

## **2015 Project Abstract**

**PROJECT TITLE:** Minnesota State University Moorhead Science Center Restoration & Monitoring

**PROJECT MANAGER:** Brian Wisenden

**AFFILIATION:** Biosciences Department, Minnesota State University Moorhead

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**FUNDING SOURCE:** Environment and Natural Resources Trust Fund

**LEGAL CITATION:** M.L. 2015, Chp. 76, Sec. 2, Subd. 08g

**APPROPRIATION AMOUNT:** \$527,000

**AMOUNT SPENT:** \$522,729

**AMOUNT REMAINING:** \$4,221

### **Sound bite of Project Outcomes and Results**

Tall grass prairie is critically endangered habitat. This project enlarged the Bluestem Prairie complex by 189 acres and restored the new area to prairie habitat. Faculty and students at MSUM monitored changes in ecosystem structure providing educational benefits for current students and training them for a future as restoration biologists.

### **Project Abstract**

The Bluestem Prairie is Minnesota's largest remnant tall grass prairie (6700 acres) comprising lands owned by The Nature Conservancy, Department of Natural Resources and Minnesota State University Moorhead. This project set out to achieve three goals: (1) acquire additional 189 acres of land contiguous with the complex, 100 acres of which were abandoned agricultural field and 89 acres comprised 60 acres of golf course fairways and 29 acres of riparian terrace forest, (2) collaborate with the MN DNR to restore 160 acres of land to tall grass prairie habitat, and (3) engage faculty and students at Minnesota state University Moorhead to monitor changes in the prairie community before, during and after restoration, to enrich undergraduate curricula, develop capacity for personnel interested in restoration biology, and develop and disseminate monitoring protocols for application to future restoration projects. In the five years since June 2015, we have successfully transferred ownership of the 189 acres of land to Minnesota State University Moorhead, restored 160 acres to tall grass prairie community and engaged 10 MSUM faculty, dozens of research students and many hundreds of undergraduates in concepts and practical skills in conservation ecology. This work has resulted in establishment of a customized GIS database at the site, active and ongoing field projects on microbial ecology, small mammal monitoring, comparison of C3 and C4 plant responses, and establishment of a nutrient network site. The results of these projects have been presented at local and regional meetings in the subdisciplines of faculty principle investigators. In addition, the ENTRF-funded prairie restoration project increased interest in the MSUM Regional Science Center as a regional research site for the study of prairie ecology from faculty at North Dakota State University, several of whom have now established long term research projects at the site.

### **Project Results Use and Dissemination**

Dissemination of project outcomes have been those presented by project faculty and their research groups at meetings of their respective professional communities in geosciences, ecology and management conferences. Dissemination of overall project description, outcomes and application to undergraduate pedagogy is forthcoming. Plans for final paper preparation were delayed by the covid-19 pandemic.



# Environment and Natural Resources Trust Fund (ENRTF) M.L. 2015 Final Work Plan

**Date of Status Update Report:** July 1, 2020

**Final report**

**Date of Work Plan Approval:** May 19, 2015

**Project Completion Date:** June 30, 2020

**PROJECT TITLE:** Minnesota State University Moorhead Prairie and Riparian Restoration and Monitoring

**Project Manager:** Brian Wisenden

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**Location:** Clay County, MSUM Regional Science Center, Buffalo River State Park (DNR), Bluestem Scientific and Natural Area (TNC), Minnesota State University Moorhead,

**Total ENRTF Project Budget:**

**ENRTF Appropriation:** \$527,000

**Amount Spent:** \$522,779

**Balance:** \$4,221

**Legal Citation:** M.L. 2015, Chp. 76, Sec. 2, Subd. 08g

**Appropriation Language:**

\$527,000 the first year is from the trust fund to the Board of Trustees of the Minnesota State Colleges and Universities System for Minnesota State University Moorhead in cooperation with the Department of Natural Resources to restore and monitor 160 acres of prairie and riparian habitat and develop and disseminate monitoring protocols. This appropriation is contingent upon the donation of a 60-acre parcel to Minnesota State University Moorhead from the Minnesota State University Moorhead Alumni Foundation and is available until June 30, 2020, by which time the project must be completed and final products delivered.

**I. PROJECT TITLE:** Minnesota State University Moorhead Prairie and Riparian Restoration and Monitoring

**II. PROJECT STATEMENT:** Minnesota State University Moorhead's Science Center will restore and monitor 160 acres of prairie and riparian forest habitat resulting in the development and dissemination of monitoring protocols for understanding long-term ecological recovery.

a) Basic project background or context

The Lake Agassiz beach ridge forms a north-south line in the prairie region of western Minnesota. The Minnesota Prairie Conservation Plan identified the Blue Stem Prairie complex (The Nature Conservancy, TNC) as one of the Core Focus Areas for prairie conservation, with recommended actions of acquisition, restoration and enhancement of lands adjacent to remnant areas. The Bluestem Prairie complex occupies an area of 23,637 acres and is adjacent to Buffalo River State Park (Department of Natural Resources, DNR) and the Regional Science Center (Minnesota State University Moorhead, MSUM). Because ecological resiliency of preserved land increases with the size of area and the connectivity of the area to other natural areas, restoration and enhancement of MSUM land contributes to the ecological functioning of the entire complex. The educational mission of MSUM will provide generations of students with a living outdoor laboratory in which to engage in monitoring the success of restored areas in comparison against reference sites in remnant prairie, and in so doing, will contribute to the development of monitoring protocols for restoration efforts across the state of Minnesota and beyond.

b) Major project objectives

The Minnesota Prairie Conservation Plan recommends several strategies: (1) Protection, (2) Restoration and Enhancement and (3) Monitoring and Assessment.

Our project has three objectives that address all three of these strategic activities:

- (1) **Restoration** of (a) 100 acres of abandoned agricultural field to mesic prairie habitat, including experimental **enhancement** of half of that area to promote abundance and diversity of pollinators important to prairie ecosystem health and (b) 60 acres of mesic prairie mixed with terrace riparian forest that includes 17 acres of golf course turf. The golf course business has leased this land from the MSUM Alumni Foundation. That lease expires March 31, 2015. The Alumni Foundation will gift the land to MSUM when LCCMR funding for this restoration project receives final approval (see attached letter). The restoration of these lands is the realization of long-held goals of MSUM consistent with the institutional educational mission and in compliance with memoranda of understanding for land stewardship among MSUM, TNC and the DNR. Funds requested in this proposal will be used to **restore natural ecological function of these lands and protect them** in perpetuity. Archaeological properties will be documented and considered in restoration plans. Restoration of these lands not only brings these areas back to ecological functioning, but also contributes to the ecological resiliency of the entire complex that includes the Bluestem Prairie Science and Natural Area (TNC) and the Buffalo River State Park (DNR).
- (2) **Monitoring and Assessment** of the restored areas will be conducted by MSUM faculty through faculty-mentored student research during the summer months and through incorporation of the restoration project into the curriculum of multiple courses during the regular academic year. Standardized metrics for assessment and monitoring of restoration projects are not well developed. We will fill this gap by monitoring the ecological health of our restored areas and disseminate the methodological tools developed to measure restoration success for the benefit of ongoing and future restoration projects in MN and elsewhere. A core of faculty in the Anthropology and Earth Sciences Department and the Biosciences Department at MSUM will oversee establishment of a GIS data base and track plant community diversity, soil microbial diversity, pollinator abundance and diversity, and small mammal diversity and compare those data to reference sites in the Bluestem Scientific and Natural Areas (SNA) and Buffalo River State Park. We will be in full

communication with local resource agencies doing similar work thereby enhancing the impact of the project by linking our data with data collected by others in the region.

(3) **Education** is the central mission of Minnesota State University Moorhead. This project will provide direct training to summer research students working under faculty mentorship, and expose large numbers of undergraduate students during the regular academic year through class projects on prairie restoration assessment. Because the regular academic year is not dependent on the funding of this proposal we will be able to sustain the educational benefits (and collect long-term data on restoration assessment) long after the life of the grant. In addition, as a regional center serving the Moorhead metro area, we offer educational programming for K-12 students and to the general public that use the Regional Center as a place for recreational hiking in cooperation with Buffalo River State Park. The restoration project will be incorporated into new signage and programming to disseminate the value of ecological restoration.

c) General project activities and methods

Activity 1: Restoration

Restoration will be led by Cindy Lueth, DNR Parks and Trails resource specialist  
Archaeological survey and assessment will be led by MSUM Anthropology faculty

Activity 2: Monitoring and undergraduate education

Monitoring and assessment of the effectiveness of the restoration will be conducted two ways: (1) faculty-mentored student research in the summer and (2) class activities incorporated into the regular Aug-May academic curriculum.

Activity 3: Dissemination

Dissemination will be achieved by (1) direct interactions with TNC, DNR and ecologists working on prairie restoration in this region, (2) presentation of progress and data from our project at regional and national meetings of restoration ecologists, (3) publication of our monitoring protocols in national and international peer-reviewed publications, and (4) public education programming at the Regional Science Center interacting with area K-12 groups and adults and families in the general public that use the facility.

d) Overall project significance

This project will

1. contribute to the MN Prairie Conservation Plan through permanent protection, restoration, enhancement and monitoring of a Core Focus Area.
2. develop and disseminate monitoring protocols for assessing restoration.
3. educate generations of undergraduate students that will help build capacity in the region for restoration ecology through development of future restoration ecologists and, significantly, building an educated citizenry that understands the importance of conserving Minnesota's natural resource heritage.

**III. OVERALL PROJECT STATUS UPDATES:**

**Project Status as of January 1 2016:**

Transfer of title of the 60-acre parcel of land from the Alumni Foundation to the University is in progress. A thorough and lengthy environmental assessment process is required by MnSCU before any gifted land can be accepted. We anticipate that the process will reach completion early in 2016 and receive approval by the MnSCU Board of Trustees at their spring meeting. Meanwhile, we have made progress in all proposed activities. Archeological survey employing shovel testing revealed widespread evidence of long-term prehistoric cultural activities focused mainly on bison processing throughout the areas to be restored. An interagency agreement between MSUM and MN DNR has been established for the restoration work. Site preparation for restoration on all 160 acres is underway, including removal of invasive woody stem (Siberian Elm). Seed collection is also ongoing with the first seeding to begin in the spring. Faculty in the Anthropology and Earth Science Department

have developed a GIS grid database for the entire area (including reference sites) and have worked with Biosciences faculty for training and consultation on building interactive maps and capabilities for data sharing and customizing iPad-based, Esri Collector apps for monitoring. Individual Biosciences faculty collaborated with TNC and DNR biologists to select appropriate reference sites within the Bluestem Prairie Complex, and began this summer developing monitoring protocols with summer interns and began collecting baseline data, resulting at least two presentations at conferences. The restoration project was incorporated into the curriculum of six different undergraduate courses in the fall of 2015. Interpretation and public outreach has included 1,543 people over 46 events, and some updated signage has been posted, with more to be installed in the spring.

**Project Status as of July 1 2016:**

We have made significant progress toward finalizing the transfer of title of the 60-acre parcel of land from Alumni Foundation to Minnesota State University Moorhead by working closely with the MN Department of Agriculture (MDA) and the Agriculture Voluntary Investigation and Cleanup (AgVIC). As of April 8, 2016 MSUM has spent more than \$56k outside of the funds from ENRTF on soil testing and other obligations to the environmental assessment process required by the MnSCU Board of Trustees to approve acceptance of the land gift. At the April 19/20, 2016 meeting of the MnSCU Board of Trustees meeting, the MSUM gift of real estate was approved on the consent agenda pending completion of the environmental review process. We are in the final stages of that process and expect a declaration of 'no further action required' in the near future. Appended to this status report are supporting documents.

While this has been going in the background, Cindy Lueth and her team have prepared and seeded 70 acres of the 100-acre parcel on the south side of the river. Seeding of the remaining 30 acres will be delayed to quell an outbreak of leafy spurge. Woody stem removal on the 60-acre golf course parcel was completed last fall. Limited native prairie plants are beginning to emerge from the seed bank but no active seeding of this parcel has been done at this point. Faculty and students have been out in full force gathering data on various aspects of prairie ecology. We are delighted to have attracted several research teams from outside of MSUM to use our site to study restoration ecology of prairie ecosystems. We have hosted public outreach events featuring the restoration project and featured student research activity.

