M.L. 2019 Project Abstract
For the Period Ending June 30, 2023

PROJECT TITLE: Promoting and Restoring Oak Savanna Using Silvopasture
PROJECT MANAGER: Rebecca Montgomery
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 08b as extended by M.L. 2022, Chp. 94, Sec. 2, Subd. 19 (c.1) [to June 30, 2023]

APPROPRIATION AMOUNT: $750,000
AMOUNT SPENT: $ 750,000
AMOUNT REMAINING: $0

Sound bite of Project Outcomes and Results

We evaluated cattle grazing as an oak savanna restoration tool, compared to prescribed burning and tree thinning. Adaptive targeted grazing reduced overgrown shrubs with minimal impacts on wildlife, water quality, or soil health. We promoted this grazing strategy by developing training workshops, webinars, online resources, and a farmer-to-farmer learning network.

Overall Project Outcome and Results

Oak savannas are highly biodiverse and on the brink of disappearing due to habitat conversion and the suppression of fire and grazing, disturbances that these ecosystems require. With less than 1% of Minnesota's oak savannas remaining, there is a critical need to determine the best strategies to restore degraded savanna remnants. This project characterized the outcomes of multiple restoration strategies: 1) no management, 2) tree thinning, 3) thinning + prescribed burning, and 4) thinning + burning + cattle grazing. We specifically wanted to evaluate the potential of adaptive, targeted cattle grazing as an oak savanna restoration tool. For four years, we monitored the response of vegetation, water quality, soil health, and wildlife (birds, bats, and butterflies) at hundreds of plots across restoration treatments. We found that thinning and burning successfully increased tree canopy openness, herbaceous vegetation cover and diversity, and savanna-associated plant species. Bird abundance and species richness also responded positively to thinning and burning, while butterfly abundance/richness and the activity of most bat species did not differ across the restoration treatments. Thinning and fire had the unwanted effect of creating dense shrub thickets, so we used adaptive targeted cattle grazing to combat the overgrown shrub layer. We grazed small areas at a high stocking density for a short duration (385 cattle in ¾-acre paddocks for 3-6 hours) and found that this was an effective strategy to reduce shrub density in the short-term, but repeated management is needed to prevent resprout. During the four years of this study, we documented no discernable impact of cattle grazing on birds, butterflies, bats, water quality, or soil health. The significance of this work is twofold; it improves the science and practice of restoration in one of Minnesota's most imperiled ecosystems and highlights how livestock production can be integrated with restoration goals.

Project Results Use and Dissemination

We created the Silvopasture Learning Network with 550 members to scale-up the adoption of adaptive grazing management for oak savanna restoration. We facilitated farmer-to-farmer learning using a combination of online and in-person tools. We developed a five-part online course, compiled an online resource library, and adapted the Farmmaps tool to include silvopasture case studies. Additionally, we implemented a volunteerism program, training events, workshops, webinars, and café chats. We disseminated our research results via a series of field days, podcast episodes, and conference presentations, and by publishing an open-access journal article. Additional scientific publications are planned for late 2023.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2019 ENRTF Work Plan Final Report

Today's Date: October 19, 2023

Date of Next Status Update Report: Final Report

Date of Work Plan Approval: June 5, 2019

Project Completion Date: June 30, 2023

Does this submission include an amendment request? No.

PROJECT TITLE: Promoting and Restoring Oak Savanna Using Silvopasture

Project Manager: Rebecca Montgomery

Organization: University of Minnesota

College/Department/Division: Forest Resources

Mailing Address: 1530 Cleveland Ave N

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Web Address:

Location: Zimmerman, MN; Statewide

Total Project Budget: $750,000

Amount Spent: $750,000

Balance: $0

Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 08b as extended by M.L. 2022, Chp. 94, Sec. 2, Subd. 19 (c.1) [to June 30, 2023]

Appropriation Language: $750,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to demonstrate, evaluate, and increase adoption of the combined use of intensive tree, forage, and livestock management as a method to restore threatened oak savanna habitats.

I. PROJECT STATEMENT:

Oak savanna is a rare shifting-mosaic plant community. Once covering nearly 5.5 million acres in Minnesota (Fig. 1) it is now reduced by approximately 99.8%, making it one of the most threatened habitats in Minnesota (Minnesota Historical Society, 1974). Historically, grazing by large herbivores such as bison and elk maintained the health and structure of these ecosystems. Restoring and protecting these natural communities is critical to preserving natural services, including rare wildlife habitat, enhanced water quality, and soil health.

Ecosystem decline, caused by agricultural expansion/conversion as well as forest succession, has altered soil composition, hydrological processes, and vegetation composition and regeneration patterns (Anderson et al. 1999). This has resulted in the encroachment of invasive plant species and diseases, and altered water quality. In 2014, over 640,000 acres (USDA-ERS, 2014) of unmanaged wooded pasture existed in Minnesota, mostly within the historical oak savanna region. Silvopasture, the practice of intentionally combining intensive management of trees, forage, and livestock as one integrated practice has been successfully used to restore environmental and economic functions of oak savannas around the world, including the Dehesa system in Spain, and within the U.S. (e.g., Oklahoma, Tennessee, California). However, its potential has not been assessed in Minnesota.

This project has two major objectives: a) to assess the impacts of silvopasture as an approach to restore oak savanna ecosystems and native species in Minnesota, as well as improve soil health and water quality for Minnesotans; and b) to scale up the use of silvopasture for oak savanna restoration through outreach activities and development of a Silvopasture Learning Network (SLN) to facilitate farmer-to-farmer learning, promotion, and information sharing to expand natural resource conservation.

This study will examine the effects of silvopasture on plant/animal and pollinator diversity and distribution, soil health, and water quality characteristics at Sherburne National Wildlife Refuge in Zimmerman, MN located in the Anoka Sand Plain (Fig. 2). This region of historical oak savanna communities serves as a critical aquifer for east-central Minnesota. We hypothesize that use of silvopasture methodology will demonstrate a significant increase in restored oak savanna acreage. The results will be developed into case studies to form the core of a Minnesota focused Silvopasture Learning Network.

II. OVERALL PROJECT STATUS UPDATES:

First Update March 1, 2020

The first field season started in July 2019 and was focused on site selection and preparation, as planned. At Sherburne National Wildlife Refuge (SNWR), eight survey zones were identified representing four management history types: 1) Grazed, burned, and mechanically thinned, 2) Burned and mechanically thinned, 3) Mechanically thinned only, and 4) Control – no management. The two zones with management type #1 were grazed in the summer of 2019 with around 100 calf-cow pairs and 5 longhorns. 35 fixed monitoring plots were established in each survey zone for a total of 280 plots. In August, baseline data was gathered for herbaceous, shrub, and sapling species. Some preliminary data analysis has been completed. Due to the project starting mid-summer, bird, reptile, bat, and pollinator surveying will not begin until June 2020. Sampling protocols for each of these surveys are under development. 34 infiltration measurements were taken in the grazed zones to calculate average hydraulic saturated conductivity (Ksat) on and off the cow paths. Water quality and chemistry

measurements will begin in summer 2020. 30cm soil cores were taken all 280 monitoring plots. The soil samples are currently being processed in the lab for CN, aggregate stability, and enzyme activity. We are also in the process of designing an adaptive multi-paddock grazing strategy to implement with the grazing cooperator at SNWR in 2020.

The Silvopasture Learning Network was launched in November, 2019 at the Green Lands Blue Waters Conference in Minneapolis, with 22 people signing up to join the network. The Silvopasture Learning Network was further developed through a social network analysis survey, launched in December, 2019. There were 292 survey respondents that signed up to join the network. Development of the Silvopasture Learning Network online learning portal has begun, and the website is live. It's been populated with relevant information for people interested in learning more about the project and the topic of silvopasture, including upcoming events, best practices, and media hits.

The vision and structure of the volunteerism program has been created. Training will be an important component of each volunteer event. The first volunteer event is scheduled for June 6, 2020, at Early Boots Farm, Sauk Centre, MN. The first project Field Day was held on September 18, 2019 at the farm of Tom Barthel and Gail Wittington, Becker, MN. Twenty eight people attended. A training workshop was held at SFA's (Sustainable Farming Association) 30th annual conference on February 8th at a workshop with 40 people in attendance. Development of knowledge products and training materials began on Nov. 18, 2019, when the team developed a rough work plan. The first knowledge product for this grant is a Silvopasture Resource Guide which will be released at the March 5th Midwest Soil Health Summit.

Amendment request June 23, 2020

The PI for this project, Diomides Zamora, is no longer with U of M Extension. We have identified Dr. Rebecca Montgomery, one of the primary collaborators on this project as our preferred new PI. Dr. Rebecca Montgomery has led the ecological assessment component of the project since its beginning. I have discussed with her and she has agreed to take on the position. We also spoke with the entire team and they all support Dr. Montgomery's leadership.

Amendment approved June 24, 2020

Second Update September 1, 2020

This summer we implemented an adaptive multi-paddock grazing strategy with a new cooperator, Thousand Hills Cattle Company. Our goal was to use high density, short duration grazing to decrease shrub cover and increase herbaceous cover and diversity. The nine research paddocks were grazed for around 4 hours each with 100 head of cattle May 22-27 and then again August 3-7. We surveyed the herbaceous, shrub, and sapling communities at all of our monitoring plots in the same manner as in 2019 in order to detect any changes in the vegetative community. We also measured cattle consumption via pre- and post-grazing herbaceous biomass harvesting, and conducted a shrub impact assessment. In June, we conducted an avian point count survey. In July, we completed a forest inventory and deployed ultrasonic bat detectors. Throughout the summer we regularly checked our coverboards to monitor herpetofauna, and conducted distance point count surveys to assess the pollinator communities. To monitor groundwater in our grazing paddocks, we installed 8 wells near the St. Francis River, and began testing samples for ion chromatography, isotopes, alkalinity and nitrate levels. Post-grazing soil samples were taken from the grazing paddocks and will be analyzed in the lab this winter.

The Silvopasture Learning Network has grown from 292 people in the last reporting period to 409 people. The Silvopasture Manual was completed and released at a Sustainable Farming Association

event on March 5, 2020. The silvopasture forum was held in conjunction with the 2020 Annual DNR Cooperative Forest Management (CFM) Meeting held at the Cloquet Forestry Center on Wednesday, March 11. Content strategy has started on the website and electronic-based learning program. Although deadlines for the Farmmaps Program/App work come later in the project, we continue to develop and improve the Farmmaps tool which will serve as the smartphone/online networking platform for sharing information on farmer case studies

Third Update May 24, 2021

Winter 2020-2021 has been focused on data processing and analysis. Baseline soil samples from 2019 have been analyzed for carbon and nitrogen, and are currently being sent out for fertility testing and biological assays including PLFA and enzyme analysis. 2020 soil samples are still being processed, and will be sent out for testing soon. Analyses are ongoing for the vegetation, pollinator, wildlife, and hydrology data collected throughout the 2020 field season. Preliminary pollinator data analysis indicates no significant difference in butterfly and moth abundance between treatment types. Preliminary vegetation analysis shows that 42% of shrub stems measured in our paddocks were impacted by the cattle either through browsing, trampling, or breakage. Of the stems that were hit by the cattle, the majority were low-level impacts where less than 10% of the stem was affected. We hope to increase cattle impact on the shrubby midstory in 2021 by doubling the number of cattle rotated through the paddocks. Thousand Hills Cattle Co. is not returning to the refuge for the 2021 season, which opens up the opportunity to work with a new cattle cooperator and a larger herd. Planning is underway for the 2021 field season data collection.

The Silvopasture Learning Network has grown from 409 people in the last reporting period to 443 people. Our Facebook page is currently at 39 followers and growing. We sent out our second quarterly newsletter in early February, with a focus on oak savanna education and events. Five case studies have been completed and a volume is being prepared for printing that will be printed in April. The Farmmaps database has been adapted to enter the silvopasture case studies and the cases will be added to the Farmmaps Program/App in the coming quarter.

Two online workshops were held in this reporting period: “Facilitating Silvopasture Adoption in Minnesota (Tools to Help Farmers),” on October 29, 2020, and “Economics of Silvopasture,” on February 8, 2021. Two webinars were completed: “Introduction to Halal Meat and Opportunities for Goat Farmers” was held on October 21, 2020, and on March 18, 2021, a webinar on Farmmaps and the Silvopasture Case Studies.

For knowledge products the silvopasture case study interviews have been completed and a volume with the case studies was published this spring. A fact sheet on Oak Savannas was also published this spring. Four podcasts have been prepared and aired on Spotify, Stitcher, Google Play and Beanpod.

Amendment request: May 24, 2021

As the project has developed several amendment requests have emerged related to the budget. A number of items originally slated as professional/service/technical contracts will be done by our team. These activities done by our team require equipment and supplies. In general, the original PI under budgeted for field equipment. Thus, we request that $22,650 be moved from professional/service/technical contracts to equipment/tools/supplies into a new line item: field supplies for silvopasture research at Sherburne. Further, the budget of professional/service/technical contracts of Great River Greening (GRG) was reduced by the former PI and they are unable to complete deliverables required of them. We request $18,600 be allocated to GRG to complete deliverables. This will come from:

a. $5850 in professional/service/technical contracts originally for TBN services to GRG to support

vegetation surveys conducted by GRG

b. $2250 in equipment/tools/supplies originally slated for Extension outreach to GRG to support their outreach efforts.
c. $4500 in other originally for advertising, which will support GRG advertising for the events they are leading related to our project
d. $4500 in other originally for stakeholders forum, which was held online. This reallocates funds to support GRG hosting in-person events in Fall 2021.
e. $1500 in other originally for bus rental to GRG to support GRG hosting in-person events in Fall 2021

Amendment Approved by LCCMR 6/17/2021

Fourth Update October 25, 2021

This summer we worked with a new grazing cooperator, GrazeTek, and were able to achieve a larger herd size, as desired for shrub management. From July 10th to 16th, 387 cow/calf pairs grazed the same research paddock areas as 2020, spending 3 to 6 hours per paddock. The impact was substantial; we have seen a 48% reduction in the number of shrub stems in our research paddocks. We conducted the refuge-wide bat and vegetation monitoring in the same manner as in 2020. We increased our herpetofauna sampling effort by doubling the number of coverboards on site. For our pollinator surveys, we hired an environmental consultant in order to improve the quality of the data. For the water quality assessment, we took water chemistry and infiltration measurements in our previously installed wells and the river. We also installed additional wells and level loggers at a nearby livestock farm to serve as a point of comparison for the cattle impact at the refuge. We are caught up on our soil analyses after delays due to COVID; all samples from 2019 to 2021 (with the exception of August 2021) have been sent out for fertility and PLFA testing. Total carbon and nitrogen elemental analysis and aggregate stability testing are in progress.

