SDSU Extension

The Nature Conservancy
Protecting nature. Preserving life.

QUANTIFYING UNDISTURBED LAND ON SOUTH DAKOTA'S PRAIRIE COTEAU

6/30
2014

A report to The Nature Conservancy from South Dakota State University based on the Prairie Coteau boundary as defined by the April 30, 2010 TNC National Fish and Wildlife Foundation Business Plan "Conserving and Restoring Tallgrass Prairie: Prairie Coteau, South Dakota and Minnesota".

Authors:
Pete Bauman, SDSU Extension Range Field Specialist, Watertown, SD.
Joe Blastick, Land Steward, The Nature Conservancy, Clear Lake, SD.
Cody Grewing, SDSU Senior Agriculture Technician, Brookings, SD.
Alexander Smart, SDSU Range Professor, Brookings, SD.

Acknowledgements:

Jim Madsen, contractor: mapping support.

Matt Morlock, Field Data Team Analyst, SD Pheasants Forever, assisted with initial GIS systems development and interpretation of FSA Common Land Unit data.

The following SDSU staff provided assistance with mapping methods, analysis, lab space and manuscript review: Xu Lan, Associate Professor, Plant Ecology/Rangeland Ecology; Dianne Narem, Graduate Research Assistant, Plant Ecology/Rangeland Ecology; Kurt Reitsma, SDSU Extension Associate; Michael Wimberly, Professor and Senior Scientist, Geospatial Sciences Center of Excellence;
Carol Johnston, Professor, Wetland Ecosystems/GIS Applications in Ecology.

Common Land Unit data provided by South Dakota Farm Services Agency under a USDS Section 1619 Cooperator Memorandum of Understanding, Huron, SD. South Dakota Farm Services Agency staff that assisted in securing Common Land Unit data included Jamie White, Executive Officer; Daryl Campbell, Agriculture Program Specialist. Huron, SD.

South Dakota water data layer provided by South Dakota Department of Game, Fish, and Parks, Pierre, SD. The following SD Game, Fish and Parks Staff provided assistance with mapping data and access to imagery: Chelsea Krause, Division Staff Specialist – GIS Coordinator; Dave Ode, Coordinator of the SD Natural Heritage Database. Pierre, SD.

South Dakota Nature Conservancy ownership, 2001 untilled prairie, and Northern Prairies Land Trust easement data layers provided by the Nature Conservancy, Minneapolis, MN. The Nature Conservancy staff that assisted included Emily Mack, Field Steward, Prairie Coteau Project Office, Clear Lake, SD; Rich Johnson, Conservation Information Manager, Minnesota Field Office, Minneapolis, MN.

South Dakota US Fish and Wildlife Service protected lands data provided by the Habitat and Population Evaluation Team (HAPET), Bismarck, ND. US Fish and Wildlife Service staff that assisted with securing grassland easement data included Connie Mueller, Project Leader, Waubay National Wildlife Refuge Complex, Waubay, SD; Susan Kvas, Supervisory Fish and Wildlife Biologist, Habitat and Population Evaluation Team (HAPET), Bismarck, ND.

Funding for this research provided by The Nature Conservancy through a grant awarded from the National Fish and Wildlife Foundation (NFWF Grant Agreement #2009-0084-000)

Executive Summary:

We employed simple GIS methods and 2012 USGS aerial imagery to evaluate land use in all or portions of 17 counties within on the South Dakota portion of the Prairie Coteau. Central to our process was the acquisition and use of South Dakota Farm Service Agency's 2012 Common Land Unit (CLU) data layer. We utilized the CLU layer to identify all areas of known previous and current cropping history and then removed those acres from analysis. We then removed all known large water bodies as defined by South Dakota Game, Fish, and Parks Department's 2010 water layer. Finally, we evaluated the landscape by reviewing remaining land in every square-mile (approximately 8,500 sections) for additional disturbances (farms, gravel pits, building sites, recent cropping, etc.). The remaining land tracts were then categorized as 'undisturbed grassland' or 'undisturbed woodland'. We estimate there are approximately 1,102,271 acres of undisturbed grasslands and woodlands remaining representing (20.3%) of the 5,434,508 total acres within the South Dakota Prairie Coteau Boundary as defined by the 2010 TNC NFWF Business Plan. Of these 1,102,271 remnant undisturbed acres, 1,065,262 acres (96.6%) are classified as 'undisturbed grasslands' and 37,009 acres (3.4%) are 'undisturbed woodlands'. Approximately 276,184 acres (25.1%) of undisturbed grasslands and woodlands are permanently protected from conversion through conservation ownership or permanent conservation easements, representing 5.1% of the 5,434,508 total SD Prairie Coteau Acres. Overall, 1,140,732 acres are included in thirteen TNC Conservation Focus Areas. Our data suggests that 512,841 acres (45.0%) of the Focus Areas are classified as undisturbed grasslands and woodlands, with 199,791 acres (39%) of those undisturbed grasslands and woodlands acres within Focus Areas under permanent conservation protection status. These 199,197 undisturbed protected acres only represent 17.5% of the 1,140,732 total Focus Area acres and 3.7% of the 5,434,508 total SD Prairie Coteau Acres.

Quantifying undisturbed land on South Dakota's Prairie Coteau

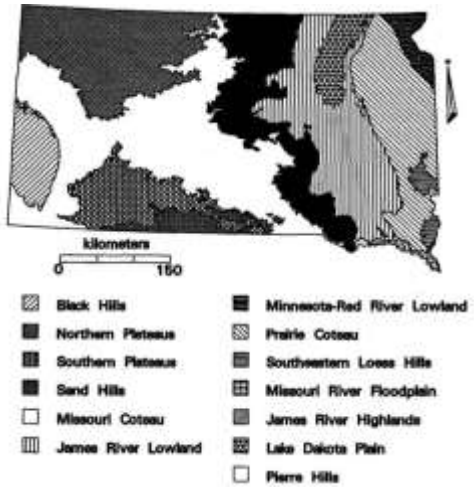
A REPORT TO THE NATURE CONSERVANCY FROM SOUTH DAKOTA STATE UNIVERSITY BASED ON THE PRAIRIE COTEAU BOUNDARY AS DEFINED BY THE APRIL 30, 2010 TNC NATIONAL FISH AND WILDLIFE FOUNDATION BUSINESS PLAN "CONSERVING AND RESTORING TALLGRASS PRAIRIE: PRAIRIE COTEAU, SOUTH DAKOTA AND MINNESOTA".

Introduction:

The Prairie Coteau portion of the Prairie Pothole Region is a rich Wisconsin-age glacial moraine extending from north of the North Dakota-South Dakota border in Sargent County, ND near Veblen, SD through several southeastern South Dakota and southwestern Minnesota Counties. The Prairie Coteau is characterized by agricultural and non-agricultural land uses, tallgrass prairie managed as habitat, native and tame pastures, wetlands, and eastern deciduous forests in the coulees or draws (Loeschke circa 1995). Also unique to the Prairie Coteau geology and ecology are its perennial flowing streams, rich east-slope woodlands, and relative abundance of calcareous fens.

Elevation of the Prairie Coteau Ranges from 1,250 to over 2000 feet above sea level and rises to over 600 feet above the surrounding valleys of the Minnesota and James Rivers (USGS 2013). Several small tributaries originate on the Prairie Coteau, condensing into increasingly larger streams and contributing to the flows of larger rivers such as the James, Big Sioux, and Minnesota Rivers; ultimately contributing to the Missouri, Mississippi, and Red River Basins.

Figure 1. The Prairie Coteau as defined by Johnson et al. (1995).



The Prairie Coteau was described by George Catlin in 1844 as "perhaps the noblest mound of its kind in the world". Several internal reports by The Nature Conservancy (TNC or the Conservancy) address the value of the Prairie Coteau to the Northern Great Plains (Aldreich et al. 1997, TNC 1998, Chapman et al. 1998, Leoschke circa 1995, Miller 2001, TNC NFWF 2010). Collectively, these reports include estimates of native untilled grasslands on the Prairie Coteau ranging from 700,000 acres (Miller 2001) to 1.4 million acres (TNC NFWF 2010).

Although the Prairie Coteau is a unique land form, there is no singular authority that has defined the landscape boundaries. Initial maps by early explores such as Nicollet's 1845 map

were inaccurate, and several authors since have defined physiographic regions based on various geographic criteria (Johnson et al 1995). Johnson et al. (1995) mapped South Dakota's physiographic regions based primarily on soils informed by topographic features, and this is perhaps the most comprehensive study on the matter in regard to the geographical shape of the Prairie Coteau in South Dakota (Figure 1). Johnson et al. (1995) sized the Prairie Coteau in South Dakota at 22,471 km^2, or roughly 5.5 million acres.

Prairie Coteau

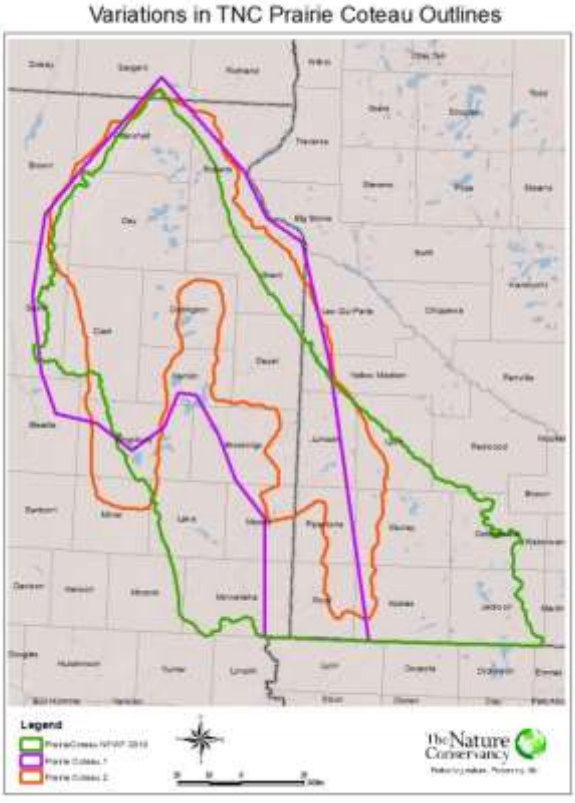
The Prairie Coteau (Fig. 2) is a wedge-shaped highland with its apex just north of the South Dakota-North Dakota border in Sargent County, North Dakota. Its eastern and western escarpments are steepest in the north and taper off to the south. Near its northern end, the plateau of the Prairie Coteau lies 300 m above the Minnesota-Red River Lowland. The region's topography is highly variable and was formed by a series of glacial advances over a preglacial shale plateau (Flint 1955; Lemke et al. 1965). Each successive glacial advance was less extensive, and consequently glacial drift and topography are older at the center of the coteau. High relief knob-and-kettle terrain, produced chiefly by the collapse of superglacial till from the Mankato substage of glaciation, occurs at the north end of the coteau, and along the eastern margin where the escarpment is steepest. Extensive areas of Carey substage-age till occur throughout the west and central portions of the Coteau along its longest axis. The most mature topography occurs east of the Big Sioux River in an area of relatively dissected terrain with numerous tributary streams.

Turkey Ridge is a range of highlands in southeastern South Dakota which Flint (1955) included in the James River Highlands physiographic region. This site and the area to the north and east have the same glacial history and soils as the rest of the Prairie Coteau. Based on soils, we extended the Prairie Coteau southward to include Turkey Ridge and the intervening area.

Soil series used to delineate the Prairie Coteau (Table 1) are Udic Hap10borolls in the north, and Udic Hap1ustolls south of an east-west axis through the center of the Coteau along the southern borders of Brookings and Kingsbury counties. Other soil series used to delineate the Prairie Coteau belonged to Typic Ca1ciboroll, Typic Endoaquoll, and Udertic Haploboroll taxonomic subgroups.

- Johnson et al. (1995)

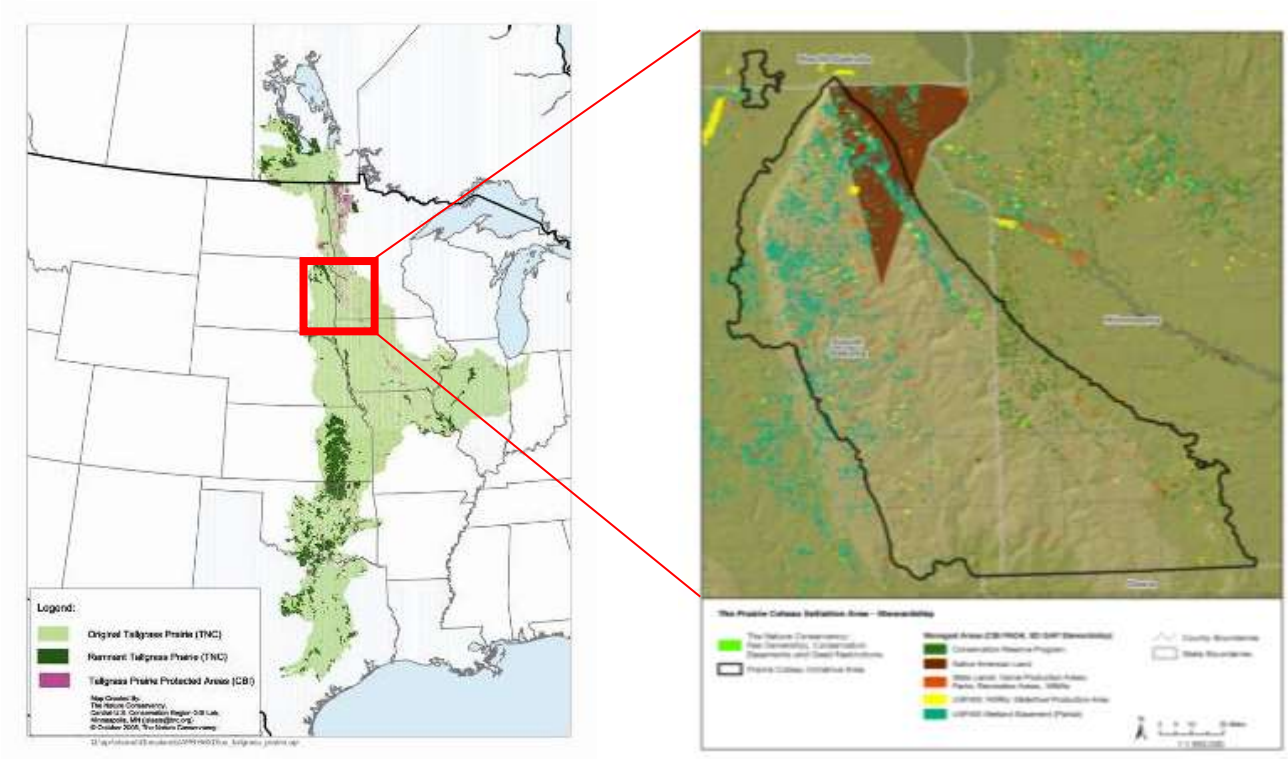
Figure 2. The Prairie Coteau as defined by The Nature Conservancy in recent years. The most current being the 2010 TNC NFWF Business Plan boundary (green).



Beyond geography, the actual boundary of a landscape can be defined based on a mix of geology and programmatic goals. Johnson et al. (1995) suggested that "landscapes within physiographic regions may have topography, land use, and wildlife habitat unlike adjacent regions". Smart et al. (2003) provide a vivid description of the Prairie Coteau beyond its strict geology or vegetation, discussing the overall scope and feel of the landscape.

The Nature Conservancy has used several iterations of the boundaries of the Prairie Coteau in recent years as a means of meshing the geological and ecological features of the landscape with programmatic goals and objectives of the organization (Figure 2). For the purposes of this analysis, we will use the 2010 TNC National Fish and Wildlife Foundation (NFWF) landform boundary as described in the 2010 TNC NFWF Business Plan (Figure 3) (TNC NFWF 2010).

Figure 3. The Prairie Coteau as defined by The Nature Conservancy in the 2010 TNC NFWF Business Plan.



This 2010 internal report developed by The Nature Conservancy as a Business Plan for the National Fish and Wildlife Foundation under the larger umbrella of the Prairie Coteau Habitat Partnership reported the following statistics for the Prairie Coteau (TNC NFWF 2010):

"The Prairie Coteau is approximately 8.3 million acres in size. Of approximately 2.3 million acres of grassland (native prairie plus planted grassland) that remain in the Prairie Coteau (27.7% of the overall landform), 1.4 million acres of untilled tallgrass prairie (17.4% of landscape) were present in 2001. Another 703,000 acres (8.5%) of the landscape is covered by wetlands including 197,000 acres of temporary and seasonal wetland (many of which are cropped), 282,000 acres of semi-permanent wetland and 210,000 acres of permanent wetlands associated with lakes and ponds.

