Minnesota Prairie Conservation Plan 2010

A habitat plan for native prairie, grassland, and wetlands in the Prairie Region of western Minnesota

Blazing Star at Glacial Lakes State Park © Alison Mickelson/Greater Good Photography

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JUNE 22, 2011

Executive Summary

Minnesota's conservation partners in the Prairie Region of the state collaborated to develop a twenty-five year strategy for accelerating conservation. This strategy was precipitated by several factors:

1. Continuing loss and degradation of prairies, grasslands, wetlands and associated habitats along with the fish and wildlife dependent upon them.

2. An acknowledged need to better coordinate between programs and organizations to maximize efficiency.

3. Tremendous opportunities provided by the passage of the Clean Water, Land and Legacy Amendment by voters in 2008 that will provide significant conservation funding through 2034.

The plan calls for three approaches to conservation in the Prairie Region of the state. First, core areas with a high concentration of native prairie, other grasslands, wetlands, and shallow lakes were identified. Within these core areas, partners will work to ensure a minimum of 40% grassland and 20% wetland with the remainder in cropland or other uses. Second, habitat corridors connecting core areas were designed that include grassland/wetland complexes nine square miles in size at about six mile intervals along and within the corridors. Within the corridor complexes a goal of 40% grassland and 20% wetland was set and for the remainder of the corridors, 10% of each legal land section is to be maintained in permanent perennial cover. Third, in the remainder of the Prairie Region a goal to maintain 10% of each Land Type Association in perennial native vegetation was established. The existing wildlife management area plan, pheasant plan, duck plan and other resource plans provided guidance in setting goals for protection, restoration and enhancement in each conservation approach. These earlier plans set a habitat goal for the Prairie Region of protecting all 204,000 acres of native prairie while protecting and restoring a total of 2.0 million acres of grassland and savanna along with a 1.3 million acres of wetlands and shallow lakes.

Based on this framework and background, we propose the following:

1. Permanent protection through the acquisition from willing sellers of fee title or easement of native prairies, wetlands and other habitats (including land to be restored): about 222,100 acres in core areas, 82,000 acres in corridors, and 547,300 acres elsewhere.

2. Restoration activities on grasslands, wetlands and other habitats: 180,900 acres in core areas, 84,100 acres in corridors, and 251,000 acres elsewhere.

3. Enhancement of prairies and grasslands via prescribed fire, conservation grazing, haying and invasive species control: 100,560 acres annually in core areas, 42,050 acres annually in corridors, and 334,397 acres elsewhere. Enhancement of 335,047 acres of existing wetlands and shallow lakes through control of invasive species and intensive water level management is also included.

4. Incorporation of conservation into "working lands" so that some conservation lands contribute directly to local economies via "grass-based" agriculture and agricultural lands in turn provide some natural resources benefits as a result of applying using the full range of conservation practices.

The Minnesota Prairie Plan Working Group established organizational goals and cost estimates associated with these outcomes. The goals are accompanied by measures of success to gauge progress towards creating functioning landscapes. In addition, strategies should be re-evaluated regularly following monitoring activities and then management practices should be adjusted accordingly. The overall cost from all sources of the actions described in this plan is $3.6 billion. Given that certain activities will be accomplished with "traditional" funding sources, partners anticipate a need of $1.1 billion from the Outdoor Heritage Fund over the next 25 years to achieve desired outcomes.

Acknowledgements

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The chief author and editor of this plan was Steve Chaplin. Rich Johnson oversaw the GIS analysis and cartography work with assistance from Bruce Gerbig, Jared Smith, Jeff Carroll, and Liza Hernandez. Ryan Drum and Diane Granfors from the USFWS HAPET Office provided the corridor pathway analysis. Most of the basic data used in this plan was developed by the Minnesota Department of Natural Resources, especially the Minnesota County Biological Survey (MCBS).

Suggested Citation

Minnesota Prairie Plan Working Group. 2011. Minnesota Prairie Conservation Plan 2010. Minnesota Prairie Plan Working Group, Minneapolis, MN. 55p.

A Vision for the Future of Minnesota's Prairie Region

Minnesota lies mid-continent at the intersection of North America's prairie, eastern broadleaf forest, and boreal forest/peatlands. Prairie habitats once covered one-third of the state but presently less than 2% remain.

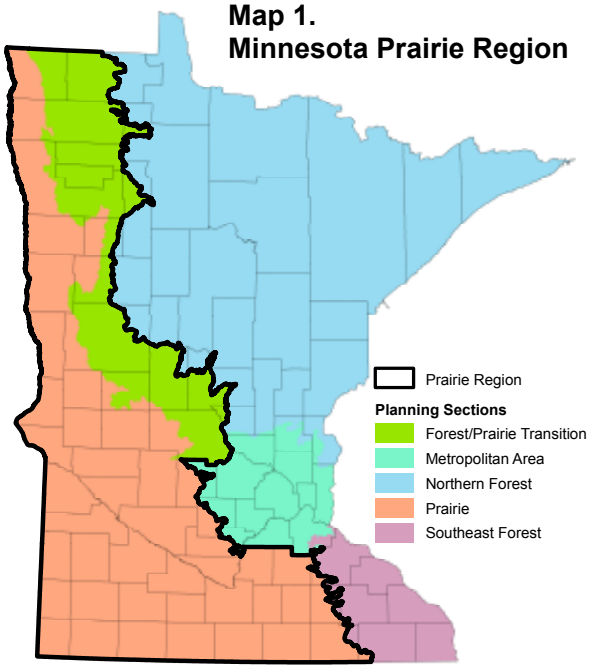
Native prairie, other grasslands that provide habitat for native species, and wetlands are key components of functional prairie landscapes that have the capacity to adapt to changing environmental conditions. These landscapes are places dominated by grasslands and wetlands that will support sustainable populations of fish, wildlife and native plants as well as compatible economic uses.

Although conventional agricultural uses will continue to dominate the Prairie Region, protecting remaining native prairie and associated habitats, reconstructing additional grasslands, expanding perennial crops, and increasing the implementation of conservation practices will make these agricultural areas more sustainable and more wildlife "friendly". In strategic locations, large areas of prairie, grassland, and associated habitats will be protected and restored to create functioning prairie systems that provide major opportunities for sustainable grass-based agriculture such as grazing and haying. These functioning landscapes will also contribute clean water, fish and wildlife habitat complexes, high quality recreational opportunities, and thriving rural communities where Minnesota's citizens will want to live and visit.

Purpose of a Minnesota Prairie Landscape Plan

With the passage of the Clean Water, Land, and Legacy Constitutional Amendment in 2008, Minnesotans placed a new emphasis on conservation in Minnesota. The organizations participating in the creation of the Minnesota Prairie Landscape Conservation Plan (hereafter Prairie Plan) strongly believe unified efforts will result in more effective and efficient conservation. Strategic coordination will prevent potential duplication of efforts, missed opportunities, and the confusion that could stem from conservation entities pursuing their own plans independently. The development of this plan has also served to strengthen working relations between the partners in their efforts to build on past efforts in prairie, wetland, and wildlife conservation. This plan is meant to cover a 25 year timeline and spans a geography that includes the Prairie and Forest-Prairie Transition Planning Sections employed by the Lessard-Sams Outdoor Heritage Council (Map 1).

Map 1.
Minnesota Prairie Region



The eastern portions of the Prairie Region coincide with the well-known "Prairie-Forest" border, an ecologically dynamic part of the state. Within human history, this border has experienced nearly continuous fluctuation in vegetation composition ("shifting mosaic") due to the various interactions of topography, waterbodies, weather events, fire, and major climate shifts. Presently a portion of this Prairie-Forest border contains substantial forest habitats that are not explicitly addressed in this plan.

The primary focus of this plan is on prairie landscapes which includes native prairies as well as other grassland, wetland, and associated prairie habitats throughout the Prairie Region of Minnesota. Associated habitats include the savanna, woodlands, parklands, and brush prairies that characterize the transitional border and that were often mapped as prairie complexes by MCBS. This Prairie Plan does not address the 17,855 acres of native prairie in the Southeast Forest Region, Metro, and Northern Forest Regions of Minnesota. These prairies are unquestionably important habitats but can be best viewed as inclusions within a forested landscape. As such they should be treated as part of the planning efforts for those regions of Minnesota. Consideration of concepts set forth in this plan is encouraged for those parts of the state.

This plan includes spatially explicit recommendations for protecting, enhancing and restoring Minnesota's prairie heritage that detail: acreage goals and realistic budgets for sustaining functional systems. The Prairie Plan is meant to complement and supplement the efforts of all conservation partners including the Lessard-Sams Outdoor Heritage Council in order to more effectively direct activities and funding for prairie conservation.

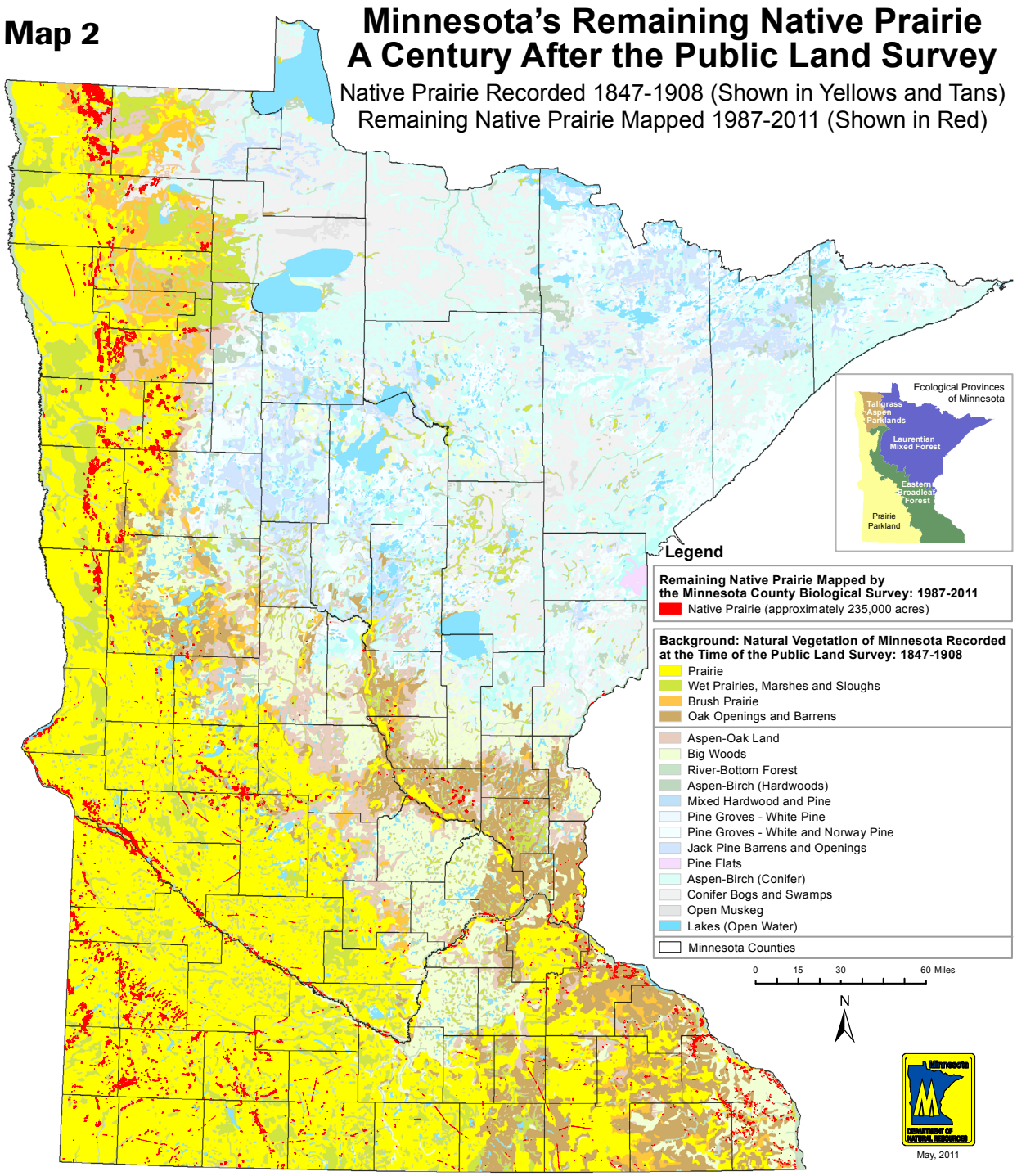
Prairie and Grasslands in Minnesota

Tallgrass prairie once covered about one-third of Minnesota or approximately 18 million acres (Marschner, 1974). The soil developed by prairie plants over thousands of years is now the basis of Minnesota's rich agricultural economy and which over the last 150 years has been largely converted to row crop agriculture. The result is that most of the prairie and associated habitats are now gone, along with the bison, elk and other key species that were integral to the functional prairie system.

Native prairies are defined here as unplowed plant communities originating on the site that are dominated by grass and sedge species with a rich mix of broad-leaved herbs and a few low shrub species. Since 1987, the Minnesota Department of Natural Resources' Minnesota County Biological Survey has recorded locations of native prairie and other native plant communities in the state. Map 2 shows (in red) the approximately 235,076 acres of remaining native prairie and prairie complexes in 71 counties with a condition ranking of excellent to good (Minnesota County Biological Survey, 2010). Only about 120,000 acres of these areas are currently protected in conservation ownership or with a conservation easement.

In addition to native prairies, Minnesota also has substantial areas of other grasslands of various origins. In some cases prairies were "improved" by spraying with broad-leaf herbicides and/or over-seeding with cool season grasses in hopes of increasing the pasture value for cattle.

The result is floristically-impoverished grassland dominated by a few species of grass. In other cases prairies were so heavily over-grazed that most of the native species were destroyed and



Additional information about this map can be found at: http://files.dnr.state.mn.us/eco/mcbs/prairie_map.pdf

replaced with a few hardy native species and a host of non-native invaders. Still other prairies were plowed in a failed attempt at row-crop agriculture and then allowed to "go back" to pastures. If the fields were only plowed for a few years many native plant species could survive or

re-establish themselves through the surviving seed bank. After several decades it can be difficult to distinguish these "go-back" prairies from native prairie that has suffered prolonged heavy use and degradation.

Besides the grasslands that were derived from native prairie as described above, an even larger area was cropped for decades prior to being planted back to grassland. A substantial portion of current grasslands are those acres enrolled in the Conservation Reserve Program (CRP). This USDA program pays farmers to retire highly erodible or environmentally sensitive cropland for 10-15 years during which it is planted to grassland or trees. Some of the land was planted with native grass species and has proven to be important habitat for pheasant and other wildlife species. In 2010, Minnesota had approximately 1.67 million acres enrolled in general and continuous CRP, much of it in grass cover (Board of Water and Soil Resources, 2010).

In total, there were 3,141,363 acres of non-native prairie grassland in CRP fields, pasture, hayfields, roadways, railroads, and other landuses in the Prairie Region of Minnesota as delineated by the 2001 National Land Classification Data and modified by the USFWS Habitat and Population Evaluation Team (HAPET). In addition to the grasslands there are 2,238,740 acres of existing wetlands in the Prairie Region that often grade into grasslands with indefinite boundaries.

Aquatic Systems

Leif Mountain Preserve, Pope County
© Michelle Kalantari/TNC

Lakes and other water bodies are important ecological features in the Prairie Region. There are 8,450 lakes in the Prairie Region with 799 being greater than 150 acres in size and 1,436 being classified as shallow lakes (greater than 50 acres in size and less than 15 feet deep). In addition to the lacustrine systems, there are more than 53,500 linear miles of rivers and streams, of which 7,980 miles are larger streams or rivers (stream order 4 or higher). More than 15,000 miles (32%) of the total river and stream miles have been channelized to facilitate drainage of wetlands and shallow lakes. Restoring the natural functioning of these channelized segments while allowing legal agricultural drainage will be a major challenge for the future. Another widespread concern about the streams and ditches in the Prairie Region is the cultivation of lands immediately adjacent to waterways despite a Minnesota Rule requiring a 50-foot buffer setback from public waters (Minnesota Board of Water and Soil Resources, 2010). Within the counties included in the Prairie Region, cultivated riparian area is estimated to be about 225,000 acres, with some counties estimated to have over 60% of their riparian buffers in cultivation (Minnesota Board of Water and Soil Resources, 2009). Cultivation within the 50-foot setback results in destabilization of stream banks and direct run-off of sediments, pesticides and nutrients into public waters. The consequences of cultivation in riparian areas are impacts on the quantity and quality of aquatic habitats that support fish and other aquatic species.

Whereas local land conservation efforts can have a direct impact on the water quality, fish assemblages, and other key aquatic species of lower order streams (headwaters), it is much more difficult to improve the ecological quality of larger streams and rivers. The water quality and fish assemblage of any one stretch of river or lake is the result of a summation of all the activities upstream in the watershed. For this reason, planning for the conservation and protection of aquatic systems often needs to take place at large scales. It is difficult to be spatially specific about the best places to work without in-depth analysis of local conditions and the impact of the upstream watershed. It is even more difficult to show actual improvements in water quality or aquatic biota as a result of any specific local conservation activity. Despite these difficulties a number of planning efforts have attempted to identify priority basins and lakes for conservation activities (Blann & Cornett, 2008; Minnesota Department of Natural Resources, Division of Fish and Wildlife, Wildlife Management Section, 2010). This plan does not try to duplicate these efforts but rather relies on them to help prioritize which lands within the agricultural matrix should be targeted for conservation activities. There will need to be significant research and analysis in the future to better integrate the needs of large-scale aquatic systems into comprehensive conservation planning.

