2008 Project Abstract
For the Period Ending June 30, 2010

PROJECT TITLE: **Accelerated Prairie Management, Survey, Acquisition and Evaluation**

PROJECT MANAGER: Carmen Converse
AFFILIATION: Division of Ecological and Water Resources, MN Department of Natural Resources

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: ML 2008, Chap. 367, Sec. 2, Subd. 3(m).
$1,250,000 is from the trust fund to the commissioner of natural resources to provide for a rapid assessment of remaining native prairie, accelerate the Minnesota county biological survey in the prairie region, provide technical assistance to private prairie landowners, accelerate management of public and private prairie lands, evaluate and monitor prairie conditions and associated wildlife, and acquire prairie natural areas, prairie bank easements, and buffers. At least $475,000 of this appropriation must be spent on acquisition. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement.

APPROPRIATION AMOUNT: $1,250,000

Overall Project Outcome and Results (includes Use and Dissemination)
Minnesota's native prairie covered about 18 million acres at the time of the public land surveys (1847-1908); currently less than one percent remains. This multi-faceted prairie project was designed to increase conservation of native prairie and provide tools for long-term management and assessment of this rare resource. Project results addressed:

1. Rapid assessment of remaining native prairie;
2. Completion of the Minnesota County Biological Survey (MCBS) in six prairie counties;
3. Increased technical assistance to private prairie landowners;
4. Acceleration of management of public and private prairie lands;
5. Establishment of a baseline dataset for long-term status trend monitoring and analysis;
6. Acquisition of prairie bank easements.

Results:
1) Rapid Assessment: The effectiveness of a computerized procedure to detect changes in mapped prairies was explored in this result. Detailed feature extraction, segmentation, and change analysis procedures using the SPRING software was completed for 1,521 prairie/savanna sites identified by the MCBS prior to 1994. The total area assessed included 65,444 acres of prairie/savanna habitat in 32 counties and over 192,000 acres of surrounding

"buffer" area. Statewide, the prairie habitat examined had a 4% change affecting 2,332 acres from 1991 to 2008. Prairie habitat outside of protected areas had significantly higher amounts of prairie loss or woody vegetation encroachment. A separate report, *Accelerated prairie management, survey, acquisition and evaluation result 1: Rapid assessment of remaining native prairie* was completed.

2) MCBS completed surveys in six counties. Less than 1,700 acres of prairie in these counties was recorded as compared to approximately 2,053,300 acres recorded in the late 1800's. The rarity of prairie species is largely due to prairie habitat loss and fragmentation. Rare plant populations were recorded at 281 new locations, including new distributional data on species such as Wild quinine and Valerian. Vegetation samples (relevés) were collected at 26 locations. A State Wildlife Grant for concurrent animal surveys resulted in 70 new records. Sites of high biodiversity significance such as the 15 acre Dexter Prairie were identified for protection as natural areas.

3) Technical assistance: DNR prairie specialists provided consultation regarding management and protection strategies for native prairies at eight public events and individually to 63 private landowners. Forty prairie stewardship plans were delivered to landowners.

4) Management: The Scientific and Natural Area program (SNA) prairie management activities resulted in 545 acres of woody plant removal, 2085 acres of prescribed burning, 2162 acres of exotic species treatments, and 84.5 acres of prairie reconstruction.

5) Status Trend Monitoring: A total of 683 vegetation transects, 42 relevés, and 1596 bird point counts were completed at 38 sites containing high quality prairie providing a baseline dataset for future proposed long-term monitoring and analysis on at least 35 sites. A separate report, *Accelerated prairie management, survey, acquisition and evaluation result 5: Prairie monitoring and evaluation* was completed.

6) Protection: SNA protected high quality prairies in Big Stone, Pipestone, Goodhue, and Fillmore counties through acquisition of five Native Prairie Bank conservation easements (totaling 476.2 acres) that provide habitat for species such as Greater Prairie Chicken, Chestnut-collared Longspur, Prairie bush clover and Plains wild indigo.

Trust Fund 2008 Work Program Final Report

Date of Report: October 31, 2010
Final Report:
Date of Work Program Approval: June 10, 2008
Project Completion Date: June 30, 2010

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Location: See attached maps- Minnesota's prairie region

Total Trust Fund Project Budget: Trust Fund Appropriation:	**$ 1,250,000**
Minus Amount Spent:	**$ 1,247,738**
Equal Balance:	**$ 2,262**

Legal Citation: ML 2008, Chap. 367, Sec. 2, Subd. 3(m).

Proposed Appropriation Language:
$1,250,000 is from the trust fund to the commissioner of natural resources to provide for a rapid assessment of remaining native prairie, accelerate the Minnesota county biological survey in the prairie region, provide technical assistance to private prairie landowners, accelerate management of public and private prairie lands, evaluate and monitor prairie conditions and associated wildlife, and acquire prairie natural areas, prairie bank easements, and buffers. At least $475,000 of this appropriation must be spent on acquisition. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement.

II. and III. FINAL PROJECT SUMMARY:
Minnesota's native prairie covered about 18 million acres at the time of the public land surveys (1847-1908); currently less than one percent remains. This multi-faceted prairie project was designed to increase conservation of native prairie and provide tools for long-term management and assessment of this rare resource. Project results addressed: 1) Rapid assessment of remaining native prairie 2) Completion of the Minnesota County Biological Survey (MCBS) in six prairie counties 3) Increased technical assistance to private prairie landowners 4) Acceleration of management of public and private prairie lands. 5) Establishment of

a baseline dataset for long-term status trend monitoring and analysis. 6) Acquisition of prairie bank easements.

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1) Rapid Assessment: The effectiveness of a computerized procedure to detect changes in mapped prairies was explored in this result. Detailed feature extraction, segmentation and change analysis procedures using the SPRING software was completed for 1,521 prairie/savanna sites identified by the Minnesota County Biological Survey prior to 1994. The total area assessed included 65,444 acres of prairie/savanna habitat in 32 counties and over 192,000 acres of surrounding "buffer" area. Statewide, the prairie habitat examined had a 4% change affecting 2,332 acres from 1991 to 2008. Prairie habitat outside of protected areas had significantly higher amounts of prairie loss or woody vegetation encroachment. A separate report, *Accelerated prairie management, survey, acquisition and evaluation result 1: Rapid assessment of remaining native prairie* was completed.

2) MCBS completed surveys in six counties. Less than 1,700 acres of prairie in these counties was recorded as compared to approximately 2,053,300 acres recorded in the late 1800's. The rarity of prairie species is largely due to prairie habitat loss and fragmentation. Rare plant populations were recorded at 281 new locations, including new distributional data on species such as Wild quinine and Valerian. Vegetation samples (relevés) were collected at 26 locations. A State Wildlife Grant for concurrent animal surveys resulted in 70 new records. Sites of high biodiversity significance such as the 15 acre Dexter Prairie were identified for protection as natural areas.

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IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Rapid assessment of remaining native prairie

Description: This result will assess the status of approximately 2900 prairie sites surveyed by the MCBS over fifteen years ago, using remote sensing. About half of these sites remain unprotected and are vulnerable to conversion including row crop agriculture, mining, housing, or other conversion. Regardless of protection status, native prairie is vulnerable to degradation due to lack of fire, encroachment by woody plants, competition from non-native plants, global climate change, and other factors. Most native prairie currently exists as small and isolated remnants that are especially susceptible to the often negative influences of adjacent land use practices such as herbicide and pesticide use, conversion of Conservation Reserve Program grasslands to row crops, and development of transportation corridors.

This result will use remote sensing to identify which of the approximately 2900 sites have been changed in the last 15 years by agriculture, mining, housing, roads, woody plant invasion, or other factors visible using remote sensing. Air photos from two time periods (1991 and 2006) will be interpreted to assess the type and extent of changes detected. A small number of sites will need further investigation to determine the type of change by first consulting with those currently knowledgeable about the condition of site, leaving a few sites that will require a site visit by DNR staff.

Photos are available at one to two meter resolution as scanned and geographically rectified digital images on the DNR GIS data server. The 1991 aerial photos are black and white infrared images from the National Aerial Photography Program (NAPP) coordinated by the US Geological Survey. The 2006 photos are true-color images from the USDA Farm Service Agency (FSA). True-color photos from 2003-2004 will be used to complement the 2006 photos as needed. Photo interpretation will be conducted by either a contractor or DNR staff with results recorded using a GIS platform.

A report will describe the status of the 2,900 prairie sites using the following three categories: 1) Number of sites with all prairie remaining. 2) Number of sites with some level of change. 3) Number of sites fully and irreversibly changed. Impact to adjacent areas will be reported as number of sites with change within 50 meters and 100 meters. Changes both within and adjacent to sites will be recorded as mining, road, development, agriculture, woody growth, or other. Depending on feasibility, changes will be mapped, allowing for a summary of the amount of area changed or disturbed. This result will not provide updated boundaries of partially converted/changed sites as this requires further field follow-up.

The outcome of Result 1 will be used to develop protocols for future rapid change analysis procedures to assess the extent of Minnesota's native prairie.

Summary Budget Information for Result 1: **Trust Fund Budget**: **$25,000**
Amount Spent: $24,803
Balance: $ 197

Deliverable	Completion Date	Budget	Status
1. Quantification of amount of remaining native prairie, changed prairie, and level of adjacent land use changes on approximately 2,900 MCBS prairie sites.	6/30/09	$20,000	1,521 sites were selected (65,443 acres)
2. Report and map detailing status of approximately 2,900 prairie sites.	12/31/09	$2,500	Report completed (Attachment B)
3. Protocols for long-term status assessment using new remote sensing tools are developed.	6/30/10	$2,500	Recommendations completed

Final Report Summary:
The rapid assessment of remaining native prairie report that is included in Attachment B was written by Ecologist Andrew Horton who was hired on a temporary basis, in part to complete this portion of the Accelerated Prairie Project. A separate report, *Accelerated prairie management, survey, acquisition and evaluation result 1: Rapid assessment of remaining native prairie* was completed (Attachment B). A summary of that report follows. Additional funding for this Result was provided by a State Wildlife Grant (see section VI below).

Site Selection: A total of 1,521 sites identified by Minnesota County Biological Survey as prairie or savanna habitat prior to 1994 were reviewed for land-use change in the last 15 years. The total area covered included 65,444 acres of prairie/savanna habitat within 32 counties and over 192,000 acres of surrounding buffer. For this report, the entire area was collectively called prairie habitat.

A feature extraction program called SPRING was used to digitize land-use boundaries present in the 2008 photography. The polygons created from this process were used to compare with 1991 imagery and each polygon was updated with a land-use category for both years if there was any change present. Land-use descriptions include detailed categories for Development, Mining, Woody Vegetation Encroachment, Agricultural Activities, Grassland types, Aquatic Habitat or Bare Soil. The final dataset contains a detailed and quantifiable list of non-overlapping land-use change categories.

Change Analysis Results: Statewide, the prairie habitat examined had a 4% change affecting 2,332 acres from 1991 to 2008. The majority of that change was an increase in woody vegetation (1,019 acres), which is potentially reversible through management. Of the areas evaluated, 1.18% of prairie habitat was lost (770 acres) by conversion to development, row crop or mining. There was 544 acres of

woody vegetation removal that was likely a benefit to the prairie habitat. The greatest prairie habitat conversion occurred in the Metro Region due largely to development, and the Minnesota River Valley West Region due to row crop agriculture. The Aspen Prairie Parklands Region had the greatest increase in woody cover growth in mapped prairie habitat when compared with the rest of the evaluated area.

Buffer areas surrounding prairie habitat experienced little change in the past 15 years and results were similar between the 100 meter and 500 meter buffers. Approximately 3% of open grassland was either converted or degraded. Native prairie buffers in the Metro Region had the highest amount of grassland/open space loss from woody encroachment and development.

Of the 1,521 sites evaluated, 1,315 sites had no change from development, mining or agriculture. For the remaining 206 sites, more than half had less than 5% of the overall polygon altered. There were only 11 sites with more than 75% of the original prairie habitat altered and 9 sites in this category were located in the Metro Region.

Of the prairie habitat evaluated, roughly half were considered protected (state, federal, county owned or private enrolled in conservation programs). Prairie habitat not protected had significantly higher amounts of prairie loss or woody vegetation encroachment. Private lands also had less woody vegetation removal than protected-lands. Prairie habitat under protective ownership had little prairie loss (19 acres) with most occurring on county lands and state Wildlife Management Areas.

Quality control checks were done for a small number of sites in Kittson, Red Lake, Mahnomen, Wilkin, Traverse, Big Stone, Grant and Redwood counties. These sites were already scheduled for a site visit to determine questionable or unknown land use, but all other known land use categories were verified and determined to be accurate for each site.

Analysis of Protocols: The change analysis procedure involved many time consuming steps making this project less efficient than originally expected. Problems encountered involved poor image quality for air photos in the southwest part of the state, the seasonal differences in the dates of photography (fall – leaf off in 1991, spring – leaf on in 2008), and the fact that the large spatial extent of area assessed resulted in slow interpretation speed. Steps taken to speed-up processing time included upgrading both computer hardware and the SPRING software and adding additional storage capacity. Given these constraints, it appeared that the processing time still was relatively fast as compared to manually digitizing each prairie and buffer area, assigning them land-use values, and recording observed changes.

Result 2: Accelerated Minnesota County Biological Survey (MCBS) in southern Minnesota counties

Description: The Minnesota County Biological Survey (MCBS) identifies significant natural areas and systematically collects and interprets data on the distribution and ecology of native plant communities, rare plants and rare animals. The information

gathered by MCBS serves as a foundation for the conservation of critical components of Minnesota's biological diversity through ecological monitoring, environmental review, planning, and critical habitat protection.

This project in the six southern Minnesota counties (Dodge, Faribault, Freeborn, Mower, Steele and Waseca) will supplement surveys in progress in other parts of Minnesota as described in Trust Fund 2007 Work Program entitled *Minnesota County Biological Survey.* See also attached map.

Procedure:
Review and site identification: Plant ecologists and zoologists will review existing relevant natural resource data and use Geographic Information Systems and the DNR's Natural Heritage Information System to consolidate and organize data. Examples of reviewed data include wetlands inventories, wildlife habitat inventories, park surveys, soil surveys, land use data, historical public land surveys, biophysical surveys, academic research, and records from museum collections. Staff will supplement this review through interpretation of aerial photography or other imagery in order to identify MCBS sites and species habitats for targeted surveys.

Coordination: Staff will notify and coordinate surveys when possible with other divisions within the DNR, universities, counties, municipalities, watershed districts, federal natural resource agencies, conservation organizations, corporations, and individual landowners.

Field Surveys: Ground surveys to assess natural area and native plant community quality and condition also will include the collection of vegetation samples using relevés in coordination with other sampling (soils, water chemistry etc.) when possible. Additional specialized techniques will be used to survey selected rare species or groups of species (e.g., plants, birds, mammals, reptiles, amphibians, insects, fish).

Natural Heritage Information System: All data collected by MCBS will be entered into the related map, manual and computerized files that make up the Natural Heritage Information System. Some of the databases include: rare features (geographic), relevé (vegetation plot samples), county checklists of plants and animals, MCBS sites, native plant community polygons (GIS), and animal aggregations. Locations of native plant communities are mapped using digital raster graphics, digital orthophotoquads and other digital imagery using ArcGIS. Shape files will be made available on the DNR's Data Deli accessible through the DNR's website. Rare species locations will be entered into Biotics, an information system developed internationally for storing and distributing rare features data such as that collected by MCBS. Photographic vouchers, color slides, digital images, and other digital media will be stored at the DNR, St. Paul and field data sheets will be filed electronically or manually.

Preparation of Collections: All plant and animal specimens will be identified and collections will be prepared for permanent storage in appropriate repositories at the

J.F. Bell Museum of Natural History at the University of Minnesota and at the Science Museum of Minnesota.

Summary Budget Information for Result 2: **Trust Fund Budget: $ 100,000**
Amount Spent: $ 99,541
Balance: $ 459

Deliverable	Completion Date	Budget	Status
Completed native plant community surveys. Rare plant and rare animal surveys in Dodge, Faribault, Freeborn, Martin, Steele, & Waseca counties.	6/30/10	$100,000	Completed field surveys in six counties.

Final Report Summary:

Field surveys were completed in all six counties. MCBS has now finished the survey of rare features in all Minnesota counties where prairie and wetlands dominated the terrestrial landscape at the time of the public land surveys (1847-1908). Less than 1,700 acres of prairie in these counties were recorded as compared to approximately 2,053,300 acres at the time of the public land surveys (1847-1908). Railroad and road rights-of-way contain about half of the extant acres.

The rarity of many of the species associated with this landscape is due largely to habitat loss and fragmentation. The conversion of the prairie and wetlands landscape to row-crop agriculture is especially evident in these six counties. In the six counties rare plant populations were recorded in 281 new locations and in 70 locations for animals. The identification of the remaining parcels of native habitat is intended to help set conservation priorities in this region. In some portions of the region, forested sites associated with riparian features represent some of the best opportunities for conservation.

The collection of vegetation plot data (relevés) at 26 new sites will be especially useful in guiding restoration and prairie monitoring efforts. The survey of species such as the Wood Turtle is contributing to the development of a statewide monitoring project of the populations of this species.

Review and Site Identification/Coordination: A part time botanist/plant ecologist, Derek Anderson was trained in MCBS procedures by senior plant ecologist/botanists and conducted most of the MCBS site, native plant community and rare plant surveys with some assistance from contractors and volunteers. He worked with the animal survey staff in identification of potential survey sites through review of the most recent air photos from the USDA Farm Service Agency (FSA). This was supplemented by review of other resource data and consultation with local natural resource staff from various agencies and individuals in the counties knowledgeable especially about the location of remnant prairies. Permits to public lands were

obtained when needed and private landowners were contacted to obtain permission for access to their lands.

Various activities in coordination with local groups, agencies and conservation organizations increased awareness and understanding of the rare resources of the region.

Examples:

- The plant ecologist solicited and organized work of volunteers from region for a week long, systematic-survey for the plant Green dragon (*Arisaema dracontium*). This plant is currently being considered for listing as a species of special concern. Plants were found in four of five sites surveyed along the Straight River in Steele County and the Cedar River in Mower County.
- A presentation to the Mower County Audubon Society highlighted MCBS 2009 outcomes in the county.
- A presentation to Boy Scout troop leaders provided information about the plants, animals and native plant communities of their region to assist with their planning of future Scout nature programs and activities.
- A MCBS booth at the Waseca County Chautauqua highlighted MCBS findings from the county. Information ranging from rare species descriptions, significant natural areas, and invasive species was shared with over 600 individuals from the greater region.
- The plant ecologist met with staff from DNR's Division of Parks and Trails to help design the Stagecoach Trail to avoid routes that would negatively impact small prairie remnants in the rights-of-way along a number of roads in Dodge and Steele counties.
- Technical assistance related to rare features was provided to the Soil and Water Conservation District of Waseca County.
- The plant ecologist assisted the landowner of a small strip of prairie along a former railroad right-of-way in interpretation and plant identification for a tour by members of the Changing Seasons Garden Club of Rose Creek.

Field Surveys/Natural Heritage Information System:

Locations of native plant communities and MCBS sites of biodiversity significance recorded during field surveys were mapped using ArcGIS for addition to DNR's Data Deli, a public site where users have access to these digital GIS files.

The statewide prairie map available on DNR's website will be updated by December 2010 to include new shape files from prairie native plant community data collected in these counties. http://files.dnr.state.mn.us/eco/mcbs/prairie_map.pdf

The classification used to map native plant communities is presented in two published field guides: *Field guide to the native plant communities of Minnesota: The Eastern Broadleaf Forest Province* and *Field guide to the native plant communities of Minnesota: The Prairie Parkland and Tallgrass Aspen Parklands provinces (2005)* Minnesota Department of Natural Resources (partial funding for these field guides

provided by the Minnesota Environment and Natural Resources Trust Fund). See also the DNR website http://www.dnr.state.mn.us/npc/classification.html

Native plant communities surveyed and mapped in the six counties.

FDs37 – Southern Dry-Mesic Oak (Maple) Woodland

- MHs37 – Southern Dry-Mesic Oak Forest
- MHs38 – Southern Mesic Oak-Basswood Forest
  - MHs38b – Basswood – Bur Oak – (Green Ash) Forest
  - MHs38c – Red Oak – Sugar Maple – Basswood – (Bitternut Hickory) Forest
- MHs39 – Southern Mesic Maple-Basswood Forest
  - MHs39a – Sugar Maple – Basswood (Bitternut Hickory) Forest
  - MHs39c – Sugar Maple Forest (Big Woods)
- MHs49 – Southern Wet-Mesic Hardwood Forest
  - MHs49a – Elm – Basswood – Black Ash – (Hackberry) Forest
- FFs59 – Southern Terrace Forest
  - FFs59a – Silver Maple – Green Ash – Cottonwood Terrace Forest
  - FFs59c – Elm – Ash – Basswood Terrace Forest
- FFs68 – Southern Floodplain Forest
- LKi54b – Mud Flat (Inland Lake)
- CTs33b – Mesic Limestone-Dolomite Cliff (Southern)
- OPp93c – Calcareous Fen (Southeastern)
- UPs13b – Dry Sand – Gravel Prairie (Southern)
- UPs23a – Mesic Prairie (Southern)
- UPs24a – Mesic Oak Savanna (Southern)
- Wps54b – Wet Prairie (Southern)
- WMs83 – Southern Seepage Meadow/Carr
  - WMs83a1– Seepage Meadow/Carr (Tussock Sedge Subtype)
- MRn93a – Bulrush Marsh (Northern)
- MRn93b – Spikerush – Bur Reed Marsh (Northern)

Vegetation samples (relevés) collected at 26 locations were added to the Relevé Database. Relevé methods are described in: Minnesota Department of Natural Resources. 2007. *A handbook for collecting vegetation plot data in Minnesota: the relevé method.* Minnesota County Biological Survey, Minnesota Natural Heritage and Nongame Research Program, and Ecological Land Classification Program. Biological Report 92. St. Paul: Minnesota Department of Natural Resources. Also available on the DNR website: http://www.dnr.state.mn.us/eco/mcbs/vegetation_sampling.html

Improvement to the computerized functionality of the Relevé Database was completed (with other funding provided to MCBS by the Environmental Trust Fund) resulting in more expedient entry of these samples.

Preparation of Plant Collection: Plant collections were made following DNR and Bell Museum of Natural History herbarium guidelines. Species identifications were verified and collections were deposited in the Museum herbarium.

Rare plants were documented at 401 locations as new records or updates to previously known populations. Due to the rarity of prairie and associated rare plants in these counties, verification of previously recorded locations was a priority. All rare plant records were entered into the Natural Heritage Information System (Biotics). The following table provides a summary of rare plant collections.

Scientific Name	Common Name	Current Status	New Locations	Updated Locations
Arisaema dracontium	Green dragon	Non	26	0
Arnoglossum plantagineum	Tuberous Indian-plantain	T	3	4
Arnoglossum reniforme	Great Indian plantain	Non	3	0
Asclepias hirtella	Prairie milkweed	T	2	2
Asclepias sullivantii	Sullivant's milkweed	T	14	5
Baptisia alba	White wild indigo	SC	42	4
Baptisia bracteata	Plains wild indigo	SC	6	4
Cacalia suaveolens	Sweet smelling Indian plantain	E	1	0
Cypripedium candidum	Small white lady's slipper	SC	7	2
Dodecatheon meadia	Prairie shooting star	E	1	2
Eryngium yuccifolium	Rattlesnake master	SC	58	36
Erythronium propullans	MN dwarf trout lily	FE	0	1
Gymnocladus dioica	Kentucky coffee tree	Non	8	0
Hydrastis canadensis	Goldenseal	E	1	0
Juglans cinerea	Butternut	SC	5	0
Lespedeza leptostachya	Prairie bush clover	FT	0	2
Napaea dioica	Glade mallow	T	4	0
Oxypolis rigidior	Cowbane	Non	25	8
Parthenium integrifolium	Wild quinine	E	36	17
Phlox maculata	Wild sweet William	Non	14	0
Platanthera praeclara	W. prairie fringed orchid	FT	0	1
Taenidia integerrima	Yellow pimpernel	Non	3	0
Valeriana edulis	Valerian	T	9	17
Total			**268**	**105**

Current status of species on federal and state lists: FE=federally endangered, FT=federally threatened, E= state endangered, T=state threatened, SC=state special concern, Non=tracked in the Natural Heritage Information System but not state listed.

Plant specimens were collected for counties that had no previously documented collection in the Bell Museum herbarium. These collections contribute to the understanding of the distribution and known ranges of rare and common native species as well as non-native species in Minnesota. Distributional data on species is a valuable for designing restorations using local species and provides a baseline for future monitoring related to management activities and climate change. It is used to update products such as the *Orchids of Minnesota* and the Rare Species Guide (found on the DNR website). The following table provides a summary of county record plant collections.

Scientific Name	Common Name	Counties
Alliaria petiolata	Garlic mustard	Dodge, Faribault, Mower
Antennaria neglecta	Field pussytoes	Dodge
Aplectrum hyemale	Putty root	Steele
Arisaema dracontium	Green dragon	Dodge, Faribault, Mower
Asclepias verticillata	Whorled milkweed	Steele
Astragalus canadensis	Canada milkvetch	Dodge
Beckmannia syzigachne	American slough grass	Mower
Betula pumila	Bog birch	Freeborn
Botrychium virginianum	Rattlesnake fern	Faribault, Freeborn, Mower, Waseca
Brachyelytrum erectum	Long-awned wood grass	Waseca
Bromus kalmia	Kalm's brome	Dodge, Mower
Cardamine bulbosa	Spring cress	Dodge
Cardamine concatenata	Cut-leaf toothwort	Dodge, Waseca
Carex albursina	White bear sedge	Dodge
Carex lasiocarpa	Fen wiregrass sedge	Freeborn
Carex sprengelii	Sprengell's sedge	Waseca
Carex tetanica	Rigid sedge	Freeborn
Caulophyllum thalictroides	Blue cohosh	Freeborn
Ceanothus americanus	New Jersey tea	Dodge, Waseca
Claytonia virginica	Spring beauty	Waseca
Comandra umbellata	Bastard toadflax	Waseca
Comarum palustre	Marsh cinquefoil	Freeborn
Cuscuta pentagona	Dodder	Mower
Cynoglossum officinale	Common hound's tongue	Waseca
Dalea candida v. candida	White prairie clover	Freeborn, Steele
Doellingeria umbellata	Flat-topped aster	Freeborn
Epilobium leptophyllum	American marsh willow-herb	Freeborn
Eragrostis hypnoides	Creeping love grass	Waseca

Eutrochium purpureum	Purple Joe-pye weed	Waseca
Fallopia scandens	Climbing false buckwheat	Mower
Galearis spectabilis	Showy orchis	Mower
Gentiana alba	White/cream gentian	Freeborn
Hackelia virginiana	Stickseed	Freeborn
Hydrophyllum appendiculatum	Appendaged waterleaf	Freeborn
Hypoxis hirsute	Yellow-star grass	Freeborn
Impatiens capensis	Orange jewel weed	Freeborn
Juniperus communis	Common juniper	Dodge
Koeleria macrantha	June grass	Freeborn
Liatris aspera	Rough blazing star	Dodge
Liparis liliifolia	Lily-leaved twayblade	Mower
Lithospermum latifolium	American gromwell	Dodge
Lysimachia terrestris	Swamp candles	Mower
Lythrum salicarisa	Purple loosestrife	Waseca
Maianthemum canadense	Canada mayflower	Dodge, Mower
Onoclea sensibilis	Sensitive fern	Dodge
Onosmodium bejariense	Western false gromwell	Freeborn, Steele
Oxalis violacea	Violet wood sorel	Freeborn
Penstemon grandiflorus	Large-flowered beard-tongue	Freeborn
Physocarpus opulifolius	Ninebark	Dodge
Physostegia virginiana	Obedient plant	Freeborn, Steele
Polemonium reptans	Jacob's ladder	Freeborn
Prenanthes alba	White lettuce	Dodge
Ranunculus flabellaris	Yellow water buttercup	Freeborn
Salix candida	Sage-leaved willow	Mower
Salix serissima	Autumn willow	Mower
Sceptridium dissectum	Dissected grapefern	Mower
Solidago nemoralis	Gray goldenrod	Dodge
Solidago ridellii	Riddell's goldenrod	Steele
Solidago speciosa	Showy goldenrod	Dodge
Thelypteris palustris	Marsh fern	Freeborn
Utricularia vulgaris	Bladderwort	Waseca
Uvularia grandiflora	Large-flowered bellwort	Dodge, Freeborn
Zizania palustris	Wild rice	Waseca

Animal surveys were funded through a State Wildlife Grant (see section VI.B). A separate report associated with this federal project includes additional detail on the accomplishments in these six counties.

Amphibian and reptile surveys were conducted between July 2008 and June 2010. Techniques used to survey terrestrial habitats included herp searches, placement of cover objects, and road surveys. Aquatic habitats were surveyed using turtle traps, aquatic funnel traps, back-packing shocking, and anuran call

surveys. Wood Turtles (*Glyptemys insculpta*) were tracked with radio-telemetry in two watersheds to locate nesting and overwintering sites and to gather information about habitat use and movements. A total of 12 species of amphibians and 12 species of reptiles were documented. This includes 27 new county records (first documented record in the county) for amphibians and 30 new records for reptiles. New locations for two state threatened species, Wood Turtle and Blanding's Turtle (*Emydoidea blandingii*) were recorded.

Scientific Name	Common Name	Current Status (E,T, SC, Non)	New Records
Glyptemys insculpta	Wood Turtle	T	4
Emydoidea blandingii	Blanding's Turtle	T	6
Total			**10**

Bird surveys began in 2009 and were completed in 2010. Bird survey staff completed 105 point counts and compiled 232 species lists.

A total of 142 potential breeding bird species were found in the south-central counties. Forty-nine records of rare species were documented.

Scientific Name	Common Name	Current Status	New Records
Cygnus buccinator	Trumpeter Swan	T	6
Botaurus lentiginosus	American Bittern	Non	3
Grus canadensis	Sandhill Crane	Non	13
Bartramia longicauda	Upland Sandpiper	Non	5
Leucophaeus pipixcan	Franklin's Gull	SC	2
Lanius ludovicianus	Loggerhead Shrike	T	1
Vireo bellii	Bell's Vireo	Non	4
Dendroica cerulea	Cerulean Warbler	SC	1
Wilsonia citrina	Hooded Warbler	SC	1
Chondestes grammacus	Lark Sparrow	Non	2
Ammodramus henslowii	Henslow's Sparrow	E	11
Total			**49**

Fish surveys were conducted in all six counties in 2009, resulting in the documentation of five rare species and the second known location of Slenderhead Darter (*Percona phoxocepha*) in the Cedar River drainage.

Scientific Name	Common Name	Current Status	New Records
Clinostomus elongatus	Redside Dace	Non	1
Etheostoma microperca	Least Darter	SC	1
Lythrurus umbratilis	Redfin Shiner	Non	3
Moxostoma duquesnei	Black Redhorse	Non	1
Notropis nubilus	Ozark Minnow	SC	5
Total			**11**

Small mammal surveys were conducted in all six counties in 2009. Twelve species were documented. No rare species were found, but twenty new county records were added.

Preparation of Animal Collections: When animal collections are made, DNR and Bell Museum of Natural History guidelines are followed for specimen preparation and are deposited in the collections of the Bell Museum.

A new MCBS web location displays maps and data on bird survey data.

http://www.dnr.state.mn.us/eco/mcbs/bird_map_list.html

Potential Natural Areas-Examples of Sites of Outstanding and High Biodiversity Significance

Dexter Prairie in Mower County includes 15 acres of high quality mesic prairie, a native plant community that is exceedingly rare in the six counties. The site contains populations of the rare plants, Tuberous Indian-plantain, Valerian, Rattlesnake master and Cowbane. These rare plant species were once relatively widespread in southern Minnesota prairies but have declined in native populations due to the extreme loss of habitat. The MCBS plant ecologist wrote an ecological evaluation for Dexter Prairie and presented this site to the Commissioner's Advisory Committee where it was approved for potential acquisition as a state Scientific and Natural Area (SNA).

In Dodge County, a small prairie knoll was identified as a site of high biodiversity significance. This site contains a dry prairie, with a large population of the federally threatened Prairie bush clover.

Also in Dodge County, a site containing a largely forested portion of Dodge Center Creek was evaluated to be of high biodiversity significance. The creek and associated floodplain and cliff native plant communities provide important habitat for a number of rare species. This includes a population of the endangered plant, Goldenseal, a large population of the state threatened species, Glade mallow, the special concern species, Butternut and Green dragon. The threatened Wood Turtle inhabits portions of Dodge Center Creek. An ecological evaluation describing the importance of this site is being prepared.

Several other large forested tracts in good condition were located along rivers and streams in the region. For example, in Faribault County, seven high quality forests were located along the Blue Earth River. Reports to the landowners include a description of the significance of their woods and conservation options. At least one site will be summarized in an Ecological Evaluation and proposed as a potential Scientific and Natural Area.

Very little remains of the native prairies that once covered a large proportion of the six county region. In Faribault County, for example, only four new locations of prairies were recorded, all on privately-owned land. Reports to the landowners

related the extreme rarity of these communities and informed them of conservation options such as prairie bank.

Result 3: Accelerated technical assistance on privately owned prairie

Description: The goal is to accelerate long-range planning assistance to private landowners through management consultation and delivery of prairie stewardship plans to landowners. DNR Prairie Specialists will offer six prairie management workshops and field days for private landowners. In addition, private-sector consultants or DNR Prairie Specialists will personally meet with fifty landowners in order to listen to their goals, examine their property, and provide technical consultation as to how to best manage their prairie. Forty of these landowners will then receive a comprehensive prairie stewardship plan that includes an evaluation of the condition of their prairie, identification of management needs, and recommendations for management action. DNR Prairie Specialists can then deliver financial and project management assistance to landowners who wish to implement their stewardship plan.