At least 262,000 acres of the untilled prairie (18%) are protected with federal or state grassland easements and if we assume a 50:50 mix of prairie:wetland on conservation lands owned in fee title (265,000 acres), an estimated 27 percent of the untilled grassland in the Prairie Coteau are protected. An additional 136,169 acres of wetlands and grassland buffer (19% of the wetlands) are protected with easements. With the same 50:50 mix of prairie:wetland on fee title conservation lands, an estimated 38 percent of the wetland is protected."

It is important to note that the above synopsis was based on the entirety of the Prairie Coteau landform as defined in the report, including portions in Minnesota, South Dakota, and North Dakota. Within the NFWF outline for the Prairie Coteau lies 17 South Dakota counties including all or portions of: Marshall, Roberts, Day, Brown, Spink, Grant, Clark, Codington, Hamlin, Deuel, Brookings, Kingsbury, Lake, Moody, Miner, Minnehaha, and McCook; all or portions of 11 Minnesota counties including: Lac Qui Parle, Yellow Medicine, Lincoln, Lyon, Redwood, Pipestone, Murray, Cottonwood, Rock, Nobles,

and Jackson; and one North Dakota County: Sargent. This report only analyzes the 17 counties in the South Dakota portion of the Prairie Coteau (Figure 4).

Figure 4. South Dakota portion of the 2010 TNC NFWF Prairie Coteau boundary.

South Dakota is losing its perennial grassland cover at a rate that is concerning to many individuals and organizations. The statewide rate of grassland loss, while likely measurable, has not been quantified in regard to actual loss of *native* grasslands. The lack of specific data concerning native grassland loss is true of the Prairie Coteau region as well.

Several non-profit conservation organizations and government agencies have committed resources to this unique landscape. The Nature Conservancy (TNC), Pheasants Forever (PF), Ducks Unlimited (DU), Northern Prairies Land Trust (NPLT), US Fish and Wildlife Service (USFWS), and SD Game, Fish, and Parks are but a few of the most prominent organizations working to preserve the ecology of the area. While claims of the Prairie Coteau's relatively intactness are prevalent, the location and scope of truly native (untilled) grasslands remaining on the Prairie Coteau is difficult to quantify beyond the generalities provided in the 2010 TNC NFWF Business Plan. Ironically, while most of these organizations have made attempts to map and identify portions of the highest-quality regions, none have developed a base map that attempted to comprehensively quantify and map the actual remaining tracts of untilled or unaltered 'native' sod at a landscape scale.

The 2010 TNC NFWF Business Plan cites conversion, fragmentation, and degradation/homogenization as leading threats to the long-term integrity of the landscape, including but not limited issues with inappropriate grazing, suppressed fire, and invasive species. Categorically, Doherty et al. (2013) cited the similar landscape influences for the greater Prairie Pothole Region. Of particular importance is land conversion from grasslands to row-crop agriculture, the drivers of which are discussed thoroughly in papers cited in the discussion portion of this report. The 2010 Business Plan also states there are five areas on the South Dakota side of the Prairie Coteau that harbor over 20,000 acres of native prairie each. As with many such reports, numbers are derived via various measures and very little information is provided as to the source or accuracy of the total area or percent of untilled or native sod. It is assumed these statistics were a 'best guess' inferred from the information available at the time, including information derived from the Conservancy's 2001 untilled prairie data layer.

Most studies attempting to quantify land use change have utilized some type of GIS remote sensing or other technology to derive at a conversion rate. Most typically, studies rely on the National Agricultural Statistics Service's (NASS) Cropland Data Layer (CDL) to report total acres 'lost' or a percent change over a period of time (Wright and Wimberly 2013; Johnston 2013, 2014; Faber et al. 2012, Decision Innovation Solutions 2013). This type of analysis can be very powerful in reporting land use trends, but because researchers have not been able to accurately and consistently separate native grasslands from

other types of planted grasslands (such as CRP), grass-like crops (such as hayfields), or other grassy habitats using NASS CDL data, it becomes nearly impossible to accurately map vegetation type at a meaningful scale.

Decision Innovation Solutions (2013) addressed the issue of error in land covers reported by NASS CDL data, especially in relation to those that "are more grassy in nature". Typically, analysts group most or all of the following NASS CDL cover categories together under a 'grass' or 'grass-like' label for analysis: 36-alfalfa, 37-other hay/non-alfalfa, 62-pasture/grass, 87-wetlands, 171-grassland herbaceous, 181-pasture/hay, and 195-herbaceous wetlands. However, Johnston (2013) also found that NASS CDL data even confused corn crops with cattail sloughs. These issues with interpretation of NASS CDL data render it impossible to quantify acreage and location of undisturbed land or native sod with any confidence.

The objective of our work was to develop a simple, systematic, repeatable, and cost-effective approach to estimating location and total area of land tracts that are likely undisturbed (i.e. native) grasslands and woodlands on the South Dakota portion of the Prairie Coteau. The central component to our analysis was the utilization of the 2012 South Dakota Farm Service Agency's (FSA) Common Land Unit (CLU) cropland data layer.

Methods

We utilized the South Dakota portion of the 2010 TNC NFWF Business Plan boundary for the Prairie Coteau as our analysis area. Sand Lake National Wildlife Refuge and the Hecla Sandhills were excluded from this analysis as they are disjunct landforms.

We developed a methodology for assessing the history of land use in the region via simple layering methods in ARC GIS in order to deduce the location and size of remaining land tracts that are potentially undisturbed (native) native sod - regardless of current vegetation type or quality. We utilized 2012 USGS aerial imagery (2012 National Ag. Imagery Program Mosaic, http://datagateway.nrcs.usda.gov/) as our base layer data, projected on-screen at approximately 8,000 ft. elevation to analyze approximately 8,500 square miles within the SD portion of the landscape boundary. This projection was selected to allow the technician to view a full square mile section (640 acres) when identifying, evaluating, and qualifying land use.

Step 1: The 2012 Farm Service Agency's (FSA) Common Land Unit (CLU) cropland data layer was then applied to the 17 counties of the South Dakota Prairie Coteau. We made no attempt in this study to verify the accuracy of the CLU cropland data layer, rather we accepted the layer as measured data provided by FSA. The CLU Crop data layer includes all recorded historic cropland and is applied to land tracts enrolled in current or historic United States Department of Agriculture (USDA) programs dating back to approximately the 1950's, however an exact initial date is not available. It is important to note that the CLU Crop layer reports historic cropping disturbance, but not all current and historic acres included in the 2012 CLU Crop layer are necessarily agricultural crops today, as these acres may have been allowed to re-vegetate as 'go back' to pasture, been developed for non-ag uses, or are in some type

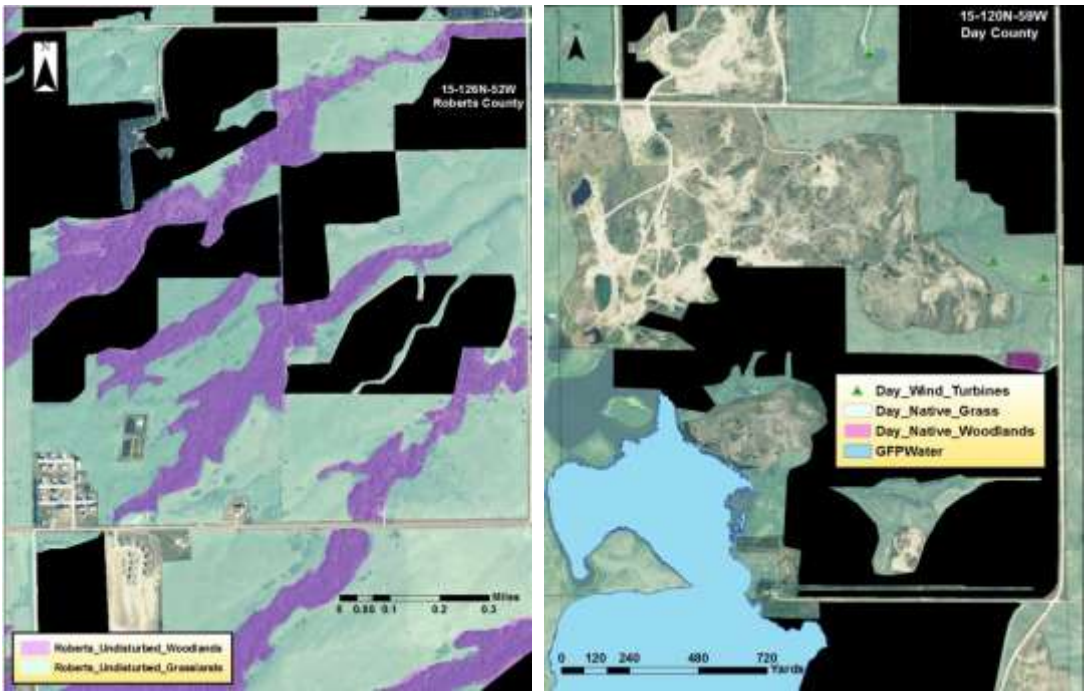
of conservation program. The 2012 CLU cropland data layer was overlaid on the base 2012 USGS maps and shaded black to represent tillage. This first level analysis allowed us to define areas without a recorded cropping history (non-crop) for further analysis.

Step 2: Technicians then mapped remaining undisturbed (native) grasslands and woodlands by evaluating remaining non-crop land tracts for indicators of disturbance. The CLU layer does not provide comprehensive representation of all crop fields if they were not enrolled in a USDA program or assigned a farm number. Crop land not represented in the CLU layer may include but is not limited to: 1) land cropped prior to the establishment of the CLU data (circa 1950) or not enrolled in USDA programs, 2) land removed from CLU tracking due to removal from USDA programs or retired farm number, or 3) land recently cropped without being enrolled in a USDA farm program or land enrolled but not yet recorded. Other disturbed areas on non-cropped land including such uses as: farmsteads, building sites, lawns, municipalities, planted shelterbelts, feedlots, gravel pits, etc.

Non-CLU disturbed areas were not mapped per se, rather initial native 'undisturbed grasslands' and 'undisturbed woodlands' polygons were developed with on-screen digitizing by *excluding* the known CLU cropland layer and all additional identified disturbed tracts (Figure 5). Initial undisturbed (native) grasslands and woodlands included all wetlands, lakes, and streams not included in the CLU cropland layer. Undisturbed grasslands and woodlands were further refined by removing the South Dakota Department of Game, Fish, and Parks lakes (SDGFP) 2010 water layer. Similar to the FSA CLU cropland layer, we made no attempt to verify the accuracy of the SDGFP lake layer, rather we simply accepted it as measured data.

Undisturbed woodlands were determined as having closed canopy comprised of deciduous species, and were primarily located in areas typically associated with eastern hardwood remnants (coulees, ravines, river bottoms, and lake shores). Closed canopy conifer stands were removed from the woodland layer if it was obvious they were planted in a pattern for wind protection or wildlife habitat (as is typical in this region). Acres covered with scattered deciduous trees remained in the native 'undisturbed' grassland layer as long as they did not appear to be planted and did not approach a closed canopy forest. Final undisturbed grassland and woodland layers were then developed through correction of polygon data for all 8,500 sections by a single qualified technician who thoroughly reviewed the data for consistency and accuracy.

Figure 5: Two sample sections of land in Roberts and Day Counties of South Dakota. Black areas indicate FSA CLU land tracts with a known cropping history excluded from analysis. Large water bodies as determined by SD GF&P lakes layer were removed. Undisturbed (native) grasslands and woodlands were then mapped based on identification of other obvious land disturbance such as building sites, planted trees, municipalities, feedlots, gravel pits, etc.

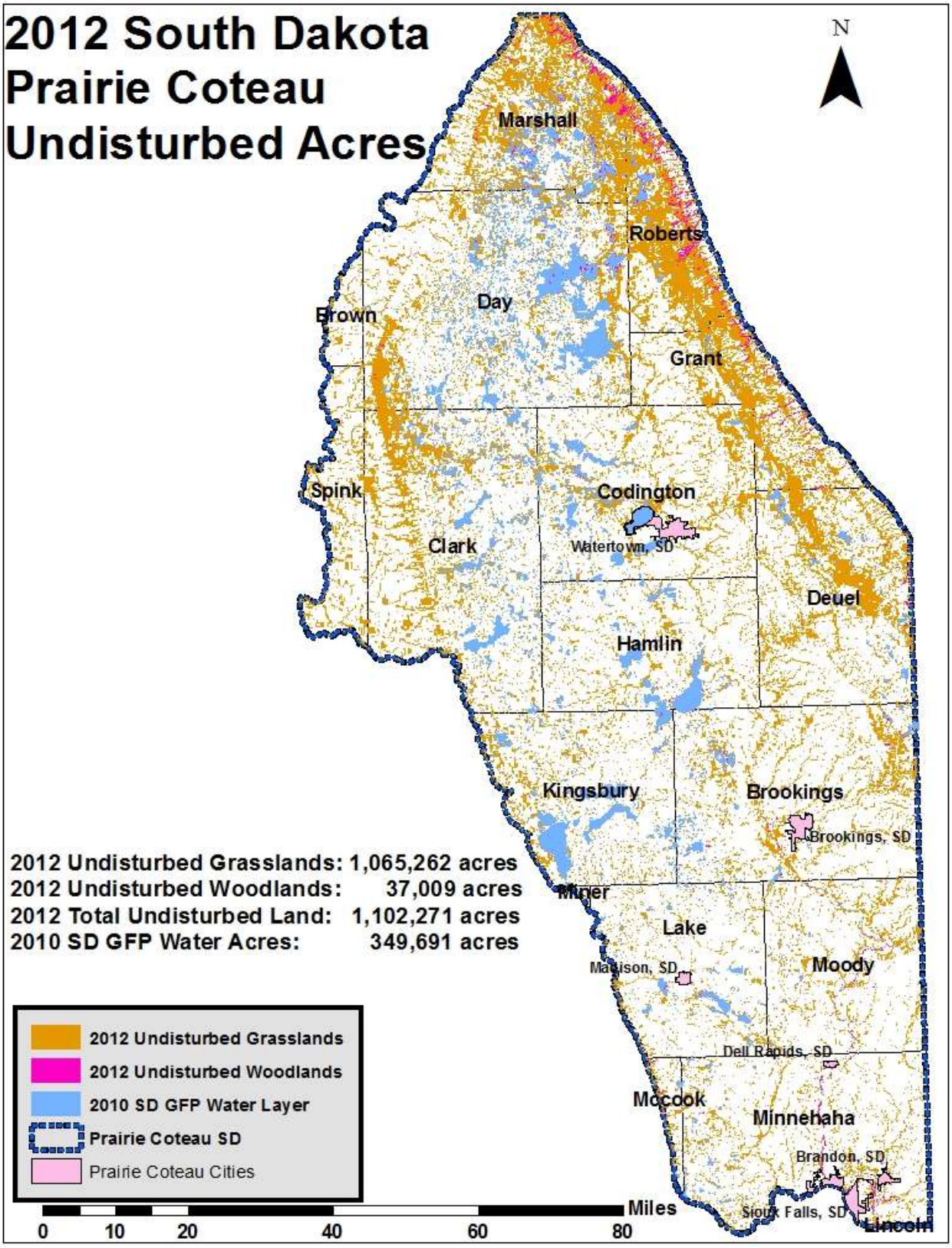


Step 3: Other landscape statistics such as protected status and county-level analysis were performed by analyzing various data layers. Of primary interest was the relative overlap of undisturbed grasslands and woodlands with records of permanent conservation protection. Conservation protection was derived by compiling the most up-to-date protection maps available. The 'protection' layer includes: US Fish and Wildlife Service fee ownership lands (refuges and waterfowl protection areas) and grassland easements; SD Game Fish and Parks fee ownership lands (parks and game production areas); Nature Conservancy grassland preserves; USDA Natural Resources Conservation Service Wetland Reserve Program easement acres; and Northern Prairies Land Trust easement acres. Protection layers were derived through direct contact with organizations holding the fee title to the property or the easement.

Results

Based on our methodology, we estimate there are approximately 1,102,271 acres of undisturbed grassland and woodlands remaining within the 2010 TNC NFWF defined boundary of the Prairie Coteau representing (20.3%) of the 5,434,508 total acres within the South Dakota portion of the landscape. Of these remnant undisturbed acres, 1,065,262 acres (96.6%) are classified as undisturbed grasslands and 37,009 acres (3.4%) are undisturbed woodlands. Approximately 349,691 acres (6.4%) are covered by large lakes as defined by the South Dakota Game, Fish, and Parks (SD GFP) 2010 water data layer (Figure 6).

Figure 6: Undisturbed (potentially native) grasslands and woodlands remaining within the South Dakota portion of the Prairie Coteau based on the 2012 landscape analysis.