Functioning Prairie Systems

To date, Minnesota's efforts to conserve prairie have consisted mainly of purchasing native prairie parcels and wetlands as part of a Wildlife Management Area (WMA), Scientific and Natural Area (SNA), State Park, Waterfowl Production Area (WPA), National Wildlife Refuge, or Nature Conservancy Preserve. The state, federal government, and conservation organization investment in these areas has resulted in the permanent protection of some of the state's highest quality native prairies and associated habitats (see Table 2). For example, WMAs contain around 65,197 acres of native prairie. To the extent that land managers can control woody plant expansion and invasive species, small prairie parcels can serve as reservoirs of some biological diversity. However, these protected prairies are often too small and isolated to be functioning prairie systems that can permanently maintain most prairie animal populations and ecosystem services.

There is no standard definition of what constitutes a functioning system. Different priorities emphasize different features but the following list includes the attributes that the authors of this Prairie Plan recognize as being key parts of a functioning prairie system:

Biological Attributes of a Functional Prairie System

1. Supports moderate to high diversity of vegetation types and native species within predominantly native prairie and associated habitats
2. Maintains viable populations of prairie landscape dependent fauna and flora
3. Is of adequate scale to support animal species that have large home ranges or require a variety of different habitat types throughout their life cycle (e.g., greater prairie-chicken, American badgers, and many amphibians)

4. Provides connectivity between grassland sites for plant and animal populations by facilitating movement and gene flow, including for species with relatively low capacity for movement

5. Provides linkages between upland and wetlands for animals that utilize both habitats

6. Has a natural disturbance regime (e.g., fire, grazing, and changing water levels)

7. Represents grasslands and wetlands with different histories of fire and grazing and time since disturbance (different successional stages)

8. Contains a complex of different habitat types including savannas, brush prairie, groundwater seepages, and a variety of wetlands that can range from temporary wetlands to shallow lakes

9. Exhibits ecosystem stability, adaptability, and resilience to environmental change

Physical Attributes of a Functional Prairie System

1. Cycles, transforms, and stores elements and nutrients (e.g., carbon, oxygen, nitrogen, and phosphorus)

2. Transfers energy between trophic levels

3. Filters and stores water

4. Anchors and builds soil

The physical attributes of prairie systems can be one of the main selling points for the maintenance and restoration of functional prairie systems. There are substantial public benefits to intact systems including reduced sedimentation rates, improved water quality, reduced peak run-off events, and enhanced ground-water recharge.

Disturbance in Landscapes: Prairie landscapes need regular disturbance. Without disturbance most grasslands, prairies, and some wetlands in Minnesota would rapidly transition into woodlands and forest. In pre-European settlement times, fire, grazing by large herbivores, and drought were the disturbances that maintained the prairies. The time of year the disturbance occurred, its intensity, and the time between disturbances are all critical in determining the plant community that will occur in any particular area (Minnesota Department of Natural Resources, 2005). By altering these factors, great variation in the structure and composition of grasslands can be achieved.

Prescribed fire in jackpine savanna
©The Nature Conservancy

The goal of landscape-scale management is to maintain the full range of community types, structures, and successional stages in the prairie landscape. This means that a diversity of management practices should be applied at different times and places within the landscape.

The large-scale disturbances that maintained prairies in the past are no longer practical today. Large herds of free-roaming bison are gone and for the safety of people and property, wildfires cannot be allowed to burn across large areas. However, cattle grazing can approximately replicate some of the effects of bison grazing when managed appropriately. Likewise, prescribed fire or haying can offer many of the benefits of wild fires while reducing the risks and negative impacts. Historically there was a strong interaction between fire and grazing. Fire clears dead and senescent vegetation and in the process releases nutrients back to the soil where they are incorporated into new plant growth. The new growth typically is more palatable to grazers because of its succulent nature and higher protein content.

Both fire and grazing in pre-European settlement times were marked by a rest period following the disturbance when the vegetation had time to recover. When herds of bison moved through an area, grazing pressure could be intense, but there usually was a period that followed when grazing was light. In the past, fire burned most prairies in Minnesota on the average of every three to six years (Collins, 1990). This sequence of disturbance and recovery is key to maintaining a healthy prairie ecosystem.

Grazing and fire also play important roles in maintaining the diversity and productivity of seasonal wetlands. Without disturbance, seasonal wetlands often become dominated by tall, perennial, emergent species such as cattail. The shallow open water required by shorebirds, waterfowl, and some amphibians and turtles in the spring is lost. Today, lack of disturbance is amplified by invasive forms of cattail and phragmites.

Drought was another important environmental factor that shaped the nature of grasslands and wetlands. Only species that could survive drought conditions endured in natural communities over time. Droughts alone were not enough to maintain treeless prairies in Minnesota but coupled with fire they had a profound effect on the structure and composition of grasslands. Wetlands, too, are impacted by drought cycles. In particular, their quality and ecological productivity is driven by changing climatic conditions. Periodic water level draw-downs play a critical role in maintaining the diversity of wetland vegetation most beneficial to prairie wildlife.

Size of Landscapes: There is no definitive answer to the question of exactly how large a prairie area must be to maintain ecosystem function and prairie animal and plant populations. Additionally, many of the attributes listed above are likely to be functional at different scales. For example, even small parcels of grassland can cycle nutrients and may maintain viable populations of some plant and small animal species. However, larger areas are necessary to retain natural hydrology and support viable populations of larger animals. Large herbivores such as bison and elk and predators such as prairie wolves are now largely gone from Minnesota's prairie as wild populations, and this plan does not propose re-establishing them. However, it may still be

possible to maintain the mid-size carnivores such as American badgers, burrowing owls, and short-eared owls as well as other area-dependent species such as the greater prairie chicken and sharp-tailed grouse.

Although we don't know how large a prairie landscape must be to retain all aspects of a functioning system, one lesson was learned at Glacial Ridge National Wildlife Refuge, the largest prairie restoration in Minnesota: When re-creating prairie landscapes, it is best to build from concentrations of existing prairie remnants. The Minnesota Statewide Conservation and Preservation Plan (Swackhammer, Coleman, & Shardlow, 2008) recognized this when it made its first habitat recommendation to "restore ecoregion-appropriate, landscape-scale complexes of habitat centered on concentrations of existing remnant habitat".

Threats to Prairie Systems in Minnesota

Across the original tallgrass prairie region, the native landscape is almost completely gone. Illinois, Indiana, Iowa, and Wisconsin have all lost 99.9% of their prairies largely due to the conversion to row-crop agriculture (Samson & Knopf, 1994). Minnesota has fared marginally better but still has lost more than 98% (Minnesota County Biological Survey, 2010).

The wetlands in Minnesota's Prairie Region have suffered nearly as much as the prairies. For the 49 counties found in the Prairie Region, an average of 91.9% of the original wetland has been lost (Anderson & Craig, 1984). Twenty-eight of the forty-nine counties in the Prairie Region have lost at least 97.5 percent of their wetland area. Wetland quality has also declined. Based on invertebrate communities, forty-seven percent of the remaining wetland basins in the Temperate Prairie Ecoregion of Minnesota are rated in poor condition (Minnesota Pollution Control Agency, 2009).

There are seven primary threats to the remaining native prairie and associated habitats in Minnesota.

1. ***Continued loss of prairie and wetlands to conversion, development, and destruction.*** According to the Minnesota Department of Natural Resources' County Biological Survey (Division of Ecological and Water Resources, Minnesota Department of Natural Resources, 2010), about 1.2% or 770 acres of the private land mapped as high-quality native prairie or savanna between 1987 and 1994 has been converted to agriculture and housing developments (Division of Ecological and Water Resources, Minnesota Department of Natural Resources, 2010). In some areas, housing may be as great a threat as agriculture because many of the remaining prairies are on hilltops or similar scenic areas.

Conversion of native prairie to flax in Clay County during the 1970s © Mark Heitlinger/TNC

Associated with agricultural conversion is the drainage of seasonal and temporary wetlands, sedge meadows, wet prairies, and other wet-mesic habitats. These habitats have been difficult to farm in the past but new drainage technologies and materials have expanded how far down the moisture gradient land can be feasibly drained. The increased installation of subsurface drain tile on agricultural land, while improving crop yields, can also disrupt local groundwater recharge/discharge patterns that are responsible for maintaining wet and wet/mesic prairies (Blann, Anderson, Sands, & Vondracek, 2009). Direct drain tile discharge to wetlands disrupts natural hydrologic regimes, adversely affecting native plant communities and compromising the habitat value of prairie-wetland complexes.

Another related threat in some areas is the loss of prairie and associated habitats to mining, sand and gravel removal, or boulder extraction for landscaping. Some prairies survived agricultural conversion only because they were too rocky or sandy to be farmed profitably. Now the same geologic resources that protected the prairie are themselves being utilized and the prairie is lost in the process.

2. ***Invasive species.*** Minnesota's native prairies and associated habitats face a host of invasive plant species such as smooth brome, reed canary grass, leafy spurge, various thistles, sweet clover, hybrid cattail, invasive Phragmites, and many others. These species often out-compete native plants and efforts to control them with techniques such as spraying and mowing can damage native plants.

3. ***Detrimental grazing practices.*** Throughout Minnesota many grasslands are subject to season-long, moderate-to-heavy-stocking density of cattle. This regimen results in a relatively uniform, low grass height and leaves relatively little 'tallgrass' habitat. Over-grazing of cattle on a continuous basis also results in loss of native plant diversity, increased potential for erosion, and higher susceptibility to invasive species. This is particularly true when native plants are selectively chosen and repeatedly grazed without a rest period allowing for recovery. Another problem is broadcast spraying of native grasslands with herbicides to remove broad-leaf plant species. This is done to "improve" pastures for livestock and control the weeds that are left after continuous grazing. Rotational grazing using high-intensity, short-duration regimens can simulate the grazing patterns once provided by large bison herds and may offer a beneficial means of achieving both conservation disturbance goals while supporting a local grazing industry.

4. ***Woody plant encroachment.*** Trees change the very nature of the open prairie landscape. Under a pre-settlement fire regime, the extent and distribution of most woody species would naturally be limited in native prairies. However, with a history of fire suppression and inadequate prescribed fire, woody plants survive and sometimes begin to dominate portions of the prairie habitat. Extensive research shows that many species of grassland specialist birds avoid nesting near trees (Bakker, 2003) both native (e.g. eastern red cedar, cottonwood, aspen, and boxelder) and nonnative (e.g. buckthorn and Siberian elm). Trees form perches for predators such as hawks, owls, or crows, and the base of the trees form den sites for nest predators such as raccoon, skunks, and foxes. Trees may invade prairies naturally but they are also planted for wildlife habitat and windbreaks. The limited amount of prescribed burning done today is not enough to keep unintended trees in check.

5. ***Energy development.*** Although it is important to decrease the country's dependence on fossil fuels, there are also some ecologically detrimental effects associated with some renewable or "green" energy sources. The development of wind and biomass energy will need to be carefully managed to minimize these potential negative effects. Economic incentives often motivate the installation of wind turbines in grassland areas due to their currently lower real estate value. However, turbines are potential threats to wildlife in four ways. First, collisions with turbines can result in direct mortality of birds and bats (Leddy, Higgins, & Naugle, 1999; Arnett, et al., 2008). Second, turbines provide the same negative visual stimulus as trees, deterring some grassland species from utilizing otherwise good nesting habitat near the structures (Pruett, Patten, & Wolfe, 2009). Third, turbines require access roads, heavy equipment, traffic, and people that collectively can disturb wildlife and habitats. Fourth, the presence of wind turbines in or near grasslands can complicate or prevent the use of prescribed fire as a management tool. All these reasons speak to the need for careful siting of wind turbines and their accompanying infrastructure.

   Another looming issue is the use of native prairie and grassland as a source of biomass and feedstock for energy production. If grasslands are harvested too heavily or at inappropriate times, wildlife and especially ground-nesting birds can be negatively impacted. Newly created grasslands for bioenergy production planted as monocultures (switchgrass) or with inappropriate species (elephant grass), can be "sinks" for wildlife populations. These areas are attractive to some wildlife species because they appear to have appropriate habitat structure but they are unsuitable because of a lack of food or other key resources that the species needs to survive or breed successfully. The result is reduced survival and breeding success. Energy plantings may also introduce inappropriate ecotypes that are bred for maximal yield production at the expense of other adaptive traits. Pollen from these ecotypes can be blown into surrounding local populations of the same species and contaminate them. Despite these potential issues, energy development affects a relatively small proportion of the Prairie Region and when managed appropriately can provide additional grassland wildlife habitat while providing a revenue stream to local economies.

6. ***Atmospheric Nitrogen Deposition.*** A newly recognized threat to prairies is the increased level of biologically-active nitrogen entering prairie systems from the air. Rates are two to seven times pre-industrial levels because of agricultural fertilization and the combustion of fossil fuels. Chronic low-levels of increased nitrogen result in a reduction of native species in prairie (Clark & Tilman, 2007) and the increase of non-native weeds and pasture grasses (Wedin & Tilman, 1996).

7. ***Change in climate.*** Although the Prairie Region of Minnesota is expected to become warmer, to have higher evapotranspiration rates, and to experience shifts in precipitation in the next 50 years (Galatowitsch et al. 2009; Johnson et al. 2005, 2010), this change will be difficult to categorize as a simple change of averages. The most likely scenario will be a disruption of climate leading to more extreme weather, especially drought and heat waves which in turn will increase the severity and frequency of wild fires. Each prairie species will react differently to a changing climate. Some will be able to withstand the new conditions but others will not.

To survive, many species will need to track their preferred environmental conditions by moving. These movements might be local where species move to wetter or cooler microclimates but others will need to move substantial distances to the north and east. Some species will fail in their attempts to move to suitable habitats unless there are dispersal corridors they can use. Continuous grassland habitat that allows easy movement for dispersal no longer exists and the habitat patches that do survive are often separated by miles of unsuitable habitat. Successful movements to new habitats will either require the species to cross these habitat barriers naturally or be moved via facilitated translocations by man.

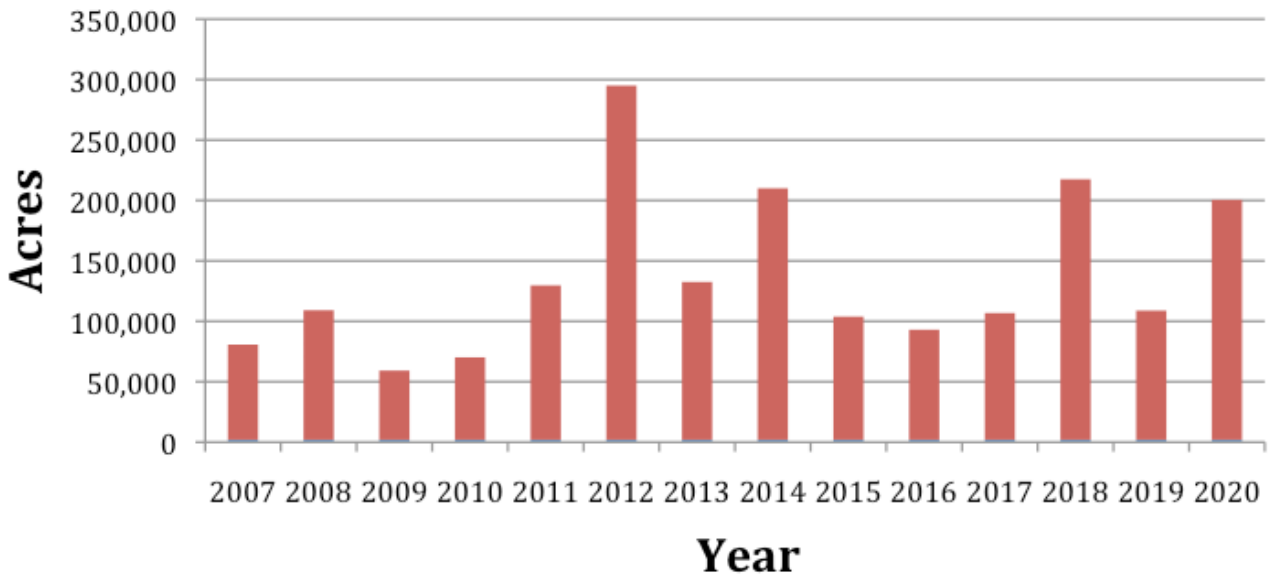
All of these threats are impacting Minnesota's prairie and wetland systems at the current time. Any one threat can be a major problem but collectively they are degrading thousands of acres annually and are creating urgency for immediate conservation action.

Agriculture and Prairie Landscape Conservation

The nature of agriculture in the United States has been greatly impacted by federal policy. For at least the last 60 years the US Department of Agriculture has tried to maintain a stable and inexpensive food supply by supporting the production of corn, soybeans, and a few other commodity crops. The consequence of this policy has been to drive land use towards those crops and away from other land uses such as livestock grazing that do not receive the subsidies. Such incentives can be a direct threat to prairies if they lead to accelerated "sodbusting", a term describing the conversion of native prairie to crop land for a few years before it is enrolled in a federal farm program. Federal farm policy also alters markets in other ways. Corn and soybean subsidies have resulted in higher crop production and lower prices than might be expected in their absence. Low prices make the use of grain for livestock feed more economical and have promoted more grain-finishing than grass-finishing of livestock. Large amounts of inexpensive grains have also led to the development of a large-scale, centralized and industrial form of agriculture where grain serves as feedstock for a multitude of foodstuff and industrial processes as well as confined-animal feeding operations.

Over the last twenty years there has been a partial shift of federal spending from commodity production to conservation programs. The Conservation Reserve Program (CRP) alone has been responsible for greatly increasing the amount of grassland in Minnesota. Other federal programs such as the Wetland Reserve Program (WRP), Grassland Reserve Program (GRP), Wildlife Habitat Incentive Program (WHIP), and Environmental Quality Incentives Program (EQIP) and state programs such as Reinvest in Minnesota (RIM) and Native Prairie Bank have all contributed to the protection and restoration of wetlands and grasslands. The scope and effectiveness of these programs in prairie landscape conservation may well increase in the future. Minnesota can continue to pursue adjustments in federal farm programs that promote diverse grasslands and wetlands that exist with compatible commercial uses of the land.