Summary Budget Information for Result 3: **Trust Fund Budget: $200,000**
Amount Spent: $198,394
Balance: $ 1,606

Deliverable	Completion Date	Budget	Status
1. Six workshops/field days developed for prairie landowners	Two by 6/30/09; four more by 1/31/10, and a total of six by 6/30/10	$5,500	8 workshops / fields completed
2. Consultations, guidance, management assistance, etc. provided to 50 landowners	50% by 6/30/09 and 100% by 6/30/10	$90,000	63 landowners provided management guidance
3. Stewardship plans provided to 40 prairie landowners	50% by 6/30/09 and 100% by 6/30/10	$104,500	40 stewardship plans provided to landowners

Final Report Summary:
SNA field staff persons hosted or collaborated on eight different events where prairie management and protection information was provided to private landowners. The dates and names of these events are listed below:

8/23/08 – Minnesota River Bluff Workshop (Location: Fort Ridgely State Park)
3/12/09 – Native Pollinator, Birds, and Grasslands (Location: St. James, MN)
8/4-6/09 – Farmfest: answer landowner questions re: conservation options (Redwood County)
8/7/09 – SNA Prairie Tours: management demonstration, landowner awareness (Mower County)
8/20/09 - Prairie ecology and history presentation (Mankato, MN)

8/29/09 – Prairie Tour: raising awareness and appreciation (Martin County)
2/25/10 – Working Lands Workshop – Prairie management options for landowners (Sunburg, MN)
4/10 & 17/2010 - Prairie Tours – “First Rite of Spring”: raising prairie awareness and appreciation (Martin County).

DNR prairie specialists provided consultation to 63 landowners regarding management and protection strategies for their native prairies. These consultations provided prairie owners an opportunity for a one-on-one conversation with a prairie resource specialist. These consultations have resulted in four new Native Prairie Bank applications from landowners, generated interest from 18 new landowners now pursuing stewardship action on their lands, and have raised the awareness and understanding of the rare prairie resource.

Contracts were awarded and completed for prairie stewardship planning services on 35 native prairie sites throughout the western and southern regions of Minnesota. DNR prairie specialists also completed another five prairie stewardship plans. These comprehensive prairie stewardship plans provide owners with an evaluation of their prairie’s condition, identification of critical management needs, and recommendations for implementing those management actions. These plans combine both the landowner’s goals for future land use and the state’s interest in prairie conservation.

Result 4: Accelerated prairie management (public/private)

Description: This result will help to maintain healthy native prairies by implementing management activities on priority public and private prairie, including: woody encroachment removal (100 acres), exotic species treatment (85 acres), prescribed burning (875 acres), and native seed harvests and restorations (~~60~~ 40 acres). Prairie management crews and/or contractors will implement prairie management across multiple programs and ownerships, including: SNA, State Parks, Wildlife Management Areas, Prairie Bank easements, and Prairie Tax Exemption lands. In many cases, the DNR will package groups of projects, such as prescribed burns, into larger contracts for competitive bidding in order to efficiently provide quality services to landowners at the lowest possible cost. As identified in Section VI.B, Statewide Wildlife Grant (federal) funds will leverage additional native prairie management on public lands.

Summary Budget Information for Result 4:	**Trust Fund Budget:**	**$280,000**
	Amount Spent:	**$280,000**
	Balance:	**$ 0**

Deliverable	Completion Date	Budget	Status
1. Woody removal from 100 acres of prairie/grassland	50% by 6/30/09 and 100% by 6/30/10	$75,000	545 acres treated on 30 units
2. Prescribed burning on 875 acres of prairie/grassland	50% by 6/30/09 and 100% by 6/30/10	$105,000	2,085 acres burned on 42 units
3. Exotic species treatment on 85 acres of prairie/grassland	50% by 6/30/09 and 100% by 6/30/10	$60,000	2,162 acres treated on 48 units
4. Prairie reconstruction on 40 acres to benefit native prairie	50% by 6/30/09 and 100% by 6/30/10	$40,000	84.5 acres reconstructed on 7 units

Final Report Summary:
The SNA program exceeded the stated deliverable goal for this result. This is in part due to the fact that a suppressed economy is making vendors compete vigorously for state contracting opportunities. The result became a better value for every ETF dollar. Contracted services were used for 36% of funding provided for implementation of projects. The ability to exceed stated acreage goals was also due in part to the nature of the specific projects completed - many projects were large in size with low to moderate complexity in management planning and execution. The SNA program completed 545 acres of woody removal, 2,085 acres of prescribed burning, 2,162 acres of exotic species treatments, and 84.5 acres of prairie reconstructions. For woody removal a variety of techniques were used including girdling, cut and stump treat, and mechanical mowing – all designed to be low impact to the prairie. A variety of low impact techniques were also used for invasive species control projects including hand pulling, spot treatments, and biological controls. All projects were completed on designated Scientific and Natural Areas and permanently protected Native Prairie Bank easements.

Result 5: Evaluate prairie condition and animal species.

Description: This result will develop and test protocols for evaluating the condition of prairies and constituent animal populations on 24 to 48 selected, high-quality native prairie sites. A critical, but often neglected, aspect of natural resource management is monitoring and evaluation. Monitoring is necessary to assess if management actions have achieved desired objectives. More broadly, monitoring can provide status and trend information to signal changes that require further action. This monitoring project focuses on the status and trends of important indicators of prairie condition and associated animal species populations.

Selection of the high-quality prairie sites will be stratified by several factors such as landscape context (embedded, isolated), prairie community class, size, ownership and geographic location (within some or all of the five focus areas identified on the attached map). Management practices will be recorded for use as covariates during

analysis. Prairie condition monitoring will test and apply existing protocols, such as belt transect and invasive species protocols, in order to perform sensitivity analyses and to develop a baseline of information for long-term monitoring on the selected prairie sites. Animal species monitoring will focus on several taxa groups and will use area-occupancy designs as described in "Occupancy Estimation and Modeling" (MacKenzie et al. 2006) and components of multiple species sampling protocols (Manley et al. 2006, Kinkead 2006). The first season (2008) will largely be used to test optimal sampling methods and to determine species detectability. This information will be used to develop preliminary protocols and sampling designs to be applied in the following field seasons. This project will be conducted by a combination of contractors, university students, and DNR staff. Databases and mobile data units will be developed to allow for data collection, storage, and analysis.

References Cited:

Kinkead, K. 2006. Iowa Multiple Species Inventory and Monitoring Program Technical Manual. Iowa Department of Natural Resources.

Mackenzie, D.I, J.D. Nichols, J.A Royle, K.H. Pollock, L.L. Bailey, and J.E. Hines. 2006. Occupancy Estimation and Modeling. Academic Press. Burlington, MA.

Manley, P.N., B. Van Horne, J.K. Roth, W.J. Zielinski, M.M. McKenzie, T.J. Weller, F.W. Weckerly, and C. Vojta. 2006. Multiple Species Inventory and Monitoring. USDA Forest General Technical Report W0-73.

Summary Budget Information for Result 5: **Trust Fund Budget: $170,000**
Amount Spent: $170,000
Balance: $ 0

Deliverable	Completion Date	Budget	Status
1. Prairie quality and condition monitoring protocols developed, tested and applied.	8-16 sites by 12/30/08	$15,000	Protocol developed and field tested.
2. Prairie quality and condition monitoring protocols refined followed by additional application.	16-32 sites by 12/30/09	$21,000	Vegetation monitoring completed at 38 sites.
3. Multiple species monitoring protocols developed and tested for several animal taxa.	8-16 sites by 12/30/08	$25,000	Animal species monitoring was explored for various taxa. Bird monitoring selected as the focus of this project

4. Multiple species monitoring protocols for several animal taxa refined and applied.	16-32 sites by 12/30/09	$35,000	Bird monitoring completed at 38 sites. Complimentary projects for other taxa explored with other funding/collaborators.
5. Databases developed and tested, data entered and analyzed.	6/30/10	~~$49,000~~ $69,000	Vegetation and bird monitoring databases created, data entered, analyzed. Contributed to the ongoing development of the Adaptive Management Spatial Database.
6. Report detailing monitoring protocols and sampling procedures.	6/30/10	$5,000	See Attachment C

Final Report Summary:
Daren Carlson, an ecologist in the Division of Ecological Resources who has oversight on monitoring efforts of the State Wildlife Action Plan (SWAP) coordinated the evaluation of prairie condition and animal species (Result 5). He also wrote a separate report, *Accelerated Prairie Management, Survey, Acquisition and Evaluation; Result 5: Prairie monitoring and evaluation* found in Attachment C. A summary of that report follows. Additional funding for this Result was provided by a State Wildlife Grant (see section VI below).

Site Monitoring: A total of 38 high quality prairie sites were monitored for baseline vegetation and bird data over the 2008-2010 field seasons. Sites were selected from sites identified by the Minnesota County Biological Survey as high quality native prairie, and were stratified according to geography and landscape context.

A total of 683 vegetation transects, 42 relevés, and 1,596 bird point counts were completed across the 38 sites, providing a substantial dataset for establishing baselines of bird and plant community conditions across the matrix of sites, testing and modifying monitoring protocols, and initiating long-term trend monitoring and analysis. Current long-term plans are to monitor a total of 35 sites on a five year rotation (7 sites per year), with five additional sites monitored every year to detect annual variation.

Collaboration: DNR staff participated in a multi-agency Grassland Adaptive Management Collaborative to develop models, refine protocols, and train field staff. This Trust Fund project was designed in part to address outstanding monitoring protocol questions such as sampling density, transect length, and selection of indicator species.

Bird Results: Over the three field seasons of bird surveys, 163 bird species were recorded using standard point count methodology. Fifty-four species were Species in Greatest Conservation Need as identified in the SWAP, 16 were state listed, and 24 were grassland dependent species. Bird community monitoring became the only

animal focus for this project. Other prairie animals, such as insects and reptiles, are now being studied in separate, but complementary projects.

For all bird species, richness (the number of bird species recorded per point) significantly increased from the southern to northern focus areas, but was not influenced by landscape context (large-embedded vs. small-isolated). For grassland dependent birds, however, the species richness was significantly higher in large-embedded sites in all but one focus area, and also followed the same geographic trend as for all species. Species abundance (the number of bird individuals recorded per point) followed similar patterns as species richness, with a few exceptions detailed in the main report.

After three years of data collection, no trends or patterns of change were detected for abundance of individual bird species per site. This indicates the value of long-term monitoring to determine species trends.

Vegetation Monitoring: The primary purposes of the 2008-2009 field seasons for prairie vegetation monitoring were to test the efficacy of the hierarchical belt transect protocols developed by Grassland Adaptive Management Collaborative as well as to collect baseline data for the long-term prairie monitoring effort. Vegetation monitoring measured four main components: 1) Rapid condition assessment (called the plant group score). 2) Presence of indicator species. 3) Vegetation structure. 4) Plant species composition.

A total of 435 plant species were recorded over the two sampling years. Species richness (number of species per transect) and plant group score was highest in the two northern-most focus areas. Certain individual plant species showed geographic patterns. In particular, Kentucky bluegrass (*Poa pratensis*), a non-native species and the most frequently measured plant overall, increased in both frequency and, more significantly, cover from north to south. The number of indicator species did not show any relationship to geography (the focus areas) or landscape context.

Sensitivity Analyses of Protocols: Preliminary findings from sensitivity analyses of the monitoring protocols are:

1) Plant group score, a rapid assessment for evaluating prairie condition, shows a fairly strong relationship to species richness and number of indicator species, although considerable variability in the relationships indicates it should not be used as a sole-measure.

2) The current suite of quality indicators are more likely to be present in Upland Prairie systems than Wet Prairie Systems and are rarely present in Wet Meadow systems. The quality indicator list should be modified to include more species typical of the wetter prairie systems.

3) Sampling density (number of transects per acre) for capturing species richness is variable by site. Sampling density may be reduced and still effectively capture quality indicators.

4) Preliminary analyses show that reducing transect length by as much as half (12.5 m or 25 quadrates) will increase sampling speed and likely not substantially alter most of the vegetation measures.

Data management: Development of applications for field entry of bird monitoring data and vegetation indicator species into mobile data recorders enabled efficient and accurate data recording, and saved considerable time and cost by not having to enter hand-written datasheets into a database following the field season.

DNR staff modified a grassland monitoring database developed by the US Fish and Wildlife Service as part of the Grassland Adaptive Management Collaborative to enable entry and storage of the most-detailed protocols while maintaining the database structure. This allowed relatively easy transfer of the core data to the Collaborative (currently managed by the USFWS Morris Wetland District).

This project contributed to the development of an Adaptive Management Spatial Database (AMSD) that allows users to set management objectives, define, track and report on management activities and track and report on biological outcomes (monitoring data).

Result 6: Native prairie acquisition

Description: The Scientific and Natural Area program will protect and buffer high priority native prairie by fee acquisition and designation as a Scientific and Natural Area (SNA) of approximately 100 acres and by acquisition of Native Prairie Bank conservation easements (administered by the SNA program) on approximately 50 acres. This high quality prairie will contain rare and endangered plant and animal species, undisturbed plant communities, and key habitats for Species of Greatest Conservation Need identified in the State Wildlife Action Plan. Sites to be acquired under this appropriation have been identified as priorities for protection by the Minnesota County Biological Survey (MCBS). In addition, to be eligible for SNA acquisition, an Ecological Evaluation for each geographic area must be approved by the Commissioner's Advisory Committee.

Currently, 144 SNAs encompassing over 181,800 acres have been designated in Minnesota, including 65 sites protecting about 11,000 acres of native prairie. Sites acquired in fee as SNA will be open to the public for scientific study, education, and nature observation and will be designated and managed as provided in MN Statute 86A.05 and MN Rules 6136.

Currently, 79 Native Prairie Bank (NPB) conservation easements totaling 6,145 acres have been acquired and protected (plus 4 sites that subsequently have become SNAs). Each Native Prairie Bank easement is, in essence, a partnership between the SNA program and the landowner. NPB easements restrict the use of the prairie in order to protect it but can (and sometimes do) allow the fee title landowner to retain limited haying, grazing, or seed collection rights on the prairie. When a landowner retains any of these rights their payment is reduced. Currently all NPB easements allow public access.

Land acquired with this appropriation will be sufficiently improved to meet at least minimum management standards as determined by the commissioner. Baseline data (i.e. a property report) for easement stewardship monitoring will be collected for easements acquired with this funding. DNR will be addressing long-term easement stewardship as part of the separate LCCMR project on conservation easement monitoring and how DNR can receive and invest/endow a fund for long term easement monitoring. Natural resource stewardship on properties acquired through this Result will be initiated (as timing permits) through Result 3 and 4 of this LCCMR project, and with other LCCMR and non-LCCMR funding (as available) through the Division's Prairie Stewardship Program for private lands and through SNA site management. All required Trust Fund acquisition reports for each acquisition will be submitted to the LCCMR.

Specifically, to date the following areas with significant native prairie have been identified as conservation priorities for potential SNA fee and/or NPB easement acquisition under this grant:

- Felton Prairie SNA addition (Clay Co)
- Chanarambie Creek (Murray Co)
- Morton Outcrops (Renville Co)
- Boiling Springs Prairie (Redwood Co)
- Big Stone Moraine prairie complex (Big Stone Co)
- Des Moines River valley prairies (Jackson Co)
- Lower Antelope Valley prairie complex (Yellow Medicine Co)
- Mikkelson Prairie (Swift Co)
- Ten Mile Creek Prairie (Lac Qui Parle Co)
- Kasota Prairie SNA addition (Le Sueur Co)
- No. Prairie Coteau prairie macrosite (Sioux Nation Area) (Yellow Medicine Co)

In addition, sites in the following townships have quality native prairie with potential for Native Prairie Bank conservation easement acquisition through this funding:

- Altona and Burke Twsp (Pipestone Co)
- Great Bend and Delton Twsp (Cottonwood Co)
- Westerheim Twsp (Lyon Co)
- Marble Twsp (Lincoln Co)
- Tilden Twsp (Polk Co)
- Benson Twsp (Swift Co)
- Akron Twsp (Big Stone Co)
- Rushford Twsp (Fillmore Co)
- Stanton Twsp (Goodhue Co)

Summary Budget Information for Result 6: **Trust Fund Budget: $475,000**
Amount Spent: $475,000
Balance: $ 0

Deliverable	Completion Date	Budget	Status
1. 250 acres NPB easements acquired.	6/30/2010	$475,000	308 acres acquired via 5 NPB acquisitions

Final Report Summary:
Five Native Prairie Bank (NPB) Conservation Easements totaling 476.2 acres were acquired in whole or part through this appropriation (308.1 LCCMR acres; 268.1 acres with other state funding – pro-rated on direct landowner payments costs). This included completing base line property reports for each of the NPB's acquired. The specific characteristics of the five sites acquired are listed below and their location is shown on the attached map. Work was initiated on acquiring additions to two SNAs; but one landowner turned down the DNR offer of buying it at appraised value and landownership issues delayed the other project past the timing of this appropriation, so this appropriation was applied entirely to NPB acquisitions.

Altona (Pipestone County) Native Prairie Bank Acquisition
The 160.2-acre Altona 31-2 Native Prairie Bank conservation easement acquisition in Altona Township in Pipestone County closed in February 2009 – with 125.2 acres paid through this funding and the remainder from 2006 NPB bonding and 2008 Prairie bonding. Specifically, the Altona 31-2 NPB is 160 acres of grazed Southern Wet Prairie and Dry Sand-Gravel Prairie that harbors the state-endangered Chestnut Collared Longspur (*Calcarius ornatus*) and includes Topeka Shiner (*Notropis tristis*) critical habitat. The protected property also provides habitat for Richardson's Ground Squirrel (*Speotyto cunicularia*) and Upland Sandpiper. This is the second of two adjoining NPBs acquired in FY09. As specifically permitted under the terms of the easements, the owner of the adjoining Altona 31-1 NPB (this owner's brother) has agreed to reduce the cattle stocking rate on both Altona 31 NPB parcels in order to manage the prairie using an ecologically more appropriate level of grazing, while also sustaining livestock production as part of the local rural economy.

Root River Valley Prairie (Fillmore County) Native Prairie Bank Acquisition
The 40.5-acre Rushford 3-1 Native Prairie Bank conservation easement acquisition in Rushford Township in northern Fillmore County closed in June 2010. The site encompasses Dry Bedrock Bluff Prairie with Outstanding Biodiversity Significance and has multiple occurrences of rare features including the Timber Rattlesnake (*Crotalus horridus*), Clasping milkweed *(Asclepias amplexicaulis)*, Valerian, Goat's rue (*Tephrosia virginiana)*, Jeweled shooting star *(Dodecatheon amethystinum)* and Plains wild indigo.

Lac Qui Parle Prairies (Big Stone County) Native Prairie Bank Acquisition – 2 sites
Two projects within the Correll Target Area in Big Stone County were acquired as NPB in cooperation with the Working Lands Initiative which contributed $75,938.14 of state Heritage Enhancement funds in landowner payments for these two projects and $105,029.82 of 2008 prairie bonding towards the later project. The 63.2-acre (52.1 pro-rated acres with this appropriation) Akron 13-1site is contiguous to both Lac Qui Parle WMA and a USFW Easement. The site encompasses B quality Mesic Prairie with High Biodiversity Significance and has several occurrences of rare species including the Upland Sandpiper, Greater Prairie Chicken (*Tympanuchus cupido*) and Prairie moonwort *(Botrychium campestre).* The 178.8-acre (56.86 pro-rated acres) Akron 11-1 is just North of Lac Qui Parle WMA. The site encompasses Mesic Prairie with Moderate Biodiversity Significance and has multiple occurrences

of vertebrate animals including the Upland Sandpiper, Lark Bunting (*Calamospiza melanocorys*), and Short-eared Owl (*Asio flammeus*).

McKnight Prairie (Goodhue County) Native Prairie Bank Acquisition
Located in northeastern Goodhue County, the 33.4-acre Stanton 18-1 site encompasses Dry Bedrock Bluff Prairie with Outstanding Biodiversity Significance. The site has multiple occurrences of rare species including Prairie Vole (*Microtus ochrogaster*), Long-bearded hawkweed *(Hieracium longipilum)*, Prairie bush clover, and Kitten-tails *(Besseya bullii).*

V. TOTAL TRUST FUND PROJECT BUDGET:

Budget Item	
Staff or contract services: private consulting services, NR Specialists, NR Technicians, NR laborers*	$558,000
Equipment: vehicle fleet costs (e.g. ATV, pick-up, ASV tracked vehicle)	$ 44,000
Development: (improvement to land or building)	$ 0
Acquisition: fee title, easements, professional services for acquisition	$462,000
Restoration: landowner reimbursements; contracts for prescribed burning, prairie reconstructions, woody encroachment, etc.	$125,000
Travel	$ 41,000
Other: $	$ 20,000
TOTAL TRUST FUND PROJECT BUDGET:	$1,250,000

Explanation of Capital Expenditures Greater Than $3,500: None

Explanation of Personnel Costs:

Only time spent on approved projects will be charged to these funds. Without these funds, none of the projects in this work program would be completed. They are an acceleration of related initiatives.

To implement projects in the work program, specialized skills (prescribed burning, knowledge of sites and management implications) are often required. DNR employees with the training, experience and certifications required to do these specialized tasks are used to directly implement these projects, and work with landowners and contractors to design, direct and certify completion of projects they carry out.

*Funds will be used to extend existing DNR seasonal crews or natural resource technicians and specialists undertaking projects in this work program. These positions are unclassified and classified (all AFSCME employees must be classified as per contract).

VI. OTHER FUNDS & PARTNERS:

A. Project Partners: DNR Scientific and Natural Area Program, DNR Division of Fish and Wildlife Area wildlife managers, and DNR Division of Parks and Recreation.

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

	Result 1	Result 2	Result 4	Result 5	**Total**
State Wildlife Grants (SWG, federal funds)	$25,000	$100,000	$75,000	$150,000	**$350,000**
Landowner Incentive Program (LIP, federal funds)				$75,000	**$75,000**

Three of the acquisition projects were acquired in part with other funding: $137,144 in state bonding (2006 NPB appropriation and 2008 SNA-NPB prairie appropriation) and $75,938 of Heritage Enhancement funds for DNR Wildlife's Working Lands Initiative. The accomplishment acres above have been pro-rated across the funds for direct landowner payments.

C. Past Spending: SNA/NPB statewide acquisition and development appropriations received in July 2005-June 2007: LCCMR SNA Metro Corridors Phase III: $243,000; LCMR SNA Metro Corridors Phase II: $300,000; 2005 Bonding: SNA $300,000 and NPB $1,000,000; and 2006 Bonding SNA $2,000,000 and NPB $1,000,000. SNA general fund includes approximately $400,000 annually for statewide operations and crew. MCBS July 2005 –June 2007 General Fund: $373,000; RIM Gen $181,400; Heritage Enhancement $1,125,000; SWG $439,000; LCMR $1,000,000. (See also Trust Fund Work Program 2007 Minnesota County Biological Survey).

D. Time: MCBS is proposed for completion in 2021. Future requests for MCBS funding, management, monitoring and acquisition from the Minnesota Legislature and other cooperators are anticipated.

VII. DISSEMINATION:

Data on rapid change assessment and surveys of native prairies and prairie species, guidance for prairie management assistance and locations of SNAs are presented on the DNR website. Many GIS datasets are delivered through the web and through agreements with the requesting agency and the DNR's Ecological and Water Resources Division. For example, for data on locations or rare features, a data request form is also available via the web: http://www.dnr.state.mn.us/eco/nhnrp

Ecological and Water Resources invests considerable time in publishing and distributing results in a variety of formats for various audiences. The DNR and Legislative libraries and other local information repositories (such as county libraries) are sent published products, including maps, reports, field guides and digital media. Increasingly products are available on the DNR website, including GIS shape files of native plant communities and MCBS sites, native plant community field guides,

guides to sampling techniques and monitoring protocols such as vegetation plot data collection using the relevé method. The web site is updated with new information and has links to associated resources.

Staff make presentations that describe goals, methodologies and results to a wide range of audiences including county boards, local planning groups, land managers, citizen and technical advisory groups, and at professional meetings. Staff provide local planners and managers with ecological interpretations related to important sites of biodiversity identified during MCBS to assist with management plans.

DNR staff also lead or participate in technical workshops and field trips to provide training in the application and interpretation of management of native prairie on public and private lands.

Copies of stewardship plans are routinely provided to local DNR managers and used by the landowner in coordination with other agencies and programs.

Monitoring protocols will be made available to other cooperators interested in prairie monitoring. The results of the monitoring efforts will serve as baseline information for long-term monitoring of the selected prairie sites.

The SNA program will issue a press release and/or publicize a dedication event for each acquisition completed through this project.

MCBS delivers data as part of NatureServe and also shares data with cooperators at colleges and universities and with others in a particular ecological region where surveys are ongoing or completed.

Physical collections are deposited at Minnesota repositories, primarily at the University of Minnesota's J.F. Bell Museum of Natural History and the Science Museum of Minnesota, St. Paul, MN. As part of a larger network of museums and herbaria, these cooperators are essential to the documentation and sharing of MCBS results. MCBS and museum staff meet periodically to address curatorial, data management, and interpretive needs.

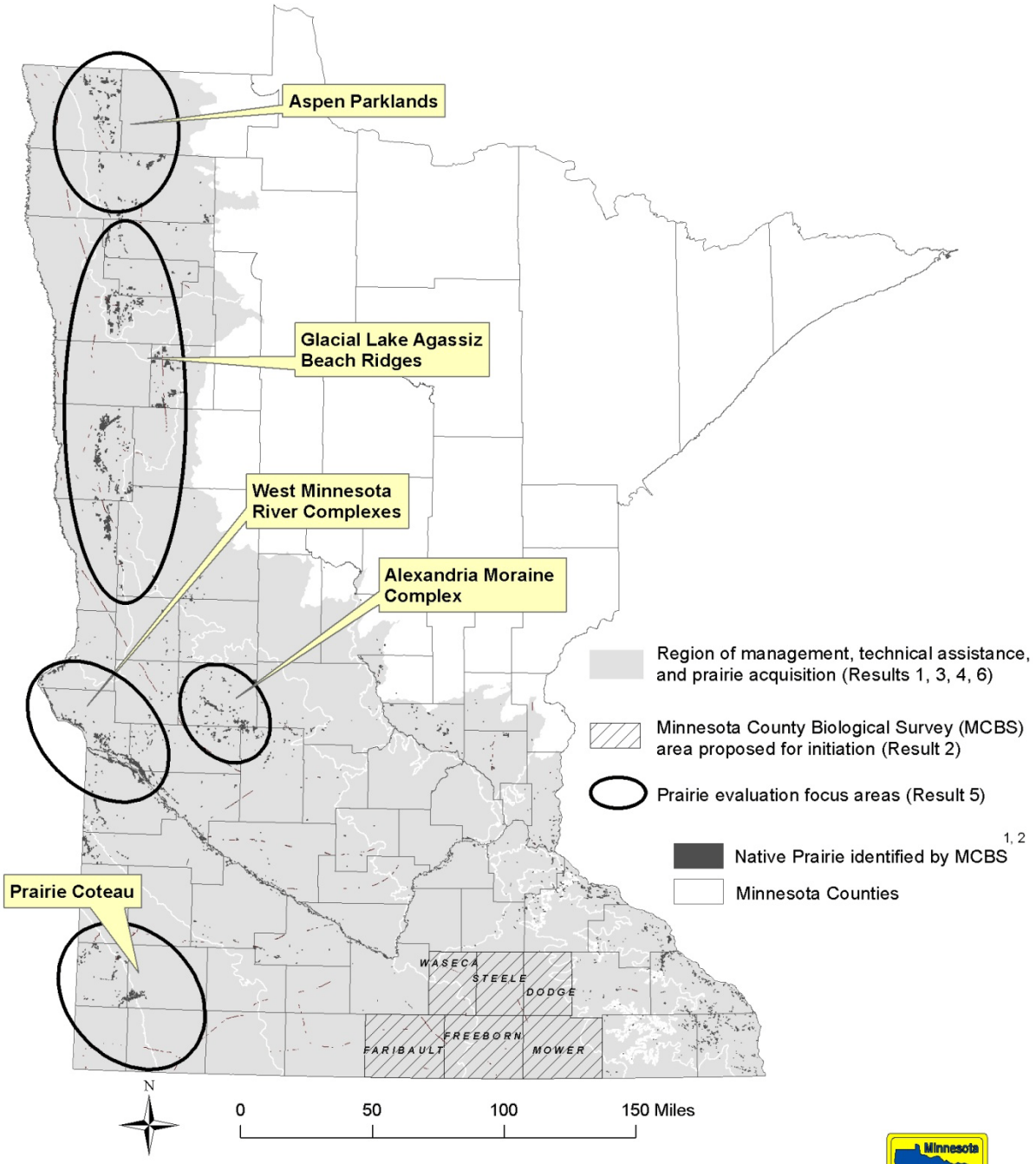
VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted no later than April 15, 2009, October 15, 2009, and April15, 2010. A final work program report and associated products will be submitted between June 30 and August 1, 2010 as requested by the LCCMR.

IX. RESEARCH PROJECTS: *NA*

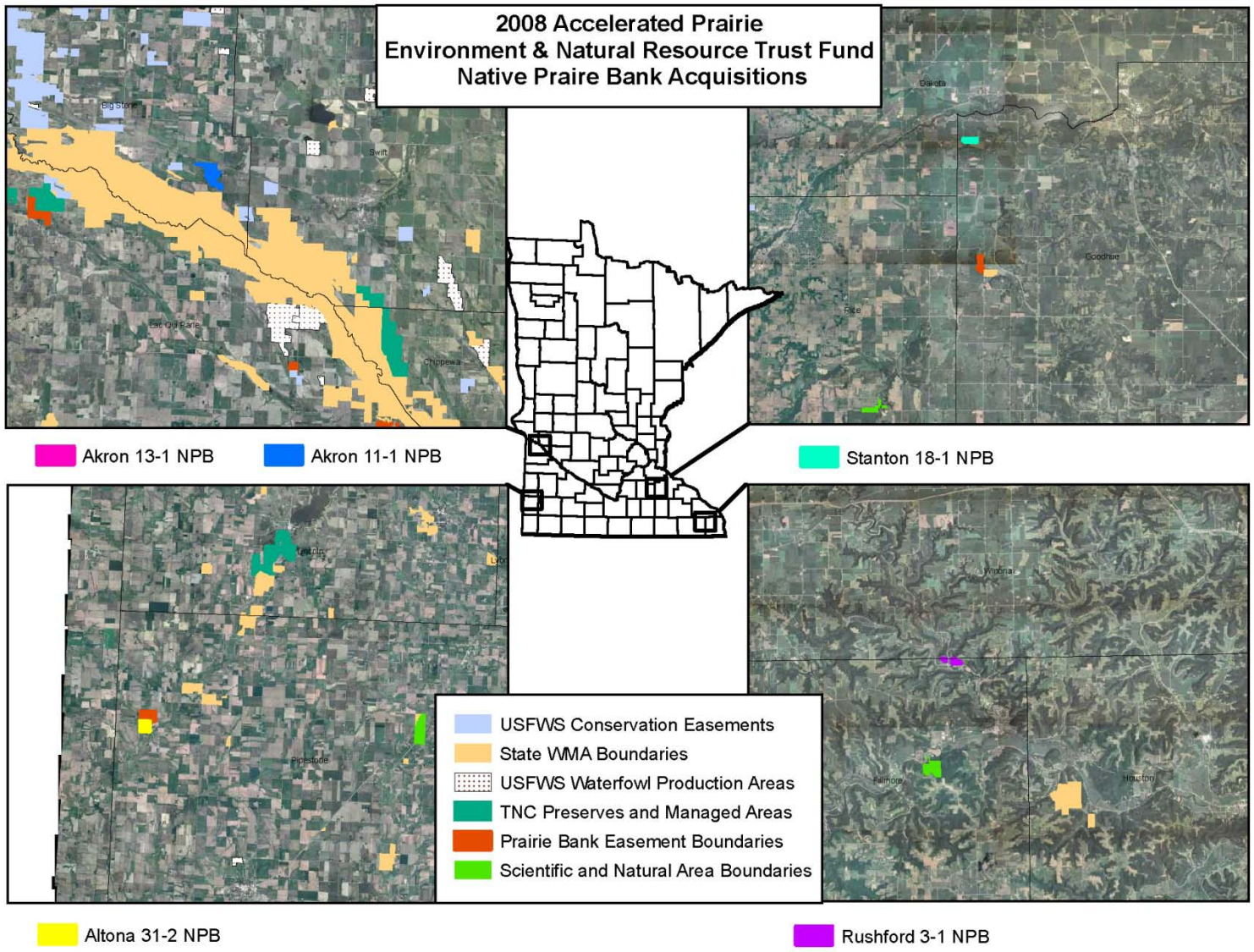
Trust Fund 2008 Work Program

Accelerated Prairie Management, Survey, Acquisition, and Evaluation



[1] Prairies mapped by MCBS in 1998. Locations shown were determined to be good and very good quality prairie as reported in Minnesota's Railroad Rights-of-Way Prairie: A Report to the 1999 Legislature (MNDNR, 1999).

[2] Prairies mapped by MCBS as of October 2007. Additional prairies will be mapped in 2007-2008. Prairie communities included are: upland prairie, wetland prairie, and prairie complexes.


