

2010 Project Abstract

For the Period Ending June 30, 2014

PROJECT TITLE: Reconnecting Fragmented Prairie Landscapes

PROJECT MANAGER: Steve Chaplin

AFFILIATION: The Nature Conservancy

MAILING ADDRESS: 1101 West River Parkway, Suite 200

CITY/STATE/ZIP: Minneapolis, MN, 55415-1291

PHONE: 612-331-0788

E-MAIL: schaplin@tnc.org

WEBSITE: <http://www.nature.org/wherewework/northamerica/states/Minnesota/>

FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: M.L. 2010, Chp. 362, Sec. 2, Subd. 4i and extension of funds in M.l. 2013, Chapter 52, Section 2, Subdivision 17.

APPROPRIATION AMOUNT: \$380,000

Overall Project Outcome and Results

The Minnesota Prairie Conservation Plan calls for protecting native prairie and restoring connectivity to prairie core areas using grass-based agriculture as a conservation tool. To provide information and techniques needed to meet these goals, we studied two prairie landscapes in western Minnesota: Agassiz Beach Ridges (127,000 acres) and Glacial Lakes (169,000 acres). Using GIS analysis and field survey, we developed a current land use/land cover map that revealed that even in high-quality prairie landscapes, over 25% was cropland and 31% was invasive dominated or mixed native-invasive grassland. To guide conservation activities, we identified conservation targets and specified methods for measuring progress. To rebuild functioning prairie systems, we identified all parcels containing native prairie for possible management and protection, as well as tracts that if restored, could buffer and reconnect prairie. A social analysis using interviews with local constituencies revealed support for conservation if it were tied to working grasslands that promoted rural socio-economic vitality. To facilitate needed restoration, we developed a state transition model that identified feasible restoration transitions from common “start states” (based on current land cover) to conservation and utility prairie and meadow “end states”. We developed restoration plans including techniques, seed mixes, and estimated costs for twenty transitions. To make the expansion of grass-based agriculture feasible, landowners will need assistance with the restoration costs. As land use decisions are driven not only by financial returns but also potentially by the value of ecological services, ongoing InVest modeling will highlight land use patterns where the provision of public and private benefits in future scenarios is optimized. These scenarios are designed to reflect the goals of the Prairie Plan, as well as social and economic constraints. This comprehensive approach provides resources for implementing prairie conservation in western Minnesota and could serve as a model for conservation planning elsewhere.

Project Results Use and Dissemination

The primary purpose of this project was to provide information and techniques for the implementation of the Minnesota Prairie Conservation plan in two prairie landscapes in western

Minnesota. The primary audience is individuals and organizations interested or involved in prairie conservation, especially the Prairie Plan Local Technical Teams. Some parts of the final report, including the prairie conservation planning maps and the social analysis, have already been shared with the teams. Information from the report has also been included in presentations to the teams and other local groups including the County Board of Commissioners. Parts of the report will be available on Conservancy or University websites. Over the next year, information from the report will form the basis for several planned publications in scientific journals.

2010 Environment and Natural Resources Trust Fund (ENRTF) Work Program Final Report

Date of Report: August 12, 2014
Date of Next Progress Report: Final Report
Date of Work Program Approval: June 16, 2010. Amendments approved by the LCCMR on April 19, 2011, June 26, 2012, February 7, 2013, May 9, 2013, and June 30, 2014.
Project Completion Date: June 30, 2014

I. PROJECT TITLE: **Reconnecting Fragmented Prairie Landscapes**

Project Manager: Steve Chaplin
Affiliation: The Nature Conservancy
Mailing Address: 1101 West River Parkway, Suite 200
City / State / Zip: Minneapolis, MN, 55415-1291
Telephone Number: 612-331-0788
E-mail Address: schaplin@tnc.org
Fax Number: 612-331-0770
Web Site address: <http://www.nature.org/wherewework/northamerica/states/Minnesota/>

Location: Two prairie landscapes in the Prairie Province portion of Minnesota. Prior to the start of this project on July 1, 2010, The Nature Conservancy will coordinate with partners to identify as project areas at least two of the 38 prairie landscapes shown in the attached map. The project areas chosen for study include the Glacial Lakes prairie core area in Pope, Kandiyohi, Swift and Stearns Counties and the Central Agassiz Beach Ridges landscape (includes Bluestem, Felton, and Syre prairie core areas) in Clay and Norman Counties.

Total ENRTF Project Budget	ENRTF Appropriation:	\$	380,000
	Minus Amount Spent:	\$	379,699
	Equal Balance:	\$	\$301

Legal Citation: M.L. 2010, Chp. 362, Sec. 2, Subd. 4i and extension of funds in M.I. 2013, Chapter 52, Section 2, Subdivision 17.

Appropriation Language:

“\$380,000 is from the trust fund to the commissioner of natural resources for an agreement with the Nature Conservancy to develop prairie landscape design plans and monitoring protocol involving local landowners and businesses to guide conservation, restoration, and related economic development. This appropriation is available until June 30, 2013, by which time the project must be completed and final products delivered.”

“The availability of the appropriations for the following projects are extended to June 30, 2014: (5) Laws 2010, chapter 362, section 2, subdivision 4, paragraph (i), Reconnecting Fragmented Prairie Landscapes;”

II. PROJECT SUMMARY AND RESULTS:

Less than 1% of Minnesota’s original tallgrass prairie remains today and what is left are scattered remnants. Restoration of healthy prairie ecosystems requires both protection and reconnection of remnants to create prairie-dominated landscape areas of 10,000 to 50,000 acres.

In order to restore and sustain prairie landscapes, we must develop prairie-based economies that generate a sustainable income for local communities. Grazing, haying, and native seed production show great promise, but must be managed to also produce desired conservation results.

This project will work within at least two of the 38 prairie landscapes identified by the Minnesota County Biological Survey (see attached map). For each of these two areas, a prairie reconnection landscape plan will be developed in cooperation with local residents and conservation entities. Plans will designate criteria to prioritize lands for conservation/protection, reconnection/restoration, and compatible economic ventures. In addition, we will develop monitoring protocols based on a rapid assessment of current conditions in order to measure success in achieving defined landscape goals. Based on what we learn in developing the landscape plans, we will identify economic opportunities for different prairie-based ventures that are appropriate for the market and resources of each landscape.

The second major component of this project is an economic analysis of innovative prairie-based ventures conducted in cooperation with the University of Minnesota. This analysis will focus on removing obstacles to sustainable agriculture and exploring the feasibility of business opportunities such as grass-fed beef, grazing collaboratives, grass banks, native seed production, second-generation bioenergy, and carbon markets.

The project will facilitate direct conservation action across each specific landscape. By showcasing prairie-based agriculture, the project has the long-term potential of leveraging results across dozens of Minnesota’s remaining prairie landscapes.

III. PROGRESS SUMMARY AS OF SEPTEMBER 30, 2010: Work focused on building datasets that will be used for conservation planning in prairie landscapes and is currently needed to develop the Minnesota State Prairie Plan. Partner organizations and agencies agreed in principle to the overall approach to prairie conservation in the state. Six landscapes were chosen as potential subjects for in-depth study: Glacial Lakes, Lac Qui Parle, Glacial Ridge, Felton/Bluestem Prairie, and Hole-in-the-Mountain, and Tallgrass Aspen Parkland. The landscape boundaries were finalized and initial contact with key individuals in each study landscapes was begun. Coordination meetings between contractors were held to determine what data was needed for each component of the project and who was best positioned to develop that information.

PROGRESS SUMMARY AS OF MARCH 31, 2011: The scopes of work for the restoration planning and economic analysis portions of the contract with the University of Minnesota were completed. Two

postdoctoral researchers were hired to conduct the work and both will start in May. Initial database work began in digitizing parcel boundaries for the Glacial Lake landscape. Meetings with potential partners were held including ones with the DNR and USFWS to discuss using public lands for private conservation grazing management. The idea of creating a mosaic of prairie and grasslands that would be part of a grass-based agricultural economy was broached with key legislators from the landscapes and some local county leaders.

Amendment Request (April 18, 2011): In the original project work plan we expected that the travel costs associated with the Reconnection and Restoration portion of Result 1 (\$3,000) would be paid directly by The Nature Conservancy out of the "Travel" portion of the budget. As we developed the contract for the work to be conducted by Dr. Galatowitsch of the University of Minnesota, we discovered it would be more appropriate to include the \$3,000 for travel expenses within the contract to the University of Minnesota. We request that \$3,000 for the travel expenses of Dr. Galatowitsch and her associates under Result 1 be moved from the "Travel" line item to the "Contract" line item.