Area of Expiring CRP Contracts in Minnesota (Figure 1)



An immediate concern for Minnesota's grasslands is the loss of CRP lands. When commodity prices are high, as they were between 2006 and 2008, there is strong pressure to convert grassland to crop land and to remove land from conservation programs in order to place it back in production. More than 312,000 acres of CRP contracts expired between 2007 and 2010 in Minnesota. Most of this land was planted grassland that had important wildlife values. Figure 1 shows the potential maximal loss of CRP lands in Minnesota for the period 2007-2020 based on data from the Farm Service Administration (US Department of Agriculture, 2010). In the future, Minnesota needs to maximize federal farm program funds and acres by providing state matching funds as an incentive for long-term grassland and wetland protection.

Multifunctional Landscapes: An Economic Strategy

Agriculture has been and will be focused on providing food and fiber for a growing human population. It is, however, increasingly being expected to provide a suite of non-traditional services including energy production, surface water purification, sequestration of carbon, and maintenance of healthy wildlife habitats. To accomplish each of these concurrently requires a shift in our approach to agricultural production.

One strategy that strives to accomplish all of these goals while maintaining the economic vitality of rural communities is referred to as multifunctional landscapes (Boody et al., 2005) or ecoagriculture (Scheer & McNeely, 2008). Multifunctional landscapes go beyond the implementation of traditional agricultural Best Management Practices in that they rely on the full integration of agriculture, conservation, and rural communities to maximize the ecological and economic potential within a landscape.

Within Minnesota's Prairie Region, there are several possibilities for capitalizing on the potential for multi-functional landscapes to deliver the desired results. One potential change is to increase the use of cover crops to reduce erosion and minimize the need for nutrient application. A second potential change is to diversify crop rotations to include more acres of traditionally-planted perennials such as alfalfa or annual small grains including wheat, oats, and barley, as well as potential new perennials in development that are currently grown as annuals such as wheat, flax, and sunflower. Creating a more diverse cropping system would likely result in healthier populations of grassland birds and improved water quality (Devries et al., 2008).

Cattle at Sheepberry Fen Preserve
©Jared Culbertson/TNC

Blann (2006) and others have identified the ideal multifunctional landscape system as one that closely mimics the structure and function of natural systems. In the prairie region, the industry that is best positioned to achieve this ideal is grass-based livestock production. In areas of the world where large areas of native grasslands have survived, it is usually because local residents can earn a greater net return from grazing large animals than they can by tilling and annually planting the land. As the economic return of agricultural crops in the U.S. rises, owing in large part to federal farm policies, there is increasing pressure to convert existing grasslands to crops. However, this trend could be reversed if farmers could benefit more by restoring marginal cropland to diverse grasslands than by continuing the necessary inputs of fuel, fertilizer, equipment, and labor required to maintain production of row-crop agriculture on marginal lands.

One difficulty with implementing grass-based agriculture from a farmers' standpoint is the large up-front capital cost of purchasing and restoring land into suitable range lands. Surveys of current and would-be farmers show that access to affordable land is the primary barrier to expanding or starting a forage-based livestock business (Stettler, 2010). In large part this is again directly tied to federal farm policy as safety nets and support programs are inadequate to justify large up-front costs or to qualify for needed financing.

Federal and/or state government could provide direct annual subsidies to encourage new grass-based industries. However, another promising approach is to use currently available and future funding to purchase easements or fee title of prairie or other grasslands. In places where grassland is largely gone, available funding could be used to buy or lease marginal cropland and restore it to grassland or wetland. As grasslands are restored by public agencies or non-government organizations, they could then be leased or possibly sold to private ranchers or hay harvesters under agreements that would provide economic returns to the producer while ensuring that the land also provides the ecological services that grasslands and wetlands can deliver. Lease rates could be sufficient to cover taxes and management costs but still be low enough to provide an incentive to expand existing grazing operations or create new ones.

These new or expanded operations could support rural economies while accomplishing ecologically-necessary land management functions. The incentive for grazing could be increased by developing commercial markets that pay ranchers a premium for producing organic, grass-fed "prairie livestock". The use of grazing as a conservation tool, however, also comes with some potential problems. Many producers may be reluctant to move livestock as frequently as may be needed for conservation grazing and the movement of grazing animals could be a vector in the spread of invasive plants.

Protection and restoration of prairie and wetland systems that contribute to both economic viability and ecological function is conceivable through innovative partnerships with agricultural producers, local communities, private organizations, and government utilizing public and private conservation funding as a catalyst. No other factor will play a greater role in the creation and maintenance of prairie landscapes than the profitability of private and leased public grasslands.

Conservation Strategies for Prairie Landscapes

The strategy for achieving functional prairie systems has three activities:

1. **Protect** the native prairie and prairie complexes, selected other grasslands, and associated habitats such as wetlands, riparian areas along streams, and shallow lakes. Within Minnesota, the County Biological Survey has identified some 235,076 acres of native prairie. The goal for these remnants should be to protect and sustain all of them through either ownership by a public or private conservation organization or a conservation easement on private lands. Currently about 110,000 acres of native prairie are in conservation ownership and another 11,000 acres are protected with conservation easements (Table 1). That means about 114,000 acres of native prairie statewide have no legal protection. Besides protecting native prairie from destruction, it will also be necessary to ensure that some percentage of the non-prairie grasslands in the state (degraded prairie or planted grasslands) remain as grasslands permanently.

2010 Statewide Native Prairie Protection in Acres (Table 1)

	Ownership	Easement	Total Protected
State Park	4,302	0	4,302
WMA	65,197	0	65,197
SNA and Native Prairie Bank	5,931	4,384	10,315
USFWS Refuge and WPA	15,140	1,399	16,539
BWSR (RIM)	0	1,722	1,722
The Nature Conservancy	19,829	59	19,888
NRCS (WRP)	0	3,371	3,371
TOTAL	**110,399**	**10,935**	**121,334**
Percent of Statewide Total	47.0%	4.7%	51.6%

2. **Restore** landscapes by connecting and buffering the native prairie and other protected habitats. Even if all native prairies in Minnesota were protected and managed properly, there would still be insufficient habitat for the long term survival of some prairie habitat-specialist species. In places where there is insufficient grassland, reconstruction will be necessary. In areas with high concentrations of native prairie most of the restoration will buffer and connect the remnant native prairie, but outside these areas more of the restoration will be in areas where there are no prairies nearby. Although the quality of prairie restorations will vary depending on funding, expertise, and site characteristics, it is desirable to meet the Minnesota legislative definition of restored native prairie. Minnesota Statute 84.02 calls for planting at least 25 representative and biologically diverse native prairie plant species. The outcomes of restoration need to be assessed and documented then corrected if needed in an adaptive management framework.

   Restoration should include previously drained wetlands in association with grasslands and other surface water features. Wetland restoration activity should promote establishing wetland complexes that include a range of water permanence. The impact of climate change is likely to be particularly severe on ephemeral and seasonal wetlands. Added emphasis needs to be given to restoring wetland types that have decreased the most from their historical distribution.

3. **Enhance** natural disturbance regimes on Minnesota's native prairie. Since fires and gazing were historically fundamental components of the prairie system, both prescribed fire and grazing management must be expanded and improved. The use of livestock grazing or haying to approximate these disturbances may be acceptable for some prairies and other habitats with proper planning, management and monitoring. As more prairies and wetlands are protected and restored, there will be an increasing need to expand the collective capacity to conduct management activities, including prescribed burns and drawdowns. For example, if each acre of native prairie is burned every four years on average, the existing native prairie alone would require an annual burning goal of 55,000 acres. This number would be dwarfed by the prescribed burning needs of restored prairie and grasslands if they were all brought into a regular burn rotation.

   Associated wetlands will also require active management to regain habitat quality. Intensive water level management, burning, or grazing may be needed depending on wetland condition. Shallow lakes impacted by degraded watersheds and invasive fish will require investments in fish barriers, water level control structures, and active management.

   The collective knowledge of management activities in Minnesota also needs to improve. New techniques such as "mob grazing" (short duration, high intensity rotational grazing), restoring seasonal flooding regimes, and biofuel harvest need to be tested to determine their effectiveness, cost, and impact on native plant species.

Three Approaches for Targeting Prairie Landscape Conservation

The protection and restoration of the remaining native prairie, grasslands, and associated wetlands of Minnesota (along with their full range of native animals and plants and their geographical diversity) will require a three-pronged conservation approach.

Prairie Core Area-based conservation: Species and ecosystem processes that require large expanses of prairie/grassland system will be conserved only if areas of suitable size, composition, and quality are available. To reach the minimum critical area needed to maintain species and processes, extensive restoration will be needed in most landscapes to buffer and reconnect the remaining prairie fragments. The goal is to create functioning prairie systems that retain the capacity for evolutionary adaptation in the face of environmental change.

Corridor-based conservation: Core areas need connectivity to enable interchange of plant and animals, and to provide pathways to refuge in times of stress or environmental change. Strategically located grassland/wetland complexes can provide stepping stones between the larger prairie core areas.

Local conservation: If conservation activities are restricted to areas where there are relatively high concentrations of native prairie, large areas of Minnesota, especially in the southern and central portions of the state, would lack conservation. This scenario is unacceptable for two principal reasons:

a. Prairie animals and plants throughout the state are adapted to their local environmental conditions. There are important geographical differences in the genetic makeup of populations in different parts of the state. Conserving this geographic genetic diversity will necessitate protecting populations throughout the state. Although we may never be able to re-create prairie habitats on the scale of thousands of acres in some parts of Minnesota, we can protect good examples of smaller prairie and wetland parcels. These parcels may be less than a hundred acres in size, but they still constitute an important reservoir of local biodiversity and ecotypes of the species that are found there.

b. An important aspect of conservation is to provide recreational opportunities. The citizens of Minnesota are most likely to use conservation lands for hunting, wildlife viewing and other types of outdoor recreation if they are located near to where they live. There needs to be prairie-based conservation in every county within the Prairie Region of Minnesota to provide grassland-oriented recreation in all parts of the state where native prairie once dominated.

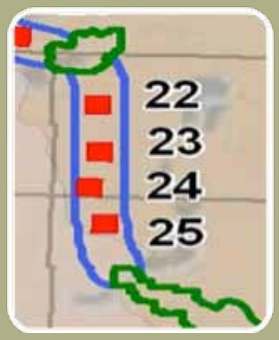
Prairie Conservation Preview

Core Areas:

- Large 5,000 to 300,000 acre landscapes (36 in total) that retain some features of a functioning prairie landscape and include 71% of Minnesota's remaining native prairie
- Function as a habitat base for wildlife species needing large areas of natural habitat
- Goal: reach 40% grassland and 20% wetland coverage within each Core Area

Corridors:

- Linear stretches of habitat 6 miles wide that connect Core Areas to each other and moderate the effects of a highly fragmented landscape
- Function as dispersal corridors that allow an exchange of individuals and genetics between populations
- Goal: 10% of each square mile in the Corridor be protected grassland and wetland habitat



Corridor Complexes:

- 9 square mile habitat complexes established every 6 miles within the Corridors
- Function as habitat "stepping stones" for mobile wildlife species within the Corridors
- Goal: reach 40% grassland and 20% wetland within each Corridor Complex

Agricultural Matrix:

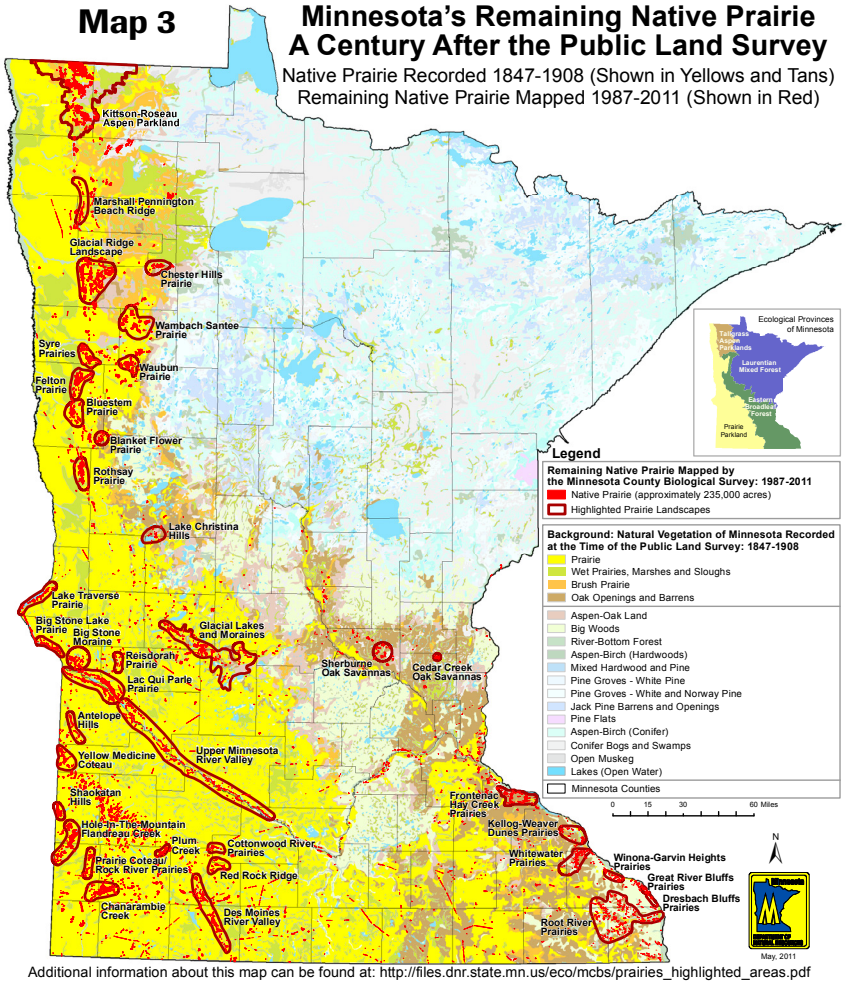
- All the remaining area of the Prairie Region outside of Core Areas, Corridors, and Corridor Complexes (21.7 Million Acres)
- Function as habitat for species adapted to live within an agricultural countryside
- Goal: reach 10% native perennial cover within each Ecological Landtype Association

Prairie Core Areas

The Minnesota County Biological Survey (MCBS) has been evaluating and mapping areas of native prairie in Minnesota since 1987. Based on the MCBS data available as of July 2010, we know that the remaining native prairie in Minnesota is not evenly distributed. Across Minnesota, there are places where prairie tends to be relatively more common. The cause of these concentrations is due to the soils and geologic landforms that drove the nature and historical uses of he land. Prairie once covered most of western and southern Minnesota and this prairie was largely undisturbed until settlers discovered that prairie soils are some of the most productive agricultural soils in the world. Starting in the early 1900s, the conversion of native prairie to agricultural production experienced dramatic acceleration due to technological improvements in tillage , harvesting, and drainage equipment. Public agricultural policy provided strong incentives for these activities. With a few minor exceptions, only places that could not be profitably converted to agricultural uses were left as native untilled prairie. These included areas that were too rocky, too wet, too steep, or too sandy to be profitably farmed. However, as technology continually improved, more and more of the formerly unsuitable areas were converted. This conversion continues to the present day.

Remaining native prairies tend to be concentrated because of unusual landforms across the state. Areas of steep slopes such as those found along the edges of the Prairie Coteau and Buffalo Ridge, areas of extensive sand and gravel such as those found in the Agassiz Beach Ridges, areas of rocky outcrops such as those along the upper Minnesota River, and areas of excessive moisture such as those in the Tallgrass Aspen Parklands are places that a relatively high density of native prairies survive.

With the information compiled by MCBS, places in Minnesota can be identified where there are high concentrations of remaining native prairie. In 2009, MCBS prairie biologists delineated rough boundaries around locations where native prairie



Additional information about this map can be found at: http://files.dnr.state.mn.us/eco/mcbs/prairies_highlighted_areas.pdf

and associated habitats are concentrated. The result was 29 locations in the Prairie Region of Minnesota (Map 3; Minnesota County Biological Survey, 2010). The boundaries of what MCBS called prairie landscapes were admittedly rough but they captured about 152,000 acres of native prairie within a total area of 2.1 million acres. The 152,000 acres represent 65% of all native prairie remaining in Minnesota.

Using the initial work of MCBS (Map 3), The Nature Conservancy in 2010 further refined the boundaries of the prairie concentration areas for the purposes of this plan (see Appendix 3 for details). The result of these revisions was to increase the number of prairie core areas to 36 but decrease their total size to 1,582,280 acres (Map 4). Within these cores are 166,458 acres of native prairie which on average represent 10.5% of the area in the landscapes. The set of 36 landscapes together capture 71% of the identified native prairie in Minnesota.

The common features exhibited by these prairie core areas allow us to define them as:

> *A prairie core area encompasses 4,500 to 300,000 acres and retains at least some of the features of a functioning prairie system. At least 15% of the area is grassland with a substantial portion being native prairie. Prairie core areas often contain other natural communities including wetlands, aquatic systems, savannas, shrublands, and a more minor component of forest.*

In addition to locating and defining the prairie core areas, another key task in prairie landscape conservation planning is to define what the desired future condition of each core area should be. The Minnesota's Working Lands Initiative (Minnesota Department of Natural Resources, 2010) used one approach to establish conservation goals for four to nine square mile grassland/wetland complexes. It describes a mix of habitats that would be desirable to sustain populations of breeding ducks, pheasants, black terns, and upland nesting shorebirds. Based on population models the predicted optimal habitat mixture is a minimum of 40% grassland and 20% wetland. The Duck Plan (Minnesota Department of Natural Resources, 2006) goes further and calls for half of the wetlands of the total landscape (10%) to be seasonal or temporary in nature. The remaining 40% of land use beyond grassland and wetlands could be in other uses, including crop-based agriculture. Although these values might not be ideal for every prairie species, it is likely a conservative estimate of what most prairie species need as long as there are some expanses of contiguous grassland covering thousands of acres within each prairie core area (Minnesota Department of Natural Resources, 2006).