Within our undisturbed layers there is a possibility that certain individual tracts could have a historic cropping or tillage history that is not detectible with the 2012 USGS imagery. These areas are commonly known as 'go back' pasture or hay land. An example would be a land tract that might have been farmed or a tillage attempt made decades ago. These tracts may not have been enrolled in any type of government farm program and thus may not have been tracked through any formal system. The condition and vegetative cover of these areas today is unpredictable, and they may be vegetated with varying degrees of quality, structure, and diversity of native, tame and exotic species. Overall, we believe that our 'undisturbed' grassland and woodland layers may harbor several thousand acres with a disturbance history, but we do not feel the impacts of such will significantly alter the overall evaluation of acres/area of remnant native land tracts on the landscape.

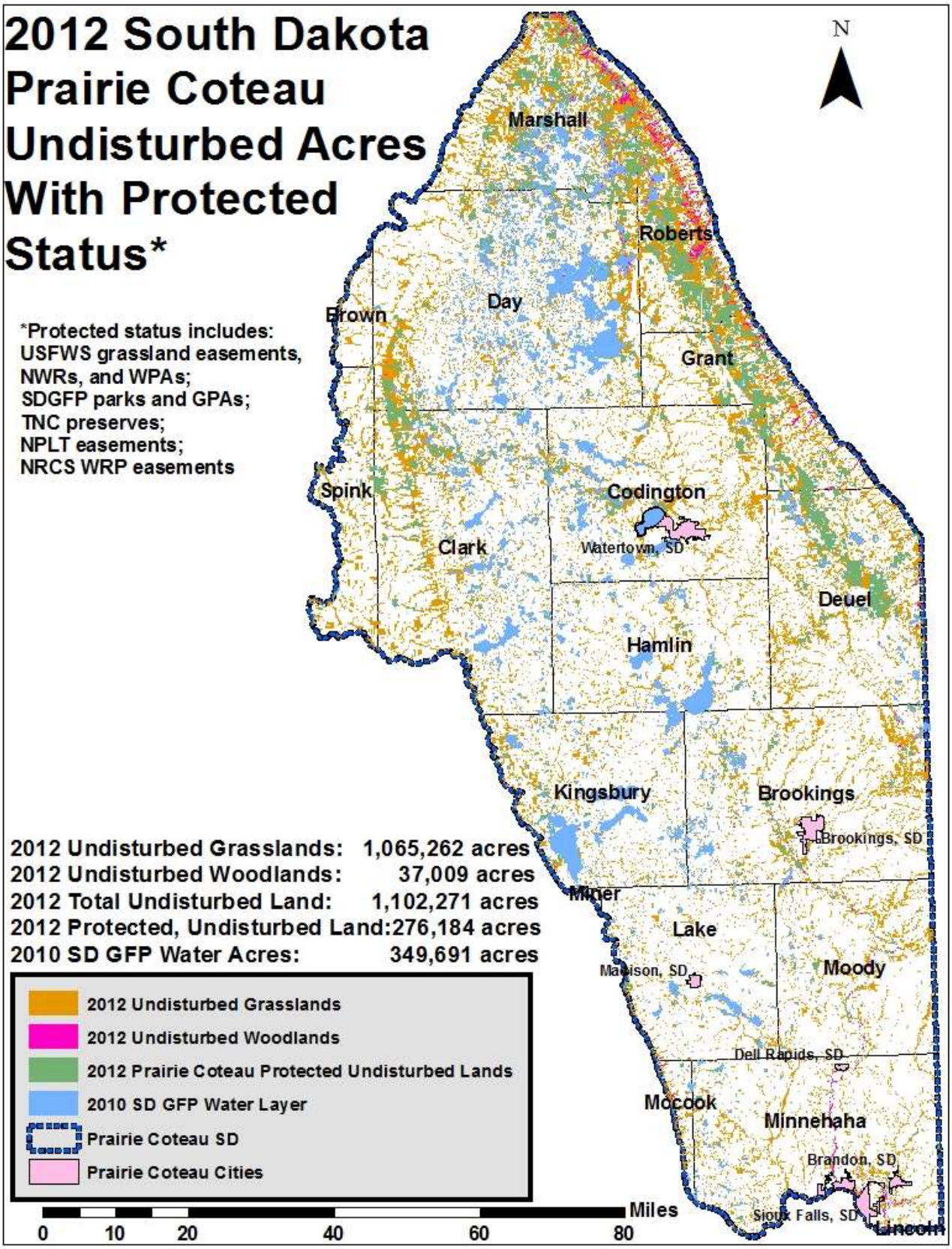
Within the overall SD Prairie Coteau Boundary, approximately 3,607,384 acres (66.4%) are classified as having a cropping history as per the FSA CLU data. An additional 375,162 acres (6.9%) were classified as 'other disturbance' within our analysis.

A key element in understanding the current and future role of these remnant undisturbed tracts in the landscape is evaluating their susceptibility to conversion (Doherty 2013). Of the 1,065,262 acres of undisturbed grasslands and woodlands, 276,184 acres (25.1%) have some sort of permanent protection from conversion. Counties that have the greatest total undisturbed acres under protection are Marshall, Roberts, Deuel, Grant, Day, and Clark. At 20.5%, Roberts County has the highest ratio of undisturbed land under protection as compared to total county acres within the landscape boundary. See Table 1 for full landscape statistics. Figure 7 highlights undisturbed areas that also have some sort of permanent conservation protection status. Appendix A contains county maps of undisturbed grasslands and woodlands. Appendix B contains county maps of undisturbed grasslands and woodlands *with* permanent protection status.

Table 1. 2012 TNC NFWF Prairie Coteau Landscape Statistics.

2012 County and Landscape Statistics Within the 2010 TNC NFWF SD Prairie Coteau Boundary														
County	Total County Area (mi^2)	Total County Area (Acres) Based on NRCS County Data	County Area (Acres) Within 2010 TNC NFWF Prairie Coteau Boundary	Percent of County Area Within 2010 TNC NFWF Prairie Coteau Boundary	2012 FSA CLU Crop Layer Acres Within 2010 TNC NFWF Prairie Coteau Boundary	2012 Other Disturbed Land Acres (non CLU crop, new crop, buildings sites, planted shelterbelts, municipalities, gravel pits, feedlots, etc.) Within 2010 TNC NFWF Prairie Coteau Boundary	GF&P Water Layer Acres Within 2010 TNC NFWF Prairie Coteau Boundary	2012 Undisturbed Grassland Acres Within 2010 TNC NFWF Prairie Coteau Boundary	2012 Undisturbed Woodlands Acres Within 2010 TNC NFWF Prairie Coteau Boundary	2012 Total Undisturbed (Grasslands and Woodlands) Acres Within 2010 TNC NFWF Prairie Coteau Boundary	Percent of County Acres Classified as Undisturbed (Grasslands and Woodlands) Within 2010 TNC NFWF Prairie Coteau Boundary	2012 Undisturbed Acres *With* 'Protected' Status Within the 2010 TNC NFWF Prairie Coteau Boundary	Percent of 2012 Undisturbed Acres *With* 'Protected' Status Within the 2010 TNC NFWF Prairie Coteau Boundary	Percent of County Acres Classified as 'Undisturbed' *With* 'Protected' Status Within the 2010 TNC NFWF Prairie Coteau Boundary
Brookings	792	515,025	515,025	100.0%	374,192	47,581	14,635	**76,958**	**1,659**	**78,617**	15.3%	**11,671**	14.8%	2.3%
Brown	1,713	1,107,146	42,114	3.8%	30,239	5,640	56	**6,179**	**0**	**6,179**	14.7%	**184**	3.0%	0.4%
Clark	958	619,036	578,000	93.4%	396,621	23,499	45,665	**111,959**	**256**	**112,215**	19.4%	**27,984**	24.9%	4.8%
Codington	689	458,789	458,789	100.0%	303,274	42,187	32,693	**80,478**	**157**	**80,635**	17.6%	**13,447**	16.7%	2.9%
Day	1,028	698,013	685,426	98.2%	436,693	17,753	108,939	**120,000**	**2,040**	**122,040**	17.8%	**28,049**	23.0%	4.1%
Deuel	623	407,511	396,964	97.4%	247,248	29,089	10,344	**109,162**	**1,122**	**110,283**	27.8%	**39,633**	35.9%	10.0%
Grant	681	440,242	221,067	50.2%	117,668	11,631	1,803	**85,681**	**4,284**	**89,964**	40.7%	**36,146**	40.2%	16.4%
Hamlin	507	344,191	344,191	100.0%	256,133	22,938	27,444	**37,379**	**296**	**37,675**	10.9%	**4,656**	12.4%	1.4%
Kingsbury	832	552,500	356,593	64.5%	248,123	22,876	41,727	**43,446**	**420**	**43,867**	12.3%	**7,093**	16.2%	2.0%
Lake	563	367,942	324,401	88.2%	258,763	23,635	13,005	**28,626**	**371**	**28,997**	8.9%	**4,360**	15.0%	1.3%
Marshall	838	566,512	323,660	57.1%	132,088	14,716	36,468	**131,097**	**9,291**	**140,388**	43.4%	**50,314**	35.8%	15.5%
McCook	574	369,238	30,001	8.1%	21,644	1,422	800	**5,815**	**320**	**6,135**	20.4%	**290**	4.7%	1.0%
Miner	570	364,998	3,232	0.9%	2,805	226	42	**159**	**0**	**159**	4.9%	**0**	0.0%	0.0%
Minnehaha	807	520,746	471,270	90.5%	338,895	69,093	6,652	**52,584**	**4,046**	**56,630**	12.0%	**2,970**	5.2%	0.6%
Moody	519	333,518	333,518	100.0%	261,307	24,759	2,831	**43,255**	**1,367**	**44,621**	13.4%	**4,733**	10.6%	1.4%
Roberts	1,101	726,494	202,289	27.8%	68,677	9,480	6,229	**106,530**	**11,372**	**117,902**	58.3%	**41,500**	35.2%	20.5%
Spink	1,504	965,715	147,969	15.3%	113,012	8,637	358	**25,955**	**7**	**25,962**	17.5%	**3,157**	12.2%	2.1%
Total	**14,300**	**9,152,096**	**5,434,508**	**59.4%**	**3,607,384**	**375,162**	**349,691**	**1,065,262**	**37,009**	**1,102,271**	**20.3%**	**276,184**	**25.1%**	**5.1%**

Figure 7: Undisturbed (potentially native) grasslands and woodlands remaining within the South Dakota portion of the Prairie Coteau that have some level of permanent protection status.



In 2001 the Conservancy mapped large blocks of potentially 'untilled prairie' in the Great Plains. Although not explicitly claiming that all acres within the 'blocks' were native prairie, the layer suggests that the majority of acres included in the blocks were untilled. The 2001 estimate of the largest blocks of untilled prairie included in the 2001 layer as reported in the 2010 TNC NFWF Business Plan was approximately 600,079 acres (11.0%) of the SD Prairie Coteau landscape. Our 2012 data suggests that total potential remaining undisturbed (untilled/native) grasslands and woodlands is 1,102,271 acres (20.3% of the landscape), the difference being the relative lack of inclusion of small/isolated prairie remnants in the 2001 analysis. These small/isolated acres were included in our analysis. However, analysis of 2012 undisturbed grasslands and woodlands occurring ***within*** the 2001 Untilled Prairie 'blocks' suggests that undisturbed/native acres within the blocks were overestimated in the 2001 analysis. We found that within the 600,079 acres of untilled prairie reported in the 2001 TNC data layer, only 358,932 acres (59.8%) were potentially undisturbed grasslands or woodlands in 2012 (Figure 8).

Doherty et al. (2013) detailed the importance of scale and timing in realistic conservation planning. The 2010 TNC NFWF Business Plan identified Conservation Focus Areas for the Prairie Coteau (Figure 9). Focus areas with significant area located within the South Dakota portion of the Prairie Coteau were Bitter Lake-Rush Lake, Bristol, Butler, Crandall, Crocker-Crandall Hills, Dakota Coteau-North, Dakota Coteau-South, Fort Sisseton, Hole-In-The-Mountain, Phipps, Shaokatan Prairies, Waubay Lake Watershed, and Yellow Medicine Coteau.

The 2010 NFWF Business Plan discusses how the perimeter of focus areas were identified as follows *"in South Dakota, the Bismarck [ND] HAPET office identified the boundaries of the focus areas based on modeling of waterfowl and grassland birds. The boundaries of all the focus areas were further adjusted to better reflect watershed boundaries and capture additional grassland and rare species occurrences."*

The shape of the 2010 Focus Areas were also influence by the location of the largest blocks of untilled prairie remaining on the Coteau as identified through the 2001 TNC Untilled Prairie data layer. While this layer is likely a fair representation of the general scale and gross location of untilled prairie, the accuracy of the layer has not been analyzed at the local landscape level. Therefore, while we agree the location of the focus areas are generally defensible, the quantification and physical location of potential untilled prairie within the Focus Areas as represented by the Focus Area maps in the 2010 TNC NFWF Business Plan have been refined/updated by our analysis and are included in this report.

Overall, 1,140,732 acres are included in the thirteen 2010 Focus Areas occurring in South Dakota. We compared the 2001 estimates of untilled prairie to our 2012 estimates of undisturbed grasslands, undisturbed woodlands, and protection status. Based on the 2001 estimate, 576,064 acres (50.1%) of the Focus Areas were comprised of untilled prairie. Our 2012 data suggests that 512,841 acres (45.0%) of the focus areas are classified as undisturbed grasslands and woodlands. The remaining 627,891 acres (55.0%) were classified as CLU Crop, SD GFP water, and 'other' disturbed. While the overall acres of the 2001 estimate of untilled prairie is fairly accurate compared to our 2012 data (50.1% vs 45.0%) the distribution of undisturbed/untilled acres within the Focus Areas was not consistent between the two analysis; with the 2012 data providing improvements in both precision and accuracy of potentially undisturbed grasslands and woodlands within the Focus Areas.

Figure 8: Occurrence of 2012 undisturbed grassland and woodland areas within 2001 TNC Untilled Prairie areas of the South Dakota Prairie Coteau.