**Project Status as of January 1, 2017:**

To date, Minnesota State University Moorhead has completed a majority of the due diligence required by MN statute and MnState Board of Trustees policy in order to accept the gift of the Ponderosa Golf Course property from the University Foundation. So far, the costs incurred by the University total approximately \$63,000 – funds not part of the ENRTF budget. A routinely required Phase I Environmental Site Assessment (ESA) determined a need for a Phase II ESA. Unfortunately, there were significant environmental issues caused by normal golf course operation. Residual chemicals are a substantial sticking point with the Minnesota Department of Agriculture (MDA) and its mission of environmental protection. With consultation from the System Office, MSUM entered into the Agricultural Voluntary Investigation and Cleanup (AgVIC) program. The results of the Phase II ESA caused an extensive review by the MDA and they proposed a work plan for additional Phase II assessment. The university is currently working with the MDA to finalize the Phase II assessment.

Restoration work continues to progress on schedule. Cindy Lueth and her team have combined 900 pounds (cleaned) of leadplant from State Park remnant prairie for use on the Science Center restoration, 300 pounds of short grass mix from State Park remnant prairie to use in Science Center, and hand harvested at least 50 species from park land to use in the Science Center. Estimated replacement value of the seed is \$450,000. On the 100-acre parcel on the south side of the river, the area has been cleared of woody stems, burned to remove duff, treated with herbicide and seeded, as reported in July 2016. There was some follow-up application of herbicide to treat an outbreak of leafy spurge, but nothing more occurred on that part of the restoration in late summer 2016. On the 60-acre parcel on the north side of the river (old fairways of former golf course), there has been application of herbicide, both RoundUp and Plateau (Plateau used where some native plants are present; RoundUp everywhere else), removal of woody stem invasives and herbicide application, mostly shrub-sized

Siberian elm, and continued piling large trees and shrubs for removal offsite. In addition, invasive species have been located and treated (new spurge sites on Sci Center property, herbaceous invasives, including thistles, spotted knapweed). Contract CCM crew spent 2 weeks treating woody buckthorn and honeysuckle in the river woodlands.

**Project Status as of July 1 2017:**

The end is in sight for the formal transfer of ownership of the Ponderosa Golf Course land from the MSUM Alumni Foundation to MSUM. Although the MnSCU Board of Trustees approved the MSUM gift of real estate at their April 2016 meeting, the approval depended on the satisfactory completion of the environmental review process. Unfortunately, the results of the Phase II environmental site assessment (ESA) caused an extensive review by the Minnesota Department of Agriculture (MDA) and they proposed a work plan for additional Phase II assessment. Rather than undertake the additional extensive & costly assessment (\$45,000-\$85,000), the University sought & received a reserve of up to \$50,000 from the University Foundation to use if any agency orders additional testing, investigation, monitoring or remediation of the property. Furthermore, we have agreed to contract a qualified, licensed, environmental firm to test any part of the property targeted by our faculty for subsurface investigation and, if any contaminants are identified, we will properly deal with them before approving the subsurface investigation or, if it's too costly, we will forego investigation at that portion of the property. We will be forwarding our documentation of this protocol/process to our System Office for their review and approval. Once the protocol is approved, we will withdraw from the MDA Voluntary Investigation and Cleanup (AgVIC) program and then finally be in a position to formally accept the gift of the Ponderosa Golf Course property from the MSUM Foundation.

Restoration work by Cindy Lueth and her associates continues on schedule. The 100 acre "Houston Property" parcel (south side of the river) is showing nice growth (seeded 2016). They just completed clipping the entire hundred acres and are in the midst of inter-seeding that site with forbs. Spurge on the site was controlled in June 2017 and thistle spot spraying will commence in 3 weeks. On the north side of the river (former golf course), the fairways received a second RoundUp spraying to follow up on the fall 2016 application and the seeding was completed this week.

**Project Status as of January 1, 2018:**

Property transfer of the Ponderosa Golf Course: Attached to this status report are summarized results of the soil testing as part of the environmental site assessment done by Terracon. Also attached to this status report is a memo from MSUM to the System Office indicating a proposal to withdraw from the voluntary investigation and cleanup program (AgVIC) and manage the property in such a way as to allow continued research and education on restoration ecology of prairie ecosystems to continue, but carefully regulate any activities that may result in significant disturbance of the soil. The memo going forward to the Minnesota Department of Agriculture (MDA) is also attached. It is our hope and expectation that this proposal will be accepted by the MDA early in the new year, which will remove the final obstacle to formal acceptance of the Ponderosa golf course land by MSUM.

Meanwhile, ecological restoration continues apace under the capable direction of Cindy Lueth. The period from July to December 2017 saw forb seed added to the Houston property, mowing of the Houston property and spraying thistle and leafy spurge on the Houston property. In the river corridor contained within the Ponderosa parcel, the restoration crew removed invasive woody stems.

**Project Status as of July 1 2018:**

Property transfer of the Ponderosa Golf course from the MSUM Alumni Foundation to Minnesota State University Moorhead is now complete!

Restoration by Cindy Lueth and her associates is on schedule. Since January 2018 they have mowed the golf course and a large section of the Houston property where sweet clover was present.

**Project Status as of January 1, 2019:**

There was more thistle mowing on the golf course (done twice in 2018), mowing of sweet clover and thistle mowing on Houston section, leafy spurge treatment and purple loosestrife treatment on golf course.

**Project Status as of July 1, 2019**

Summer faculty-mentored research is winding down from the peak of the past few years. There is now sustained research effort on the prairie nutrient network and monitoring of small mammal populations. The DNR crew continue to suppress invasive species and prepare the golf course area for planting of trees in the terrace forest habitat. Faculty are preparing manuscripts for dissemination of the restoration project for publication in conservation biology, and biological education journals.

**Project Status as of January 1, 2020**

Faculty-mentored student research continued in late summer on small mammal population surveys, shifts in the soil microbiome, C3/C4 plant ecology and the nutrient network study plot. Restoration work by Cindy Lueth and her crew were busy through late summer and fall controlling invasive species. The final six months of the project will prioritize preparation of manuscripts for dissemination of project results.

**Project Status as of July 1, 2020**

Some faculty-mentored student research occurred in early summer 2020 on the nutrient network project while maintaining social distancing and other measures to reduce risk of transmission of covid-19. Restoration efforts by Cindy Lueth and her team continued as scheduled. With the chaos that resulted from the transition to online teaching and working from home, work on manuscripts for dissemination was postponed to a time after July 1 2020.

**Overall Project Outcomes and Results:**

The Bluestem Prairie is Minnesota's largest remnant tall grass prairie (6700 acres) comprising lands owned by The Nature Conservancy, Department of Natural Resources and Minnesota State University Moorhead. This project set out to achieve three goals: (1) acquire additional 189 acres of land contiguous with the complex, 100 acres of which were abandoned agricultural field and 89 acres comprised 60 acres of golf course fairways and 29 acres of riparian terrace forest, (2) collaborate with the MN DNR to restore 160 acres of land to tall grass prairie habitat, and (3) engage faculty and students at Minnesota state University Moorhead to monitor changes in the prairie community before, during and after restoration, to enrich undergraduate curricula, develop capacity for personnel interested in restoration biology, and develop and disseminate monitoring protocols for application to future restoration projects. In the five years since June 2015, we have successfully transferred ownership of the 189 acres of land to Minnesota State University Moorhead, restored 160 acres to tall grass prairie community and engaged 10 MSUM faculty, dozens of research students and many hundreds of undergraduates in concepts and practical skills in conservation ecology. This work has resulted in establishment of a customized GIS database at the site, active and ongoing field projects on microbial ecology, small mammal monitoring, comparison of C3 and C4 plant responses, and establishment of a nutrient network site. The results of these projects have been presented at local and regional meetings in the subdisciplines of faculty principle investigators. In addition, the ENTRF-funded prairie restoration project increased interest in the MSUM Regional Science Center as a regional research site for the study of prairie ecology from faculty at North Dakota State University, several of whom have now established long term research projects at the site.

**IV. PROJECT ACTIVITIES AND OUTCOMES:**

**ACTIVITY 1:** Restoration of 143 acres of prairie and 17 acres of riparian terrace forest

Archaeological survey and assessment will be led by MSUM Anthropology faculty

**Description:** Prairie restoration of units consisting of 100 acres of old brome field that will be restored to mesic prairie and 60 additional acres gifted to MSUM from the MSUM Alumni Foundation comprising 43 acres of mesic

prairie and 17 acres of terrace forest within the Buffalo River floodplain. The Alumni Foundation property contains cultured turf as part of a golf course that operated on the property until the end of the 2014 season. Cindy Lueth from Department of Natural Resources Parks & Trails will oversee the restoration process.

Restoration timeline

Year	Season	Action	Notes
2015	Late summer/early fall	Chemical site prep of 100 acres	Apply during active growing season of brome
		Archaeological inventory, pedestrian survey, shovel testing	Under Phase I Reconnaissance Permit
		Consider management of archaeological sites in restoration planning	Site data filed with SHPO
		removal of golf turf irrigation system	
		Chemical site prep, as needed	Sod removal
2016	Late summer, fall	Seed collection	Combine, hand harvest
	Spring	Chemical site prep	
	May-June	Seed, drill/broadcast	
2016 - 2019	June-July-Aug-Sept-Oct	Seed collection, as needed	Collect early species missed during 2015; collect additional seeds of species of interest or that were collected in limited quantities during 2015
2017 - 2019	August 2016 as needed	mow to 4-6 inches weed control	Includes both broad leaf and cool season grasses
2017	June and Aug	mow 4-6 inches	As needed--once natives are established abundantly, mowing stops; mowing keeps light levels high for emerging seedlings
2020	April	plant tree seedlings/whips; add deer protection	Floodplain forest

Summary Budget Information for Activity 1:

ENRTF Budget: \$246,620  
 Amount Spent: \$461,222  
 Balance: \$398

Outcome	Acres	Completion Date
1. Archaeological survey	140	August, 2015
2. Woody stem removal, herbicide, pile burn	160	October, 2018
3. Prairie seed harvest/cleaning, planting	143	October, 2018
4. Tree/shrub seed harvest & propagation	17	June, 2020
5. Weed control, mowing, prescribed fire	143	June, 2020
6. Buckthorn and invasive control	17	June, 2020
7. Plant trees, deer protection, add herbs	17	June, 2020

**Project Status as of January 1 2016:**

Archeological survey has been conducted within the areas to be restored. Dr. George Holley and his students completed about 800 shovel tests and uncovered abundant evidence of Native American occupation. Prehistoric activities span the period following the draining of glacial Lake Agassiz (approximately 8,000 years ago) to just before contact. It appears that bison processing was a focal activity. Consultation with the Office of the State Archeologist has been completed regarding the documentation of these cultural resources, and site form submissions are in progress. Planning for the restoration effort began in earnest on July 8, 2015 at the MSUM Regional Science Center when we hosted a discussion group that included all the faculty from MSUM named in this work plan, and our partners in prairie restoration in the region from the MN DNR (Melody Webb, Parks and Trails; Shelley Hedtke, Scientific and Natural Areas) and TNC (Brian Winter, manager of the MN Tallgrass Prairie Ecoregion). This was followed by a larger meeting of the Grassland Restoration Network on July 21-23, also hosted at the interpretation center at the MSUM Regional Science Center. At this meeting we consulted with restoration ecologists from across the Midwest on the sites we will restore. We plan to plant a forb-rich seed mix to promote pollinator abundance and diversity. Site preparation began in fall 2015 and included reducing trees and shrubs from the former golf course and cutting burn breaks around the 100 acres south of the river. Buffalo River State Park seed adjacent to the MSU parcel was combined and selective forbs were hand harvested to prepare for planting the south site in the spring of 2016. We removed woody stems from the golf course site but did not remove the sod as originally planned because the environmental assessment process discovered pesticide contamination of the soil. Leaving the golf course sod in place will help contain contaminants to the few localized spots where they were detected.

**Project Status as of July 1 2016:**

The archeological survey work is completed. Cindy Lueth and her team have completed woody stem removal at the golf course site. At the 100-acre parcel they conducted a prescribed burn. They also applied herbicide treatments (20#/acre of RoundUp) to 30 acres to control leafy spurge and smoothed gopher mounds over 20 acres of the 100-acre parcel in cooperation with the archeologists. They seeded the 70 acres that were not covered by leafy spurge with native prairie seed mix.

**Project Status as of January 1, 2017:**

The details of work done to manage invasive species, and harvest and drill local seed, were described in the update in the previous section. The restoration work is proceeding as scheduled. The balance for this part of this budget remains unchanged since the July 1, 2016 report because the MN DNR did not send us any invoices for work done between July 1 and Dec 31, 2016.

**Project Status as of July 1 2017:**

We were invoiced for \$44,000 on Jan 23, 2017 as partial payment for their on-going restoration efforts at the site. As described in the overall progress report in the previous section, the restoration effort is on schedule.

**Project Status as of January 1, 2018:**

As mentioned above, restoration work continued in the 100-acre parcel known as the *Houston Property* as well as the river corridor contained within the 60-acre fairway area of the former Ponderosa Golf Course.

