop (possibly due to lagging effects of covid on MNNPS). I propose to rebudget the $12,000 allocated to the MNNPS to graduate student salary and fringe, since with the additional jumping worm study there will be more ongoing graduate student work (during 2023) than was anticipated in the original

Activity 3
This activity will mostly take place during 2023 as per the original schedule. However, there will be 2 graduate theses (rather than just one), one already completed by Louis Goodall in 2022, and a second in 2023 by Nick Partington. This is due to the larger graduate student effort for reasons explained in activity 2 above.

Dissemination
Dissemination via public lectures, media appearances and peer-reviewed publications is scheduled to take place at the end of the project in 2023. However, project manager Frelich has already presented lectures and given a few media interviews on the overall conservation status of the big woods.

Status Update Reporting

Status Update June 1, 2022

Date Submitted: May 31, 2022

Date Approved: June 2, 2022

Overall Update

We are making huge progress in collecting field data to compare the number of native plant species in undisturbed old growth and second growth Big Woods (maple, basswood and oak) forests during 2021 and 2022, with the assistance of two graduate students (Louis Goodall, funded by UMN and Nick Partington funded by this LCCMR grant). We have reached out to the Minnesota Native Plant Society through its newsletter and will follow up with a presentation at the monthly meeting on June 2, 2022, to get that collaboration underway, per the LCCMR proposal. We have gathered and continue to gather as much historical data on native plant diversity as we can find, to compare with the contemporary field data to see whether the current fragmented remnants of Big Woods continue to support the same level of diversity as they did decades ago.

Activity 1

We have searched herbarium records (electronic) and gathered other historic data that is available (species lists from various sites and scientific literature about plant diversity in fragmented landscapes). However, synthesis is not complete because it needs to be integrated with the field data analyses. In retrospect, it is obvious that this activity should have been scheduled on a longer timeline (December 2022 rather than March 2022), since the analysis of historical data ultimately needs to be matched with the field sites chosen, so it needs to be revisited at the end of the summer 2022 field season (see amendment request for activity 1 timeline).

Activity 2

We have selected six pairs (12 total) of second growth and old growth Big Woods forests for comparisons of plant diversity. Four of these were surveyed during summer 2021 (graduate student Louis Goodall). Surveys include as many one-hectare blocks of forest as will fit in a given forest; each block has 20 subplots where all plant species abundances are recorded, and a list of any additional plant species not present on the subplots. The remaining eight stands are being surveyed during summer 2022 (graduate student Nick Partington). Surveys occur three times (spring, mid summer and early autumn) to cover plants that bloom at different times during the growing season. We discovered that the newly invasive jumping worms are having an impact on native plant diversity and decided that we need an additional analysis comparing sites with and without jumping worms (4 additional sites). An article about this project has been published in the latest Minnesota Native Plant Society Newsletter (May 2022), and project manager Frelich will talk to the society at their June 2, 2022 monthly meeting, which should lead to the collaboration with society members needed to gather information on plant diversity at additional

Activity 3

This activity essentially is analyses of data and writing manuscripts, so no progress has been made and none was expected at this time.

Dissemination

This is not scheduled to occur until 2023.