2008 Accelerated Prairie
Environment & Natural Resource Trust Fund
Native Praire Bank Acquisitions
Akron 13-1 NPB
Akron 11-1 NPB
Stanton 18-1 NPB
Altona 31-2 NPB
Rushford 3-1 NPB
USFWS Conservation Easements
State WMA Boundaries
USFWS Waterfowl Production Areas
TNC Preserves and Managed Areas
Prairie Bank Easement Boundaries
Scientific and Natural Area Boundaries

Attachment A: Budget Detail for 2008 Projects

Project Title: Accelerated Prairie Management, Survey, Acquisition and Evaluation

Project Manager Name: Carmen Converse

Trust Fund Appropriation: $ 1,250,000

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

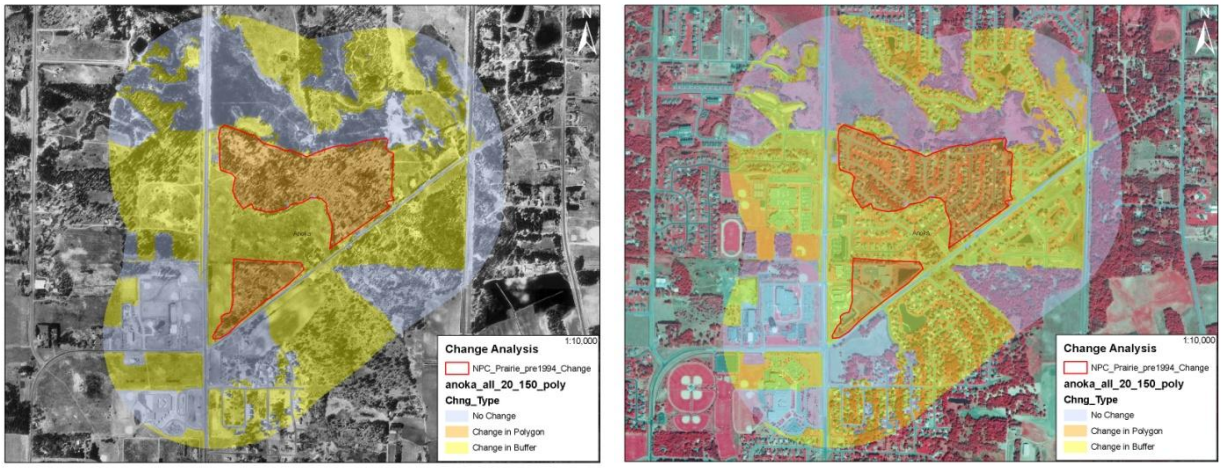
2) Remove any budget item lines not applicable

2008 Trust Fund Budget	Result 1 Budget: Rapid assessment of remaining native prairie	Amount Spent	Balance	Result 2 Budget: Accelerated MCBS Southern Counties	Amount Spent	Balance	Result 3 Budget: Accelerated Technical Assistance on privately owned prairie	Amount Spent	Balance	Result 4 Budget: Accelerated Prairie Management (public/ private)	Amount Spent	Balance	Result 5 Budget: Evaluate prairie condition and animal species	Amount Spent	Balance	Result 6 Budget: Native Prairie Acquisition	Amount Spent	Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM			0			0			0			0			0	0		0	0	0
PERSONNEL: wages and benefits: Result 2-plant ecologist; Result 3&4&6 - represents 2.4 FTE's per year. SNA staff paid almost exclusively with special project funds: ~ 0.1 FTE acquisition specialist and ~ 0.1 FTE project crew as needed to bring sites up to minimum standards . Fringe varies from 14 - 20%	25,000	24,803	197	70,000	86,437	-16,437	89,500	88,770	730	125,000	119,654	5,346	148,725	156,950	-8,225	2,384	2,384	0	460,609	-18,389
Contracts			0		5,000	-5,000			0			0			0	0		0	0	-5,000
Professional/technical (Stewardship Plan Consultants, animal survey experts, graduate student, statistics consulting)			0			0	104,500	103,200	1,300			0				0		0	104,500	1,300
Other contracts (contracts for prescribed burning, prairie reconstructions, woody encroachment, etc)			0			0			0	105,000	100,287	4,713			0	0		0	105,000	4,713
Other direct operating costs *(for what? – be specific)*			0			0			0			0			0	0		0	0	0
Equipment / Tools: Results 3, 4, 5 & 6: vehicle fleet costs (e.g. truck, car tractor, trailer, ATV, Pick-up, ASV tracked vehicle), incidental parts for tractor, vehicles, etc.			0			0	4,000	4,090	-90	30,000	34,897	-4,897	160	160	0	141	141	0	34,301	-4,987
Office equipment & computers - NOT ALLOWED unless unique to the project			0			0			0			0			0	0		0	0	0
Other Capital equipment *(list specific items)*			0			0			0			0			0	0		0	0	0
Land acquisition			0			0			0			0			0	0		0	0	0
Land rights acquisition *(less than fee)*			0			0			0			0			0	430,908	430,908	0	430,908	0
Professional Services for Acq.			0			0			0			0			0	41,567	41,567	0	41,567	0
Printing			0			0			0			0			0			0	0	0
Other Supplies: Result 4 - herbicide, safety supplies, fencing. Result 5 - Plot markers, flagging, measuring tape Result 6 - fencing, signs, etc as needed to bring sites up to minimum standards. Result 6: direct expenses not included above for purposes of meeting minimum standards			0			0			0	17,000	21,540	-4,540	156	156	0			0	17,156	-4,540
Travel expenses in Minnesota			0	30,000	8,104	21,896	2,000	2,334	-334	3,000	3,622	-622	959	959	0	0		0	35,959	20,940
Travel outside Minnesota *(where?)*			0			0			0			0			0			0	0	0
Construction *(for what?)*			0			0			0			0			0			0	0	0
Other land improvement:			0			0			0			0			0			0	0	0
Other: service agreement with DNR MIS for database development			0			0			0			0	20,000	11,775	8,225			0	20,000	8,225
COLUMN TOTAL	**$25,000**	**$24,803**	**$197**	**$100,000**	**$99,541**	**$459**	**$200,000**	**$198,394**	**$1,606**	**$280,000**	**$280,000**	**$0**	**$170,000**	**$170,000**	**$0**	**$475,000**	**$475,000**	**$0**	**$1,250,000**	**$2,262**

Attachment B

Accelerated Prairie Management, Survey, Acquisition and Evaluation
Result 1: Rapid assessment of remaining native prairie

Final Report to the Legislative-Citizen Commission on Minnesota Resources
July 1, 2008 to June 30, 2010
ML 2008, Chap. 367, Sec. 2, Subd. 3(m)



September 2010

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Prepared by Andrew Horton, Ecologist
Division of Ecological and Water Resources, Minnesota Department of Natural Resources

Funding provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources and State Wildlife Grants.

Purpose

The Division of Ecological and Water Resources in the Department of Natural Resources (DNR) has long recognized that native prairie is one of the state's most threatened habitats. Beginning in 1987, the Minnesota County Biological Survey (MCBS) began the systematic mapping and evaluation of remaining native prairie, revealing that 220,000 acres of native prairie remain from the nearly 18 million acres recorded during the state's early public land surveys (1847-1908). The Department's State Wildlife Action Plan identified native prairie as one of the key habitats for animal species in greatest conservation need due to the tremendous loss of this habitat and its continued vulnerability to degradation or conversion. Since much of the MCBS data on prairie native plant communities were collected over 15 years ago, a project to conduct a rapid assessment of the current extent and condition of prairie was jointly funded by a State Wildlife Grant and by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Project Overview

Aerial photography from 1991 and 2008 was used to document and classify changes to prairie and savanna habitat in Minnesota mapped by MCBS in 1993 or earlier. For this analysis 59,184 acres of prairie and 6,260 acres of savanna were evaluated, totaling 65,444 acres. For this report, the entire area was collectively called prairie habitat. Source data are available on the DNR's geographic information system (GIS) data deli and a query was used to select all prairie communities with a date of 1993 or earlier. The purpose of the project was to quantify the number of acres of prairie mapped by MCBS between 1971 and 1993 that have been altered or converted to other uses by 2008. Changes were classified by land use/impact type (Table 1).

The analysis of current land cover for this project used United States Department of Agriculture, Farm Service Agency (FSA) 2008 color-infrared air photos. Photo dates were from mid-summer when deciduou8s trees had full leaf canopy. 2006 and 2003 true-color FSA air photos were also used occasionally when the 2008 photos were insufficient. Black and white air photos, taken in mid-spring before full leaf out, were used for the 1991 comparison.

To help accomplish this project, the computerized feature extraction program SPRING (Camara et al. 1996) was used to create new polygons of similar land cover using the 2008 FSA photos. These new polygons were analyzed and classified as either remaining prairie or one of several change features using the Change Type categories. The difference between the 1991 prairie habitat and prairie habitat present in 2008 was analyzed to determine the number of acres of native prairie converted over the past 17 years.

The second component to the project involved classifying land use surrounding the prairies. Using polygons from the feature extraction program described above within a

100-meter and 500-meter buffer, the area surrounding the prairie habitat was assessed. The buffer analysis highlights the management pressures surrounding the remaining native prairies and assesses the quality of habitat they provide to prairie-dependent species.

Methods

Summary of native prairie polygons:

The original prairie polygons used for this change analysis were mapped by the MN DNR's MCBS from surveys completed in 1993 or earlier. Plant ecologists used air photo interpretation of 1991 color-infrared or older photos to delineate potential native prairie sites. This was followed by field surveys of most sites to determine the extent, condition, and quality of native prairie. When access to a site was not possible, aerial survey or additional remote sensing tools were used. In much of the western part of the state, prairies less than 10 acres were not mapped. In southern and southeastern Minnesota, prairies as small as one acre were mapped largely due to the complexity of matrix landscape (bluff lands) or extreme rarity of prairie in areas of intense row crop agriculture. These data were recorded as native plant community polygons using the GIS tools available in 1993 or earlier. This subset of prairie habitat used for this change analysis consisted of 47 different native plant communities (Table 2).

The area originally considered for this analysis consisted of 2,678 prairie polygons totaling 73,134 acres. In Goodhue, Houston and Winona counties, 1157 prairie polygons totaling 7,690 acres were removed from analysis for the following reasons: 1) aerial photography for these counties had heavy shadows, due to both the time of day the photos were taken and the highly dissected terrain of the area, rendering image analysis unfeasible, 2) many sites were located in oak savanna habitat making precise verification of site boundaries difficult due to woody vegetation cover present in 2008 aerial photos but not visible in the 1991 leaf-off imagery and 3) the mean size for these prairie polygons was 7 acres, well below the rest of the state, reducing the accuracy of polygon boundaries. Thus, 1,521 prairie polygons, totaling 65,444 acres (Figure 1) were selected for final evaluation. The mean size for these prairie sites was 43 acres.

Because of the time required for analyzing buffer polygons surrounding prairie habitat, a simplified procedure was needed. Three counties were selected for a reduced buffer analysis from 500 m to 100 m and three additional counties were classified using a random 20% sampling of 100 m buffers and no 500 m buffers. The counties of Dakota, Washington, and Lac Qui Parle were analyzed using 100 m buffers for each prairie polygon. Dakota and Washington counties were selected for this since we anticipated more buffer change given their proximity to the Metro Region, but the large number of sites in these counties precluded the full 500 m analysis. Lac Qui Parle was also selected for full 100 m sampling of all sites because we observed more errors in this county related to digitizing of the original prairie boundaries than other counties. It was also important to classify as much area as time allowed in this county in case we could rectify any of the boundary issues and adjust the data accordingly. The counties of

Kittson, Marshall, and Pennington were completed with a random 20% sampling of 100 m buffer areas, with the remaining prairie sites in these counties evaluated without a buffer. This sampling approach was applied to the northwest counties because fewer land use changes were observed in the buffer areas.

Digitizing Prairie Polygons:

The computer program SPRING was used to automatically digitize landscape features present on the 2008 FSA color-infrared air photos. This process, called feature extraction and segmentation, creates polygons that are similar in color and "texture" on a digital image based on user-specified sensitivity settings. The process used by this software (called "region growing") starts by selecting a single pixel and then adding neighboring pixels that match the color, texture, and minimum size parameters set by the user. The "polygon" grows by adding similar pixels until the color or texture of the pixels are different enough to stop growing the polygon. A new polygon is then created and begins to "grow" by grouping similar pixels again. The end result is a digitized map of polygons delineating areas of similar color and texture on the photo that can be used to classify land-use. Several iterations were run to get the appropriate sensitivity for the purposes of this analysis, and final parameters were set to a sensitivity such that a "polygon" of the canopy of a single large tree in the 2008 aerial photo could be detected and delineated.

Classifying Segmented Polygons:

Segmentation aided in recognizing change by providing the outlines of buildings, roads, and major land-use grouping such as agriculture. This new dataset was then imported into Esri's ArcMap (version 9.3), a geospatial processing program. When the 1991 aerial photo was compared with the segmented polygon dataset, it was easy to match up features that were present in both time periods (no change), and identify features that differed and required a change classification.

Segmented polygons were classified separately by county to increase ArcMap processing speed. This also enabled the observer to become familiar with identifying regional characteristics, such as wetter soils in the northwest or identifying the presence of more hay fields in certain areas that without extensive review may be confused as row crop agriculture. An attribute table related to the polygon shapefile was created to record the land-use category observed in the 1991 photo and the land-use category observed in the 2008 photo. Segmented polygons inside of MCBS mapped prairie habitat were assigned a three-letter code if land-use changes existed (i.e. land-use was different in 2008 compared to 1991) (see table below). For example; a segmented polygon with woody deciduous natural vegetation present inside of the mapped prairie in 1991 was given a code of WDN. By 2008, the woody vegetation had been removed and open grassland existed (coded as GRA). To simplify the data for reporting purposes, all woody vegetation types were grouped together to reduce the number of change combinations possible. Although the database is detailed enough to identify deciduous or coniferous species and natural occurrence or plantation planting, regional

trends were only determined using a single category for all woody vegetation. For land classified outside the MCBS mapped polygons, within either the 100 m or 500 m buffer, a single or two-letter code was used. For all land-use that was the same between 1991 and 2008, the land-use category for 2008 was listed as "NC" (no change). The final dataset contains a detailed and quantifiable list of non-overlapping land-use change categories by county.

Change Categories:

Outside of Mapped Polygons		**Descriptors Inside of Mapped Polygons**		
Change Category	Description	**Reporting Category**	Change Category	Description of Change Cetegories
NC	No change	**NC**	NC	No change
D	Development	**DR**	DRS	Residential structures
		DO	DOS	Other structures (sheds, buildings, etc)
		DR	DRD	Road Development
		DR	DTR	Trails
		DO	DOO	Other development
M	Mining	**MGR**	MGR	Gravel and or clay mining
W	Woody vegetation encroachment	**Wy**	WCN	Natural invasion of coniferous woody vegetation
		Wy	WCP	Plantation of coniferous woody vegetation
		Wy	WDN	Natural invasion of deciduous woody vegetation
		Wy	WDP	Plantation of deciduous woody vegetation
		Wy	WMM	Mixed coniferous/deciduous encroachment, origin unspecified
Ag	Agricultural activities	**Ag**	ARC	Row crop agriculture
		GRA	AGR	Grazing
		Ag	APD	Pond Dugout
		Ag	AOO	Other agriculture
L	Land Management	**GRA**	LHA	Haying
		GRA	LBU	Prescribed burn
G	Grassland	**GRA**	GRA	Intact native or non-native grassland or open vegetation
A	Aquatic	**A**	ALR	Lake/river
		A	ARP	Retention Pond
		A	AWE	Wetland
O	Misc/other	**OBS**	OBS	Bare soil/dead vegetation/ disturbed ground
		OOT	OOT	Other, describe in notes as needed

Other change classifications were generalized to either decrease review time or simplify reporting categories. Thinning of woody vegetation from 1991 to 2008 was recorded in the dataset, but reported as no change for this report. However, if the woody vegetation present in 1991 was removed and created a contiguous area with prairie or other open habitat, the 2008 classification was listed as grassland. In many areas evaluated, it was possible to identify haying and prescribed burning in both time periods, and they were recorded as such in the dataset. For this report, however, they are listed as grassland since management for both maintain intact grasslands. Developed areas involving residential or other structures were also generalized. All areas within these property boundaries were recorded as Development Residential Structures (DRS) or Development Other Structures (DOS) even though they may include driveways or maintained yards.

Quality control checks were done by visiting a small number of sites in Kittson, Red Lake, Mahnomen, Wilkin, Traverse, Big Stone, Grant and Redwood County. Land use categories surrounding these sites were verified and determined to be accurate.

In this report, changes within prairie habitat and within buffer areas were sometimes referred to using specific descriptors that grouped several change categories:

	Reporting Descriptor	**1991 Land Use**	**2008 Land Use**
PRAIRIE	Prairie Created	Woody Vegetation Bare Soil	Grassland Grassland
	Prairie Degraded	Grassland	Woody Vegetation Bare Soil
	Prairie Converted	Grassland	Housing Other Structure Roads Mining Agriculture
BUFFER	Open Habitat Created	Development Mining Agriculture Woody Vegetation Bare Soil	Grass or Aquatic Habitat
	Grassland Degraded	Grassland Grassland Bare Soil	Bare Soil Woody Vegetation Woody Vegetation
	Grassland Converted	Grassland Bare soil	Housing Other Structure Roads Mining Agriculture
	Other Change	Woody Vegetation Agriculture Agriculture	Development Development Woody Vegetation

Results

Prairie Habitat:

Changes were reported by state, county, and by six distinct regions (Figure 2). The regions include Aspen Parklands, Glacial Ridge, Central, Metro, MN Valley West, MN Valley East, and Southeast.

1,521 mapped prairies were assessed in 32 counties totaling over 65,000 acres. Within MCBS mapped prairie habitat, 1,788 acres (2.73%) were altered in a way that reduced the quality or presence of prairie habitat. Of this, 770 acres were converted to development, row crop, or mining and 1,019 acres had an increase in woody vegetation (Figure 3). When comparing regions, the Aspen Parklands Region had the greatest increase of woody vegetation, the Metro Region had the greatest increase of development, and the Minnesota River Valley West Region had the greatest increase of prairie to row crop conversion (Figure 5). Counties with the greatest acreage of altered prairie were Kittson and Pennington (from increased woody vegetation), Marshall and Clay (from increased woody vegetation and row crop), Big Stone (from conversion to row crop, woody vegetation and development), and Sherburne, Anoka and Washington (from increased development) (Figures 4-9). There was also a change of 544 acres of woody vegetation to prairie which occurred largely in the Aspen Parklands Region and Metro Region (Figure 5). The counties with the greatest acreage of woody vegetation removal included 183 acres in Marshall, 83 acres in Kittson, 77 acres in Anoka and 75 acres in Sherburne (Figures 4-9).

One category that was not reported in the above figures included cultivated agriculture lands identified within the original prairie polygons in 1991 and recorded as grass in 2008. This was most likely either a digitizing or interpretation error during the original MCBS mapping. Since the area was not intended to be marked as prairie habitat, these data were removed from analysis or listed as an error. There was 296 acres that fell in this category.

100 meter & 500 meter Buffer:

Within 100 m and 500 m buffers, 192,000 acres were assessed for land-use changes. Total change in the 100 meter buffer was about 9% (4,765 acres); however 6% (3,226 acres) consisted of open habitat created (Figure 10). Excluding this change only 3% (1,528 acres) of the surrounding 100 m buffer had a reduction in the amount or quality of open grassland habitat. Total change within the 500 meter buffers was 6% (13,764 acres); however 4% (8,014 acres) consisted of open habitat created (Figure 11). Excluding this change, only 3 % (5,750 acres) of the surrounding 500 m buffer had a reduction in the amount or quality of open grassland habitat. In both buffers, a large component of the “open habitat created” category was from cultivated agricultural lands entered into the Conservation Reserve Program (CRP) and identified in 2008 as grassland.

The Metro Region, when compared with other regions, had the highest total acreage of change resulting from prairie converted to development or increased woody vegetation for both the 100 meter and 500 meter buffers (Figure 12-13). The MN Valley West Region had the next highest total acreage of change for these two categories within the 100 meter buffer compared with the remaining regions (Figure 12). MN Valley West Region along with the Glacial Ridge Region had significantly more open habitat created through woody vegetation removal and agriculture lands becoming CRP grasslands (over 1,200 acres each) within the 100 meter buffer than the rest of the evaluated area (Figure 12). Within the 500 meter buffer, the Glacial Ridge Region had more open habitat created (over 5,500 acres) compared to the rest of the evaluated area (Figure 13).

Intact or Altered Status:

The percentage of "converted change" was calculated for each prairie site and grouped into six categories and compared by region (Figure 14). The six categories consisted of: intact (no change), 0-5% altered, 2-25% altered, 25-50% altered, 50-75% altered, 75-100% altered. The prairie converted change classification included grassland, woody vegetation, or bare soil present in 1991 that was classified as road, structure, mining or row crop agriculture in 2008.

Of the 1,521 prairie polygons assessed, 1,304 had no converted change. For the 217 sites with some converted change, most had only a small percentage of converted change (123 sites had 0-5% change, and 73 sites had between 5-50% change). Ten sites had 50-75% change and 11 sites were altered by 75-100% change. Statewide, 14% of the prairies had converted change and of that, less than 1% fell within the 75-100% range. The Metro Region had the most altered sites in the state (Figure 14).

When looking at change from open grassland to development, mining, or agriculture surrounding prairie habitat, 660 sites had change within the 100 meters buffer (610 acres of converted change). The number of sites with converted change within 50 meters was also calculated to determine the impact of these adjacent areas. The results from this differed very little with the 100 meter data, so only the 100 meter results are discussed.

Analysis by Ownership:

The relationship between land ownership and change type was also examined. Ownership was classified into two groups. The first group, "protected", consists of land that was managed for conservation and included land owned by the state, federal and county governments as well as The Nature Conservancy (TNC) and private lands entered into programs such as CRP and Prairie Bank Stewardship. The second group, "unprotected", included all other private land as well as county land not set aside for conservation purposes. Nearly all of the change that resulted in a converted loss of prairie occurred on unprotected land ownership (756 acres). Unprotected lands also had more than twice the amount of woody vegetation expansion than protected lands

and about one-third the amount of prairie enhancement through tree removal (Figure 15).

On “protected” land ownership, the amount and types of changes vary widely (Figure 16). Ownership categories include County, CRP, Prairie Bank, State, State Forest, State Parks, State Reinvest in Minnesota (RIM), TNC, United States Fish and Wildlife Service (USFWS) Refuge and USFWS Waterfowl Production Area. Prairie land listed as “State,” included University of Minnesota (U of M), Minnesota Department of Transportation, Minnesota Department of Corrections, Minnesota Department of Military Affairs (MNDMA) and undifferentiated state-owned land. The category “State SNA” ownership, consisted of state-owned land, but managed by either the State or TNC. It is important to note that percentages of change vary widely based on the total acreage for each land ownership category. Total acreage ranges from 242 acres of State Reinvest in Minnesota lands (RIM) to 15,398 acres of State Wildlife Management Area owned lands.

County owned lands had greater than 1% loss of prairie habitat to development, mining or agriculture, and amounted to 8.5 acres. RIM lands had the next highest percentage of prairie loss (less than 1%) and resulted in the loss of 1 acre. State Wildlife Management Area lands also had less than 1% loss of prairie and resulted in 6 acres of prairie lost. The percent of increased woody vegetation was similar between all ownership categories, but lower on TNC, State Forest, State RIM, and USFWS lands. The most significant expansion of woody vegetation consisted of 209 acres from State WMA, 20 Acres from State SNA, and 19 acres from State Parks. “State” ownership had the highest percentage of woody vegetation removal (over 12%) and nearly all of the 64 acres of change came from the Cedar Creek Ecosystem Science Reserve owned by U of M. “State SNA” had 7% of woody vegetation removal and resulted in 87 acres of change.

Conclusion

The results of this project indicate that statewide, prairie habitat examined had a 4% change affecting 2,332 acres. The majority of that change was an increase in woody vegetation (1,019 acres), which is potentially reversible through management. Of the areas evaluated, 1.18% of prairie habitat was lost by conversion to land uses identified as development, row crop, or mining. The greatest prairie habitat loss occurred in the Metro Region due largely to development and the western portion of the Minnesota River Valley Region due to conversion to row crop agriculture. The Aspen Prairie Parklands Region had the greatest increase in woody cover growth when compared with the rest of the state.

There was little change over the past 15 years surrounding the MCBS mapped prairie habitat when looking at the 100 m and 500 m buffers. Approximately 3% of open grassland was either converted or degraded. Native prairie buffers in the Metro Region had the highest amount of grassland/open space loss from increased woody vegetation and development.

There were 206 sites that were altered by development, mining or agricultural change, although more than half of these sites had less than 5% of the overall polygon altered. A small number of sites had more than 75% of the original prairie habitat altered. Nine of the eleven sites in this category were located in the Metro Region and nearly all on private land. The majority (85.73%) of the prairie sites analyzed remain intact with no change occurring inside of the prairie.

Of the prairie habitat evaluated, roughly half were considered protected (state, federal, county owned or private enrolled in conservation programs). Prairie habitat not protected had significantly higher amounts of prairie loss or increased woody vegetation. Private lands also had less woody vegetation removal than protected-lands. Prairie habitat under protective ownership had little prairie loss (19 acres) with most occurring on County and State WMA owned land.

The results of this project indicate that little prairie has been lost from 1991 for those sites identified by MCBS in 1993 or earlier and evaluated in this study. Much of the change that has taken place consisted of an increase in woody vegetation. Land managers should consider the suitability of woody vegetation in the prairie matrix for each individual site.

The procedures used in this project were challenging in terms of processing time, quality and dates of aerial photographs, and the technology and resources available at the time the original prairie polygons were mapped.

1.) Processing time was the most significant problem encountered. Although the feature extraction and segmentation through SPRING was faster than manually digitizing land-use boundaries, it was still slow and prone to technical difficulties. Large file sizes slowed processing time exponentially requiring some polygons to be processed overnight, often taking more than six hours to complete. The segmentation process of buffer polygons greater than 3,000 acres would often fail half way through the processing time, requiring the polygons to be split in ArcMap and reprocessed. Once the segmented lines were created in SPRING, several time-consuming steps were still needed to create polygons in ArcMap and to project the spatial data correctly. It is estimated that the entire processing time to segment the 1521 buffered polygons (half the original workload) took 5 months of effort. Time expended would have been much longer if processing was not accomplished overnight and on weekends when computer networks were not tied up.

2.) Reviewing overall change for the segmented polygons was also a much more time consuming process than originally anticipated. The use of leaf-on photos for 2008 and leaf-off photos for 1991made interpretation difficult and made woody vegetation appear less dense in the 1991 photos than in the 2008 photos. If this project were repeated, the use of aerial photos taken during the same season is highly recommended. This factor, along with poor photo quality, including

significant shadow effect in Goodhue, Winona, and Houston counties, made interpretation time consuming and unreliable.

Another issue was related to inaccuracies in the mapping of original prairie polygons. Geographic positioning systems (GPS) and geographic information systems (GIS) were either unavailable or rudimentary when these prairies were mapped in the late 1980s and early 1990s. Some polygons contain non-prairie features, such as row crop or housing in 1991 aerial photography. Some of these issues were clearly due to mapping errors, but it was possible that some of the non-prairie features occurred between the time that the prairie was mapped and when the 1991 photo was taken. While the source of the errors could not be determined, the changes for these polygons were still mapped, but removed from the final analysis and results.

Recommendations

1.) Equipment

The original computer used lacked sufficient processing speed and random access memory (RAM) to run the imaging software for feature extraction and segmentation, even when smaller amounts of data were being processed. Once a computer with a processing speed of 2.99 GHz, and 3.25 GB of Ram was purchased, these issues occurred less often.

Due to the volume and size of images being produced through each step, future projects should have access to large network hard drives for file storage.

2.) Software

The slow processing speed of the software SPRING was a problem especially when large file sizes were being segmented and persisted even after upgrading existing hardware. Reducing the file size of images being processed was necessary to alleviate this problem. Reviewing the most recent image processing software is recommended for future projects and should be tested with large batches of data early in the segmentation process to determine if changes need to be made of if other software should be tested.

3.) Dates of Aerial Imagery

High quality aerial photos taken during the same time period for each year being observed should be used if possible. Interpretation of leaf-on and leaf-off photos over multiple years delayed the change analysis, and caused some areas to be discarded from the project.

4.) Testing

Future projects should examine if new software is available to effectively use "Unsupervised" analysis methods to process data. This method involves programming software to recognize specific color and texture parameters as a unique item such as prairie. The computer then analyzes the entire area and makes assumptions that all areas with these parameters are prairie. Manual review of the landscape would only be needed for verification and quality control. At the time of this project however, we felt the software available was not advanced enough to correctly identify the complex landscape.

References

Bakker, K.K. 2003. The effect of woody vegetation on grassland nesting birds: An annotated bibliography. Proceedings of the South Dakota Academy of Science 82:119-141.

Camara G, RCM Souza, UM Freitas, & J. Garrido. 1996. SPRING: Integrating remote sensing and GIS by object-oriented data modeling. Computers & Graphics, 20: (3) 395-403.

Table 1: Prairie Polygon Summary Data

	County	No Change	Development	Woody Vegetation Encroachment	Row Crop	Mining	Woody Vegetation Removal	Prairie Acres
Aspen Park NW	Kittson	7397.25	1.65	372.51	3.57	0.00	83.26	7870.00
Aspen Park NW	Marshall	6790.98	0.66	174.98	49.78	0.00	182.98	7276.48
Aspen Park NW	Pennington	2388.63	3.33	81.44	0.53	0.32	23.10	2532.68
Aspen Park NW	Red Lake	706.27	0.00	25.00	0.00	0.00	0.38	731.65
Glacial Ridge	Clay	8208.66	18.98	59.03	57.20	9.60	4.81	8382.57
Glacial Ridge	Mahnomen	1312.60	0.00	20.96	0.00	0.00	36.40	1371.37
Glacial Ridge	Wilkin	8445.19	0.27	0.43	22.02	0.00	3.59	8488.39
Central	Benton	119.89	1.17	0.00	0.00	0.00	3.05	124.18
Central	Grant	73.24	0.00	1.96	0.00	0.00	0.03	78.10
Central	Morrison	353.46	1.46	9.24	0.01	0.00	1.90	366.26
Central	Pope	51.76	0.00	2.50	2.20	0.00	0.00	57.14
MN Valley W	Big Stone	8291.43	50.09	53.26	116.61	0.38	8.98	8524.62
MN Valley W	Lac Qui Parle	9861.93	8.35	56.72	30.78	0.51	10.92	10131.90
MN Valley W	Swift	1369.69	0.00	1.62	14.13	0.00	0.00	1387.18
MN Valley W	Traverse	3071.42	2.93	5.88	7.35	0.00	1.79	3104.35
MN Valley W	Yellow Medicine	71.33	0.00	5.29	14.65	0.00	0.01	91.36
MN Valley E	Brown	150.93	1.71	3.33	0.23	0.00	0.11	158.07
MN Valley E	Nicollet	11.49	0.31	3.52	0.00	0.00	0.00	15.36
MN Valley E	Redwood	90.73	5.35	11.95	0.00	5.44	0.00	113.89
MN Valley E	Renville	87.85	1.42	10.36	0.91	0.00	0.60	101.80
Metro	Anoka	651.70	78.94	3.43	0.00	0.00	77.36	830.74
Metro	Chisago	85.84	0.06	0.20	0.00	0.00	1.60	87.70
Metro	Dakota	501.04	12.86	14.26	3.09	0.00	9.90	545.83
Metro	Isanti	32.58	0.00	0.48	0.00	0.00	0.00	33.50
Metro	Ramsey	17.17	2.95	1.23	0.00	0.00	0.07	21.47
Metro	Rice	171.70	2.39	37.87	0.00	0.00	1.39	217.87
Metro	Sherburne	1775.17	129.30	10.99	8.74	0.00	74.61	2017.45
Metro	Washington	551.13	97.31	46.28	0.00	0.00	16.82	721.14
SE	Fillmore	2.78	0.00	0.29	0.00	0.00	0.00	3.07
SE	Olmsted	47.03	0.05	3.29	0.00	0.00	0.10	51.51
SE	Wabasha	4.10	0.00	0.45	0.00	0.00	0.20	4.75
	Total	62694.94	421.55	1018.73	331.78	16.26	543.96	65442.38

Table 2 – Native Plant Communities evaluated for change analysis.

NPC	Native Plant Community	NPC	Native Plant Community - Complexes
DOCEBA	Dry Oak Savanna (Central) Barrens Subtype	ABR_CX	Agassiz Beach Ridge Complex
DOCESG	Dry Oak Savanna (Central) Sand-Gravel Subtype	AOX_CX	Aspen - Oak Woodland Complex
DOSEBA	Dry Oak Savanna (Southeast) Barrens Subtype	ASR_CX	Agassiz Shoreline Ridge and Swale Complex
DPCEBA	Dry Prairie (Central) Barrens Subtype	DPW_CX	Dry Prairie - Woodland Complex
DPCESG	Dry Prairie (Central) Sand-Gravel Subtype	PBW_CX	Parkland Brush Prairie - Wetland Complex
DPSEBB	Dry Prairie (Southeast) Bedrock Bluff Subtype	PMA_CX	Wet-Mesic Prairie / Lowland Aspen Complex
DPSEHI	Dry Prairie (Southeast) Hill Subtype	PWL_CX	Prairie Wetland Complex
FDs38a	Oak - Shagbark Hickory Woodland	ROP_CX	Rock Outcrop - Dry Prairie Complex
MPCEXX	Mesic Prairie (Central)	SWP_CX	Saline Wet Prairie Complex
MPSEXX	Mesic Prairie (Southeast)		
MPSWXX	Mesic Prairie (Southwest)		
OPp93	Prairie Extremely Rich Fen		
UPn12a	Dry Barrens Prairie (Northern)		
UPn12b	Dry Sand - Gravel Prairie (Northern)		
UPn12c	Dry Sand - Gravel Brush-Prairie (Northern)		
UPn12d	Dry Hill Prairie (Northern)		
UPn13	Northern Dry Savanna		
UPn13b	Dry Barrens Oak Savanna (Northern)		
UPn13c	Dry Sand - Gravel Oak Savanna (Northern)		
UPn23a	Mesic Brush-Prairie (Northern)		
UPn23b	Mesic Prairie (Northern)		
UPs13a	Dry Barrens Prairie (Southern)		
UPs13b	Dry Sand - Gravel Prairie (Southern)		
UPs13c	Dry Bedrock Bluff Prairie (Southern)		
UPs13d	Dry Hill Prairie (Southern)		
UPs14a2	Dry Barrens Oak Savanna (Southern) Oak Subtype		
UPs14b	Dry Sand - Gravel Oak Savanna (Southern)		
UPs14c	Dry Hill Oak Savanna (Southern)		
UPs23a	Mesic Prairie (Southern)		
UPs24a	Mesic Oak Savanna (Southern)		
WPCEXX	Wet Prairie (Central)		
WPn53a	Wet Seepage Prairie (Northern)		
WPn53b	Wet Brush-Prairie (Northern)		
WPn53c	Wet Prairie (Northern)		
WPn53d	Wet Saline Prairie (Northern)		
WPs54a	Wet Seepage Prairie (Southern)		
WPs54b	Wet Prairie (Southern)		
WPs54c	Wet Saline Prairie (Southern)		

Figure 1 – Blue histogram represents the all sites originally intended for this change analysis project. Red histogram represents the sites evaluated after adjustments were made.