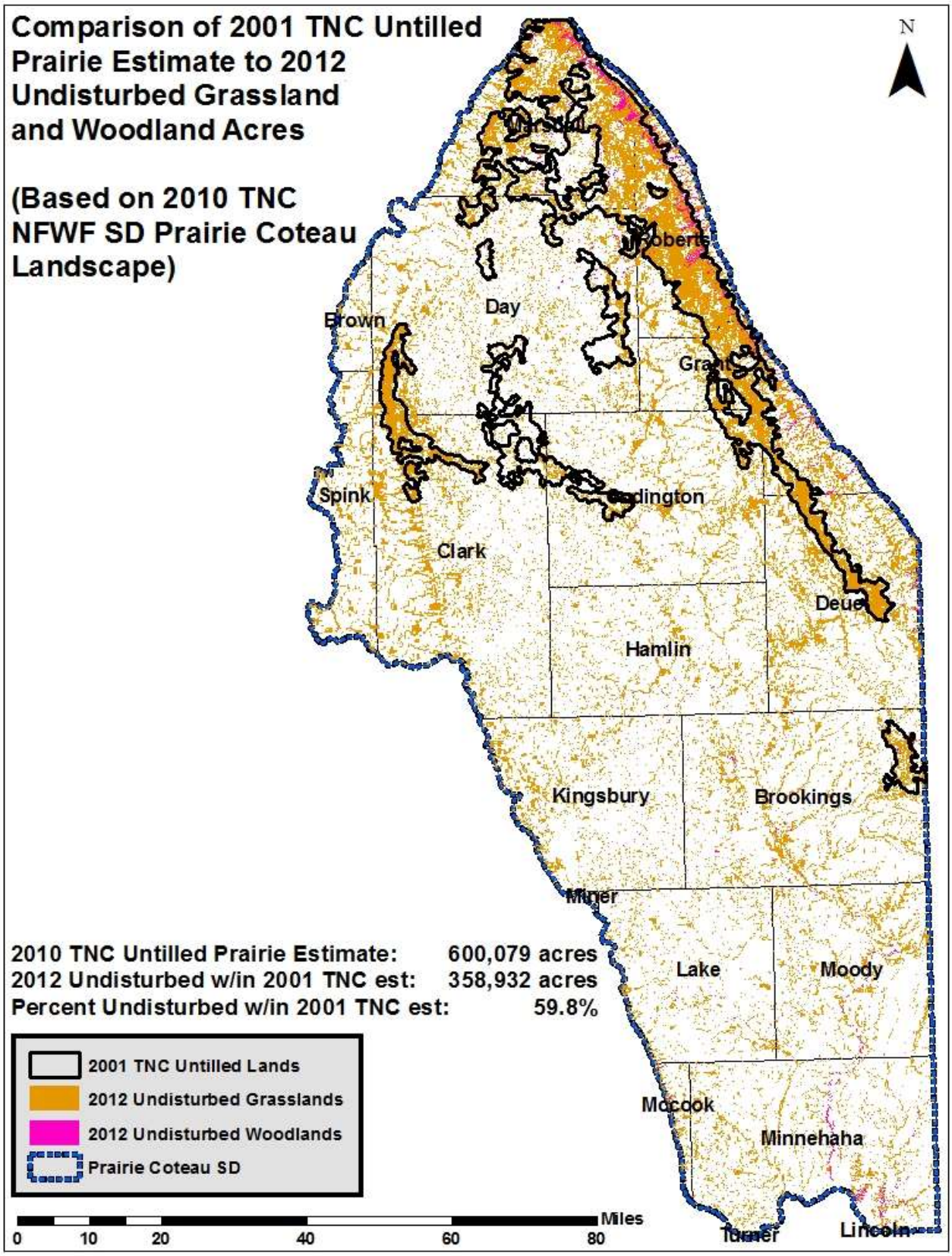
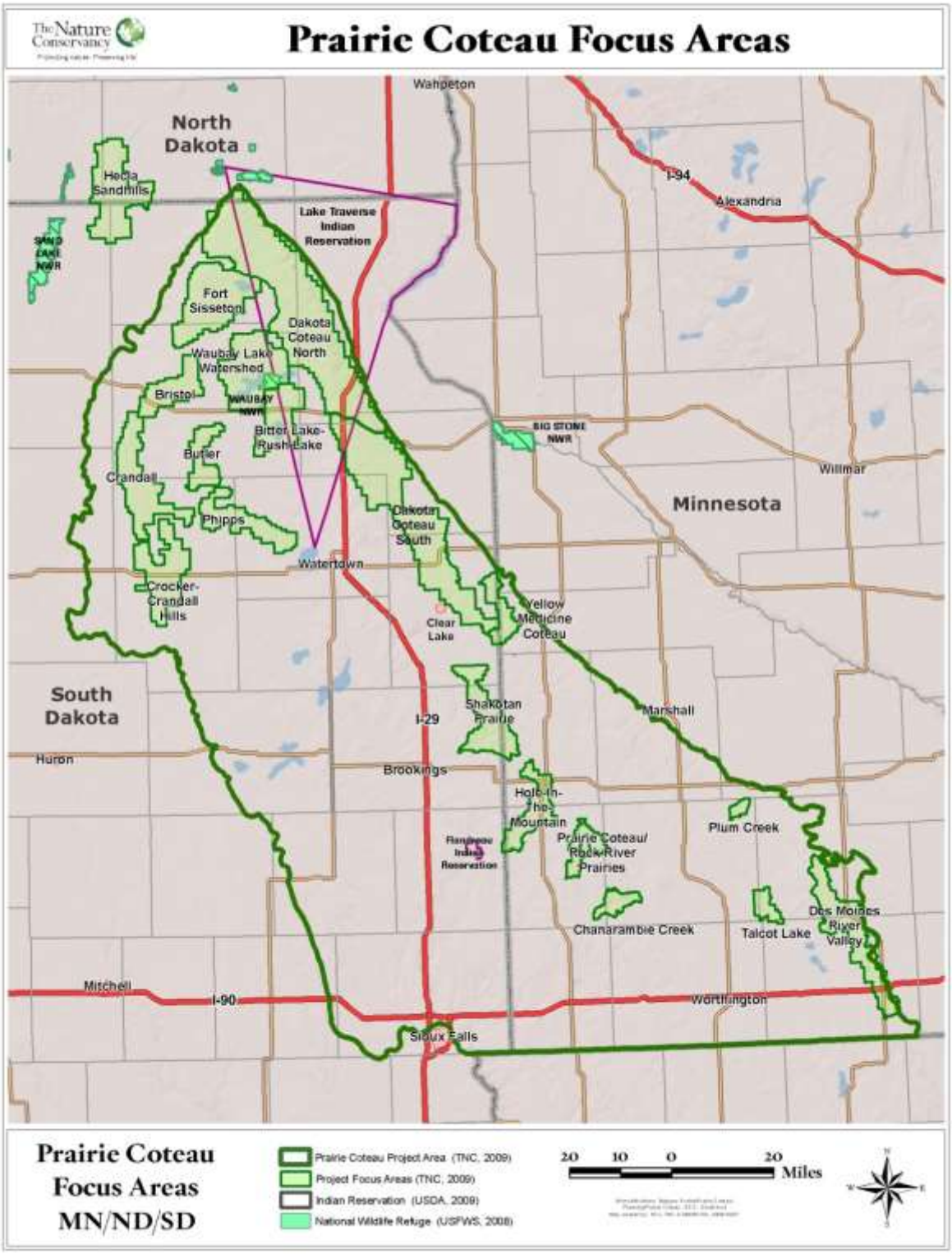


Figure 9. 2010 TNC NFWF Business Plan Conservation Focus Areas for the Prairie Coteau.



In addition to the overall analysis of remaining undisturbed grassland and woodland acres within the Focus Areas, we also analyzed the level of conservation protection on these acres. Of the 512,841 acres of undisturbed grasslands and woodlands in the Focus Areas, 199,791 acres (39%) had some sort of permanent conservation protection status as of 2012. When compared to the 1,140,732 *total* acres within the focus areas, 2012 undisturbed acres with protection status was 17.5%. See Table 2 for full Focus Area statistics. Appendix C contains updated Focus Area maps of undisturbed grasslands and woodlands *with* permanent protection status.

Table 2. 2012 TNC NFWF Prairie Coteau Focus Area Statistics.

2012 TNC NFWF Prairie Coteau Focus Area Analysis (For SD Portions of Focus Areas Only)									
Focus Area	Focus Area Acres Within SD Prairie Coteau	2001 'Disturbed' Acres In Focus Area	2001 TNC Untilled Prairie Acres In Focus Area	2012 Total FSA CLU Crop, Other Disturbed, and SD GFP Water Acres In Focus Area	2012 Total Undisturbed (Grasslands and Woodlands) Acres In Focus Area	Percent of Focus Area Classified as Undisturbed (Grasslands and Woodlands) In Focus Area	2012 Total Undisturbed Land Acres *With* 'Protected' Status In Focus Area	Percent of 2012 Undisturbed Acres *With* 'Protected' Status In Focus Area	Percent of Focus Area Classified as 'Undisturbed' *With* 'Protected' Status
Bitter Lake-Rush Lake	54,266	31,026	23,240	42,255	12,012	22.1%	2,296	19.1%	4.2%
Bristol	46,371	41,318	5,053	37,592	8,779	18.9%	1,862	21.2%	4.0%
Butler	32,632	14,983	17,650	27,311	5,321	16.3%	998	18.8%	3.1%
Crandall	82,755	37,146	45,609	33,860	48,895	59.1%	18,916	38.7%	22.9%
Crocker-Crandall Hills	75,259	75,259	0	54,189	21,070	28.0%	2,709	12.9%	3.6%
Dakota Coteau-North	310,548	51,770	258,777	108,701	201,847	65.0%	77,301	38.3%	24.9%
Dakota Coteau-South	213,849	121,514	92,334	97,097	116,751	54.6%	65,460	56.1%	30.6%
Fort Sisseton	103,273	40,150	63,124	63,697	39,577	38.3%	16,533	41.8%	16.0%
Hole-in-the-Mountain	801	801	0	287	514	64.2%	0	0.0%	0.0%
Phipps	56,604	20,491	36,113	40,544	16,060	28.4%	5,518	34.4%	9.7%
Shaokatan Prairies	55,111	37,113	17,997	34,389	20,721	37.6%	1,490	7.2%	2.7%
Waubay Lake Watershed	96,908	80,742	16,166	81,444	15,464	16.0%	5,389	34.8%	5.6%
Yellow Medicine Coteau	12,355	12,355	0	6,524	5,831	47.2%	1,319	22.6%	10.7%
Total	**1,140,732**	**564,668**	**576,064**	**627,891**	**512,841**	**45.0%**	**199,791**	**39.0%**	**17.5%**

Discussion

The last several years have yielded great interest from researchers and policy makers regarding land conversion and many popular, semi-technical, and technical papers have been published on the topic. The most notable papers providing background on the status of the Prairie Pothole Region, South Dakota, and the Prairie Coteau in general are summarized below.

Wright and Wimberly (2013) analyzed NASS CDL data from 2006 to 2012 across five states, including South Dakota. As is typical the various grass-dominated land covers could not be resolved in the satellite imagery due to their spectral similarity. Overall, while acknowledging the inability to separate native sod from other grassland types, Wright and Wimberly (2013) reported a net loss of approximately 451,000 acres of all South Dakota grasslands from 2006 to 2012. The authors found that grassland conversion in the Dakotas took place primarily east of the Missouri River and they suggested that landowners in Minnesota and the Dakotas may be seeking higher rates of return from high-quality

pasture by converting those lands to crops, a trend that is consistent with observations on the Prairie Coteau over the last decade or so.

Johnston (2013, 2014) analyzed land use change via NASS CDL data from 2006 to 2012, National Wetlands Inventory (NWI), and U.S Geological Survey National Land Cover Database (NLCD) for wetland use change for the Dakota Prairie Pothole Region of North Dakota and South Dakota. These studies incorporated all grassland/herbaceous, pasture, and hay cover by merging them into a single 'grassland' layer (not including alfalfa). Johnston (2014) found that grassland cover rose slightly annually from 2006 to 2011 via annual 'exchanges' in grassland acres with other crops until a major decline in grassland cover was recorded from 2011 to 2012. Perhaps the most notable observation by Johnston (2014) is the discussion of loss on long-duration natural land (land continuously in non-crop vegetation for five or six years), which the author suggests may serve as a 'proxy' for native sod conversion. Conversion of these lands averaged about 4% annually from 2010 to 2011 and 2.7% from 2011 to 2012. However, the author suggests that the majority of land converted to agricultural expansion was not native prairie, but rather other herbaceous vegetation rotated into production intentionally or unintentionally due to climatic or other factors.

The Environmental Working Group published two recent papers on the topic of land conversion (Faber et al. 2012; Cox and Rundquist 2013). While not peer reviewed, these papers did draw on similar data sources for analysis. Faber et al. (2012) utilized 2008 – 2011 NASS CDL data in a method of pixel counting for their landscape analysis. They reported that the counties in the Prairie Coteau region of South Dakota and Minnesota each experienced between 5,000 and 50,000 acres of conversion of grasslands/wetlands/shrubs to crop production. This data, while reported in map form on a county by county basis, cannot be quantified in relation to our 2010 TNC NFWF Prairie Coteau boundary, nor can it be used to specifically determine native grassland conversion as their NASS CDL analysis did not differentiate between various grass, hay, CRP or other grass-like vegetation types.

Decision Innovation Solutions (2013) was commissioned by seven state Farm Bureau organizations collectively to evaluate land use change between 2007 and 2012. Again, this study relied on NASS CDL data to determine land use change from a fairly generic category of "grassy habitat" to various other categorical uses including crops, woody habitat, and non-agricultural uses. Similar to Faber et al. (2012), this report indicates conversion of grassy habitat in South Dakota Prairie Coteau counties as ranging from between 1- 25,000 acres to 1-75,000 acres per county from 2007 to 2012; mostly attributed to conversion to crops. Somewhat surprisingly, conversion of grassy habitat to woody habitat was a significant contributor to grassy habitat loss in this report. We speculate that this may be due to lack of refinement in analyzing these land covers rather than true conversion to woody cover. In Minnesota Prairie Coteau counties, conversion of grassy habitat ranged from 1-25,000 per county between 2007 and 2012, again primarily due to cropping.

While none of these reports were specific to the land form we are evaluating, they do indicate trends in shifting land use from grasslands to cropland or other uses across South Dakota and/or the northern Great Plains region, and likely provide adequate indications of trends of grassland loss.

In addition to the papers mentioned above, many papers discuss the relative importance of intact native vegetation and the consequences of land conversion in general. Stephens et al. (2008) and Rashford et

al. (2010) discuss spatial and economic factors related to conversion of grasslands in the Prairie Pothole Region in general, with the Stephens et al. (2008) making an early attempt at predicting land use change over time for the Missouri Coteau region of the Dakotas.

Cox and Rundquist (2013) listed South Dakota as the state with the highest rate of wetland conversion, most of which was concentrated in the Prairie Pothole Region. This report indicated that South Dakota Prairie Coteau counties each lost between 2,500 and 7,500 acres of wetlands between 2008 and 2012. No such analysis was performed on Minnesota Prairie Coteau counties. Johnston et al. (2013), Blann et al. (2009), Werner et al. (2013), Voldseth et al. (2007, 2009), and Doherty et al. (2013) expanded the discussion on wetland conversion in the region, focusing on various impacts as a result of cropping systems, drainage, climate change, and grassland restoration.

Caution should be applied when utilizing any of the mentioned data for evaluating land use changes on the Prairie Coteau specifically because while likely an accurate 'ball park' estimate for the regions sampled, these data do not differentiate between native grasslands and several types of non-native grass or grass-like vegetation and thus cannot provide accurate indication of loss of truly native sod. That said, the trend in grassland loss obviously does include some percentage of native sod and the overall loss of all grassland habitat types can have significant impacts on the general use and distribution of grassland-dependent species.

While it would be simple to assume current land use or rates of conversion for the Prairie Coteau as similar to other regions of South Dakota, the geology of the landform itself is highly variable with some areas lending themselves to conversion to farmland while other areas remain topographically challenging even with today's modern farm equipment. In addition, because of the prevalence of conservation work in the region, 276,184 acres of undisturbed land in the South Dakota portion of the Prairie Coteau are under permanent protection from land conversion due to conservation easements or agency ownership.

Perhaps the most locally accurate numbers on land use change relative to the Prairie Coteau to be reported thus far would be those of Reitsma et al. (2014). Using a rather unique system of point observations to verify NASS CDL trends in nine observation areas based on USDA-NASS reporting districts, the authors evaluated landscape gain/loss and percent change of several categories of land use. Statewide, they reported approximately a 1.8 million acre loss in South Dakota's overall grassland coverage from 2006 – 2012 with this method (over four times what was reported by Wright and Wimberly [2013]). As with previous studies, 'grasslands' included range, pasture, hay, alfalfa, and other grasslands. Habitat (wetlands and forests) increased over the same time period by approximately 129,000 acres statewide.

Of greatest significance in the Reistma et al. (2014) paper to this report were the estimated land use changes to the Northeast NASS district (including Prairie Coteau counties of Marshall, Day, Roberts, Clark, Codington, Hamlin, Grant, and Deuel counties) and to the East Central NASS district (including Prairie Coteau Counties of Kingsbury, Brookings, Sanborn, Miner, Lake, Moody, Davison, Hanson, McCook, and Minnehaha counties). Although not exact, these two NASS regions do encompass the majority of the Prairie Coteau in South Dakota and more closely mimic our focal area than do other studies.

For the northeast NASS district, Reitsma et al. (2014) reported a gain of 239,700 acres of cropland (12.7%); a loss of 269,000 acres of grasslands (16.9%); no change in non-ag land; a loss of 24,000 acres of habitat (8.1%); and a gain of 53,300 acres of water cover (17.2%) from 2006 to 2012. In the East Central District they report a gain of 163,000 acres of cropland (7.8%); a loss of 217,200 acres of grassland (15.9%); a gain in non-ag land of 4,900 acres (2.6%); a gain in habitat of 37,000 acres (18.5%); and a gain in water of 12,300 acres (13.5%). Of most notable significance to the Prairie Coteau in this report is the combined loss of grasslands in these two regions totaling an approximately 486,200 acres.

Doherty et al. (2013) made the most comprehensive attempt to date to not only quantify land use change, but to also tie land use decisions directly to conservation strategies. Arguably, this paper drew on the widest array of known data to develop a general 'picture' of the Prairie Pothole Region. Of particular not in this paper is the effect of both time and scale as critical factors in developing land use policy/opportunity that are reflective of agency conservation goals. While not specific to the Prairie Coteau, the parallels in this paper in regard to land use decisions and drivers between the greater Prairie Pothole Region and the Prairie Coteau are largely comparable.

Further complicating any analysis of land use change is the fact that historically many areas of the Prairie Coteau were farmed only to be allowed to re-vegetate naturally (more or less). These tracts, if identified, are often referred to as 'go-back' pastures, indicating they were allowed to 'go-back' or vegetate naturally. The conversion and subsequent natural reclamation of these tracts occurred primarily prior to the onset of the heavy use of agricultural herbicides, thus vegetation diversity and quality can be variable. While nearly impossible to confidently categorize from aerial imagery, the land use history of many of these tracts can be determined by on-the-ground evaluation of physical and ecological indicators such as tillage furrows, rock piles, and simple plant communities infested with exotic species. In rare cases, they can be very difficult to identify solely based on plant community composition where physical indicators may be limited and where plant community composition reflects a high diversity of native plants (a very rare occurrence).