One interesting feature of the identified core areas is that they have retained more natural habitat than other parts of agricultural Minnesota (Table 2). Although there is significant variation among areas, on average they consist of 38.2% grasslands (native prairie plus pastures and hay fields) and 16.4% wetlands. These totals verge on the 40% grassland and 20% wetland minimums set by the Working Lands Initiative. Another feature of this set of core areas is that some have already reached the protection goals for grasslands and wetlands (Table 3). Twelve core areas exceed the 50% permanent protection goal for grasslands and six exceed it for wetlands.

Map 4. Prairie Core Areas

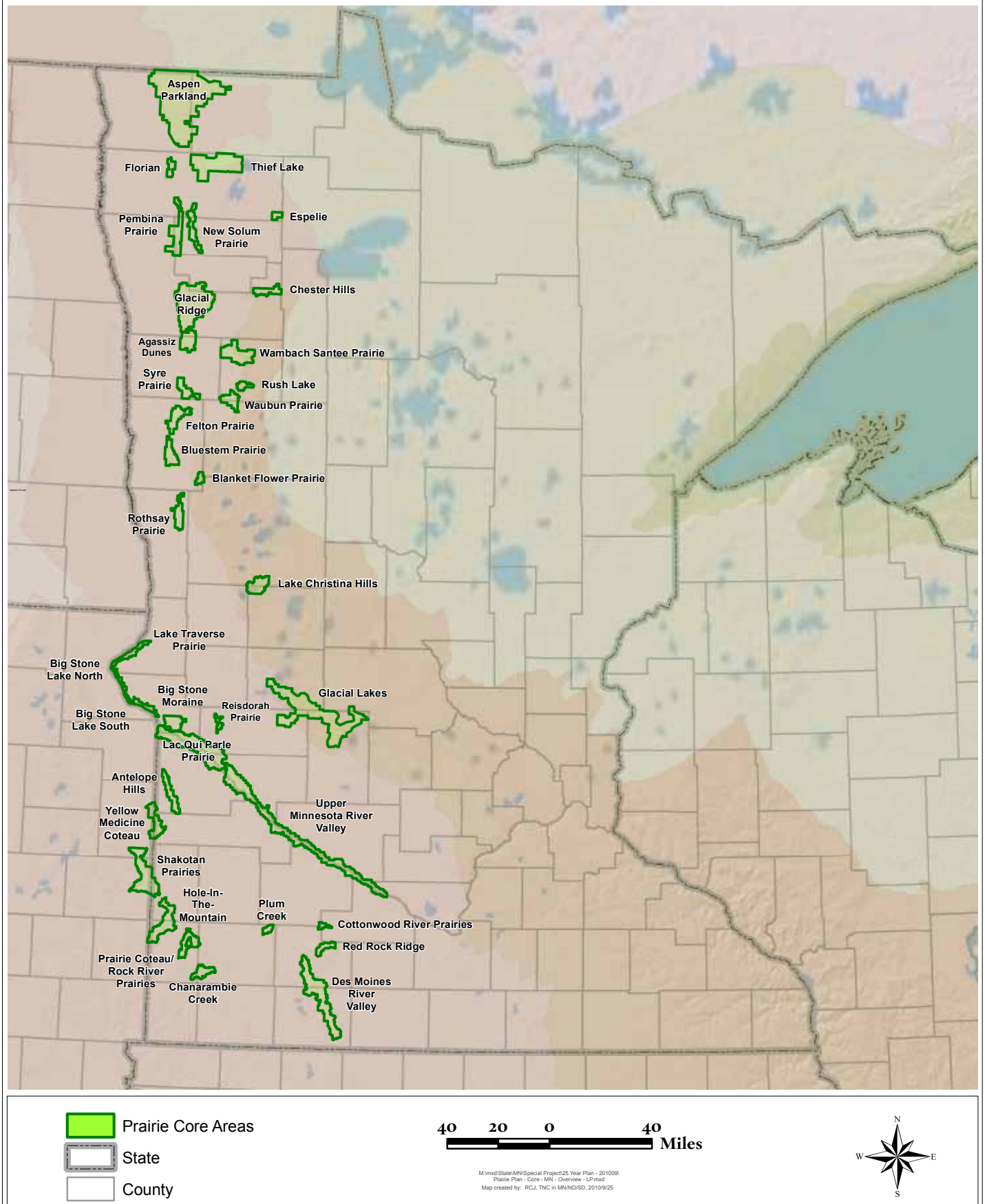


Table 2. Habitat in Core Areas (Acres)

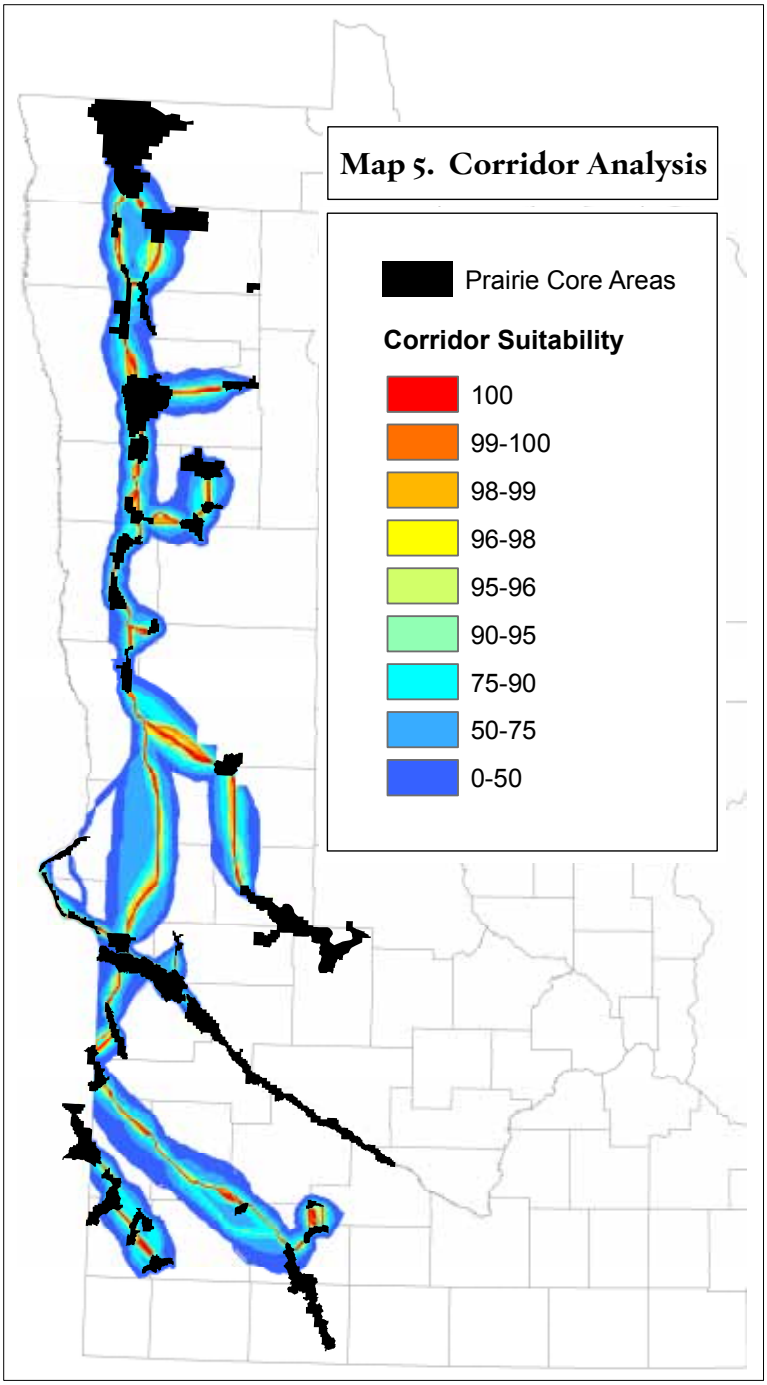
Prairie Core Area	Core Area Acreage	Native Prairie (NP)	Other Grassland	Grassland Habitat Shortfall from 40% Goal	Wetland	Wetland Habitat Shortfall from 20% Goal
Agassiz Dunes	26,572	1,869	11,333	0	4,670	644
Antelope Hills	24,924	1,950	8,567	0	2,961	2,024
Aspen Parkland	297,693	44,549	91,580	0	71,115	0
Big Stone Lake North	9,463	1,312	1,314	1,159	819	1,074
Big Stone Lake South	11,157	1,688	1,034	1,740	383	1,849
Big Stone Moraine	22,870	2,848	5,292	1,007	2,905	1,669
Blanket Flower Prairie	7,530	1,439	3,334	0	418	1,088
Blue Stem Prairie	23,637	5,142	7,100	0	2,820	1,907
Chanarambie Creek	17,709	3,193	3,342	548	558	2,984
Chester Hills Prairie	17,641	1,031	5,881	145	5,624	0
Cottonwood River	4,889	355	1,715	0	426	552
Des Moines River	87,064	4,073	11,991	18,762	3,327	14,085
East Park - Thief Lake	89,393	3,163	23,336	9,258	25,895	0
Espelie	6,420	2,099	934	0	1,773	0
Felton Prairie	27,412	7,507	9,320	0	3,201	2,281
Florian	10,434	1,028	3,567	0	1,616	471
Glacial Lakes	169,305	7,223	55,362	5,137	36,326	0
Glacial Ridge	118,567	17,599	48,078	0	20,956	2,758
Hole-In-The-Mountain	45,305	3,930	16,808	0	1,298	7,762
Lac Qui Parle Prairie	106,672	16,135	21,910	4,624	14,501	6,834
Lake Christina Hills	27,966	374	7,749	3,063	3,810	1,783
Lake Traverse Prairie	17,068	2,556	698	3,574	764	2,649
New Solum Prairie	25,501	1,435	7,635	1,130	5,690	0
Pembina Prairie	41,426	2,608	16,871	0	4,868	3,417
Plum Creek	6,321	414	848	1,266	107	1,157
Prairie Coteau/Rock R.	24,702	1,469	9,420	0	1,428	3,512
Red Rock Ridge	12,233	707	1,019	3,168	151	2,296
Reisdorah Prairie	6,551	364	699	1,558	642	668
Rothsay Prairie	22,607	7,263	3,477	0	2,712	1,810
Rush Lake	9,179	1,696	1,189	787	2,326	0
Shaokatan Prairies	10,762	1,286	5,814	0	281	1,871
Syre Prairie	20,146	2,874	7,506	0	3,453	576
Upper Minn. R. Valley	150,591	4,440	27,962	27,835	19,255	10,863
Wambach Santee	45,669	5,118	3,756	9,393	6,948	2,186
Waubun Prairie	20,651	3,826	1,811	2,624	4,869	0
Yellow Medicine Coteau	15,978	1,835	9,343	0	798	2,397
Total	**1,582,008**	**166,396**	**437,597**	**96,778**	**259,694**	**83,169**

Table 3. Current Protection of Habitat in Core Areas (Acres)

Prairie Core Area	Protected NP	NP Protection Shortfall	Protected Other Grassland	Grassland Protection Shortfall	Grassland in CRP	Protected Wetland	Wetland Protection Shortfall	Wetlands in CRP
Agassiz Dunes	930	939	1,293	2,152	3,631	1,452	1,205	301
Antelope Hills	323	1,626	1,937	1,099	2,359	1,402	1,091	177
Aspen Parkland	31,763	12,786	26,281	0	26,019	47,317	0	1,588
Big Stone Lake North	167	1,146	114	467	199	101	845	35
Big Stone Lake South	546	1,142	560	0	16	133	983	0
Big Stone Moraine	1,701	1,147	2,152	0	478	1,078	1,209	60
Blanket Flower Prairie	272	1,167	185	0	1,447	101	652	69
Blue Stem Prairie	3,811	1,331	3,253	0	858	995	1,368	217
Chanarambie Creek	372	2,821	332	16	398	160	1,611	59
Chester Hills Prairie	0	1,031	45	2,453	567	1,969	0	31
Cottonwood River	161	194	204	419	513	109	380	33
Des Moines River	1,231	2,842	2,167	11,173	2,592	511	8,195	131
East Park - Thief Lake	2,315	848	4,378	10,338	8,413	17,557	0	664
Espelie	1,551	548	58	0	537	771	0	379
Felton Prairie	2,795	4,712	2,098	0	1,659	1,363	1,378	110
Florian	446	582	288	771	1,363	641	402	97
Glacial Lakes	2,813	4,410	8,227	18,411	14,224	8,170	8,760	1,386
Glacial Ridge	12,575	5,024	18,708	0	15,235	13,158	0	1,052
Hole-In-The-Mountain	1,564	2,366	2,139	2,992	2,092	312	4,219	55
Lac Qui Parle Prairie	10,086	6,049	12,998	0	1,583	10,418	249	186
Lake Christina Hills	254	120	891	4,328	1,292	713	2,083	99
Lake Traverse Prairie	196	2,360	34	824	158	14	1,693	41
New Solum Prairie	255	1,180	324	3,341	2,560	772	1,778	255
Pembina Prairie	566	2,041	1,558	4,120	8,428	1,609	2,534	306
Plum Creek	64	349	106	745	51	38	594	4
Prairie Coteau/Rock R.	606	863	726	2,745	2,141	242	2,228	59
Red Rock Ridge	391	315	335	1,404	109	28	1,195	13
Reisdorah Prairie	92	272	221	726	120	108	547	16
Rothsay Prairie	4,171	3,092	1,379	0	1,008	1,839	422	78
Rush Lake	784	911	189	0	317	720	198	128
Shaokatan Prairies	0	1,286	34	833	620	43	1,033	14
Syre Prairie	1,647	1,227	1,306	0	1,533	1,606	409	236
Upper Minn. R. Valley	859	3,581	9,892	15,786	2,080	5,241	9,818	317
Wambach Santee	4,602	516	973	3,043	1,468	2,756	1,811	666
Waubun Prairie	2,711	1,115	397	0	379	1,522	543	185
Yellow Medicine Coteau	667	1,168	1,414	0	1,256	192	1,406	35
TOTAL	**93,288**	**73,108**	**107,194**	**88,185**	**107,701**	**125,164**	**60,837**	**9,084**

Prairie Corridors

When prairie covered more than one third of Minnesota, few barriers prevented the movement of grassland animals and plants from one end of the Prairie Region to the other. In today's highly fragmented agricultural countryside, barriers to movement abound. The landscape is typified by many miles of unsuitable habitat between scattered prairie remnants making the dispersal and colonization of some organisms to new locations extremely difficult. Many prairie species have disappeared from portions of their former ranges. Two notable examples are the greater prairie chicken and sharp-tailed grouse. Two hundred years ago these species ranged throughout the Prairie Region of Minnesota but now are restricted to isolated populations in the western and northwestern parts of the state. As additional grassland is restored and protected in the future, more suitable habitat for these prairie grouse species will be available. Dispersal corridors will be needed between suitable habitat areas or we will need to facilitate movement directly for these species to re-colonize new habitat. Current barriers to movement also prevent the spread of other species and new ecotypes in the face of changing environmental conditions.

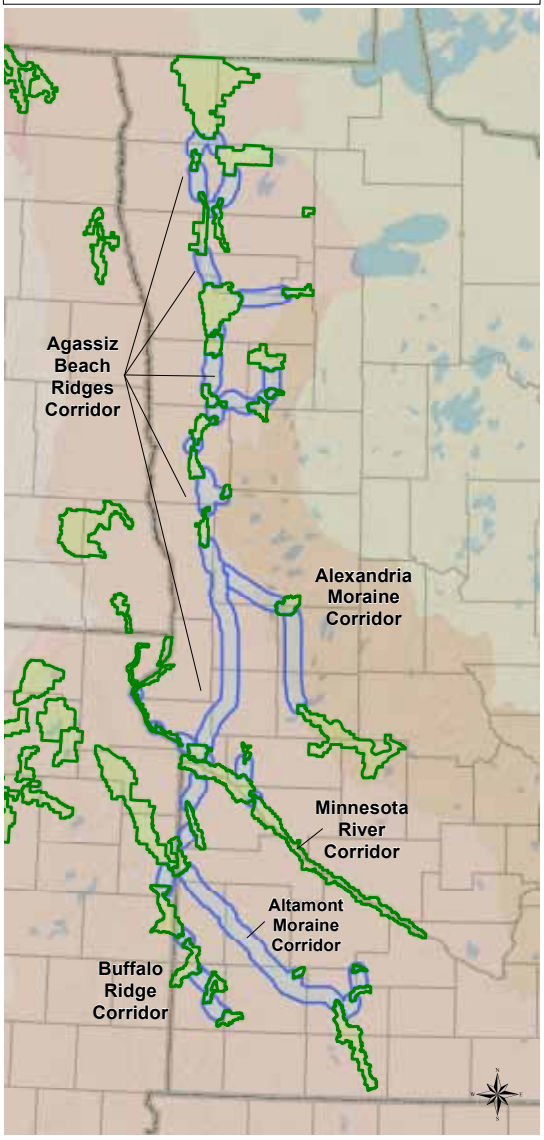


Although river and stream corridors allow movement through agricultural landscapes for some grassland species, riparian areas tend to be wooded and unsuitable for many prairie-dependent organisms. For prairie organisms in Minnesota, there are five potential major natural dispersal corridors. These five corridors are based on geologic features (Hobbs & Goebel, 1982) that have high concentrations of native prairie: the Lake Agassiz Beach Ridges, the Alexandria Moraine, the Minnesota River, Buffalo Ridge (Bemis moraine or Inner Prairie Coteau), and the Altamont Moraine (slopes of the Outer Prairie

Coteau). The Minnesota River corridor was defined as a prairie core area and will be treated in that category although it functions as a dispersal corridor as well.