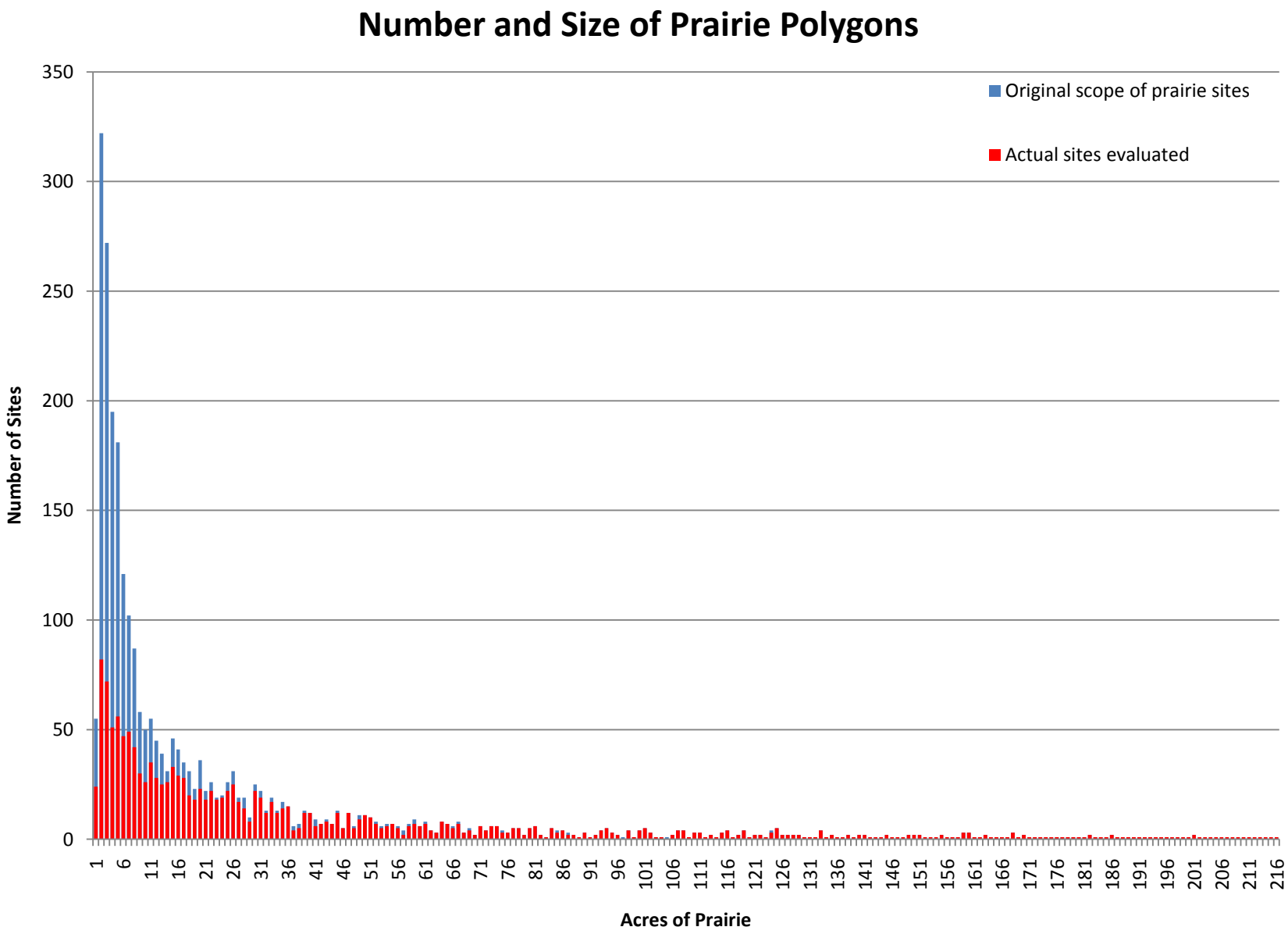


Figure 2 – Prairie habitat evaluated

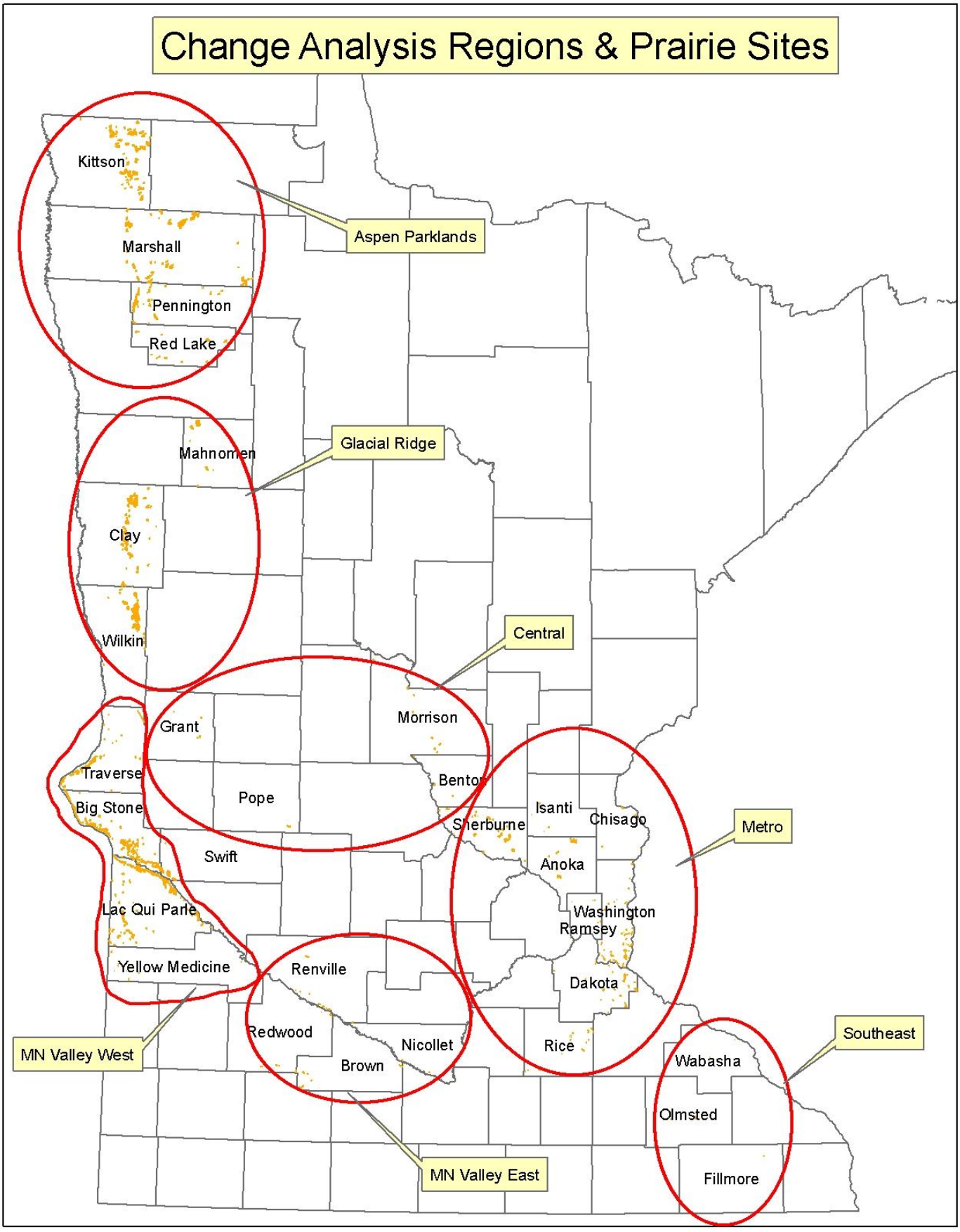


Figure 3 – Left graph represents total change of prairie habitat that was evaluated for this project. Right graph includes detailed categories of change. Development category includes roads, residential structures, and other structures.

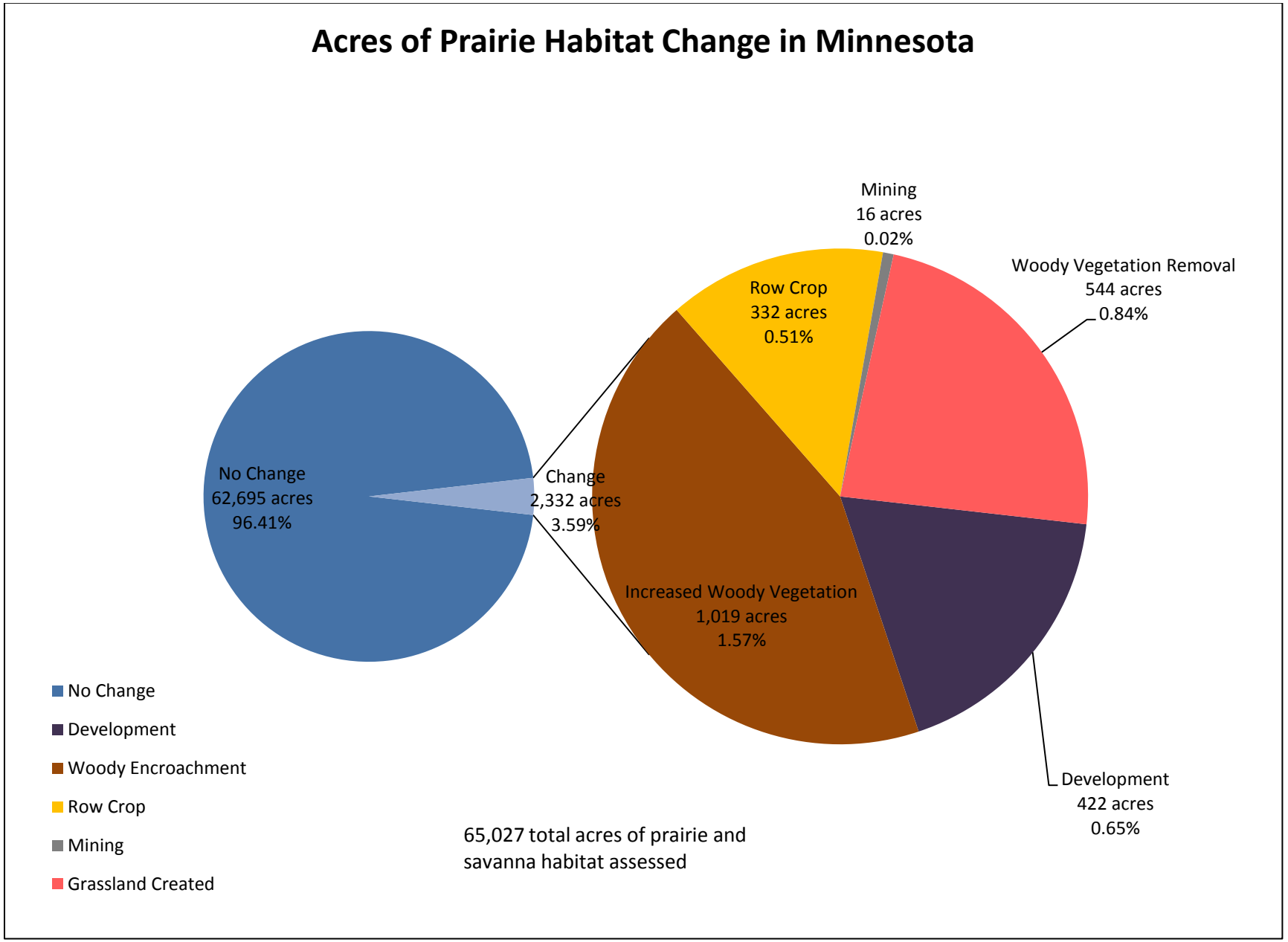


Figure 4 – Increase of prairie habitat includes wood vegetation reduction and bare soil converted to grassland. Loss of prairie habitat includes development, mining, and agriculture row crop conversion.

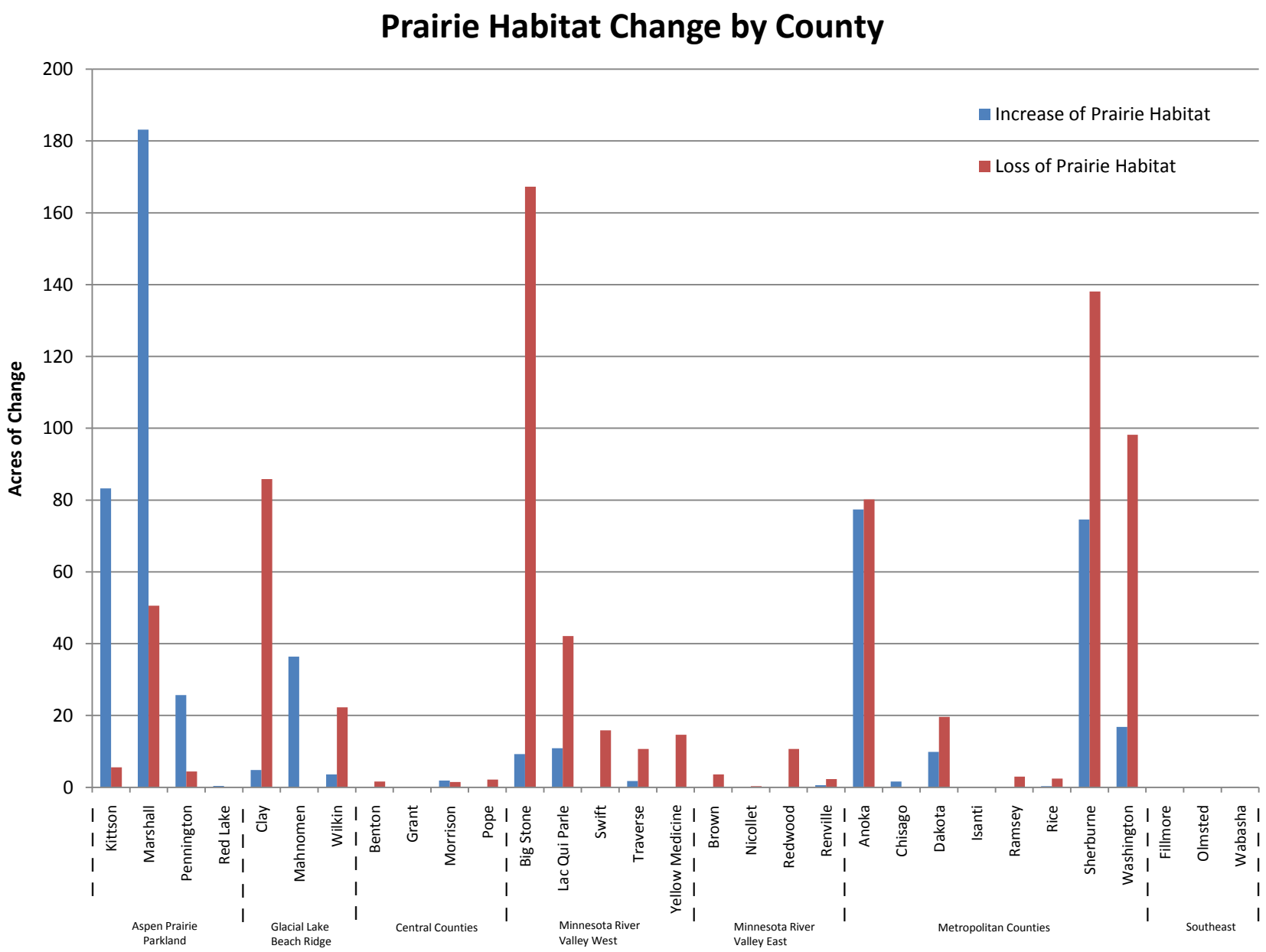


Figure 5 - Bars depict acres of change and are associated with left side of vertical axis, red lines depict total acres and are associated with the right side of the vertical axis. Woody Vegetation Removal also includes a small amount of bare soil to grassland change (<5 acres).

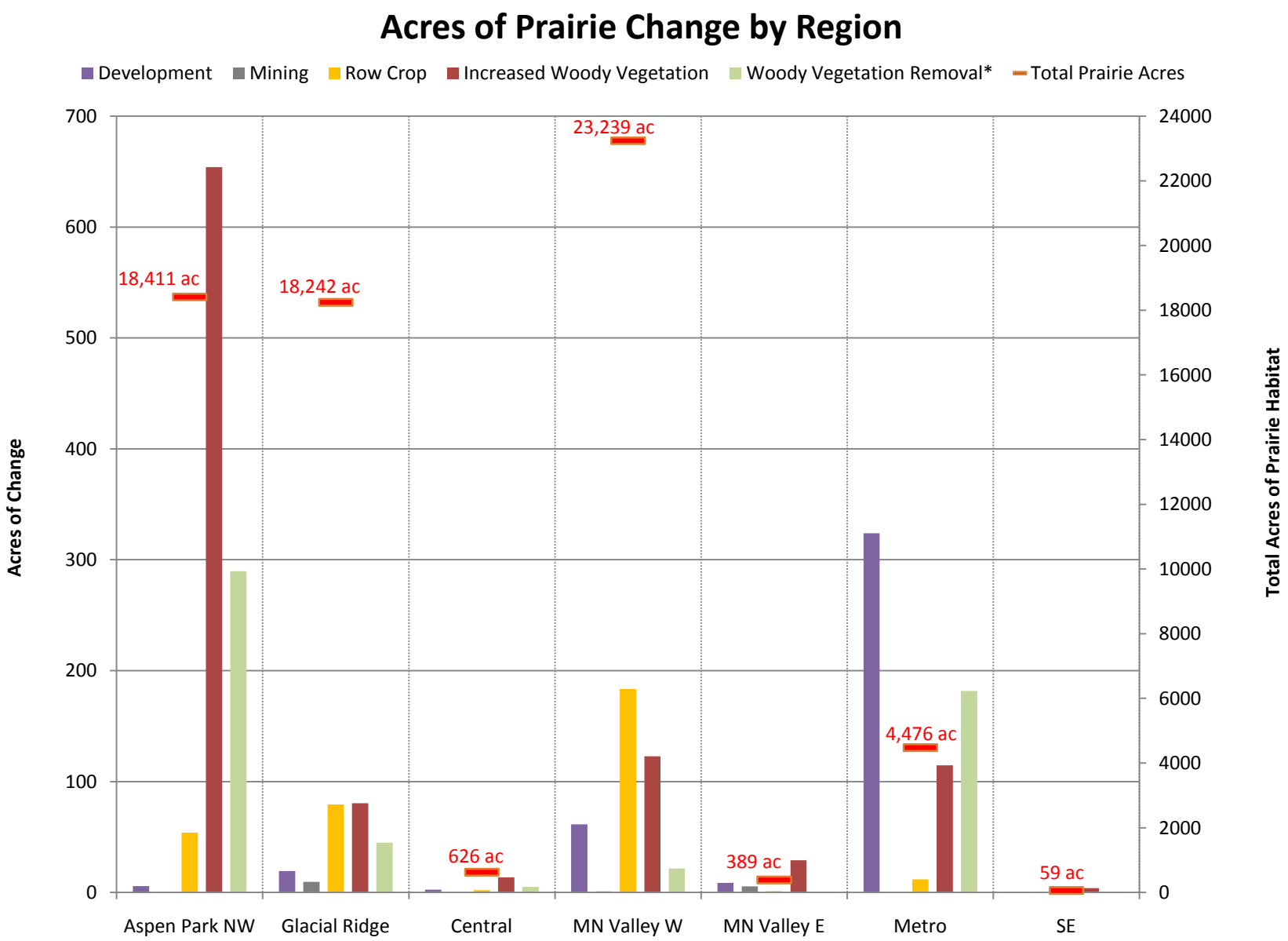


Figure 6 - Bars depict acres of change and are associated with left side of vertical axis, red lines depict total acres and are associated with the right side of the vertical axis. Woody Vegetation Removal also includes a small amount of bare soil to grassland change (<5 acres).

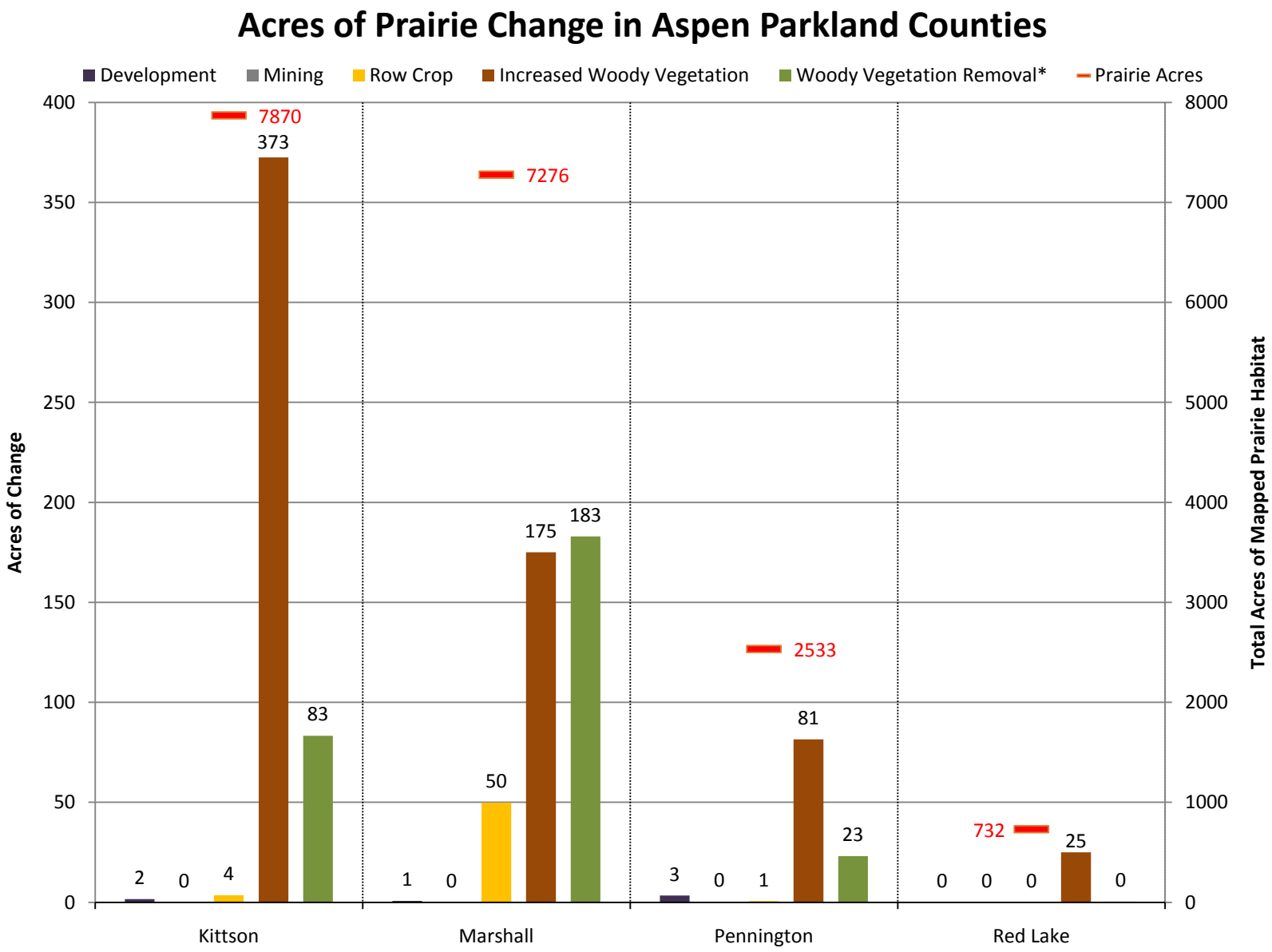


Figure 7 - Bars depict acres of change and are associated with left side of vertical axis, red lines depict total acres and are associated with the right side of the vertical axis. Woody Vegetation Removal also includes a small amount of bare soil to grassland change (<5 acres).

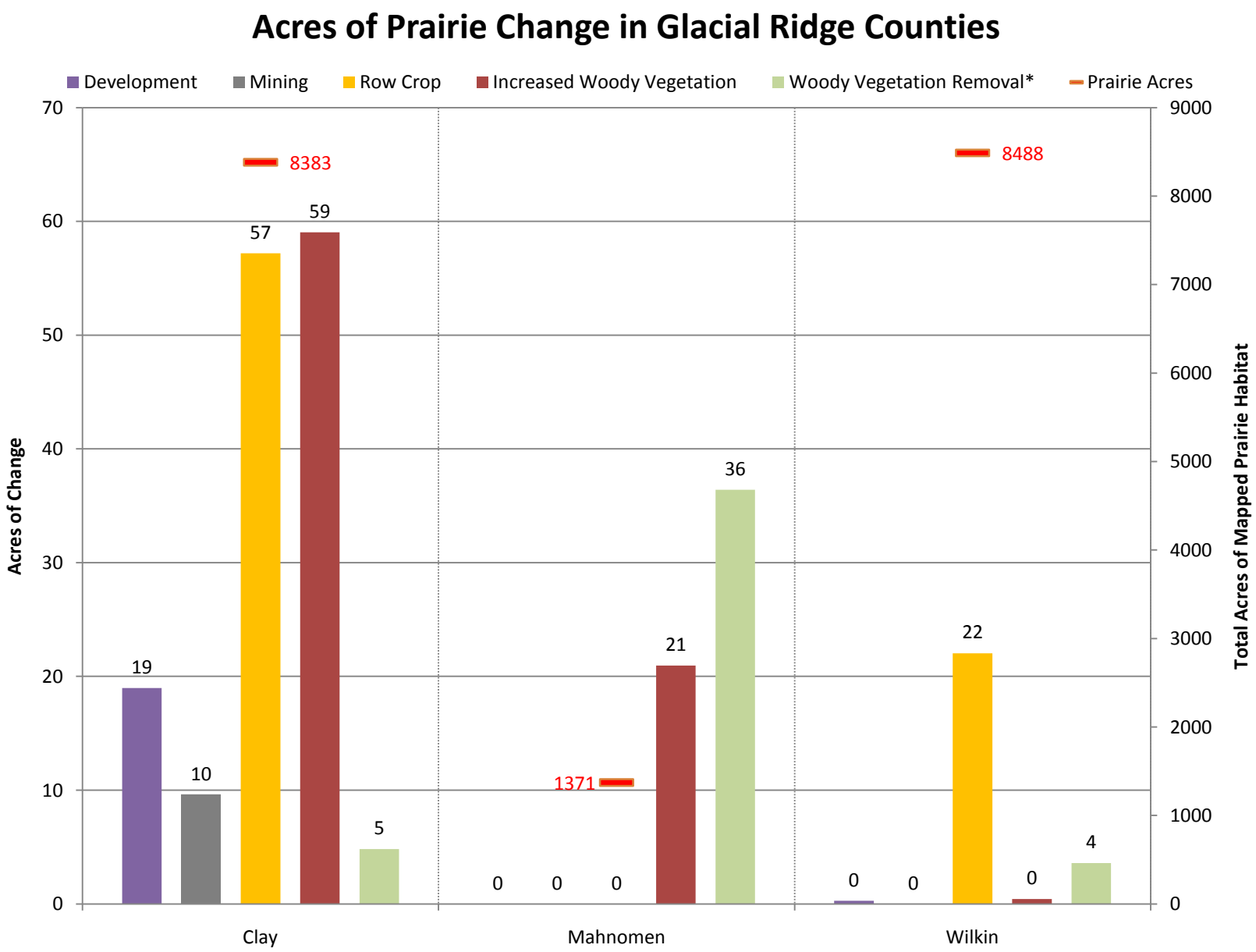


Figure 8 - Bars depict acres of change and are associated with left side of vertical axis, red lines depict total acres and are associated with the right side of the vertical axis. Woody Vegetation Removal also includes a small amount of bare soil to grassland change (<5 acres).

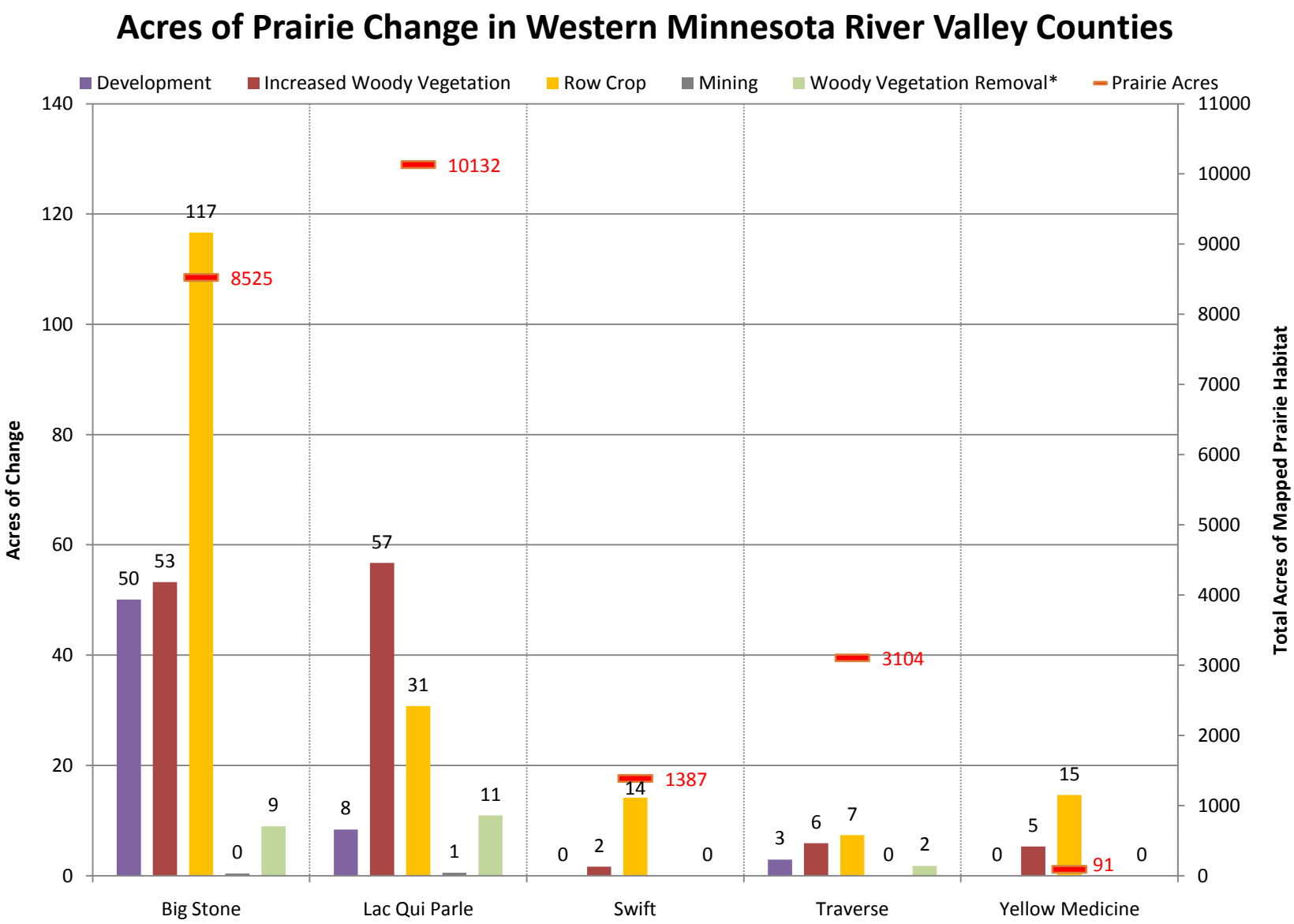


Figure 9 - Bars depict acres of change and are associated with left side of vertical axis, red lines depict total acres and are associated with the right side of the vertical axis. Woody Vegetation Removal also includes a small amount of bare soil to grassland change (<5 acres).

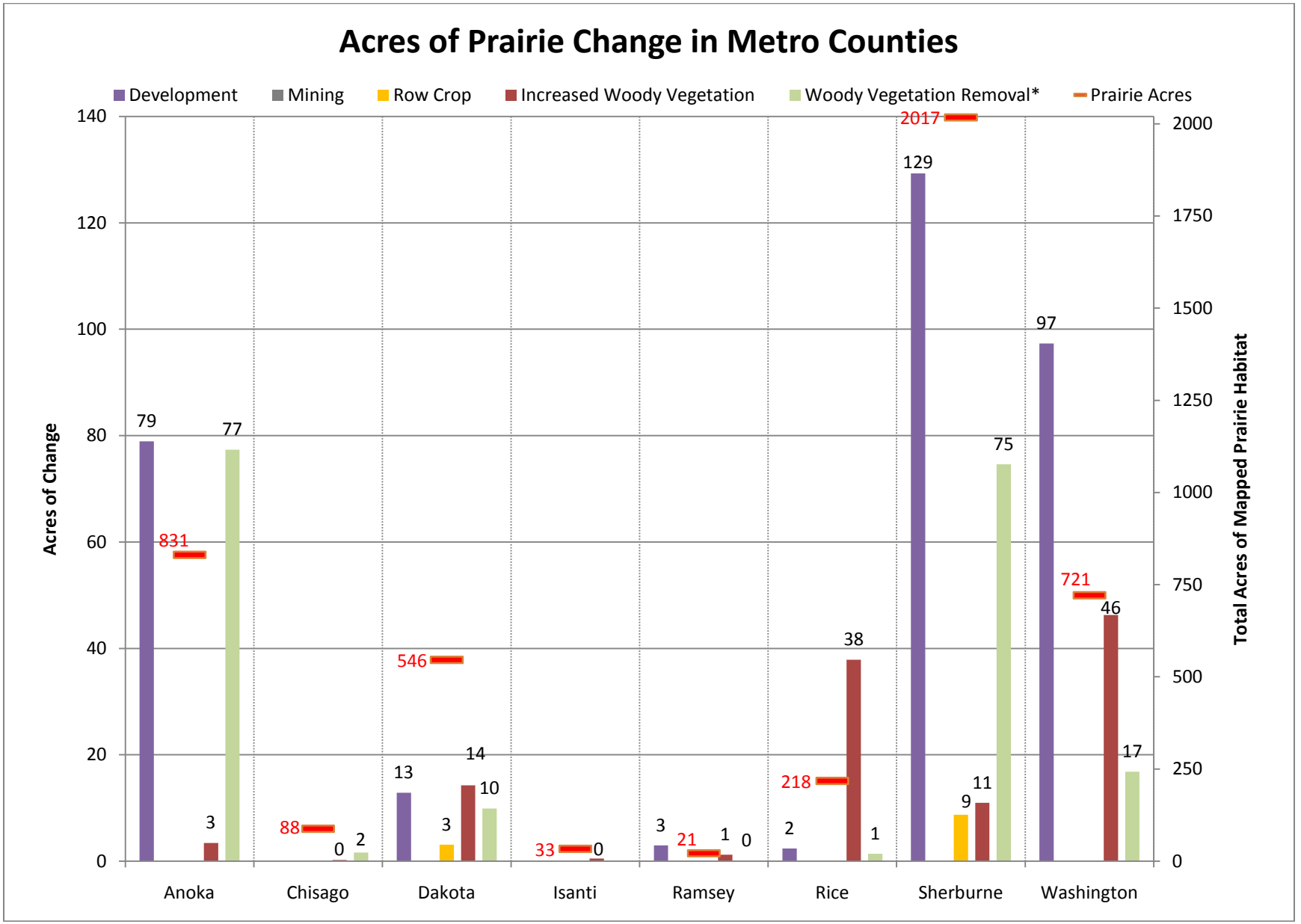

Acres of Prairie Change in Metro Counties
Development
Mining
Row Crop
Increased Woody Vegetation
Woody Vegetation Removal*
Prairie Acres
Acres of Change
Total Acres of Mapped Prairie Habitat
0
20
40
60
80
100
120
140
0
250
500
750
1000
1250
1500
1750
2000
79
831
3
77
88
0
2
13
546
3
14
10
33
0
3
21
1
0
2
218
38
1
129
2017
9
11
75
97
721
46
17
Anoka
Chisago
Dakota
Isanti
Ramsey
Rice
Sherburne
Washington

Figure 10 - Left graph represents total change of prairie habitat that was evaluated for this project. Right graph includes detailed categories of change. "Open Habitat Created" category includes any change that resulted in increased grassland or aquatic habitat. Development category includes roads, residential structures, and other structures.