Unfortunately simple quantification of land tracts under conservation easement or ownership by agencies is not an accurate indication of native lands because many 'go back' tracts (which are not truly native) are included in easements and ownership. Further, many truly native tracts remain in private ownership as working farms and ranches not under easement or conservation contract, and thus any quantification of native sod based solely on 'protection' status would be a gross underestimate.

Because no baseline exists for native or undisturbed sod on the Prairie Coteau, we cannot provide a reasonable estimate of land use change over time that can support or refute trends reported by others. However, with our methodology, we were able to quantify all areas of the Prairie Coteau that are likely native untilled sod (as of 2012) to a degree not previously attempted. Our methodology provides a 'road map' to future analysis that will provide a baseline of reasonable potential areas of native sod based on known measured data. Final analysis of quality of these tracts can only be quantified by qualified personnel who will evaluate these sites for objective physical or ecological indicators as to what is truly 'native' sod and the quality of the plant community therein.

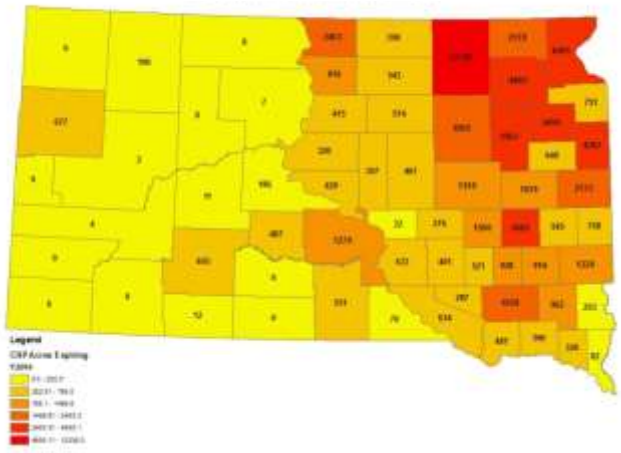
Management Implications

Rashford et al. (2010) stated that *"the scientific basis for predicting ecological consequences of grassland conversion is much better developed than the basis for predicting conversion itself"*. We found this simple statement to be quite true in our evaluation of attempts to quantify grassland loss. While some authors suggest that land conversion and subsequent loss of grasslands must be considered objectively against societal values (Reitsma et al. 2014), it is important to understand the losses and conversion rates reported in those studies do not differentiate between the general loss of grass cover to the actual loss of native grasslands, nor do they necessarily consider the cumulative loss of native grasslands over time and space. What is consistent across all reports is that we can expect land use changes and conversion to continue (Doherty et al 2013).

Within those reports, native grassland is included as an unidentified portion of total grassland loss. The remainder of grassland conversion reported is better described as grass 'crop' acres, such as Conservation Reserve Program (CRP) acres, small grains, alfalfa, tame grass, or even historic crop fields that have actively or passively re-vegetated with some semblance of native and exotic vegetation. Use of these previously tilled acres and the type of crop they produce (including grasses) may ebb and flow, and these simplified planted habitats can be destroyed and re-created over time and space. The conversion of these grass 'crop' acres can have social, economic, and ecological benefits and detriments, but they are not suitable surrogates for evaluation of the loss of truly native grassland acres (Doherty et al. (2013).

> *When one land use expands, it is always at the expense of another"*
>
> - Johnston (2014)

Figure 10. South Dakota 2014 Conservation Reserve Program Expirations by County (SD Farm Services Agency, May 2014).



The best representation of the 'rotation' of these acres is found in evaluating the gain and loss in CRP acres. Figure 10 shows the expiration of CRP contracts for South Dakota in 2014. The Prairie Coteau region has had some of the highest average acres of expirations since 2012. While many of these acres will likely be rotated to crops if current trends persist, some landowners may choose to re-enroll their acres in CRP contracts for an additional ten or fifteen years. Simply put, CRP can be re-created over time and space.

Native grassland cannot be re-created over time and space. Once converted, native grassland is gone forever. Converted native grassland acres can eventually be re-cropped with grass and grass-like covers that may provide some of the social, economic, and ecological values provided by the original native grassland, but it is impossible to re-create all values inherent in native grassland and undisturbed soils,

thus the ecological, social, and economic impacts of conversion of grass 'crop' acres are not necessarily equal to those incurred with the conversion of native grasslands.

If native grasslands are lost at recent rates reported for all grasslands, a 2-4% annual loss can hypothetically become a 20-40% loss of an irreplaceable resource over a ten year period. Therefore, conversion of remnant native grassland requires a cost/benefit analysis that acknowledges true loss of an irreplaceable ecosystem. Perhaps Doherty et al. (2013) captures the argument for the cumulative effects of time on grassland conversion and conservation policy more thoroughly than any other report, calling for the identification and protection of high-diversity remnant areas as a critical step in conservation planning in relation to timing (i.e. sooner than later).

As grasslands continue to be one of the most threatened ecosystems on the planet, the northern Great Plains is a focal area for grassland conversion. Our methodology not only provides a model for mapping the remainder of the Prairie Coteau in Minnesota, it can be applied to identifying and mapping all of South Dakota's potential remaining native habit, as well as those in other states. Once our methods were refined, mapping became quite simple and efficient. While there is still a small degree of subjectivity involved, our techniques provide a reasonable estimate of native untilled sod with a far greater degree of local accuracy at a usable scale than do previous estimates.

Our native grassland and native woodland results establish a simple base data layer for future analysis. Because of the clarity provided by the USGS imagery, new cropping/conversion or disturbances are quite obvious through on-screen analysis. By utilizing GIS technology to overlay our 2012 grassland and woodland layer results on future USGS aerial imagery, analysis of additional land disturbances within our polygons will allow researchers to estimate an accurate rate of conversion for this region while also allowing continues refine of the undisturbed grassland and woodland layers over time.

Unfortunately, the total acres of undisturbed native grassland can only remain constant or decrease over time. However, there is potential for the woodland portion of the layer to increase if volunteer native woody vegetation infiltrates native grasslands and achieves a density that would indicate closed canopy cover. That measure is somewhat subjective and we believe that significant change in the native woodland layer would be required in order to accurately detect change through short term analysis.

In addition to expansion of native woody cover, the Prairie Coteau will likely be subject to increasing invasions of exotic and aggressive woody species such as eastern red cedar (*Juniperus virginiana*). This situation may pose a particular challenge in future analysis of the undisturbed grassland layer, as these woody invaders can eventually achieve a dense canopy appearance. Our suggestion would be that these areas continue to be classified as native grasslands unless or until the density of trees is so prevalent that physical removal of the trees from the landscape is likely impractical, at which time those land tracts should be eliminated from the native grassland and native woodland data layer and classified as disturbed land.

Overall, our methodology and subsequent results will allow for improved analysis of the quality of the remaining undisturbed portions of the landscape by providing a 'road map' for researchers to target their efforts to quantify overall undisturbed grassland biological diversity and habitat potential. As stated previously, there is a certain percentage of our undisturbed grassland and woodland layers that are likely

'go back' pasture that is relatively low in diversity. Those areas cannot be quantified without some sort of improved evaluation through ground truthing. The same need for ground truthing holds true for identifying the highest quality areas.

Overall, quality, structure and function of remnant grasslands and landscape fragmentation play a key role in overall habitat suitability for a variety of species and are important considerations for a variety of grassland birds (Chapman et al. 1998, Higgins et al. 2002., Rich et al. 2004, Doherty et al. 2013). Current research conducted by South Dakota State University in conjunction with the South Dakota Department of Game, Fish, and Parks is focused on assessing quality of vegetation on the Prairie Coteau (Narem, 2013, unpublished data). In this work, researchers selected a 225 mi^2 area located on a portion of the east slope of the Prairie Coteau in Day and Roberts counties to assess habitat suitability for endemic Dakota skipper (*Hesperia dacotae*) and Poweshiek skipperling (*Oarisma poweshiek*) butterflies based on established metrics suitable for the region. Our map will allow for improvements in systematic evaluations of undisturbed grassland habitat quality by allowing researchers to evaluate these tracts based on parameters such as size, location, or relation to other habitats (such as wetlands).

Undisturbed (native) grassland and woodland protection is important for long-term conservation of the Prairie Coteau. Rashford et al. (2010) and Stephens et al. (2008) suggested that grasslands on high-quality soils are more likely to be converted to cropland than grassland on low-quality soils in the Prairie Pothole Region. While this is likely true in most cases, recent observations on the Prairie Coteau have indicated that land managers are willing to engage in the risky conversion of marginal and poor land with the intent of growing crops on the historically rocky and/or wet native prairie/pasture areas, independent of the perceived impacts of market trends.

Figures 11 and 12 illustrate examples of a recent poor land use decision in Grant and Day Counties of the Prairie Coteau in South Dakota. During the period of time represented in Figure 11 (spring 2013), corn prices (assumed to be a primary driver of land conversion) were very high (~$7.00/bu.). Conversely, Figure 12 photos were taken in May of 2014. In this case conversion of native sod to crops continues while corn prices have dipped to approximately $4.00/bu., suggesting the drivers of land conversion are complex (Doherty et al. 2013).

In conclusion, we believe our mapping methods allow assessment of future land use change for previously undisturbed or native tracts that have occurred after 2012 such results will allow conservation organizations such as The Nature Conservancy, The National Fish and Wildlife Foundation, and others to target evaluation and conservation specifically aimed on protection of undisturbed grasslands and woodlands.

Figure 11: Grant County South Dakota (east slope of the Prairie Coteau). Native sod conversion attempted for cropping during the spring of 2013 (left). Light soils and an overwhelming density of rocks appear to have caused the owner to abandon the cropping project by the fall of 2013 (right). Once destroyed with the use of chemical applications and tillage, the total structure and function of this native grassland, its soils, and its ecology can never fully be recreated (photos by Pete Bauman).

Figure 12: Day County South Dakota near Bitter Lake in the Heart of the Prairie Coteau. Native sod conversion to cropping during the spring of 2014 (photos by Ben Lardy).

Literature Cited

Aldrich, J. M., W. R. Ostlie, and T. M. Faust. 1997. The Status of Biodiversity in the Great Plains: Great Plains Landscapes of Biological Significance. Supplemental Document 2, *In:* W.R. Ostlie, R.E. Schnieder, J.M Aldrich, T.M. Faust, R.L.B. McKim and S.J. Chaplin, The Status of Biodiversity in the Great Plains. The Nature Conservancy, Arlington, VA. 135pp. + VIII.

Blann, K. L, J. L. Anderson, G. R. Sands, and B. Vondracek. 2009. Critical Reviews in Environmental Science and Technology. 39:909-1001.

Catlin, C. 1844. Letters and Notes on the Manners, Customs, and Condition of the North American Indians.

Chapman, K., K. Hiller, and J. Haferman. 1998. Identification of Important Bird Sites in the Northern Tallgrass Prairie Ecoregion: A Step in Ecoregion-Based Conservation. The Nature Conservancy, Minnesota Chapter, Minneapolis, MN, USA.

Cox, C. and S. Rundquist. 2013. Going, Going, Gone! Millions of Acres of Wetlands and Fragile Land Go Under the Plow. Environmental Working Group. 11 pp. http://www.ewg.org/research/going-going-gone

Decision Innovation Solutions. (2013). 2013 *Multi-State Land Use Study: Estimated Land Use Changes 2007-2012*. Urbandale, IA 50322: Decision Innovation Solutions. Retrieved March 17, 2014, from http://www.decision-innovation.com/images/docs/130715%20Multi-State%20Land%20Use%20Report%20(FINAL).pdf

Doherty, K. E., A. J. Ryba, C. L. Stemler, N. D. Niemuth, and W. A. Meeks. 2013. Conservation Planning in an Era of Change: State of the U.S. Prairie Pothole Region. Wildlife Society Bulletin. 37:546-563. http://ppjv.webfactional.com/resources/reports/state-of-the-prairies

Faber, S., S. Rundquist, and T. Male. 2012. Plowed Under: How Crop Subsidies Contribute To Massive Habitat Losses. Environmental Working Group. 12 pp. http://static.ewg.org/pdf/plowed_under.pdf

Higgins, J. J., G. E. Larson, and K. F. Higgins. 2002. Managing Tallgrass Prairie Remnants: The Effects of Different Types of Land Stewardship on Grassland Bird Habitat. Ecological Restoration. 20:18-22.

Johnson, R. R., K. F. Higgins, and D. E. Hubbard. 1995. Using Soils to Delineate South Dakota Physiographic Regions. Great Plains Research: A Journal of Natural Sciences. Paper 211. http://digitalcommons.unl.edu/greatplainsresearch/211

Johnston, Carol A. 2014. Agricultural Expansion: Land Use Shell Game in the U.S. Northern Plains. Landscape Ecology 29:81-95.

Johnston, Carol A. 2013. Wetland Losses Due to Row Crop Expansion in the Dakota Prairie Pothole Region. Wetlands 33:175-182.

Loeschke, M. J. Circa 1995. The Prairie Coteau Natural Areas Inventory: Day, Marshall, and Roberts Countys (sic), South Dakota. South Dakota State University, Brookings, SD. 41 pp.

Miller, C. 2001. Prairie Coteau Conservation Initiative. The Nature Conservancy, Clear Lake, SD. 22 pp.

Narem, 2013. Mapping and Characterization of Native Grassland Habitats on South Dakota's Prairie Coteau. Interim Report. T-54-R-1 Amd #2 Study #: 2464. Jan 1 – Dec 15, 2013.

Rashford, B. S., J. A. Walker, and C. T. Bastian. 2010. Economics of Grassland Conversion to Cropland in the Prairie Pothole Region. Conservation Biology. 25:276-284.

Reitsma, K. D., D. E. Clay, C. G. Carlson, B. H. Dunn, A. J. Smart, D. L. Wright, and S. A. Clay. 2013. Estimated South Dakota Land Use Change from 2006 to 2012. White paper; South Dakota Governors Pheasant Habitat Work Group. SDSU Extension. 03-2001-2014. 4 pp. Available at http://gfp.sd.gov/pheasantsummit/docs/SDSULandUse2001-2014.pdf (Verified May 16, 2014).

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A . M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, NY.

Smart, A., P. Bauman, and B. Dunn. 2003. Discover the Prairie Coteau: Located in the Heartland of America, this Unique Region Showcases the Diverse Tallgrass Prairie. Rangelands. 25:39-42.

Stephens, S. E., J. A Walker, D. R. Blunck, A. Jayaraman, D. E. Naugle, J. K. Ringelman, and A. J. Smith. 2008. Predicting Risk of Habitat Conversion in Native Temperate Grasslands. Conservation Biology. 22:1320-1330.

The Nature Conservancy, Northern Tallgrass Prairie Ecoregional Planning Team. 1998. Ecoregional Planning in the Northern Tallgrass Prairie Ecoregion. The Nature Conservancy, Midwest Regional Office, Minneapolis, MN, USA. 208 pp. + iv.

The Nature Conservancy. 2010. Business Plan. Conserving and Restoring Tallgrass Prairie: Prairie Coteau, South Dakota and Minnesota. Submitted to the National Fish and Wildlife Foundation. The Nature Conservancy, Minneapolis, MN. 59 pp.

US Geological Survey. 2013. Northern Prairie Wildlife Research Center http://www.npwrc.usgs.gov/resource/habitat/ndsdeco/46l.htm

Voldseth, R. A., W. C. Johnson, T. Gilmanov, G. R. Guntenspergen, and B. V. Millett. 2007. Model Estimation of Land-Use Effects on Water Levels of Northern Prairie Wetlands. Ecological Applications. 17:527-540.

Voldseth, R. A., W. C. Johnson, G. L. Guntenspergen, T. Gilminov, and B.V. Millet. 2009. Adaptation of Farming Practices Could Buffer Effects of Climate Change on Northern Prairie Wetlands. Wetlands. 29:635-647.