The Silvopasture Learning Network has grown from 443 people in the last reporting period to 526 people. Our Facebook page has grown from 39 followers to 157 followers. We sent out our third quarterly newsletter in August, with a focus on volunteer contributions and events. A volunteer event was held on June 12 at Early Boots Farm, Sauk Centre, MN.

A workshop and field day titled, “Silvopasture, Oak Savanna, and Bison Program and Tour,” were held on June 24 in Mankato and at Minneopa State Park, respectively. A training event titled, “Energized Fence Training & Silvopasture Field Tour,” was held at Sherburne National Wildlife Refuge on April 23. One webinar was completed in this reporting period: “Saving the savanna: Restoring a historic habitat in Burnsville, Minnesota,” was held on April 20.

Amendment request: January 31, 2022

Our partner the Sustainable Farming Association (SFA) has a subcontract with us for a variety of activities that support the grant. The lead PI on this changed during the first year moving from someone with extensive silvopasture experience to an ecologist (Dr. Rebecca Montgomery). Thus, SFA has increased their engagement to support this grant. As such, their subcontract is running out of funds before our grant and deliverable are complete. I thus am requesting a rebuget that increases their funds. Specifically, given the impacts of COVID and the move to many virtual online engagement activities, we have used less of the main travel funds than expected and relied more on personnel and partners.

I request an increase of $17,580 to SFA to complete deliverables around field days and workshops. These

funds would come from:

1. From Travel, $12,500 to subcontract. To support SFA travel to field days and workshops as well as related expenses of hosting events including communication.

2. From Personnel, $5,080 to subcontract. To support salary and fringe of additional staff time for SFA.

Amendment Approved by LCCMR 2/16/2022

Fifth Update March 1, 2022

We are currently finalizing statistical analyses on the last three years of data for all components of the research project. After two summers of targeted cattle grazing, shrub stem density has been significantly reduced by 48% within the paddocks. However, we are also seeing a decline in several herbaceous vegetation metrics. Based on this data, we have adapted our grazing plan to include a rest year in 2022, and we will resurvey in August to track herbaceous recovery. Avian point count data analysis is nearing completion. Overall bird species diversity, richness, and abundance were higher in burned and grazed areas than in the control zones. Butterfly data analysis is partially complete, and has revealed no significant differences in butterfly abundance across the different management zones. Bat data from the summers of 2020 and 2021 is still in the process of being analyzed. Nearly all of the soil samples have been processed, and most soil health metrics now have complete datasets with some preliminary results. Water quality samples from summer 2021 are still being processed in the lab.

The Silvopasture Learning Network has grown from 526 people in the last reporting period to 540 people. Our Facebook page has grown from 157 followers to 195 followers. The email short course (referred to as “e-tools” in the grant) was released. A volunteer event with 25 attendees was held on October 14, 2021, at Living Song Farm, Howard Lake, MN.

Two workshops were held in this reporting period. The first was “Restoring ecosystem health with targeted disturbance: oak savanna, Silvopasture and adaptive grazing,” and was held on December 13, 2021. The second was “Targeted Grazing to Restore Woody-Encroached Oak Savannas,” and was held on February 16, 2022. A field day at Sherburne National Wildlife Refuge was held on Thursday, October 22, 2021, with 45 attendees. A webinar was produced and released from video created at a 2020 field day. Three Cafe Chats were completed with a total of 43 attendees.

Update June 30, 2022

Project extended to June 30, 2023 by LCCMR 6/30/22 as a result of M.L. 2022, Chp.94, Sec. 2, Subd. 19, legislative extension criteria being met.

Sixth Update November 3, 2022

All fieldwork and data collection are complete on this project, excluding water quality sampling. We have also finished the targeted cattle grazing associated with this research. Vegetation data analysis is ongoing. Shrub density is 20% lower than it was at the start of the project and the herbaceous community has recovered to its pre-grazing condition. Data analysis is complete for our bird and butterfly data. Butterflies were not impacted by restoration treatment, but bird abundance and richness varied significantly, with some species responding positively to grazing and others negatively. Our soil health data analysis is also complete, and we found no significant impact of cattle grazing. Bat and water quality data processing and analysis are ongoing. The remainder of the duration of the grant will be devoted to finalizing data analysis

and preparing three manuscripts for publication in scientific journals.

The Silvopasture Learning Network has a final count of 556 people and will continue to be managed by SFA, but the Facebook page will be retired. Extension's Silvopasture Learning Network website will remain live, but without new content. New content will be posted on SFA's silvopasture site. Our e-Learning course will continue to run. The Farmmaps app, silvopasture forum, volunteer events, and cafe chats are all complete. A field day at Sherburne National Wildlife Refuge was held on June 21, 2022 with 63 attendees. Two webinars and one podcast episode were produced during this reporting period.

Our research results were disseminated through presentations at five conferences: Midwest Ecology and Evolution Conference (March 5), North American Forest Ecology Workshop (June 21), Annual Meeting of the Ecological Society of America (August 17), and Natural Areas Association Conference (September 9).

Seventh Update as of March 1, 2023

In the final months of this project, we are focused on synthesizing our findings and preparing them for publication. The majority of our data analyses are complete, including butterfly, bird, bat, soil health, and most of the vegetation data. Water quality samples are being processed and analyzed in the lab. A manuscript on oak savanna restoration approaches has been submitted and reviewed by a journal and two more, one on targeted grazing and one on wildlife impacts, are in preparation. We have completed all aspects of the project related to volunteerism, extension, outreach, education, and dissemination (Activities 2 and 3).

Final Report as of June 30, 2023 – Overall Project Outcomes and Results

Oak savannas are highly biodiverse and on the brink of disappearing due to habitat conversion and the suppression of fire and grazing, disturbances that these ecosystems require. With less than 1% of Minnesota's oak savannas remaining, there is a critical need to determine the best strategies to restore degraded savanna remnants. This project characterized the outcomes of multiple restoration strategies: 1) no management, 2) tree thinning, 3) thinning + prescribed burning, and 4) thinning + burning + cattle grazing. We specifically wanted to evaluate the potential of adaptive, targeted cattle grazing as an oak savanna restoration tool. For four years, we monitored the response of vegetation, water quality, soil health, and wildlife (birds, bats, and butterflies) at hundreds of plots across restoration treatments. We found that thinning and burning successfully increased tree canopy openness, herbaceous vegetation cover and diversity, and savanna-associated plant species. Bird abundance and species richness also responded positively to thinning and burning, while butterfly abundance/richness and the activity of most bat species did not differ across the restoration treatments. Thinning and fire had the unwanted effect of creating dense shrub thickets, so we used adaptive targeted cattle grazing to combat the overgrown shrub layer. We grazed small areas at a high stocking density for a short duration (385 cattle in ¾-acre paddocks for 3-6 hours) and found that this was an effective strategy to reduce shrub density in the short-term, but repeated management is needed to prevent resprout. During the four years of this study, we documented no discernable impact of cattle grazing on birds, butterflies, bats, water quality, or soil health. The significance of this work is twofold; it improves the science and practice of restoration in one of Minnesota's most imperiled ecosystems and highlights how livestock production can be integrated with restoration goals.

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1 Title: Establish and demonstrate oak savanna restoration using Silvopasture

methodology at Sherburne National Wildlife Refuge.

Description: Using the grazing plan of the Sherburne National Wildlife Refuge (NWR), we will establish monitoring (demonstration) plots in the NWR to assess and demonstrate the impacts of silvopasture on restoring oak savanna by understanding changes in species diversity (plants, animals, birds, and insect – pollinators), soil health, and water quality. Baseline data will be collected and these parameters will be assessed annually thereafter. In consultation with staff from the NWR, we will establish these demonstration plots in silvopasture areas in the NWR and the imaginary boundaries of each plot will be demarcated using GPS waypoints. We will establish control plots to allow us to determine the impacts of silvopasture from no-management scenarios. The following parameters will be monitored and assessed:

Vegetation Management and Monitoring (Rebecca Montgomery - UMN, Steve Huckett – Great River Greening)

- Vegetation sampling will take place in the Northeast Grazing Unit of Sherburne NWR. Within this Unit of the NWR grazing plan, we will survey the area to identify the general location(s) of prior management activities within the NWR including ***Fire*** only, ***Grazed*** only, and ***Fire and Grazing***. We will work on- site in each of these prior management activities to assess and compare the impacts of silvopasture on oak savanna ecosystem restoration. This information will be projected to a map of the area so that all three prior management activity types are represented. The following methods will be used to assess vegetation impacts:
    - **Mature Trees:** We will use standard forest inventory methods that use fixed radius plots to survey tree abundance, size distribution, basal area and species composition of trees greater than 5 cm DBH. The number of plots surveyed per management unit will depend on unit size.
    - **Shrubs, tree saplings, and herbs:** Within the demonstration plots**,** we will randomly select a beginning point location to establish one - 100 meter belt transect to survey for shrubs, tree saplings (<50 cm tall), and herbaceous vegetation cover. The beginning point of each will be identified by a unique GPS point. Surveys will always begin at this unique GPS point and extend in a northerly direction, with sample being collected at 10 meter intervals along the transect using a Daubenmire frame that measured 50 centimeters by 25 centimeters. We will also sample the species composition and biomass of grasses and forbs along transects using a pin-frame with ten pins spaced evenly along a 1 m frame. The pin-frame will be placed at 0, 50 and 100 m along each transect. At each placement of the pin-frame, and for each pin, we will record the number of hits for each species of any blade of grass touching the pin, and whether that blade is brown or green. The total number of hits for each placement of the pin-frame will be converted to total plant biomass (gm^{-2}). For analysis, we will calculate the total number of hits per species (differentiating green and brown hits of each species) per pin-frame placement, and then determine the mean number of hits for each transect. We will average estimates for each transect for all transects on each property and this mean will be used for subsequent comparisons among properties.

Wildlife Species Assessment (John Loegering - UMN, Jodie Provost - DNR) ● Characterize annually the wildlife community composition, species diversity and abundance in three groups of vertebrates: birds, bats, and reptiles in the demonstration plots that will be established at the NWR. Our on-site assessment will include one year prior to grazing and 3 years after implementing grazing.

- Use variable circular plots to characterize the savanna bird community composition and density (Ralph and Scott 1980). Each demonstration plots will be surveyed three times during June for a 10-minute survey period. All detections by sight and sound within the plot will be recorded as

well as the distance to the observer.

- Use passive acoustic sampling to identify bat species using the silvopasture demonstration plots. We will use passive acoustic bat detectors to record echolocation calls as it is one of the most efficient and least intrusive methods of characterizing the bat community (Coleman et al. 2014). We will place bat detectors (e.g., Anabat SD2 or Wildlife Acoustics SM4BAT recorders) in the center of each plot for 5 days each per month during the months of June, July, and August.
- Use cover boards (Schemnitz et al. 2012) to document reptile species using the silvopasture plots. We will place five cover boards at randomly-determined locations in each plot. We will apply the cover boards every other week during June, July and August. All reptiles and amphibians observed or captured from beneath the boards will be recorded and released unharmed.

Pollinators Assessment (Anna Hess – DNR, Jessica Petersen -DNR)

- The project sites will be visited 3 times per summer, in June, July and August when weather permits. We will employ a minimum of 3 weeks between surveys. Preferably conduct surveys on first week of each month. Surveys will be conducted during these weather conditions: 1) Sunny or partly cloudy; 2) > 65°F and < 90°F; 3) < 10mph of wind speed, 4) No rain or drizzle.
- Establish permanent transects at each of the demonstration plots. Transects will be laid out perpendicular to the long axis of the site. These transects will have a random starting point, and be spaced contiguously 30 meters apart. Transect end points will be marked with bamboo stakes with high-visual flagging or paint.
- Observers and recorders will walk each transect during appropriate weather conditions. Record time spent surveying (record both start and stop times).
- Identify butterflies and moths seen along the transect route. GPS units will be used to capture location of each specimen. The use of Distance sampling technique will be used to measure the distance from the center point of the transect to identify the butterfly or moth initial or resting location. For each Lepidopteran, record initial position where observer spotted the insect.
- Confirm identification at site, or take photo or written description and identify at lab. Identify preferably to genus and species, but family if necessary.
- Conduct statistical analyses. The Distance sampling results will be used to calculate encounter rates and absolute population estimates of individual or pooled species. Species diversity will also be calculated based on observations per site, and species distribution will be calculated based on GPS locations.
- Comparisons of total Lepidopterans counted, absolute population estimates, and encounter rates among silvopasture control sites and silvopasture grazing, fire, and grazing/fire sites will be calculated using appropriate method (nonparametric Kruskal-Wallis).
- Additional analyses will include intersecting GPS points with the Daubenmire frames used for vegetation analyses. Overlap areas will be used to analyze relationships between Lepidopteran species and vegetation cover. This will be assessed using logistical (presence/absence) and stepwise (abundance) regressions.
- Results will be used to determine impacts of silvopasture grazing on Lepidopteran populations. These results will be incorporated into case studies to form the core of Minnesota focused Silvopasture Learning Network.