**Project Status as of July 1 2018:**

As mentioned above, mowing and suppression of clover has been the main activity in the past 6 months.

**Project Status as of January 1, 2019:**

The latter part of 2018 was spent on control and management of invasive species on the golf course and Houston parcels.

**Project Status as of July 1 2019:**

May 2019: Prescribed fire used on the south side of the river (100 acres "Houston" area)

May-June 2019: It has been a cool season, we did spot spraying on 10 acres on non-native grass on the north side of the river (golf course fairways).

**Project Status as of January 1, 2020:**

The final installment of the subcontract to MN DNR (Cindy Lueth) was transferred over this 6-month period.

Cindy Lueth and her crew did the following actions:

All fairways on the north side of the river were gridded and treated as needed for quackgrass (49 acres)

- Purple loosestrife was controlled, N side of the river (1.8 ac)
- The entire restoration was treated for leafy spurge, as needed (120+ ac)
- Fairways were mowed to encourage continued establishment of the planted prairie (56 acres)
- 2 large piles were burned dating back to the golf course era
- Thistle was treated as found (15 ac)

**Final Report Summary: July 2020**

The Bluestem Prairie is Minnesota's largest remnant tall grass prairie (6700 acres) comprising lands owned by The Nature Conservancy, Department of Natural Resources and Minnesota State University Moorhead. This project set out to achieve three goals: (1) acquire 189 acres of land contiguous with the complex, 100 acres of which were abandoned agricultural field and 89 acres comprised 60 acres of golf course fairways and 29 acres of riparian terrace forest, (2) collaborate with the MN DNR to restore 160 acres of land to tall grass prairie habitat, and (3) engage faculty and students at Minnesota state University Moorhead to monitor changes in the prairie community before, during and after restoration, to enrich undergraduate curricula, develop capacity for personnel interested in restoration biology, and develop and disseminate monitoring protocols for application to future restoration projects. In the five years since June 2015, we have successfully transferred ownership of the 189 acres of land to Minnesota State University Moorhead, restored 160 acres to tall grass prairie community and engaged 10 MSUM faculty, dozens of research students and many hundreds of undergraduates in concepts and practical skills in conservation ecology. This work has resulted in establishment of a customized GIS database at the site, active and ongoing field projects on microbial ecology, small mammal monitoring, comparison of C3 and C4 plant responses, and establishment of a nutrient network site. The results of these projects have been presented at local and regional meetings in the subdisciplines of faculty principle investigators. In addition, the ENTRF-funded prairie restoration project increased interest in the MSUM Regional Science Center as a regional research site for the study of prairie ecology from faculty at North Dakota State University, several of whom have now established long term research projects at the site.



**Photo of the Houston property in July 2020, formerly abandoned agricultural field of brome grass.**



**Photo (July 2020) of prairie restoration of golf course fairway.**

**ACTIVITY 2:** Post-Restoration Monitoring by Minnesota State University Moorhead faculty and undergraduate students

**Description:** Undergraduate students will collect foundational data on species distribution and genetic diversity in adjacent references sites of remnant prairie in the Bluestem Prairie Complex. Faculty-mentored research students will conduct surveys of ecosystem health and indicator species to assess the progress and success of the restoration. These activities will use a customized GIS database to facilitate the development of restoration monitoring strategies and protocols and the assessment effort. During the summer of 2015 the restoration work will be primarily in the form of site preparation and an archaeological survey of the areas to be restored (as described above). George Holley from the Anthropology and Earth Sciences (AES) Department will conduct the archaeological survey. Concomitantly, AES Faculty Kirk Stueve will establish the GIS database for organizing and integrating ecological data collected throughout the ecological monitoring and assessment. AES faculty Rinita Dalan will assist in this effort, incorporating the archaeological data into a GIS layer and management plan with respect to the restoration, and building interactive maps and capabilities using mobile apps for monitoring and data sharing. The GIS piece is a critical part of the monitoring effort because it will ensure that the data collected will be accessible and retrievable long into the future and by restoration ecologists working in other regions of the state and beyond.

Year	Season	Action	Notes
2015	October	Contact MN DNR, Nature Conservancy, and other partners with overlapping activities	Bryan Bishop and Laura Aldrich-Wolff from Concordia University Moorhead have overlapping research activities
	October	Coordinate collection of raster-based geospatial data from local, regional, and national agencies	LiDAR, high-res aerial photography, etc.
	October	Coordinate collection of vector-based geospatial data from local, regional, and national agencies	Existing boundaries, existing field sites, soil types, etc.
	October	Perform spatial analyses and classifications to produce derivatives from collected geospatial data	Solar radiation exposure, slope aspect, slope angle, wetness index, proximity to forest edge, proximity to field edge, proximity to stream, patchiness index, habitat site classifications, etc.
	October	Develop custom spatially weighted sampling strategy for quantifying species composition of restoration efforts at landscape-scales  Build interactive maps for data collection  Train Faculty Team Members	Using Esri Collector app  Collector app and basic map making and analytic tools
	October	Create online group for data sharing	LCCMR group in MSUM online ArcGIS organization
2017	October	Coordinate with field crews regarding the integration of data into the existing GIS database.	

In 2015 the restored areas will be undergoing preparation work (see activity 1 above). Faculty in the Biosciences Department (Sara Anderson, Chris Chastain, Alison Wallace, Brian Wisenden, Donna Stockrahm) will use 2015 as a time to establish reference sites on adjacent remnant prairie reference sites and work with students to develop monitoring protocols. In the summers of 2016 and 2017 Biosciences faculty and their research students will extend monitoring to include the restored areas for direct comparisons. Each faculty member will contribute a unique component to the monitoring effort. Sara Anderson: metagenomics of soil bacterial communities as indicators of soil and ecosystem health; Chris Chastain: environmental physiology of C3 and C4 photosynthetic plants in prairie ecosystems; Alison Wallace: seed germination rates as a function of storage time, plant community structure; Brian Wisenden: pollinator/plant interactions, diversity and phenology; and Donna Stockrahm: abundance, diversity and movements of small mammals.

Starting in the fall semester of 2015, and continuing indefinitely, AES and Biosciences faculty will incorporate the restoration project into the curriculum of the regular academic year (Aug-May). This is easily done because the Regional Science Center is only 15 miles from the main campus thus, a typical 3-hour lab period can be structured around 30 min transportation to and from the site and 2 hours of on-site activity. There is no better form of learning than learning by doing. Using this pedagogical model AES and Biosciences faculty can leverage the impact of the restoration project to augment the learning experience of thousands of undergraduates.

Moreover, we will be able to extend this benefit long past the 3-year life of the grant because faculty salary is part of the regular academic year and students work for academic credit. The focused summer research efforts will develop the data collection techniques to be incorporated into the regular curriculum during the regular academic year. The data collection methods will be, by necessity, streamlined (GIS automated) and efficient to collect by undergraduates given only basic orientation. The goal is that we will be able to use undergraduate education as a vehicle to generate long-term data sets for monitoring and assessing the fate of the restored areas on MSUM property. Because the data collection methods we develop will be streamlined, we expect that the methods we develop will be easy to adopt, adapt and apply to other restoration projects in Minnesota and beyond where any trained organizer can effectively oversee and manage restoration assessment. The methods we develop and perfect will be communicated at conferences attended by resource managers and published in conservation journals (see Activity 3).

**Summary Budget Information for Activity 2:**

**ENRTF Budget: \$ 240,000**  
**Amount Spent: \$ 238,229**  
**Balance: \$ 1,771**

<b>Outcome</b>	<b>Completion Date</b>
<b>1.</b> Customized GIS database development and management	October, 2017
<b>2.</b> Development and application of protocols and faculty-mentored student research on: a) microbial metagenomic diversity in soil (Anderson) b) environmental physiology of C4-dominant photosynthesis of plants (Chastain) c) seed germination rates as a function of seed storage duration (Wallace) d) pollinator diversity, phenology and pollinator- plant associations (Wisenden) e) diversity and movements of small mammals (Stockrahm)	October, 2017
<b>3.</b> Incorporation of restoration ecology into field-based curricula for Organismal Biology, Ecology, MN Plant ID, Principles of Genetics, Wildlife Ecology, Water, Land, and People, GPS Field Techniques, Introduction to GIS, Spatial Analysis, Geoarchaeology, Arch/Geoarch field schools	Fall 2015 – indefinite future

**Project Status as of January 1 2016:**

We met with DNR and TNC personnel at the restoration site, and with others in the region active in prairie restoration, such as Jack Norland (Prairie Grass Specialist, on faculty at North Dakota State University), Bryan Bishop (Entomologist specializing on bee-flower interactions, on faculty at Concordia College), Joseph Whittaker (Mammalogist, on faculty at Concordia College) and Peter Bergholz (soil microbial ecologist, on faculty at North Dakota State University). These consultation have helped MSUM Biosciences faculty plan their research, as well as make sure that the work we do complements the work done by others in the region. We selected two reference sites as standards with which to compare the progress of the areas to be restored in this project. One area is remnant tallgrass prairie located on TNC land but administered by the DNR as a Scientific and Natural Area. The second are is an area on TNC land that was restored from an abandoned farm field in YEAR?.

Dr. Kirk Stueve and student interns have built a GIS database for the Regional Science Center. Key elements of the database include high-resolution aerial photography flown by Midwest Aerial Technologies and other vendors, high-resolution topography data from LiDAR flights, property boundaries, soil types, land cover, and landscape fragmentation metrics. These data layers have been shared with project personnel for use in survey planning and data analysis. Dr. Rinita Dalan completed two DNR-training sessions on the Esri Collector app at the Minnesota GIS LIS Fall conference. She has developed ArcGIS Online and Collector training materials and has set-up and tested 12 iPads for use in mobile mapping for restoration monitoring. Several project personnel have completed this training. Dalan has created interactive webmaps using ArcGIS Online for the archaeological work and the environmental testing and has created data sharing groups for the archaeologists and the biologists in MSUM’s ArcGIS online organization. As part of MSUM’s second annual GIS Day celebration (November 18,

2015), Dr. Sara Anderson hosted a table and display highlighting this grant and prairie restoration and monitoring efforts at the Regional Science Center, including ecological challenges and management opportunities. A focus of the display was how MSUM students are gaining “real world” experience using GIS in research, management, and assessment, as well as participating in networking opportunities with agencies such as the MN DNR, TNC, and other land management organizations. A write-up on this display was featured in the MSUM Center for Geospatial Studies December newsletter. Intern Gary George is also working on high-resolution images of the Regional Science Center for a large display on the MSUM campus.

Individual faculty research on monitoring protocols began with a “boot camp” orientation for student interns on June 4, 2015. In total 14 undergraduate student interns worked for a sum of 895 hours during the summer and fall in collaboration with faculty on the design and implementation of monitoring protocols. These efforts laid the foundations for methods we will apply in 2016 for (i) marker enzymes for C3 and C4 photosynthesis, (ii) forb phenology and growth on different soil types, (iii) soil collection methods and use of ecoplates in citizen science, (iv) diversity of small mammals, and tracking their movements using PIT tags, and (v) use of bee bowls at multiple elevations to monitor abundance and diversity of pollinators; study of associations between the regal fritillary and violets.

In the fall semester (Aug-Dec) undergraduate students from campus visited the restoration sites for educational activities as part of their 3-hour labs. Courses that developed and incorporated restoration ecology into their lab curricula were Organismal Biology (152 students), Principles of Ecology and Evolution (35 students), Invertebrate Zoology (11 students), Wildlife Ecology (13 students), Geoarcheology (11) and Archeology (34).

**Project Status as of July 1 2016:**

Construction of the GIS database is complete. It includes many variables such as elevation, slope angle, slope aspect, solar radiation potential from various times of the year, proximity to river, proximity to roads, land cover, topographic moisture indices, soil, and others. It is being housed on two external drives. One functions as the working/operable copy and one functions as the backup copy. We are generating ESRI Collector Apps to help researchers automate the collection and analysis of data related to the LCCMR project. The App closest to completion is related to the butterfly transects. Annika Bordak (undergraduate intern) will be able to find the transects with the Collector App, record time-stamped data, and select from the most common butterfly species in a drop down menu available in the App. These data and the App can also be shared, as needed, with community "scientists". We are also developing ESRI Collector Apps that mark ongoing research activities related to the LCCMR project and for logging key Regional Science Center infrastructure.

MSUM faculty: Drs. Chris Chastain, Sara Anderson, Donna Stockrahm, Alison Wallace, Becky Andres, Kirk Stueve, and George Holley have hired 17 students as summer interns as part of their summer research on prairie restoration ecology. Many of these students are authors on poster presentations about their research presented to the campus community at the MSUM Student Academic Conference in April 12, 2016 and to a showcase convened at the interpretation center at the MSUM Regional Science Center (at the restoration site) on April 21, April. The showcase was attended by members of the upper administration, members of the MSUM Alumni Foundation Board, faculty and student of Biology, Archeology and Geosciences, and Physics and Astronomy. The showcase included a walking tour of the parcels to be restored by this project.