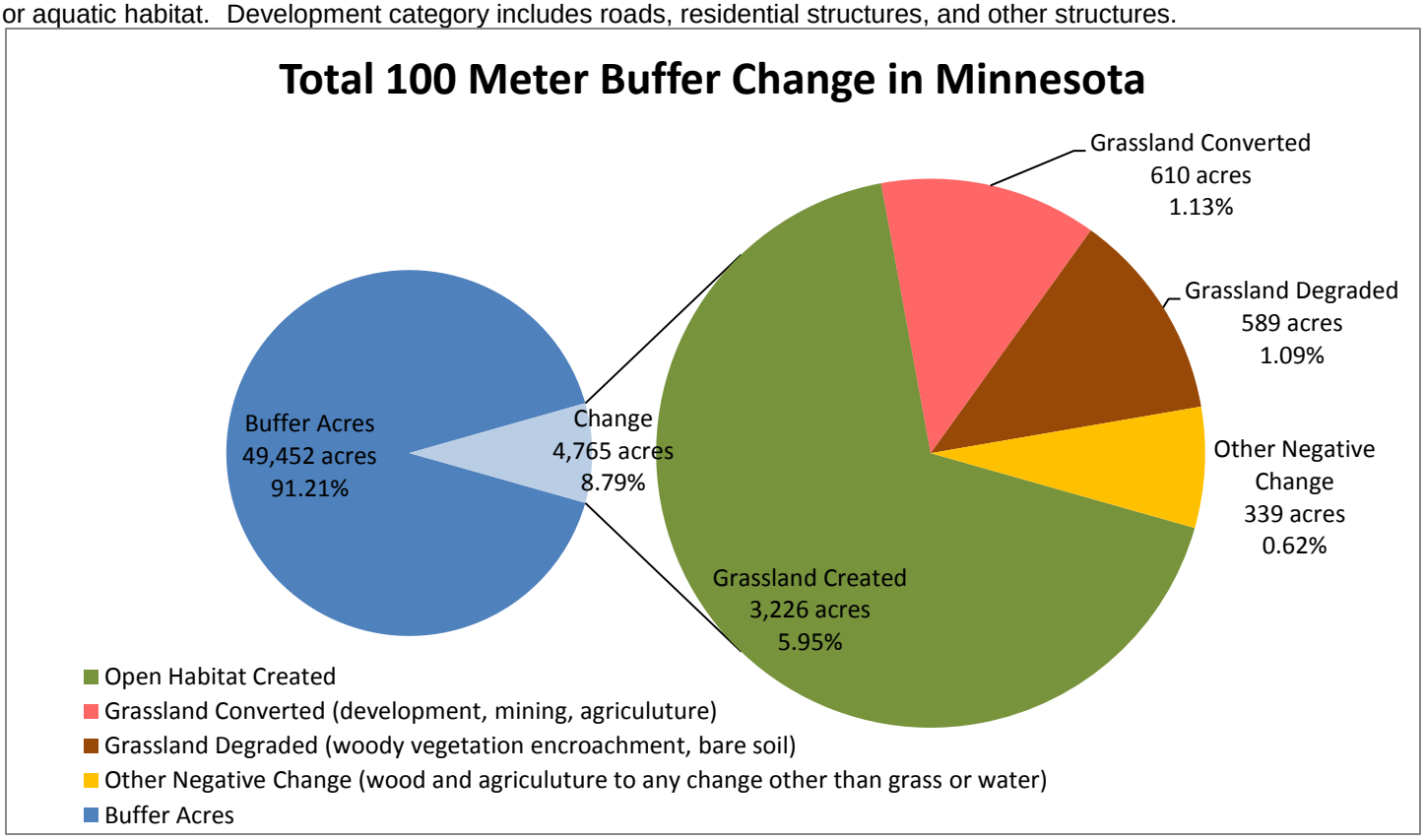


Figure 11 - Left graph represents total change of prairie habitat that was evaluated for this project. Right graph includes detailed categories of change. "Open Habitat Created" category includes any change that resulted in increased grassland or aquatic habitat. Development category includes roads, residential structures, and other structures.

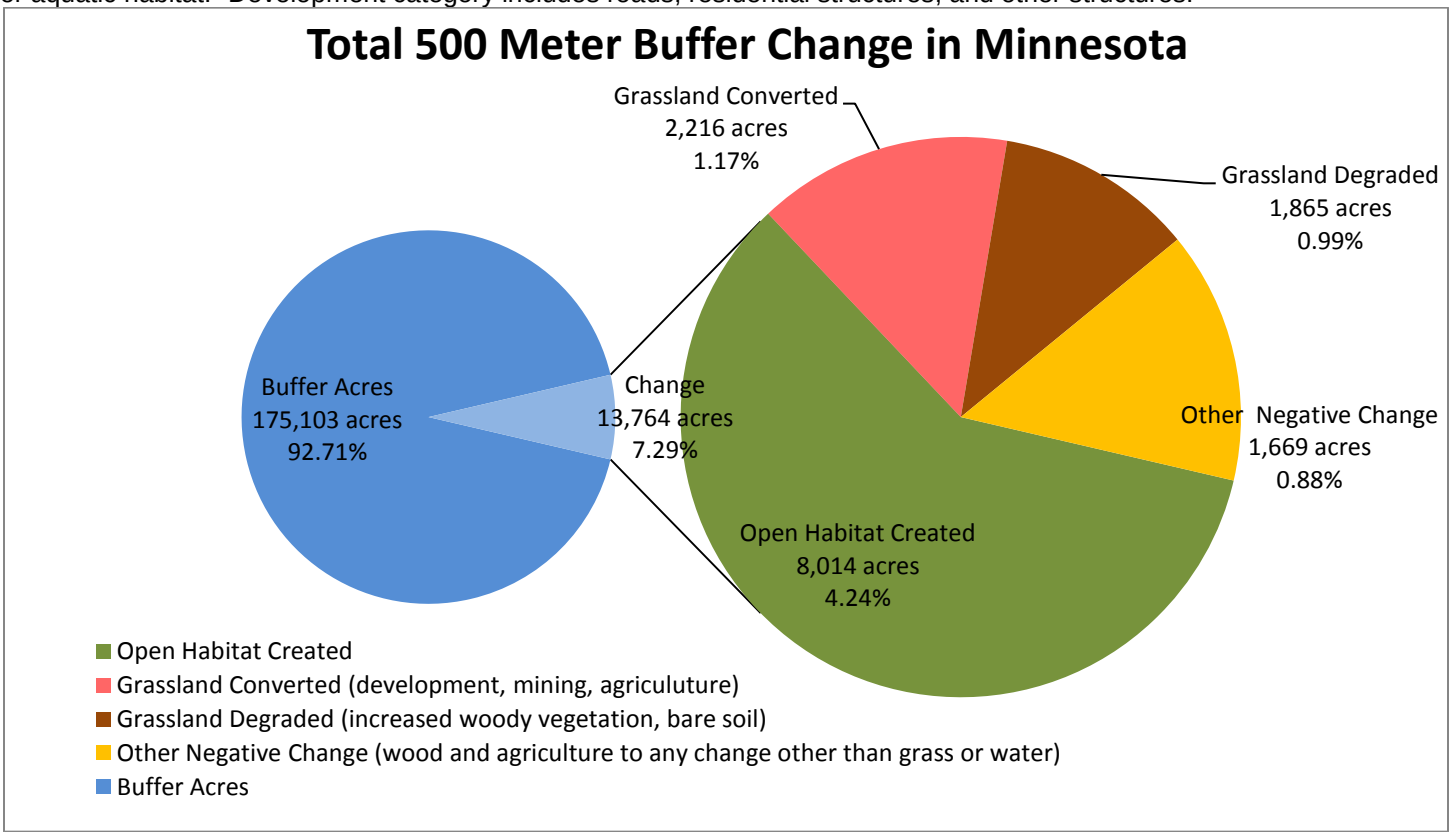


Figure 12 - Bars depict acres of change and are associated with left side of vertical axis, red lines depict total acres and are associated with the right side of the vertical axis. Detailed change categories listed below are discussed in methods.

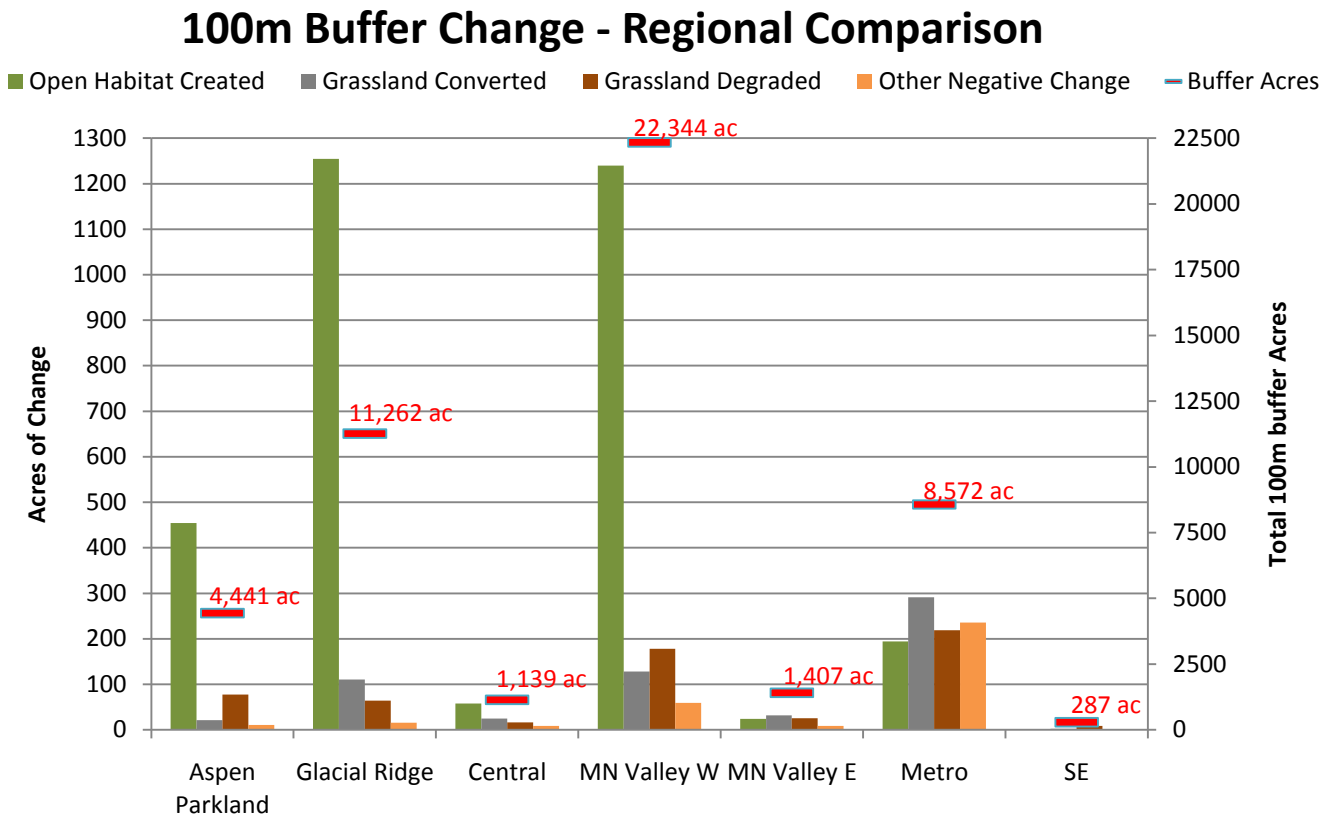


Figure 13 - Bars depict acres of change and are associated with left side of vertical axis, red lines depict total acres and are associated with the right side of the vertical axis. "Detailed change categories listed below are discussed in methods.

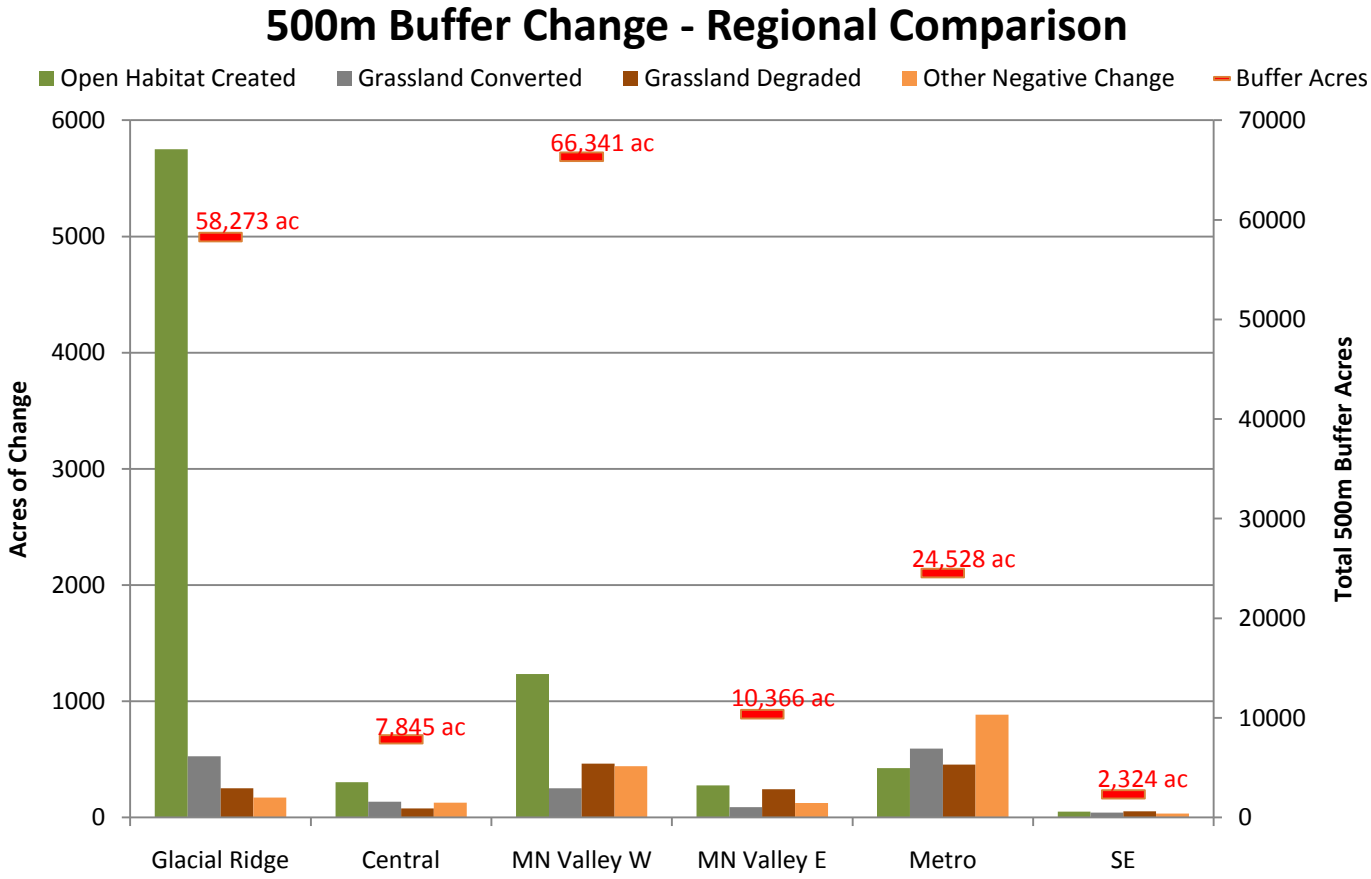


Figure 14 – number of individual prairie sites that were altered or left intact

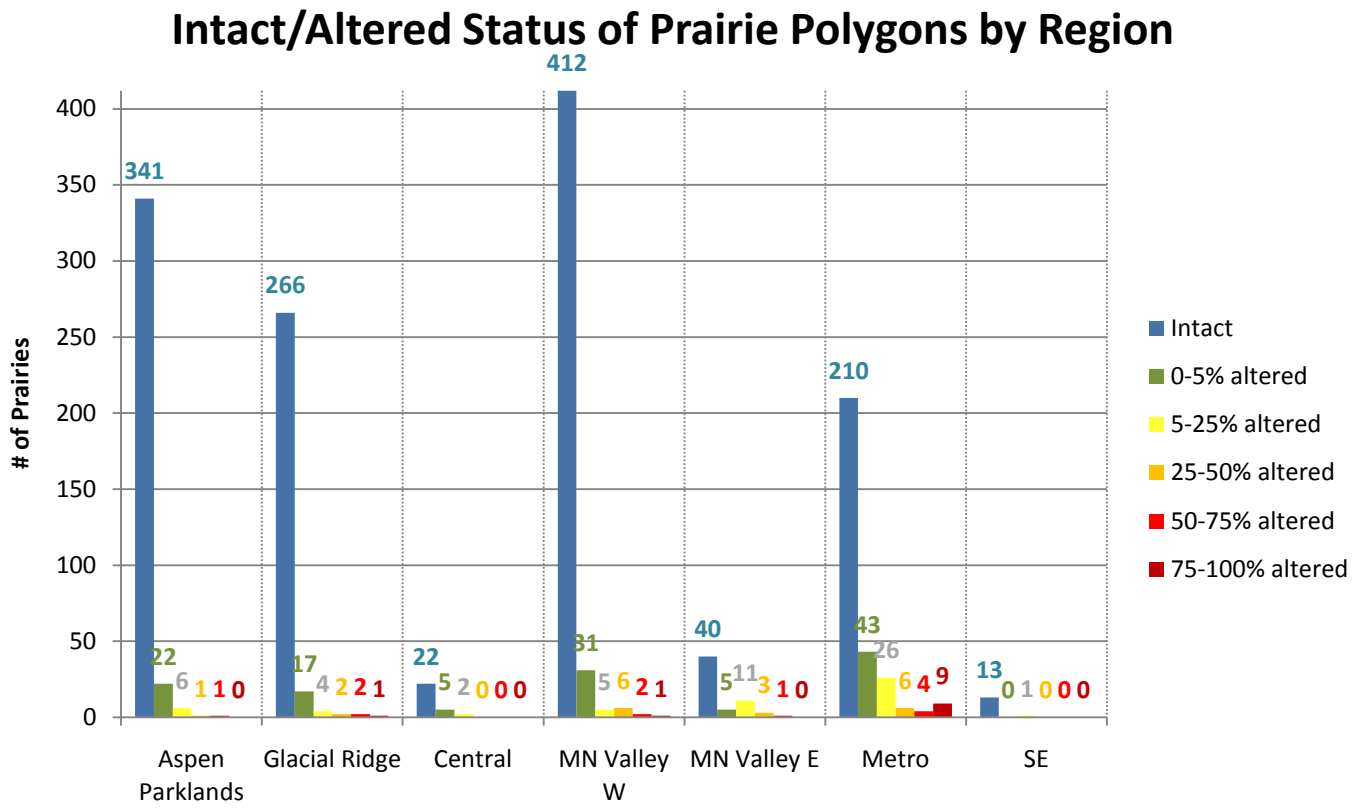


Figure 15 – Protected sites include state, federal and county land, as well as private land listed as CRP, Prairie Bank, or owned by TNC.

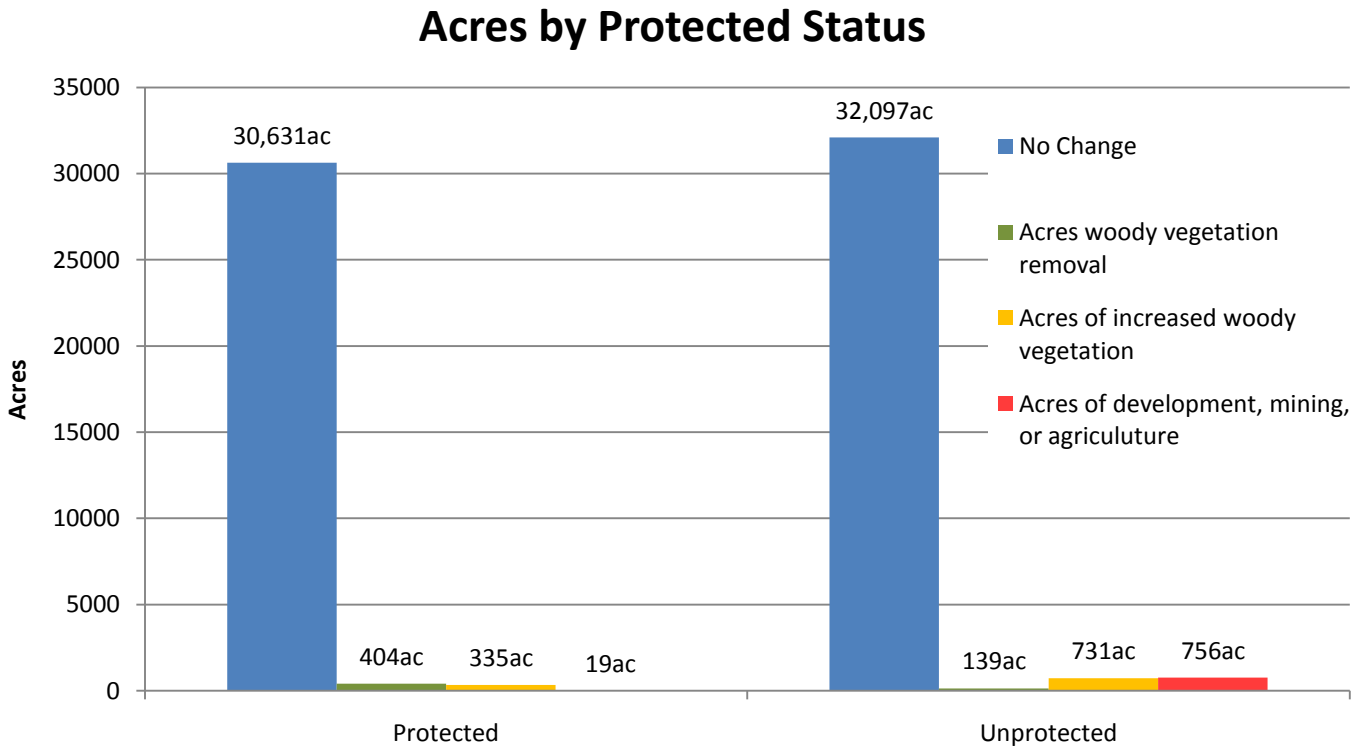
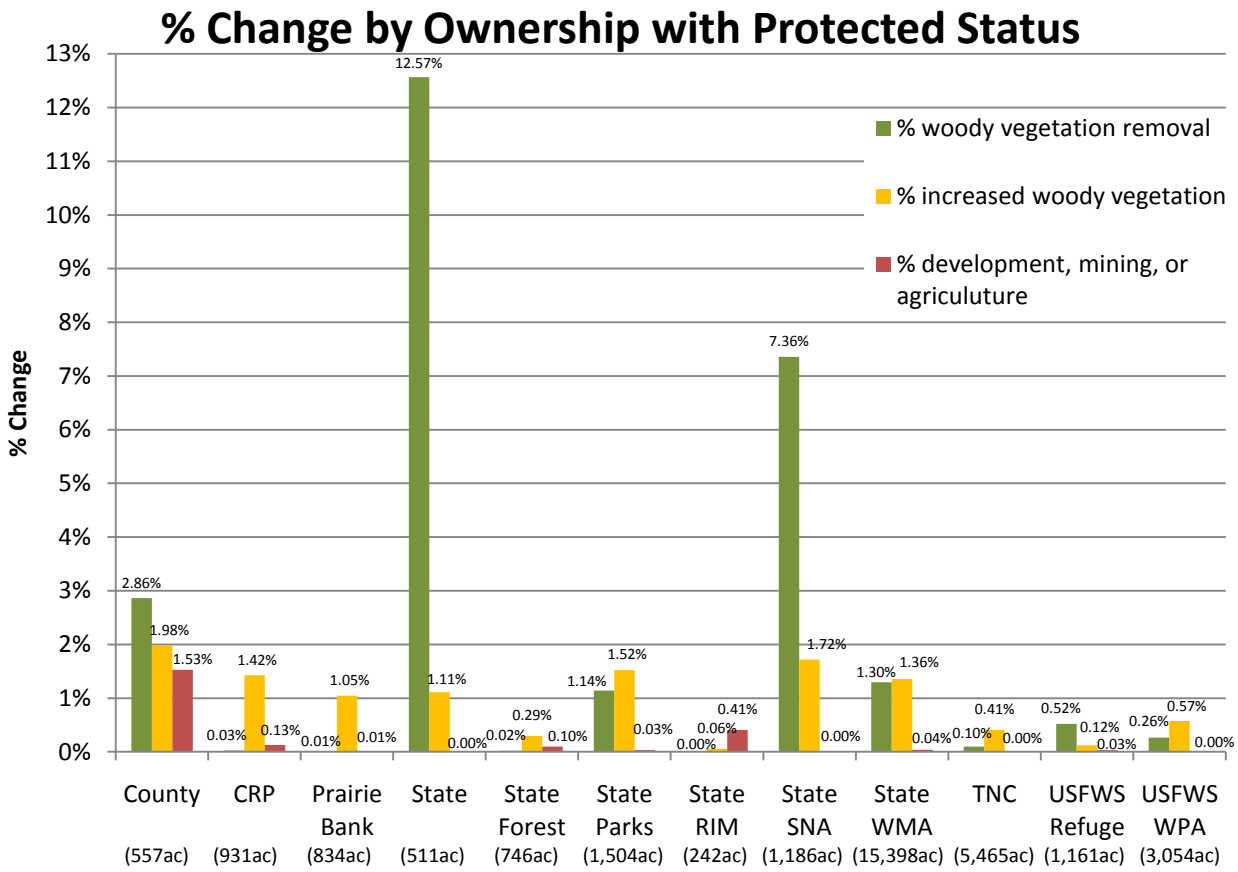


Figure 16 - % of habitat change for prairie sites with protected ownership. % based on total area (listed as acres on x-axis) for each land ownership category. "State" consists of University of Minnesota (U of M), Minnesota Department of Transportation, Minnesota Department of Corrections, Minnesota Department of Military Affairs (MNDMA), and undifferentiated state-owned land. Percent woody vegetation removal under "state" consists of 62 acres from U of M and 2 acres from MNDMA.



Attachment C

Accelerated Prairie Management, Survey, Acquisition and Evaluation
Result 5: Prairie monitoring and evaluation

Final Report to the Legislative-Citizen Commission on Minnesota Resources
July 1, 2008 to June 30, 2010
ML 2008, Chap. 367, Sec. 2, Subd. 3(m)

September 2010

Prepared by Daren Carlson, State Wildlife Action Plan Monitoring Coordinator
Division of Ecological and Water Resources, Minnesota Department of Natural Resources

Cover photo: Lac Qui Parle Wildlife Management Area, Chippewa County, MN by Daniel Wovcha.

Funding provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources and State Wildlife Grants.

Purpose

This project initiated a long-term monitoring study to track the status and trends of native prairie plant and bird communities in response to two key drivers of change – climate change and fragmentation of habitat. In addition, this study was designed to help inform prairie vegetation protocol development as part of a multi-agency Grassland Adaptive Management Collaborative (GAMC) to test and improve prairie management effectiveness. This project was jointly funded by a Federal State Wildlife Grant and by the Minnesota Environment and Natural Resources Trust Fund (ENRTF) as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Overview

A total of 38 high quality prairie sites, distributed among five focus areas, were monitored for baseline vegetation and bird data over the 2008-2010 field seasons. The sites were identified by the Minnesota County Biological Survey as high quality native prairie, and were stratified according to geography and landscape context. The project was designed in part to address outstanding monitoring protocol questions such as sampling density, transect length, and selection of indicator species.

A total of 683 vegetation transects, 42 relevés, and 1596 bird point counts were completed across the 38 sites, providing a substantial dataset for establishing baselines of bird and plant community conditions, testing and modifying monitoring protocols, and initiating long-term trend monitoring and analysis. Current long-term plans are to monitor a total of 35 sites on a five year rotation (7 sites per year), with five additional sites monitored every year to detect annual variation.

Bird Monitoring: Over the three field seasons of bird surveys, 163 bird species were recorded using standard point count methodology. Fifty-four species were Species in Greatest Conservation Need as identified in the Minnesota's State Wildlife Action Plan (SWAP), 16 were state listed, and 24 were grassland dependent species. Bird community monitoring became the only animal focus for this project. Other prairie animals, such as insects and reptiles, are being studied in separate, but complementary projects.

For all bird species, richness (the number of bird species recorded per point) significantly increased from the southern to northern focus areas, but was not influenced by landscape context (large-embedded vs. small-isolated). The species richness of grassland dependent birds, however, was significantly higher in large-embedded sites in all but one focus area, and also followed the same geographic trend as for all species. Species abundance (the number of bird individuals recorded per point) followed similar patterns as species richness, with a few exceptions detailed in the main report.

After three years of data collection, no trends or patterns of change were detected for abundance of individual bird species per site. This indicates the need for long-term monitoring to determine species trends.

Vegetation Monitoring Collaboration: DNR staff participated in a multi- organization Grassland Adaptive Management Collaborative to develop models, refine protocols, and train field staff.

Vegetation monitoring: The primary purposes of the 2008-2009 field seasons for prairie vegetation monitoring were to test the efficacy of the hierarchical belt transect protocols, developed by the Grassland Adaptive Management Collaborative, as well as to collect baseline data for the long-term prairie monitoring effort. Vegetation monitoring measured four main components: 1) rapid condition assessment (called the plant group score) 2) presence of indicator species; 3) vegetation structure; and 4) plant species composition.

A total of 435 plant species were recorded over the two sampling years. Species richness (number of species per transect) and plant group score was highest in the two northern-most focus areas. Certain individual plant species showed geographic patterns. In particular, Kentucky bluegrass (*Poa pratensis*), a non-native species and the most frequently measured plant overall, increased in both frequency and, more significantly, cover from north to south. The number of indicator species did not show any relationship to geography (focus area distribution) or landscape context (large-embedded vs. small-isolated).

Sensitivity analyses of protocols: Preliminary findings and recommendations from sensitivity analyses of the monitoring protocols:

1) Plant group score, a rapid assessment for evaluating prairie condition, shows a fairly strong relationship to species richness and number of indicator species, although considerable variability in the relationships indicates it should not be used as a sole-measure for prairie condition.

2) The current suite of quality indicators are more likely to be present in Upland Prairie systems than Wet Prairie systems and are rarely present in Wet Meadow systems. The quality indicator list should be modified to include more species typical of the wetter prairie systems.

3) Sampling density (number of transects per acre) for capturing species richness is variable by site. Sampling density could be reduced and still effectively capture quality indicators.

4) Preliminary analyses show that reducing transect length by as much as half (12.5 m or 25 quadrats) will increase sampling speed and likely not substantially alter most of the vegetation measures.

Data management: Development of applications for field entry of bird monitoring data and vegetation indicator species into mobile data recorders enabled efficient and accurate data recording, and saved considerable time and cost by not having to enter hand-written datasheets into a database following the field season.

DNR staff modified a grassland monitoring database developed by the US Fish and Wildlife Service as part of the Grassland Adaptive Management Collaborative to enable entry and storage of the most-detailed protocols while maintaining the database structure. This allowed relatively easy transfer of the core data to the Collaborative (currently managed by the USFWS Morris Wetland District). DNR data are provided to the USFWS, and is also stored a databases on DNR central servers. Data are available to other parties upon request. In order to associate monitoring data trends with management practices, DNR staff are developing an Adaptive Management Spatial Database (AMSD) that allows users to set management objectives, define, track and report on management activities and track and report on biological outcomes (monitoring data).

Introduction

Minnesota's native prairie covered about 18 million acres at the time of the public land surveys (1847-1908); currently less than one percent remains. Recent acceleration of efforts to maintain or restore prairies have accentuated the need for long term data collection, storage and analysis using a consistent set of monitoring protocols to: 1) detect changes and long-term trends (status and trend monitoring) and 2) evaluate the success of prairie management and restoration activities (effectiveness monitoring).

The remaining native prairie habitat continues to face loss from conversion such as agriculture, mining, and development, and additional pressures such as climate change, invasive species, and fragmentation threaten protected prairie in numerous, and often not well understood, ways. Long-term status and trend monitoring provides critical data to help inform how prairie is to be protected and maintained over time as related to anticipated or often unexpected changes due to these key drivers of change.

The results of effectiveness monitoring are crucial for evaluating whether or not management actions are achieving desired outcomes, and subsequently help direct adaptive management decisions.

Related to the loss of prairie habitat, many prairie associated animal species are now rare and continue to show declining trends. Minnesota's State Wildlife Action Plan – Tomorrow's Habitat for the Wild and Rare, identified more prairie associated Species in Greatest Conservation Need than any other habitat in Minnesota (MN DNR 2006). One animal group, grassland birds, have experienced significant declines in the last several decades, both across North America and in Minnesota and more than any other group of birds.

Fragmentation of habitat has two key components – the size of the tract of native prairie and the type of landuse and habitat surrounding a prairie tract, collectively termed landscape context. Numerous studies indicate that prairie species are highly dependent on both the size of native habitat and the type of land surrounding it (e.g. trees, development, etc.).

This project initiated a long-term monitoring study to track the status and trends of native prairie plant and bird communities in response to two key drivers of change – climate change and fragmentation of habitat. In addition, this study was designed to help inform prairie vegetation protocol development as part of a multi-agency Grassland Adaptive Management Collaborative (GAMC) to test and improve prairie management effectiveness.

Grassland Adaptive Management Collaborative

In 2007, grassland managers and scientists formed the Grassland Adaptive Management Collaborative (GAMC), a multi-organization group with participants from the U.S. Fish and Wildlife Service, the U.S. Geological Survey, The Nature Conservancy, and the MN Department of Natural Resources Divisions of Fish and Wildlife, Parks and Trails, and Ecological and Water Resources. The purpose of the group was to develop cooperative, standardized monitoring protocols to more effectively resolve uncertainties about grassland management. A collaborative effort facilitates comparisons of data across ownerships and throughout the tallgrass prairie region of Minnesota. While focused on native prairie, the methods could likely be applied in restored areas.