The Habitat and Population Evaluation Team (HAPET) of the US Fish and Wildlife Service in Fergus Falls, MN conducted a habitat suitability analysis using ArcGIS to help identify the pathways for a set of corridors for six species of waterfowl, four species of marsh birds, eight species of grassland passerine birds, eight species of shorebirds, and two game birds (see Appendix 3 for detailed description). Together these species are good conservation umbrella species. Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that comprise their ecological community. Four corridors were evaluated using the Aspen Parklands, Lac qui Parle, Glacial Lakes, Chanarambie Creek, and Des Moines River Valley core areas as endpoints for corridors. Map 5 shows the result of this analysis where the quality of habitat for these species based on GIS models is weighted against the difficulty of establishing connectivity. The final corridors were extended three miles on either side of the centerline creating corridors six miles in width totaling 1,629,976 acres (Map 6).

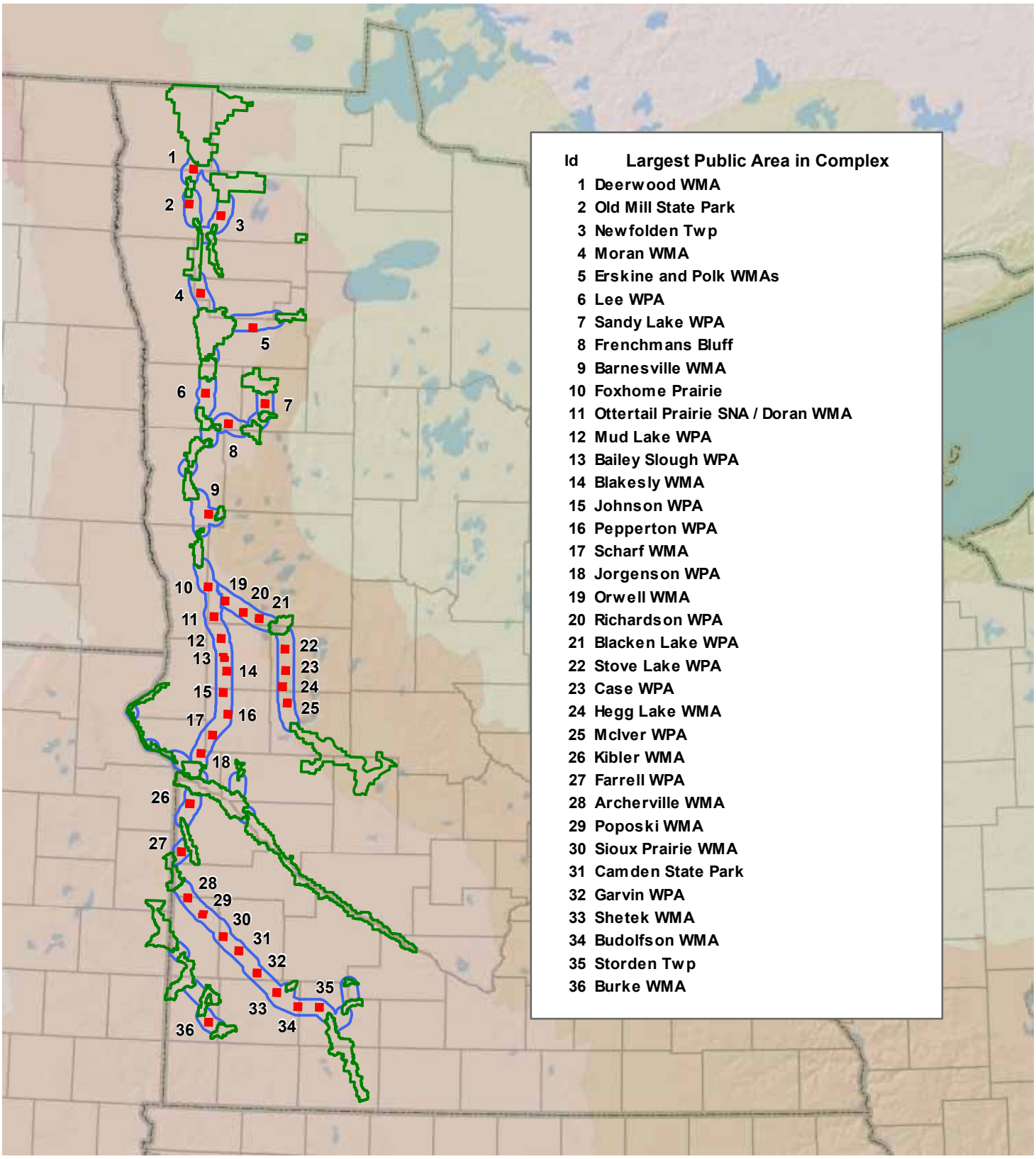
Map 6. Prairie Corridors



For many bird and insect species and more mobile mammals there is no need to provide continuous grassland habitat as long as there are suitable habitat patches within the dispersal range of the species. This concept led to the recommendation that within the major dispersal corridors at least 10% of each square mile section be protected in permanent grassland or wetland habitat. In addition, larger "stepping stone" grassland/wetland complexes (corridor complexes) containing at least 2,000 grassland acres should be established every six miles along the corridors.

In order to estimate the amount of protection and restoration needed within corridors, it is necessary to tentatively identify where the "stepping stone" corridor complexes could most easily be established based on current landcover and land ownership. These complexes were defined as areas of nine square miles (nine sections of land in a square three miles on a side) each equaling approximately 5,760 acres. As recommended in Minnesota's Duck Plan, the goal for these complexes would be to reach 40% grassland, 20% wetland, and 40% other landuses, with half of the grasslands being permanently protected. A set of 36

Map 7. Potential Corridor Complexes



Potential Corridor Complexes

Prairie Core Areas

Prairie Corridors

40 20 0 40 Miles

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Prairie Plan - Core, Corridor & Complex - MN - Overview - LP.mxd
Map created by: RCJ, TNC in MN/ND/SD, 2010/9/25

N W E S

Table 4. Habitat and Protection in Corridor Complexes (Acres)

Complex Name	Native Prairie (NP)	Other Grassland	Grassland Habitat Shortfall	Wetland	Wetland Habitat Shortfall	Pro-tected NP	Protected Other Grassland	Grassland Protection Shortfall	Grassland in CRP	Pro-tected Wetland	Wetland Protection Shortfall
Archerville WMA	241	2,932	0	172	999	98	506	424	985	69	517
Bailey Slough WPA	0	453	1,867	480	680	0	263	897	34	352	228
Barnesville WMA	370	1,443	546	1,770	0	194	394	416	296	882	0
Blacken Lake WPA	0	492	1,815	710	443	0	166	987	11	102	475
Blakesly WMA	0	640	1,659	858	291	0	271	879	226	249	326
Budolfson WMA	16	502	1,820	408	761	0	280	872	38	225	359
Burke WMA	34	782	1,494	244	911	5	30	1,091	1	75	502
Camden State Park	339	2,498	0	257	918	231	1,470	0	342	93	494
Case WPA	0	1,416	887	822	329	0	330	821	87	218	358
Deerwood WMA	151	2,195	0	1,162	0	10	452	540	448	124	448
Erskine WMA	0	2,685	0	1,446	0	0	1,086	73	872	1,153	0
Farrell WPA	109	2,538	0	597	580	68	724	344	552	362	226
Foxhome Prairie	518	357	1,438	197	959	513	51	587	0	19	559
Frenchmans Bluff	190	1,734	392	212	946	37	11	957	136	0	579
Garvin WPA	172	1,432	709	362	794	37	118	866	353	20	558
Hegg Lake WMA	20	1,192	1,088	1,000	150	12	423	706	239	330	245
Johnson WPA	0	694	1,617	701	454	0	393	763	38	237	341
Jorgenson WPA	0	373	1,904	741	398	0	264	875	27	285	284
Kibler WMA	83	985	1,419	498	745	26	390	771	112	268	354
Lee WPA	152	1,102	1,071	1,210	0	12	41	969	583	136	445
McIver WPA	26	794	1,513	716	450	26	81	1,060	2	154	429
Moran WMA	0	2,126	204	468	697	0	424	741	283	202	381
Mud Lake WPA	0	706	1,597	284	868	0	372	779	256	204	372
Newfolden Twp	0	3,105	0	488	681	0	22	1,147	1,860	18	567
Old Mill State Park	2	2,620	0	296	862	0	338	819	1,680	51	528
Orwell WMA	0	655	1,554	488	617	0	4	1,100	0	17	535
Ottertail SNA	332	951	1,022	417	735	311	585	235	88	326	250
Pepperton WPA	0	670	1,642	899	257	0	503	653	19	461	117
Poposki WMA	453	1,005	658	152	906	66	74	530	234	45	484
Richardson WPA	9	698	1,564	1,008	127	9	485	641	49	609	0
Sandy Lake WPA	0	231	2,079	626	529	0	91	1,065	0	51	526
Scharf WMA	0	639	1,644	594	547	0	229	913	24	208	362
Shetek WMA	58	891	1,379	514	649	57	396	710	138	287	295
Sioux Prairie WMA	575	1,539	190	268	884	246	517	60	45	154	422
Storden Twp	336	990	977	246	906	75	101	715	225	35	541
Stove Lake WPA	0	633	1,665	785	364	0	190	959	1	285	290
TOTAL	**4,185**	**44,698**	**37,413**	**22,098**	**20,439**	**2,035**	**12,076**	**25,967**	**10,284**	**8,306**	**13,397**

nine-square mile complexes totaling 207,965 acres was needed within the corridors to maintain a rough distance of six miles between complexes. The specific locations were chosen to maximize the amount of native prairie, grassland, and protected lands in complexes (Map 7, Table 4). The specific complexes were chosen to illustrate the amount of protection and restoration that will be needed, but it is likely a different set could be chosen by local conservation professionals that would be equally or more valid.

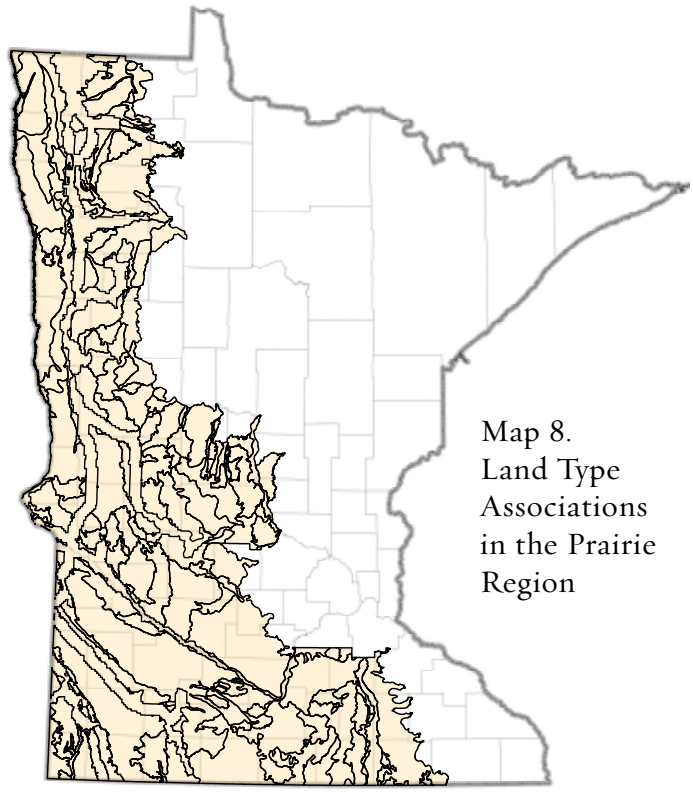
Outside corridor complexes, other land use in each corridor must be analyzed on a section-by-section basis to ensure that at least 10% of each legal section is dedicated to conservation actions. There are 2,391 sections with more than half their area within the corridors but outside the complexes. Thirty-seven of these sections have no native prairie, grassland, or wetland and 853 have fewer than 64 acres. To reach the 10% goal in each section (about 640 acres), an additional 26,271 acres of restored grasslands and wetlands are needed even though there are 357,868 acres of wetlands and grasslands total. To reach the goal of having at least 10% of each section in protected conservation lands an additional 115,118 acres of non-native prairie grasslands and wetlands will need to be acquired, placed under conservation easement, or enrolled or continued in a long-term conservation program.

Table 5. Corridor Section Analysis

Acres in Corridors minus complexes	1,412,628
10% Perennial Goal with 64 acres per section	141,263
Existing Native Prairie	8,643
Existing Other Grassland (excludes NP)	239,562
Existing Wetland (excludes NP)	109,663
Acres Existing NP, other Grassland, and Wetlands	357,868
Habitat Shortfall of Grassland and Wetland below 10% Goal	26,271
Acres Native Prairie in Permanent Protection	2,704
Protection Shortfall of Native Prairie	5,939
Acres Other Grassland in Permanent Protection	22,497
Acres Other Grassland in 10-15 Year Contract	75,122
Acres Wetland in Permanent Protection	18,297
Acres Wetland in 10-15 Year Contract	8,036
Acres NP, Grassland, Wetland in Permanent Protection	43,499
Protection Shortfall of Grassland, and Wetland in addition to NP to reach 10% Goal. Existing CRP is not included in current protection.	115,118

Local Conservation within the Agricultural Matrix

Overall, there are 24,904,015 acres of land and water within the Prairie Region of Minnesota. If the 1,582,280 acres found within prairie core areas and the 1,629,976 acres located in dispersal corridors are subtracted, the 21.7 million acres that are left form the heart of Minnesota's agricultural economy. Low lying areas may still be lakes or wetlands but most of the uplands are used for agricultural purposes. Sixty years ago, much of this land was a diverse mix of row crops, small grains, fallow fields, hedgerows along fence lines, and pastures. Now many of the fencerows are gone, corn and soybean fields dominate, wildlife populations have declined, and water quality in lakes and streams has suffered. A guiding question is "how do we complement the intensive agriculture in this area to make the countryside more wildlife friendly and improve water quality while still retaining the economic vitality of the region?"



Map 8. Land Type Associations in the Prairie Region

This plan's proposed answer is a combination of strategic conservation efforts: one focusing on grassland/wetland complexes of up to several thousand acres and the other a more even and comprehensive distribution of small conservation projects that include ditch and stream grassland buffers, grass waterways, and small restored wetlands. To ensure conservation representation in all parts of the state, a minimum of 10% of each Land Type Association (LTA) outside the core areas and corridors should be set aside for soil, water, and wildlife conservation purposes. Landtype associations are units within U.S. Forest Service and Minnesota DNR Ecological Classification System subsections defined by areas of land with similar characteristics such as glacial landform, depth to bedrock, bedrock type, topographic roughness, pre-European settlement vegetation, and surface water features (lakes, streams and wetlands) or combinations of the above occurring in repeating patterns. LTAs were delineated at a scale of 1:100,000. The size of the LTAs in the Prairie Region of Minnesota ranges from 10,000 to 2,000,000 acres (Map 8).

The justification for maintaining at least 10% of each LTA in perennial grassland, wetland or other appropriate native cover is based on recent scientific studies that suggest only 10% of a

small watershed needs to be in perennial prairie strips to reduce sediment loss by 90-95% (Jarchow & Liebman, 2010). Furthermore, "native plant species richness was more than 400 percent greater in watersheds with 10 to 20 percent of the area planted to native prairie species than in watersheds occupied entirely by crops" (Liebman et al., In press). Ten percent is also the goal established by the Land Stewardship Project for the Chippewa 10% Project to "meaningfully improve the safety of the water, reduce flood potential, restore wildlife habitat, and stimulate a thriving local and regional foods economy" (Ness, 2010). It is essential, however, to conserve the right 10%. Projects must be located strategically to achieve the desired impact. The 10% figure should also be viewed as a starting point. Much more research is needed to determine what percentage of perennial cover is needed in any specific watershed to achieve the desired environmental results.

Table 6. Matrix Analysis (Area Outside Core and Corridors)

Acres In Matrix (Total LTA Acres minus Cores, Corridors, Complexes)	21,698,076
10% Habitat Goal	2,169,808
Existing Native Prairie (NP) in Matrix	37,933
Existing Other Grassland in Matrix (excludes NP)	2,419,204
Existing Wetlands in Matrix (excludes NP)	1,847,146
Total Existing NP, Grassland, Wetlands in Matrix	4,304,283
Habitat Shortfall in NP, Grassland, and Wetlands from 10% Goal (restoration)	250,952
Native Prairie in Matrix in Permanent Protection	14,177
Native Prairie in Matrix Protection Shortfall	23,756
Other Grassland in Matrix in Permanent Protection	203,860
Other Grassland in Matrix in CRP	411,833
Wetland in Matrix in Permanent Protection	290,008
Wetland in Matrix in CRP	65,426
Total NP, Grassland, and Wetland in Permanent Protection	508,044
Protected Shortfall if only Permanent Protected Acres of NP, Grassland, and Wetland are counted toward 10% Goal	1,768,971
Protected Shortfall in Grassland and Wetlands assuming all NP will be protected	1,745,214
Total NP, Grassland, and Wetland in CRP during 2007	477,258
Total Protected Shortfall of combined Permanent Protection and CRP	1,336,829

Within the Prairie Region there are 104 LTAs covering about 21.7 million acres once the area found within core areas, corridors, and corridor complexes are removed. There are 4.3 million acres of native prairies, grassland, and wetland within this area but only about 2.2 million acres are needed to reach the 10% goal. However, our goal is to reach at least 10% of each LTA in grassland, wetland or other appropriate perennial cover and 24 LTAs do not meet this standard. The habitat shortfall and restoration goal in these 24 LTAs totals 250,952 acres. The 10% goal includes not only the presence of grasslands and wetlands but also that the acres meeting the goal are protected either permanently through fee title or conservation easement or through 10-15 year contracts. The protection shortfall totals 1.8 million acres if only permanently protected acres are counted, however, as of 2007, 477,258 of these grassland and wetland acres were enrolled in the Conservation Reserve Program. This means that if the 2007 CRP totals are maintained 1.34 million additional acres will need to be protected in some manner (Table 6).