Soil and Water Assessment (Joe Magner – UMN, Jessica Gutknecht – UMN, Craig Sheaffer – UMN)

<u>Soil Health/Ecology:</u>

- At each demonstration plot, randomly selected positions will be identified for performing soil characterization and determination of soil health. Soil samples will be collected to determine physical attributes, chemical attributes, and biological indication of the abundance and activity of soil organisms important for soil health outcomes and soil functioning.

- o Physical Characteristics: At a single representative location in each demonstration plot, we will do a full soil profile description as a baseline for understanding subsequent changes in soil characteristics. At each soil profile location we will also take soil samples at 0-15 and 15-30 cm depth to perform soil moisture flux, water infiltration analysis, and wet aggregate stability analysis. Subsamples from this representative location will also be analyzed for the chemical and biological analyses described below.
- o Chemical Characteristics: Using the same transect locations and approach described above for tree, sampling, and herb samplings, we will randomly choose 5 of the plant sampling locations along the transect to take 0-15 and 15-30cm soil samples. Samples will be air-dried, ground, and analyzed for total organic carbon, total nitrogen, readily available carbon (POX-C), pH, and micronutrient analysis.
- o Biological Characteristics: Using a frozen portion of the soil samples taken as described for chemical analysis, we will perform lipid analysis to determine the abundance of bacteria and fungi at each demonstration plot. We will also determine the microbial decomposition activity through performing extracellular enzyme assays.

● Data sets from the physical, chemical, and biological characteristics of soil quality will be combined for a broad perspective of how the soil resource is altered by Silvopastoral management approaches. Sampling will also be coordinated with the water quality and plant sampling campaigns so that soil, water, and plant community data can be interpreted and combined together for an ecosystem-wide perspective on demonstration plot strategies.

<u>Water Quality:</u>
Water quality will be measured at the site scale using water table access tubes (with data loggers) and at the small watershed scale with measurement of precipitation (at NWR office), hydraulic head, and flow (if possible). Water chemistry will be measured using hand-held sonde instruments and field specific probes/sensors. Lab measurements of stable isotopes will be used to infer watershed scale influences upon region water quality from defined management practices.

ACTIVITY 1 ENRTF BUDGET: $359,106

Outcome	**Completion Date**
1. Silvopasture demonstration plots established at Sherburne National Wildlife Refuge; baseline data established and collected	October 2019
2. Vegetation management, assessment, and monitoring	Annually
3. Wildlife community, assessment and monitoring of three groups of vertebrates (i.e., birds, bats, and reptiles)	Annually
4. Pollinator diversity assessment and monitoring	Annually
5. Water quality monitoring and assessment	Annually
6. Soil Health Assessment	October 2019, October 2021
7. Research findings reported.	Annually

First Update March 1, 2020

The first field season started in July 2019 and was focused on site selection and preparation, as planned. At Sherburne National Wildlife Refuge, eight survey zones were identified representing four management history types: 1) Grazed, burned, and mechanically thinned, 2) Burned and mechanically thinned, 3) Mechanically thinned only, and 4) Control – no management. The survey zones are between 30-35 acres, with the exception of one of the grazed sites which is 68 acres. The two zones with management type #1 were grazed in the summer of 2019 with around 100 calf-cow pairs and 5 longhorns. Grazing occurred in the first zone from the end of May through the first week of July, and in the second zone from July through mid-August. SNWR terminated the contract of the grazing cooperator at the end of the season and will be partnering with a new cooperator for the summer of 2020. We are in the process of designing an adaptive multi-paddock grazing strategy to implement with this new cooperator.

Vegetation Management and Monitoring

In August 2019, 35 fixed monitoring plots were established in each survey zone for a total of 280 plots. Previous data from an oak savanna ecosystem in Minnesota indicates that 35 plots is enough to adequately capture the diversity of vegetation. Survey protocols were written, and in August, baseline 7 data was gathered for herbaceous, shrub, and sapling species. Herbaceous vegetation was sampled at each of the monitoring plots using a 0.5m x 1.0m rectangular frame. Cover classes were estimated for each species based on the vertical projection of plant parts onto the area of the frame. Shrub and seedling were sampled within a circular quadrat with 1-meter radius around each of the monitoring plots. Woody stems were counted and recorded by species. For saplings, the species, dbh at 1.35 m from the ground, and an estimated height (in size classes) were recoded. Some preliminary data analysis has been completed.

Wildlife Species Assessment

Due to the activity level of the birds, it is best to conduct bird surveys in the month of June. Since the project did not begin until July 2019, bird surveying will begin in June 2020. Similarly, snake and bat surveys are most effective when implemented throughout the full summer and will therefore begin in June 2020. Sampling protocols for each of these surveys are under development.

Pollinators Assessment

The baseline vegetation data gathered in August 2019 was used to inform the design of the pollinator assessment. A protocol using the Distance Point County method at a subset of the fixed monitoring plots has been developed. Specimens will be identified and their distance from the survey point will be recorded. The pollinator assessment is set to begin in June 2020.

Soil and Water Assessment

Initial infiltration measurements were taken using both a dual head (double ring) infiltrometer and a modified Philip-Dunne (MPD) falling head infiltrometer to understand geomorphology of the study site. It was determined that the MPD method was best suited to the site, and 34 infiltration tests were performed in the two grazed zones. Average hydraulic saturated conductivity (Ksat) was calculated on and off the cow paths. Water quality and chemistry measurements will begin in summer 2020. 30cm deep soil cores were taken at the 35 monitoring plots in each of the survey zones. From those 35 samples, the 3 samples in closest proximity to each other were pooled to give a total of 12 samples per survey zone. The soil samples are currently being processed in the lab; tests will include CN and aggregate stability analyses, and enzyme and POX assays. Pending adequate soil volume, subsamples may be sent out for pH and micronutrients analysis.

Second Update September 1, 2020

Throughout the spring, we worked with the Sustainable Farming Association and the new grazing cooperator, Thousand Hills Cattle Company, to design an adaptive multi-paddock grazing strategy. Nine 1-acre paddocks were identified for high density, short duration grazing with the goal of reducing shrub cover and increasing herbaceous cover and diversity. This new grazing strategy is more intentional, research-based, and restoration-oriented than last year's approach. The refuge used a forestry mower to prepare the site, and we delineated the paddocks with temporary polywire fences. From May 22-27, each research paddock was grazed for around 4 hours at a density of 53,300 pounds of cattle per acre. The cattle had access to two of the paddocks overnight due to water-related logistics. The group was primarily yearling cattle, and the stock density was about ⅓ what we originally planned for, so there was less impact on the shrubs than expected. From August 3-7 we ran the cattle through the research paddocks for a second time, this time with around 65,000 pound of cattle per acre. Again, the cattle were in each research paddock for around 4 hours, with access to two overnight for watering. We strategically incorporated a mineral feeder and water tanks to facilitate additional impacts on the shrub layer. From our assessment, we believe that an additional 50-100 head of cattle would allow us to best achieve our vegetation goals; conversations are ongoing between Thousand Hills, SFA, SNWR, and UMN to develop this plan for next year.

Vegetation Management and Monitoring

In May 2020, we established two fixed monitoring plots in each of the nine high-intensity grazing paddocks, adding to the 280 vegetation plots established in 2019. We conducted pre-grazing shrub, sapling, and herbaceous surveys in the high-intensity paddocks according to the 2019 methods. In July, we completed a forest inventory at a subsample of 20 plots in each of the 8 management zones (Burn/Graze/Thin, Burn/Thin, Thin Only, Control). At each of the selected monitoring plots we recorded all tree species within an 8-meter radius, measured their diameter breast height, and estimated canopy cover using a spherical densiometer. In August, we carried out herbaceous, shrub, and sapling surveys at all of our monitoring plots in the same manner as in 2019 in order to detect any annual changes in the vegetative community. We also evaluated the impact of the cattle on the vegetation in two ways: 1) herbaceous biomass harvesting before and after each round of grazing to estimate consumption, and 2) a shrub impact assessment. We evaluated the latter before and after grazing using a line-point intercept method along 3 north-south transects in each grazing paddock. Every 5-meters, we dropped a post and recorded all species touching the post, and their level and type of grazing impact. Additionally, we marked randomly selected stems along the transects and recorded the number of leaves per stem pre- and post- grazing. We are now in the process of analyzing this data.

Wildlife Species Assessment

In May, we deployed 39 cover boards to monitor herpetofauna (1 board per grazing paddock, plus 5 per zone in the Burn/Graze/Thin, Burn/Thin, and Control management areas). We checked these boards approximately every two weeks throughout the summer, recording any species we found, and their weight and length when possible. In June, we conducted an avian point count surveys at 3 points per zone in the Burn/Graze/Thin, Burn/Thin, and Control management areas, as well as 2 points in the high intensity grazing paddocks (20 points total)**.** Point counts began 30 minutes before sunrise and finished no later than 10:00am. For 6-minutes, the observer recorded all songbird species encountered within a 100 meter radius, including flyovers. All points were surveys 3 times over the course of 3 weeks. In mid-July, we deployed two bat detectors to study the bat population using a passive ultrasonic monitoring. The bat detectors recorded data every night from 30 minutes before sunset until 30 minutes after sunrise, and were moved every 7-12 days to capture all pairings between management types (Burn/Graze/Thin, Burn/Thin, and Control). All wildlife data analysis will begin in the fall.

Pollinators Assessment

The pollinator assessment began in May using a distance point count sampling method at a subsample of 60 of our fixed vegetation monitoring plots (15 plots per management zone). For 2 minutes, the surveyors recorded all Lepidopteran species seen within a 180° arc, their behavior, and their distance from the plot marker. Notes were made about the level of cattle impact at each plot and photos of the specimens were taken when possible. Four rounds of pollinator surveys were completed, with one

occurring prior to the grazing in May, and three occurring after. Pollinator data will be analyzed in the fall using Distance software and other statistical methods.

Soil and Water Assessment

In June, we began taking soil cores and scoping the site for access tube placement. We installed 8 wells in one of the high intensity grazing paddocks near the St. Francis River to monitor groundwater water levels. At each well location we performed tests to determine the infiltration rate of both the A and B horizons. We also collected and processed water samples from the wells, which were then tested for ion chromatography, isotopes, alkalinity and nitrate levels.

Last summer's soil samples are still being processed in the lab; tests include CN and aggregate stability analyses, and enzyme and POX assays. At the end of August, post-grazing soil samples were taken in the nine high-intensity grazing paddocks, near the vegetation monitoring plots. Six 30-cm cores were taken at each plot and pooled together into the 0-15 cm and 15-30 cm increments. Subsamples were separated for enzyme and PLFA tests. Laboratory analysis of the soils will continue into the fall and winter.

Third Update May 24, 2021

The winter season of 2020-2021 has been focused on data processing and data analysis for all of the research project components. Planning for the 2021 field season is also underway. Data collection protocols will be consistent with previous years, with small changes to maximize our ability to detect differences (if present) between the grazing paddocks and controls. Thousand Hills Cattle Co. will not be returning to Sherburne NWR for the 2021 season, so we are working with the refuge managers and SFA to secure a new cooperator. Based on our results from last year, the goal is to increase the size of the herd by 50 or 100 cattle.

Vegetation Management and Monitoring

In the zones where targeted grazing is being implemented, the dominant shrub species are *Corylus americana* and *Rubus sp.* Average shrub cover is 54% which is 20% higher than SNWR's target for oak savanna. Preliminary data analysis shows that the cattle impacted 42% of shrub stems measured in our paddocks through browsing, trampling, or breakage. Of the stems that were hit by the cattle, the majority were low-level impacts where less than 10% of the stem was affected. Across the paddocks, average defoliation per shrub stem was five leaves. The cattle consumed on average 28% of the standing herbaceous biomass in our sample plots. We hope to increase cattle impact on the shrubby midstory in 2021 by doubling the number of cattle rotated through the paddocks.

Wildlife Species Assessment

Data analysis is ongoing - no update to report. We are looking into expanding our herpetofauna surveys for the 2021 field season.

Pollinators Assessment

Preliminary data analyses have shown no significant differences in pollinator abundance across the different management zones (thin only, thin+burn, thin+burn+graze, high density grazing). Additional data cleaning and analyses, including working with the distance software, are ongoing. The 2021 surveys will be modified to ensure that we are able to get species-level butterfly and moth data.

Soil and Water Assessment

Baseline soil samples from 2019 have been analyzed for carbon and nitrogen, and are currently being sent out for fertility testing and biological assays including PLFA and enzyme analysis. These results will serve as a baseline comparison for our 2020 and 2021 samples. 2020 soil samples are still being processed, and will be sent out for testing soon. Planning is ongoing for the 2021 field season; we will sample inside and outside of the grazing paddocks, and add on aggregate stability measures. On the water samples, we have conducted stable isotope, nitrate, and phosphorus analyses. Data analysis and planning for 2021 fieldwork continues.

Fourth Update October 25, 2021

This summer we worked with a new cooperator, GrazeTek, a custom and conservation grazing company. 387 cow/calf pairs (774 head of cattle) were delivered to the refuge between May 28-June 4. As planned, we grazed the same research paddock areas from 2020. Given that we had our target herd size this year, we were able to graze the research paddocks once instead of twice. The cattle reached the research area on July 9th, where they spent 3 hours in the 3 most northern paddocks. On July 10th, they spent 6 hours in the next 2 paddocks where they had access to water. On July 16th, the cows spent 6 hours in the 4 southern paddocks. Again, we used strategic salt block, mineral feeder, and water tank placement to increase impact. After each high intensity paddock, the cattle always had access to a larger, fresh paddock for additional feed. Cattle are not expected to return to the research area for at least one year.