Several meetings since 2007 resulted in a framework for adaptive grassland management in Minnesota and the Northern Tallgrass Prairie Ecoregion of North Dakota and South Dakota. Generally, the adaptive management process involves defining a problem, identifying potential management alternatives, predicting (modeling) the expected system response to those management alternatives, implementing the management and evaluating the results. The collaborative developed hierarchical monitoring protocols (most-detailed to least-detailed) to sample prairie vegetation, and is collectively storing and sharing vegetation data providing for a larger, more robust dataset. Based on the monitoring data collected, future decisions can be adapted to best meet the goals of the project. The goal of the collaborative is to determine broad plant composition and structural changes over time in response to a suite of land management techniques including grazing, burning, and haying.

As part of this ENRTF funded project, the SWAP monitoring coordinator and other DNR staff participated in the collaborative to develop models, address specific protocol questions (such as sampling density, transect length, and selection of indicator species), and train field staff. Preliminary results are presented below.

Methods

Sites with high quality, native prairie were selected within the Prairie Parkland and Tallgrass Aspen Parkland Provinces in western Minnesota (http://www.dnr.state.mn.us/ecs/index.html). Prairies in eastern Minnesota, such as bluff prairies in the southeast, were excluded In order to limit the project scope and variability in the data. Five focus areas were selected based on concentrations of remaining native prairie identified by MCBS and geographic distribution. Sites were stratified by geographic location (within each of the five focus areas) and landscape context in order to detect long-term changes as a result of climate change and habitat fragmentation (Figures1a & 1b, Table 1). Sites were selected if they were generally either: a) large and embedded within a matrix of grassland, or b) small and isolated [1].

[1] *Large was defined as greater than approximately 50 acres. Small was defined as less than approximately 50 acres. Embedded was defined as more than approximately 50% of a 500 m buffer was grassland or other open native community. Isolated was defined as less than approx. 25% of a 500 m buffer was grassland or other open native community.*

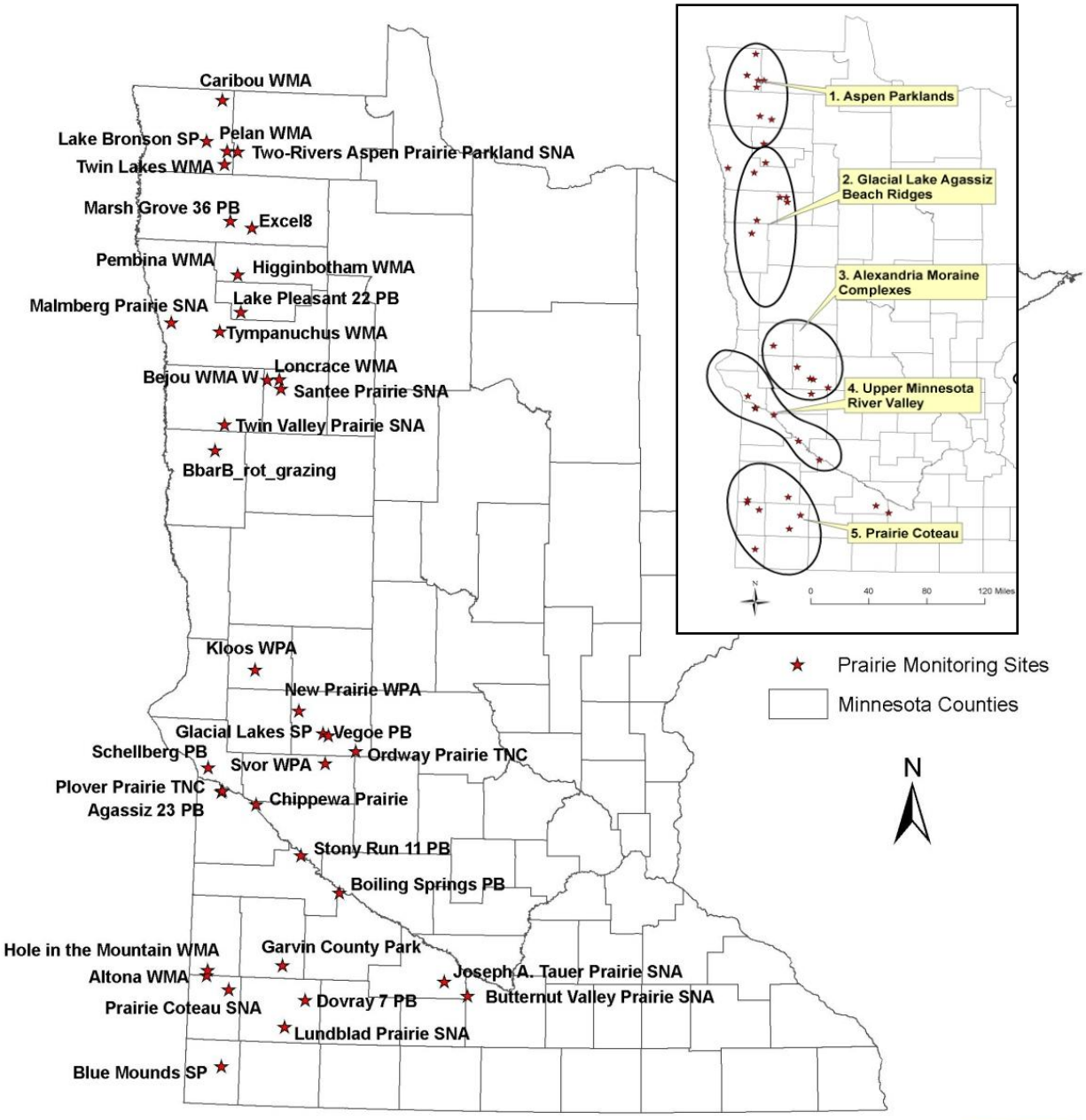
Sites were not stratified to the specifications originally proposed in the Trust Fund work program, because relative size and isolation is variable depending on the landscape, thus affecting the available pool of sites. Three sites (Malmberg Prairie, Butternut Valley SNA, Joseph A. Tauer SNA) were selected outside of the focus areas given their unique small and isolated situations.

Prairie bird monitoring

As part of this initial phase, bird monitoring during the breeding season was conducted at 38 sites in 2008 and 2009. In 2010 twelve sites were resampled, initiating a long-term sampling design (Table 2). Bird monitoring consisted of standard, ten minute point counts repeated three times per season. A minimum of seven point counts (with a few exceptions, see below), spaced a minimum of 200 meters apart were assigned to sites in the office prior to field surveys. Point count locations were first assigned to points previously established by Minnesota County Biological Survey (MCBS) bird surveyors (about 10% of points). When feasible, remaining points were arranged 200 meters apart in a hexagonal grid to match the Iowa MSIM protocols (Manley et al. 2006, Kinkead 2006). Often this was not possible because of the arrangement of the pre-existing MCBS points or because sites were too small or irregularly-shaped to fit a grid of that size. In these cases, plots were located to cover as much of the area as possible while still being 200 meters apart. For exceptionally small sites, only two to five points could be assigned (Table 2). Coordinates for these pre-determined point count locations were downloaded and located in the field using Trimble Nomad GPS data units.

Figure 1a Prairie monitoring sites

Figure 1b Location of focus areas



Prairie monitoring sites as part of the ENRTF funded Accelerated Prairie Project. Sites were monitored for birds and vegetation in 2008 and/or 2009. Twelve of these sites are in the process of being monitored in 2010 - bird monitoring was completed in June 2010 as part of the ENRTF funding.

Table 1 Site summaries

Focus Area	Size/ context[1]	Name	County	Ownshp	Acres	2008 Bird	2009 Bird	2010 Bird	2008 Veg Trans	2008 Releve	2009 Veg trans	2009 Releve
1	LE	Twin Lakes WMA	Kittson	WMA	32		5				12	2
1	LE	Caribou WMA	Kittson	WMA	553		28				40	2
1	LE	Twin Valley Prairie SNA	Norman	SNA	226		10				23	1
1	SI	Pelan WMA	Kittson	WMA	141		7				21	2
1	LE	Marsh Grove 36 PB	Marshall	PB	395		15	15			40	3
1	LE	Excel8	Marshall	DNR - Swamp trust	400		14				40	2
1	LE	Two Rivers Aspen Prairie Parkland SNA	Roseau	SNA	96		7				20	1
1	SI	Higginbotham WMA	Pennington	WMA	130		11	11			13	3
1	SI	Lake Bronson SP	Kittson	SP	32		5	5			6	1
2	LE	B bar B	Clay	PB	271	14						
2	LE	Lake Pleasant 22 PB	Red Lake	PB	18	3	3	3	3	1	3	
2	LE	Santee Prairie SNA	Mahnomen	SNA	22	7			15	1		
2	LE	Tympanuchus WMA	Polk	WMA	24	7		7	6	1		
2	SI	Bejou WMA W	Mahnomen	WMA	7	7			3			
2	SI	Loncrace WMA	Mahnomen	WMA	34	5	5		6	1	6	
2	SI	Malmberg Prairie SNA	Polk	SNA	51	7			10	1		
3	LE	Ordway Prairie	Pope	TNC	278	9	15		21	1	35	1
3	LE	Glacial Lakes SP	Pope	SP	495	14	13				50	2
3	LE	Vegoe PB	Pope	PB	55		7	7			6	1
3	LE	Svor WPA	Swift	WPA	34	7	7		2	1	4	
3	SI	Kloos WPA	Grant	WPA	17	7	7				3	1
3	SI	New Prairie WPA	Pope	WPA	15	4	4	4			3	1
4	LE	Agassiz 23 PB	Lac Qui Parle	PB	64	6			7			
4	LE	Plover prairie	Lac Qui Parle	TNC	201	7		7	13	1		
4	LE	Chippewa Prairie/Lac Qui Parle WMA	Chippewa	TNC/WMA		18	14		100	3	30	2
4	LE	Windsor 13 NE PB	Traverse	PB, partial	159	7			5	1		
4	LE	Schellberg PB	Big Stone	PB	177			10				
4	SI	Boiling Springs PB	Redwood	PB	27	7	7	7	6	1	6	
4	SI	Stony Run 11 PB	Yellow Medicir	PB	11	4	4		3	1	3	
4	SI	Joseph A. Tauer Prairie SNA	Brown	SNA	80		7				8	1
4	SI	Butternut Valley Prairie SNA	Blue Earth	SNA	12		2				2	1
5	LE	Altona WMA	Pipestone	WMA	25	7	7		5		5	
5	LE	Hole in the Mountain	Lincoln	TNC/WMA	148	14	9	14	26		13	
5	LE	Prairie Coteau SNA	Pipestone	SNA	234	7	7		12		12	
5	LE	Blue Mounds SP	Pipestone	SP	131		13	13			13	1
5	SI	Dovray 7 PB	Murray	PB	6	2			3			
5	SI	Garvin County Park	Lyon	County	22	7	7		4		4	
5	SI	Lundblad Prairie SNA	Murray	SNA	17	5	7		8		4	
		Total			**4640**	**182**	**247**	**103**	**258**	**14**	**425**	**28**

[1] LE = large, embedded; SI = Small, isolated

Table 2 Serially alternating design for prairie monitoring project

Year	S_0	S_1 2010	S_2 2011	S_3 2012	S_4 2013	S_5 2014	# sites/yr	Cumulative # of sites
1	5 sites	7 sites					12	12
2	5 sites		7 sites				12	19
3	5 sites			7 sites			12	26
4	5 sites				7 sites		12	33
5	5 sites					7 sites	12	40
6	5 sites	7 sites					12	
7	5 sites		7 sites				12	
8	5 sites			7 sites			12	
9	5 sites				7 sites		12	
10	5 sites					7 sites	12	
11	5 sites	7 sites					12	
12	5 sites		7 sites				12	
13	5 sites			7 sites			12	
14	5 sites				7 sites		12	
15	5 sites					7 sites	12	

40 sites total
S_0 – sites sampled every year, n = 5 (one from each focus area)
S_1 – sites sampled every 5 years starting in year 1 and repeated every 5 years, n=7.
S_2 – sites sampled every 5 years starting in year 2 and repeated every 5 years, n=7.
S_3 – sites sampled every 5 years starting in year 3 and repeated every 5 years, n=7.
S_4 – sites sampled every 5 years starting in year 4 and repeated every 5 years, n=7.
S_5 – sites sampled every 5 years starting in year 5 and repeated every 5 years, n=7.

Bird point counts were conducted on three separate days at each point location at each site during the breeding bird survey period (June 1 through the first week of July) in order to calculate species detectability using Area Occupancy models (MacKenzie et al. 2006). At each point, surveyors recorded all bird species seen or heard during a ten-minute interval, and also recorded estimated distance, sex, and breeding evidence. The full bird field monitoring protocols can be found in Appendix A. Most data were recorded in Trimble mobile handheld units and downloaded into a Microsoft Access database (see Data Management below). Approximately 15% of the data were recorded on data sheets and later entered into the Access database, as there were not enough Trimble units to accommodate all bird surveyors.

Vegetation Monitoring

Vegetation monitoring was conducted mid-July through mid-September in 2008 and 2009. Two methods were used: 1) The belt transect method developed by the Grassland Adaptive Management Collaborative (Appendix B), and 2) relevés as described in the relevé handbook (MN DNR 2007).

The primary purposes of the 2008-2009 field seasons for prairie vegetation monitoring were to test the efficacy of the hierarchical belt transect protocols developed by Grassland Adaptive Management Collaborative (Appendix C) and to collect baseline data to inform the long-term prairie monitoring effort. Protocols were tested using increased sampling density at some sites (1 transect per 5 acres vs. 1 per 10 acres), and conducting relevés.

Location of transect starting points, and random bearings for transect direction, were assigned in the office prior to field survey, at a minimum density of 1 transect per 10 acres. Seventeen of the 38 sites were assigned a transect density of 1 transect per 5 acres to test effective sampling density. Transect starting points were assigned at all bird point count locations that had been previously assigned for the June bird surveys (see above). Since transects generally outnumbered bird points at a given site, additional transects were randomly assigned with a minimum distance of 80 m between transects, using a DNR sampling extension in ArcView 3.3. Transects were designed to allow for sampling of a relatively homogenous prairie system (upland prairie, wet prairie, or wet meadow as defined MN DNR 2005), and the protocols specify procedures for moving transects if they are found in the field to cross into a different system type. For relevés, at sites where relevés had been sampled in the past, the same locations were resampled, otherwise new relevés were located based on the procedures described in the relevé handbook (MN DNR 2007).

Data for the species indicator portion of the protocols were entered directly into Trimble Nomad handheld data units. The bulk of the transect data was collected using paper sheets, and later entered into a Grassland Monitoring Database (see Data Management below).

Data Management

Hand-held applications

An application for field entry of bird monitoring data (using the software Pen Dragon) into Trimble Nomad handheld data recorders was developed by the DNR Management Information Services (MIS) unit. This enabled efficient and accurate data recording, and saved considerable time and cost by not having to enter hand-written datasheets into a database following the field season.

The SWAP Monitoring Coordinator modified the Pen Dragon bird application for recording the plant indicator portion of the habitat monitoring protocols. This application was successfully used by some of the field staff in all vegetation monitoring seasons.

Development of a complete application for the vegetation monitoring was explored, but was not pursued. The cost for development of this application was high given the complexity of the protocols and would need to be custom built. An application will be developed following final protocol development.

A grassland monitoring database was developed by the US Fish and Wildlife Service as part of the Grassland Adaptive Management Collaborative. The original database was developed for the least-detailed level of the hierarchical monitoring protocols (core data). DNR staff modified the database to enable entry and storage of the most-detailed protocols while maintaining the database structure for transfer of the core data to the main Collaborative database (currently managed by the USFWS Morris Wetland

District). Project data are also stored on DNR central servers, and are available upon request.

Adaptive Management Spatial Database

In order to facilitate the use of monitoring information to improve management activities, an Adaptive Management Spatial Database (AMSD) is under development. The Adaptive Management Spatial Database allows users to set management objectives, define, track and report on management activities and track and report on biological outcomes. The intent of AMSD is to increase management effectiveness and efficiencies along with increasing communication to show what we did and how well it worked for future financial and stakeholder support.

The design and development of a spatial database provides standardization of terminology and facilitate flexible, outcome-based reporting by:

- allowing the calculation of habitat management acres in various ways,
- linking habitat management activities to project goals and objectives, and biological responses (monitoring data),
- tracking the status of habitat management projects and/or practices (start and end dates, completion dates),
- linking staff activities and habitat management practices and acres to designated funding strings and financial spreadsheets (program budgets, encumbrances),
- tracking project accomplishments by funding source,
- integrating with other department applications and data sets

Results

Over 2008-2010 field seasons, a total of 683 vegetation transects, 42 relevés, and 1596 bird point counts were completed across the 38 sites (Table 1). The point counts repeated three times in each field season at 532 bird point plots. This level of effort provided a substantial dataset for establishing baselines of bird and plant community conditions across the matrix of sites, testing and modifying monitoring protocols, and initiating long-term trend monitoring and analysis.

Prairie bird monitoring

Staff and contractors completed bird point count surveys during the breeding season at 24 native prairie sites in 2008, 28 sites in 2009, and 12 sites in 2010 for a total of 38 sites overall. Of the 38 sites, 18 sites were sampled 2 of the 3 years and 4 sites were sampled all 3 years (Table 1).

Over the three field seasons of bird surveys, 163 bird species were recorded (121 in 2008, 149 in 2009, and 113 in 2010). 54 of which were Species in Greatest Conservation Need (SGCN), 16 were state listed, and 24 grassland dependent species.

Across all sites, the most commonly recorded bird was the Red-winged blackbird – a generalist species typically associated with wetlands. Seven of the 20 most common species recorded are considered grassland dependent (Table 3, Appendix C).

Table 3 Counts of the 20 most common bird species across all sites

Common Name	Grassland dependent	Total count (all years)	2008	2009	2010
Red-winged Blackbird		1162	526	493	143
Clay-colored Sparrow	Y	1022	353	454	215
Common Yellowthroat		766	243	392	131
Bobolink	Y	599	320	186	93
Yellow Warbler		533	120	322	91
Common Grackle		513	226	284	3
Sedge Wren	Y	498	186	222	90
American Goldfinch		478	152	266	60
Grasshopper Sparrow	Y	459	214	148	97
Brown-headed Cowbird		455	156	266	33
Savannah Sparrow	Y	379	136	164	79
Song Sparrow		359	109	182	68
Tree Swallow		347	115	213	19
Canada Goose		343	178	165	0
Western Meadowlark	Y	283	131	70	82
Mallard		218	123	91	4
Alder Flycatcher		211	21	138	52
Swamp Sparrow		196	64	92	40
Cedar Waxwing		157	17	133	7
Le Conte's Sparrow	Y	150	31	98	21

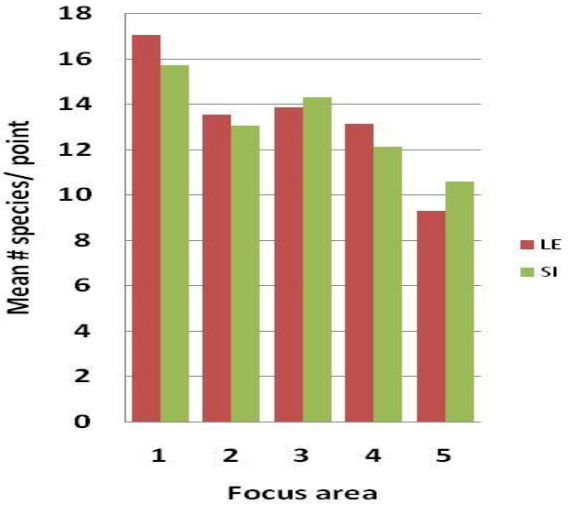
Analysis of bird communities

Species richness (number of bird species per point count averaged by site and across years) varied significantly ($p = 0.003$) by focus area, but not by landscape context. In general, the number of bird species per point count decreased from north (focus area 1) to south (focus area 5, Figure 2a).

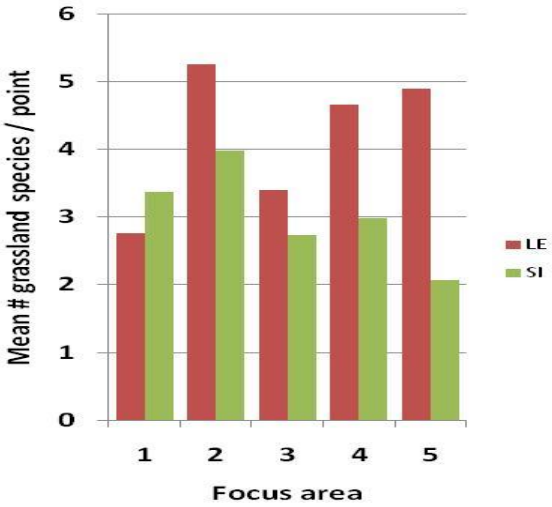
However, the number of grassland dependent bird species was significantly influenced by landscape context ($p=0.0034$), as well as focus area ($p = 0.080$) and their interaction ($p=0.063$). Large, embedded sites had more grassland species per point count in all regions, except for the northern focus area 1 where the pattern was reversed (figure 2b). Focus area 1 also had the lowest mean number of grassland bird species per point of all focus areas.

Figure 2 Mean number of bird species per point by focus area and landscape context (LE = large embedded, SI = small isolated)

2a) All species



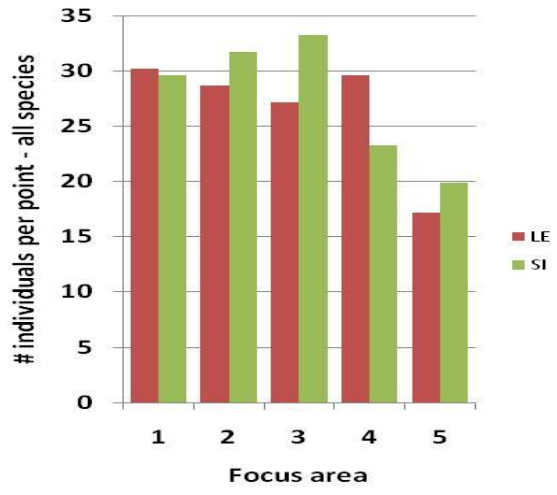
2b) Grassland dependent species



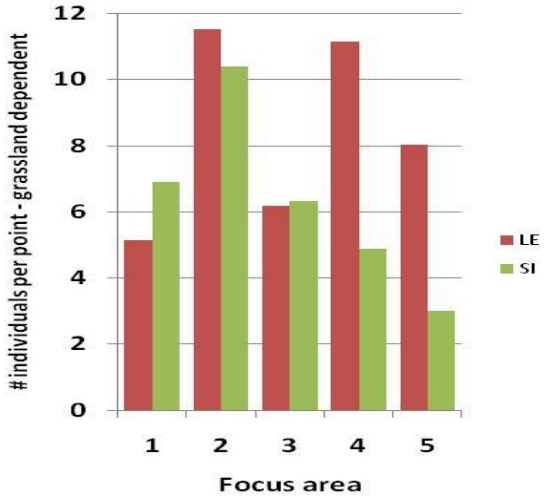
Species abundance (the number of bird individuals per point) followed similar patterns as species richness. Total number of individuals per point for all bird species was significant for focus area (p=0.0012), and not landscape context. This result was driven primarily by the southern-most focus area (focus area 5) which had about half the mean individuals per point than the other focus areas (Figure 3a). For grassland dependent bird species, focus area (p=0.038), landscape context (p=0.049), and their interaction (p=0.0099) all significantly influenced the number of individuals per point, with mixed responses. In the two southern-most focus areas, mean abundances of grassland bird species on large-embedded sites were than two-times those on small isolated sites (Figure 3b). This trend was reversed in the northern-most focus area where abundance at small-isolated sites was slightly higher than at large-embedded sites.

Figure 3 Mean number of individual birds per point by focus area and landscape context (LE = large embedded, SI = small isolated)

3a) All species



3b) Grassland dependent species



Examples of individual bird species trend data are available from the four sites that were sampled all three years. Since typically species numbers vary greatly on an annual basis due to population fluctuations, weather, observers, etc., a dataset from a period longer than three years is needed to determine trends related to climate change and habitat fragmentation. It will also be important to include other data such as weather and climate, the vegetation, management activities to further explain trend patterns. Sample data are presented below as an example of the type of information that will be available as this long-term monitoring project continues over time.

The four sites sampled in all three years are located in four of the five focus areas and evenly split between the two size-context categories (Table 4). Four grassland associated bird species are presented; bobolink (*Dolichonyx oryzivorus*), Clay-colored sparrow (*Spizella pallida*), Savanna Sparrow (*Passerculus sandwichensis*), and Western Meadowlark *(Sturnella neglecta)*.

Table 4 Sites that have been sampled for birds in all three years

Site Name	Focus area	Size, Context	Number of sample points
Lake Pleasant 22 NPB	2	Large, Embedded (LE)	3
New Prairie WPA	3	Small, Isolated (SI)	4
Boiling Springs NPB	4	Small, Isolated (SI)	7
Hole in the mountain TNC/WMA	5	Large, Embedded (LE)	14

The Bobolink was the second most abundant grassland bird species and fourth most abundant of all bird species across all sites (Table 3). Of the four sites examined for trends, it was recorded at all but New Prairie WPA, with the highest numbers in the southern two sites (Figure 4a). Preliminary trends are mixed. Abundance increased substantially at Boiling Springs Native Prairie Bank (NPB), remained steady at Hole in the Mountain WMA/TNC preserve, and decreased to zero detected at Lake Pleasant NPB.

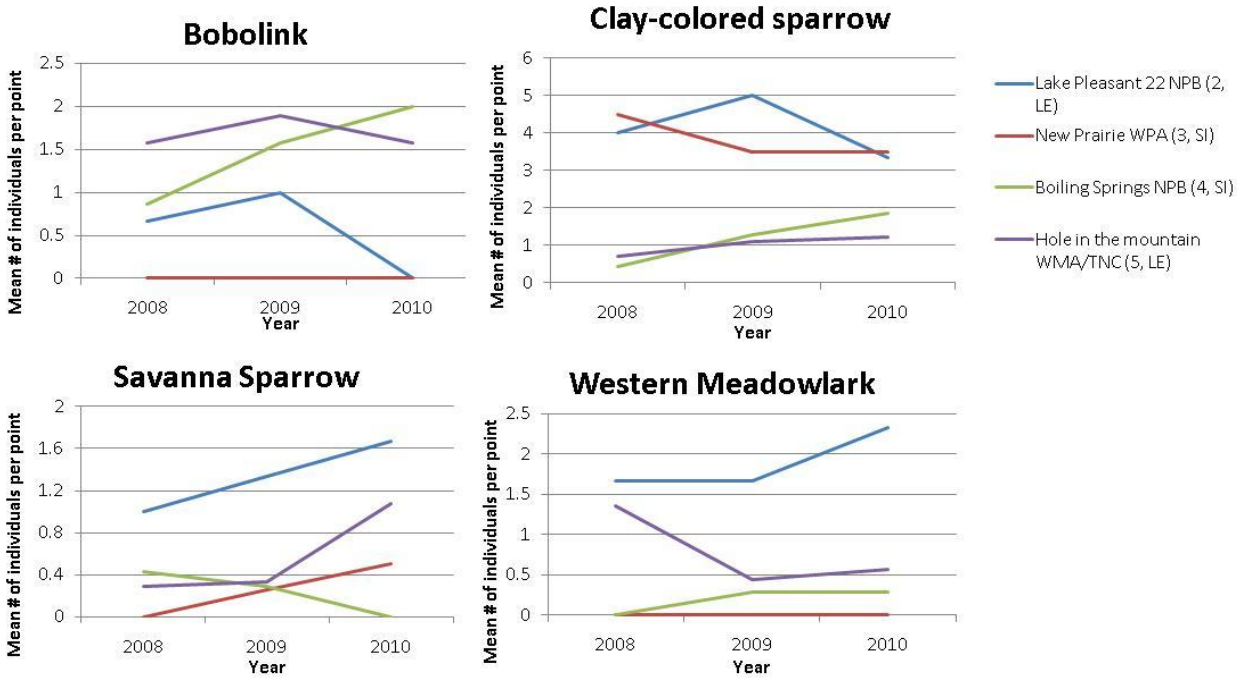
The Clay-colored Sparrow was the most abundant grassland bird and the second most abundant of all bird species across all sites (Table 3). Its abundance was much higher in the two northern sites (Lake Pleasant 22 NPB, New Prairie WPA) than at the two southern sites (Boiling Springs NPB, Hole in the Mountain WMA/TNC). Preliminary trends reveal minor increasing abundances at the southern sites and steady to declining numbers at the northern sites (Figure 4b).

The Savanna Sparrow was the sixth most abundant grassland bird and the 11th most abundant of all bird species across all sites (Table 3). Preliminary trend data show its abundance decreasing at Boiling Springs, with slight to moderate increases at the other sites. It was most abundant at Lake Pleasant Native Prairie Bank (Figure 4c).

The Western Meadowlark was the sixth most common grassland bird species (Table 3). It was present in three of the four sites, and most abundant at Lake Pleasant 22.

Preliminary abundance trends were mixed, with increases at Lake Pleasant 22 and Boiling Springs, and a substantial decrease from the first year at Hole in the Mountain (Figure 4d).

Figure 4 Preliminary trend data for the a) Bobolink (*Dolichonyx oryzivorus*), b) *Clay-colored Sparrow (*Spizella pallida*)*, c) *Savannah Sparrow (*Passerculus sandwichensis*),* and d) Western Meadowlark (*Sturnella neglecta*)



Vegetation Monitoring

Staff and contractors completed vegetation transects and relevés at 20 sites in 2008 and 28 sites in 2009 for a total of 36 sites overall (12 sites were sampled in both 2008 and 2009). A total of 683 transects (258 in 2008 and 425 in 2009) and 42 relevés (28 in 2008 and 14 in 2009) were completed over the two field seasons. In 2009, 20 transects were sampled twice by two different field crews to test repeatability.

Analyses presented for these two field seasons provide summary baseline information of differences between sites and strata (geographic location - focus area and landscape context), preliminary tests of the efficacy of sampling protocols for long-term monitoring, preliminary tests of remaining protocol questions such as transect length, sampling density, and sampling frequency. Full sensitivity analyses, including analysis of relevé data, will be completed following the 2010 field season and are not included in this report.

The transect protocols measure four main components: 1) rapid condition assessment called the plant group score 2) presence of indicator species; 3) vegetation structure; and 4) plant species composition. Summaries of these for components and their interrelationships are discussed in separate sections below.

1) Rapid condition assessments – plant group score

The plant group score is based on the relative amount of invasive species, presence of woody plants, and relative amounts grasses and forbs (Appendix B). A score is assigned to each of the 50 quadrats along the 25 m transect, summed for the entire transect, and averaged among all transects at a site. Plant group score, along with structure and a subset of the indicator species, represent the data that are collected at the most basic level of the protocols. These data are collected by all participants within the Grassland Adaptive Management Collaborative and pooled into a common dataset.

The range of possible plant group scores is from -185 to 185, with the bulk of the score determined by dominance of invasive vs. native plant species (Table 5). A higher score indicates better condition, although this score only incorporates plant composition as broad categories. There is a strong relationship between mean plant group score per transect and number of native species per transect and number of quality plant indicators per transect (see sensitivity analysis below).

Table 5 Plant group score breakdown. Each quadrat along a transect is scored based on its condition in A, B, and C below. Each transect is then averaged, and a site is averaged between transects. For example, if a quadrat is >75% native, >50% herbaceous, and a 25-75% grass-forb, then the score is 150+25+10 = 185. The maximum possible.

A) Native vs. invasive		**B) Herbaceous vs. woody**		**C) Grass vs. forb**	
Category	**Score**	**Category**	**Score**	**Category**	**Score**
Native >75%	150	Herbaceous >50%	25	Grass >75%	0
Native 50-75%	50	Low shrub >50%	0	Grass-Forb25-75%	10
Invasive 50-75%	-50	Tall shrub >50	25	Forb>75%	-10
Invasive > 75%	-150				

The mean plant group score per site ranged from -114 at Kloos WPA, a small-isolated site in focus area 3 to 180 at Lake Pleasant 22 NPB, a large-embedded site in focus area 2 (Appendix D). Plant group score was significant for focus area ($p<0.0001$), and the interaction between focus-area and size-context ($p=0.0074$), but not size-context alone ($p=0.79$). The two northern-most areas (Focus areas 1 and 2) had significantly higher plant group scores than the other areas with the exception of small-isolated sites in focus area 4 (Figure 5). Plant group scores by size-context was not statistically significant, although some differences were significant in specific focus areas. In particular, small-isolated sites were higher than large-embedded sites in focus area 4, with a reverse trend in focus area 3 (Figure 5).

2) Presence of indicator species

Indicator species fall into five categories: 1) Tier1 quality indicators, 25 plant species; 2) Tier 2 quality indicators, 30 plant species; 3) Tier 1 invasive indicators, 36 plant species; 4) Tier 2 invasive indicators, 36 plant species; and 5) Disturbance increasers, 13 plant species. Disturbance increasers are native plants generally associated with grassland sites overly-disturbed by grazing, soil disturbance, etc. While the invasive and

disturbance increaser indicators will be important for assessing management actions and detecting trends over time, this report focuses on the Tier 1 and Tier 2 quality indicators.

The mean number of quality indicator species (Tier 1 and Tier 2, 55 species total) per transect ranged from zero at Agassiz 23 NPB, a large-embedded site in focus area 4, to 10.5 at Lundblad Prairie SNA, a small-isolated site in focus area 5 (Appendix D) . Mean numbers were highly variable between focus areas and size-context, with no discernable patterns present (Figure 6). One possible explanation is due to the fact that the presence of indicator species is highly dependent upon the system type being sampled (see sensitivity analysis below).

Figure 5 Mean plant group score per transect vs. focus area and landscape context

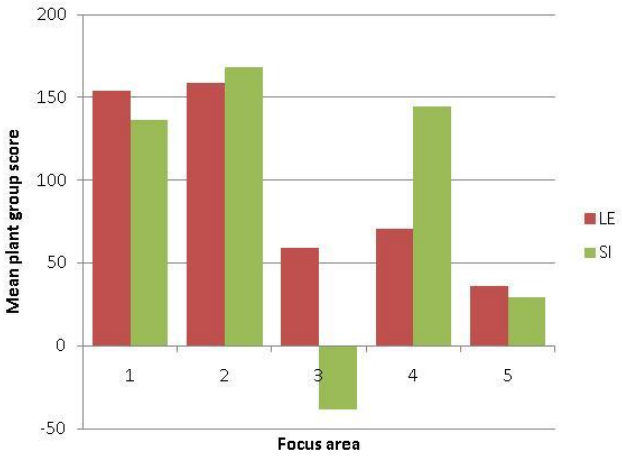
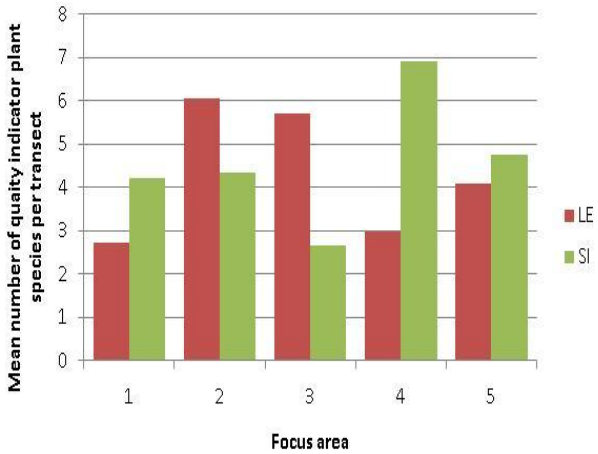


Figure 6 Mean number of quality indicators per transect vs. focus area and landscape context



3) Vegetation structure

Vegetation structure was characterized using Visual Obstruction Readings (VOR) at the beginning of each transect, and litter depth at every 5th quadrat along a transect (see Appendix B for more information).