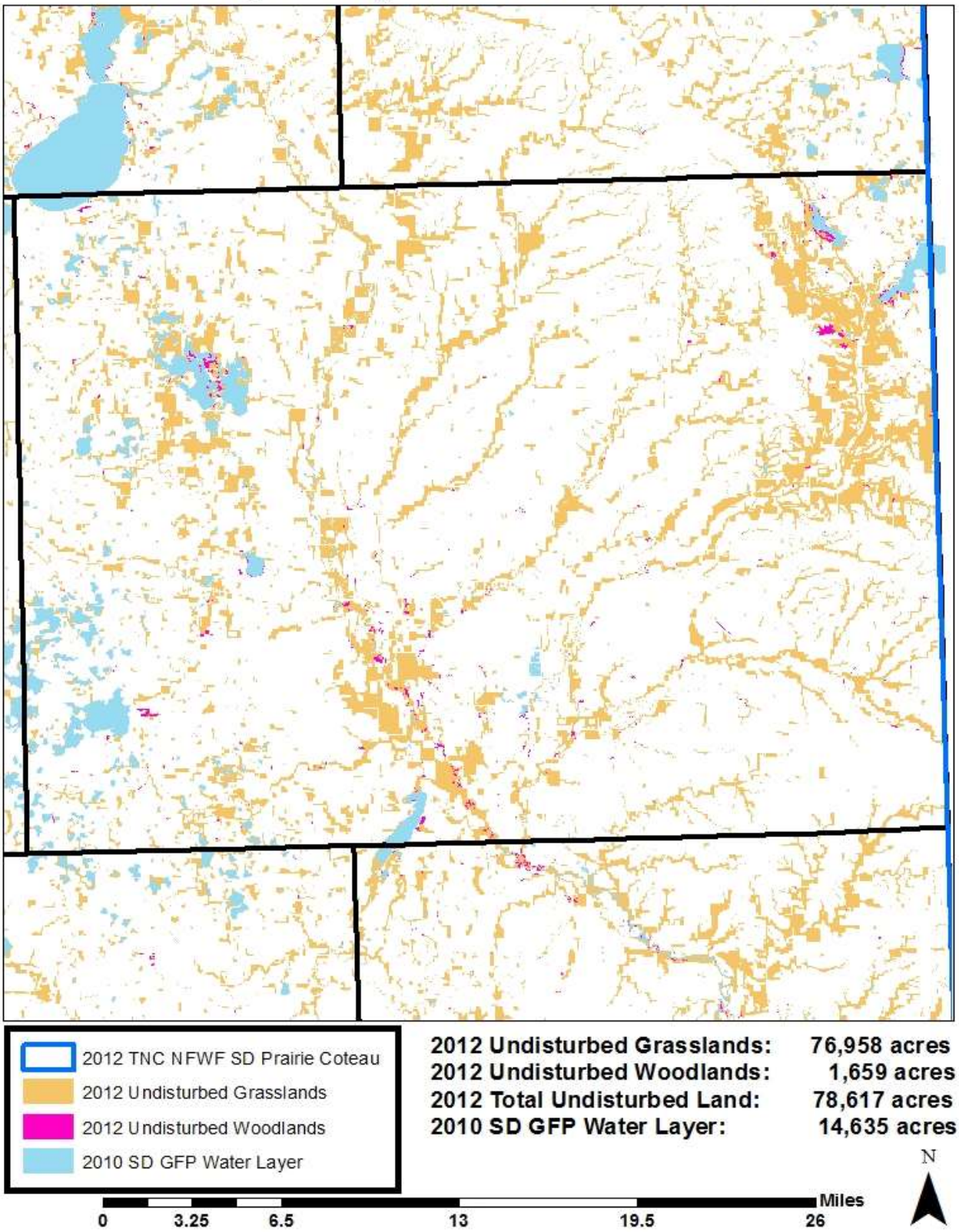
Werner, B. A., W. C. Johnson, and G. R. Guntenspergen. 2013. Evidence of 20th Century Climate Warming and Wetland Drying in the North American Prairie Pothole Region. Ecology and Evolution. 3(10):3471-3482.

Wright, C. K., and M. C. Wimberly. 2013. Recent Land Use Change in the Western Corn Belt Threatens Grasslands and Wetlands. Proceedings of the National Acadamy of Sciences of the United States, 110(10), 4134-4139.

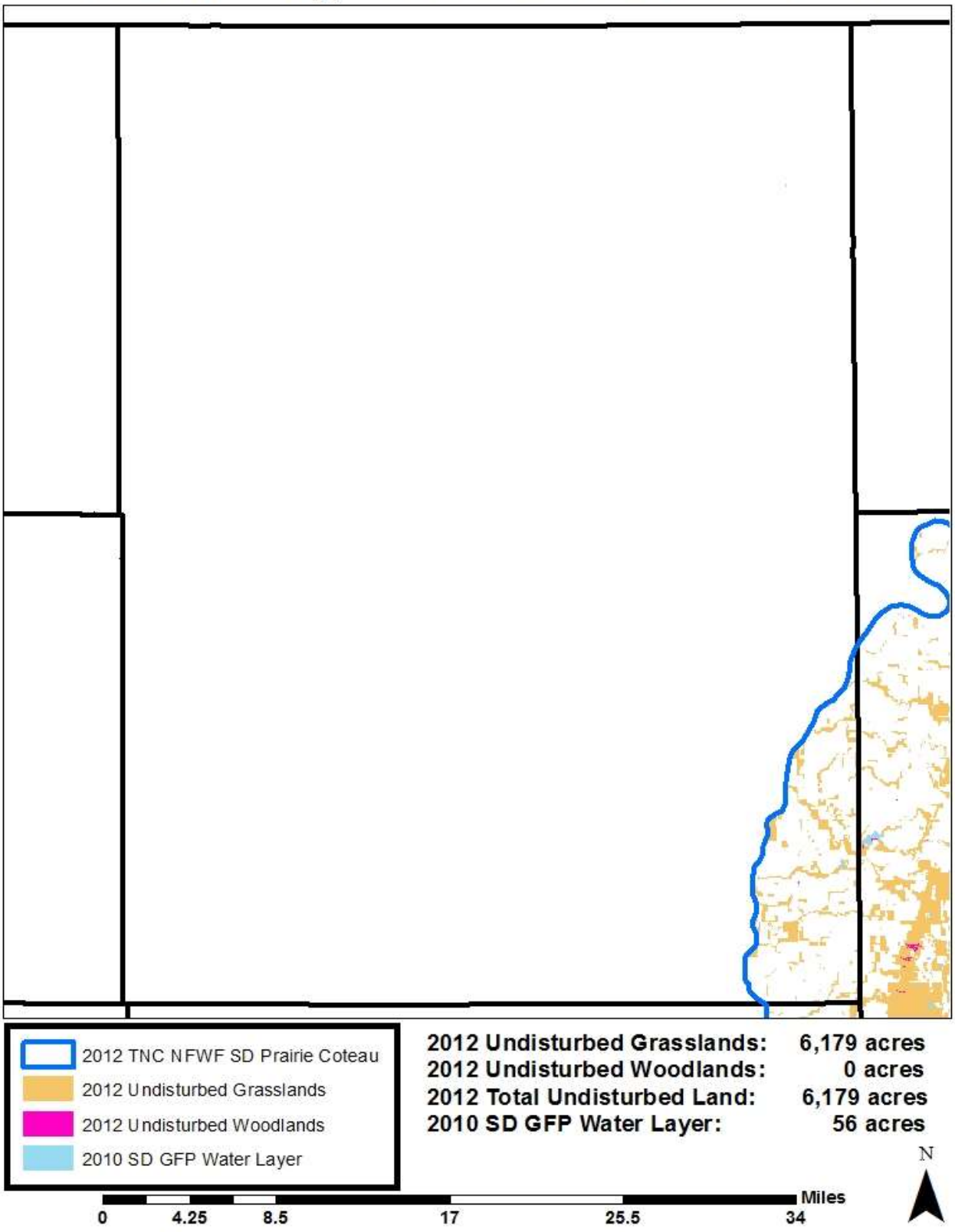
Appendix A:

Undisturbed Grasslands and Woodlands in the South Dakota Prairie Coteau, by County.

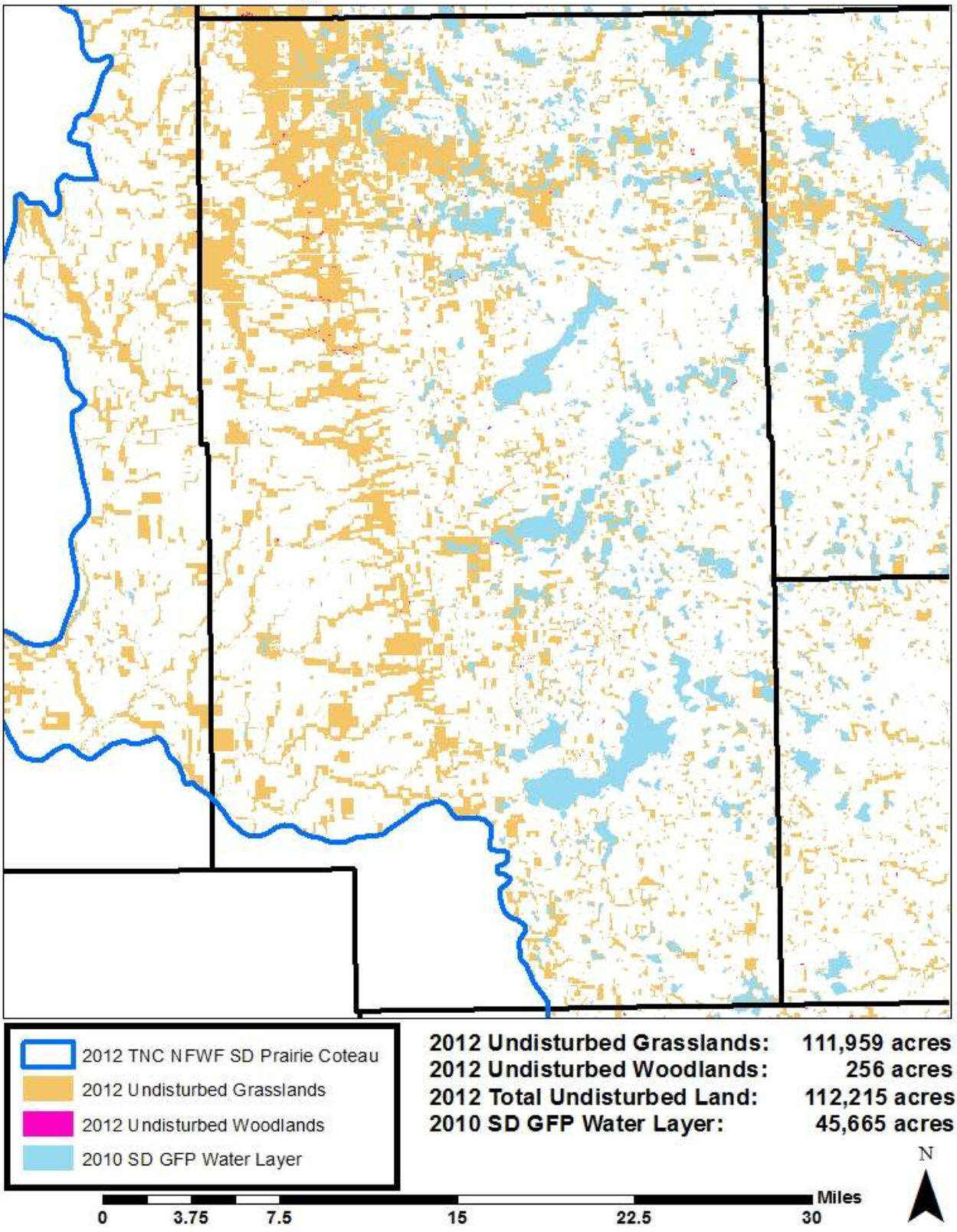
2012 Brookings County, SD Prairie Coteau Undisturbed Acres



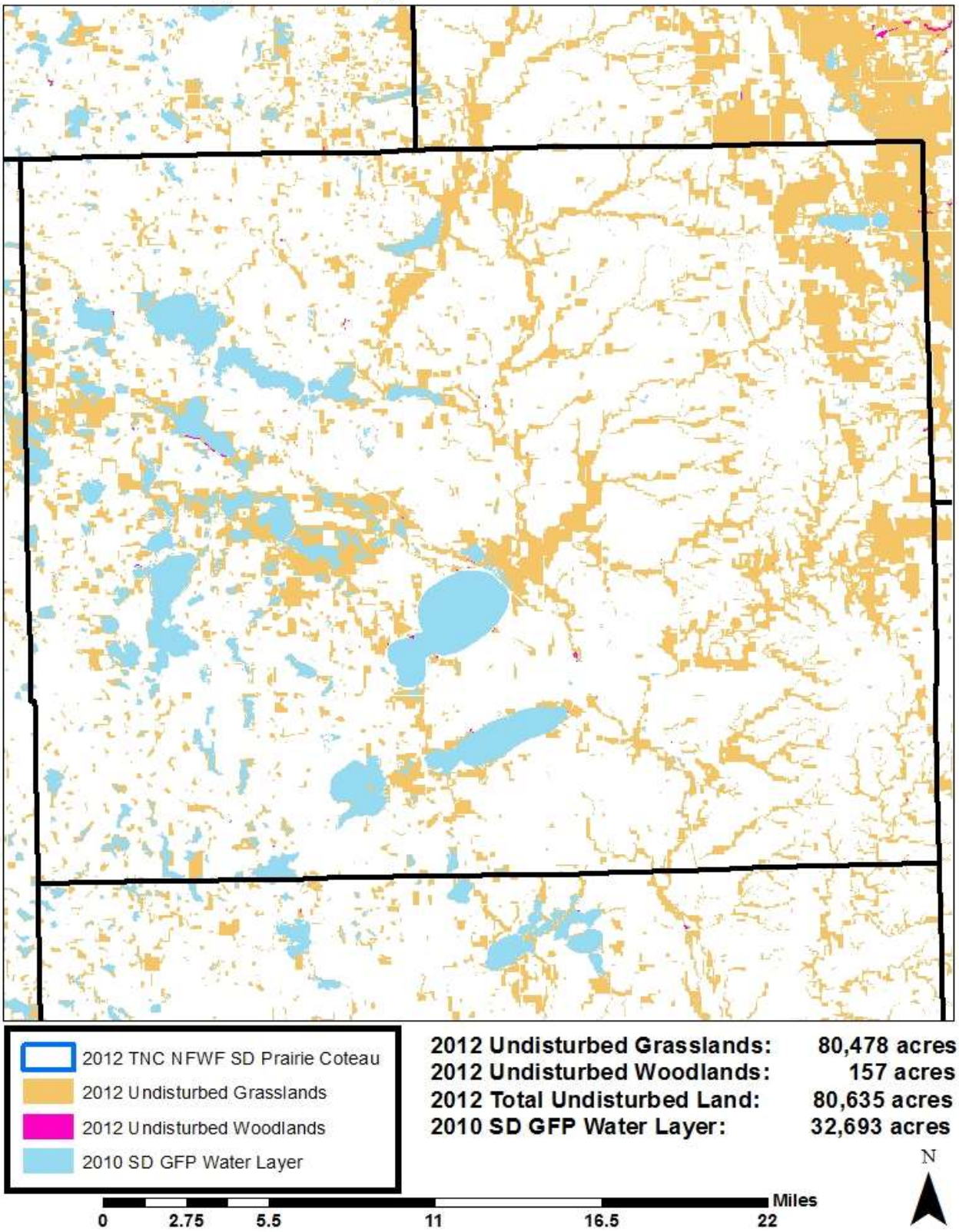
2012 Brown County, SD Prairie Coteau Undisturbed Acres