Our original estimate of the personnel costs under the same contract was also off slightly. The actual contract costs for personnel proved to be \$146 more than predicted. We request that \$146 be moved from the "Personnel" line item to the "Contract" line item. These two budget shifts result in no net change in total costs.

Amendment Approved: April 19, 2011

PROGRESS SUMMARY AS OF September 30, 2011: The final contract with the University of Minnesota was negotiated and signed. Both postdoctoral researchers started their positions and an initial site visit to the two focal landscapes (Glacial Lakes and Central Agassiz Beach Ridges) was made to familiarize all the project participants with the local areas, natural communities, and conservation/economic issues. Data development proceeded at a satisfactory pace with basic datasets on landownership parcels, native prairie locations, landcover, crop cover, wetlands, protected lands, soils, and others now available for use by the project participants. Using data elements and knowledge gained from site visits, we began developing a "state transitions" framework that will be used to estimate costs of restoration and land-use conversion within the focal landscapes.

PROGRESS SUMMARY AS OF MARCH 31, 2012: During the past six months of the project we agreed on a final work plan with University Minnesota for the restoration and economic analysis. Many of the details in the grant work program and final contract needed to be worked out once initial data was gathered and analyzed. As a result of the initial analysis, we developed a work plan for the Rapid Assessment Technician, recruited and hired a highly qualified individual, and designed the sampling protocol for next summer's fieldwork. Another key milestone in the project was the completion of the process to identify key areas for restoration and economic analysis within the landscape. A process was developed that automated the prioritization of parcels for conservation and restoration to allow consistency between landscapes independent of the individual conservation planner doing the work.

Amendment Request (June 20, 2012): As work on this grant has proceeded, we have realized that we underestimated the difficulty in getting good information on the attitudes of key local producers and opinion leaders towards conservation, restoration, and grass-based economic ventures in the study

areas. Local community outreach is an important part of this project and we need a better way to get input on future landscape and economic scenarios of the two study areas. We propose to redirect some of the funding from the contract of Result 1 that was to be used to identify priority lands by conservation/habitat modeling to a contract to conduct a social landscape analysis utilizing interviews and workshops. We would like to divert \$7,000 of the \$10,000 to contract with a private contractor experienced in such analyses. The remaining \$3,000 would be used to extend the GIS Database staff to do the work of identifying priority areas in-house rather than by contract. Much of the identification work has already been done and with some additional funding for the GIS Database position we could complete the work. The GIS Database Intern is already familiar with the project and would be more efficient and produce faster results than a contractor. Furthermore, it is doubtful we could find a contractor to complete the identification work with the \$3,000 remaining. We will follow the Conservancy's standards and procedures on contracts in selecting a contractor and setting up the social analysis contract. These budget shifts result in no net change in total costs.

Amendment Approved: June 26, 2012

PROGRESS SUMMARY AS OF September 30, 2012: During the early portions of this reporting period, landuse/landcover maps for the two project areas were developed using multiple GIS based datasets. Fieldwork to accuracy-check the landuse/landcover maps was initiated and proceeded rapidly in the last three months to provide the basis for the restoration planning and economic analysis. A social analysis of stakeholder values and opinions was also initiated and the field interviews for the project were completed. The ongoing work of writing restoration plans for different landcover transitions continued on schedule. The work on the economic analysis of various conservation, status quo, and intensive agriculture scenarios moved forward to a point where we can begin the computer simulations. Finally, a new conservation strategy of Coordinated Landscape Grazing was developed and vetted by local stakeholders as part of the conservation planning work. This strategy attempts to bring needed large-scale grassland disturbance management to multiple properties within high priority prairie areas.

Amendment Request (January 30, 2013): We would like to request variances between budget line items. We are likely to underspend the direct operating costs, printing, supplies, and travel portions of the budget, but come up short on personnel costs. Additional funds in personnel will allow us to expand GIS and graphic work in the final report, to develop more fully the Measures of Success portion of the final report, and to complete additional restoration transition descriptions. To accomplish these goals, we would like permission to move \$1,500 from Other Direct Operating Costs, \$200 from Printing, \$300 from Supplies, and \$4,500 from Travel Expenses. Of these funds, \$4,100 would be moved to the GIS Database Intern and \$2,400 to Monitoring Protocol Design. In addition we would like to move \$1864 from travel to personnel within the Reconnection/Restoration contract with the University of Minnesota. All of these budget adjustments will result in no change to the overall budget amount. We request that these budget line variances be approved effective as of October 1, 2012, to account for overages in the amount spent on Personnel for Monitoring Protocol Design.

Amendment Approved: February 7, 2013

Amendment Request (January 30, 2013): Although the overall project remains on schedule, the economic analysis portion of the project (Result 2) got a late start due to a delay in hiring the Post-Doctoral Research Analyst position. The result is that the economic analysis will meet the basic grant requirements but not the full depth of analysis or robustness that could be achieved with additional time. We propose to extend the project timeline an additional year to June 30, 2014 with no additional cost to the budget.

Amendment Approved: May 9, 2013

PROGRESS SUMMARY AS OF March 31, 2013: A major focus of this reporting period was the planning and initial drafting of the project's final report. A rough draft of the report covering conservation in the Glacial Lakes landscape was completed and the integration of the results from the economic, restoration, and social analyses is ongoing. The economic analysis work compiled the data necessary to compare grass-based agriculture with crop systems under different environmental conditions. This work is feeding into the ecosystem service analysis using the InVest model to compare economic returns versus environmental benefits (water and carbon sequestration) in different land-use scenarios. Initial computer runs have been successful but further work is needed for better resolution. The restoration analysis work has resulted in initial plans for re-creating conservation and utility prairies (dry soils) and conservation and utility meadows (wet soils). Integration with the economic analysis and a newly initiated survey of restoration professionals allows us to develop cost estimates for each transition from current land cover to the desired future state. Finally, the social analysis work that entailed extensive interviews with landowners, producers, and local conservation professionals was completed and the final contract report was delivered. The results of the social analysis indicate high potential for grassland conservation in the study areas.

PROGRESS SUMMARY AS OF September 30, 2013: During the past six months the initial draft for the Glacial Lakes portion of the study was expanded and incorporated into the final report structure that includes the Agassiz Beach Ridges results as well. During this process the all of the project staff participated in a reorganization of the report to better tie all of the subprojects together. The contract restoration planning and social analysis projects were completed and their final reports were submitted to The Nature Conservancy to fully meet the contract requirements. Those reports have now been incorporated into the overall project final report. Finally, the economic analyses and results were largely finalized during the past reporting period. Net returns to the land and to the operator are now complete for multiple time periods and for a broad range of land use practices across the major watershed for each landscape.

PROGRESS SUMMARY AS OF March 31, 2014: A draft version of the first seven chapters was completed during the reporting period. Only chapters eight and nine still await drafting. Chapters one through seven were compiled and formatted into a single document. Each chapter was reviewed by other members of the project team and revisions were made and incorporated into the document. Missing citations were added and a bibliography for the manuscript was generated. The Table of Contents, Introduction, and Acknowledgements were written and many problems with formatting were addressed. Thirty-six figures were created and reworked for consistent formatting. Conservation parcel

maps were shared with all 10 of the Prairie Plan's Local Implementation Teams. Final document assembly was begun (incorporating figures and tables) in preparation for the final completion date of June 30, 2014.

Amendment Request (April 23, 2014): We request a modification to the Result 1 budget line items. The University of Minnesota will be leaving \$36 on their contract for Result 1 and we are likely to underspend the direct operating costs, printing, supplies, and travel portions of the budget, but come up short on personnel costs. Additional funds in personnel will allow us to continue compiling, enhancing, and completing the final report. To accomplish these goals, we would like permission to move \$340 from Other Direct Operating Costs, \$36 from Printing, \$340 from Supplies, and \$212 from Travel Expenses. Of these funds, \$696 would be moved to the Personnel. All of these budget adjustments will result in no change to the overall budget amount.