Management objectives as part of the Adaptive Management Collaborative are to maintain a variety of vegetation VOR readings (measured as the coefficient of variation) at a site, as a variety of structures is important to maximize habitat quality for a suite of species. Target litter depths are around 5-7 cm. Both VOR and litter depth are highly dependent upon the intensity and time since management, as well as type of prairie (dry vs. mesic vs. wet).

The coefficient of variation of VOR readings showed no relationship to mean plant group score per site (Figure 7). Litter depth tended to be higher in wet meadow and wet prairie systems, and showed little relationship to prairie quality as measured by plant group score (Table 6).

Figure 7 coefficient of variation (CV) of visual obstruction reading (VOR) vs mean plant group score per site

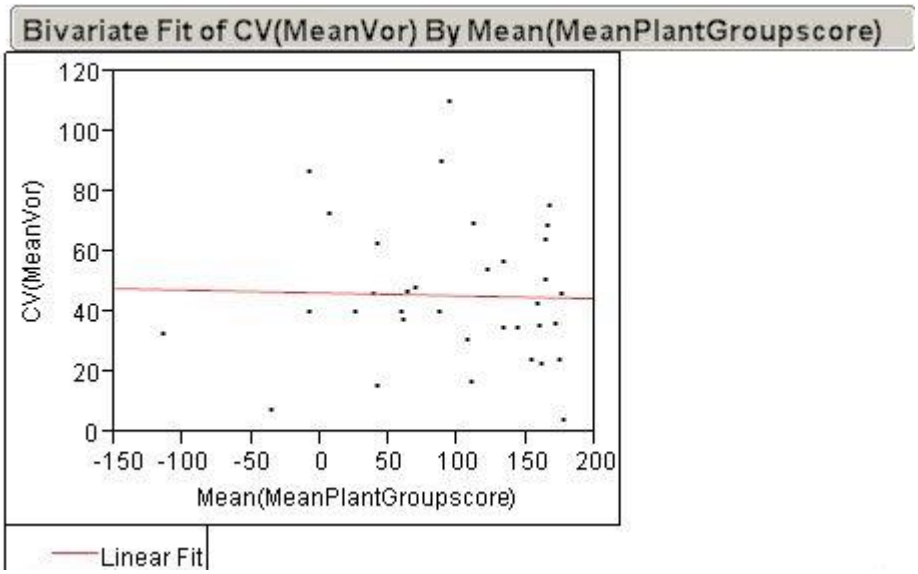


Table 6 Mean Litter depth – summarized by "Transect quality" and system type for all focus areas.

"Quality" (Plant Group Score)	System Type	N	Mean Litter Depth	Std Err Litter Depth
<-50 "Worst"	WP	10	5.46	1.02
	UP	40	3.19	0.41
	WM	1	2.30	
-50to100 "medium"	WP	25	2.92	0.48
	UP	167	3.09	0.18
	WM	3	6.22	1.02
100+ "Best"	WP	150	3.07	0.17
	UP	153	1.75	0.18
	WM	83	6.10	0.53

4) Plant species composition and diversity

A total of 435 plant species were recorded over the two sampling years. Across all transects sampled, the most frequently occurring species was Kentucky bluegrass (*Poa pratensis*, 59% of all quadrats), followed by Big Bluestem (*Andropogon gerardii*, 26%), Smooth brome (*Bromus inermis*, 17%), Indian grass (*Sorghastrum nutans*, 10%), and Side-oats grama (*Bouteloua curtipendula*, 9.9%, Table 7). Kentucky bluegrass was twice as frequent, and had 1.5 times more total cover than big bluestem, the next most common plant species. These patterns differed by focus area. For example, the frequency and mean percent cover of Kentucky bluegrass increased from north to south (Figure 8). While the frequency of Kentucky bluegrass peaked at almost 80% in focus areas 3, 4, and 5, the mean percent cover continued to increase from near 15% in focus area 3 to over 30% in focus area 5. Cover and frequency of Kentucky bluegrass was not influenced by landscape context (not pictured).

The other primary prairie invasive species, Smooth brome (*Bromus inermis*), was the third most frequent and abundant species overall, but also varied considerably by focus area (Table 7, Figure 9). Smooth brome was almost non-existent in the northern two focus areas (1 and 2), peaked at nearly 50 percent frequency in focus area 3, and leveled-off around 20 percent in the southern areas (4 and 5). Mean percent cover followed similar patterns.

Table 7 Most frequent species across all sites and 683 transects

Scientific Name	Common Name	Native	Mean % cover	Frequency
Poa pratensis	Kentucky bluegrass	I	15.5	58.98%
Andropogon gerardii	Big bluestem	N	9.0	25.55%
Bromus inermis	Smooth Brome	I	5.3	17.27%
Sorghastrum nutans	Indian Grass	N	3.3	10.41%
Bouteloua curtipendula	Side-oats grama	N	2.9	9.87%
Stipa spartea	Porcupine grass	N	2.8	9.87%
Solidago canadensis	Canada goldenrod	N	2.4	9.12%
Solidago missouriensis	Missouri goldenrod	N	1.7	6.27%
Schizachyrium scoparium	Little bluestem	N	1.7	5.60%
Populus tremuloides	Quaking aspen	N	1.6	4.13%

Figure 8 Frequency and average cover of Kentucky bluegrass by focus area

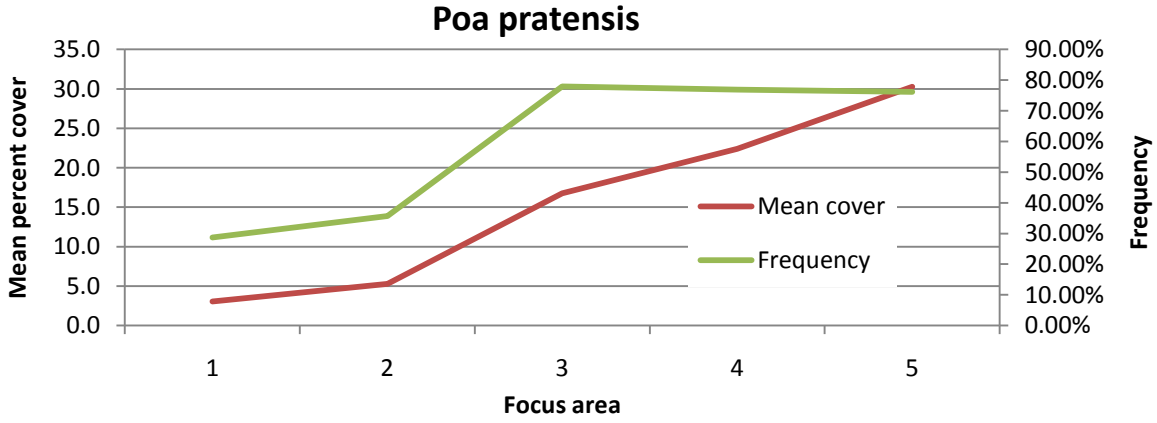
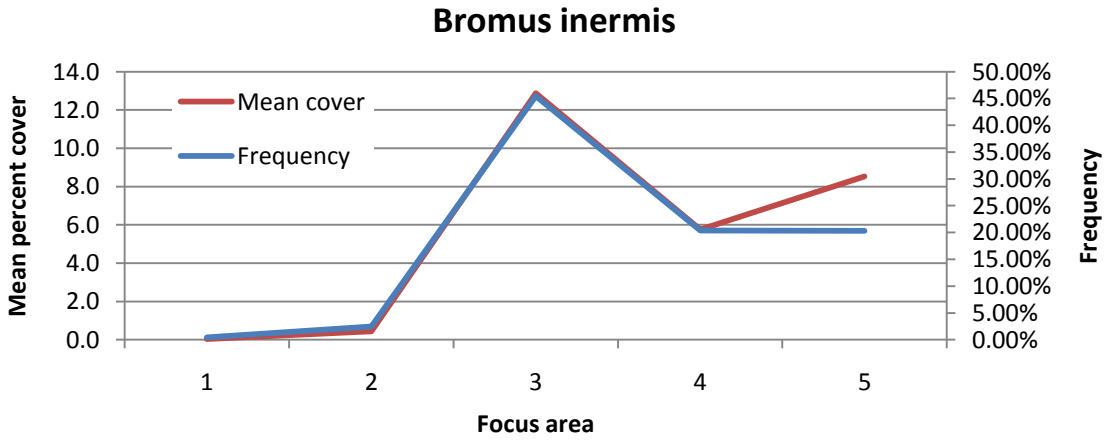
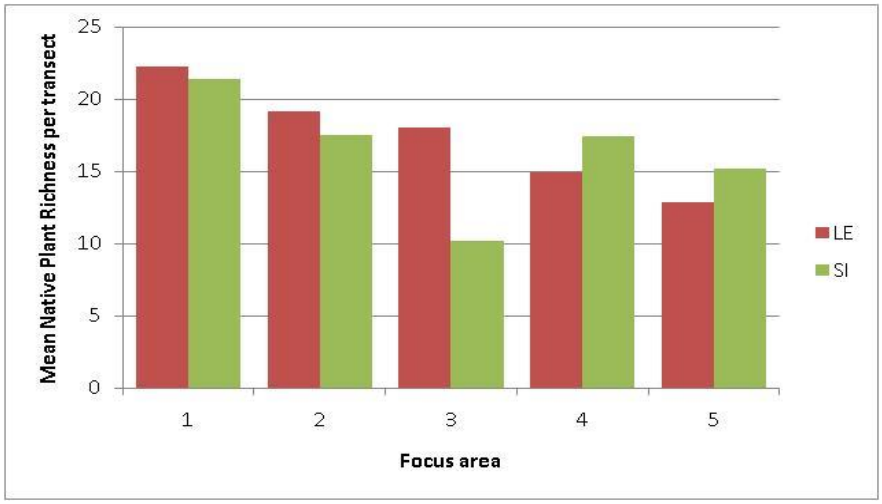


Figure 9 Frequency and average cover of Smooth brome by focus area



Mean richness (number of native species per transect) ranged from 7 at Kloos WPA, a small-isolated site in focus area three, to 25.9 at Higginbotham WMA, a small-isolated site in focus area one (Appendix D). Mean richness was significantly influenced by focus area (p=0.0026), but not by landscape context (p=0.87). Species richness tended to be higher in the two northern-most focus areas (1 and 2) and lower in the southern focus areas (Figure 10).

Figure 10 Mean number of native species per transect vs. focus area and landscape context



Sensitivity analysis and protocol recommendations for the grassland management collaborative

Sensitivity analyses of the protocols will be completed following the 2010 field season (provided by funds other than ENRTF). Preliminary results are discussed below.

Indicator species: The current suite of quality indicators are dependent on the system type (Upland Prairie, Wet Prairie, Wet Meadow). They are more likely to be present in Upland Prairie systems than Wet Prairie systems, and are rarely present in Wet Meadow systems (Table 8). The indicator list should be modified to include plants more characteristic of wetter prairie systems.

Table 8 Tier 1 quality indicators – summarized by plant group score and system for focus areas 2,3,4,5 (Focus area 1 did not have enough indicators for analysis).

"Quality" (Plant Group Score)	System Type	Median # Indicators	N	Mean Proportion	Std Err of proportion
<-50 "Worst"	WP	0	10	0.016	0.007
	UP	1.5	36	0.081	0.014
	WM	0	1	0.000	
-50to100 "medium"	WP	2	19	0.080	0.018
	UP	4	163	0.171	0.009
	WM	0	3	0.013	0.013
100+ "Best"	WP	4	54	0.167	0.009
	UP	6	134	0.253	0.009
	WM	0	15	0.019	0.013

Plant group score: Plant group score showed a substantial association with species richness and with the number of quality indicators (Figures 11, 12), suggesting this rapid assessment may be a good method for determining prairie quality, with the following caveats. This project focused on high quality prairie, and it is important to include poorer quality prairie sites from the larger pool of sites within the Grassland Adaptive Management Collaborative in such an analysis in order to get a broader spectrum of prairie quality. While a relationship exists between plant group score and species richness and with the number of indicators, considerable variability in the data remains, suggesting that additional species level information may be necessary. A more detailed species-level sampling on a less-frequent rotation (e.g. every 5 or 10 years) is suggested in order to fully assess prairie plant community condition in response to management and other drivers of change.

Figure 11 Number of native plant species per transect vs. mean plant group score per transect

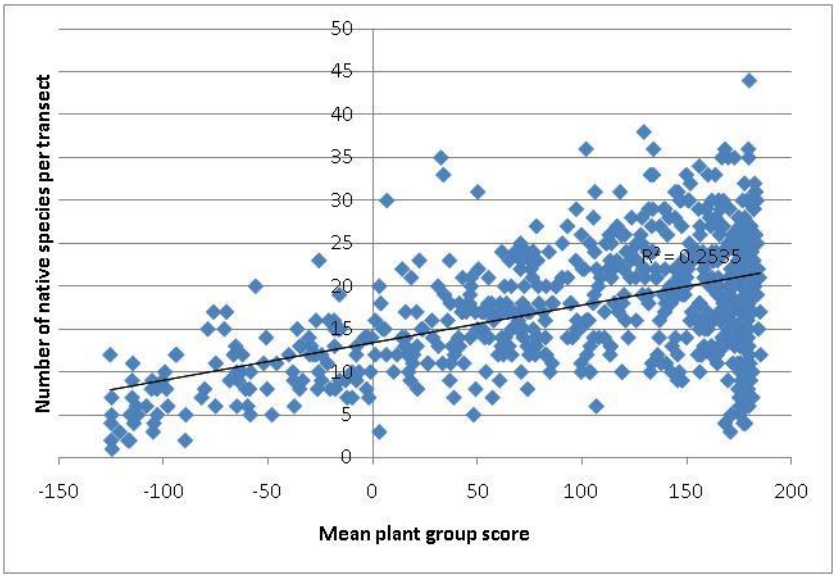
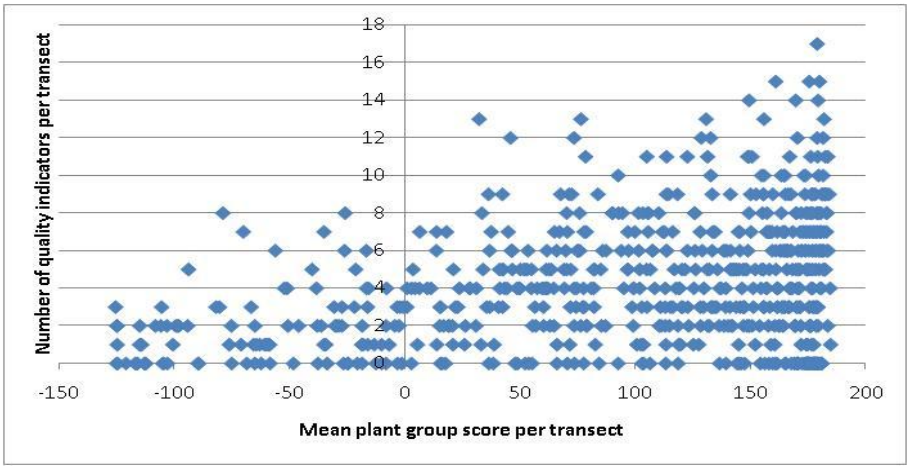


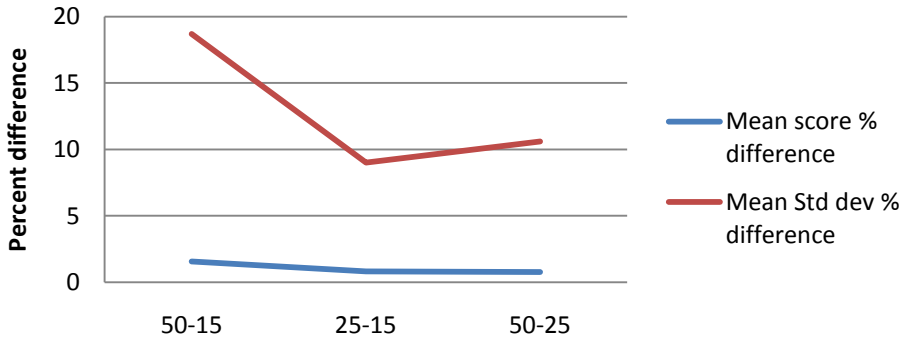
Figure 12 Number of quality indicator plant species per transect vs. mean plant group score per transect



Transect length (number of quadrats per transect):
Transects are currently 25 meters long by 0.1 meters wide and consist of 50 half-meter long quadrats. Along the same 25 meters, a 3 meter wide belt is used for additional detection of indicator species. The following preliminary analyses test whether a shorter transect with fewer quadrats could provide the same accuracy while resulting in less effort for data collection. Shorter transects could also allow for more transects to be sampled per site with the same amount of effort, providing more statistical power for the site overall. Preliminary analyses of plant group score, species indicators, and plant composition are discussed below.

For mean plant group score per transect, reducing the number of quadrats per transect from 50 (25 m transect length) to as low as 15 (7.5 m transect length) results in a mean difference of less than two-percent per transect (Figure 13). However, the variation in difference is nearly 20 percent when reducing to 15 plots, and about 10 percent when reducing to 25 plots.

Figure 13 Plant group score vs. number of quadrats



50-15 = comparison of average plant group score using 50 plots vs. 15 plots, 25-15 = 25 plots vs. 15 plots, 50-25 = 50 plots vs. 25 plots.

For number of indicators per transect, reducing the number of quadrats from 50 to 20 decreased the mean number of indicators by nearly 35-40% for all indicators except for Tier 1 Invasives, which saw a decrease of 20% (Figure 14). The rate of decrease is generally higher going from 50 quadrats to 30 quadrats, than from 30 quadrats to 20 quadrats. However, a much larger rate of gain in number of indicators, especially for Quality Tier 1 indicators, is realized by adding the additional 3m belt along the transect (Figure 14). The data do not exist to examine 3m belt transects shorter than 25 m since the data was collected along the entire 25 m length.

Mean number of species per transect ranged from 12 when a transect was 7.5 m long with 15 quadrats to 20 when a transect was 25 m long with 50 quadrats (Figure 15). The rate of increase in species count is slightly higher going from 30 to 50 quadrats than when going from 15 to 30 quadrats, suggesting a longer transect crosses more variation in the plant community.

Figure 14 Mean number of indicators per transect vs. number of quadrats

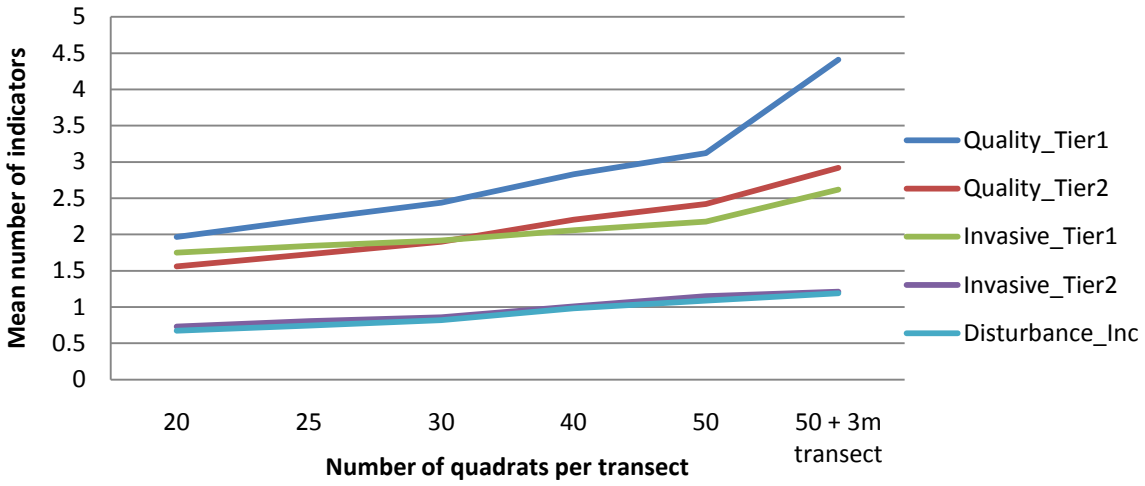
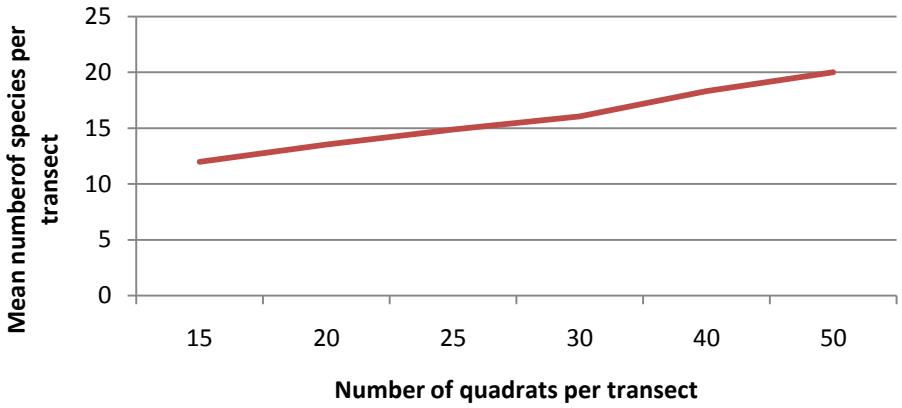


Figure 15 Mean number of species per transect vs number of quadrats per transect



Sampling density

The recommended sampling density is one transect per 10 acres of a site. This recommendation is from the original Grant et al. (2004) study in North Dakota, and it has not been tested if this density applies for sites in Minnesota. Ultimately, analyses will be completed to determine the number of transects to achieve a certain level of power for detecting change after the 2010 data are entered into the database. Preliminary patterns in sampling density for three sites where the sampling density was increased to 1 transect per 5 acres are presented below.

Three sites, Boiling Springs Native Prairie Bank, Two-Rivers Aspen Prairie Parkland SNA, and Ordway Prairie TNC Preserve were examined using the species accumulation curve in Pc-Ord 5.0 (McCune & Mefford, 2006). Boiling Springs is small-isolated site in focus area 4, and is 27 acres in size with 6 transects samped. Two-Rivers Aspen Prairie Parkland SNA is a large-embedded site in focus area 1 and is 96 acres in size with 20 transects. Ordway Prairie TNC preserve is a large-embedded site in focus area 3 and is 380 acres in size with 52 transects.

The species accumulation curve for Boiling Springs shows a very slight decrease in the number of species per transect at 3 transects (1 transect per 9 acres, called subplots in Figure 16), but the number of species is still increasing beyond 6 transects. Two-Rivers Aspen Prairie Parkland SNA shows a leveling-off in the species accumulation curve at about 15 transects (1 per 7.5 acres, Figure 17). The species accumulation curve for Ordway Prairie TNC preserve shows a decrease in the accumulation rate at about 20 transects (1 transect per 20 acres), but shows little sign of leveling off at 52 transects (1 transect per 7 acres, Figure 18). However, at Ordway Prairie, the species accumulation curve for quality tier 1 indicators shows a strong leveling off at about 15 transects (1 transect per 25 acres, Figure 19). Species accumulation curves for indicator species have yet to be completed at other sites or for other indicator groups.

Figure 16 Species accumulation curve for Boiling Springs NPB

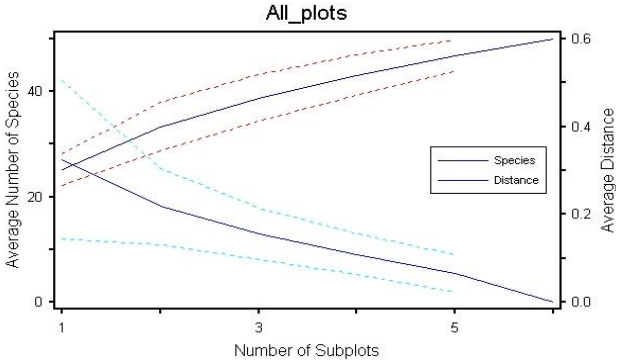


Figure 17 Species accumulation curve for Two-Rivers Aspen Prairie Parkland SNA

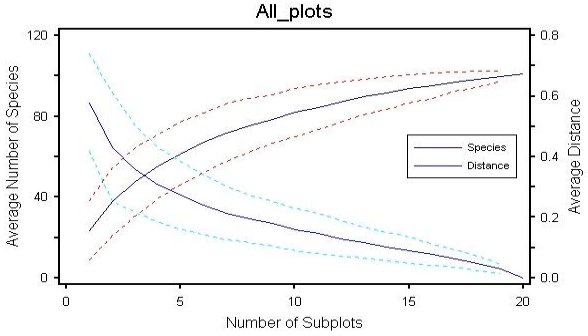


Figure 18 Species accumulation curve for Ordway Prairie TNC preserve, All species

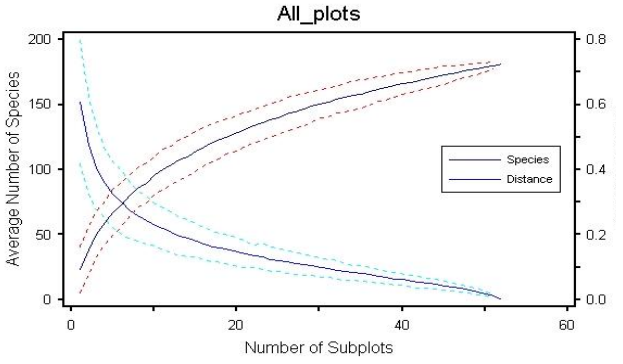
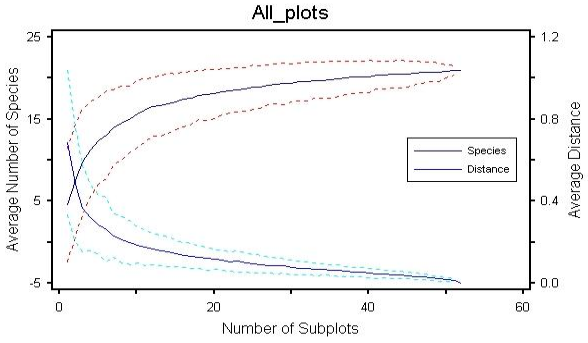


Figure 19 Species accumulation curve for Ordway Prairie TNC preserve, Quality Tier1 Indicators only



Conclusions

This project provided substantial data to help test and refine prairie monitoring protocols and establish baseline ecological information on remnant native prairie in western Minnesota. Analysis of the baseline information indicates that some regional and landscape differences in plant and bird communities exist. However, additional years of data are required to determine if the ecological trends are significant, especially in the context of climate change.

The 38 sites monitored as part of this project exceeded the originally proposed number of sites. However, bird community monitoring became the only animal focus for this project. Other prairie animals, such as insects and reptiles, are being studied in separate, but complementary projects.

Current long-term plans are to monitor a total of 40 sites using a serially alternating design with 5 sites monitored every year to detect annual variation, and 35 sites monitored every five years (7 sites per year), for a total of 12 sites monitored per year (Table 2).

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http://www.dnr.state.mn.us/eco/mcbs/vegetation_sampling.html

Appendix A: Bird Monitoring protocols **June 2009**

Survey points:
Point locations are pre-assigned prior to fieldwork and will be located using a GPS unit. In general, points are at least 200m apart, although there may be a few exceptions in small sites. Each site should have 7 points, except again for exceptionally small sites.

Survey Frequency:
Each site will be surveyed 3 times, with a minimum of 3 days in between repeat surveys. If possible, have at least one repeat survey completed by a different individual.

Time of day:
- point counts should be conducted from 15 minutes before sunrise to approximately 4.5 hours after sunrise (about 0930 hrs). End point counts a little earlier or later depending on bird activity.

General data recording:
-Record the coordinates in UTM or Lat-long, area name, site id, point#, date, observer name, and waypoint if recording the location into a GIS
- Record start time (if using datasheet), approximate temperature in 10 F intervals, wind speed category, and sky code (see definitions below).

Bird data recording:
- record all birds heard or seen during a ten-minute interval, noting those first detected in the first 5 minutes and those first detected in the last 5 minutes. If using a data recorder, it should record the elapsed time for you so you do not need to make note of the time interval.
- Record the estimated distance the bird is from the point in one of four categories: 0-25m, 25-50 50-100m, > 100m. If the bird is flying over, mark it as FO instead of a distance.
- for each individual, indicate the sex as male, female, unknown. It can be assumed that a singing bird is a male.
- Record breeding evidence using codes provided on datasheet or on data unit.

- Tally individual numbers of birds up to 10. For larger groups of birds of the same sex and species use categories or 10-25 and 25+.

- if a bird is known/suspected to be in a habitat different than upland prairie/grassland, record in the "miscellaneous" column with the code DH, and note the habitat. It is very important to make sure that birds recorded at a given point are actually within the habitat being surveyed. For example, if you are sampling a deciduous forest, you know that a loon heard in the distance is certainly not in the forest. Unfortunately, this determination is often difficult. If the observer is at least 150m from the habitat edge, then the distance to the bird in question is probably the best guide (if bird is more than 150m it may be outside the habitat). Particularly troublesome are flyovers that cannot be seen. For example, if an observer suspects that a crow heard in the distance is flying, then it should be counted as a flyover. Birds commonly heard flying include: gulls, terns, corvids, waxwings, Icterids (blackbirds, etc.), and Fringillids (finches).

Site/locality information:
- Point locations are preassigned, but if you have to move a point for some reason, take a GPS reading; write (accurately) coordinates on datasheet and save position on GPS unit.

Rare species:
- for all state-listed or rare species, record exact GPS coordinates (or estimated bearing and distance from point count location).

Points to remember:
- do not count the same individual more than once (e.g., the same pair of sandhill cranes may be audible at 5 consecutive points. Only count it once).

- Species abbreviations are okay, but make sure they are recognizable and unique (e.g., "S. Sparrow" could be Song, Swamp, or Savannah; or "sharptail" could be sparrow or grouse).

- if you use standardized 4-letter common name codes, make sure you know the correct ones (for example: BANS=Bank Swallow, BARS=Barn Swallow – not BASW for either spp.).

Weather constraints:
- do not conduct point counts when wind or rain are obviously negatively affecting bird activity, or your ability to detect birds.
- Do not survey is the wind speed is 25 mph or greater (ideally surveys should only be done in winds less than 6 mph).Light rain or mist may be okay unless nothing seems to be singing. It may often be worth waiting out heavier rain if it appears that it might stop shortly, particularly if you have already walked/driven a long distance to get to a site.

Code definitions:

Temperature

30 (30-40 F)
40 (40-50 F)
50 (50-60 F)
60 (60-70 F)
70 (70-80 F)
80 (80-90 F)
90 (90-100 F)
100 (go home!)

Wind speed (<1, 1-3, 4-7, 8-12, 13-18, 19-24 mph)

Sky codes

0 Clear or a few Clouds
1 Partly cloudy (scattered) or variable sky
2 Cloudy (broken) or overcast
4 Fog or smoke
5 Drizzle or light rain
7 Snow
8 Showers

- Breeding evidence code

ne -- nest with eggs or young
nb -- adult building nest/ carrying nest material
an -- adult on nest
dd -- distraction display, mobbing
uy -- unfledged young away from nest
cf -- carrying food, fecal sac
ac -- adult entering nest cavity/hole
fj -- flying juvenile away from nest
IB -- any other territorial or nesting behavior (not listed above) suggesting bird is nesting nearby.

Appendix B
GRASSLAND MONITORING TEAM
STANDARDIZED MONITORING PROTOCOL

MN DNR Version (DRAFT)
06 July 2009

Background and Objectives

Grassland management goals in Minnesota, North Dakota, and South Dakota often include preservation or restoration of the historical native condition and providing habitat for wildlife. As endangered or declining ecosystems, remnants of tallgrass prairie are also intrinsically important to preserve. Remnant and restored prairies in the northern Great Plains are threatened by encroaching invasive species, particularly cool-season introduced grasses and woody vegetation. The main focus of grassland management efforts is on protecting or enhancing the competitive ability of native plants. However, because we typically operate without clear objectives for prairie management and with little or no evaluation of management effects, there are considerable uncertainties about the most appropriate management tools and prescriptions.

In 2007, a multi-agency group of grassland managers and scientists formed the Grassland Monitoring Team (GMT). The group felt that a cooperative, standardized monitoring effort would improve our effectiveness at resolving uncertainties about grassland management. A collaborative effort will facilitate comparisons of data across ownerships and throughout the tallgrass prairie region of Minnesota. Our effort is focused on native prairie, but the methods could likely also be applied in restored areas.

In November 2007, several representatives from this group participated in a workshop with prairie ecologists and experts in adaptive management and modeling. At this workshop, we developed a rough framework for adaptive grassland management in Minnesota and the Northern Tallgrass Prairie Ecoregion of North Dakota and South Dakota. Generally, the adaptive management process involves defining a problem, defining potential management alternatives, predicting (modeling) the expected system response to those management alternatives, implementing the management and evaluating the results. Based on the monitoring data collected, future decisions can be adapted to best meet the goals of the project.

Our goal is to determine broad plant composition and structural changes over time in response to a suite of land management techniques including grazing, burning, and haying.

The partners in this project have overlapping goals, but it should be noted that each of us has some specific goals that are not addressed with this effort. Within the context of this project, the following objectives apply across all ownerships and participants.

- Maintain or increase the percentage cover of native prairie vegetation relative to invasive/exotic vegetation.
- Minimize the percentage cover of invasive/exotic vegetation, with particular attention to a short list of species (see list).
- Maintain the structural diversity of native grassland ecosystems.
- MN DNR objective: Maintain high quality native prairie plant communities over time*.

*The MNDNR-SWAP has an additional objective to maintain high quality plant communities, therefore we are committed to collect information on community composition.