Some highlights of ongoing research by faculty and their undergraduate students:

- Development of pyruvate phosphate dikinase (PPDK) as a biomarker to distinguish flora that use C3 (PPDK in small quantities) or C4 (PPDK in large quantities) for surveying plant communities during restoration to native flora.

- Germination viability of select plant species after varying amounts of time in storage.
- Baseline and transitional survey of small mammal abundance and diversity in both the golf course (60 acre) and abandoned farm land (100 acre) parcels.
- Successful implementation of iPad-based *Collector* app for ArcGIS, which provides consistent field data collection along with accurate GPS locations for each soil sample collected. To date, we have collected 91 soil samples (20 late fall 2015; 71 early summer 2016), representing restoration sites and reference sites managed by TNC. We are currently processing soil samples in the lab, which includes DNA extraction and community level physiological profiling (CLPP). Initial data indicate different CLPP results among and within sites.
- Submission of a CAREER grant proposal to the National Science Foundation by Sara Anderson to expand on her ENRTF research in this project
- Experimental testing of sampling techniques for pollinator diversity and abundance using “bee-bowls” positioned at different heights at the site. These data allow for linking phenology and spatial distribution of pollinator with the phenology of their nectar and pollen sources.

As hoped and predicted, this project has raised the profile of the MSUM Regional Science Center as a regional site for academic study of prairie restoration ecology. The value of data collected by an individual scientist is enhanced by being able to link those data to a community of scientists working on other aspects of prairie ecology at the same site. The ENRTF fund was the catalyst that started a positive feedback process. The scale and scope of prairie research currently ongoing or planned in the near future has grown to include:

- Endocrine-behavior interactions in wild songbirds as a function of shifting climate (Dr. Tim Greives and his students, North Dakota State University), including a pending research proposal for work at the site submitted to the National Science Foundation
- Regional adaptation in prairie smoke using a common garden approach (Dr. Jill Hamilton and her students, North Dakota State University)
- Pollinator-plant community gene dispersal as a function of habitat fragmentation (ENRTF-funded research Dr. Lauren Sullivan, University of Minnesota) – who hired a MSUM undergraduate as a summer intern.
- Response of herpetological communities to prairie restoration (Dr. Matthew Smith, North Dakota State University).

**Project Status as of January 1, 2017:**

In the Fall academic semester, there were 41 MSUM visits to the site by students in Principles of Ecology, Organismal Biology, and Genetics, summing to a total impact of 800 students. We developed a new module in Organismal Biology where students compare functional diversity of soil microbes in samples taken from remnant prairie, restored prairie, and unrestored prairie (golf course). In addition, we ran a bird-banding activity on 7 mornings during the fall for students in Organismal Biology (operated by Dr. Grieves and his students).

**Project Status as of July 1 2017:**

Soil Microbiome research (Sara Anderson): Since January 1, 2017, two undergraduate research students have been analyzing data from the first year of data collection. Data includes samples collected by three research students during the summer (June-July) and samples collected by 70 students in our majors Genetics course in September. The 2017 field season started on June 5<sup>th</sup> with four new research students. To date, we have collected 80 soil samples this June with approximately 30 more samples to collect before July 1<sup>st</sup>. Students have also processed the samples in the lab to extract total DNA and to establish the community level physiological profiles of each sample. Later in the summer we will continue with DNA sequencing. All samples are geotagged at time of collection and associated site characteristics recorded in a geodatabase.

Nutrient Network Site (Alison Wallace): We set up one Nutrient Network site in a 20 year old restoration last fall and collected baseline data. This spring we added the nutrient treatments and will collect data in August. We are in the process of working with the DNR and the Geospatial folks to select a location to set another one up in the Houston property (will happen July 11-13) to allow us to follow plant cover and species diversity over the next 10 years, at least, while plugging into a larger, international network looking at basic grassland ecology questions. About 8 students have received research credit for this project, and two have received student research grants. Several will attend the annual Nutrient Network conference at the U of M at the end of July where data sharing and paper writing happens.

Small mammal monitoring (Donna Stockrahm): Populations of small mammals are too low until after July 4 to make trapping worthwhile. That work will begin in early July.

Photosynthesis in C3 and C4 plants (Chris Chastain): That work is done primarily in the late summer and fall. There is nothing new to report on that.

Pollinator ecology (Becky Andres): bee traps have set and being checked. No conclusions to report at this point. We have also added two new researchers from NDSU working on sphingid moth pollination of prairie flora, including the prairie fringed orchid that occurs on our site.

#### **Project Status as of January 1, 2018:**

a) Soil microbiome research (Sara Anderson): During the 2017 field season (June 5 - September 25), we collected 190 soil samples from the restoration and reference sites. Five undergraduate student researchers worked approximately 450 hours during the same time period, which included both field collection and laboratory processing and analysis of samples. Approximately 70 of the samples were collected and processed by the Biol 341 (Genetics) class during Fall 2017 in part to fulfill our integration of restoration monitoring into the curriculum and to give students a genuine research experience within a course.

#### Ongoing activities:

We are in process of generating the DNA sequencing data for this year's samples. Once all of the sequencing data is complete, we will continue with data analysis. We are also working with our GIS collaborators to obtain detailed elevation, slope, and aspect information for all of our sites, because preliminary analysis suggests that topography is an important variable associated with microbial community diversity.

#### Conference presentation (all co-authors are undergraduate students):

Anderson, Kristen O., Elias P. Holte, and Sara J. Anderson. Baseline Assessment of Restoration Sites Reveals Soil Microbial Diversity does not Match Expectations based on Pre-restoration Status. 2017 Ecological Society of America. Portland, OR.

Summary results presented: the pre-restoration sites and our reference sites (1 remnant and 2 previously restored prairies) were compared with respect to microbial taxonomic and functional diversity. Our expectations were that the golf course site would have the lowest diversity, the remnant would have the highest diversity, and all other sites would be somewhat intermediate. We found that using a very basic but commonly reported diversity metric (Shannon's Index), the sites were not different in taxonomic diversity. However, using more sophisticated analysis revealed that the composition of taxa was different among sites. Overall, the golf course, for example, was not less diverse than a previously restored site, however it did have a different composition of bacterial groups than other sites. This seemed to be true for all sites, and is something we are following up in subsequent years.

#### Course integration outcomes:

Some of the summer research students assisted with the *Genetics* (Biol 341) class in two different weeks, which was a good opportunity for these students to gain confidence in their acquired expertise and gave the class some “near peers” to ask questions or learn more about research. The Biol 341 class completed both pre- and post-surveys of the Colorado Learning Attitudes About Science survey (nationally used and validated survey). Outcomes of the survey indicate that students overall had positive, realistic, and achievable attitudes about science and their potential role in research. Increased positive attitudes in problem solving strategies, problem solving effort, and reasoning are encouraging, as these are fundamental qualities needed in research endeavors.

b) Nutrient Network Site (Alison Wallace):

I worked with 7 undergraduates during the summer of 2017 to do the following:

- Applied randomized nutrient treatments (N,P,K) to the North Pond Nutrient Network site (20 year old restoration).
- Collected light intensity, identify species and estimate their percent cover for the Nutrient Network North Pond site.
- Established a new site at the Houston property so that we can monitor changes in the plantings over the next 10-20 years. Baseline light intensity, species composition and percent cover data were collected, but no aboveground biomass samples were taken since the area had been mowed to control for weeds.
- Worked with the GIS assistant, Amy Woodruff, to map the plot locations of the Houston NutNet site.

I worked with our new faculty member (Chris Merkord) to design a lab activity in which two sections of Ecology labs collected aboveground biomass samples from each of the 40 plots in the North Pond site and learned about our local restoration as well as the global Nutrient Network activities.

My main research assistant, Hayley Hilfer, attended the annual Nutrient Network meeting at the University of Minnesota in July. We are one or two sites (out of nearly 100 worldwide) that are operated by an undergraduate institution.

My students gave a presentation and prepared a poster at the 2017 Student Academic Conference. They presented their progress in both the spring and the fall student research seminars (FREE).

Hilfer H, Akhidenor S, Kovacevic A, Schanz J. 2017. Grassland ecology investigations of baseline monitoring data. Poser presentation at the MSUM Student Academic Conference, April 2017

Geister-Jones G (2017) MSUM Nutrient Network. Poser presentation at the MSUM Student Academic Conference, April 2017

Hilfer H, Kovacevic A, Huynh B, Grieger T, LaFromboise J (2017) The Nutrient Network at MSUM. Oral presentation at the Friday Research Exploration and Education, November 2017

c) Small mammal monitoring (Donna Stockrahm)

Donna and her crew of students trapped on Houston and Ponderosa sections of the restoration area through late summer and fall. Work was slowed, but only a little, because Donna broke *both* her legs. She has an active research group that kept the activity at high level at the site.

d) Environmental physiology of C3 and C4 plants (Chris Chastain):

In late-summer of 2016 we established five vegetation survey plots for annual monitoring of grass and forb composition. Each plot was laid out as a 6 X 6 meter area subdivided into 16-1.5 X 1.5 meter quadrants. Three of these plots were located within MSUM land, with two of the plots placed within non-golf course areas undergoing restoration, and another plot on land that had undergone the process of restoration to tall-grass

prairie within the last decade. Another two plots were located within the TNC Bluestem Prairie Preserve. In late-summer 2017, we established another plot for annual monitoring within the former golf course:

Sites:

1. Houston property N. site
2. Houston property S. site
3. MSUM Science Center - restored prairie
4. TNC Bluestem Prairie N. site
5. TNC Bluestem Prairie S. site
6. MSUM former golf course (est. 2017)

### **Summary of Progress for the 2017 July-December period**

- established an additional survey plot within the former golf course
- completed systematic digital imaging of survey plots 1-6 for the 2017 growing season
- formatted and archived digital images of survey plots in preparation for vegetation-type analysis
- completed quantitative vegetation-type analysis for 2016 growing season - plots 1 & 2
- partially completed quantitative analysis vegetation-type analysis for 2016 growing season

In late-summer 2017, we established another 6 x 6 meter plot for annual monitoring within the former golf course. In late August, all plots were visited and systematically photographed for later analysis of grass and forb composition. We completed the comprehensive vegetation analysis for the Houston property sites for 2016. These sites were in the initial year of growth after restoration planting. The results showed an equal distribution of grasses and forbs within the plots. The quantitative breakdown by vegetation types per area of ground was as follows:

#### Percent of Total Plot Area

C4 grasses - 11%

C3 grasses - < 1%

Forbs - 11.5%

Unoccupied ground - 77.2%

In late summer 2017, the same plot was digitally photographed. Preliminary analysis of these photos shows an expansion of native forb species along with an extensive assortment of invasive (weedy) forb species. The grass segment of the vegetation lagged considerably behind the expansion of forb species as a percent of occupied ground. In contrast, the grass species occupied the established prairie sites

- e) Pollinator ecology (Becky Andres): Bees were collected in the restoration area are brought to the lab for identification. Those samples are still being processed.
- f) GIS and Geodatabase Development (Dave Kramar = new hire who replaced Kirk Stueve)

#### *GPS Data Collection and GIS Data Collection:*

During the spring, summer, and fall of 2017 GPS data were collected for numerous different projects currently supporting the larger Prairie Restoration project. Data collection was conducted using a Trimble Geo7x Mapping Grade GPS unit with the Terra Sync software, and a desktop deployment of Pathfinder Office for post-processing needs. Data were collected in a manner to reduce overall Position Dilution of Precision (PDOP) error and locations were averaged over the course of a minute or two.

Data were collected for the following projects:

- Small Mammal Trap Site and Transect locations.

- Nutrient Network Site locations.
- Several trails as requested by the Director of the Regional Science Center.

In addition, we set up a Trimble M3 Total Station and surveyed the entirety of one of the Nutrient Network sites. In addition to the collection of GPS data, we have also been collecting and archiving readily available GIS data from online sources such as the USDA Geospatial Data Clearinghouse, and the Clay County data access portals. In addition to participating in the data collection efforts, faculty and staff with the Center for Geospatial Studies have worked with the various teams and have provided technical support as needed for GIS.

*Geodatabase Development:*

Over the course of the spring, summer, and fall of 2017 we deployed and configured an Enterprise ArcGIS Server and Portal instance to facilitate data-sharing of the Regional Science Center GIS data. We have identified and cataloged approximately 15 GB of both newly collected data, and historical data as it relates to the MSUM Regional Science Center and the ongoing prairie restoration efforts supported under LCCMR.