Vegetation Management and Monitoring

We conducted our vegetation monitoring with the same methods as 2020. We conducted pre-grazing vegetation surveys at the permanent plots in the high-intensity paddocks. We harvested herbaceous biomass immediately before and after grazing to get an estimate of consumption. We also used the same line-point intercept and leaf count methods (pre- and post- grazing) to assess shrub impact. Our results show the cows consumed 54.0% of standing herbaceous biomass (dry weight) and browsed an average of 45 leaves per shrub stem. Overall, we have seen a 48% reduction in shrub stems compared to our very first survey. This is significant progress toward our goal of reducing the shrub midstory in order to promote herbaceous savanna species. In August, we carried out our annual herbaceous, shrub, and sapling surveys at all of our monitoring plots across all treatment zones on the refuge. We now have 3 years of monitoring data that we can use to assess the various, layered oak savanna management strategies. Vegetation data analysis will be ongoing through the fall and winter.

Wildlife Species Assessment

In June, we doubled the number of cover boards we had out on the refuge in an attempt to increase our ability to detect herpetofauna. We checked the boards approximately every other week throughout the summer, but did not record any snake species. As in 2020, we deployed two bat detectors to study the bat population using passive ultrasonic monitoring. The bat detectors recorded data every night from 30 minutes before sunset until 30 minutes after sunrise, and were moved every 7-12 days to capture all pairings between management types (Burn/Graze/Thin, Burn/Thin, and Control). Analysis of the bird and bat data will be ongoing throughout the fall and winter.

Pollinators Assessment

This summer, we hired a professional consultant, Endangered Resources LLC, to conduct the pollinator assessment. Using the same distance point count sampling as in 2020, the consultant completed one survey per month in June, July, and August, for a total of 3 rounds. Lepidopterans were recorded to the species level and photos of the specimens were taken when possible. Compared to last year, pollinator numbers were low due to the drought. Distance software is being used to calculate population estimates. Other statistical methods will be used throughout the winter to assess the relationship between the pollinator and vegetation data.

Soil and Water Assessment

Soil samples were taken in May before grazing and in August after grazing. The May samples have been tested for total nitrogen and carbon elemental analysis. All samples from 2019 to 2021 have been sent to Agvise for fertility testing, and we are waiting on results from the August 2021 samples. The 2020 and May 2021 samples have been sent out for PLFA testing, and the August 2021 samples have been freeze-dried in preparation but not yet mailed out. All samples from 2019 to 2021 have had a portion prepared and set aside for the POX-C testing. The August 2021 samples for total carbon and nitrogen elemental analysis are prepared, and the aggregate stability samples have been air dried in preparation for testing.

For the water quality assessment, we had installed data level loggers and had taken water

chemistry measurements (NO3, DO, pH, T and SPC) in the wells and river. Bromide infiltration tests, as well as dual head infiltration tests, were conducted near all the wells installed and in areas disturbed by the presence of cattle. This summer, wells and level loggers were installed at a nearby livestock farm to serve as a point of comparison for the cattle impact at the refuge. Water chemistry and physical measurements were taken, as well as soil physical tests.

Fifth Update March 1, 2022

We have spent the winter finalizing statistical analyses on the last three years of data for all components of the research project. Based on the response of the vegetation, we have adapted our grazing plan to include a rest year. This means the research paddocks will not receive any grazing or burning treatments in 2022.

Vegetation Management and Monitoring

After two summers of targeted cattle grazing, shrub stem density has been significantly reduced by 48% within the paddocks ($p<0.001$). Stock density (animal pounds per acre) significantly predicted change in stem numbers ($p=0.013$). Similarly, shrub cover has been reduced by 40%. This indicates that targeted grazing is a viable tool to help suppress the shrub layer in woody-encroached savannas, particularly in restorations where fire has failed. However, we are also seeing a decline in several herbaceous vegetation metrics. Herbaceous cover and richness have decreased by 40% ($p=0.005$) and 56% ($p=0.005$), respectively. This trend can be explained by the fact that we conducted our surveys shortly after an intense grazing event where much of the vegetation was removed. Our plan is to complete one more round of vegetation surveys in August 2022 to monitor how the herbaceous community has recovered, pending approval of our grant extension.

Wildlife Species Assessment

Statistical analysis of the avian point count data is nearing completion. During our bird surveys, we observed 1,302 individuals of 69 bird species, including 16 species listed as Minnesota Species in Greatest Conservation Need. Overall bird species diversity, richness, and abundance were higher in management zones that had been grazed than in the control zones. However, they were even higher in zones that had been only thinned+burned (no grazing). Field sparrow abundance responded particularly positively to the grazing treatment. Bat data from the summers of 2020 and 2021 is currently being analyzed for differences across the management zones. Interestingly, we recorded calls from 7 of the 8 bat species in Minnesota.

Pollinators Assessment

Statistical analysis revealed no significant differences in butterfly abundance across the different management zones in 2021, consistent with our 2020 results. This indicates that targeted grazing doesn't impact pollinator populations. We are currently analyzing butterfly abundance data in relation to specific vegetation metrics, to better understand butterfly response to oak savanna restoration activities.

Soil and Water Assessment

The following variables have complete data sets and have started preliminary statistical analysis: pH, organic material, phosphorus ppm, potassium ppm, nitrate lbs/acre, soil conductivity, total nitrogen, total carbon, carbon to nitrogen ratio, oxidizable carbon, and aggregate stability. The PLFA data is complete, and is starting to be processed. The extracellular enzyme analysis has had some unexpected delays, but progress on both finishing processing the samples and analysis have resumed and are anticipated to be complete by March 7. The entire Sherburne soil research is anticipated to be complete by April 8. Water quality samples from summer 2021 are currently being processed and analyzed in the lab. There are no preliminary results yet. Additional samples may be collected in March depending on weather conditions.

Update as of June 30, 2022

Project extended to June 30, 2023 by LCCMR 6/30/22 as a result of M.L. 2022, Chp.94, Sec. 2, Subd. 19, legislative extension criteria being met.

Sixth Update November 3, 2022

All fieldwork and data collection is complete on this project as of August 2022, excluding water quality sampling. After our final vegetation survey, the cattle briefly grazed the research paddocks during the second week of August. They were not stocked at a high density or managed to target the shrubs, but rather, passed through on their way to another grazing unit. The remainder of the duration of the grant will be devoted to finalizing data analysis and preparing three manuscripts for publication.

Vegetation Management and Monitoring

We completed our final vegetation survey in August. The purpose was to follow up on the recovery of the vegetation one year post-grazing. There was a substantial amount of shrub resprout this year. Shrub stem density is still 20% lower than when we began in 2020, but the difference is no longer statistically significant. Herbaceous cover has increased back up to 36%, which is higher than it was in 2020. Herbaceous richness has also rebounded and is nearly equal in grazed and ungrazed plots. This indicates that repeated targeted grazing can be used to combat shrubs without detriment to the herbaceous community. A manuscript comparing the vegetation community across different oak savanna restoration levels is on track to be submitted for publication this winter.

Wildlife Species Assessment

Bird data analysis is complete and we are writing the results up in a manuscript for publication. This paper will be on wildlife response to different oak savanna restoration practices and will include our bird, bat, and pollinator data. Our bat data is still being processed and data analysis is ongoing.

Pollinators Assessment

Butterfly data analysis is complete and the results are being incorporated into the aforementioned wildlife manuscript. Butterfly abundance was significantly lower in 2021 than in 2020. Temperature significantly predicted abundance; warmer weather was associated with more butterflies. In terms of vegetation metrics, higher herbaceous cover and diversity, and lower shrub density were predictors of greater butterfly abundance.

Soil and Water Assessment

Soil health data analysis is complete. None of the soil metrics were significantly different between grazed and ungrazed areas, except for microbial biomass which was higher inside the grazed paddocks. Phosphorus, pH, potassium, nitrate, salinity, and microbial community composition varied more across years, and total carbon and total nitrogen varied more across season, than across treatments. Organic material, pH, P, K, NO3, and conductivity were also correlated with seasonal precipitation amount. This indicates that other ambient factors influence soil health much more than grazing, and that we can use cattle to target the vegetation without negatively impacting soil health.

Additional water quality samples were collected in 2022. The results show no water quality impact from cattle grazing at SNWR over the study period. Though soil water infiltration suggests there could be a pollution impact, no pollutant indicators were detected beyond background conditions because animals were allowed to move over a larger area compared to the reference control. The grazed reference control did show pollutant transport to groundwater. Our conclusion is that animal density and duration make a difference. The higher the animal density and the longer the grazing period, the risk of groundwater contamination increases in Anoka Sand Plain soils. One more round of sampling will occur in October 2022.

Seventh Update as of March 1, 2023

All fieldwork and data collection for this project are finished. As this project comes to a close, we are focused on synthesizing our findings and preparing them for publication. The majority of our data analyses are complete, including butterfly, bird, bat, soil, and most of the vegetation data. One manuscript has been submitted to a journal, and two more are in various stages of preparation.

Vegetation Management and Monitoring

A manuscript with data from this project entitled "Oak Savanna Vegetation Response to Layered Restoration Approaches: Thinning, Burning, and Grazing" was submitted to *Forest Ecology and Management* in December. We are now making minor revisions before resubmitting. Data analysis and synthesis related specifically to the impact of targeted grazing on shrub control and other vegetation outcome is ongoing. This targeted grazing manuscript is in the process of being written and should be ready for publication this summer.

Wildlife Species Assessment

All bat call files have been processed through an acoustic software and data analysis is complete. We found that total bat activity (calls/night) was on average 50-60% higher in the thin+burn+graze treatment than in the thin+burn treatment and unmanaged control. Big brown bat was the only species whose activity varied among treatments and was significantly higher in the treatment that included grazing. A draft manuscript on butterfly, bird, and bat response to different oak savanna restoration practices has been written. This manuscript will be submitted to a journal for publication within the next few months.

Pollinators Assessment

Butterfly data analysis is complete, and the results are synthesized in the previously mentioned wildlife manuscript.

Soil and Water Assessment

Soil health data analysis is complete. These results will be incorporated into the manuscript on the impacts of targeted grazing described above. The final water quality samples were collected from the access tubes in October 2022. These samples are still being processed analyzed in the lab, but we are on target to have the analyses completed in May. The data showed a continued pattern of lower nitrate at the targeted grazing sites and higher nitrate at the continuously grazed reference site. We suspect this is due to lower vegetative cover at the continuously grazed site leading to less nitrogen uptake and more manure-based nitrogen leaching into the water table.

Final Report as of June 30, 2023 – Final Report Summary

Vegetation Management and Monitoring

We implemented an observational study to characterize the response of oak savanna vegetation structure and community composition to a gradient of restoration effort. We surveyed the canopy, saplings, shrubs, and herbaceous layer three times over 2019-2021 at 232 plots spread across four restoration histories: 1) unmanaged, 2) thinning only, 3) thinning + burning, 4) thinning + burning + low-intensity cattle grazing. We found that increasing restoration effort did not produce consistent shifts toward savanna vegetation structure but did coincide with a transition from woodland plant species to savanna associates. Compared to the reference, the additions of thinning and fire increased canopy openness and herbaceous cover, but also increased shrub cover. Low-intensity grazing provided no further benefits, but rather, decreased herbaceous cover and slightly increased shrub cover in comparison to thinning+burning. Each restoration treatment generated a unique species composition, but the most pronounced community differences were between unburned and burned treatments. Burning increased herbaceous richness, diversity, and non-native herb abundance, and decreased non-native shrub density. The results of this work were published in an open-access article in *Forest Ecology and Management* entitled "Oak savanna vegetation response to layered restoration approaches: Thinning, burning, and grazing" (Yantes et al., 2023).

Since we found that all restoration strategies used in the past failed to control the shrub layer, we decided to test a new approach: adaptive targeted cattle grazing. We established nine 0.3-hectare paddocks in the areas that had previously received thinning, burning, and low-intensity grazing. We rotated 100-385 cattle through, spending only 3-6 hours per paddock per year. We tracked the response of the shrubs and herbaceous community using a combination of plot and transect based surveys. We found that this type of high density, short duration cattle grazing reduced shrub density over the short term, but there was

substantial resprout after one year of no grazing. Targeted grazing lowered herbaceous cover and shifted species composition but did not affect herbaceous species density or diversity. We saw no increase in non-native cover during the study, though we documented isolated occurrences of new non-native species in the grazing paddocks. Overall, our study points to the potential of targeted cattle grazing as a viable tool to help restore the understory of woody-encroached ecosystems. These results will be published in a manuscript that is in preparation for *Restoration Ecology*.

Wildlife Species Assessment

In 2020, we deployed 39 cover boards across the restoration treatments to monitor herpetofauna. We checked these boards approximately every two weeks throughout the summer but recorded no individuals. We double the number of cover boards in 2021 and continues checking biweekly, but again recorded no individuals. Therefore, the herpetofauna dataset was abandoned.

We conducted avian point-count surveys in June of 2020 at six points in the unmanaged and thin+burn treatments, and eight points in the thin+burn+graze treatment. We recorded 69 bird species including 11 savanna-associates and 17 species listed as Minnesota Species in Greatest Conservation Need. Total abundance, species richness, and diversity were significantly higher in the thin+burn and thin+burn+graze treatments than in the unmanaged areas. Of the frequently detected bird species, we found six species to be significantly affected by restoration treatment: eastern towhee, field sparrow, golden-winged warbler, gray catbird, mourning dove, and yellow warbler. All six of these species had higher abundances in the thin+burn level than in the unmanaged level. Moreover, 5 of 6 species (not the golden-winged warbler) had higher abundances in the thin+burn+graze level than in the unmanaged level. We used passive ultrasonic bat monitoring to survey bats in June-September of 2020 and 2021. We deployed two bat detectors simultaneously in two different restoration treatments and repeated in all combinations of pairs. We recorded seven of the eight species of bats in Minnesota: big brown bat, silver-haired bat, hoary bat, eastern red bat, evening bat, tricolored bat, and little brown bat. Average total bat activity (calls/night) was 53-60% higher in the thin+burn+graze level than in the thin+burn and unmanaged treatments, however, this was driven by exceptionally high big brown bat activity at a single detector location. Little brown myotis activity was two to three times higher in the thin+burn+graze areas than in the thin+burn and unmanaged areas. No other bat species showed differences in activity among treatments. This work is on track to be submitted for publication in *Ecological Restoration* in September of 2023.