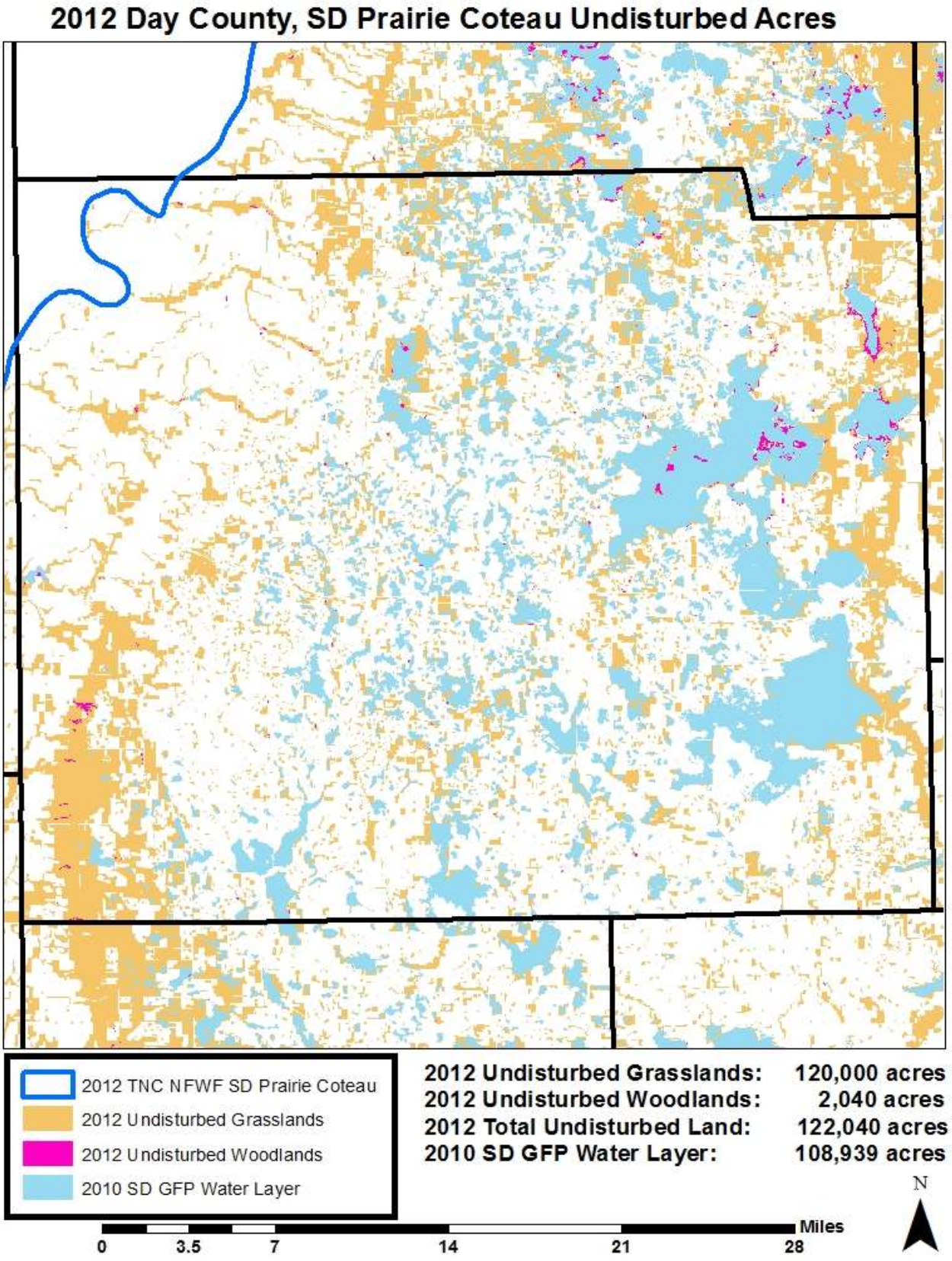


2012 Clark County, SD Prairie Coteau Undisturbed Acres

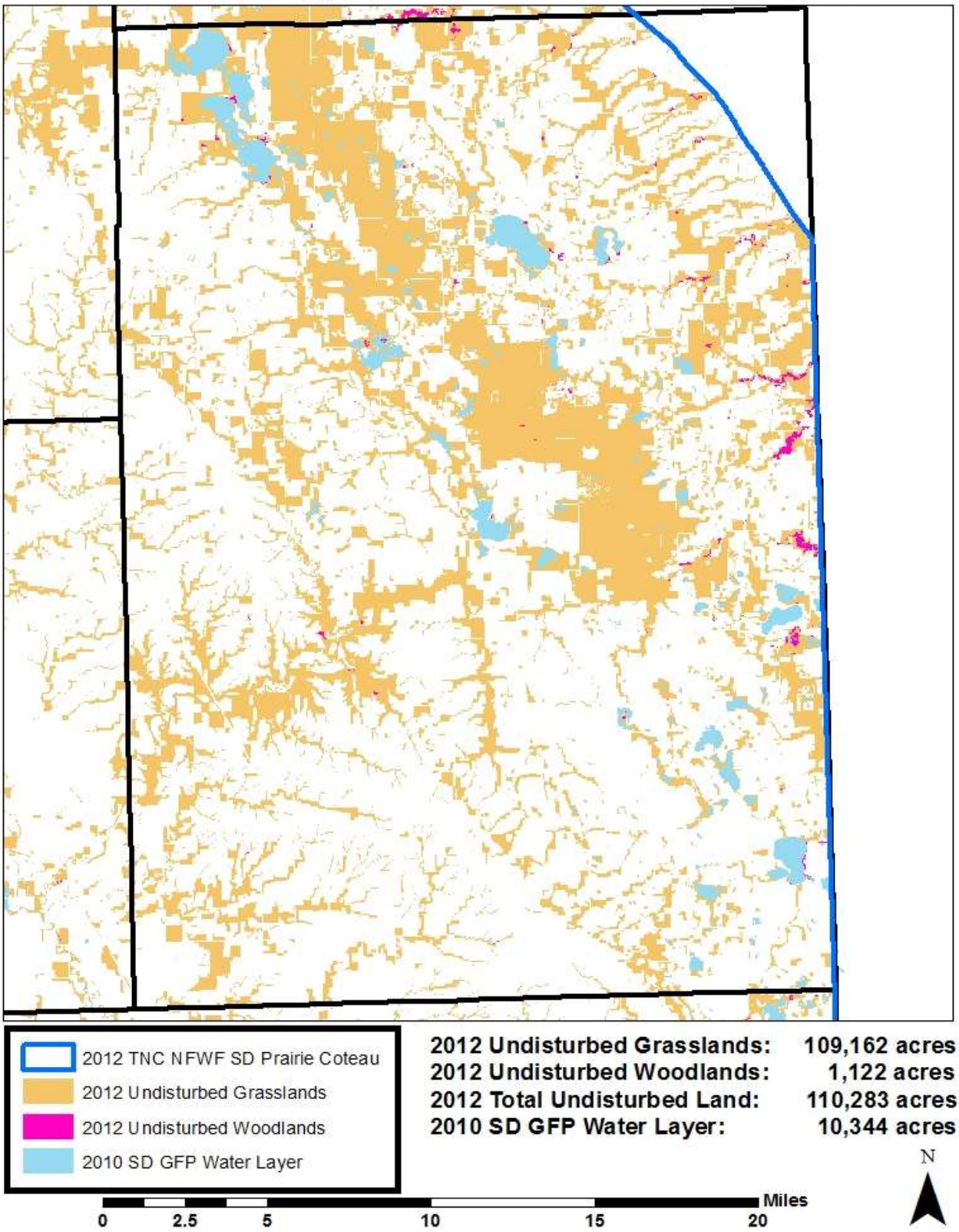


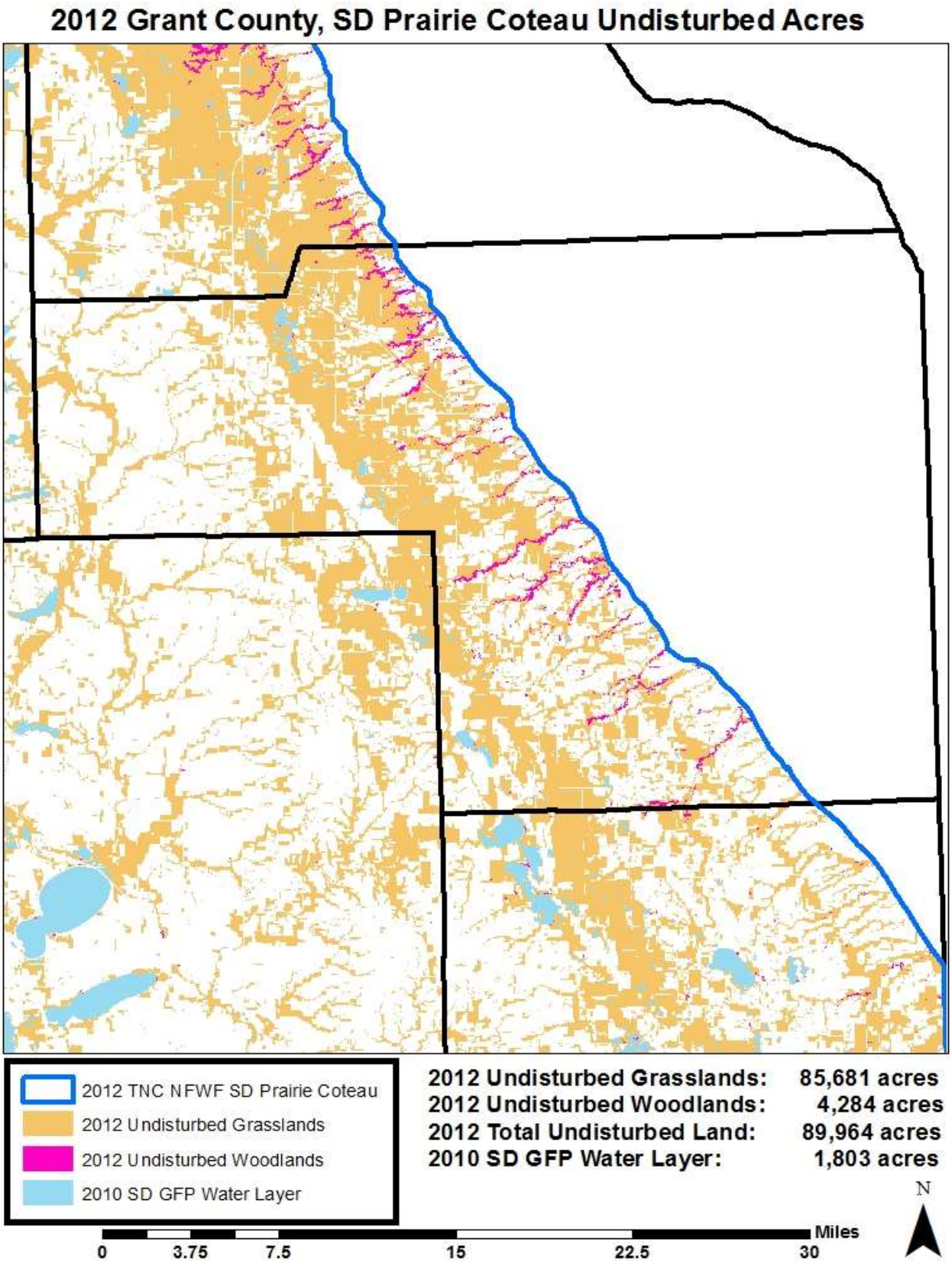
2012 Codington County, SD Prairie Coteau Undisturbed Acres



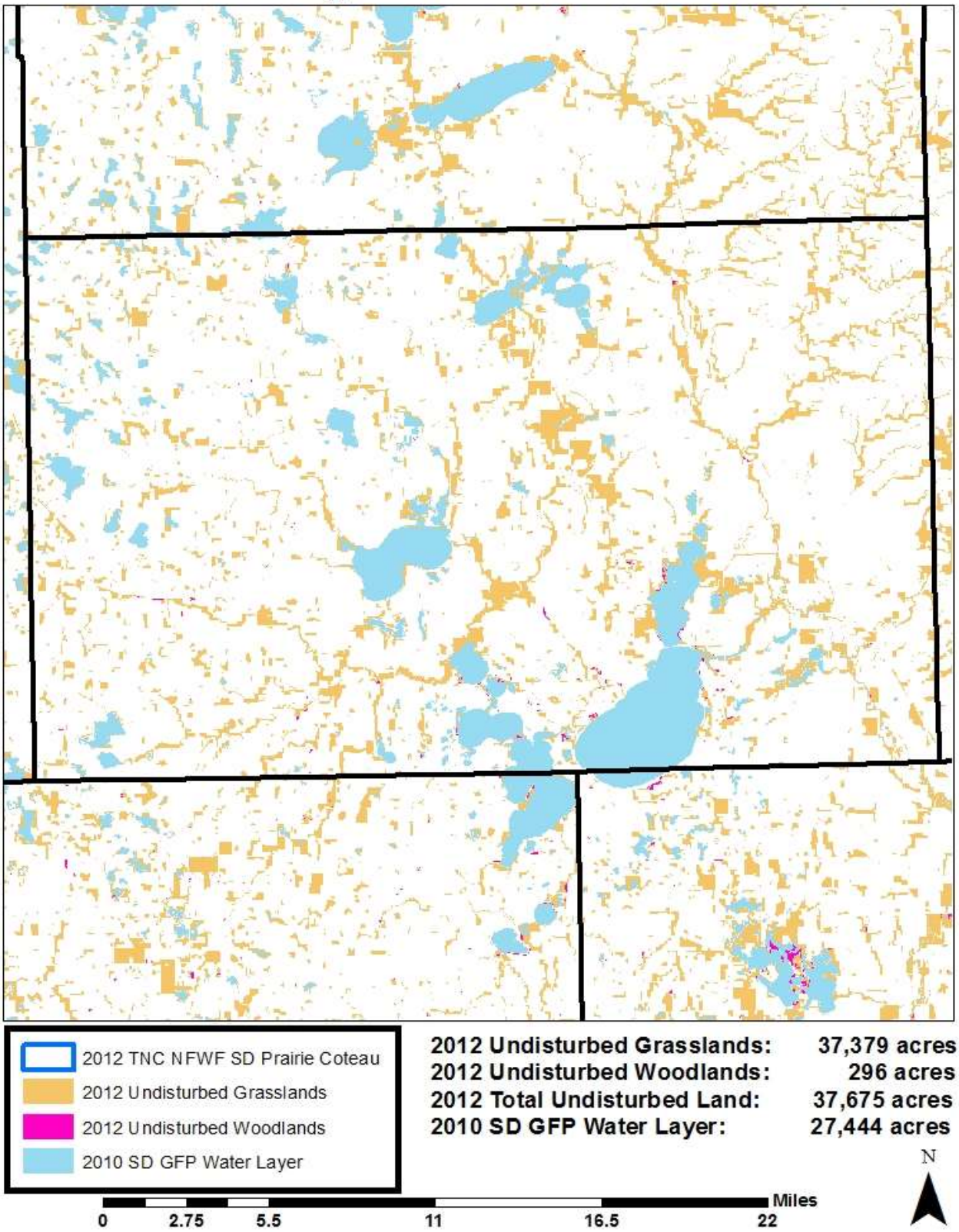

2012 Day County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 120,000 acres
2012 Undisturbed Woodlands: 2,040 acres
2012 Total Undisturbed Land: 122,040 acres
2010 SD GFP Water Layer: 108,939 acres
N
Miles
0
3.5
7
14
21
28

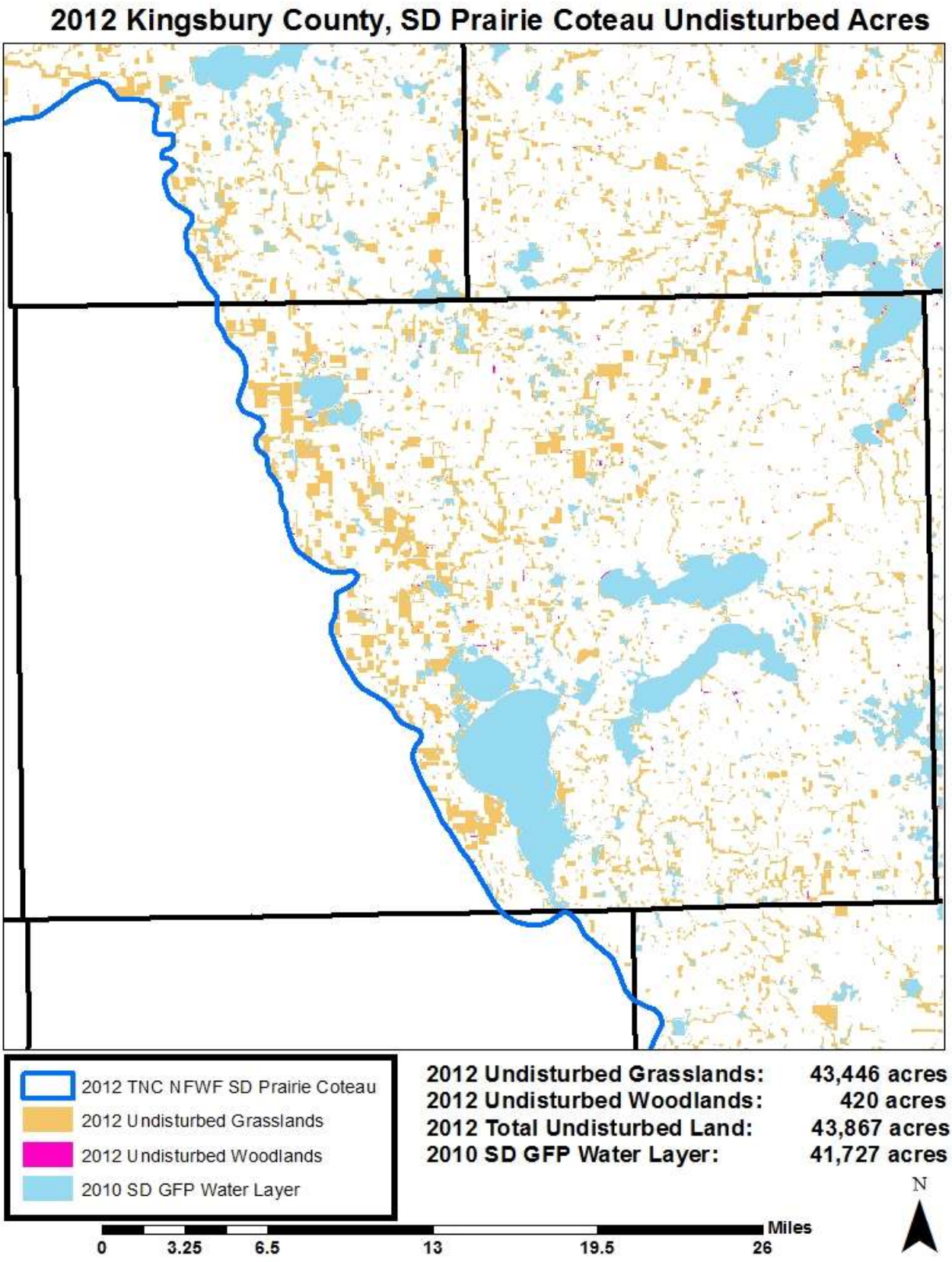
2012 Deuel County, SD Prairie Coteau Undisturbed Acres