Amendment Approved: June 30, 2014

FINAL REPORT SUMMARY June 30, 2014:

Overall Project Outcome and Results

The Minnesota Prairie Conservation Plan calls for protecting native prairie and restoring connectivity to prairie core areas using grass-based agriculture as a conservation tool. To provide information and techniques needed to meet these goals, we studied two prairie landscapes in western Minnesota: Agassiz Beach Ridges (127,000 acres) and Glacial Lakes (169,000 acres). Using GIS analysis and field survey, we developed a current land use/land cover map that revealed that even in high-quality prairie landscapes, over 25% was cropland and 31% was invasive dominated or mixed native-invasive grassland. To guide conservation activities, we identified conservation targets and specified methods for measuring progress. To rebuild functioning prairie systems, we identified all parcels containing native prairie for possible management and protection, as well as tracts that if restored, could buffer and reconnect prairie. A social analysis using interviews with local constituencies revealed support for conservation if it were tied to working grasslands that promoted rural socio-economic vitality. To facilitate needed restoration, we developed a state transition model that identified feasible restoration transitions from common "start states" (based on current land cover) to conservation and utility prairie and meadow "end states". We developed restoration plans including techniques, seed mixes, and estimated costs for twenty transitions. To make the expansion of grass-based agriculture feasible, landowners will need assistance with the restoration costs. As land use decisions are driven not only by financial returns but also potentially by the value of ecological services, ongoing InVest modeling will highlight land use patterns where the provision of public and private benefits in future scenarios is optimized. These scenarios are designed to reflect the goals of the Prairie Plan, as well as social and economic constraints. This comprehensive approach provides resources for implementing prairie conservation in western Minnesota and could serve as a model for conservation planning elsewhere.

Project Results Use and Dissemination

The primary purpose of this project was to provide information and techniques for the implementation of the Minnesota Prairie Conservation plan in two prairie landscapes in western Minnesota. The primary audience is individuals and organizations interested or involved in prairie conservation, especially the Prairie Plan Local Technical Teams. Some parts of the final report, including the prairie conservation planning maps and the social analysis, have already been shared with the teams. Information from the report has also been included in presentations to the teams and other local groups including the County Board of Commissioners. Parts of the report will be available on Conservancy or University websites. Over the next year, information from the report will form the basis for several planned publications in scientific journals.

IV. OUTLINE OF PROJECT RESULTS:

Result/Activity 1: Prairie Reconnection Landscape Plans

Budget: \$ 225,500

Two landscapes will be selected based on feasibility and environmental conditions. In cooperation with local residents and landowners, we will identify a range of options within three main categories of opportunity: 1) conservation/protection of remnants; 2) reconnection and restoration, and 3) compatible economic ventures.

The three categories are interconnected. For example, some types of reconnection and restoration will also convey one or more prairie-based economic development opportunities. In turn, economic development may at times generate funds for landowners that can enable additional reconnection and restoration work. Protected remnants may also contribute to local economies, but likely in different ways than restored reconnections might. Result 1 will entail a thorough exploration of these interrelationships as well as the range of options within each category. We will further assess to what extent the options can be generalized from place-to-place and what options are more situation-specific.

- 1) Conservation/Protection. As a first step, we will coordinate with conservation partners (both agency and non-profit) to determine what currently-available land protection and related conservation incentive programs will most effectively protect different types of native prairie remnants. To inform these discussions we will build a GIS database that will document current landownership and levels of protection. We will also compile information on location of marginal and prime farm land and natural resource features. These GIS datasets will be used to identify priority lands for early conservation action, likely in conjunction with a spatial habitat model. These GIS datasets will be informed by the data developed by the Statewide Conservation and Preservation Plan. We will coordinate with the Board of Water and Soil Resources (Greg Larson) and other agencies to avoid duplication of effort in developing intra-landscape data. In situations where our current land protection approaches are insufficient, we will propose potential new conservation tools and/or programs that will facilitate the type of large-scale conservation needed to sustain prairie landscapes. New tools may include such approaches as the use of public lands as part of a grazing mosaic for private grazers. While the current conditions are being assessed, we will also hold

meetings between conservation partners and local government officials, landowners, producers, and other community members to gather information and get local input.

- 2) Reconnection and restoration. We will conduct a rapid assessment of the current condition across each landscape. We will use a combination of aerial photographs and drive-by surveys to complete this work. A reconnection analysis will follow, in which we collaborate with the local community to specify a range of desired future ecological conditions across the landscape, including a goal for prairie restoration. The desired future ecological conditions will encompass both terrestrial and wetland habitats and range from high-biodiversity buffers adjacent to native remnants to matrices of moderate biodiversity “working” lands and to low-biodiversity areas that are nonetheless compatible with the ecological and economic goals of the broader landscape. The reconnection analysis will define the types of natural communities that will be restored in each area, the approaches or methods that are most appropriate for each type of environment, and solutions to obstacles to restoration in local areas.

- 3) Compatible Economic Ventures. Broad categories of sustainable grazing, haying for bioenergy and forage, carbon credits, native seed production, continuation of row-crop agriculture, etc. will be identified and vetted with the local community. The ideas for prairie-based economic ventures that are most appropriate for each prairie landscape will become the subjects for the Economic Analysis of Result 2.

Deliverable/Outcome	Completion Date	Budget
1. Analysis of 2 prairie landscapes including conservation/protection, reconnection/restoration, and compatible economic ventures; with attention to options, synergies and trade-offs for each category	Summer, 2013	\$ 170,500
2. Landscape concept maps showing specific areas for different protection options and restoration approaches. Methods for evaluation and a tracking system to measure success will also be included.	Summer, 2013	\$ 55,000

Summary Budget Information for Result/Activity 1:	ENRTF Budget:	\$225,500
	Amount Spent:	\$225,199
	Balance:	\$ 301

Result 1 Completion Date: April 30, 2013

Result 1 Status as of September 30, 2010:

The first three months of the grant were spent laying the foundation for the activities described in the grant work program. Specifically, individuals who will be paid from the grant in the future focused on compiling and writing the Minnesota State Prairie Landscape Comprehensive Plan 2010. This document is the work of over twenty-two prairie conservation leaders. It will define the framework and major approaches for prairie conservation in Minnesota for the next 25 years and will set goals to be achieved.

The work done on the prairie landscape plan is closely related to the work program and contributes to it. However, the prairie landscape plan work is being paid for by a private foundation and no costs have been incurred by the grant for its completion. This outside funding has meant that no LCCMR grant funds have been expended in the first three months.

In order to complete the State Prairie Landscape Plan, prairie core areas were defined and datasets on landcover, soils, biodiversity features, and others were assembled to describe them. This data will be the basis for the landscape planning and economic analysis described in the grant work program. The prairie landscape plan also sets conservation goals for each core area in the acres of native prairie, other grasslands, and wetlands that should be protected, restored, and enhanced. These goals are the ones that the grant landscape plans will strive to meet. Other data on prairie corridors to connect the core areas and the surrounding agricultural matrix will also be essential to establish the context within which the prairie landscapes will be embedded.

Result 1 Status as of March 31, 2011:

The five focal landscapes for conservation planning were chosen for database development: Glacial Lakes, Lac Qui Parle, Glacial Ridge/Agassiz Dunes, Hole-in-the-Mountain, and Bluestem/Felton Prairies. Digitizing parcel boundaries was initiated for the Glacial Lakes landscape. Restoration planning will focus on the Glacial Lakes and Bluestem/Felton Prairie landscapes. A post doctoral researcher, Laura Phillips-Mao, was hired for the restoration planning work. Coordination meetings with Drs. Galatowitsch and Phillips-Mao were held to work out contract issues and to define the specific scope of work for the contract with the University of Minnesota. Research to identify potential cooperators and key leaders in the Glacial Lakes landscape was initiated. Meetings with potential partner organizations to explore cooperating in conservation planning and outreach in focal landscapes were started with conversations with the Chippewa 10% Project, Green Lands Blue Waters, and the Land Stewardship Project's Farm Beginnings Program. For background information and to establish local contacts, staff attended a Grass-fed beef workshop in Glenwood, MN.

Result 1 Status as of September 30, 2011:

Data development for the five focal landscapes continued at a rapid pace. Electronic data on parcel boundaries were completed for the five landscapes using existing data where it was available and digitizing individual parcels where it was not. Other datasets were compiled including landcover, crop cover, presettlement vegetation, soils, protected lands, and wetlands. Minnesota County Biological Survey data including native prairie and other areas of biodiversity significance were downloaded for the landscapes as well. All of the data was uploaded to a ConservOnline workspace to allow access by the different project participants.

The process of identifying priorities for restoration and conservation within the Glacial Lakes and Central Agassiz Beach Ridges landscapes was initiated using the distance to the nearest native prairie and the number of native prairie quarter-sections within 2000 or 4000 meters. Different models were used to identify parcels of land that best connect and buffer native prairies.

For each landscape, a set of maps and statistics was developed to present the concept of conservation and grass-based agriculture primarily to interested parties within the landscapes. The format used was a three-ring binder that could be used in one-on-one meetings in the field.