Pollinators Assessment

We surveyed butterflies 3-4 times per summer in 2020 and 2021 at 60 plots spread across the four restoration treatments described above. Average butterfly abundance (butterflies/plot) was not significantly different among restoration levels, but was slightly lower in the thin+burn+low-graze level. Shrub density was also a significant predictor of butterfly abundance, with more individuals at plots with fewer shrub stems. We observed 26 of Lepidopteran species in our 2021 surveys. Average species richness per plot was lower in the grazed restoration levels than in the unmanaged and thin+burn levels. Our habitat-based analyses revealed no significant differences in the abundances of generalist, forest, or grassland species across restoration levels. Overall, our butterfly numbers were low due to severe drought, which made it difficult to draw conclusions about the impacts of the different restoration strategies. Our limited dataset provides some evidence that well-managed thinning, burning, and grazing can improve bird habitat quality while minimally impacting bats and butterflies. This work is on track to be submitted for publication in *Ecological Restoration* in September of 2023.

Soil and Water Assessment

In 2019, we collected eight 0-15cm soil cores and eight 15-30cm soil cores prior to the start of targeted grazing. In 2020, we sampled the paddocks in August after targeted grazing (18 0-15cm and 15-30cm samples). In 2021, we took soil cores before and after targeted grazing (in May and August) in both the control and paddock plots. We tested several chemical and biological parameters associated with soil health: organic matter, pH, phosphorus, potassium, total carbon, and total nitrogen, POXC, enzyme activity, and microbial biomass and composition. There was no clear change in any metric from 2019 to 2021 due to grazing. We also saw very little effect of targeted grazing on any metric from the 2021 pre to post samples;

instead, seasonality seemed to be the primary driver of change. C:N ratio in the top 0-15cm was the only soil parameter affected by grazing. There was a significant decrease in C:N from pre to post grazing within the paddocks, while there was no change in the controls. Overall, we conclude that other ambient factors influence soil health much more than carefully managed adaptive grazing, and that we can use cattle to target the vegetation without negatively impacting soil health. A caveat is that we only have three years of data, and many soil metrics would not be expected to show detectable changes within that timeframe.

Between the years 2020 and 2022, nitrate samples were collected from four wells near our targeted grazing paddocks at SNWR, and two wells at a nearby farm with continuous grazing for comparison. Sampling spots were established using PVC wells, and Solinst level loggers were installed to monitor changes in the water table over the sampling period. Higher well water levels were associated with lower nitrate levels. In general, wells at the farm with continuous grazing had higher nitrate levels than those near the targeted grazing paddocks at SNWR. However, it is difficult to draw conclusions about the effect of our cattle management on water quality due to the severe drought, strong influence of precipitation, and the short timeframe of the study.

ACTIVITY 2 Title: Establish Silvopasture Learning Network and initiate a Silvopasture Volunteerism program (UMN Extension, Sustainable Farming Association, Great River Greening)**.**

Description: We will establish an active Silvopasture Learning Network (SLN) to support the promotion and adoption of silvopasture as an approach to oak savanna restoration. The Silvopasture Learning network will use an integrated outreach, education, and research approach to foster active learning with current silvopasture practitioners, interested operators, researchers, extension agents, natural resource professionals, non-government and other institutional partners across the state. The SLN will facilitate farmer-to-farmer learning, and information sharing about silvopasture.

Learning networks involve people voluntarily learning from each other (peer to peer learning), and sharing their experience with others (learners become teachers). This SLN will be moderated by U of MN Extension. One model for fostering learning that the University of Minnesota has found successful is the Master Woodland Owner Program. A blended on-line and faced to face learning environment that fosters peer to peer learning. Through SLN, we expect to reach at least 400 landowners, and these landowners will seek out and participate in the network, the network will continue beyond the end of this grant. Multiple educational models may be used to create the SLN.

To achieve a functional Silvopasture Learning Network, the University of Minnesota Extension will work with collaborators including the Sustainable Farming Association of Minnesota (SFA) and the Great River Greening. SFA is a farmer to farmer network comprised of family farmers, small business people, agricultural professionals, educators, and food advocates who are dedicated to protecting farming resources by advancing sustainable farming practices. The University of Minnesota Extension and collaborators will identify farmers, landowners, natural resource professionals and other stakeholders with an interest in and potential for adoption of silvopastoral methods and techniques. The University of Minnesota Extension will foster the nascent learning network fostering outreach and supporting farmers and landowners. The U of MN Extension will also develop e-learning tools, for producers, farmers, and natural resource professionals to share their experiences and foster peer to peer learning about silvopasture and the restoration of oak savanna. The e-learning tool will contain resources, blogs, discussion forums, and links to training sessions on silvopasture. All these activities form part of the SLN.

To further accelerate the promotion and adoption of silvopasture for oak savanna restoration, we will initiate a Silvopasture Volunteerism Program. The purpose of the Silvopasture Volunteerism program is to foster peer to peer learning for farmers, livestock producers, woodland owners, about the “hands on”

application of silvopasture as a practice to restore oak savannas.

We will establish two silvopasture demonstration sites (one each in Central and SE Minnesota) that were historically oak savanna. Participants in the volunteerism program will be asked to volunteer and help in the establishing these demonstration sites. During volunteerism events, expert speakers will be invited to share knowledge and train participants about how silvopasture can be used to restore oak savanna.

ACTIVITY 2 ENRTF BUDGET: $214,452

Outcome	**Completion Date**
1. Silvopasture Learning Network launched with initial gathering of participants and practitioners; then annual ongoing SLN recruitment	Annually beginning January, 2020
2. Silvopasture Learning Network field days (2) and workshops (2) each year, held in Central and Southern Minnesota initially and other regions as SLN grows	September, 2020, September, 2021 June, 2022
3. Silvopasture Learning Network e-tools and online portal development	January, 2020
4. SLN online portal and e-tools update and maintenance, quarterly and as needed to include research results and materials generated from Activity 1	Beginning January, 2020, updates as needed
5. Silvopasture Oak-Savanna Volunteerism program established and its associated activities started.	Annually beginning year 2
6. Two silvopasture demonstration sites established as a component of SLN and the Oak Savanna Volunteerism program.	Summer 2020
7. SLN and Oak Savanna Volunteers workshop at demonstration sites, 1 per site annually	Summer 2020, Summer/Fall 2021

First Update March 1, 2020

Silvopasture Learning Network

The Silvopasture Learning Network was launched in November, 2019, at the Green Lands Blue Waters Conference in Minneapolis. SFA coordinated a panel presentation “Silvopasture and Managed Woodland Grazing for Oak Savanna Restoration” at Green Lands Blue Waters attended by 23 people. It included Dr. Zamora, Celie Borndal of MN NRCS Forestry Specialist, Dr. Ashley Conoway, University of Missouri Forestry Institute, and Tom Barthel. UMN Extension Educator Jeffrey Jackson unveiled the Silvopasture Learning Network and recruited 22 initial members to it.

The Silvopasture Learning Network was further developed through a social network analysis survey. Social network analysis is the process of identifying social relationships and structures. The survey was launched in December, 2019, and concluded in February, 2020. Databases used for survey contacts include those from SFA and University of Minnesota Extension. The survey results are now being

analyzed to identify relationships between people and organizations that have interests directly related to the grant activities.

As well, the survey developed a list of people interested in learning more about silvopasture, oak savanna restoration, field days, and volunteer events. The survey had 657 respondents, with 292 people asking to be included in project updates and event invitations. The initial gathering of participants and practitioners for the Silvopasture Learning Network is complete. Recruitment of new people into the Silvopasture Learning Network will be an ongoing part of this project. Analysis of the social network data is just beginning and will lead to new strategies to reach landowners and interested parties to become involved in this project.

Silvopasture Learning Network e-tools and Online Portal Development

Development of the Silvopasture Learning Network online learning portal has begun, and the website is live. It's been populated with relevant information for people interested in learning more about the project and the topic of silvopasture, including upcoming events, best practices, and media hits. Research fact sheets are currently in production and will be added when completed, and work is progressing on additional materials and resources from other components of the project.

Volunteerism Program

Through a series of planning meetings, the vision and structure of the volunteerism program was created. The volunteerism program will complement existing Extension volunteer programs and will be designed to continue after this grant has been completed. Training will be an important component of each volunteer event. During events, expert speakers will be invited to share knowledge and train participants about how silvopasture can be used to restore oak savanna. The goal is for participants to leave an event feeling confident that they have the skills to contribute to oak savanna restoration on their own or other's land.

The first volunteer event is scheduled for June 6, 2020, at Early Boots Farm, Sauk Centre, MN. Volunteer activities will help develop part of the property into a demonstration site for the project. The structure of the event is as follows. Four stations will be created on the property, and volunteers will spend one hour at each station. At each station they will receive training from a subject matter expert, then participate in a volunteer activity. Activities include installing electric fence, seeding native forage species, soil health demonstrations, and invasive species removal.

Second Update September 1, 2020

Silvopasture Learning Network

We have grown the Silvopasture Learning Network through active recruitment at meetings and events. The Silvopasture Learning Network has grown from 292 people in the last reporting period to 409 people. Approximately 20 attendees at 2 SFA Silvopasture Field Days (Aug. 6, 2020 and Aug. 13, 2020) who were not previously in the Learning Network are also being added.

Silvopasture Learning Network e-tools and Online Portal Development

Content strategy has started on the website (https://sites.google.com/umn.edu/silvopasture) and electronic-based learning program. We have also drafted the first issue of a quarterly newsletter, which will be sent to our network members on September 1, 2020.

Volunteerism Program

The June 6, 2020, volunteer event at Early Boots Farm, Sauk Centre, MN, was postponed due to COVID-19 policy limitations on in-person events. It will be rescheduled for spring, 2021. Two other potential sites have been identified and are currently being evaluated for service and learning value. Two volunteer events will be held in 2021.

Third Update May 24, 2021

Silvopasture Learning Network
We have grown the Silvopasture Learning Network through active recruitment at meetings and events. The Silvopasture Learning Network has grown from 409 people in the last reporting period to 443 people. A geographical analysis of Network members showed that members are concentrated in the Twin Cities area, Rochester, Duluth, and along Highway 94 from the Twin Cities to Fergus Falls. The outreach team is using this information to strategically choose sites for field days and volunteer events.

Silvopasture Learning Network e-tools and Online Portal Development
Facebook page - currently at 39 followers and growing. Analytics were just added to the website to track unique visitors and acquisitions, and resources have been added as they are created. We also sent out our second quarterly newsletter in early February, with a focus on oak savanna education and events. The email short course (referred to as e-tools in the grant) is almost complete and will be launched this spring. It consists of 5 weekly emails, each covering important topics to introduce people to the project and important concepts such as silvopasture and oak savanna restoration.

Volunteerism Program
The postponed volunteer event at Early Boots Farm, Sauk Centre, MN, is scheduled for June 12, 2021. A complete write-up will be included in the next reporting period. A second volunteer event is being planned for September, 2021.

Fourth Update October 25, 2021

Silvopasture Learning Network
We have grown the Silvopasture Learning Network through active recruitment online, and at meetings and events. The Silvopasture Learning Network has grown from 433 people in the last reporting period to 526 people.

Silvopasture Learning Network e-tools and Online Portal Development
Online outreach efforts continued on the Facebook page, with 157 total followers. Website analytics show steady visitor rates and 1,221 page views since February 2021. We also sent out our third quarterly newsletter in August, with a focus on volunteer contributions and events. Release of the email short course (referred to as e-tools in the grant) was delayed due to technical issues, but is on track for a fall release.

Volunteerism Program
A volunteer event was held at Early Boots Farm, Sauk Centre, MN, on Saturday, June 12, 2021. The event provided hands-on learning about silvopasture and oak savanna restoration. Turnout was lower than anticipated due to a string of very hot days prior to and on the day of the event. There were 13 volunteers and 5 staff in attendance. Volunteers planted 20 4-ft oaks and 24 2-ft oaks, seeded 3 acres with native seed, and set up 4 protective fence enclosures. Feedback from participants was highly positive, and one volunteer provided this feedback: ”Farmers are hardworking people! They care about the land as well as the crop they produce, whether it be animal or other produce...It was good to help out in a small way!”

Fifth Update March 1, 2022

Silvopasture Learning Network
We have grown the Silvopasture Learning Network through active recruitment at meetings and events, and through online registrations. The Silvopasture Learning Network has grown from 526 people in the last reporting period to 540 people.

Silvopasture Learning Network e-tools and Online Portal Development
Online outreach efforts continued on the Facebook page, with 195 total followers, and we released the email short course (referred to as e-tools in the grant). The website was updated as new materials were made available, and plans are underway for shifting oversight of the site and materials as the initial phase of the grant comes to a close.

Volunteerism Program
The second and final volunteer event was held at Living Song Farm, 7616 25th St SW, Howard Lake, MN, on October 14, 2021. There were 17 volunteers at the event. It was a well-rounded mix of volunteers, including farmers, ag and natural resource professionals, Master Naturalists, and two people who found the event by searching the web for "sustainable agriculture." The volunteers were guided by 8 members of this project team. All project goals were accomplished, including planting oak seedlings, hauling red cedar debris, pulling buckthorn, and spreading prairie seed across 3 acres. Volunteers provided positive feedback on what they learned and accomplished.

The team is now building a "Restoration Volunteer Training" online course. The course is designed for volunteers participating in restoration projects, and it will increase their effectiveness and satisfaction as restoration volunteers. For those that desire it, the training will also prepare them for leadership roles on restoration projects. This online course will launch this spring, and will continue to be available after this grant is completed.

Update as of June 30, 2022
Project extended to June 30, 2023 by LCCMR 6/30/22 as a result of M.L. 2022, Chp.94, Sec. 2, Subd. 19, legislative extension criteria being met.