Sampling Design

The population of interest for this project is remnant tallgrass prairie in Minnesota as well as eastern North Dakota and South Dakota . The subset available for sampling (study sites) is a field of native prairie that will undergo one consistent treatment at any given point in time. Study sites can include federal, state or private properties, and are under the management of a project partner. Study sites can optionally be organized into management units (e.g., a county, management district, or landscape).

Sample units are permanent transects, distributed randomly in the study site at a density of one transect per 10 acres. The transects are 25-m long and 0.1-m wide, with 50 0.5-m long quadrats along a transect (Grant et al. 2005). A list of potential transects are established in the office, then field checked to ensure they meet the study criteria. We will use a random point generator tool to establish transect starting points. Each point should be at least 25-m from the edge of the study site and at least 50-m from another point. Exclude areas that are obviously in a wetland or heavily wooded area, are more than 75% nonvegetated (e.g., rock pile), or that cross between systems (i.e., upland grassland, lowland grassland, and wet meadow). Create enough points to have 1 per 10 acres plus a few extra in case you have to reject some during the field check. Use Excel or other software to generate a random compass bearing for the transect. If during the field check the transect as assigned will violate rejection criteria, follow the "Procedures for moving a transect" detailed below. **For those working in the Aspen Parklands, please note the section below.**

Sites will be sampled at least once every three years (in some cases more frequently), from July through September. This time period was chosen because it is a period during which the greatest number of tallgrass prairie plants can be identified.

Procedures for moving a transect:

1. Flip the bearing of the transect 180 degrees. For example, if the initial transect bearing was 85 degrees, try running the transect 265 degrees. If the transect is still not within the target community after shifting the transect bearing 180 degrees, try the +90 degree bearing, then the +270 degree bearing.

2. If the 4 directions (in step 1) do not work, move the transect starting point 25 m from the initial starting point along the original bearing assignment. For example, if the 265 degree bearing (from the 180 degree flip) still falls in a non-target community, move the starting point 25 m in the 85 degree direction.

3. If step 2 is still unsuccessful, repeat step 1 at 25 m from the initial point (180 degree flip, +90, +270). For example, if 25 m from the initial starting point along the 85 degree bearing is within a non-target community, try moving 25 m out in a 85+180 = 265 degree bearing, then 85+90 = 175 degree bearing, then a 85+270 = 355 degree bearing.

4. If moving 25 m along the 4 bearings still falls within a non-target community, repeat step 3, but move 50 m.

5. If still unsuccessful after trying to move the starting point 50 m. A new random location will need to be assigned – contact the DNR monitoring coordinator.

Notes on target communities:

While the MNDNR-SWAP monitoring project is targeting upland prairie systems, many of the areas are naturally heterogeneous and will contain wetter depressions. Only move the transect if the area is clearly more of a wetland community. Do not move the transect if it includes areas that have shrubs as a result of lack of management (woody encroachment). Shrub swamps should be considered a different community and warrants moving the transect. Forested areas with >50% cover and than should be considered a different community and warrant moving the transect. Individual trees should not warrant moving the transect.

Aspen Parklands modifications

The Aspen Parklands province presents unique challenges since systems and plant communities are naturally heterogeneous rejection criteria likely require modifications from those detailed above. For example, it may be difficult to effectively locate a transect that does not cross between systems. Current guidelines for this region will be that the transect must fall within 75% of a particular system type, although this may need to be modified as field work commences. In addition, since stands of forest (primarily aspen) both occur naturally and are more likely as a result of lack of management in the Aspen Parklands, forested areas should not be excluded. Finally, the procedures for moving a transect may need to be modified in that they are more targeted to fall within a particular system type.

Field Methods

Field season prep, Sequence of events during season, Details of measurements with forms, Post collection processing, end of season procedures

The protocol is hierarchical in terms of effort expended on acquiring detail on composition of the plant community. All participants will collect the same basic structural information. Options A, B, and C represent different levels of detail on plant community composition data. Subsequently complex options incorporate all features of the simpler options, so that the most basic set of data will be collected at every site.

Typical series of events at a transect:

1. Use GPS to navigate to the transect starting point.
2. Collect VOR readings. We recommend doing this before anything else, because activity of observers can disturb the vegetation cover.
3. Run out a 25-m cloth tape, staking it at both ends to prevent shifting during data collection.
4. If using a two-person team, we find that an efficient approach is to have one person identify and call out the plant codes and invasive species present in each quadrat. The other person acts as the data recorder and also measures litter depth (and optionally, plant height) as the team moves along the transect.
5. When you come to the end of the transect, walk slowly along either side of the tape looking for the indicator species within the wider transect buffer. The buffer is 1.5 m (a Robel pole length) on either side of the standard belt transect, making it 25 m X 3 m.

Equipment needed:
Compass, GPS, VOR pole (standardized VOR poles were provided to each team at the beginning of the 2007 field season by the USFWS – Glacial Ridge/Rydel National Wildlife Refuges), meter stick, rebar/stakes, meter tape, map and list of azimuths/coordinates, datasheets (with extra), scratch paper, pencils, personal gear, photo guide and camera if doing photopoints

Structure

Visual Obstruction Reading (VOR). At the beginning of the transect, take a set of VOR readings from the four cardinal directions (e.g., N, E, S, W) using a VOR (Robel) pole. The VOR pole has alternating decimeters clearly marked along the length of the pole (Robel et al. 1970). The observer will take VORs at a height of 1 m and a distance of 4 m from the pole. Record the lowest half-decimeter mark visible on the pole (i.e., not completely obscured by vegetation). It is recommended that you record VOR before doing anything else that may disturb the vegetation structure at the site (e.g., running out the transect).

Litter Depth. Using a meter stick, record litter depth to the nearest cm at 5-m intervals along the transect (5, 10, 15, 20, 25 m). Place the bottom of the meter stick on the ground and make sure that it is flush with the soil surface. The litter measurement is the height of the litter layer – that is, the layer lying horizontal (not leaning, not standing, etc.).

Vegetation Height (optional). Using a meter stick, record plant height to the nearest cm at 5-m intervals along the transect.

Composition

Plant groups. Record a plant group code for each quadrat along the belt transect, using the hierarchical list of plant groups provided (Appendix **). This list has been carefully designed to allow roll up into various levels. It is not species dependent, which allows the methods to be used in any grassland system regardless of the main invasives of concern.

Plant codes represent a spectrum that spans from Native to Invasive (mostly exotic) and everything in between. The plant codes represent a hierarchical tree, which functions as a dichotomous key. Arrival at the final code for an individual plot involves making four sets of independent decisions:

- Native (Natives>50% cover) vs. Invasive (Invasives>50% cover)
- All Native vs. Mostly Native OR Mostly Invasive vs. All Invasive
- Herbaceous vs. Low Shrub vs. Tall Shrub
- Graminoid vs. Graminoid-Forb vs. Forb

Some general tips about assigning plant groups:

- The decision about whether a plot is native vs. invasive-dominated is determined based on all plants present within the plot, whether herbaceous or shrub.
- Use foliar, as opposed to canopy cover, to make plant code determinations. ***Foliar cover*** "subtracts out" the "blank" spaces while ***canopy cover*** "fills in the gaps" between leaves, branches, etc.
- Assign 900 code ("Other," for bare ground, animal mounds, rock pile, etc.) if >75% of the plot is unvegetated.
- If >25% of the plot is vegetated, use relative percentages within the vegetated portion of the plot to make plant code determinations.
- To distinguish between low and tall shrub, use current height not the potential height of the species
- In determining native/invasive composition, use the list of Tier 1 and 2 invasive species provided. Note that some of these invasive species are actually native to parts of the region.
- Remember that the four classes (native/invasive; all native (invasive)/mostly native (invasive); herbaceous/low shrub/tall shrub; grass/grass-forb/forb) are independent decisions. Therefore, you should include woody species when making the native/invasive decision. The only exception is that grass/forb ignores woody components.
- Include dwarf shrubs (e.g., prairie rose, lead plant) in with the Low Shrub category.

Option A	Option B	Option C
Numeric code only	Numeric code	Numeric code

Invasive Species. Use the Tier 1 (and when appropriate, Tier 2) list of invasive species provided (Appendix *). This list was developed by Robert Dana (MBCS, 2008) and includes *****

	Option A	Option B	Option C
Quadrat level	Record all Tier 1 invasives present, regardless of cover. Circle "Dominant" invasive(s), those dominating >50% of the plot, where applicable	Record all Tier 1 invasives present, regardless of cover. Circle "Dominant" invasive(s), those dominating >50% of the plot, where applicable	Record all Tier 1 and Tier 2 invasives present, regardless of cover. Circle "Dominant" invasive(s), those dominating >50% of the plot, where applicable
Transect level (25m x 3m buffer centered on the standard belt transect)	Use checklist to record presence of Tier 1 invasives (optional??)	Use checklist to record presence of Tier 1 and/or Tier 2 (optional) invasives	Use checklist to record presence of Tier 1 and Tier 2 invasives

Quality indicators. Use the Tier 1 (and when appropriate, Tier 2) list of quality indicator species. The list was developed by Robert Dana and Fred Harris (MCBS, 2008) and includes conservative species that are sensitive to grazing and easily identified.

	Option A	Option B	Option C
Quadrat level	n/a	n/a	Record all Tier 1 quality indicators present, regardless of cover
Transect level (25m x 3m buffer centered on the standard belt transect)	Record presence of Tier 1 quality indicators	Record presence of Tier 1 and/or or Tier 2 (optional) quality indicators	Record presence of Tier 1 or Tier 2 quality indicators not already recorded in quadrats

Other species. Additional information can be collected about species composition within each quadrat.

Option A	Option B	Option C
n/a	Record dominant native species from a select list (optional)	Record any species with >10% absolute cover of quadrat, and indicate whether it is >50% or <50%.

One option for participants using either Option A or B might be to collaborate with partners to do a thorough Option C survey at more infrequent intervals, e.g., every 10 years.

Data handling, analysis, and reporting

Metadata procedures, Overview of database design, Data entry, verification, editing, routine summaries and analyses, reporting schedule, report format (summary table and figure examples), methods for long term trend analysis, data archive procedures

The FWS Biological Monitoring Team has developed an Access database for this project. In addition to data entry capabilities, the relational database also has a couple of simple reporting functions that enable quick analysis of entered data at the end of each field season. Any updates to the database will be provided on the BMT website (http://www.fws.gov/bmt/database_gmd.htm)

Personnel requirements and training

Roles and responsibilities, Qualifications, Training procedures

Project coordinators are responsible for organizing training sessions, facilitating communication among the group members, disseminating any changes to the protocol or database, and working with a statistician to analyze data.

In addition, provide a consistent plant guide – complete with species that frequently are mistaken for each other- is recommended for all the indicator species (both for grazing sensitive species and for invasives). It would be helpful if flowering times on indicator species list could be provided.

Field office staff will be responsible for choosing study sites in their work area, assigning transects, data collection, data entry, ensuring data accuracy, and sending their data to the project coordinators.

The protocol was designed to be used by field staff or seasonal employees with a working knowledge of tallgrass prairie plant species common in Minnesota. A training session will be provided as needed each year in early July. Following the session, we will hold periodic quality assurance checks in the field by double-sampling a set of transects. This will be done fairly early in the season to allow time to correct inconsistencies among observers. We recommend that quality-assurance checks be held in conjunction with additional training in species identification.

Table 1. Invasive species lists.

Tier 1Invasives

Code	Common Name	Scientifc Name
ACENEG	Boxelder	*Acer negundo*
AGRCRI	Crested Wheatgrass	*Agropyron cristatum*
AGRGIG	Redtop	*Agrostis gigantea/stolonifera*
ARTABS	Absinthe Sagewort	*Artemisia absinthemum*
BROANN	Annual Bromes	*B. japonicus, tectorum, secalinus*
BROINE	Smooth Brome	*Bromus inermis*
CARACA	Plumeless Thistle	*Carduus acanthoides*
CARNUT	Musk Thistle	*Carduus nutans*
CENMAC	Spotted Knapweed	*Centaurea maculosa*
CHRLEU	Ox-eye Daisy	*Chrysanthemum leucanthemum*
CIRCAN	Canada Thistle	*Cirsium arvense*
CIRVUL	Bull Thistle	*Cirsium vulgare*
CORVAR	Crown-vetch	*Coronilla varia*
DAUCAR	Queen Anne's Lace	*Daucus carota*
ELAANG	Russian Olive	*Elaeagnus angustifolia*
ELYREP	Quack-grass	*Elytrigia repens*
EUPESU	Leafy Spurge	*Euphorbia esula*
FRAPEN	Green Ash	*Fraxinus pennsylvanica*
LINVUL	Butter-and-eggs	*Linaria vulgaris*
LONTAT	Tartarian Honeysuckle	*Lonicera tatarica*
LOTCOR	Birdsfoot Trefoil	*Lotus corniculatus*
MEDSAT	Alfalfa	*Medicago sativa*
MELISP	Sweet Clovers	*Melilotus alba & officinalis*
PASSAT	Parsnip	*Pastinaca sativa*
PHAARU	Reed Canary-grass	*Phalaris arundinacea*
PHLPRA	Timothy	*Phleum pratense*
POACPX	Canada and Kentucky Bluegrass	*Poa compressa, pratensis*
POPDEL	Cottonwood	*Populus deltoides*
RHACAT	Common Buckthorn	*Rhamnus cathartica*
RHAFRA	Glossy Buckthorn	*Rhamnus frangula*
ROBPSE	Black Locust	*Robinia pseudo-acacia*
SONARV	Sow-thistle	*Sonchus arvensis*
TRIPRA	Red & Alsike clovers	*Trifolium pratense, hybridum*
TRIREP	White Clover	*Trifolium repens*
ULMAME	American Elm	*Ulmus americana*
ULMPUM	Siberian Elm	*Ulmus pumila*

Tier 2 Invasives

Code	Common Name	Scientifc Name
AMABLI	Prostrate Pigweed	*Amaranthus blitoides*
ARCMIN	Burdock	*Arctium minus*
BERINC	Hoary Alyssum	*Berteroa incana*
CALSEP	Hedge Bindweed	*Calystegia sepium*
CARARB	Siberian Pea-tree	*Caragana arborescens*
CHERUB	Alkali Blite	*Chenopodium rubrum*

CONARV	Field Bindweed	*Convolvulus arvensis*
CRETEC	Hawk's Beard	*Crepis tectorum*
DACGLO	Orchard Grass	*Dactylis glomerata*
ERUGAL	Dog-mustard	*Erucastrum gallicum*
FESELA	Meadow and Tall Fescues	*Festuca pratensis & elatior*
GRISQU	Curly-top Gum Weed	*Grindelia squarrosa*
KOCSCO	Summer-cypress	*Kochia scoparia*
LAPPSP	Stickseeds	*Lappula redowski & squarrosa*
MEDLUP	Black Medick	*Medicago lupulina*
MORALB	White Mulberry	*Morus alba*
NEPCAT	Catnip	*Nepeta cataria*
PINSYL	Scotch Pine	*Pinus sylvestris*
PLANSP	Common & American Plantains	*Plantago major & rugellii*
POLPER	Lady's Thumb	*Polygonum persicaria*
POTARN	Silvery Cinquefoil	*Potentilla argentea*
POTREC	Sulphur-flowered Cinquefoil	*Potentilla recta*
PUCDIS	European Alkali-grass	*Puccinellia distans*
RUMACE	Sheep Sorrel	*Rumex acetosella*
RUMSPP	Dock	*Rumex patientia, crispus, stenophyllus*
SALALB	White Willow	*Salix alba*
SALTRA	Russian Thistle	*Salsola tragus*
SAPOFF	Bouncing Bet	*Saponaria officinalis*
SETASP	Foxtails	*Setaria glauca, viridis, faberi*
SILCSE	a campion	*Silene cserei*
SILVUL	Bladder-campion	*Silene vulgaris*
SINARV	Charlock	*Sinapis arvensis*
SISALT	Tumble Mustard	*Sisymbrium altissimum*
TAROFF	Dandelion	*Taraxacum officinale*
VERTHA	Common Mullein	*Verbascum thaspus*
XANSTR	Cocklebur	*Xanthium strumarium*

Table 2. Native indicator species.

Tier 1 Quality Indicators

Code	Common Name(s)	Scientific Name
AMOCAN	Leadplant	*Amorpha canescens*
ANEPAT	Pasque Flower	*Anemone patens*
ASTCRA	Ground Plum, Buffalo-bean	*Astragalus crassicarpus*
ASTSER	Silky Aster	*Aster sericeus*
CALSER	Toothed Evening Primrose	*Calylophus serrulatus*
CORPAL	Bird's Foot Coreopsis	*Coreopsis palmata*
DALCAN	White Prairie Clover	*Dalea candida*
DALPUR	Purple Prairie Clover	*Dalea purpurea*
ECHPAL	Narrow-leaved Purple Coneflower	*Echinacea pallida var. angustifolia*
HELAUT	Sneezeweed	*Helenium autumnale*
HEURIC	Alum Root	*Heuchera richardsonii*
LIAASP	Rough Blazing Star	*Liatris aspera*
LIALIG	Northern Plains Blazing Star	*Liatris ligulistylis*
LIAPUN	Dotted Blazing Star	*Liatris punctata*
LIAPYC	Great Blazing Star	*Liatris pycnostachya*
LILPHI	Wood Lily	*Lilium philadelphicum*
LYSQUA	Prairie Loosestrife	*Lysimachia quadriflora*
PEDESC	Prairie Turnip	*Pediomelum esculentum*
PHLPIL	Prairie Phlox	*Phlox pilosa*
POTARGU	Tall Cinquefoil	*Potentilla arguta*
PRERAC	Smooth Rattlesnakeroot	*Prenanthes racemosa*
TRABRA	Bracted Spiderwort	*Tradescantia bracteata*
ZIGELE	White Camas	*Zigadenus elegans*
ZIZAPT	Heart-leaved Alexanders	*Zizia aptera*
ZIZAUR	Golden Alexanders	*Zizia aurea*

Tier 2 Quality Indicators

Code	Common Name(s)	Scientific Name
AGOGLA	Glaucus False Dandelion	*Agoseris glauca*
AMONAN	Fragrant False Indigo	*Amorpha nana*
ASCOVA	Oval-leaved Milkweed	*Asclepias ovalifolia*
ASCSPE	Showy Milkweed	*Asclepias speciosa*
ASCTUB	Butterfly Weed	*Asclepias tuberosa*
ASTADS	Prairie Milk Vetch	*Astragalus adsurgens*
ASTLAE	Smooth Blue Aster	*Aster laevis*
ASTNOV	New England Aster	*Aster novae-angliae*
ASTOBL	Aromatic Aster	*Aster oblongifolius*
ASTOOL	Sky-blue Aster	*Aster oolentangiensis*
ASTUMB	Flat-topped Aster	*Aster umbellatus*
CARFIL	Thread-leaved Sedge	*Carex filifolia*
CASSES	Downy Paintbrush	*Castelleja sessiliflora*
DELVIR	Prairie Larkspur	*Delphinium virescens*
GAIARI	Blanket Flower	*Gaillardia aristata*
GENPUB	Downy Gentian	*Gentiana puberulenta*

LATVEN	Veiny Pea	*Lathyrus venosus*
LIACYL	Few-headed Blazing Star	*Liatris cylindracea*
LYTALA	Winged Loosestrife	*Lythrum alatum*
MUHCUS	Plains Muhly	*Muhlenbergia cuspidata*
PANLEI	Leiberg's Panic Grass	*Panicum leibergii*
PEDLAN	Swamp Lousewort	*Pedicularis lanceolata*
SILLAC	Compass Plant	*Silphium laciniatum*
SOLPTA	White Aster-like Goldenrod	*Solidago ptarmicoides*
SOLRID	Riddell's Goldenrod	*Solidago riddellii*
SOLSPE	Showy Goldenrod	*Solidago speciosa*
SORNUT	Indian Grass	*Sorghastrum nutans*
SPOHET	Prairie Dropseed	*Sporobolus heterolepis*
THADAS	Tall Meadow-rue	*Thalictrum dasycarpum*
VERVIR	Culver's Root	*Veronicastrum virginicum*

Native Plant System Level Descriptions
(Excerpts from Minnesota Department of Natural Resources (MNDNR). 2005. Field guide to the native plant communities of Minnesota: the Prairie Parkland and Tallgrass Aspen Parklands Provinces. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. MNDNR St. Paul, MN.)

Upland Grass
*Upland Prairie (UP) communities are herbaceous plant communities dominated by graminoid species, with a species-rich forb component that can approach codominance with the graminoids. The tall grass big bluestem (*Andropogon gerardii*) and the midheight grasses prairie dropseed (*Sporobolus heterolepis*) and little bluestem (*Schizachyrium scoparium*) are the most important graminoids. Indian grass (*Sorghastrum nutans*), a tall grass, and porcupine grass (*Stipa spartea*) and side-oats grama (*Bouteloua curtipendula*), both midheight grasses, are the most important associated graminoids. Sedges (*Carex *spp.*) are sometimes common in UP communities but are typically a minor graminoid component. The most common and widespread woody species are the low semi-shrubs leadplant (*Amorpha canescens*) and prairie rose (*Rosa arkansana*), and the tall shrub wolfberry (*Symphoricarpos occidentalis*). Purple prairie clover (*Dalea purpurea*), heath aster (*Aster ericoides*) and stiff goldenrod (*Solidago rigida*) are common forbs. The main vegetation layer in UP communities is usually less than 40in (1m) high, although some forbs and the flowering stalks of the tall grasses exceed this height as the growing season progresses.*

Lowland Grass
Northern Wet Prairie: Grass-dominated but forb-rich herbaceous communities, often with a strong shrub component, on somewhat poorly drained to poorly drained loam soils formed in glaciolacustrine sediments, unsorted glacial till, or less frequently outwash deposits. Present primarily on level to very gently sloping sites. Flooded for brief periods at most; upper part of rooting zone is not saturated for most of growing season. Drought stress is infrequent, usually brief, and not severe. Fires were very frequent historically.

Southern Wet Prairie: Grass-dominated but forb-rich herbaceous communities on poorly drained to very poorly drained loam soils formed in lacustrine sediments, unsorted glacial till, or less frequently outwash deposits. Typically in slight depressions, sometimes on very gentle slopes. Flooded for brief periods at most; upper part of rooting zone is not saturated for most of growing season, but saturation usually persists in lower zone for much of season.

Wet Meadow
Northern Wet Meadow/Carr: *Open wetlands dominated by dense cover of broad-leaved graminoids or tall shrubs. Present on mineral to sapric peat soils in basins and along streams.*
Southern Basin Wet Meadow/Carr: *Open wetlands dominated by dense cover of broad-leaved sedges. Typically present in small, closed, shallow basins isolated from groundwater inputs.*
Prairie Wet Meadow/Carr: Open wetlands dominated by a dense cover of graminoids. Present in small, shallow depressions in the western and southern parts of the state.

Appendix C: Total individual bird counts

Common Name	Grassland dependent	Total count (all years)	Count of individuals 2008	2009	2010
Red-winged Blackbird		1162	526	493	143
Clay-colored Sparrow	Y	1022	353	454	215
Common Yellowthroat		766	243	392	131
Bobolink	Y	599	320	186	93
Yellow Warbler		533	120	322	91
Common Grackle		513	226	284	3
Sedge Wren	Y	498	186	222	90
American Goldfinch		478	152	266	60
Grasshopper Sparrow	Y	459	214	148	97
Brown-headed Cowbird		455	156	266	33
Savannah Sparrow	Y	379	136	164	79
Song Sparrow		359	109	182	68
Tree Swallow		347	115	213	19
Canada Goose		343	178	165	0
Western Meadowlark	Y	283	131	70	82
Mallard		218	123	91	4
Alder Flycatcher		211	21	138	52
Swamp Sparrow		196	64	92	40
Cedar Waxwing		157	17	133	7
Le Conte's Sparrow	Y	150	31	98	21
Eastern Kingbird		148	53	79	16
Brewer's Blackbird		144	22	114	8
Gray Catbird		142	42	78	22
Marsh Wren		138	41	81	16
House Wren		137	29	94	14
Wilson's Snipe		129	25	89	15
Field Sparrow		128	41	70	17
Mourning Dove		120	54	64	2
Ring-necked pheasant	Y	120	86	28	6
American Robin		110	26	74	10
Barn Swallow		105	46	53	6
Double-crested Cormorant		93	39	54	
American White Pelican		89	21	67	1
Least Flycatcher		88	19	64	5
Upland Sandpiper	Y	83	44	36	3
Unknown		70	29	34	7
Dickcissel	Y	68	2	39	27
American Crow		65	3	51	11
Veery		63	3	50	10
Killdeer	Y	58	24	27	7
Vesper Sparrow	Y	58	11	40	7
Cliff Swallow		53	43	10	
Unknown sparrow		52	21	30	1
Start		51	44	7	
Marbled Godwit	Y	50	32	18	
Willow Flycatcher		49	34	13	2

Common Name	Grassland dependent	Total count (all years)	Count of individuals 2008	2009	2010
Blue-winged Teal		46	36	10	
Red-eyed Vireo		45	4	31	10
Warbling Vireo		44	5	32	7
Brown Thrasher		43	17	19	7
European Starling		41	28	13	
Northern Harrier	Y	41	15	22	4
Yellow-headed Blackbird		40	21	19	
Eastern Towhee		36	3	33	
Rose-breasted Grosbeak		36	6	29	1
Unknown blackbird, finch, grosbeak		35	34	1	
Great Crested Flycatcher		34	11	19	4
American Redstart		33	1	13	19
Turkey Vulture		31	6	23	2
Chipping Sparrow		30	5	18	7
Unknown woodpecker, swallow		28	27	1	
Black-capped Chickadee		27	8	14	5
Baltimore Oriole		26	5	20	1
Blue Jay		26	11	15	
Northern Flicker		25	11	13	1
Orchard Oriole		25	7	14	4
Sandhill Crane		25	1	24	
Ring-billed Gull		23	13	10	
Indigo Bunting		22	6	15	1
Eastern Bluebird		21	4	15	2
Red-tailed Hawk		21	6	15	
Eastern Wood-Pewee		20	4	15	1
Yellow Rail		20	1	19	
Great Egret		19	8	11	
Unknown duck, grebe, etc		19	16	3	
Bank Swallow		18	6	11	1
Yellow-bellied Sapsucker		17	4	12	1
Black Tern		16	12	4	
Black-billed Cuckoo		16	3	13	
Wood Duck		16	2	14	
Great Blue Heron		15	4	11	
Nashville Warbler		15		15	
Northern Rough-winged Swallow		15	4	11	
Northern Cardinal		14	3	9	2
Unknown rail, sandpiper		14	3	11	
Chestnut-sided Warbler		13		13	
Eastern Meadowlark	Y	13	2	8	3
Sora		13	8	5	
Western Kingbird		13	2	11	
American Bittern		12	5	7	
Common Nighthawk		12	4	8	
Unknown blackbird		12		12	

Common Name	Grassland dependent	Total count (all years)	Count of individuals 2008	2009	2010
Common Tern		10		10	
Greater Prairie-Chicken	Y	10	7	3	
Horned Lark	Y	10	7	3	
Common Loon		9	3	6	
Forster's Tern		9	2	5	2
Hairy Woodpecker		9	2	7	
Ovenbird		9	2	7	
Rock Dove		9	2	7	
Unknown grouse		9			9
Yellow-throated Vireo		9	1	8	
Red-bellied Woodpecker		8	1	7	
Yellow-billed Cuckoo		8	5	3	
Belted Kingfisher		7	3	4	
Black-and-white Warbler		7		7	
Blue Grosbeak		7		4	3
Short-eared Owl	Y	7		7	
Unknown grouse, gull, tern		7	7		
Unknown swallow		7		6	1
Cooper's Hawk		6	2	4	
Downy Woodpecker		6	2	4	
Gadwall		6	6		
Henslow's Sparrow	Y	6	4	1	1
Unknown Gull		6		6	
Franklin's Gull		5		5	
Northern Shoveler		5	5		
Ruby-throated Hummingbird		5	3	2	
Sharp-tailed Grouse	Y	5	1	3	1
Unknown woodpecker		5		5	
Wood Thrush		5		2	3
American Kestrel		4		3	1
Black-billed Magpie		4		4	
Eastern Phoebe		4		3	1
Herring Gull		4	4		
Olive-sided Flycatcher		4		4	
Purple Martin		4	1	3	
Unknown flycatcher, vireo, wren, warbler		4	4		
Hooded Merganser		3	1	2	
Lark Sparrow	Y	3		3	
Pine Siskin		3		3	
Scarlet Tanager		3		3	
Unknown Duck		3		3	
Unknown flycatcher		3		3	
Unknown Misc		3		3	
Unknown wren		3		3	
Virginia Rail		3	1	2	
White-breasted Nuthatch		3	2	1	

Common Name	Grassland dependent	Total count (all years)	Count of individuals 2008	2009	2010
Bald Eagle		2		2	
Black-crowned Night-Heron		2		2	
Broad-winged Hawk		2		2	
Common Moorhen		2	2		
Nelson's Sharp-tailed Sparrow		2		2	
Osprey		2		2	
Sharp-shinned Hawk		2		2	
Spotted Towhee		2		2	
Wild turkey		2	2		
American Woodcock		1		1	
Baird's Sparrow	Y	1	1		
Blackpoll Warbler		1		1	
Blue-gray Gnatcatcher		1		1	
Bonaparte's Gull		1	1		
Canvasback		1		1	
Caspian Tern		1		1	
Chestnut-collared Longspur	Y	1	1		
Common Raven		1		1	
Greater Yellowlegs		1	1		
Green Heron		1	1		
House Finch		1		1	
House Sparrow		1	1		
Loggerhead Shrike		1		1	
Pied-billed Grebe		1		1	
Semipalmated Plover		1			1
Swainson's Hawk	Y	1		1	
Unknown Hawk		1		1	
Unknown thrush		1		1	
Unknown thrush, corvid		1		1	
Wilson's Phalarope	Y	1		1	
Wilson's Warbler		1		1	
Winter Wren		1		1	

Appendix D Vegetation summaries by site and year

Unit_Name	Focus area	Acres	Size-Context	Sampling Year	# of transects	Mean plant group score	Mean # quality indicators/ transect	Mean Richness /transect
Agassiz 23	4	63.75	L-E	2008	7	62.31	0.00	10.86
Altona WMA	5	24.99	L-E	2008	5	-23.10	1.80	9.80
Altona WMA	5	24.99	L-E	2009	5	6.72	4.40	14.00
Bejou WMA W	2		S-I	2008	3	49.67	4.33	14.00
Blue Mounds State Park	5	130.76	L-E	2009	13	-8.17	2.08	10.54
Boiling Springs Prairie	4	27.09	S-I	2008	6	134.70	8.00	24.50
Boiling Springs Prairie	4	27.09	S-I	2009	6	173.10	10.33	20.67
Butternut Valley Prairie SNA	4	11.67	S-I	2009	2	177.00	9.00	21.50
Caribou WMA	1	552.9	L-E	2009	40	132.71	2.43	23.35
Chippewa Prairie	4	1328.02	L-E	2008	101	45.18	3.94	16.43
Chippewa Prairie	4	1328.02	L-E	2009	30	112.77	7.03	19.40
Dovray 7	5	6.02	S-I	2008	3	-36.87	3.33	13.67
Excel8	1	400.48	L-I	2009	46	164.08	1.13	14.96
Garvin County Park	5	22.12	S-I	2008	4	-40.53	2.25	8.50
Garvin County Park	5	22.12	S-I	2009	4	6.25	3.75	13.00
Glacial Lakes State Park	3	494.57	L-E	2009	50	40.75	4.00	13.58
Higginbotham_WMA	1	130.65	S-I	2009	16	162.89	4.44	25.88
Hole in the mountain	5	147.14	L-E	2008	25	78.78	4.12	12.36
Hole in the mountain	5	147.14	L-E	2009	13	69.19	7.15	16.46
Joseph A. Tauer Prairie SNA	4	79.8	S-I	2009	8	121.80	4.75	13.63
Kloos WPA	3	16.54	S-I	2009	3	-114.53	2.00	7.00
Lake Bronson State Park	1	31.94	S-I	2009	6	109.15	4.00	17.00
Lake Pleasant 22	2	18.23	L-E	2008	3	170.30	6.33	18.67
Lake Pleasant 22	2	18.23	L-E	2009	3	180.37	6.00	22.67
Loncrace WMA	2	34.15	S-I	2008	6	175.77	4.67	17.17
Loncrace WMA	2	34.15	S-I	2009	6	155.72	5.17	20.67
Lundblad Prairie SNA	5	17.38	S-I	2008	9	107.38	3.89	17.22
Lundblad Prairie SNA	5	17.38	S-I	2009	4	109.03	10.50	23.75
Malmberg Prairie SNA	2	50.96	S-I	2008	10	173.65	3.20	14.70
Marsh Grove 36	1	395.16	L-I	2009	39	157.24	4.28	24.92
New Prairie WPA	3	15.24	S-I	2009	3	37.80	3.33	13.33
Ordway Prairie	3	379.51	L-E	2008	21	78.84	7.43	24.76
Ordway Prairie	3	379.51	L-E	2009	30	98.65	6.40	18.03
Pelan WMA	1	141.11	L-E	2009	12	143.34	3.00	25.75
Plover Prairie	4	200.95	L-E	2008	13	107.27	1.31	12.46
Prairie Coteau SNA	5	244.09	L-E	2008	12	44.62	3.42	12.00
Prairie Coteau SNA	5	244.09	L-E	2009	13	85.98	5.69	14.62
Santee Prairie SNA	2	21.87	L-E	2008	15	170.55	6.93	18.13
Stony Run 11	4	9.43	S-I	2008	3	107.27	4.33	13.33

Unit_Name	Focus area	Acres	Size-Context	Sampling Year	# of transects	Mean plant group score	Mean # quality indicators/ transect	Mean Richness /transect
Stony Run 11	4	9.43	S-I	2009	4	154.75	5.00	11.25
Svor WPA	3	54.87	L-E	2008	2	19.90	5.00	16.50
Svor WPA	3	54.87	L-E	2009	4	77.90	7.00	20.50
Twin Lakes WMA	1	31.79	L-E	2009	11	164.77	3.64	21.91
Twin Valley Prairie SNA	2	226.75	L-E	2009	23	111.05	4.39	17.22
Two-Rivers Aspen Prairie Parkland SNA	1	96.43	L-I	2009	20	159.88	1.95	22.90
Tympanuchus WMA	2	24.14	L-E	2008	6	159.92	6.67	19.33
Vegoe PB	3	49.39	L-E	2009	6	40.52	4.50	15.17
Windsor 13 NE	4	159.09	L-E	2008	5	25.34	2.60	15.40