Specifically, each feature class has been associated with a larger feature dataset based on commonalities within the data subject. In addition, we have isolated which coordinate systems are associated with which data sets and have initiated the use of a standardized projection and coordinate system based of the Universal Transverse Mercator (UTM) projection. Moving forward ALL data will be stored in the common projection.

The centralized geodatabase is housed in a PostgreSQL database instance and is currently available on the MSUM internal network. Faculty associated with the Center for Geospatial Studies have worked towards both an online delivery system for the LCCMR data, as well as the ability to directly connect to the geodatabase to facilitate data editing and updating, as well as data download. The online delivery system will operate like an ArcGIS REST endpoint and facilitate data sharing, whereas the direct connection will be used by data administrators to add new and update existing datasets. It should be noted that access to a direct database connection will be managed by the geodatabase administrator, and access will be granted using a Centralized Authentication System (CAS).

We are currently in the process of developing Python scripts to automate the projection/coordinate conversion tasks. We are also currently in the process of finalizing the geodatabase schema and beginning the migration of the currently available geospatial data into the geodatabase feature class format.

Additional work between January 2018 and July 1 2018:

Faculty and their student teams have been active in continuing the projects of the past three years.

Monitoring of small mammals:

We had posters at the MN chapter of TWS in Feb 2018, posters and talks at SAC, and DNR report for our permit - see references below and attachments. Also - students trapped the RSC Golf Course about 2 weeks ago, and they are currently trapping Houston. I am also presenting a poster at the National TWS meeting in Cleveland in October. Tiffany Grieger and Breanna Huynh also did some small mammal work with game cameras on the NUTNET project plots.

Grieger, Tiffany A., Breanna N. Huynh, Alison M. Wallace, and Donna M. Bruns Stockrahm. 2018. Small mammal occurrences captured by game cameras in fertilized versus unfertilized grassland plots. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society, St. Cloud, MN, on 12-14 February 2018.

Huynh, Breanna N., Grieger, Tiffany A., Alison M. Wallace, and Donna M. Bruns Stockrahm. 2018. Small mammal occurrences captured by game cameras in fertilized versus unfertilized grassland plots. Poster

presented at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.

Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society, St. Cloud, MN, on 12-14 February 2018.

Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Oral presentation by Sarah S. Sanderson and Miranda J. Sater at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.

Stockrahm, Donna M. Bruns, Sarah S. Sanderson, Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Early stages of restoration of a western tallgrass prairie in Clay County, Minnesota: impacts on small mammals. Poster abstract submitted for the Annual Meeting of the National Chapter of The Wildlife Society, TWS Meeting in Cleveland, Ohio, on 7-11 October 2018; Abstract submitted on 22 April 2018.

Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society, St. Cloud, MN, on 12-14 February 2018.

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Stockrahm, Donna M. Bruns, Sarah S. Sanderson, Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Early stages of restoration of a western tallgrass prairie in Clay County, Minnesota: impacts on small mammals. Poster abstract submitted for the Annual Meeting of the National Chapter of The Wildlife Society, TWS Meeting in Cleveland, Ohio, on 7-11 October 2018; Abstract submitted on 22 April 2018.

Stockrahm, Donna M. Bruns, and Sarah S. Sanderson. 2018. Report to the Minnesota Department of Natural Resources for Special Permit No. 22746 (for 2017 Data) for live-trapping small mammals and squirrels. Unpublished, pp. 1-7. Submitted 29 January 2018.

The Nutrient Network project is active with a team of students working under Dr. Alison Wallace.

Implementation of the GIS Database has made significant progress in the past six months.

- 1) Draft of a Prairie Restoration Story Map for public distribution, detailing the project and its components.
- 2) Continued work on customized GIS database
- 3) Analysis of archaeological resources using analytic capabilities of the GIS
- 4) Drone flights and vegetative analysis of images from nutrient network sites
- 5) Field based curricula developed and implemented as part of the Archaeological Field School as listed in the work plan.

**Project Status as of January 1 2019:**

Deliverables continue to occur based on the momentum created during the 2015-2018 period:

1. Document year-to-year compositional changes of C4 versus C3 grass species each year of the 5-year MN ENRTF-MSUM Science Center prairie restoration project.

In late August, we performed annual surveys for C3 and C4 grass composition in three of our 6 x 6 meter study plots. Each of these plots was digitally photographed as in previous years. As these surveys represent the end of the third growing season of the restoration process, significant observations are beginning to emerge with respect to the succession dynamics of the plots undergoing restoration. Foremost among these is the contrast in succession outcomes between the north and south sites within the area referred to as the Houston property. In the first growing season following the seeding, we documented that both sites had the same initial composition of emergent grass and forb species, with the sown C4 grasses abundantly more represented than C3 grasses. By year three, the south site was largely dominated by C4 grasses and began to resemble the restored TNC Bluestem Prairie S. site also included in this year's survey. In stark contrast, the north site was a largely dominated by non-native C3-grasses, indicative of a failure in the restoration effort. The primary difference between the two sites is topography and sand content of the soil. The north site is located on flat, poorly drained terrain, qualifying this site as a mesic or semi-wet prairie. The south site is located on high sloping ground and is well-drained. Additionally, the soil of the south site has a higher sand content qualifying this site as a dry or xeric prairie. Other interesting annual successional changes such as increase and then decline in forb species also been observed within the plots. The descriptions for the species content in the plots as evident in the plot photographs is summarized in the following table:

	Year 1	Year 2	Year 3
Houston South Site  (xeric site)	emergent C4 grasses, few C3-grasses	primarily C4 grasses – but none maturing into flowering stage. Plot equally dominated by native forbs; few if any C3 grasses.	high density of C4 grasses – all maturing into flowering stage; Little Bluestem dominant C4; Forb content much reduced; No C3 grasses evident.
Houston North Site  (mesic site)	emergent C4 grasses, few C3-grasses	primarily C3 grass dominated; C4 grasses evident but none maturing into flowering stage	high density of non-native C3 grasses (Poa and Brome); C4 grasses are minimal with <i>A. gerardii</i> sparse
TNC Restored Prairie South Site  (xeric site)	flora typical of established native dry prairie: dominated by C4 grasses (5 species identified) with Little Bluestem dominant. C3 grasses present including non-native Poa and native Porcupine Grass.	Flora composition and species density nearly identical from year 1 through 3	

These new observations lead us to the following hypothesis: Re-colonizing former tall-grass prairie with native C4 grasses is favored by xeric conditions, i.e., conditions that favor the physiology of C4 species over non-native C3 species.

In subsequent years of the restoration project, we will test this hypothesis by accumulating more detailed data in terms of C4 vs C3 species composition and density of these plots.

2. Update of Current UAS Work at the Minnesota State University Regional Science Center

UAS data collection efforts for 2018 began the second week of May 2018 and continued every two weeks until the end of September 2018. The two locations that we collected UAS data at are part of the LCCMR Prairie restoration efforts, and are also associated with the Nutrient Network. The imagery was collected at 70' altitude and corresponds to 0.25" ground sampling distance (0.25" pixel resolution). Aerial imagery was "anchored" using 9 ground control points (GCPs) marked in the center to +/- 1cm. GCP locations were collected using a Trimble Geo7x and the resulting data post-processed and differentially corrected.

The UAS platforms consisted of two DJI Phantom 4 Advanced drones. Secondary to LCCMR, but important to the researchers we utilized two different mission planning platforms and flew both sites twice on each visit. This will allow us to compare how the mission planning software platforms manage the required sidelap and endlap of the images that is required for creating a seamless mosaic. This also provides redundancy in the data collection efforts.

The resulting imagery was processed using Pix4D and represents vegetation growth from the second week of May until the end of September. We have applied several non-nir vegetation indices (some standard, and some created/modified) to compare their applicability in monitoring healthy versus unhealthy and native versus non-native vegetation within the two sites. In addition, we are currently exploring the use of these indices to calculate total-above-ground biomass (TAGB), and assess the sensitivity of the non-nir vegetation indices to subtle differences between vegetation species, using phenology as a way to differentiate native versus non-native.

Preliminary results from this work is being presented at the 2019 Association of American Geographers conference in Washington DC this April.

### 3. Soil microbial ecology project

January 2019 update

In the 2018 field season, we focused our sampling on the sites currently undergoing restoration. We're currently in the process of analyzing the DNA sequencing data with associated geospatial data.

We hosted one public outreach event in coordination with the Buffalo River State Park Naturalist, Paula Comeau. One of the research students, Allison Raddatz, took the lead for the event and did a great job engaging the audience. More than 20 people attended the 2.5 hour event, including a girl scout troop full of very curious and engaged girls!

One of our goals for this overall project is to incorporate the research and monitoring into our undergraduate courses. In light of this goal, I have been working to build a genuine research experience into our Biol 341 (Genetics) course. This serves dual purposes in being able to continue the monitoring of soil bacterial communities into the future, and to give students genuine field and lab skills associated with applications of molecular genetics. I have experimented with different DNA sequencing platforms and bioinformatics approaches over the past three years, and while there was a shortage of appropriate tools at the beginning of this study, the development of educational tools has started to catch up to the broader scientific community. I have developed and/or implemented different approaches that each have varying cost, time requirements, and skill levels. I presented the classroom efforts for this research project at the 2018 North Central Branch meeting of the American Society for Microbiology.

Anderson, Sara J and Michelle Tigges. Oxford Nanopore Sequencing in the Undergraduate Classroom. September 2018. North Central Branch meeting of ASM.

### 4. Small mammal census

Huynh, Breanna N., Grieger, Tiffany A., Alison M. Wallace, and Donna M. Bruns Stockrahm. 2018. Small mammal occurrences captured by game cameras in fertilized versus unfertilized grassland plots. Poster presented at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.

- Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society, St. Cloud, MN, on 12-14 February 2018.
- Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Oral presentation by Sarah S. Sanderson and Miranda J. Sater at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.
- Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society, St. Cloud, MN, on 12-14 February 2018.
- Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Oral presentation by Sarah S. Sanderson and Miranda J. Sater at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.
- Stockrahm, Donna M. Bruns, Sarah S. Sanderson, Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Early stages of restoration of a western tallgrass prairie in Clay County, Minnesota: impacts on small mammals. Poster abstract submitted for the Annual Meeting of the National Chapter of The Wildlife Society, TWS Meeting in Cleveland, Ohio, on 7-11 October 2018; Abstract submitted on 22 April 2018.
- Stockrahm, Donna M. Bruns, and Sarah S. Sanderson. 2018. Report to the Minnesota Department of Natural Resources for Special Permit No. 22746 (for 2017 Data) for live-trapping small mammals and squirrels. Unpublished, pp. 1-7. Submitted 29 January 2018.
- Stockrahm, Donna M. Bruns. 2019. Report to the Minnesota Department of Natural Resources for Special Permit No. 23530 (for 2018 Data) for live-trapping small mammals and squirrels. Unpublished, pp. 1-6. Submitted 25 January 2019.

### **Activity Status as of January 1, 2020**

Continued progress related to activity 2

Small mammal population monitoring:

Stockrahm, DS, et al. 2019. Report for Special Permit No. 28446 (for 2019 Data) and Request for Permit Renewal for 2020. Methods for Live-trapping at the Minnesota State University Moorhead (MSUM) Regional Science Center (RSC) near Glyndon, MN (for Restoration Study)

Nutrient network:

We established a second Nutrient Network site on the Houston property restoration and collected baseline data for it during the 2019 season. We designed an educational activity using the NutNet sites and incorporated it into an Organismal Biology lab (so 166 students experienced it).

GIS mapping:

Continued work on the serial imagery acquisition for use in monitoring and mapping the restoration efforts.

### **Activity Status as of July 1, 2020**

Covid-19 notwithstanding, faculty-mentored monitoring continues at the site. The nutrient network project was active this spring. Other faculty decided to suspend their field activities this spring.

### **Final Report Summary:**

Faculty and their students at MSUM have developed and implemented protocols for measuring the transition from altered landscape to restored prairie. These protocols will be described and disseminated in the near future as part of activity 3, below. This activity has been enormously impactful on the professional activities of participating faculty, and introduced multiple cohorts of students to experience in restoration ecology.

### **ACTIVITY 3: Interpretation of restoration project**

**Description:** Project data will serve as a guide for ongoing restoration efforts and provide broader state-wide impact as a case study for future restoration projects elsewhere. Our results and curricular protocols appropriate at the undergraduate level will be published in peer-reviewed journals in restoration ecology and education. Example target journals include, but are not limited to: *Biological Conservation*, *Conservation Biology*, *Bioscience*, *Ecological Applications*, *Journal of Applied Ecology*, *Environmental Monitoring and Assessment*, *The American Biology Teacher*, *International Journal of Science Education*, and *the Journal of Biological Education*. Brian Wisenden, as project manager, and also as author and co-author of 76 peer-reviewed scientific publications and book chapters, and serves as managing editor of the international peer-reviewed journal *Behaviour*, will lead this effort.