Sixth Update November 3, 2022

Silvopasture Learning Network
The Silvopasture Learning Network has grown from 540 people in the last reporting period to 556 people. This is a final number as of Aug 9, 2022. A final newsletter to the network on June 23, 2022. The newsletter discussed: 1) research updates thus far, 2) outreach thus far, and 3) end of grant transitions/where to find information (see section below).

Silvopasture Learning Network e-tools and Online Portal Development
This project is now at a time of transition. University of Minnesota Extension and Great River Greening's roles are complete, and moving forward SFA will be the main contact.

- Silvopasture Learning Network: SFA will maintain the network database and send out new event information.
- Facebook: The Silvopasture Learning Network Facebook page will be retired; look for new posts on the Facebook pages of SFA and Extension Natural Resources.
- Websites: Extension's Silvopasture Learning Network website will remain live, but without new content. New content will be posted on SFA's silvopasture site.
- Our e-Learning course will continue to run. Here is the link to the course sign up.

Volunteerism Program
Our volunteer events are complete. We are still developing a *Restoration Volunteer Training Curriculum*. This online course will help volunteers to be more effective at habitat restoration projects. We currently have six modules in development.

Seventh Update as of March 1, 2023

All components of Activity 2 are complete.

Final Report as of June 30, 2023 – Final Report Summary

Silvopasture Learning Network

The Silvopasture Learning Network (SLN) was launched in November 2019 and further developed through a social network analysis survey. Over the three years of the project, the SLN grew to 556 members through active recruitment at meetings and events. This network is now managed by the MN Sustainable Farming Association.

Silvopasture Learning Network e-tools and Online Portal Development

We developed a website for Silvopasture Learning Network with relevant information for people interested in learning more about the project and the topic of silvopasture. We created and compiled an online resource library including our Silvopasture Resource Manual and Silvopasture Case Studies, as well as videos, recommended readings, best practices, fact sheets, and podcast episodes. We also developed a five-part email-based short course (referred to as e-tools in the grant). Additionally, we sent out a quarterly newsletter to network members and created a Facebook page with 195 followers. The Facebook page is now retired; look for new posts on the Facebook pages of SFA and Extension Natural Resources. Our e-Learning course will continue to run.

Volunteerism Program

A volunteer event was held at Early Boots Farm, Sauk Centre, MN, on Saturday, June 12, 2021. The event provided hands-on learning about silvopasture and oak savanna restoration. There were 13 volunteers and 5 staff in attendance. Volunteers planted 20 4-ft oaks and 24 2-ft oaks, seeded 3 acres with native seed, and set up 4 protective fence enclosures. The second volunteer event was held at Living Song Farm on October 14, 2021. There were 17 volunteers at the event. It was a well-rounded mix of volunteers, including farmers, ag and natural resource professionals, Master Naturalists, and two people who found the event by searching the web for “sustainable agriculture.” The volunteers were guided by 8 members of this project team. All project goals were accomplished, including planting oak seedlings, hauling red cedar debris, pulling buckthorn, and spreading prairie seed across 3 acres. We also worked on developing restoration volunteer training curriculum to help volunteers to be more effective at habitat restoration projects.

ACTIVITY 3: Scale up the use of Silvopasture across Minnesota through development of networking tool, conducting outreach/extension activities and development of educational materials. (UMN Extension, Sustainable Farming Association)

Description: In addition to using the Silvopasture Learning Network and initiating a Silvopasture Volunteerism Program, we will employ several outreach and extension activities to scale up the use of Silvopasture for oak savanna restoration throughout historically oak savanna region in Minnesota (from southeast Minnesota to northwest Minnesota) using the following approaches/activities:

- Adapt a GIS-based Farmmaps program/app to include silvopasture case studies (Task 1). The Center for Integrated Natural Resources and Agricultural Management (CINRAM) together with the Southwest Regional Sustainable Development Partnerships at the University of Minnesota and the Minnesota Sustainable Farming Association have developed a tool used for farmer and natural resource professional networking and education. The Farmmaps program/app is a tool designed to promote the adoption of sustainable farming agricultural practices by connecting farmers who are interested in trying to implement practices with experienced farmer practitioners who have successfully adopted those practices. Changing farming practices can be a risk, and farmers need a platform for exchanging their experiences. We will utilize the Sustainable Agriculture Case Study Database that provides a forum for sharing the methods, challenges and

results of Minnesota farmers who have adopted specific conservation practices. Farmers using the database can search for examples in close geographic proximity. Participants willing to talk to other farmers are invited to share their contact information. If someone is interested in adopting silvopasture, they can talk with someone who has done it, and learn from a farmer's perspective what the challenges and benefits are. The Farmmaps tool will promote "farmer to farmer" learning, and also provides a source of information for natural resource professionals and extension to use to plan field days related to silvopasture systems. It also provides farmer vetted information to other farmers interested in adopting silvopasture systems/practices. Sub activities for this activity include:

- o Meet with project partners and farmers interested in silvopasture to define a minimum data set for each case to be included in the database. The minimum data set will include information that potential adopters need to make a decision and monitoring data that will allow us to track progress over time.
- o Data base development. Programmer will develop a database structure and user interface for entering case study information into the database.
- o Program preparation. Programmer will prepare a program suitable for online use and also apps for smartphone use to present information from database in a format most useful to the potential farmer and natural resource professional users.
- o Field testing and implementation. Once the initial database and program are ready they will be tested by farmer cooperators and natural resource professionals to ensure it meets their needs. Program use will be monitored, and adjustments will be made as necessary over the life of the task.

● Work with farmers practicing silvopasture to develop case studies that can be accessed by other farmers and natural resource professionals interested in learning more about silvopasture and how to apply it in practice. A total of 5 cases will be prepared with project funding. This activity will allow the project to prepare the cases that will be presented in the database and tool explained above. Sub activities for this activity include:

- o Meet with project partners and farmers interested in silvopasture to define a minimum data set for each case to be included in the database. The minimum data set will include information that potential adopters need to make a decision and monitoring data that will allow us to track progress over time.
- o Identify cases to be presented. Working closely with project partners, we will identify cases to be included in the database and presented using the program developed in Task 1. Criteria for selection may include but are not limited to: i) successful implementation of silvopasture practices; ii) willingness to be part of database and provide advice to other farmers; iii) established silvopasture practice 3+ years.
- o Gather data for cases. Formats and user interface programs will be prepared for gathering data in the field and entering the data in the database. This will require visits to the participating farms to interview owner/operators.
- o Enter data and test the database and output program. This will be coordinated with "field testing and implementation" as described above.

● Train farmers, livestock producers, and natural resource professionals on the use of principles, science, and establishments of silvopasture. In partnership with the Sustainable Farming Association, we will provide farm consults, and on-site assistance and support to farmers and landowners who are adopting silvopasture techniques. This "boots on the ground" approach is a key technique to provide farmers the information, support and consultation necessary to adopt new, innovative practices and monitor and measure inputs and outcomes.

● Organize and lead the training sessions on silvopasture with farmers and stakeholders in Silvopasture Learning Network so they are prepared to lead silvopasture gatherings in their communities.

- Offer one silvopasture forum with state agencies and stakeholders to advance silvopasture adoption for oak savanna restoration.
- Develop an array of knowledge products and training materials for use in silvopasture educational programming to reach more farmers, and natural resource professionals on silvopasture. These extension publication materials will be made available to the public via a number of outlets.

ACTIVITY3. ENRTF BUDGET: $176,442

Outcome	Completion Date
1. A GIS-based Farmmaps program/app adapted to include silvopasture casestudies.	June 2021, June 2022
2. 5 case studies of silvopasture with some video documentations developed, which will also form part of the SLN.	Summer 2021
3. Two training/workshop session/camps/field days on Silvopasture offered each year targeting farmers, and natural resource professionals in historically oak savanna region in Minnesota.	Annually
4. One silvopasture forum offered with government agencies, and stakeholders to advance silvopasture adoption for oak savanna restoration	March 2021
5. One webinar per year, beginning in year 2, to reach stakeholders.	Mar 2021; Mar 2022
6. One volunteerism event each year offered to train volunteers on silvopasture	May 2021, July 2021
7. Three local, informal gatherings modelled after “café chats” in year 2 and 3 offered to bring trained farmers together with their peers, to introduce people to silvopasture techniques and learn from each other.	Jan. – Mar. 2021 and 2022.
8 An array of knowledge products and training materials produced to be used at “café chats”, plus workshops and field days in Activity 2	Jan. 2021, updated Jan. 2022
9. Final Project Report written	June 2022

First Update March 1, 2020

<u>Training/Workshop Session/Camps/Field Days</u>

SFA launched its work on the Silvopasture Project in July, 2019 by planning its first LCCMR project related Field Day which was then held on September 18, 2019 at the farm of Tom Barthel and Gail Wittington, Becker, MN. A full day which combined classroom and field work was conducted, and included a presentation by Dr. Diomy Zamora and an engaging view of Tom’s “oak tree liberation project.” Twenty eight people attended. SFA also used social media and took photos. SFA’s Livestock

and Grazing Specialist Kent Solberg facilitated, and Executive Director Theresa Keaveny helped with logistics.

Kent Solberg and Soil Health Associate Doug Voss have done site visits and field consultations at the Sherburne Wildlife Refuge to assist the LCCMR research team in its grazing and soil health planning. Kent (and as needed, Doug or Tyler Carlson) will now be a part of that team moving forward. Tyler Carlson has been contracted by SFA to be a Silvopasture Lead, to coordinate activities and generate knowledge products related to the LCCMR grant, including finalizing the Silvopasture Resource Guide and crafting talking points. He will also be a coach and mentor for farmers seeking to adopt these practices. Tyler is also assisting with the SFA PDP grant, described below.

Another outreach and education event was planned and held at SFA"s 30th annual conference on February 8th at a workshop moderated by Wayne Monsen "Silvopasture: Managed woodland grazing for oak savanna restoration." Roughly 40 people attended, and it featured UMN Extension's Gary Wyatt, Tyler Carlson, Vickie Kettlewell, Joe Gans and Tom Barthel, farmers who use silvopasture practices.

A meeting is set for March 4th with the Outreach and Education team of the LCCMR project to map out plans for summer and fall including workshops and field days; and to continue identifying knowledge products and research needs.

Volunteerism Event

See information in "Volunteerism Program," Activity II, above.

Café Chats

SFA is not slated to hold Cafe Chats for this project this year but will begin planning them in the last quarter of 2020 for late February and March, 2021.

Array of knowledge products and training materials

A half day convening of a newly-formed Silvopasture Team occurred on Nov. 18, 2019 that brought together SFA members and silvopasture practitioners with the field team of the LCCMR grant. Wayne Monsen, SFA Special Projects Coordinator, presented a review of the literature, and consultant Keefe Keeley with the Savanna Institute offered suggestions on talking points for farmers, landowners and foresters. A rough workplan was developed and meeting proceedings have been circulated. At that meeting, Wayne reviewed a draft Silvopasture Manual which is being developed into a Silvopasture Resource Guide for release at the group's Mar. 5th Midwest Soil Health Summit. This is SFA's first knowledge product for the LCCMR grant.

Additional Information

Related to the LCCMR grant, SFA has obtained funding through the North Central SARE's Professional Development Project for 2 years (Oct. 1, 2019 – Sept. 30, 2021) to educate and coach ag professionals, farmers, and forestry educators on silvopasture principles and practices. Wayne Monsen, Special Projects Coordinator, manages this grant and Tyler Carlson provides expertise and coaching. The grant requires 3 workshops annually, held in the north, central and southern regions of Minnesota, 3 field days annually, also held in the same regions and 1 webinar. SFA has scheduled its first workshop as part of a Silvopasture track during its Mar. 5th Midwest Soil Health Summit; and is planning other workshops on April 14th in Faribault and April 15th in Little Falls. Three field days, one per region, are being planned for the end of July with a webinar in the fall.

Second Update September 1, 2020

Farmmaps Program/App

Although deadlines for this work come later in the project, we continue to develop and improve the

Farmmaps tool which will serve as the smartphone/online networking platform for sharing information on farmer case studies. We have recently updated the software being used for the database and moved the mapping functions from Google to another mapping program to save on potential costs of the Google mapping application.

Training/Workshop Session/Camps/Field Days

Two Silvopasture field days were held during the last reporting period (Sept.14, 15, 2019, Aitken and Sept.16, 2019, Becker). Another Silvopasture Field day is being planned for October 2020, observing COVID19 limitations. Sites being considered are the Brainerd area to observe previous research sites of Silvopasture and the Minneopa State Park near Mankato where there is a bison herd and Oak Savanna landscapes. Due to COVID policies, we are planning to video tape segments of the field days and speakers to post on our websites.

Workshops held include a day long Silvopasture event on March 5, 2020 at Oliver Kelly Farm, held in conjunction with SFA's Midwest Soil Health Summit. Attendance was 198 of whom roughly 80 attended the Silvopasture break out. Approximately 50 attendees signed up to be added to the Silvopasture Learning Network. A second gathering was held on March 4th, bringing together the LCCMR project partners to plan field days, workshops and knowledge products.

Array of knowledge products and training materials

The Silvopasture Manual was completed and released at the SFA March 5th event. It can be found at https://www.sfa-mn.org/wp-content/uploads/2020/04/SILVOPASTURE-HANDBOOK-3.0-1.pdf Another knowledge product in draft form is a Silvopasture Assessment Tool, crafted by Tyler Carlson for SFA's field days. Based on feedback from participants, the tool will be refined and finalized in the next quarter.

Silvopasture Forum

The silvopasture forum was held in conjunction with the 2020 Annual DNR Cooperative Forest Management (CFM) Meeting held at the Cloquet Forestry Center on Wednesday, March 11. The CFM meeting's purpose is to keep field practitioners up to date on what is happening with private and urban forest management in Minnesota. There were a variety of topics discussed in addition to silvopasture. These included forest stewardship plan writing procedures, EQIP, CRP, 2c, SFIA, and more.