This plan does not attempt to identify particular places where conservation activities should be located to meet the 10% goal. These choices will be made over time and depend on local circumstances, opportunities, and landowner agreement. However, suggested priorities for certain types of projects can be made. The projects chosen for local conservation efforts should target those areas with the highest probability of building wetland and grassland habitat complexes over time, protecting rare communities such as forests and savannas, and achieving the greatest improvement in water quality and fisheries habitat. Much of this work will be done by Soil and Water Conservation Districts, Watershed Districts, and other local units of government working with state and federal agencies. Taking advantage of funding from federal farm programs and easement programs such as RIM/WRP, CREP, and GRP (see Table 8) and state funds such as Clean Water Legacy, priorities should be set using criteria such as:

1. Proximity to native prairie
2. Areas of High or Outstanding Biodiversity Significance (MCBS)
3. Bordering public conservation land
4. Containing restorable wetlands
5. Priority basins or basins with portfolio lakes
6. Proximity to high priority shallow lakes
7. Adjacent to high priority warm-water streams
8. Adjacent to other watercourse or water body
9. Within a Grassland Bird Conservation Area (HAPET) or Important Bird Area (Audubon)
10. Highly erodible soils
11. Known populations of Species of Greatest Conservation Need

A great deal of additional work and planning is needed to integrate all of these criteria and make spatially explicit recommendations. This work will be especially challenging because improvement in water quality and other ecosystem functions are not likely to be evident until some yet undefined threshold of land conservation is achieved over large areas.

Table 7. Summary of Existing and Protected Acres (fee and easement) within the Prairie Region.

	Prairie Core Areas	Corridor Complexes	General Corridor	Agricultural Matrix	TOTAL
Total Area (acres)	**1,582,008**	**207,965**	**1,412,628**	**21,698,076**	**24,900,677**
Existing Native Prairie (NP)	166,396	4,185	8,643	37,933	**217,157**
NP Easement	5,069	214	415	1,903	**7,601**
NP Fee	88,219	1,821	2,289	12,275	**104,604**
NP (Fee + Easement)	93,288	2,035	2,704	14,177	**112,205**
Existing Grassland	437,597	44,698	239,562	2,419,204	**3,141,060**
Grassland Easement	13,134	1,133	4,053	36,854	**55,173**
Grassland Fee	94,060	10,943	18,445	167,006	**290,454**
Grassland (Fee + Easement)	107,194	12,076	22,497	203,860	**345,627**
Existing Wetland	259,694	22,098	109,663	1,847,146	**2,238,601**
Wetland Easement	7,152	494	2,283	26,340	**36,269**
Wetland Fee	118,012	7,812	16,014	263,668	**405,506**
Wetland (Fee + Easement)	125,164	8,306	18,297	290,008	**441,775**
TOTAL EASEMENT	**25,355**	**1,841**	**6,750**	**65,097**	**99,043**
TOTAL FEE	**300,291**	**20,576**	**36,749**	**442,948**	**800,564**
TOTAL PROTECTION	**325,646**	**22,417**	**43,499**	**508,045**	**899,607**

Goals and Objectives (Acres and Costs)

A number of state, federal, and private programs will play important roles in implementing this plan. The activities each program will engage in are detailed in Table 8. The acreage goals listed below are summarized in Table 9.

Protection

As defined earlier, protection is the acquisition of land rights that will influence future land use either permanently or temporarily. The most common forms are the acquisition of fee title (outright purchase of all rights) or the purchase of a conservation easement that prevents certain activities on the land in the future. Prairie and grassland easements are permanent and typically prevent the current owner from plowing, developing, or subdividing the land. USFWS wetland easements are similar although they may allow tillage as long as the wetland basin is not filled, leveled, or drained. Shoreline easements typically restrict development and may require a riparian buffer.

All of the easements discussed in this plan are assumed to be permanent. Although this plan will make recommendations on how much land should be acquired, the actual proportion of land that is protected via easement versus outright purchase from willing sellers will be determined on a parcel by parcel basis depending on such factors as landowner preference, relative cost, available funding, and what the anticipated future use of the land will be.

Protecting Native Prairie

A key goal of this plan is to protect all remaining native prairie in Minnesota that lacks legal protection. Within the Prairie Region of Minnesota 217,157 acres of native prairie have been identified by the Minnesota County Biological Survey as of May 2011. About 166,396 acres of this native prairie are within the identified prairie core areas and 73,108 of these acres lack any form of legal protection. Within the five prairie corridors there are 4,185 acres of native prairie within the habitat complexes and another 8,643 acres in the corridors outside the complexes. Of these, 2,150 acres in the complexes and 5,939 acres outside the complexes lack legal protection. In the broader Agricultural Matrix of the Prairie Region there are 37,933 acres of native prairie of which 23,756 acres need legal protection. Together, the unprotected native prairie within core areas, corridors, and the agricultural matrix within the Prairie Region totals 104,594 acres.

The experience of Minnesota's Native Prairie Bank Program has been that landowners have chosen fee title acquisition in 30% of the transactions to protect native prairie and conservation easements in 70%. Assuming this same split in the future, 21,932 acres would be acquired and 51,176 acres protected via conservation easement.

The fair market value of native prairie in Minnesota in 2010 has been estimated at $2,700 per acre by the Lessard-Sams Outdoor Heritage Council (Management Analysis and Development, 2009). Using this value the cost of acquiring 31,486 acres of native prairie would be $85,012,740. Minnesota's Native Prairie Bank Program pays 58.5% of the average

assessed valuation of cropland in the township in which the prairie is located. LSOHC estimates the value of cropland to be $4,000 per acre but that is likely to be an overestimate because areas near existing prairies tend to be lower quality cropland. A second factor affecting the cost of conservation easements are the rights retained by the landowner. Native Prairie Bank easements prohibit grazing or haying unless the owner retains those rights and receives a lower payment. With those caveats, the cost of protecting 73,468 acres at 58.5% of $4,000 per acre would be an estimated $171,914,652.

Protecting Grasslands and Wetlands

In addition to native prairie, other types of grasslands and wetlands will be needed to reach the desired levels set for perennial natural habitat. Establishing goals for the protection of these grasslands and wetlands was a two-step process. First, preliminary acreage goals based on protection shortfalls were set without considering how many acres will be protected during the restoration process to meet the habitat shortfall. Second, after restoration needs were established, the acres protected prior to restoration were subtracted from the preliminary protection goals to establish the final protection goals.

Within the core areas, there are 437,597 acres of existing non-prairie grassland and 259,694 acres of wetlands. The Working Group's goal was to have 40% of the core areas in grasslands and prairies with half of those acres in permanent protection. Since all the native prairie is to be protected, whatever shortfall exists for the combined prairie and grasslands will be made up by protecting non-native prairie grasslands. To reach that goal in the core areas, fee acquisition or conservation easements are needed on 88,185 acres of non-native prairie grasslands. The goal for wetlands is 20% of the core areas with half in permanent protection. To reach the wetland protection goal in the core areas, 60,837 acres of wetland will need to be protected. If the newly protected grassland and wetland acres are protected using a 40:60 acquisition:easement split as recommended in Minnesota's Duck plan, 35,274 acres of grassland and 24,335 acres of wetland (59,609 total) will need to be purchased in fee from willing sellers and 54,994 acres of grassland and 36,502 acres of wetland (89,413 total) will be placed under a conservation easement within the core areas. With half the grassland and wetlands needed to reach the core area habitat goals protected permanently, that leaves 149,022 total acres of grasslands and wetlands that will be in private ownership either under voluntary conservation management or 10-15 year conservation contracts (e.g. CRP).

Based on 2001 landcover data, the corridors contain 416,021 acres of non-native prairie grassland and wetland (44,698 acres of grassland in corridor complexes and 239,562 in the general corridor plus 22,098 acres of wetlands in the corridor complexes and 109,663 in the general corridor). Only 266,042 acres are needed to reach the 10% natural landcover in the general corridors (141,263 acres) and the 60% grassland and wetlands goal within the 36 corridor habitat complexes (124,779 acres). However, the 60% goal in each habitat complex (40% of each complex in grassland with half permanently protected and 20% of each complex in wetland with half permanently protected) will require the acquisition of fee or conservation easement on 25,967 acres of non-native prairie grassland and 13,397

acres of wetlands. Assuming the same 40:60 acquisition:easement split used in the core areas, this translates to the fee purchase of 10,387 acres of grassland and 5,359 acres of wetlands (15,745 acres total) and conservation easements on 15,802 acres of grassland and 8,038 acres of wetlands (23,618 acres total) in the corridor complexes. The habitat goals require that another 39,364 acres of grassland and wetlands either be enrolled in 10-15 year contracts or be maintained in voluntary conservation management.

In the rest of the corridors, there are only about 43,499 acres of land currently protected in fee or by conservation easement leaving 119,607 acres yet to be protected to reach the 10% goal of each legal section in permanently protected perennial cover. Assuming all native prairie will be protected, an additional 115,118 acres of grasslands and wetlands needs to be protected. Using a split that emphasizes farm and conservation program contracts and voluntary conservation management where 10% is fee title, 20% is easement, and 70% is contract or voluntary conservation management, this translates to 11,512 acres of fee acquisition, 23,024 acres of easement, and 80,583 acres of 10-15 year contract or voluntary conservation management.

The protection goal for the agricultural matrix was 10% of each Land Type Association. Although 508,045 acres of native prairie (14,177), grassland (203,860), and wetland (290,008) are currently protected via easement or public ownership within this area, an additional 1,768,971 acres needs protection to reach the 10% level of each LTA. Assuming all native prairies are purchased or placed under conservation easement, that leaves 1,745,214 acres of grassland and wetlands still to be protected in some form. These figures do not include lands that are currently enrolled in CRP and other temporary protection programs. Although the split between purchase, easement, and contract is flexible, if we assume a 10:20:70 ratio, 174,521 acres would need to be purchased, 349,043 placed under conservation easement, and 1,221,650 enrolled in conservation contracts or placed under voluntary conservation management.

For the purpose of this plan, we are assuming that the value of existing grassland and wetlands is the same as native prairie ($2,700 per acre) but that a conservation easement on existing grassland or wetland would be $1,200 per acre (based on the estimated 2010 cost of grassland easements paid by the USFWS). These values include only the land cost and not the costs associated with real estate acquisitions or the long term monitoring of conservation easements.

Restoration

In order to provide ample habitat to maintain viable populations of prairie landscape species and processes, existing prairies and grasslands will need to be supplemented with reconstructed grasslands and wetlands. Within this plan, the restoration of grassland and wetlands are an equal priority with protecting remaining native prairie and prairie systems.

If state funds are to be used for restoration, it should take place only on public lands or on private lands subject to a conservation easement, deed restriction or contract. For the purpose of this plan, the same ratio of 10:20:70 is used to allocate restoration following fee acquisition, easement, and conservation contract.

Within core areas, 97,778 acres of new grassland and 83,169 acres of restored wetlands (180,947 total) will be needed to reach a minimal goal of 40% grasslands and 20% wetlands in each core area (Table 2). These figures are likely to be substantially underestimated because even in core areas that currently exceed the 40% grassland and 20% wetland minimums there will be need to buffer and connect native prairie to increase their viability.

For the Corridors there is a shortfall of 37,413 acres of grasslands and 20,439 acres of wetlands (57,852 total) to meet the 40% grassland and 20% wetland goal in the complexes and 26,271 combined acres of wetlands and grasslands to reach the 10% goal in each section for the remaining portion of the corridor. In total 84,123 acres of restored wetlands and grasslands are required to meet the corridor goals.

Within the Agricultural Matrix an additional 250,952 acres of new wetlands, grasslands, or other appropriate native vegetation are needed to meet the goal that 10% of each Landtype Association outside of cores and corridors be in natural cover.

The cost of restoration varies with the cost of acquiring the rights to conduct restoration and then carrying out the restoration work. Since most restoration work will take place on former or existing cropland we assume a value of $4,000 per acre for land based on the LSOHC value of cropland, $3,000 per acre for a conservation easement based on 2008-2010 RIM-WRP Partnership sign-ups, or $734 per acre for the present value of a conservation contract paying $47/per acre/year (2010 CRP payment rate) for 25 years with a 4% discount rate. A split of 10:20:70 for acquisition:easement:conservation contract is assumed to calculate the percentage of restoration work done under different types of protection. A cost of $500 per acre is used for restoration of either grassland or wetlands per LSOHC estimates (Management Analysis and Development, 2009).

Enhancement

To maintain the vitality of grassland systems, they must be ecologically disturbed (or managed) at regular intervals. The major types of disturbance activities called for in this plan are prescribed fire, conservation grazing, and mowing (includes haying). The disturbance events need to occur on average every four years.

Native Prairies

The primary management technique for prairies in conservation ownership has been prescribed fire or mowing. There are 104,604 acres of native prairie in conservation ownership in the Prairie Region of Minnesota. Due to a lack of resources there have often been times when many prairies have not received timely management actions. This plan calls for an annual goal of burning or mowing one quarter of all conservation-owned native prairies.

This amounts to 26,151 acres annually. This total will grow as additional prairies are publically protected. Local resource managers will decide which prairies are more appropriately burned or mowed.

For native prairie on private lands, 7,601 acres are under conservation easement. Some easements restrict certain types of management activity as, for example, livestock grazing of any type. All native prairie lands with conservation easements should have prescribed fire or mowing as part of their management at least every four years. These lands add another 1,900 acres that should receive the same management as public prairie lands for a total of 28,051 acres annually. The remaining 104,952 acres of native prairie on private land lack any form of legal protection. Much of this unprotected land is currently being grazed but it is often continuous or long-rotation in nature. The goal of this plan is to encourage private landowners by offering technical and/or financial assistance to incorporate prescribed fire into their management regime and to convert their grazing cycle to short rotations. An aggressive goal would be to implement disturbance management (fire, mowing, or high-intensity short-term grazing followed by rest) at four-year intervals on at least half of the privately owned prairies with no legal protection. The annual acreage affected by the preceding goal would be 13,119 acres

The cost of enhancement activities depends greatly on the specific needs of a particular parcel. The Nature Conservancy has calculated that a rough cost estimate for prescribed fire is about $20 per acre. The cost for prescribed burning can vary greatly depending on size, complexity, risks, and other variables. Prescribed burning costs for grassland fuel types can range from $20-$120 per acre in Minnesota. The net cost of grazing management or haying will also vary but for the purpose of this plan, the same per acre cost is used. Based on these estimates, the cost of managing native prairies is $14.0 million per year on currently protected lands, but this number will grow as additional prairie lands are protected. The cost of management on currently private lands would be $6.6 million.

Grasslands and Wetlands

Just as native prairies are helped with disturbance management, other grasslands and wetlands can benefit as well. There are 3,141,060 acres of non-native prairie grasslands in the Prairie Region of Minnesota (Table 7) with 345,627 acres in permanent protection (public ownership or conservation easement). For wetlands the values are 2,238,610 acres total with 441,775 acres protected.

For protected grasslands and wetlands the same four year disturbance cycle and management cost estimate established by The Nature Conservancy ($20 per acre per year) was used to calculate total annual acreage goals and total 25 year cost. Cost estimates for both grassland and wetland management need further verification.

The cost of managing unprotected grasslands and wetlands is difficult to estimate. For sake of consistency, the same methods for unprotected grasslands and wetlands were used that were employed for unprotected native prairies. We assume that half of the unprotected grasslands and wetlands will be managed once every four years. Many of the unprotected

grasslands are currently enrolled in CRP and this status will influence the allowable management options. Except in emergency situations CRP cannot be grazed or hayed and there may be restrictions on prescribed fire as well.

Funding Needs for Prairie Landscape Conservation

Based on the calculations of the previous sections (summarized in Table 9), the overall cost of prairie landscape conservation in Minnesota may well reach $3.6 billion over 25 years. Although this is a daunting figure it may be more feasible than it appears at first consideration. The first mitigating factor is that actual cost to purchase fee title or conservation easements from willing sellers may be less than assumed. Land within prairie landscapes is often less productive due to its rocky, steep, sandy, or wet nature than average farm land in the same vicinity. Generally the value of crop ground is correlated to its productivity. There is also a possibility of partial donations in some transactions. The second mitigating factor is that overall cost of conservation activities will be borne by many different entities. If grass-based agriculture becomes more prevalent, a substantial portion of prairie landscape restoration and management activities will be paid by private landowners. The role of public agencies should be to catalyze these private activities. The publicly-funded activities can be paid for by a number of different agencies and programs. Federal farm programs already pay for temporary conservation activities and many long term easements. Farm programs could be targeted more towards activities that would further this prairie landscape plan. If a greater proportion of farm subsidies went to conservation and ecosystem services payments, they would go a long ways towards creating functioning prairie systems in Minnesota.

One goal of this plan was to roughly estimate what could be used from the new Clean Water, Land, and Legacy Amendment to complete prairie conservation activities in the Prairie Region of Minnesota. The overall cost of this plan was calculated to be $3.6 billion. Federal farm programs such as CRP could largely pay the $829.0 million costs of temporary protection (under 10-15 year contracts) especially if CRP was more targeted to meet the goals of this plan. Other farm programs plus private landowners are predicted to cover $445.7 million of restoration costs on private unprotected lands. Finally, half of the costs ($146.8 million) for enhancement on private unprotected lands should be covered by private landowners.

The remaining total of $2.1 billion is the amount that would be needed from state, federal and private conservation sources. Since the Clean Water, Land and Legacy Amendment approximately doubled the amount of funding for conservation purposes in Minnesota, the amount that might be allocated from the Outdoor Heritage and Clean Water Funds could approach $1.1 billion dollars.