Restoration planning for the landscapes will be done by defining a set of common starting points for restoration (“start states”) and a set of desired future conditions (“end states”). The restoration planning will detail the techniques, seed mixes, types of seedlings needed, and how to overcome the problems encountered in transitioning from the current vegetative start state to the desired end state. Assessment of data elements and a field visit to both the Glacial Lakes and Central Agassiz Beach Ridges landscapes helped develop a draft list of start and end states for analysis.

Result 1 Status as of March 31, 2012:

The identification of priority areas for restoration and conservation was completed for the Glacial Lakes and Agassiz Beach Ridges landscapes. The final process entailed scoring each quarter-quarter section of land (40 acres) within the landscapes based on three factors: 1) The presence of native prairie, 2) Whether the quarter-quarter was immediately adjacent to a quarter-quarter with native prairie, and 3) The number of quarter-quarter sections with native prairie within 2 miles. Parcels of land were prioritized based on the value of the highest scoring quarter-quarter they contained. Based on prioritization scores a list of 188 landowners with native prairie were identified for the Glacial Lakes landscape and 99 native prairie landowners for the Central Agassiz Beach Ridges.

A second major focus for Result 1 was the drafting of restoration plans for state transitions and developing a process for classifying lands by start state. We have drafted a prototype restoration plan for the utility prairie end state, including transitions from five priority start states (crop, annual-dominated, invasive perennial-dominated, mixed native and invasive, and cedar-invaded). Recommendations for restoration and management are based on literature review and consultation with experts. In particular for the utility prairie, seven experts on grazing native prairies were consulted for input on creating seed mixes for grazed prairies and introducing cattle to newly restored prairies. We have also begun work on drafting a restoration plan for conservation prairies.

The organizing framework for much of this project entails identifying the common start states and desired end states for land use within each landscape. The start states and end states have been described roughly but more information is needed on the amount of each state currently in the landscape. This data will be gathered in the coming field season by a Rapid Assessment Technician. A job description and work plan were developed and a recruitment process initiated that resulted in the hiring of a new project member to perform the work. Additional work has focused on identifying and obtaining available digital data sets that can be used to coarsely classify and quantify start states in the project areas. A set of rules for identifying the start states based on the combination of information from multiple land use/land cover datasets, MCBS survey data, and remote sensing data if needed is under development. We have also begun work on developing a protocol for ground-truthing these start states in the field, with a goal to begin field work in mid-May, 2012.

To avoid duplication of effort we coordinated our work with that of the Prairie Pothole Region Integrated Landscape Conservation Strategy (PPRILCS) project led by the HAPET office of the U.S. Fish and Wildlife Service. The PPRILCS is developing a conservation tool to integrate habitat and water planning in the prairie regions of Minnesota and Iowa. They agreed to use the two focal areas chosen for this project as places to test their model. We also coordinated with the Chippewa 10% project, which includes the Glacial Lakes landscape as part of their project area. Coordination with the Chippewa 10% project will allow us to utilize data they have gathered to accomplish some of the goals of this project. The final group we coordinated with was the Natural Capital Project. Nat Cap is developing the InVest software that we intend to use in this project. As a result of our discussions, Nat Cap is considering the improvement of models for row crop agriculture and grazing to make them more useful for Minnesota landscapes. Nat Cap may even use Minnesota as a place to test the new models.

Other key events in the past six months include a photo trip to landscapes to get images for written materials and the development of outreach contact lists to residents and conservation leaders in each landscape. Another task was to compile information on conservation grazing as a key landuse for a grass-based economy within the landscapes.

Result 1 Status as of September 30, 2012:

Major milestones in Result 1 were achieved as we hired and trained the Rapid Assessment Field Technician to conduct accuracy-assessment fieldwork and we developed a contract to conduct a social analysis to better assess the values and opinions of key stakeholders in the two landscapes. To encourage both conservation and grass-based economies, we developed the concept of coordinated landscape grazing (CLG). CLG attempts to bring high-intensity, short-duration rotational grazing for conservation management to multiple property ownerships (both private and public) over the course of a season. Initial vetting of the concept was held at meetings of local producers, landowners, and public landowners.

Other work on Result 1 focused on drafting restoration plans for the state transition model, defining start states, and further developing the start-state classification system. The draft restoration plans for conservation prairie and utility prairie end states were completed and revised with input from TNC field staff and other restoration experts. Restoration plans for the utility prairie and conservation meadows are well underway. Using multiple GIS data sources, we created a base map of land cover and land use, which provides the context for our restoration plans, baseline information for the economic and ecosystem service analyses of Result 2 and future monitoring efforts. With the base map complete our Rapid Assessment technician spent much of his time visiting sites in each landscape selected according to a sampling design which allows us to assess the accuracy of our base map. The Rapid Assessment technician has not had any trouble gaining access to private lands – something that was a concern. Accuracy assessment of the base land use/land cover map is underway. Based on initial analyses it appears that our ability to tease apart grasslands of varying quality, especially on protected lands, is fairly good. Using the accuracy data we will be able to generate a list of ways the underlying spatial data could be combined differently to a result in base land use/land cover maps with even greater accuracy.

Result 1 Status as of March 31, 2013:

The bulk of the data analysis and map making for the conservation planning portion of project has been completed and an initial draft of the final report for the Glacial Lakes landscape is well underway. Of particular note is a set of maps for the “Coordinated Landscape Management” portions of four landscapes (Glacial Lakes, Agassiz Beach Ridges, Lac Qui Parle, and Prairie Coteau) depicting parcels with more than 20 acres of native prairie, less than 20 acres, and parcels in positions to buffer and reconnect native prairie.

For conservation coordination in the landscapes, multiple meetings with conservation partners were held in the Glacial Lakes and Lac Qui Parle areas to promote the goals of the Minnesota Prairie Conservation Plan and the concept of coordinated landscape management. The outreach to private landowners and operators continued with the completion of the landscape social analysis conducted by Ryan Atwell. His study documented the shared interest in the maintenance of grasslands by the conservation and agriculture communities (although for different reasons).

The restoration portion has continued to focus on drafting restoration plans for the state transition model. We are continuing to revise the completed conservation prairie and utility prairie restoration plans and in addition restoration plans for the conservation and utility meadow end states are nearing completion. Our research efforts have focused on best restoration practices for particularly challenging start states (e.g. inter-seeding in Mixed Native-Invasive start states), for which little information is published. We have begun to develop a process for restoration cost estimation and integrating these costs with the economic analyses (Result 2). To this end, we used outside funds to hire a highly-qualified Graduate Research Assistant to survey regional restoration practitioners and vendors and develop accurate and detailed cost estimations for each restoration transition. In addition to augmenting the quality of our restoration plans and economic analyses, we anticipate that these restoration cost estimates will have tremendous value to restoration planners and practitioners statewide, as this type of detailed information currently is unavailable for Minnesota.

The Rapid Assessment Technician completed mapping, accuracy assessment, and analysis of a base land-use land-cover map of the Glacial Lakes and Agassiz Beach Ridges landscapes. These maps provide baseline information for restoration and monitoring plans as well as for the economic and ecosystem service analyses (Result 2). Finally, monitoring protocols were completed to track conservation success.

Result 1 Status as of September 30, 2013:

The data analysis and map making for Result 1 is now complete and the final report is being drafted. To reach this point each of subprojects (social analysis, restoration planning, and monitoring protocols) were completed and their final reports were submitted. The subproject final reports were reviewed and accepted as fully meeting the contract requirements.

An introductory chapter for the full project report was written and background chapters were revised with the aim of improving the flow and organization of material among chapters originating from TNC-

and UMN-led project components (background information on the landscapes, base land use and land cover information, restoration analyses, economic analyses, social landscape analyses, monitoring plans, and land use optimization.

The social analysis work detailed prevailing attitudes towards conservation and grassland management in the Glacial Lakes and Lake Agassiz Beach Ridges landscapes. The results suggest that a different approach to conservation will be needed in the two areas: a more traditional conservation oriented approach will work best in the Glacial Lakes area but one focused on ties to agriculture will likely be more successful in the Beach Ridges. Local leaders and residents in both areas recognized the value of grassland and grass-based agriculture.

The restoration planning work completed the development of the transition state model and the descriptions of the start and end habitat states. Considerable effort went into describing the transitions from each start state to each end state and the restoration activities needed to make the transition successfully.