Attending this meeting were foresters and plan writers that work face-to-face with private landowners through the Forest Stewardship Program. This includes DNR foresters, Soil & Water Conservation District staff, private consulting foresters, industry foresters, and others. A total of 120 participants were at the meeting. Tyler Carlson, Early Boots Farm; Jeff Jackson, U of MN Extension; and Mike Reichenbach, U of MN Extension, provided materials on silvopasture to all who attended. An additional 35 people expressed interest in the silvopasture project. Of these 26 were added as active Silvopasture Learning Network members.

Webinars

The first webinar for the grant is scheduled for October 21, 2020. Titled "Introduction to Halal Meat and Opportunities for Goat Farmers," it will feature a panel of expert speakers. The webinar's goal is to educate producers and resource professionals about the market potential for Halal goat meat in Minnesota, barriers for ethnic communities to access Halal goat meat, and silvopasture goat production opportunities for local livestock producers. The key speakers as related to this grant are Dr. Tom Prieve and Dr. Sue Wika, from Paradox Farms, Ashby, MN. Their presentation is titled, "Raising Goats in Silvopasture: Fundamental Considerations." On their own farm they are using goats in a silvopasture system to restore oak savanna, and they will provide guidance for participants from their own research and experience.

Café Chats

Cafe Chats are being planned for later February and early March, 2021 depending on COVID limitations. Under present restrictions, these can be held in selected venues for <10 people, making it likely that more Cafe Chats will be held to reach a bigger audience. However, this activity, like others, is hinged on COVID19 restrictions in place in 2021.

Third Update May 24, 2021

Farmmaps Program/App

Five case study interviews have been carried out and a volume is being prepared for printing that will be printed in April. The Farmmaps database has been adapted to enter the silvopasture case studies and the cases will be added to the Farmmaps Program/App in the coming quarter.

Training/Workshop Session/Camps/Field Days

The online workshop, "Facilitating Silvopasture Adoption in Minnesota (Tools to Help Farmers)," was held on October 29, 2020. It was targeted to NRCS and SWCD staff to help them understand the new EQIP funding opportunities for establishing silvopasture systems. Presenters included: Gary Wyatt (UM Ext), Tyler Carlson (SFA) and Lance Smith (NRCS). There were 27 attendees.

On February 8, 2021, "Economics of Silvopasture," was held and presented by Dr. Ashley Conway, PhD, PAS, Assistant Research Professor, University of Missouri Center for Agroforestry and Dr. Joseph Orefice PhD, Lecturer and Director of Forest & Agricultural Operations at the Yale School of Forestry & Environmental Studies. This workshop was hosted by Tyler Carlson, SFA Silvopasture & Agroforestry Project Lead. This was held as part of the SFA Annual Conference. Attendance was 122.

No LCCMR field days were held in this reporting period due to COVID restrictions.

Our first field day in 2021 will be held Friday, April 23, 2021. Participants will be divided into two groups , Silvopasture walk and hands-on fencing demonstration/work activity at the Sherburne Wildlife Refuge, near Zimmerman, MN. SFA is planning this event with UM Extension staff helping facilitate the day experience.

Our second field day in 2021, combined with an educational workshop, will be held on June 24th in Mankato, featuring a silvopasture 101 presentation for agriculture and natural resource professionals in southern Minnesota. This will be followed by a tour of the oak savanna area at Minneopa State Park, with DNR presentations on the restoration work underway, and its relation to bison, which populate the park.

Array of knowledge products and training materials

Farmmaps and the Silvopasture Case Studies are farmer educational tools that have been developed, with the Case Studies completed in March, 2021. Additionally, an Oak Savanna Fact Sheet has been completed to complement the other learning products available. These tools should help farmers connect with farmers in adopting Silvopasture and other sustainable farming practices.

Podcasts that have been prepared and aired on Spotify, Stitcher, Google Play and Beanpod by SFA include #23 "Origins of Oak Savanna", #24 "Oak Savanna Restoration and #27, "Home on the Free Range - Chickens and Silvopasture". Podcasts produced in an earlier reporting period but not reported include #9 "Silvopasture in Minnesota, and #10 "Implementing Silvopasture".

A series of short videos on a Silvopasture Field Day are in production and will be released in the next reporting period, featuring content from a field day at the Tom Hunter farm near Wabasha on October 7, 2020.

Silvopasture Forum

This deliverable is complete. The Silvopasture Forum was held on March 20, 2020.

Webinars

"Introduction to Halal Meat and Opportunities for Goat Farmers" was held on October 21, 2020. It educated producers and resource professionals about the market potential for Halal goat meat in Minnesota, barriers for ethnic communities to access Halal goat meat, and silvopasture goat production opportunities for local livestock producers. There were 53 attendees.

On March 18, 2021, a webinar on Farmmaps and the Silvopasture Case Studies was held. Presenters included: Dean Current, UM CINRAM and Jared Luhman, Sustainable farming Association. Farmmaps is a new tool developed by the Center for Integrated Natural Resources and Agriculture Management to help you learn about soil health and silvopasture practices. It highlights farmers around Minnesota who are implementing innovative practices and allows you to connect with them. Jared Luhman also shares the newly-released series of Silvopasture Case Studies that are also highlighted on Farmmaps. Attendance 51.

Café Chats

Due to COVID 19, Cafe Chats were not scheduled in this reporting period. They will now be held in November, 2021 and the first quarter of 2022 if COVID 19 restrictions allow.

Fourth Update October 25, 2021

Farmmaps Program/App

The silvopasture case studies have been completed and have been published as an edited volume that is being used in outreach efforts of the project. The case studies have been entered into the Farmmaps App but are still in the process of being edited and we continue to work on including short descriptions of the case studies in the App. Currently, a pdf file describing the case is available for each case which can be downloaded and printed if the user chooses to do that or it can be read online within the App. We continue to receive input on the App and will update the App based on input from the users throughout the remainder of the project.

Training/Workshop Session/Camps/Field Days

On June 24, our team led a workshop and field day titled, "Silvopasture, Oak Savanna, and Bison Program and Tour." The workshop section of this event was held in Mankato, and the field day section at Minneopa State Park. The audience was agriculture and natural resource professionals and farmers/landowners. There were 33 attendees.

On April 23, our team led the "Energized Fence Training & Silvopasture Field Tour" at Sherburne National Wildlife Refuge. There were 20 attendees.

Our next planned field day is on October 22, 2021. It is titled, "Adaptive grazing management and oak savanna restoration," and will be held at Sherburne National Wildlife Refuge, Elk River, MN.

Array of knowledge products and training materials

Video of a fall, 2020 Silvopasture field day in Wabasha County is being edited into a series of shorter videos by University of Minnesota Extension, for release in late 2021 and early 2022. They will be made available via the Silvopasture Learning Network, to the Sustainable Farming Association's network, and Great River Greening.

Silvopasture Forum

This deliverable is complete. The Silvopasture Forum was held on March 20, 2020.

Webinars

Our team completed 1 webinar during this reporting period: "Saving the savanna: Restoring a historic habitat in Burnsville, Minnesota." It was held on April 20, and the speakers were Rebecca Montgomery and Caleb Ashling, City of Burnsville. The attendance was 137.

Café Chats

Cafe Chats were not planned for this reporting period, but are planned as follows for the fall/winter:

- Tuesday, November 2, 2021 w 9am - noon at in Motley, led by Kent Solberg, SFA
- Wednesday, November 3, 2021 9am - noon in Floodwood, led by Tyler Carlson, SFA
- Thursday, November 4, 2021 9am - noon in Northfield, led by Gary Wyatt, UMN Extension

Depending on COVID19 restrictions and how the first three Cafe Chats go, the three early 2022 Cafe Chats envisioned may instead be substituted for 3 workshop presentations on silvopasture and oak savanna restoration as follows:

- MN Soil Water Conservation District annual meeting (December, 2021), Tyler Carlson, SFA
- MN Agroforestry Cooperative (3 other Cafe Chats will be scheduled in first quarter of 2022, Tyler Carlson, SFA
- MASWCD Agroforestry Work Group annual meeting (February or March, 2022), Tyler Carlson, SFA

Fifth Update March 1, 2022

Farmmaps Program/App

The silvopasture case studies are now complete in the app. Because of the dynamic nature of the app, we can make additional changes if needed but the task is complete. We continue to make changes to the app as needed to make it more user friendly based on comments we receive.

Training/Workshop Sessions/Camps/Field Days

On **December 13, 2021**, SFA organized and presented an in-person panel presentation and discussion titled: "Restoring ecosystem health with targeted disturbance: oak savanna, Silvopasture and adaptive grazing," This was held at the MN Soil Water Conservation District Annual Meeting in Bloomington, MN. Speakers included: Austin Yantes, Tyler Carlson, Gary Wyatt, and Doug Voss. Jim Chamberlain introduced the panel and acted as moderator. 65 people attended and participated in a robust discussion during and after the event.

Austin Yantes presented a virtual workshop session during the Prairie Enthusiast's Conference, held on **February 16, 2022**. The session was titled: "Targeted Grazing to Restore Woody-Encroached Oak Savannas." Preliminary results from the research at Sherburne National Wildlife Refuge and the managed grazing approach were presented, followed by a robust discussion with the audience. More than 200 people attended.

A field day at Sherburne National Wildlife Refuge was held on **Thursday, October 22, 2021**. Kent Solberg, Doug Voss, Austin Yantes, Tyler Carlson, and other staff were there to present. The group toured the research plots, discussed the research project and preliminary results, discussed oak savanna ecological history and management approaches and challenges, and also toured other areas of the refuge to observe for themselves how the use of adaptive grazing and target animal disturbance/impact can achieve beneficial habitat and vegetation management goals. There were 45 people in attendance.

Array of knowledge products and training materials

A Silvopasture Economics tool is being developed and tested by Tyler Carlson and Dean Current. UMN graduate student Kalvin Moschkau is creating the tool, which will be publicly presented for the first time at SFA's Midwest Soil Health Summit in early March, 2022.

Silvopasture resources have been posted on two websites: UMN Extension and the Sustainable Farming Association:

- UM Extension: https://extension.umn.edu/forestry/agroforestry#silvopasture-2013763
- Sustainable Farming Association: https://www.sfa-mn.org/silvopasture-agroforestry/

Silvopasture Forum

This deliverable is complete. The Silvopasture Forum was held on March 20, 2020.

Webinars

Selected video from a field day held at Tom Hunter's farm in 2020 has been edited and released as a webinar.

Café Chats

On **Thursday, November 4th**, a Silvopasture Cafe Chat was held at Rich's Truck Stop Cafe in Motley, MN. The event, titled "Grazing Management to Promote Savanna and Silvopasture", was organized and attended by Kent Soblerg, Jim Chamberlain, Vickie Kettlewell, Greg Booth, and the local SWCD. Fourteen people attended.

On **Wednesday, December 1st** a Silvopasture Cafe Chat was held at Ruth's on Stafford in Dundas, MN. The event, titled "Grazing Management to Promote Savanna and Silvopasture", was organized and attended by Gary Wyatt, Brad Gordon, Travis Bruce, Jake Langeslaag, and Claire LeCanne. There were 14 people in attendance. All participants reported that they learned something new that they can use on their own operation or farm. They also mention topics for future Cafe Chats: CRP, funding opportunities (stacked funding), no-till and cover crops, riparian management, recharging groundwater and water storage.

On **Thursday, December 2nd** a Silvopasture Cafe Chat was held at Wilbert Cafe in Cotton, MN. The event titled "Silvopasture Opportunities in Northern Minnesota",was organized and attended by Tyler Carlson, Troy Salzer, and Tom Gervais. There were 15 people in attendance.

Update as of June 30, 2022

Project extended to June 30, 2023 by LCCMR 6/30/22 as a result of M.L. 2022, Chp.94, Sec. 2, Subd. 19, legislative extension criteria being met.

Sixth Update November 3, 2022

Farmmaps Program/App

This deliverable is complete.

Training/Workshop Sessions/Camps/Field Days

A field day was held at Sherburne National Wildlife Refuge on **June 2, 2022**. Kent Solberg, Doug Voss, Austin Yantes, and other staff were there to present. Attendees learned about oak savanna restoration and silvopasture, and the promising results from our research using targeted cattle grazing to restore oak savanna habitat. Attendees also completed hands-on activities including taking Brix readings, setting up electric fencing, and measuring canopy cover. There were 63 people in attendance.

Array of knowledge products and training materials

- Economics of Silvopasture tool. Graduate student Kalvin Moschkau demoed a new digital tool he is building out at the Midwest Soil Health Summit on March 8, 2022. This tool is still under development and will help potential and existing silvopasture practitioners make decisions around labor, fencing, finances, and environmental benefits.
- Podcast Episode 48: "Grazing Cattle to Restore Oak Savanna in the Sherburne National Wildlife Refuge" with Austin Yantes, Doug Voss, and Jared Luhman. Prepared by SFA and aired on Spotify, Stitcher, Google Play and Beanpod.

Silvopasture Forum

This deliverable is complete.

Webinars

- April 28, 2022. Discussed Silvopasture to the NRCS Forest Sub-Committee (Tyler Carlson, Gary Wyatt). 25 attendees.
- April 29, 2022. Silvopasture and Agroforestry Practices (Tyler Carlson, Gary Wyatt). As part of Fridays with a Forester series. 32 attendees.

Volunteerism Event
Please see information in "Volunteerism Program," Activity II, above.

Café Chats
This activity is complete.

Seventh Update as of March 1, 2023

All components of Activity 3 are complete.

Final Report as of June 30, 2023 – Final Report Summary

Farmmaps Program/App
Five silvopasture case studies were completed and published as an edited volume, and were entered into the Farmmaps App.