Site specific interpretive signage consistent with MSUM and MN DNR signage guidelines will educate and inform the reader of complexities related to restoration ecology. Signage will also acknowledge Minnesota's commitment to protect, conserve, preserve, and enhance Minnesota's "air, water, land, fish, wildlife, and other natural resources" for the benefit of current citizens and future generations as per the Environment and Natural Resources Trust Fund mission.

The Science Center will host monthly public "field day" programs that involve visitors in the restoration process by collecting native seed, monitoring plant phenology, assisting with plant surveys and helping to remove and control noxious plants. These programs will engage visitors side by side with our science faculty and undergraduate students to gain firsthand experience working through the intricacies of field work related to ecological restoration and monitoring.

Third grade students attending the Center's K-12 science programming (~600 annually) will participate in restoration activities by collecting native seed during a fall visit. Students will grow selected native seedlings in their classroom through the winter months that will be transplanted in restoration plots the following spring visit.

Design work on initial signage will begin July of 2015 with fabrication and installation in April 2016. Signage updates will occur each summer with necessary updated signage installed in April of 2017 and 2018. Public field day programs will begin in August 2015 and occur monthly through October 2015. Subsequent field day programs will be held monthly from May through October in 2016, 2017 and May through June of 2018. Third grade seed collection and planting activities will occur during the 2015/2016, 2016/2017 and 2017/2018 academic school years.

Signage design and cost will be \$1500 the first year and \$600 during years 2 & 3. Science Center will pay this cost. Public field day programming cost: The student salary/mileage related to activity 3 will be spread out over the field day activities. Third grade seed collection and planting activities will be incorporated into the center's on-going science education programming. Program development and implementation cost will be covered by Science Center.

Our only budget request for Activity 3 is one month salary per summer for the project manager and 2 student interns and mileage for assistance in signage and other aspects of project maintenance.

**Summary Budget Information for Activity 3:**

**ENRTF Budget: \$40,380**  
**Amount Spent: \$38,329**  
**Balance: \$2,051**

<b>Outcome</b>	<b>Completion Date</b>
1. Signage installed and public programming delivered	October, 2016
2. Citizen monitoring and seedling program established	October, 2016
3. Project management, publication of manuscripts	October, 2018

**Project Status as of January 1 2016:**

**Signage:**

Interpretive staff identified 3 locations for long-term signage that will highlight the project and educate the general public about ecological restoration. Pre-restoration “Before” photos are being collected for use in signage. MSUM Marketing and Communications department has been brought into the planning process to provide support. Buffalo River State Park’s Interpretive Naturalist was consulted and will be included in the design and updating portions of the signage. A cost center and funds have been identified to pay for cost of sign fabrication. Installation of signage in spring of 2016 is on the project calendar of the MSUM physical plant.

**Citizen monitoring and other public programs:**

A total of 11 public programs were presented highlighting the project during the period of July 4, 2015 – October 10, 2015. Total attendance at these events was 244 people, for an average of 22 people attending each event. Topics included: pollinators, native grasses, archaeology, seed collecting and project awareness. Presenters included MSUM staff, faculty, students and DNR Buffalo River State Park Naturalist. In addition, 709 school children attended K-12 programs over 16 events with an average of 44 per visit from July – October. Students spent the day learning about the prairie including collecting native prairie seeds for restoration use.

In sum, there have been already 46 public events hosted at the MSUM Regional Science Center attended by 1,543 people that incorporated the restoration project in some capacity:

- 10 public events, 244 people, average of 24 people per event
- 16 K-12 events, 709 people, average of 44 people per event
- 20 university class visits, 590 people, average of 30 people per event

Publications: None to date.

**Project Status as of July 1 2016:**

Interpretive signage is installed or being fabricated for installation. The University’s Marketing & Communications office is developing a web presence to promote and report on the restoration activities. This web presence is expected to go live by end of summer 2016.

**Citizen monitoring and other public programs:**

A total of 9 public programs were presented highlighting the project during the period of January 1, 2016 – June 30, 2016. Total attendance at these events was 430 people, for an average of 47 people attending each event. Topics included: pollinators, native grasses, archeology, seed collecting and project awareness. Presenters included MSUM staff, faculty, students and DNR Buffalo River State Park Naturalist. In addition, 670 school children attended K-12 programs over 14 events with an average of 47 per visit from January - June. Students spent the day learning about the prairie including collecting native prairie seeds for restoration use.

Publications: none to date.

**Project Status as of January 1, 2017:**

Interpretive signage is being updated to reflect additional work done during the second half of 2016. This will be re-installed by April 2017 for the 2017 field and program season.

**Citizen monitoring and other public programs:**

A total of 10 public programs were presented highlighting the project during the period of July 1, 2016 – December 31, 2016. Total attendance at these events was 105 people, for an average of 10 people attending each event. Topics included: pollinators, native plants, archeology, seed collecting and project awareness. Presenters included MSUM staff, faculty, students and DNR Buffalo River State Park Naturalist. In addition, 1852 school children attended K-12 programs over 30 events with an average of 61 per visit from July - December. Students spent their time learning about the prairie, native habitats and included collecting native prairie seeds for restoration use.

Publications: None to date.

**Project Status as of July 1 2017:**

**Signage:**

Interpretive signage continues to be updated as the project moves forward. Additional efforts to interpret the project will include the use of story maps using GIS software.

**Citizen monitoring and other public programs:**

Thirteen public programs were presented highlighting the project during the period of January 1, 2017 – June 30, 2017. Total attendance at these events was 481 people, for an average of 37 people attending each event. Topics included pollinators, native grasses, archeology, seed collecting and project awareness. Presenters included MSUM staff, faculty, students and DNR Buffalo River State Park Naturalist. In addition, 935 schoolchildren attended PreK-12 programs over 26 events with an average of 35 per visit from January - June. Students spent time learning about the prairie, including collecting native prairie seeds for restoration use.

Publications: None to date.

**Project Status as of January 1, 2018:**

Interpretive signage continues to be updated as the project moves forward. Additional efforts to interpret the project will include the use of story maps using GIS software.

**Citizen monitoring and other public programs:**

Twenty-five public programs were presented highlighting the project during the period of July 1 – December 31, 2017. Total attendance at these events was 719 people, for an average of 28 people attending each event. Topics included pollinators, native grasses, archeology, seed collecting and project awareness. Presenters included MSUM staff, faculty, students and DNR Buffalo River State Park Naturalist. In addition, 1767 schoolchildren attended PreK-12 programs over 32 events with an average of 55 per visit from July through December. Students spent time learning about the prairie, including collecting native prairie seeds for restoration use.

Publications: none to date

**Project Status as of July 1 2018:**

**Signage:**

On-site and campus interpretive signage continues to be updated as the project moves forward. Story maps using GIS software to interpret the project are under development.

Citizen monitoring and other public programs:

Fourteen public programs were presented highlighting the project during the period of Jan 1 – June 30, 2018. Total attendance at these events was 1170 people, for an average of 83 people attending each event. Topics included habitat conservation, pollinators, plants and project awareness. Presenters included MSUM staff, faculty, students and DNR SNA/Buffalo River State Park Naturalist. In addition, 1125 schoolchildren attended PreK-12 programs over 19 events with an average of 59 per visit from January through June. Students spent time learning about prairie and habitat conservation.

**Project Status as of January 1, 2019:**

Signage:

Interpretive signage continues to be updated as the project moves forward.

Citizen monitoring and other public programs:

Twenty-six public programs were presented highlighting the project during the period of July 1 – December 31, 2018. Total attendance at these events was 873 people, for an average of 33 people attending each event. Topics included pollinators, native grasses, archeology, seed collecting and project awareness. Presenters included MSUM staff, faculty, students and DNR Buffalo River State Park Naturalist.

In addition, 1940 schoolchildren attended PreK-12 programs over 41 events with an average of 47 per visit from July through December. Students spent time learning about the prairie, including collecting native prairie seeds for restoration use.

**Project Status as of July 1 2019:**

Signage:

Interpretive signage continues to be updated as the project moves forward.

Citizen monitoring and other public programs:

Fifteen public programs were presented highlighting the project during the period of Jan 1 – June 30, 2019. Total attendance at these events was ~425 people, for an average of 28 people attending each event. Topics included pollinators, native grasses, archeology, seed collecting and project awareness. Presenters included MSUM staff, faculty, students and DNR Buffalo River State Park Naturalist. Two teacher/volunteer trainings were also held with 30+ people attending.

In addition, 1325 schoolchildren attended PreK-12 programs over 29 events with an average of 45 per visit from January through June.

Students spent time learning about the prairie, including collecting native prairie seeds for restoration use.

**Project Status as of Jan 1 2020:**

Public outreach programs are a continual and permanent part of the Regional Science Center activities, which now include narrative about the prairie restoration project funded by the ENRTF.

**Final Report Summary:**

We achieved all the major objectives of the grant proposal. Interpretive signage including credit to the Environment and Natural Resources Trust Fund was installed on site and public outreach programs addressing pollinators, native grasses, archeology, seed collecting and project awareness were conducted during roughly 125 public events reaching 4,400 people and roughly 200 preK-12 school events reaching roughly 10,000 students. We had started the preparation of publications, but completion was interrupted by covid-19. We are

bound by professional ethos to complete these publications in due course. Outreach activities were canceled this spring due to covid-19.

## V. DISSEMINATION:

### Description:

The assessment protocols, results of monitoring, ongoing conclusions from the evolving long-term data and the pedagogical benefits of experiential learning will be published in the aforementioned journals.

The results of this project will be presented at academic meetings specializing in each faculty member's area of expertise in addition to local and national meetings for resource management agencies. We will also make our data publicly available on a web site, complete with GIS reference points and links to various reports.

### Project Status as of January 1 2016:

We have already had two poster presentations about the restoration project.

Anderson S. 2015. Restoration of native habitats at the regional science center. Poster presentation at GIS Day, November 18, 2015, Minnesota State University Moorhead.

Lindstrom JM, Bordak AM, Teige EC, Stockrahm DMB. 2016. Starting an LCCMR prairie restoration grant: Monitoring small mammals. Poster presentation at the Wildlife Society Meeting, February 9-22, Mankato, MN.

### Project Status as of July 1 2016:

Poster presentations by undergraduates at the MSUM Student Academic Conference on April 21, 2016, and the Showcase at the MSUM regional Science Center on April 21, 2016:

Jessica Lindstrom, Annika Bordak and Elisabeth Teige: *Starting an LCCMR Prairie Restoration Grant: Monitoring of Small Mammals* Advisor: Donna Stockrahm

Marissa Reeves and Stacy Peterson: *Elucidating local bee species diversity using DNA barcoding in Clay County* Advisors: Sara Anderson and Rebecca Andres

Vincent Anani and Nancy Castro Borjas: *From Golf Course to Prairie: initial assessment of local microbiomes in restoration areas* Advisor: Sara Anderson

Marissa Reeves and Philip Larson: *Assessing bee species diversity in local grassland ecosystems in order to determine conservation status* Advisor: Rebecca Andres

Kelley Larson, Emily Bushaw, Hayley Hilfer and Tiffany Grieger: *From Golf Course to Prairie: The Effects of Chemical Carryover on Plant Growth* Advisor: Alison Wallace

Hayley Hilfer, Trevor Harder, Taylor Jensen and Michael Holtan: *Plants vs. Poison: Will chemical carryover affect the success of an ecological restoration of a former golf course to prairie?* Advisor: Alison Wallace

Annika Bordak: *Prairie Restoration Butterfly Survey: A Pilot Study* Advisor: Rebecca Andres

Loida Guajardo: *Development of a biomarker for use in identifying C4 grasses in a Tall Grass Prairie restoration project* Advisor: Chris Chastain

Poster presentation at the National Meeting of the American Society of Mammalogists:

Stockrahm DMB, Lindstrom JM, Bordak AM, Teige EC (2016). *Starting an LCCMR Prairie Restoration Grant: Monitoring Small Mammals.*

**Project Status as of January 1, 2017:**

MSUM hosted "GIS DAY" on November 16, 2016. This event featured activities of the GIS Center on campus, including work done by faculty and students at the Regional Science Center related to the ENTRF-related prairie restoration. These presentations included:

Emily Bushaw, Hayley Hilfer, Tiffany Grieger, Kelley Larson, Alison Wallace: *From golf course to prairie: the effects of chemical carryover on plant growth.*

Donna Bruns Stockrahm, Chris Chastain, Sara Anderson, Alison Wallace, Rebecca Andres, Kirk Stueve, Rinita Dalan, Brian Wisenden, Anthony Bormann, Stephanie Akhidenor, Annika Bordak, Tiffany Grieger, Loida Guajardo, Kayley Hilfer, Elias Holte, Taylor Jensen, Phil Larson, Jessica Lindstrom, Marissa Reeves, Miranda Shier, Jade Schwartz, Elisabeth Teige: *Restoration of native habitat at the Regional Science Center*

Donna Bruns Stockrahm, Jessica Lindstrom, Annika Bordak, Elisabeth Teige: *Starting an LCCMR prairie restoration grant: monitoring of small mammals*

Vincent Anani, Nancy Castro Borjas, Sara Anderson: *From golf course to prairie: initial assessment of local microbiomes in restoration areas.*

Marissa Reeves, Stacy Petersen, Rebecca Andres, Sara Anderson: *Assessing populations by DNA barcoding to monitor pollinator diversity during prairie restoration in northwestern Minnesota*

Kiersten Anderson, Elias Holte, Marissa Reeves, Sara Anderson: *Preliminary assessment of taxonomic and functional diversity of bacteria across a prairie quality gradient.*

Annika Bordak, Anthony Bormann, Gary George, Kirk Stueve: *Simulating the extent of a riparian woodland in the northern tallgrass prairie*

Carlie Peterson, Langley Bradley, Taylor Ness: *2015 MSUM Archeological Investigations of Chief Looking's Village*

**Project Status as of July 1 2017:**

Recent presentations related to research on restoration ecology at the site:

Anderson, Kristen O., Elias P. Holte, and Sara J. Anderson. Baseline assessment of restoration sites reveals soil microbial diversity does not match expectations based on pre-restoration status. Abstract accepted for August 2017 national Ecological Society of America. Portland, OR. Poster.