Table 8. Prairie and Wetland Conservation Programs

	Core	Corridor	Agricultural Matrix
Protect Native Prairie			
Fee Acquisition	WMA, SNA, WPA, SP, TNC, NWR	WMA, SNA, WPA, SP, TNC	WMA, SNA, SP, WPA
Easement	NPB, GEP, GRP	NPB, GEP, GRP	NPB, GEP, GRP
Protect Other Grassland and Wetlands			
Fee Acquisition	WMA, WPA, NWR, SP	WMA, SP, WPA	WMA, SP, WPA
Easement	WPA, GRP, GEP	WPA, GRP, GEP	WPA, GRP, GEP
Restore Grassland and Wetlands			
After Acquisition	TNC, WMA, WPA, SP, NWR	WMA, SP, WPA, TNC	WMA, WPA
After Easement	RIM, WRP, GRP	RIM, WRP, GRP	RIM, WRP, CREP, GRP
Under 10-15 Year Contract	CRP, CCRP, GRP	CRP, CCRP, GRP	CRP, CCRP, GRP
Enhancement on Public Lands			
Prescribed Fire	WMA, SNA, SP, WPA, TNC, NWR	WMA, SNA, SP, WPA, TNC	WMA, SNA, SP, WPA
Grazing Management	WMA, SNA, WPA, TNC	WMA, SNA, WPA, TNC	WMA, SNA, WPA, TNC
Invasive Species Control	WMA, SNA, WPA, TNC, SP	WMA, SNA, WPA, TNC	WMA, SNA, WPA, TNC
Enhancement on Private Lands			
Prescribed Fire	TNC, WHIP, LIP, HE, PFW, EQIP, NPB	WHIP, LIP, HE, PFW, EQIP, NPB	WHIP, LIP, HE, PFW, EQIP, NPB
Grazing Management	TNC, EQIP, LIP, HE, PFW, NPB	EQIP, LIP, HE, PFW, NPB	EQIP, LIP, HE, PFW, NPB
Invasive Species Control	TNC, WHIP, EQIP, LIP, HE, PFW, NPB	WHIP, EQIP, LIP, HE, PFW, NPB	WHIP, EQIP, LIP, HE, PFW, NPB

WMA = MN DNR Wildlife Management Area

SNA = MN DNR Scientific and Natural Area

WPA = USFWS Waterfowl Production Area

TNC = The Nature Conservancy Preserve, Stewardship Program

SP = MN DNR State Park

NPB = MN DNR Native Prairie Bank

GRP = NRCS Grassland Reserve Program

GEP = USFWS Grassland Easement Program

PFW = USFWS Partners for Fish and Wildlife Program

NWR=USFWS National Wildlife Refuges

RIM = MN BWSR Reinvest in Minnesota Reserve Easements

WRP = NRCS Wetlands Reserve Program

CRP = FSA Conservation Reserve Program

CCRP = FSA Continuous Conservation Reserve Program

WHIP = NRCS Wildlife Habitat Incentive Program

EQIP = NRCS Environmental Quality Incentives Program

HE = MN DNR Heritage Enhancement Projects

LIP = NRCS Landowner Incentive Program

Table 9. Prairie, Grassland, and Wetland Conservation Goals — Acres and Cost

	Core	Corridor Complex	General Corridor	Agricultural Matrix	Total	Cost
Native Prairie Protection Goals						
Fee Acquisition ($2,700 / acre)	21,932	645	1,782	7,127	31,486	$85,012,740
Easement ($2,340 / acre)	51,176	1,506	4,157	16,629	73,468	$171,914,652
Total	73,108	2,151	5,939	23,756	104,954	$256,927,392
Preliminary Protection Goals for Other Grassland and Wetlands Based on Protection Shortfalls						
Fee Acquisition	59,609	15,745	11,512	174,521	261,387	
Easement	89,413	23,618	23,024	349,043	485,097	
Contract and Voluntary Conservation Management	149,022	39,364	80,583	1,221,650	1,490,618	
Total	298,044	78,727	115,118	1,745,214	2,237,103	
Restoration Goals for Grassland and Wetlands						
After fee acquisition ($4,000 + $500 restoration/acre)	18,095	5,785	2,627	25,095	51,602	$232,209,900
After easement ($3,000 + $500 restoration/acre)	36,189	11,570	5,254	50,190	103,204	$361,215,400
After signing 10-15 year contract ($734* + $500 restoration/acre)	126,663	40,496	18,390	175,666	361,215	$445,739,804
Total	180,947	57,852	26,271	250,952	516,022	1,039,165,104
Final Protection Goals for Other Grassland and Wetlands (Subtracts Land Protected as Part of the Restoration Process)						
Fee Acquisition ($2,700 / acre)	41,514	9,960	8,885	149,426	209,785	$566,419,500
Easement ($1,200 / acre)	53,224	12,048	17,769	298,852	381,893	$458,271,600
Contract and Voluntary Conservation Management ($734*/acre)	22,359	0	62,193	1,045,983	1,129,403	$828,981,802
Total	117,097	22,007	88,847	1,494,262	1,721,081	$1,853,672,902
Annual Goals for Enhancement on Protected Lands - Management Every Four Years (Cost over 25 Years)						
Native Prairie ($20 / acre/ year)	23,322	509	676	3,544	28,051	$14,025,574
Other Grasslands ($20 / acre/ year)	26,799	3,019	5,624	50,965	86,407	$43,203,411
Wetlands ($20 / acre/ year)	31,291	2,077	4,574	72,502	110,444	$55,221,883
Total	81,412	5,604	10,875	127,011	224,902	$112,450,868
Annual Goals for Enhancement on Unprotected Lands - Management Every Four Years on Half the Lands (Cost over 25 Years)						
Native Prairie ($20 / acre/ year)	9,139	269	742	2,970	13,119	$6,559,516
Other Grasslands ($20 / acre/ year)	41,300	4,078	27,133	276,918	349,429	$174,714,574
Wetlands ($20 / acre/ year)	16,816	1,724	11,421	194,642	224,603	$112,301,605
Total	67,255	6,070	39,296	474,530	587,151	$293,575,696
TOTAL	**519,819**	**93,685**	**171,228**	**2,370,511**	**3,154,110**	**$3,555,791,961**

** Present value of an income stream of $47/acre (current CRP payment) for 25 years with a 4% discount rate*

Measures of Success for Prairie Landscape Conservation

This plan is the first attempt to bring all organizations working toward prairie landscape conservation together to devise a common vision and explicit goals with the intent of making more effective use of limited conservation resources. As such, it is important to measure the progress made toward desired outcomes. This plan lays out three primary conservation strategies to advance prairie conservation in the state of Minnesota (Protect, Restore, and Enhance) and one economic strategy (Mulitifunctional Landscapes). These strategies are designed to address the threats to prairie and grassland in the state that have been outlined in this plan (conversion of habitat, invasive species, detrimental grazing practices, woody encroachment, energy development, climate change, and the loss of CRP). The implementation of these strategies will move us closer to restoring functioning grassland landscapes throughout the Prairie Region of Minnesota. However, it is essential that measures of success are clearly articulated so that we can assess the effectiveness of this plan in achieving our goals, better understand the results of management activities, and adapt our strategies as needed.

Three sets of measures are proposed to gauge the progress of conservation activities in achieving our desired outcomes. The first are effectiveness measures, designed to track the collaborations established in the plan and the progress made toward the objectives outlined for each strategy. The second set is designed to evaluate the effectiveness of restoration and management techniques at accomplishing the intended management objectives. This is a critical step in the adaptive management process that will ensure that activities being implemented are achieving success. The last set of measures is designed to evaluate the actual impact on landscape-scale ecological function and the associated animal and plant populations and communities.

Effectiveness Measures for the Partnership:

All measures should be tracked and calculated at regular intervals to gage progress and if possible, should be broken down by core area, corridor, and local conservation.

Partnership Development

1. Official endorsement of the plan and Memorandum of Understanding by all contributing organizations.

2. Amount and percent of prairie/wetland funding or resources from each organization directed toward the agreed upon core, corridor and local conservation sites.

Protect

1. Amount and percent of funds spent to protect prairie/grassland/wetland through fee title or easement.

2. Percent of goal acres of native prairie protected (fee title or easement).

3. Percent of goal acres of grassland and wetland protected (fee title or easement).

Restore

1. Amount and percent of funds spent to restore habitat.
2. Percent of goal acres of prairie successfully restored.
3. Percent of goal acres of grassland and wetland successfully restored.

Enhance

1. Number of adaptive management plans developed and being implemented in the core, corridor and local conservation landscapes.
2. Amount and percent of funds spent to enhance habitat.
3. Acres receiving management/enhancement.

Private Lands/Grass-Based Agriculture

1. Acres of private crop land converted to grass-based agriculture.
2. Number of conservation acres used as Grass Bank acres to leverage better management on private lands, and number of private land acres with enhanced management because of grass banks.

Effectiveness Measures for Restoration and Enhancement Activities:

Management practices need to be evaluated to determine how well they are working. In the adaptive management process, strategies should regularly be re-evaluated following monitoring activities and management practices should be adjusted accordingly. For example, grazing, like many other management practices, has the potential for either enhancing or degrading native prairie habitats. Therefore, grazing variables (stocking rate, timing, duration) must be evaluated and adjusted so that the desired effects are achieved (for example, reduce expansion and invasion of invasive species or increase wildlife habitat suitability) without unintended consequences (promoting invasive species expansion or degrading the condition of native prairie). Similar to traditional management practices, such as burning or grazing, restorations also need to be evaluated to determine whether they are successfully expanding high diversity native plant communities and habitat used by wildlife. Successful management or restoration of a prairie can only be achieved by monitoring and adjusting activities based on outcomes. Furthermore, if ineffective management practices continue, valuable resources and time will be wasted.

The types of measures used to evaluate management and restoration activities will vary depending on the activity, scale and intended outcome. However, all effectiveness measures for management or restoration should be able to clearly answer the questions:

- Did the activity achieve the desired outcome?
- Did the activity result in negative consequences?

When activities are determined to be failing to meet desired outcomes, or if they are having direct negative consequences, then practices should be modified accordingly and monitoring efforts should continue to evaluate their effectiveness and inform necessary changes.

Although universal measures for management and restoration effectiveness would be difficult to establish, the following are basic measures for use with common conservation activities.

Fire and Grazing

1. Stable or increasing native plant diversity, condition and cover
2. Stable or decreasing cover of invasive woody vegetation
3. Supports diverse populations of native birds and insects, including declining prairie-obligate species

Invasive Species Treatments

1. Decrease in diversity and cover of invasive species
2. No loss of native plant species diversity or coverage

Restoration

1. Establishment of a diverse community of native grasses and forbs with geographically appropriate local ecotypes
2. Cover dominated by native plants
3. Colonization of habitat by native fauna

Ecosystem Measures:

The indicators listed below are measures that were chosen to represent many of the different components of functioning landscapes as described earlier in this plan. These indicators were chosen for two reasons: 1) they represent different aspects of the prairie/wetland ecosystem and 2) the data for these indicators are already in existence at a regionwide level (the scale of this plan). Three game bird species, two non-game songbird species, a group of prairie insects, one aquatic species group, two endangered/rare plant species, one diversity measure, and one water quality measure were chosen to represent different aspects of the prairie/wetland system. Although these measures were chosen at the time of writing this plan, the 25-year timeline for the plan allows time for other measures to be developed and implemented. The authors of this plan recognize that certain taxa are missing from this list (particularly mammals), but the hope is that statewide indicators for these important components of prairie/wetland systems will be developed and drawn upon in the future.

1. ***Stable or increasing breeding populations of mallards in the state.***

   Mallards were chosen to represent the functional link between wetlands and uplands within the prairie region of Minnesota because they require upland for nesting habitat and wetlands for brood-rearing habitat.

2. ***Stable or increasing greater prairie-chicken populations in the state.***

   Greater prairie-chickens have been chosen to represent species dependent on upland prairie or grassland habitat because they depend upon numerous successional stages of habitat to complete their life cycle.

Prairie chickens at lek © Dale Rehder

3. ***Stable or increasing ring-necked pheasant harvests in the state.***

   Pheasants have also been chosen to represent upland grassland species because they require the presence of grasslands to persist in a landscape. In areas designated as local conservation or corridors areas, pheasant harvests could be particularly useful for measuring success.

4. ***Stable or increasing western meadowlark populations in Minnesota.***

   Meadowlarks are widely distributed across the Prairie Region of Minnesota and are common in grassland habitats. They were chosen to represent upland songbirds because the Breeding Bird Survey (BBS) data for this species is considered reliable. Although other species of grassland birds, such as the grasshopper sparrow, upland sandpiper and marbled godwit, could also be used as indicators, the BBS data for these species is currently not as reliable. However, if other data sources present themselves in the future, these species could also be good indicators.

5. ***Stable or increasing sedge wren populations in Minnesota.***

   Sedge wrens are widely distributed across the Prairie Region of Minnesota and are common in wet (sedge) meadows. They were chosen to represent mesic prairie songbirds because the BBS data for this species is considered reliable.

6. ***Stable or increasing frog populations.***

   The Minnesota DNR coordinates a citizen science project to track the distribution of frogs and toads in the state. Frogs represent a group of aquatic species that will serve to evaluate the wetland component of this plan.

7. ***Stable or increasing populations of prairie butterfly populations including regal fritillary, Dakota skipper, Poweshiek skipper, Arogos Skipper, and pawnee skipper.***

   Prairie butterflies are good indicators of the impacts of prairie management and the success of prairie species with mid-range dispersal capabilities of moving along corridors between native prairie patches.

8. ***Stable or increasing native prairie orchid populations, specifically the small white lady slipper (Smith, 1993) and the western prairie fringed orchid (U.S. Fish and Wildlife Service, 1996, 2009).***

   These two species were chosen because they are highly correlated with high quality prairie, intact hydrology, and intact below-ground processes (fungal associates). Additionally, Minnesota has the world's largest populations of these species and a large, robust data set available for analysis and evaluation.

9. ***Stable or increasing native plant diversity and condition on remaining native prairie and prairie complexes across the state.***

   Sustaining the native wildlife and plant populations of Minnesota's native prairies depends on effective management to maintain the integrity and diversity of prairie habitats. This task is made more complex by changing environmental conditions and onslaughts of new invasive species. Several ongoing monitoring efforts, such as the multi-agency Grassland Monitoring Collaborative, will provide managers with important information on the consequences of different combinations of management strategies and the condition of native prairie habitats over time.

10. ***Stable or increasing wetland condition and quality as measured by biotic and chemical properties.***

    The Minnesota Pollution Control Agency (MPCA) has established a long-term wetland monitoring program that measures biological, chemical and physical information from a set of representative wetlands in the Prairie Region of Minnesota (since 2002). These data will provide a good baseline and future effectiveness measures for how impacts on wetland condition and quality.

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Appendix 1: Definition of Conservation Terms

For the purpose of this plan we define these terms as follows:

Adaptive management: An iterative process of decision making where decisions are continually evaluated and adjusted as new information emerges.

Conservation grazing: Sustainable, rotational grazing with livestock that achieves conservation goals such as mimicking natural processes in addition to providing sustainable economic returns

Enhancement: The improvement of prairie, grassland, savanna, or aquatic habitat condition through proper management. Common activities will include the increased use of prescribed fire, employing conservation grazing practices, natural water level management, and effective invasive species control.

Functional system: A native ecosystem that is of sufficient size, habitat condition, and landscape composition to maintain natural ecological processes and viable populations of nearly all of the native animals and plants that would naturally be found there.

Grass-based agriculture: Economic activities based on native prairie or other grasslands to produce a sustainable economic return.

Grassland: A plant community dominated by grass or sedge species. Trees are scattered and infrequent. Native prairies are one type of grassland but the opposite extreme of planted single-species grass stands, are also included.

Invasive species control: The use of chemicals, biological control vectors, and mechanical means to reduce the populations of invasive species or to prevent their spread.

Native prairie: An unplowed plant community originating on the site that is dominated by grass and sedge species with a rich mix of broad-leaved herbs and a few low shrub species.

Prairie Region: That portion of Minnesota covered by the Prairie and Forest-Prairie Transition Planning Sections employed by the Lessard-Sams Outdoor Heritage Council. This area is the part of Minnesota that was dominated by prairie and associated plant communities prior to European settlement.

Prescribed fire: A technique using the controlled burning of vegetation to accomplish a number of objectives including: the reduction of unwanted plant species, the alteration of vegetation structure, the removal of potential fire hazards, and the improvement of habitat for cattle grazing or other purposes.

Protection: The legal protection of land for conservation purposes either permanently or temporarily. The most typical activity would be the purchase of land or conservation easement from a willing seller.

Restoration: The planting of degraded habitats including former cropland to the original vegetation type of the site using local ecotypes of native species appropriate to the habitat.

Wetland draw-down: The temporary lowering of water levels in wetlands and shallow lakes to simulate natural drought conditions, reduce invasive fish, and increase water clarity, aquatic plants and invertebrates.

Appendix 2: Highlights from Past Planning in the Prairie Region of Minnesota

WMA Plan (Citizens' Advisory Committee, 2002)
Minnesota's WMA Acquisition Plan for the Next 50 Years calls for acquiring an additional 702,200 acres of land for WMAs broken down into 263,050 acres at existing WMAs and 439,150 acres of new WMAs. Over 73% of the this total is slated for the Prairie Region of the state, including 182,340 acres of inholdings at existing WMAs and 331,818 acres of new Wildlife Management Areas. The goal of the plan in the Prairie Region is to double the pheasant population and to create 40 large grassland complexes of at least 2,000 acres each to maintain prairie dependent species.