Training/Workshop Sessions/Camps/Field Days

The first Field Day was held in September 2019 at the farm of Tom Barthel and Gail Wittington, in Becker, MN. A full day which combined classroom and field work was conducted and 28 people attended. In June 2021, our team led a workshop and field day titled, "Silvopasture, Oak Savanna, and Bison Program and Tour" at Minneopa State Park with 33 attendees. We also held two online workshops "Facilitating Silvopasture Adoption in Minnesota (Tools to Help Farmers)" in October 2020 and "Economics of Silvopasture," in February of 2021. Additionally, we held three field days at SNWR: one on Energized Fence Training (April 2021, 20 attendees) and two on Adaptive Grazing Management and Oak Savanna Restoration (October 2021 with 45 attendees, June 2022 with 63 attendees).

A workshop, "Silvopasture: Managed woodland grazing for oak savanna restoration," was held at SFA's 30th annual conference in February 2020 and roughly 40 people attended. In March 2020, we held a workshop at Oliver Kelly Farm in conjunction with SFA's Midwest Soil Health Summit (80 attendees). In December 2021, SFA organized and presented an in-person panel presentation and discussion titled "Restoring ecosystem health with targeted disturbance: oak savanna, silvopasture and adaptive grazing" at the MN Soil Water Conservation District Annual Meeting (65 attendees).

Array of knowledge products and training materials
We developed and released a Silvopasture Resource Guide, Silvopasture Case Studies, Economics of Silvopasture tool, and an Oak Savanna Fact Sheet. We also released several podcast episodes on the *Dirt Rich* podcast: #23 "Origins of Oak Savanna", #24 "Oak Savanna Restoration, #27, "Home on the Free Range - Chickens and Silvopasture", and #48: "Grazing Cattle to Restore Oak Savanna in the Sherburne National Wildlife Refuge".

Silvopasture Forum

The silvopasture forum was held in conjunction with the 2020 Annual DNR Cooperative Forest Management (CFM) Meeting held at the Cloquet Forestry Center on Wednesday, March 11. There were a variety of topics discussed in addition to silvopasture. Attending this meeting were DNR foresters, Soil & Water Conservation District staff, private consulting foresters, industry foresters, and others. A total of 120 participants were at the meeting.

Webinars

We put on four webinars including: "Introduction to Halal Meat and Opportunities for Goat Farmers" in October 2020 with 53 attendees, "Farmmaps and the Silvopasture Case Studies" in March 2021 with 51 attendees, "Saving the savanna: Restoring a historic habitat in Burnsville, Minnesota" in April 2021 with 137 attendees, and "Silvopasture and Agroforestry Practices" in April 2022 with 32 attendees.

Café Chats

We held three café chats on topics related to silvopasture and grazing management to promote savannas. These meetings were held at various cafes in central Minnesota in November and December 2021 with 14-15 people in attendance.

IV. DISSEMINATION:

Description: We will offer a number of approaches to disseminate our project results. As presented above, the Silvopasture Learning Network will be used to reach farmers and natural resource professionals throughout Minnesota while the Silvopasture Volunteerism program will be used to train core individuals on silvopasture with the expectations that these core individuals will accelerate promotion of the use of silvopasture throughout the state through peer-to-peer discussion. Furthermore, the networking tool we will employ will also allow farmers to share their experience on silvopasture with each other. Two camps/field days will also be offered to reach farmers, producers, and natural resource professionals on silvopasture. We will also organize three local, informal gatherings modelled after "café chats" in years 2 and 3 to bring trained farmers together with their peers, to introduce people to silvopasture techniques and learn from each other. We will use existing educational events such as the Minnesota Cattlemen's Association summer tour, winter and summer gathering of the Crow Wing River Forage Council, and soil health field days and workshops of the Sustainable Farming Association to reach our key audience. At least 400 farmers, producers and natural resource professionals are reached out during these events.

Results will also be presented during workshops and conferences of professional organizations in Minnesota. Educational materials such as factsheet series, you tube videos, and case study videos will be developed and will be posted at the Silvopasture Learning Network sites. These materials will be linked with partners' websites.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines

First Update March 1, 2020

See update for Activity 2 and 3 above.

Second Update September 1, 2020

See update for Activity 2 and 3 above.

Third Update May 24, 2021

See update for Activity 2 and 3 above.

Fourth Update October 25, 2021

See update for Activity 2 and 3 above.

Fifth Update March 1, 2022

Conference Presentations

- February 16, 2022. "Targeted Grazing to Restore Woody-Encroached Oak Savannas". Prairie Enthusiasts Conference (virtual). Austin Yantes. 200 attendees.

Update as of June 30, 2022

Project extended to June 30, 2023 by LCCMR 6/30/22 as a result of M.L. 2022, Chp.94, Sec. 2, Subd. 19, legislative extension criteria being met.

Sixth Update November 3, 2022

Conference Presentations

- March 5, 2022. "Targeted Grazing to Restore Woody-Encroached Oak Savannas". Midwest Ecology and Evolution Conference (virtual). Austin Yantes.
- June 21, 2022. "Oak Savanna Response to Layered Restoration Approaches: Thinning, Burning, and Targeted Grazing". North American Forest Ecology Workshop (virtual). Austin Yantes (presenter), Rebecca Montgomery, Kent Solberg.
- August 17, 2022. "Layering Disturbances to Improve Oak Savanna Restoration: Thinning, Burning, and Targeted Grazing". Annual Meeting of the Ecological Society of America. Austin Yantes, Rebecca Montgomery, Kent Solberg.
- September 9, 2022. "Layering Disturbances to Improve Oak Savanna Restoration: Thinning, Burning, and Targeted Grazing". Natural Areas Association Conference, as part of a symposium on prescribed disturbance for maximizing ecological integrity. Austin Yantes (presenter), Rebecca Montgomery, Kent Solberg.

Seventh Update as of March 1, 2023

See update for Activity 2 and 3 above.

Final Report as of June 30, 2023 – Final Report Summary

We created the Silvopasture Learning Network with 550 members to scale-up the adoption of adaptive grazing management for oak savanna restoration. We facilitated farmer-to-farmer learning using a combination of online and in-person tools. We developed a five-part online course, compiled an online resource library, and adapted the Farmmaps tool to include silvopasture case studies. Additionally, we executed two volunteer events, three café chats, five field days, five workshops, four webinars, and a

silvopasture forum. We disseminated our research results via four podcast episodes and five conference presentations, and by publishing an open-access journal article (Yantes et al., 2023). Additional scientific publications are planned for late 2023.

V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures

Explanation of Capital Expenditures Greater Than $5,000:

Explanation of Use of Classified Staff:

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

17,140	8.24

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

4,223	2.04

VI. PROJECT PARTNERS:

A. Partners outside of project manager's organization receiving ENRTF funding

Sustainable Farming Association = $98,255
Great River Greening = $50,100

B. Partners outside of project manager's organization NOT receiving ENRTF funding

Minnesota Department of Natural Resources

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

University of Minnesota Extension will include results in its outreach and education efforts to create increased impacts of the program. It is expected that a functional SLN will yield interest and resources to expand this work throughout the state.

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted March 1 and September 1 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2023

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet
B. Visual Component or Map
C. Parcel List Spreadsheet
D. Acquisition, Easements, and Restoration Requirements
E. Research Addendum

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2019 Budget Spreadsheet
Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 08b
Project Manager: Rebecca Montgomery
Project Title: Promoting and Restoring Oak Savanna using Silvopasture
Organization: Regents of the University of Minnesota
Project Budget: $750,000
Project Length and Completion Date: 4 Years, June 30, 2023
Today's Date: October 19, 2023

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 522,489	$ 522,489	$ -
Principal Investigator, $28,506 (74.5% salary 25.5% benefits), 10% each year for 3 years			
Extension Professor, $12,441 (68% salary 32% benefits), 4% each year for 3 years			
Extension Professor, $3,699 (70% salary 30% benefits), 1% each year for 3 years			
Economist, $30,089 (74.5% salary 25.5% benefits), 8% each year for 3 years			
Hydrologist, $14,868 (74.5% salary 25.5% benefits), 3% each year for 3 years			
Wildlife Biologist, $9,279 (74.5% salary 25.5% benefits), 2% each year for 3 years			
Ecologist, $5,170 (74.5% salary 25.5% benefits), 1% each year for 3 years			
Program Manager, $192,934 (81% salary 19% benefits), 100% each year for 3 years			
Program Coordinator, $118,473 (80% salary 20% benefits), 75% each year for 3 years			
Undergraduate Students, $68,375 (100% salary 0% benefits), 10% each year for 3 years			
Professional/Technical/Service Contracts			
Great River Greening (Subaward and will be paid for actual costs incurred) -	$ 50,100	$ 50,100	$ -
Sustainable Farming Association (Subaward and will be paid for actual costs	$ 89,933	$ 89,933	$ -
TBN - Pollinator crew to access bee and other pollinators	$ 9,000	$ 9,000	$ -
Equipment/Tools/Supplies	$ 33,500	$ 33,500	$ -
Dual-Wall Permeameter ($3,500)			
Water quality materials and supplies ($2,100)			
Wildlife assessment field supplies for data collection ($1,500)			
Computer for Program Coordinator (new position in Extension) to conduct			
Office supplies for use in outreach activities ($2,250)			
Field supplies for silvopasture research at Sherburne (fencing, flagging, cattle			
Travel expenses in Minnesota	$ 22,593	$ 22,593	$ -
Mileage for project personnel to implement all components of the project -			
Lodging for project personnel to implement all components of the project -			
Meals for project personnel to implement all components of the project - 51			
Travel expenses to present results - MN Assoc of Soil & Water Conservation			
Other			
Soil sample analysis for soil health parameters	$ 19,385	$ 19,385	$ -
Workshops - facility rental $1,000, printing of promotional materials $2,000	$ 3,000	$ 3,000	$ -
COLUMN TOTAL	**$ 750,000**	**$ 750,000**	**$ -**

3,392 is balance

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status	Budget	Spent	Balance
Non-State:			$ -	
State:			$ -	
In kind:			$ -	

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount	Budget	Spent	Balance
Current appropriation:			$ -	
Past appropriations:			$ -	

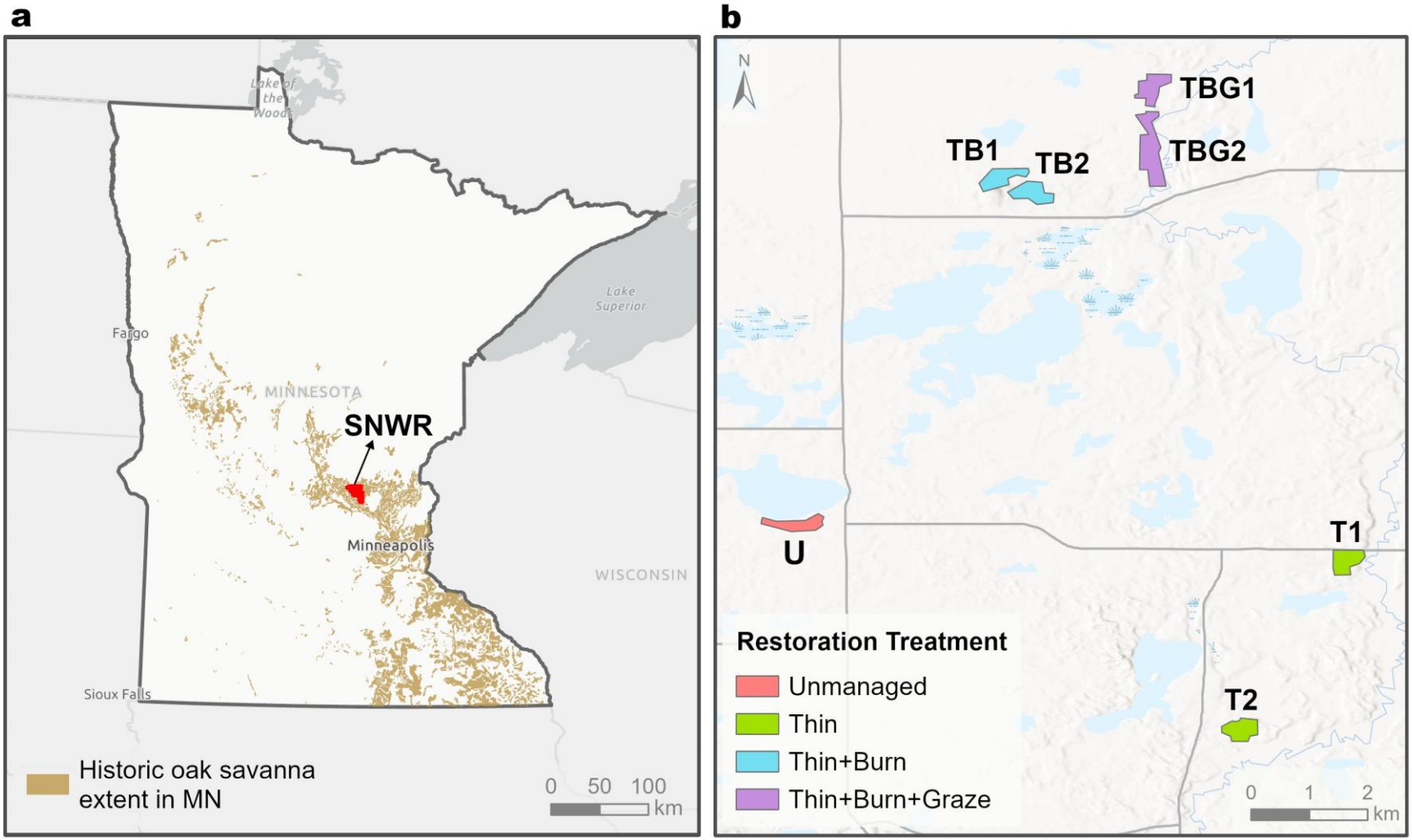

Figure 1. *Map of a) the location of Sherburne National Wildlife Refuge (SNWR) within Minnesota's historic oak savanna extent (MN DNR shapefile), and b) survey sites at SNWR labeled with treatment type: TBG (Thin+Burn+Graze), TB (Thin+Burn), T (Thin), or U (Unmanaged reference).*