Outreach to Prairie Plan Implementation Teams continued to bring the results of this project to the individuals that are charged with carrying out conservation activities in the key landscapes. Maps for Coordinated Landscape Management Areas that depict conservation priorities were completed and presented to the Glacial Lakes, Agassiz Beach Ridges, Mahnommen, Lac Qui Parle, Prairie Coteau, Red Rock, Pembina, and Aspen Parkland teams. Part of the presentations included a discussion of the benefits of coordinated landscape management and the utilization of grass-based agriculture as a driving force in prairie conservation.

Result 1 Status as of March 31, 2014:

A draft version of the chapters covering Result 1 was completed during the reporting period. Chapters covering each component of Result 1 were compiled and formatted into a single document. Each chapter was reviewed and comments were sent to the authors. Revisions were made and incorporated into the document. Missing citations were added and a bibliography for the manuscript was generated. The Table of Contents, Introduction, and Acknowledgements were written and many problems with formatting were addressed. Thirty-two figures were created and reworked for consistent formatting. In some cases, data had to be re-analyzed to create new figures that matched the current data set. Revisions were made to Chapter 4 to include more analysis of key conservation parcels. Conservation parcel maps were shared with Prairie Plan Implementation Teams for the Glacial Ridge, Minnesota River, and Lake Christina areas completing the process of sharing maps with all 10 of the local Implementation Teams. Final document assembly was begun (incorporating figures and tables) in preparation for the final completion date of June 30, 2014.

Final Report Result 1 June 30, 2014:

The Result 1 portion of this project is now complete. Seven chapters have been written including the introduction, landscape descriptions, current landuse and landcover, prairie parcel planning, measures of success and monitoring, social analysis, and restoration planning.

The highlights for the project's prairie parcel planning chapter include delineating boundaries for conservation focal areas within the study landscapes ranging in size from 29,635 acres in the Felton Prairie area to 13,447 acres in the Glacial Lakes State Park area, developing conservation parcel priority maps for the five focal areas, and identifying the private parcels with >20 acres and less than <20 acres of native prairie as well as key parcels to buffer and reconnect those with native prairie. In the five focal areas, only 135 parcels with > 20 acres of native prairie, 124 with < 20 acres, and 145 buffer and reconnecting parcels will be the subject of land owner contact for future conservation work.

In the measures of success chapter we defined large-scale desired outcomes for both the Agassiz Beach Ridges and Ordway Glacial Lakes landscapes and developed measures and monitoring approaches aimed at tracking these outcomes. Outcomes for both landscapes include restoration and protection efforts that achieve the 40-20-40 breakdown of grassland, wetland, and other uses as laid out by the Minnesota Prairie Plan as well as increasing the quality of the grassland by reducing woody cover and increasing cover of native plant communities. Native wildlife outcomes were developed for both landscapes and include stable or increasing populations of prairie obligate butterflies. Greater Prairie-Chicken populations are good indicators of large areas of grassland habitat that includes a range of vegetation structure. In the Agassiz Beach Ridges landscapes where Greater Prairie-Chicken populations still persist, the goal is to maintain stable or increasing populations. Minnesota's grasslands are a matrix of grass and wetlands that are critical to sustaining all prairie species, and for each landscape, we specifically defined aquatic outcomes. In the Agassiz Beach Ridges, where calcareous fens are a prominent feature of the landscape, the goal is to maintain the diversity of indicator species specific to fen communities. In the Ordway Glacial Lakes landscape, where lakes are a prominent feature, the goal is to ensure compatible land use around key lake basins.

The social analysis chapter interviewed key rural constituencies within the two study landscapes and found support for grassland conservation initiatives that were seen as simultaneously bolstering both conservation outcomes and rural socio-economic vitality. Rural residents perceived lands owned and managed by government agencies and conservation organizations for prairie or wetland conservation to be largely "wasted," both because economic return was limited and because these lands lacked necessary management. The growing recognition in the conservation community that ecosystems often exist in alternative states and need active management to maintain ecological function was found to be an important point of connection with the rural value that land is malleable and should be worked to promote desirable outcomes. While maintaining rural livelihoods through profitable economic returns from the land was seen as essential, interviewees voiced diverse and complex decision making strategies that were based only partially on economic considerations. In particular, relationships with local conservation personnel and effective partnerships among conservation organizations and agricultural entities were seen as essential. Pragmatic suggestions were offered for how conservation and agricultural entities could better cooperate to advance mutually beneficial outcomes in the future. In the Agassiz Beach Ridges (ABR) landscape in far western Minnesota, people were more suspicious and less aware of conservation programs and partnerships. While this area had more unprotected native prairie, land use decisions were concentrated in the hands of fewer, larger landowners and farmers.

Strategic partnerships with key owners and operators handled with great sensitivity will be crucial to conservation success in this area. Comparatively, the Ordway Glacial Lakes (OGL) landscape in south central Minnesota has had a long history of visible conservation activities and partnerships marked by conflict with agricultural entities and county government. In this landscape, increased collaboration between grazing and conservation interests focused on working grasslands is encouraging both sides to overcome historic differences.

The restoration planning chapter focused on the challenges of the site-specific nature of restoration decision-making and implementation. Budgeting for landscape-scale projects requires a method for anticipating restoration prescriptions and costs that is sensitive to site and project variability, but can also be rapidly applied across large landscapes. To address this need, we developed a qualitative state-transition model as a coarse-resolution tool for landscape-scale restoration planning and applied it to two landscapes to guide implementation of restoration goals set forth in the 2011 Minnesota Prairie Plan. We specified common “start states” based on vegetation, and restoration “end states” distinguished by plant community, soil moisture, and project goals. We assessed which transitions from start to end states could be achieved through restoration, and for a subset, we developed generalized restoration plans based on best practices; created seed mixes reflecting commercial availability and regional differences; and surveyed restoration practitioners to estimate the costs of achieving each transition. Cost estimates ranged widely based on starting conditions, project goals and restoration targets. The per-acre cost difference between the cheapest transition—crop to moderate-diversity prairie—and the most expensive—restoring high-diversity wet meadow on a site invaded by reed canary grass (*Phalaris arundinaceae*)—was greater than threefold (\$800-\$2700).

Result/Activity 2: Native Perennial Economic Development Frameworks **Budget:** \$ 154,500

We will generate economic development plans that compare capital startup costs, annual expenditures, expected revenue, and expected return on investment for conventional agriculture versus various prairie-based agriculture land uses. The type, extent, and suggested location for prairie-based ventures examined will be determined by with local input in the development of the landscape plans of Result 1 but may include the following and other new ideas:

- public grass banks
- prairie beef
- second-generation bioenergy
- carbon markets
- working prairie easements
- grazing leases on public lands
- native seed harvest

Part of the economic analysis will be to identify economic barriers to large-scale conservation and restoration for each landscape. Strategies will focus on removing obstacles to sustainable agriculture and explore innovative business solutions. The key question we will try to answer is: “Can prairie-based economic uses provide a sufficient return on labor and investment to sustain rural families and communities?”

Deliverable/Outcome	Completion Date	Budget
1. Economic development framework evaluating the feasibility of prairie-based economic ventures identified in Result 1 with a map detailing which lands are most appropriate for each economic venture within the two landscapes.	Spring 2014	\$ 100,500
2. Report on enhancing conservation business capacity in the landscape.	Spring 2014	\$ 54,000

Summary Budget Information for Result/Activity 2:

ENRTF Budget:	\$ 154,500
Amount Spent:	\$ 154,500
Balance:	\$ 0

Result 2 Completion Date: March 31, 2014

Result 2 Status as of September 30, 2010

During the first quarter of the meetings were held between conservation planning, restoration, and economic analysis project leaders for the grant. Coordination between the projects was discussed, the subcontract with the University of Minnesota was negotiated, and the search for an appropriate post-doctoral researcher to conduct the economic analysis work was initiated. By the end of the quarter, a post-doctoral researcher had been identified and hired to conduct the work required in the work program. This individual will start her position in February 2011 when she completes her doctoral program. No grant funds were expended to conduct the planning or recruitment process during the first quarter.