Higgins, Ashley and Sara J. Anderson. Prairie Grassland Microbial Soil Diversity. 2017 Student Academic Conference. Minnesota State University Moorhead. Poster.

Holte, Elias P., Kristen O. Anderson and Sara J. Anderson. Preliminary assessment of taxonomic and functional diversity of bacteria across a prairie quality gradient. 2017 Student Academic Conference. Minnesota State University Moorhead. Oral.

Teige, Elisabeth C., Sarah S. Sanderson, Jessica L. Loeffler, Miranda J. Sater, Jessica M. Lindstrom, and Donna M. Bruns Stockrahm. 2017. Impacts of early restoration processes on small mammals in a western tall grass prairie in Clay County, Minnesota. Poster at the MSUM Student Academic Conference, April 2017.

Teige, Elisabeth C., Sarah S. Sanderson, Jessica L. Loeffler, Miranda J. Sater, Jessica M. Lindstrom, and Donna M. Bruns Stockrahm. 2017. Impacts of early restoration processes on small mammals in a western tall grass prairie in Clay County, Minnesota. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society in Callaway, MN, 14-16 Feb 2017.

**Project Status as of January 1, 2018:**

In addition to the presentations listed for individual faculty activities, we had several presentations at the MSUM GIS Day in November 2017.

Stockrahm DMB, Chastain C, Wallace A, Anderson S, Andres R, Dalan R, Stueve K, Wisenden B, Bormann A, Akhidenor S, Bordak A, Grieger T, Guajardo L, Hilfer H, Holte E, Jennson L, Larson P, Lindstrom J, Reeves M (2017) Restoration of Native Habitats at the Regional Science Center. Poster presentation at the MSUM GIS Day Nov 15, 2017.

Ahumada D, Mugavero D, Olowoshile A, Leonard K, Holley G (2017) The Development of the Landscape at the MSUM Regional Science Center and its Influence on the Occupation of Indigenous Peoples: Interpreted from Lake Agassiz Shoreline and Recent Deposits. Poster presentation at the MSUM GIS Day Nov 15, 2017.

Teige EL, Sanderson SS, Loeffler JL, Satler MJ, Lindstrom JM, Stockrahm DMB (2017) Impacts of early restoration processes on small mammals in a Western tall grass prairie in Clay County, Minnesota. Poster presentation at the MSUM GIS Day Nov 15, 2017.

Geister-Jones M, Hilfer H, Wallace A (2017) Minnesota State University Moorhead Nutrient Network: A Global Research Cooperative. Poster presentation at the MSUM GIS Day Nov 15, 2017.

Anderson, KO, Holte EP, Anderson SJ (2017) Baseline Assessment of Restoration Sites Reveals Soil Microbial Diversity does not Match Expectations based on Pre-restoration Status. Poster presentation at the MSUM GIS Day Nov 15, 2017.

**Project Status as of July 1 2018:**

Faculty and their students have been active in disseminating the results of their research on prairie restoration, as described in "activities between January 2018 and July 2018". We are currently sketching out the frameworks to being to disseminate the results from this project in the peer-reviewed literature.

**Project Status as of January 1, 2019:**

There have been many posters at local and regional meeting about the work.

Blocks of time needed for writing will not be available until the end of the spring semester in May.

**Project Status as of July 1 2019:**

Preliminary planning has begun for strategies for disseminating the results of this project. In addition to individual manuscripts based on research data, collectively we plan to produce a paper on the role of interdisciplinary collaborations to achieve the goals of ecosystem conservation and restoration, for publication in a journal of conservation biology. We also are planning a second paper on our pedagogical approach of using the restoration project as a permanent component of our undergraduate curriculum, complete with assessment of student learning outcomes.

**Project Status as of Jan 1 2020:**

Individual project participants continue to produce posters, abstracts and presentations on activity related to the restoration project. "GIS day", now an annual event each November on MSUM campus thanks in large part to the ENRTF-funded restoration project, prominently featured several of the research projects associated with this grant. Faculty involved in this project are making the preparation of manuscripts to disseminate the results of the project – both scientific and pedagogical – a priority for the final phase of the project period.

#### **Final Report Summary:**

We had started the preparation of publications, but completion was interrupted by covid-19. We are bound by professional ethos to complete these publications in due course. Similarly, professional meetings where faculty might have presented their research findings were all canceled this year. These data and deliverables will occur in future years when conditions allow it.

Dissemination of project outcomes have been those presented by project faculty and their research groups at meetings of their respective professional communities in geosciences, ecology and management conferences. Here is the list of presentations:

Hilfer H, Akhidenor S, Kovacevic A, Schanz J. 2017. Grassland ecology investigations of baseline monitoring data. Poser presentation at the MSUM Student Academic Conference, April 2017.

Geister-Jones G (2017) MSUM Nutrient Network. Poser presentation at the MSUM Student Academic Conference, April 2017

Hilfer H, Kovacevic A, Huynh B, Grieger T, LaFromboise J (2017) The Nutrient Network at MSUM. Oral presentation at the Friday Research Exploration and Education, November 2017.

Grieger, Tiffany A., Breanna N. Huynh, Alison M. Wallace, and Donna M. Bruns Stockrahm. 2018. Small mammal occurrences captured by game cameras in fertilized versus unfertilized grassland plots. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society, St. Cloud, MN, on 12-14 February 2018.

Huynh, Breanna N., Grieger, Tiffany A., Alison M. Wallace, and Donna M. Bruns Stockrahm. 2018. Small mammal occurrences captured by game cameras in fertilized versus unfertilized grassland plots. Poster presented at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.

Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society, St. Cloud, MN, on 12-14 February 2018.

Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Oral presentation by Sarah S. Sanderson and Miranda J. Sater at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.

Stockrahm, Donna M. Bruns, Sarah S. Sanderson, Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Early stages of restoration of a western tallgrass prairie in Clay County, Minnesota: impacts on small mammals. Poster abstract

submitted for the Annual Meeting of the National Chapter of The Wildlife Society, TWS Meeting in Cleveland, Ohio, on 7-11 October 2018; Abstract submitted on 22 April 2018.

- Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Poster presented at the Annual Meeting of the Minnesota Chapter of The Wildlife Society, St. Cloud, MN, on 12-14 February 2018.
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- Stockrahm, Donna M. Bruns, Sarah S. Sanderson, Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Early stages of restoration of a western tallgrass prairie in Clay County, Minnesota: impacts on small mammals. Poster abstract submitted for the Annual Meeting of the National Chapter of The Wildlife Society, TWS Meeting in Cleveland, Ohio, on 7-11 October 2018; Abstract submitted on 22 April 2018.
- Stockrahm, Donna M. Bruns, and Sarah S. Sanderson. 2018. Report to the Minnesota Department of Natural Resources for Special Permit No. 22746 (for 2017 Data) for live-trapping small mammals and squirrels. Unpublished, pp. 1-7. Submitted 29 January 2018.
- Anderson, Sara J and Michelle Tigges. Oxford Nanopore Sequencing in the Undergraduate Classroom. September 2018. North Central Branch meeting of ASM.
- Huynh, Breanna N., Grieger, Tiffany A., Alison M. Wallace, and Donna M. Bruns Stockrahm. 2018. Small mammal occurrences captured by game cameras in fertilized versus unfertilized grassland plots. Poster presented at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.
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Sanderson, Sarah S., Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Impacts of third-year restoration processes on small mammals in a western tallgrass prairie in Clay County, Minnesota. Oral presentation by Sarah S. Sanderson and Miranda J. Sater at the Minnesota State University Moorhead Andrew B. Conteh Student Academic Conference on 17 April 2018.

Stockrahm, Donna M. Bruns, Sarah S. Sanderson, Miranda J. Sater, Rachel H. Rusten, Dylan C. Leach, Breanna N. Huynh, and Donna M. Bruns Stockrahm, M. 2018. Early stages of restoration of a western tallgrass prairie in Clay County, Minnesota: impacts on small mammals. Poster abstract submitted for the Annual Meeting of the National Chapter of The Wildlife Society, TWS Meeting in Cleveland, Ohio, on 7-11 October 2018; Abstract submitted on 22 April 2018.

Stockrahm, Donna M. Bruns, and Sarah S. Sanderson. 2018. Report to the Minnesota Department of Natural Resources for Special Permit No. 22746 (for 2017 Data) for live-trapping small mammals and squirrels. Unpublished, pp. 1-7. Submitted 29 January 2018.

Stockrahm, Donna M. Bruns. 2019. Report to the Minnesota Department of Natural Resources for Special Permit No. 23530 (for 2018 Data) for live-trapping small mammals and squirrels. Unpublished, pp. 1-6. Submitted 25 January 2019.

Stockrahm, DS, et al. 2019. Report for Special Permit No. 28446 (for 2019 Data) and Request for Permit Renewal for 2020. Methods for Live-trapping at the Minnesota State University Moorhead (MSUM) Regional Science Center (RSC) near Glyndon, MN (for Restoration Study)

- 2. How has information from your project been used and/or disseminated? Please reference and attach any documents, resources, or tools that were created as a result of this project that should be shared with the public, members and resource managers.*

Dissemination of overall project description, outcomes and application to undergraduate pedagogy is forthcoming. Plans for final paper preparation were delayed by the covid-19 pandemic.