Pheasant Plan (Minnesota DNR, Division of Fish and Wildlife, 2005)
The goal of Minnesota's Pheasant plan is to double the state's 1987-2000 pheasant harvest to 750,000 roosters which represents a fall population of 3 million birds. To accomplish this goal, 1.56 million acres of additional grassland habitat is required, most of it within the Prairie Region. On average, one acre of new grassland is needed to increase the pheasant population by one bird in the fall population (up to a maximum of 50% grassland).

Duck Plan (Minnesota Department of Natural Resources, 2006)
The primary objective of the Duck Plan is to restore a breeding population of one million birds that will produce a fall population of 1.4 million ducks from Minnesota. The primary strategy is to restore and protect 2 million additional acres of which 30% should be wetland and 70% grassland. From a 2006 base of about 1.0 million acres of wetland and 1.86 million acres of grassland in the Prairie Region of Minnesota the additional lands needed equal about 580,000 acres of wetland and 1,420,000 acres of grass. Of the lands protected, 60% will be under a permanent or long-term easement and 40% will be owned by a conservation entity.

AMA Plan (Aquatic Management Area Acquisition Planning Committee, 2007)
The focus of the AMA plan is to set acquisition priorities to protect Minnesota's aquatic ecosystems. Two priorities are identified: first, trout streams and second, lakes and warm-water rivers/streams. The vision of this plan includes the acquisition of 1,100 miles of lake and warm-water stream habitat statewide by 2032 of which 35 miles will be in the Northern Prairies and Parklands Section, 65 miles in the Red river Valley Prairies Section, 125 miles in the Minnesota River Prairies Section, and 444 miles in the Deciduous Transition Section (only a small part of the Deciduous Transition Section falls in the Prairie Region of Minnesota).

Minnesota State Wildlife Action Plan (SWAP) (Minnesota DNR, Division of Ecological Resources, 2006)
The SWAP identifies 292 Minnesota species as Species in Greatest Conservation Need (SGCN). This plan discusses the actions needed to stabilize and increase SGCN populations, improve knowledge about SGCNs and enhance people's appreciation and enjoyment of SGCN. Within each ecological subsection of the Prairie Region, the set of SGCNs are highlighted, their key habitats are described and priority conservation actions for management, survey, research, monitoring, and education are identified.

LSOHC Strategic Plan (Management Analysis and Development, 2009)
This plan resulted from a series of meetings with conservation professionals with public input in five regions of Minnesota (including a Prairie Section). The participants set 25 year goals for native prairie (88,000 acres), restored prairie (884,000 acres), surrogate grasslands (500,000 acres), wetlands (178,500 acres), lakeshore (1030 miles), shallow lakes (2,000 acres), and streams and rivers (25,000 shoreline miles). Total cost of all activities over 25 years was estimated to be over $10 billion.

Scientific and Natural Area Plan (Minnesota DNR, Division of Ecological Resources, 2004)
The protection objectives of the SNA Program is to protect through SNA designation up to three occurrences of each plant species, animal species, geological feature, or other special feature and up to five occurrences of each plant community in each landscape region (subsection) where they occur. This approach may be impossible in the southern and western portions of the state where so little natural habitat remains. Protecting every natural site of statewide significance in that portion of the state may be a more realistic goal.

Prairie Pothole Joint Venture Plan (Ringelman, 2005)
The PPJV Plan is comprised of four parts each focusing on a different group of bird species: waterfowl, shorebirds, waterbirds, and landbirds. The foundation of the waterfowl plan is to keep critical wetland and grassland habitats intact by securing 1.4 million wetland acres and 10.4 million grassland acres across the portions of five states covered by the Prairie Pothole Joint Venture. The goals of the shorebird, waterbird, and grassland bird plans are less specific calling for the protection of existing wetlands and native grasslands.

Statewide Conservation and Preservation Plan (Swackhammer, Coleman, & Shardlow, 2008)
The SCPP makes recommendations on strategic planning, habitat, land use, transportation and energy. The habitat recommendations include the protection of critical lands of which high priority examples include native prairie, savanna, old-growth forest, and areas that add to or provide linkages between large, intact ecosystems. A key factor in conservation and preservation of Minnesota's critical habitats is to restore ecoregion-appropriate landscape-scale complexes of habitat centered on concentrations of existing remnant habitats with a broader goal of developing/maintaining conservation corridors between existing and restored habitats.

Fifty year Vision: Conservation for Minnesota's Future (Campaign for Conservation, 2008)
This effort of the Belwin Conservancy and partners describes a conservation vision for 14 conservation regions in Minnesota including five in the Prairie Region. The primary conservation action varies by conservation region: 1) In the Red River Valley it will be the restoration of wetlands and grasslands in the context of coordinated flood management and wildlife corridors, 2) In the Glacial Lake Agassiz Beach Ridges it will focus on protecting large tracts of habitat building upon existing native prairies, 3) In the northern Aspen Parklands it will be maintaining the 90% of the region that is currently in wetlands and grasslands while in the southern portion there should be a 50:50 mix of cropland to grassland/wetland, 4)In the Minnesota River Prairie it will be to ensure that 15% of the region will be native vegetation concentrated as vegetative buffers around rivers, lakes, streams, and surviving wetlands, and 5) In the Prairie Coteau it will be to protect the remaining native prairie and to bring back some of the most important wetlands and restore the health of those that remain.

Windom WMD Comprehensive Conservation Plan (US Fish and Wildlife Service, 2003)

Big Stone WMD Comprehensive Conservation Plan (US Fish and Wildlife Service, 2003)

Morris WMD Comprehensive Conservation Plan (US Fish and Wildlife Service, 2003)

Fergus Falls WMD Comprehensive Conservation Plan (US Fish and Wildlife Service, 2003)

Litchfield WMD Comprehensive Conservation Plan (US Fish and Wildlife Service, 2003)

Detroit Lakes WMD Comprehensive Conservation Plan (US Fish and Wildlife Service, 2003)

These are a series of Wetland Management District plans that cover most of the Prairie Region of Minnesota. Each plan follows the same format and reaches the same general goals to preserve diversity and increase the abundance of waterfowl and other key wildlife species in the Northern Tallgrass Prairie Ecosystem. Other goals include restoring native prairie plant communities, creating functioning wetland complexes, and maintaining the cyclic productivity of wetlands. In total, the plans call for purchase of 391,460 acres and the acquisition of perpetual conservation easements on another 587,320 acres. These goals have been approved by the appropriate county governments. As of 2003, 183,212 acres have been purchased and conservation easements taken on 285,351 acres.

Prairie Coteau Business Plan (draft) (National Fish and Wildlife Foundation, 2010)
This 10 year conservation plan calls for a variety of conservation actions in the Prairie Coteau subsection of southwest Minnesota. The most pertinent is to acquire 5,000 acres and place conservation easements on another 10,000 acres of the remaining native prairie in the Minnesota portion of the Coteau. A second major strategy is to restore 24,000 acres of marginal cropland to grassland within eight prairie landscapes (half by acquisition and restoration on public land and half by conservation easement and restoration on private land). Twelve other major strategies are proposed to deal with the conversion of prairie and grassland, fragmentation of prairie landscapes, degradation and homogenization of native habitats and other threats unique to high priority species.

Northern Tallgrass Prairie Ecoregion Plan (Northern Tallgrass Prairie Ecoregional Planning Team, 1998)
In this first ecoregional plan of The Nature Conservancy a total of 38 ecoregional portfolio sites were identified in Minnesota. Sites were chosen by the presence of imperiled species and high quality natural communities. Of the 38 sites, four were given highest priority for conservation action: Aspen Parklands, Glacial Ridge, Bluestem Prairie, and Felton Prairie.

Important Bird Sites in the Northern Tallgrass Prairie Ecoregion (Chapman, Hiller, & Haferman, 1998)
This first update to the Northern Tallgrass Prairie Ecoregional Plan adds additional sites to the portfolio to capture important bird species and assemblages. Although the birds are not necessarily imperiled at this point, they are good indicators of habitat quality and size. Forty-six species of birds were evaluated and 15 were chosen as targets because they were not found regularly at conservation sites. These fifteen species were used to select sites. A total of 35 important bird sites were selected, including six in Minnesota that were not previously identified in the ecoregional plan (Heron Lake, Swan Lake, Lake Traverse, Minnesota Lake, Thielke Lake, and Thief Lake).

Northern Tallgrass Prairie Ecoregional River and Stream Plan (Gagnon et al., 2004)
The second update to the Northern Tallgrass Prairie Ecoregional Plan adds the aquatic component to what had been solely a terrestrial plan previously. A total of 27 stream systems were added to the ecoregional portfolio including the Otter Tail, Red Lake and Wild Rice Rivers in the Red River Basin, the Rock and Little Sioux Rivers in the Missouri Basin, and the Chippewa, Cottonwood, Blue Earth, and Redwood Rivers in the Minnesota River Basin.

Prairie-Forest Border Ecoregional Plan (The Nature Conservancy, 2001)
A total of 166 sites were selected that protect all native natural communities, globally rare species and other important species of the Prairie-Forest Border Ecoregion. Oak savannas cover only 1/100th of 1% of their extent prior to European settlement and native prairies cover less than 1/10th of 1% in this transitional ecoregion. . Ecological Significant Areas (portfolio sites) in the Prairie Region included the Chester Hills Prairies, Glacial Lakes, Rollag Hills, and Waubun Prairie as well as the Otter Tail, North Fork Crow, Minnesota, Straight and Turtle Rivers.

Northern Tallgrass Prairie Habitat Preservation Area Plan (US Fish and Wildlife Service, 1998)
This environmental impact statement examines ways to preserve, restore, and manage up to 77,000 acres of the remaining critical northern tallgrass prairie in Minnesota and Iowa. The preferred alternative would protect and enhance native prairie remnants through partnership, incentives, education, cooperative agreements, acquisition, and conservation easements. In addition, about 7,000 acres of cropland would b converted to restore native grassland.

Northern Tallgrass Prairie NWR Focus Proposal (Division of Conservation Planning, Midwest Region, U.S. Fish and Wildlife Service, 2007)
Five focus areas in Minnesota and five in Iowa were identified using GIS technology to complete the Northern Tallgrass Prairie Refuge. The data used in the analysis included the density of prairie species or communities, the density of conservation estate lands, and the density of grasslands. The five focus areas in Minnesota are the Northern Border (Aspen Parkland), Glacial Ridge, Beach Ridge (Agassiz Beach Ridges), Big Stone, and Prairie Coteau.

Minnesota Wetlands Conservation Plan (Minnesota Department of Natural Resources, 1997)
The Wetlands Conservation Plan describes the current conditions of wetlands in Minnesota and sets a goal of restoring the quality and diversity of wetlands while increasing their overall quantity. To achieve this goal regional management within 14 wetland ecological units (regional areas) is necessary as well as regulatory simplification and education. Although no quantitative goals are set, general strategies in each regional area are established.

Wetlands Restoration Strategy (Minnesota Board of Water and Soil Resources, 2009)
This strategy calls for the targeting of wetland restorations to the sites that provide the greatest environmental benefits at a landscape, watershed, or flyway scale. Criteria for targeting include improved water quality, wildlife habitat, surface water flows, and groundwater recharge. Pilot projects in the Chippewa and Wild Rice River watersheds illustrate a potential approach to prioritization.

Shallow Lakes Program Plan (draft) (Minnesota Department of Natural Resources, Division of Fish and Wildlife, Wildlife Management Section, 2010)
Statewide, the goal of the shallow lakes program is to protect and manage at least 1,800 lakes that are at least 50 acres in size but less than 15 feet deep. This includes maximizing

management for waterfowl habitat of all 154 shallow lakes inside WMAs, WPAs, NWRs, and all Designated Management lakes and increasing wildlife management of the 1,959 shallow lakes with a portion of the shoreline in public ownership or access.

Appendix 3: Methods

1. Identifying areas of native prairie
Native prairie locations were based on field survey data covering work performed from 1987-2009 by the Minnesota County Biological Survey (MCBS). By the end of the 2009 season, field survey of all the counties in the prairie portions of Minnesota was complete. Final data was used in the analysis for this plan with the exception of eastern Murray and Polk counties. Only preliminary estimates of were available for those areas. Some of the prairies used in this analysis may have been destroyed since the time of their documentation by MCBS.

2. Calculating the amount of grassland and wetlands in an area
National Land Classification Data (2001) as reclassified by the USFWS HAPET office in Fergus Falls was the starting point for delineating the location and area of grasslands and wetlands. Grasslands included all land classified in the MN Land Cover file as 11 (Hayland) or 100 (Grass). Any native prairie data (MCBS) that was included in the Hayland or Grassland categories was removed. Calculating wetlands acreage was more complicated. The reclassified NLCD (2001) was again the starting point. The categories included were: 2 (Wetlands), 4 (Riparian Cattails), 22 (Riverine), 23 (Seasonal), 24 (Semi-permanent), 25 (Temporary), and 26 (Forested Wetlands). Categories 1 (Water) and 21 (Permanent) were not included in the initial analysis because the distinction between the two was often arbitrary. Both appear to be dominated by open water. In order to get an estimate of permanent wetlands, National Wetland Inventory data was used. The area classified as "Permanent" or "Open" by the reclassified NLCD (2001) data was intersected with the NWI data to identify the portion that was identified as wetlands versus the portion that was identified as open water. The NWI identified wetlands within the NLCD categories of Permanent" or "Open" was then identified to an adjusted wetlands layer used in the analysis of this plan.

3. Identifying protected lands
The figures provided in this report for protected lands, and their division into fee and easement interests, were calculated using GIS data from a number of public and partner sources. Ownership information for state lands in the State Parks, Wildlife Management Areas and Scientific and Natural Areas were downloaded from the Minnesota Department of Natural Resources Data Deli in Spring 2011. Data for permanent easements administered by the Minnesota Board of Water & Soil Resources was acquired from the Board in Fall 2010. Information on the Prairie Bank easement program in the MN DNR Division of Ecological and Water Resources was provided in Spring 2011. Ownership and easement information for the US Fish & Wildlife Service was acquired from the Bureau in Spring 2011. Only permanent FWS easements classified as conservation or grassland easements were included. Data for the Wetland Reserve Program administered by the Natural Resources Conservation Service was provided by the Service in Spring 2010. Ownership and permanent easements held by The Nature Conservancy was provided by the Conservancy in Spring 2011. Where an ownership interest overlapped a permanent easement (e.g. Conservancy owned-land enrolled in WRP), the easement was not included in our analysis. Information on lands included in the Conservation Reserve Program was based on a file of CRP enrollments obtained in 2010. Only contracts with expiration dates between May 1, 2008 and April 30, 2023 were included.

4. Choosing the prairie core areas
Staff prairie biologists from Minnesota County Biological Survey used their knowledge of prairie landscapes across the state along with the compiled MCBS and Natural Heritage databases to delineate rough boundaries around locations where native prairie and associated habitats are concentrated. The result was 29 locations in the Prairie Region of Minnesota that were drawn on a map showing the locations of native prairie in Minnesota. The prairie landscape map is available on the Minnesota DNR's website: http://files.dnr.state.mn.us/eco/mcbs/prairies_highlighted_areas.pdf.

5. Defining the boundaries of prairie core areas
The starting point was a file of Prairie Landscapes created by the Minnesota County Biological Survey (MCBS) in 2009 (Minnesota County Biological Survey, 2010). Staff members from The Nature Conservancy refined the rough boundaries by reducing the buffer around areas of surveyed native prairie to a ½ mile buffer. Several additional areas with concentrations of native prairie were added (e.g. New Solum). The resulting 36 core areas were then re-examined using on-screen digitizing to refine the boundaries to include additional area with rare species habitat (Minnesota Element Occurrence Data, MN CBS, 2008), areas of high biodiversity significance (Minnesota Biodiversity Significance Data, MN CBS, 2008), areas of extensive grassland and wetlands (MN/ND/SD Grasslands Analysis, TNC 2009 and NLCD Land Cover Data 2001 Categories 71 (grass) and 95 (wetland)) and Grassland Bird Conservation Areas (USFWS HAPET). Final boundary adjustments were made to follow watershed divides and ownership/field boundaries where appropriate, and to remove extensive areas of cropland using summer 2008 National Agricultural Imagery Program aerial photography of one-meter resolution.

6. Determining the centerline of dispersal corridors
The USFWS HAPET Office developed a series of corridors to connect all prairie focal areas (not including Espelie, which was excluded because it fell outside the boundaries of the habitat models). A cost surface was created using a suite of habitat models for waterfowl (mallard, blue-winged teal, gadwall, northern pintail, northern shoveler, and wood duck), marsh birds (pied-billed grebe, American bittern, sora, and Virginia rail), grassland passerine birds (bobolink, clay-colored sparrow, dickcissel, grasshopper sparrow, LeConte's sparrow, savannah sparrow, sedge wren, and western meadowlark), shorebirds (marbled godwit, American avocet, willet, Wilson's phalarope, semipalmated sandpiper, Hudsonian godwit, dunlin, and

white-rumped sandpiper), and game birds (pheasants and prairie chickens). This combination of spatial models consisted exclusively of bird habitat models but was developed to represent of a broad range of ecological/functional requirements for many prairie species. Corridors were identified using the cost distance and (least cost path) corridor analyses in ArcGIS 9.3, where the "cost surface" was inversely proportional to habitat quality; high quality habitat (including native prairie) was considered low "cost" and relatively poor quality habitat was considered high "cost". Thus the corridor paths identified are intended to maximize the benefits of existing habitat and native prairie throughout the landscape, identifying priority areas to concentrate preservation and restoration efforts in order to achieve maximum efficiency and promote landscape-scale connectivity.

7. Selecting the number and location of stepping stone complexes along dispersal corridors

The complexes are placed at approximately 6 mile intervals along the corridors. These are areas of approximately nine square miles (nine sections of land in a square three miles on a side) located to maximize the amount of native prairie, grassland, and protected lands in the complex. TNC staff used 'heads-up' digitizing to define these complexes in September, 2010. Each complex was named for the largest managed area unit within the complex or if there was no public land for the name of the township.