Result 2 Status as of March 31, 2011:

Meetings with Dr. Polasky were held to refine the goals of the economic analysis portion of the grant. The Glacial Lakes and Bluestem/Felton Prairie landscapes were chosen as the focus of the economic work. Postdoctoral research analyst Harriet Van Vleck, was introduced to the project but was delayed in starting until May. A scope of work for the contract with the University of Minnesota was finalized. The use of the INVEST model to look at the economic and ecological impacts of different land use scenarios within the focal landscapes was discussed. A landscape analysis for each landscape will be done that describes the provision of ecosystem services and the economic value of those services for five scenarios: 1) current trends, 2) conversion to the Prairie Plan goal of a minimum of 40% prairie and grassland, 20% wetlands, and 40% other and 3) scenarios to maximize ecosystem services, biodiversity, and economic returns. A profitability analysis (economic development plan) for agricultural operations will also be done that compares grass-fed beef, grass-reared but grain-finished beef, conventional corn and soybean, native plant seed harvest, hay production for sale or bioenergy production, and carbon sequestration. This approach was coordinated with the work that Kris Johnson of the Land Stewardship Project's 10% Percent Chippewa project is doing. Consultations were also made with Minnesota Department of Agriculture and LSP grazing specialists to better develop ideas on high intensity, short duration grazing techniques that can be used both as a conservation management tool and a way to increase grazing profitability.

Result 2 Status as of September 30, 2011:

Consultation with other researchers active in the economic analysis of the Glacial Lakes and Central Agassiz Beach Ridges landscapes continued. In particular, Crop Productivity Index data was used to modify township level land value (both obtained from Steve Taff at the University of Minnesota) to establish the value of particular parcels of land for GIS analysis. Research into both state and federal programs that could help landowner overcome the economic hurdles associated with land-use transitions is underway.

The site visit in early September to both landscapes helped generate additional ideas for grass-based economic ventures. Key contacts within communities in each landscape were made, these individual will be able to help assess the suitability of economic ventures for each landscape based on community interest as well as ecological conditions. In coordination with progress toward Result 1, determination of the start and end states and the suitability of each end state for particular economic activities is also being determined. Quantification of the restoration costs associated with transitions from each start to each end state has begun. Using this framework for the economic analysis will make the results more broadly applicable throughout each landscape than if the analysis were done at the parcel level.

The postdoc working on Result 2 attended a workshop on use of InVEST. Use of this model will provide quantification and valuation of ecosystem services associated with each start to end state transition. Ecosystem services generated by the transition to grass-based economies include not only private but also public benefits. Though not all of these services are valued in the market, for some landowners, understanding both the private and public goods realized by land-use change may influence their decision.

Result 2 Status as of March 31, 2012

In the last six months, Result 2 has focused on determining the process to be used for the economic analysis. Management operation costs will be determined for two phases of each priority transition: the "start-up" phase and a "maintenance" phase. The start-up phase estimates will include the cost of transitioning from start states to end states as well as the timeframe needed for each transition. The maintenance phase will include estimates of the cost of maintaining each end state as well as an estimate of the timeframe for incursion of maintenance costs and any changes expected in these costs over time. Throughout, we will determine if there is a minimum viable geographic scale for each transition or end state. Revenue estimates and timeframes associated with each phase of the transitions will allow us to calculate the timeframe for a landowners' return on investment and the net revenue change associated with each land use transition, for each landscape. By June 2012 we aim to have a complete database of costs and revenue associated with each land use as well as a baseline analysis of changes in net revenue associated with a priority set of transitions identified in Result 1.

Changes in ecosystem service quantity and value associated with each land use transition will also be determined. The decision of which ecosystem services to assess will be based on goals identified in Result 1 and through identification of landowner and stakeholder interests. Transitions may result in a

reduction of annual revenue. We will examine means of offsetting reduced annual net revenue for landowners (or supplementing increased net revenue) through programs including conservation easements, payments for ecosystem services, state or federal programs incentivizing conservation, etc. We have already generated an initial list of programs that may assist landowners overcome potential financial barriers to conservation.

Our final report will include an analysis of changes in ecosystem services associated with each transition. The latter analysis will include quantification of changes in ecosystem services provided with each transition and how inclusion of ecosystem service quantification impacts the baseline economic analysis. Economic and ecosystem service impacts of multiple scenarios will also be presented: current land use, maximized economic return to the landowner, and land use allocation which meets the MN Prairie Plan targets. The possibility of analyzing a high quality of life scenario is currently being discussed with a colleague at the Natural Capital Project at Stanford.

Our progress on Result 2 to date has been focused on refining base land use/land cover maps for each landscape, using this base map to help identify occurrence of each start state on the landscape, and collecting both economic and ecosystem service data for multiple grass-based land use operations. A second focus has been to compile enterprise budgets for a range of grazing and agricultural operations (ranging from conventional cropping systems to hay and biofuel production). These budgets were obtained from public datasets for Minnesota such as FINBIN and through outreach to other research groups at UMN and at the Land Stewardship Project. Refinement of these budgets is ongoing as additional data is collected. Additional data will allow us to determine if there is sufficient data, or a need, to develop region-specific budgets for the two landscapes.

In addition to economic data, we are compiling data on ecosystem service provision from grazing and agricultural operations. The ecosystem service model we will be using, InVEST, requires parameterization for each land use operation. Specifically, changes in soil carbon storage, water quality, habitat provision and biodiversity will be assessed for each land use transition. This requires data on how each land use operation impacts the provision of these ecosystem services. Collaborators at UMN and at the Land Stewardship Project are working on complimentary projects which will continue to inform our ecosystem service, as well as economic, modeling. We plan to develop a grazing module for InVEST in collaboration with the Natural Capital Project at Stanford.

Result 2 Status as of September 30, 2012:

In the last six months, work has focused on economic activity budgets, ecosystem service analyses, and land owner/manager communication. Economic activity budgets have been developed and were refined to reflect differences in soil productivity within each county. For each activity, yields, costs, revenue, and net returns to the land and to the landowner, are specified for each soil productivity class within each county. For crops, these values are also presented for two time periods, 2002-2006 reflecting historical crop prices, and 2007-2011 reflecting current, higher, crop prices.

Preparation to begin ecosystem service analyses is well underway. Though we will readily be able to show differences between grazing and cropland systems, as yet we are not certain how well we will be able to parameterize the model to reflect minor differences between grazing operations. Primarily this is a function of what data is available in existing data sets on the impacts of different types of grazing operations on ecosystem service provision. Relevant literature has been collected and data from these sources will be incorporated in of land use change scenarios. These scenarios will reflect: 1) business as usual land use/land cover trends, 2) high corn price impacts on land use and land cover, and 3) policy driven changes in land use and land cover, namely changes outlined in the MN Prairie Plan (40% grass, 20% wetland, and 40% other landuses). Additional scenarios will be driven by the outcomes of land owner/manager interviews.

Dr. Ryan Atwell was brought on as a consultant and together we have developed and revised interview questions to maximize the utility of the interview data for scenario development. He has conducted interviews with land owners, managers, and conservation organization staff in each of the two regions during August and September. Based on these interviews we have begun to develop a set of scenarios that reflect both conservation priorities and land owner/manager priorities.

Result 2 Status as of March 31, 2013:

Economic activity budgets continue to be refined to reflect differences in soil productivity within each county. For each activity, yields, costs, revenue, and net returns to the land and to the landowner, will be specified for each soil productivity class within each county. We have summarized impacts of crop price (reflecting changes between 2002-2011) and soil productivity (defined by crop productivity range) on net returns from cropping systems. This allows for comparison of alternative, grass-based economic activities with crop returns at a range of prices and crop yields. Through conversations with other researchers and land owners we are working to define the broad classes of grazing operation types which currently exist on the landscapes. Doing so will allow us to summarize pasture grazing operation budgets such that they reflect the impacts of farm scale and grazing system on land use transition and operation returns. We have begun compiling economic data for the period of operation establishment. These data are one component of the costs and returns incurred with land use/land cover (LULC) transitions.

We have made several adjustments in our approach to the grass-based operation budgets. First, based on Dr. Ryan Atwell's work we revised the grazing operation parameters for which we have developed budgets and are estimating transition costs. Second, we are currently expanding our grazing and haying yield estimates from grassland communities typical of conventional grazing systems (mixed native-invasive and invasive dominated grassland start states), to yield estimates representative of higher diversity grassland communities (utility and conservation grassland end states). These revised yield estimates improve the accuracy of the grass-based operation budgets, transition budgets, and inputs for the InVEST carbon storage model.