**VI. PROJECT BUDGET SUMMARY:**

**A. ENRTF Budget Overview:**

<b>Budget Category</b>	<b>\$ Amount</b>	<b>Overview Explanation</b>
Personnel:	\$ 282,360	All faculty at MSUM are on 9-month appointments. Summer salary requests are calculated for 20 days (=160 hours = 0.0769 FTE) per summer. George Holley: \$9,180 x 1 = \$9,180; Kirk Stueve: \$7,080 x 3 summers = \$21,240; Rinita Dalan \$9,400 x 3 summers = \$28,200; Sara Anderson \$7,080 x 3 summers = \$21,240; Chris Chastain \$9,400 x 3 summers = \$28,200; Alison Wallace \$9,180 x 3 summers = \$27,540; Brian Wisenden \$9,180 x 3 summers = \$27,540; Project Manager (Wisenden) \$9,180 x 3 summers = \$27,540; Donna Stockrahm \$11,360 x 3 summers = \$34,080;  9 student interns for 3 years and 3 interns for 1 year: 10 x \$12/h x 40h/wk x 4 wk/yr x 3 yr = \$57,600
Professional/Technical/Service Contracts:	\$240,240	\$231,240 to Cindy Lueth, Department of Natural Resources Parks & Trails. This cost includes all equipment, seed and personnel costs. Specific activities: Woody stem removal, herbicide, burns: \$59,240 Prairie seed harvest, cleaning, planting: \$60,000 Weed control, mowing, prescribed burn: \$66,000 Plant trees, deer protection, add herbs: \$17,000  \$3000/yr x 3 yrs = \$9000 for genetic sequencing services needed for analysis of soil metagenomics.
Travel Expenses in MN:	\$4,400	Mileage: (3 cars x 32mi x 25 trips x \$0.55/mi x 3 summers=\$3,960) + (1 car for 1 year=\$440) = \$4,400
Other:	\$0	
<b>TOTAL ENRTF BUDGET: \$527,000</b>		

**Explanation of Use of Classified Staff:** N/A

**Explanation of Capital Expenditures Greater Than \$5,000:** N/A

**Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:** 4.23

**Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:** 0

**B. Other Funds:**

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
<b>Non-state:</b>	0	0	
<b>State</b>			
MSUM	\$250,000 in-kind	\$250,000	Club house removal, salaries for Anthony Bormann and research faculty during the academic year, MSUM research facilities
<b>TOTAL OTHER FUNDS:</b>	<b>\$250,000</b>	<b>\$250,000</b>	

**VII. PROJECT STRATEGY:**

**A. Project Partners:**

Cindy Lueth, MN DNR Parks and Trails, will oversee the restoration;

Not receiving funds

Sue Galatowitsch, University of Minnesota has/will continue to provide consultation for the monitoring effort; Dan McEwen, Biosciences MSUM will assist with data analysis, and include restoration ecology in his course in *Principles of Ecology and Evolution* during the academic year

Receiving funds:

- George Holley: Archeologist, to conduct archeological survey of areas to be restored
- Kirk Stueve: GIS expert, to develop and maintain GIS database for monitoring data
- Rinita Dalan: Geoarcheologist, to incorporate archeological data into the GIS layer, build interactive maps, develop iPad app for data entry
- Sara Anderson: Landscape geneticist, to design and research changes in soil microbial communities in response to restoration
- Chris Chastain: Plant Physiologist, to design and research environmental physiology of C3 and C4 plant photosynthesis in response to restoration
- Donna Stockrahm: mammalogist, the design and research effects of resotration on small mammal communities
- Alison Wallace: Plant Ecologist, to design and research seed viability in response to storage conditions
- Brian Wisenden: Behavioral Ecologist, the design and research plant-pollinator interactions in response to restoration; also serves as overall project manager

**B. Project Impact and Long-term Strategy:**

Prairie habitat once covered one third of Minnesota but now only 2% of that natural heritage remains intact. These natural areas provide ecological services and habitat for rare and endangered species that depend on prairie habitat. The Minnesota Prairie Conservation Plan (2011) outlined urgent strategies to protect existing remnant prairie and to acquire land to restore it to its original condition. In that report, the Lake Agassiz beach ridge was identified as one of priority areas where conservation efforts should be focused. Property owned by Minnesota State University Moorhead (100 acres) and the MSUM Alumni Foundation (60 acres) is in this focus area. One of the reasons why this area is of great ecological value is that it connects to existing remnant prairie in Buffalo River State Park (DNR) and the Bluestem Scientific and Natural Area (TNC). The proposed project will restore these 160 acres to 143 acres of mesic prairie habitat and 17 acres of terrace forest habitat. Upon approval of funding for this project, the Alumni Foundation will transfer ownership of their parcel of land to the University. Thus, one significant impact of this project is to acquire land, protect it, and restore it to natural prairie habitat. Because the MSUM land is adjacent to DNR and TNC land, this restoration effort will indirectly contribute to the value and ecosystem stability of lands managed by DNR and TNC. Large patches of habitat are inherently more diverse and resistant to local extirpation than small patches of habitat. The second and third activities described in this proposal will develop and disseminate protocols for assessing and monitoring the fate of restored lands relative to reference sites in nearby remnant habitat. The fate of restoration projects is

generally poorly known. This project will fill this gap with protocols in several important aspects of ecosystem health using undergraduates. This not only provides a rich educational experiences for generations of our students, the methods we develop will be easily replicated elsewhere because they will be designed to be conducted by anyone with only one or two years of college. Thus, this project will impact the field of restoration ecology in general. The protocols developed here will be easily adopted, adapted and applied in many restoration projects.

The long term strategy is to 1) create a functioning prairie ecosystem, 2) provide hands-on experiential learning opportunities for MSUM students, 3) coordinate and link with other agencies engaged in restoration research in the region, and 4) offer the MSUM lands as a case study in restoration monitoring and assessment. The funds for summer salary for faculty and students will initiate a new focus of research activity at the MSUM Regional Science Center and facilitate the establishment of the Center as a field station for study of restoration ecology and research on prairie ecosystem functioning on the combined lands of the Bluestem Prairie ecosystem.

**C. Funding History:**

Funding Source and Use of Funds	Funding Timeframe	\$ Amount
none		\$

**VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:**

**A. Parcel List:** see attached

**B. Acquisition/Restoration Information:**

**Restoration**

**1. Provide a statement confirming that all restoration activities completed with these funds will occur on land permanently protected by a conservation easement or public ownership.**

MSUM administration is committed to retaining the lands at the Regional Science Center in their natural state in perpetuity for the education of MSUM students, students and researchers in the region, and the general public. There are two parcels of land to be restored by funds provided by this proposal. The first parcel is a 100-acre old brome field, which is currently owned by MSUM. The second parcel is an 89-acre parcel owned by the Alumni Foundation, which will be gifted to the University upon final approval of funding of this proposal. Sixty acres of the Alumni Foundation land will be restored by funds in this proposal. MSUM is committed to long-term conservation of lands to be gifted by the Alumni Foundation.

**2. Summarize the components and expected outcomes of restoration and management plans for the parcels to be restored by your organization, how these plans are kept on file by your organization, and overall strategies for long-term plan implementation.**

Restoration: The 100-acre brome field will be restored to mesic prairie habitat. Part of this area will receive an extra forb seed mixture to enhance pollen and nectar sources for native pollinator species. The 60 acres to be restored on the parcel gifted from the Alumni Foundation contains 43 acres suitable to be restored to mesic prairie while 17 acres are suitable to be restored to terrace forest.

Management plans: Activities 2 and 3 focus on the monitoring and dissemination of protocols we will develop to assess ecosystem health and the success of the restoration effort, including informing decisions about future amelioration efforts. From the onset we will have a well-developed GIS database of the restored areas and adjacent reference sites that will be maintained by MSUM faculty in the Department of Anthropology and Earth Sciences.

**3. Describe how restoration efforts will utilize and follow the Board of Soil and Water Resources “Native Vegetation Establishment and Enhancement Guidelines” in order to ensure ecological integrity and pollinator enhancement.**

Cindy Lueth, Restoration Specialist with the DNR Parks and Trails, will oversee the restoration. She is expert in methods of prairie and forest restoration to achieve ecological integrity, including pollinator enhancement.

**4. Describe how the long-term maintenance and management needs of the parcel being restored with these funds will be met and financed into the future.**

Monitoring of restored areas will be monitored in perpetuity by undergraduates as part of the regular curriculum during the academic year. No additional financing is anticipated at this time.

**5. Describe how consideration will be given to contracting with Conservation Corps of Minnesota for any restoration activities.**

Cindy Lueth is widely recognized for her expertise in restoration ecology and uses the Conservation Corps of Minnesota when and where appropriate.

**6. Provide a statement indicating that evaluations will be completed on parcels where activities were implemented both 1) initially after activity completion and 2) three years later as a follow-up. Evaluations should analyze improvements to the parcel and whether goals have been met, identify any problems with the implementation, and identify any findings that can be used to improve implementation of future restoration efforts at the site or elsewhere.**

Evaluation will be implemented immediately after the restoration is begun, and will continue annually through ongoing incorporation of monitoring by undergraduates into the regular academic curriculum. Assessment of success of the restoration will be done by comparing ecosystem diversity with data collected concurrently from reference sites. The assessment protocols developed in our project will be disseminated through conferences and publications to inform restoration workers across the state of Minnesota and elsewhere.

**IX. VISUAL COMPONENT or MAP(S):**

We have included two maps:

- 1) The map that was included in the proposal of the region of the bluestem prairie complex showing the juxtaposed areas of Buffalo River State Park, TNC Bluestem Science and Natural Area and the MSUM Regional Science Center. Within the MSUM property the inset indicates the areas to be restored.
- 2) This map shows only the MSUM Regional Science Center land, the areas to be restored to mesic prairie and terrace forest and a dashed border denoting the boundaries of the parcel to be gifted to the University by the Alumni Foundation.

**X. RESEARCH ADDENDUM: N/A**

**XI. REPORTING REQUIREMENTS:**

**Periodic work plan status update reports will be submitted no later than** January 1 2016, July 1 2016, January 1 2017: July 1 2017, January 1 2018, July 1 2018, January 1 2019, July 1 2019, and January 1 2020.

**A final report and associated products will be submitted between June 30 and August 15, 2020.**

**Environment and Natural Resources Trust Fund  
M.L. 2015 Project Budget**



**Project Title:** Minnesota State University Moorhead Prairie and Riparian Restoration and Monitoring  
**Legal Citation:** M. L. 2015, Chp. 76, Sec. 2, Subd. 12-18  
**Project Manager:** Brian Wisenden  
**Organization:** Minnesota State University Moorhead  
**M.L. 2015 ENRTF Appropriation:** \$ 527,000  
**Project Length and Completion Date:** 5 years, June 30, 2020  
**Date of Report:** July 1, 2020

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
<b>BUDGET ITEM</b>	<b>Restoration and Archeological Survey</b>			<b>Develop and apply monitoring protocols</b>			<b>Interpretation of restoration project</b>				
<b>Personnel (Wages and Benefits)</b>	\$14,940	\$14,940	\$0	\$228,360	\$228,360	\$0	\$39,060	\$38,329	\$731	\$282,360	\$731
George Holley, conduct archeological survey, 20 days summer salary \$9,180 (86.35% salary, 13.65% benefits); 7.7% FTE											
3 student interns to assist in archeological survey @ \$12/h x 40h/wk x 4 wk = \$5,760 (100% salary)											
Kirk Stueve, will design, create and manage GIS database, 20 days summer salary \$7,080 (86.35% salary, 13.65% benefits); 7.7% FTE X 3 summers = \$21,240											
Rinita Dalan, integrate GIS with archeological data, build interactive maps, mobile apps for data logging by ecologists, 20 days summer salary \$9,400 (86.35% salary, 13.65% benefits); 7.7% FTE, x 3 summers = \$28,200											
Sara Anderson, geneticist, document soil microbial diversity and community metagenomics, 20 days summer salary \$7,080 (86.35% salary, 13.65% benefits); 7.7% FTE x 3 summers = \$21,240											
Chris Chastain, monitor C3 and C4 photosynthetic plants and environmental physiology, 20 days summer salary \$9,400 (86.35% salary, 13.65% benefits); 7.7% FTE, x 3 summers = \$28,200											
Alison Wallace, plant ecologist to study seed germination, floral community structure, 20 days summer salary \$9,180 (86.35% salary, 13.65% benefits); 7.7% FTE, x 3 summers = \$27,540											
Brian Wisenden, pollinator/plant interactions, 20 days summer salary \$9,180 (86.35% salary, 13.65% benefits); 7.7% FTE x 3 summers = \$27,540											
Donna Stockrahm, mammalogist, 20 days summer salary \$11,360 (86.35% salary, 13.65% benefits); 7.7% FTE, x 3 summers = \$34,080											
Brian Wisenden, project manager, 20 days salary \$9,180 (86.35% salary, 13.65% benefits); 7.7% FTE x 3 years = \$27,540											
7 student interns @ \$12/h (100% salary) x 40h/wk x 4 wk x 3 summers											
2 student interns @ \$12/h (100% salary) x 40h/wk x 4 wk x 3 summers											
<b>Professional/Technical/Service Contracts</b>	\$231,240	\$231,240	\$0							\$231,240	\$0
Cindy Lueth, Restoration Specialist, DNR Parks and Trails											
Woody stem removal, herbicide, pile burn = \$59,240											
Prairie seed harvest/cleaning, planting = \$60,000											
Tree/shrub seed harvest & propagation = \$5,000											
Weed control, mowing, prescribed fire = \$66,000											
Buckthorn and invasive control = \$24,000											
Plant trees, deer protection, add herbs = \$17,000											
Genetic sequencer services: \$3000 x 3 summers				\$9,000	\$9,000.00	\$0				\$9,000	\$0
<b>Travel expenses in Minnesota</b>											
Mileage: (3 cars x 32mi x 25 trips x \$0.55/mi x 3 summers=\$3,960) + (1 car for 1 year=\$440) = \$4,400	\$440	\$42	\$398	\$2,640	\$869	\$1,771	\$1,320	\$0	\$1,320	\$4,400	\$3,489
<b>COLUMN TOTAL</b>	<b>\$246,620</b>	<b>\$246,222</b>	<b>\$398</b>	<b>\$240,000</b>	<b>\$238,229</b>	<b>\$1,771</b>	<b>\$40,380</b>	<b>\$38,329</b>	<b>\$2,051</b>	<b>\$527,000</b>	<b>\$4,221</b>