We began ecosystem service analyses (InVEST) in October. We are in the process of compiling data from the literature on ecosystem service values by land use. To illustrate the type of data required for

InVEST analyses, we need data on the amount of carbon stored in soil carbon pools, aboveground plant biomass, belowground plant biomass, and dead organic matter for each LULC class in order to model impacts of LULC on carbon sequestration. Collecting the necessary data to run the carbon and water quality models continues. The carbon model has been successfully run for this landscape at a very coarse LULC resolution, and work will continue with this model to refine the LULC resolution. The next step is to run each model under a variety of LULC change scenarios. We will run at least three scenarios which reflect: 1) business as usual land use/land cover trends, 2) high corn price impacts on land use and land cover, and 3) policy driven changes in land use and land cover, namely changes outlined in the MN Prairie Plan. Based on Ryan Atwell's interviews with landowners and managers we will continue to revise our set of scenarios to include additional scenarios. Application of the InVEST water model progressed less quickly than expected due to challenges getting the model to run with the landscape-specific input data. Determining the right balance between the spatial resolution of the digital elevation data and the model processing time required significant testing. At this point the water model has been run for one of the two landscapes. Due to the challenges of getting the water model running, efforts to refine the water quality model input data is ongoing. As they do not impact the digital elevation data utilized, changes to the input parameters should not trigger any further problems with the model. We plan to compare how land use and land cover, in a given region of the landscape, affect net returns (private benefits) as well as carbon storage and multiple indices of water quality (public benefits).

Result 2 Status as of September 30, 2013:

With the assistance of Pieter Ver Steig and collaborators at the Land Stewardship Project we developed a process of combining spatial crop yield data over time to develop maps of crop rotations in each landscape. This work is nearly complete.

In an effort to better capture the economic and ecological differences among grazing systems we examined the potential for incorporating forage quality data into our economic budgets, but found there was insufficient underlying data for the necessary range of grazing operations and grassland communities.

The most significant progress has been toward finalizing the economic analyses and writing up a summary of these results. We expanded our mapping of yields and net returns from the landscape boundary to the boundaries of the major watersheds encompassing both landscapes. These data are necessary for the ecosystem service analyses which are completed at the watershed, rather than landscape, scale as well as providing a regional context for our understanding of the viability of economic activities. Net returns to the land and to the operator are now complete for multiple time periods and for a broad range of land use practices across the major watershed for each landscape. The final step remaining with the budgets is to join the establishment cost data and the transition costs data with the spatial representation of operation budgets in order to depict potential net returns from land use transitions across these two landscape. The written summary of these results is nearly complete.

The final component of our work is to utilize the economic, ecological, and social data to identify regions where specific land use transitions optimize these components individually or in combination. With

colleagues at the University of Minnesota and The Natural Capital Project, we are working to combine our economic and ecosystem service data in a multi-service optimization model. We have also continued to make progress, working with Ryan Atwell, on incorporation of the social landscape data for these regions into an optimization model.

Result 2 Status as of March 31, 2014:

During the reporting period the final report chapter describing the methods for LULC map development, field sampling, and accuracy was completed. Seven figures and seven tables were developed to accompany the chapter. Collaboration with TNC on additional revisions to the whole report will continue until the final report is submitted to LCCMR on or before June 30th, 2014. Revisions to the economic analysis write up continued during this time. Further revisions to the yield data for a range of grass based systems were made and maps of crop and grass yields were assembled and formatted for the final report. Most of the tables needed to present net returns from operations were compiled and formatted for the report.

Final Report Result 2 August 12, 2014:

Since March 31, 2014, operation budgets which reflect variability in soil productivity and land use practice have been integrated with the transition costs associated with restoration. The potential economic viability of a transition from row-crop agriculture to any grass-based operation is highly dependent on the following four factors: the initial type of cropping system, the current crop prices, and the underlying soil productivity, and for grazing systems – the intensity of the grazing operation. Net returns from cropland operations were highest for corn and soybean in both landscapes on high productivity soils (land capability classes 1 and 2); returns for all annual crops showed declined rapidly on lower productivity soils (land capability class 3 or higher). Controlling for soil productivity class, cropland returns were higher in the Glacial Lakes landscape than in the Agassiz Beach Ridges landscape. Net returns from grazing operations also declined with soil productivity levels, but showed significantly less variability with soil productivity than did cropland returns. Annual net returns per acre increased with the intensity of the grazing system due to modeled increases in stocking rates and utilization rates. Estimated annual net returns per acre for management intensive grazing systems are fairly comparable to returns from crops even on high productivity soils, with the exceptions being corn and soybeans, and these grazing returns in some cases exceed many crops on lower productivity soils.

However, these annual net return data do not include the costs of transitioning from one land cover and use to another, or the costs of establishing a new operation. Any comparison of operations based solely on the estimated annual return data is incomplete. Across soil productivity levels, our results suggest that landowners will need significant financial assistance with restoration and establishment costs for a transition to a grass-based system to be economically viable. Even with assistance on these one-time transition costs, opportunities are very dependent the specific characteristics of their site and their management practices.

Financial returns are not the only incentive driving land management decisions as the results of the social landscape analysis showed. Our final analyses examining the impacts of land use practices on the provision of services which benefit the public and help inform the implementation teams are ongoing.

V. TOTAL ENRTF PROJECT BUDGET:

Personnel: 160,810

- | | |
|--|---------|
| 1. Senior Project Manager, 50% FTE for 2 years (Chaplin) | 108,710 |
| 2. GIS Database Intern (part time 1024 hours = 25% FTE) | 20,700 |
| 3. Rapid Assessment Seasonal Staff (1440 hours over 2 field seasons = 37.5% FTE) | 19,400 |
| 4. Monitoring Protocol Design - Aquatic and Terrestrial (200 hours) = 12% FTE | 12,000 |

Contracts: \$ 214,010

1. Conservation/Protection: Conduct social analysis using interviews and workshops to assess local attitudes on conservation and future visions (private contractor) \$ 7,000
2. Reconnection/Restoration: Conduct detailed reconnection analysis - \$52,510 (One of the following will be selected: University of Minnesota or RFP)
3. Compatible Economic Ventures: Economic analysis of select prairie-based agriculture approaches - \$154,500 (Postdoctoral Research Fellow under supervision of Steve Polasky/University of Minnesota) – Contract includes \$ 151,000 for personnel, \$ 3,000 for travel, and \$ 500 for printing.

Printing (Page charges, fliers, and factsheets): \$ 300

Equipment/Tools/Supplies (Plat books, maps, binoculars, GIS data recorder and other): \$592

Travel (Lodging, mileage, car rental (if cost saving), and meals to meetings in prairie landscapes, rapid assessment and other field work): \$4,288

Additional Budget Items (Expense for hosting meetings - room rental, audio visual rental): \$ 160

TOTAL ENRTF PROJECT BUDGET: \$ 380,000

VI. PROJECT STRATEGY:

- A. Project Partners:** The project will be a partnership involving many different entities. The Nature Conservancy will serve as the project lead, but will work closely with the University of Minnesota as a sub-recipient of this grant, in particular on Result 2, Native Perennial Economic Development Frameworks, as well as components of Result 1, Prairie Reconnection Landscape Plans. Several agency partners that will not receive funding from this grant have agreed to assist in launching and implementing the project, including DNR – Division of Ecological Resources; DNR – Section of Wildlife; U.S. Fish and Wildlife Service (Glacial Ridge National Wildlife Refuge); and the Board of Water and Soil Resources (RIM easements). In addition, we will reach out to the Minnesota Native Wildflower/Grass Producers Association and numerous other groups that represent key areas of expertise that will be central to this project.

B. Project Impact and Long-Term Strategy: This project addresses fundamental planning needs and economic development guidelines for a long-term prairie landscape conservation initiative. The planning process will design buffers and connections of native perennial plants around and between existing prairie remnants that will provide economic benefits. We envision the products from this work as specific, ready-to-implement projects for which we will pursue additional funding. For example, we have already submitted a "Prairie Recovery" proposal to the Lessard-Sams Outdoor Heritage Council (LSOHC) for cooperative conservation action. We will coordinate the location and activities of the two projects, which are closely related but are separate projects with no mixing of funds. This project will focus on planning and outreach while the LSOHC project will concentrate on acquisition and implementation. We will further explore other sources of funding as well for implementation such as Minnesota Capital Investment funds (bonding), and federal and private sources. We view the current project as an opportunity to demonstrate the power of focused implementation planning and economic modeling to identify those areas with the greatest potential for developing prairie-based economies and scaling up conservation. If successful, a new approach to prairie conservation and restoration may be applied more broadly.

C. Other Funds Proposed to be Spent during the Project Period:

\$87,590 (privately-raised funds in the form of unrecovered indirect costs using the Conservancy's federally approved negotiated indirect cost recovery rate of 23.05% of total project cost)
\$26,350 (TNC State Science Director will contribute approximately \$26,350 in staff time (10% FTE,))

D. Spending History:

TNC staff are likely to engage with partners on conducting preparatory work prior to the official start date of July 1, 2010 at the expense of the Conservancy. Among the activities that may be completed prior to this date are: selecting the two prairie landscapes in which the work will be conducted, posting seasonal positions, and assembling GIS data layers relevant to the project. There is no prior history of state appropriations for this project.

VII. DISSEMINATION:

- Prairie reconnection landscape plans will be available for download and on CD upon request and to all participants in the planning process for each of the two landscapes.
- A ConserveOnline workspace will be set up for each landscape so that products may be posted as they are generated. Links to the workspace will be provided on The Nature Conservancy and Partner websites.
- It is possible that a peer-reviewed scientific publication will be generated by this work, in which case pdfs and/or hard copies may be made available by agreement with the publisher.
- Results will be presented at planner and natural resource forums around the state and nationally as appropriate.

VIII. REPORTING REQUIREMENTS:

We propose to submit progress reports on the following dates:
September 30, 2010

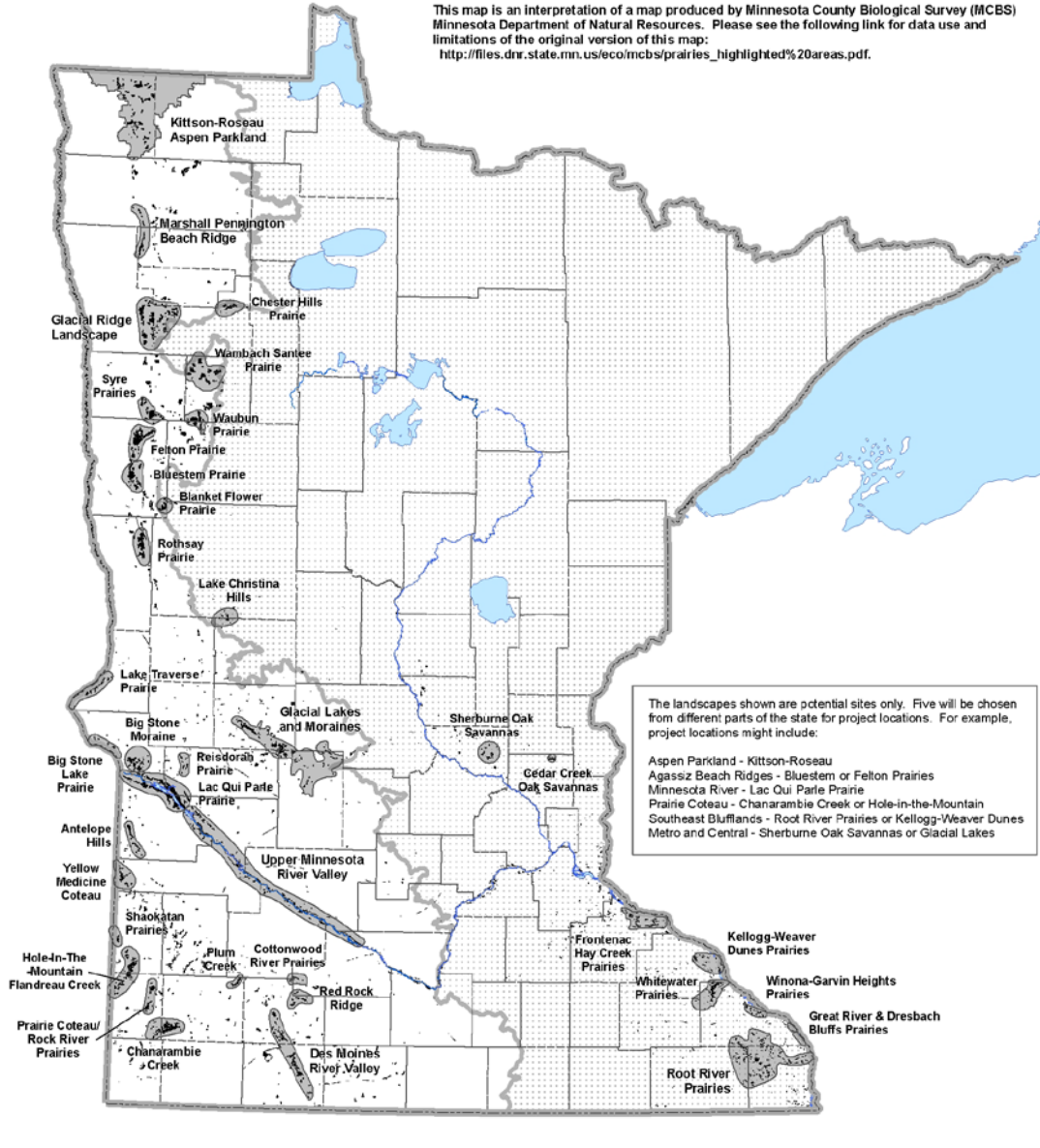
March 31, 2011
September 30, 2011
March 31, 2012
September 30, 2012
March 31, 2013
September 31, 2013
March 31, 2014.
Final Report June 30, 2014

Reconnecting Minnesota's Fragmented Prairie Landscapes

The Nature Conservancy

May 2009 Proposal

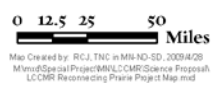
This map is an interpretation of a map produced by Minnesota County Biological Survey (MCBS) Minnesota Department of Natural Resources. Please see the following link for data use and limitations of the original version of this map:
http://files.dnr.state.mn.us/eco/mcbs/prairies_highlighted%20areas.pdf.



The landscapes shown are potential sites only. Five will be chosen from different parts of the state for project locations. For example, project locations might include:

- Aspen Parkland - Kitson-Roseau
- Agassiz Beach Ridges - Bluestem or Felton Prairies
- Minnesota River - Lac Qui Parle Prairie
- Prairie Coteau - Chanarambie Creek or Hole-in-the-Mountain
- Southeast Blufflands - Root River Prairies or Kellogg-Weaver Dunes
- Metro and Central - Sherburne Oak Savannas or Glacial Lakes

- Native Prairie Landscapes (MCBS 2009)
- Native Prairie (MCBS 2009)
- Prairie Provinces
- Forest Provinces



Final Attachment A: Budget Detail for 2010 Projects								
Project Title: Reconnecting Minnesota's Fragmented Prairie Landscapes								
Project Manager Name: Steve Chaplin								
Trust Fund Appropriation: \$ 380,000								
2010 Trust Fund Budget	Revised Result 1 Budget (Revision Approved 6/30/2014)	Amount Spent (6/30/14)	Balance (6/30/14)	Result 2 Budget:	Amount Spent (6/30/14)	Balance (6/30/14)	TOTAL BUDGET	TOTAL BALANCE
DESCRIPTION	Prairie Reconnection Landscape Plans			Prairie-based Economic				
BUDGET ITEM								
OVERALL PERSONNEL: Wages and benefits Senior Project Manager, 50% FTE for 2 years- Chaplin (\$108,710) GIS Database Intern, parttime 30% for 2 years FTE (\$20,700) Rapid Assessment Seasonal Staff, 37.5% FTE for two field seasons (\$19,400) Monitoring Protocol Design - Aquatic and Terrestrial, 15% FTE (12,000)	160,650	160,650	0				160,650	0
CONTRACTS: Professional/technical								
1) (Conservation/Protection) Conduct social analysis using interviews and workshops to assess local attitudes on conservation and future visions (private contractor)	7,000	7,000	0				7,000	0
2) (Reconnection/Restoration) Conduct detailed reconnection analysis (e.g. University of Minnesota &/or RFP)*	52,510	52,509	1				52,510	1
3) (Compatible Economic Ventures) Economic frameworks (Postdoctoral Research Fellow under supervision of Steve Polasky/University of Minnesota)**			0	154,500	154,500	0	154,500	0
OTHER DIRECT OPERATING COSTS Expense for hosting meetings - room rental, audio visual rental	160	160	0				160	0
PRINTING (Page charges, fliers, and factsheets)	300	0	300				300	300
SUPPLIES (Plat books, maps, binoculars, GIS data recorder and other)	592	592	0				592	0
TRAVEL EXPENSES IN MINNESOTA -Lodging, mileage, car rental (if cost saving), and meals to meetings in prairie landscapes, rapid assessment and other field work	4,288	4,288	0				4,288	0
COLUMN TOTAL	\$225,500	\$225,199	\$301	\$154,500	\$154,500	\$0	380,000	\$301
* to include \$51,410 for personnel and \$1,136 for travel								
** to include \$151,000 for personnel, \$3,000 for travel, and \$500 for printing								