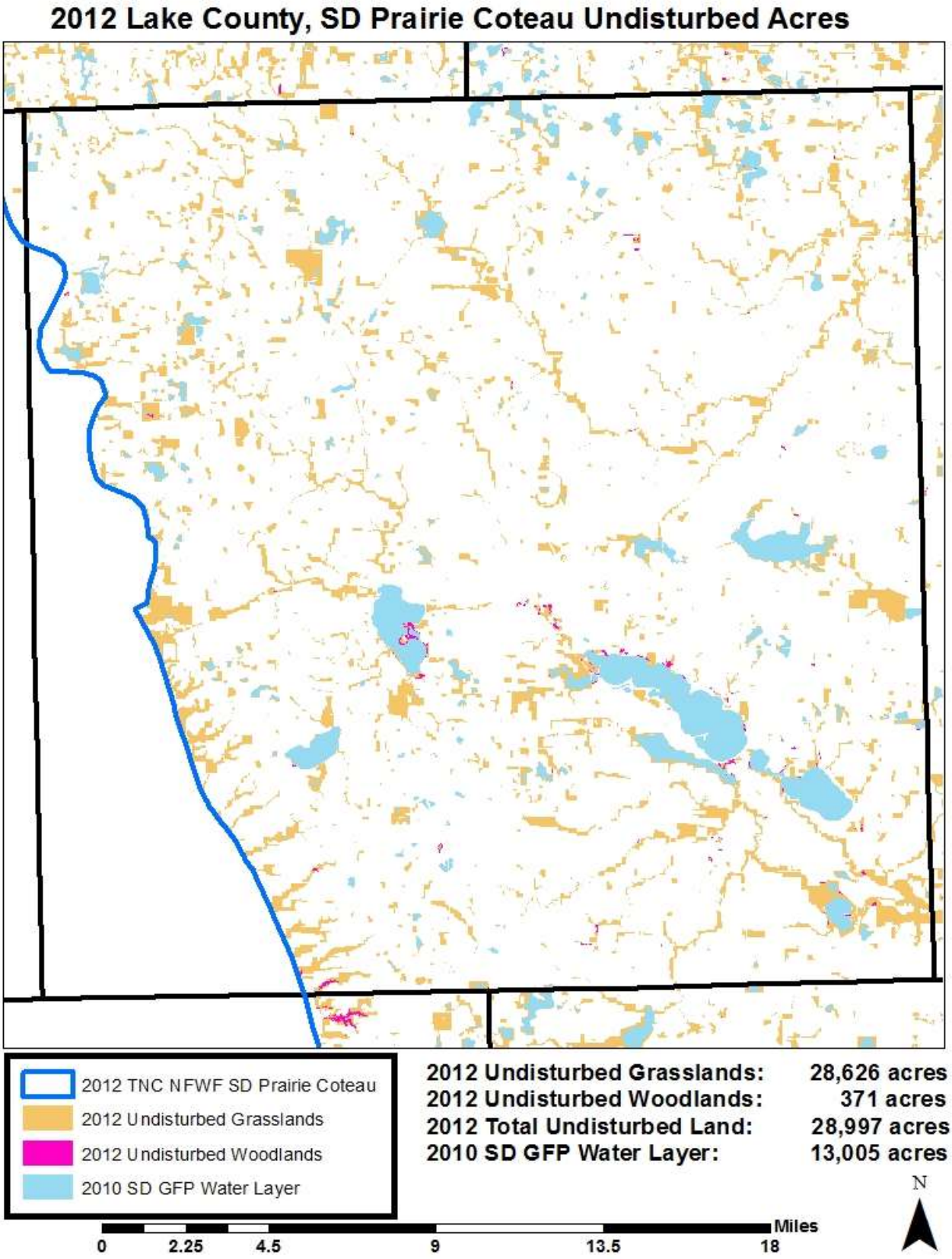



2012 Grant County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 85,681 acres
2012 Undisturbed Woodlands: 4,284 acres
2012 Total Undisturbed Land: 89,964 acres
2010 SD GFP Water Layer: 1,803 acres
N
Miles
0
3.75
7.5
15
22.5
30

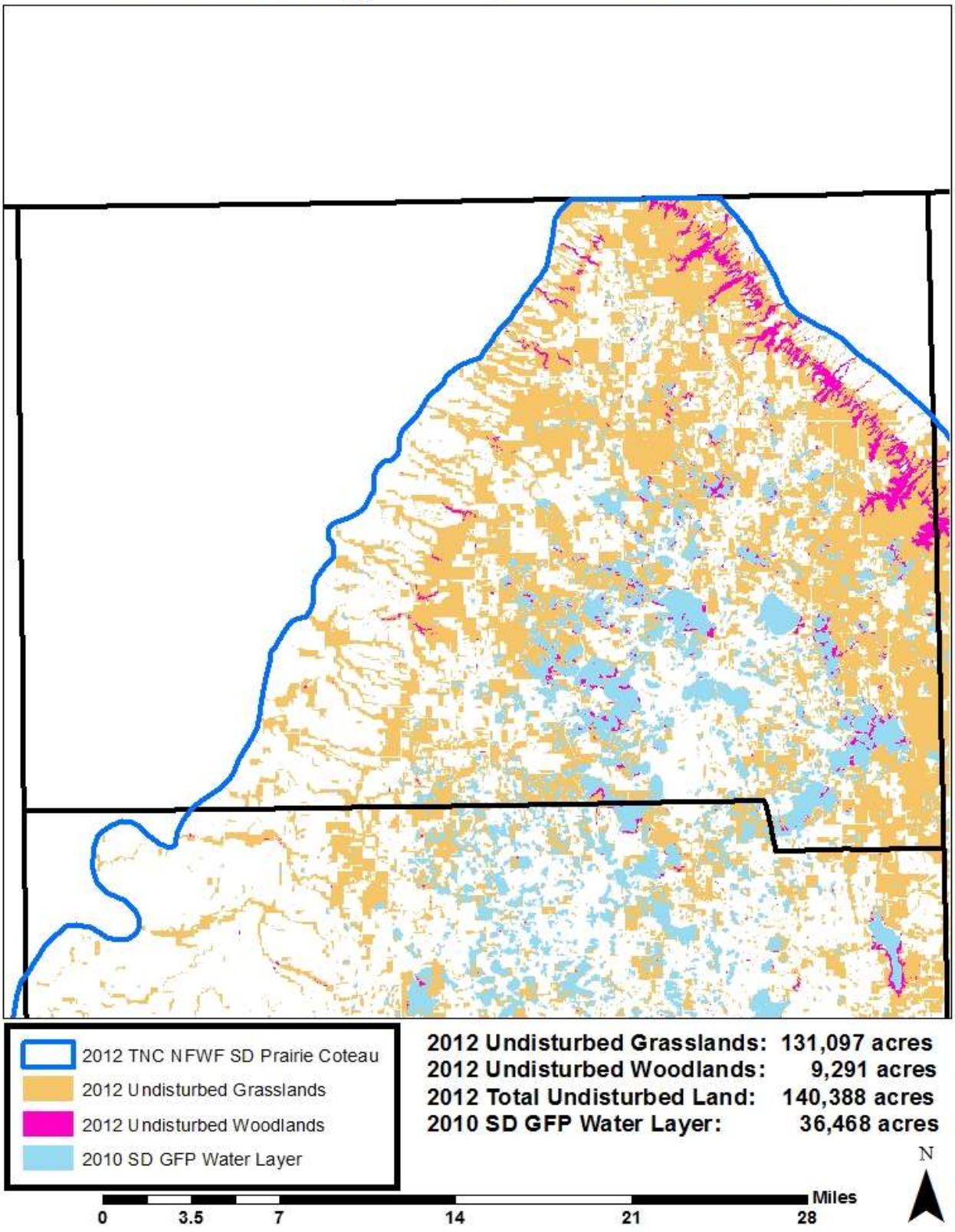
2012 Hamlin County, SD Prairie Coteau Undisturbed Acres

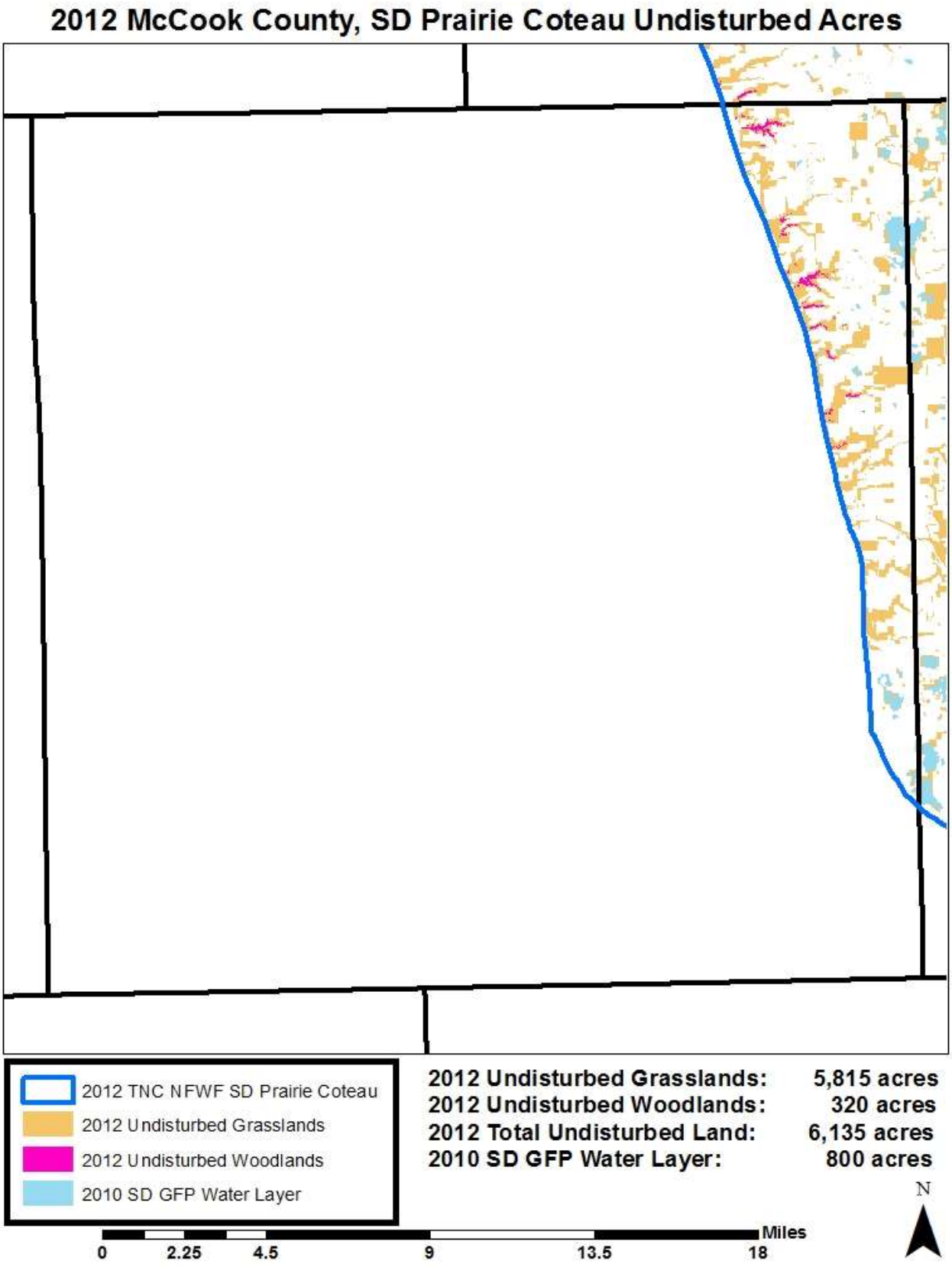


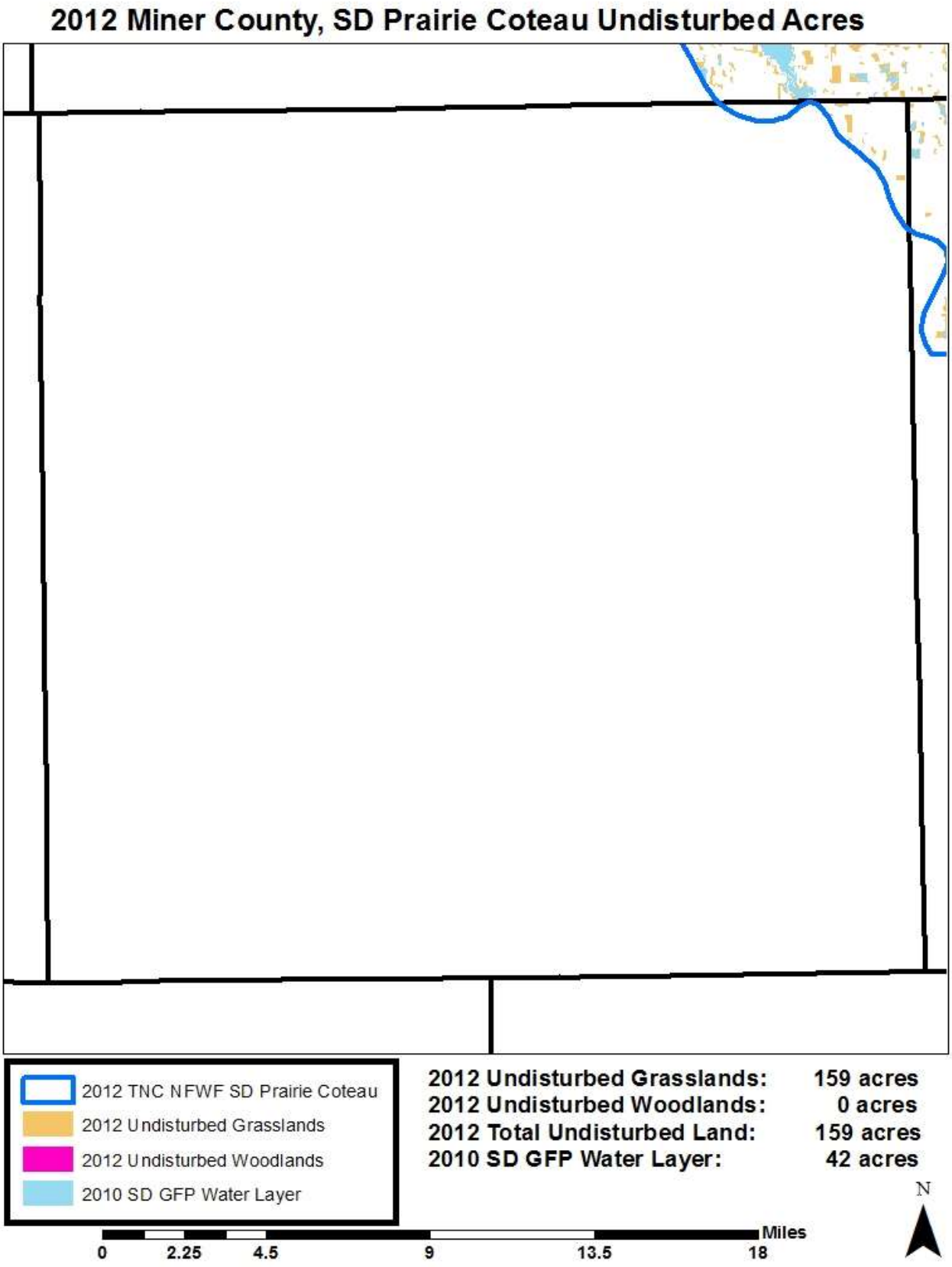

2012 Kingsbury County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 43,446 acres
2012 Undisturbed Woodlands: 420 acres
2012 Total Undisturbed Land: 43,867 acres
2010 SD GFP Water Layer: 41,727 acres
N
Miles
0
3.25
6.5
13
19.5
26

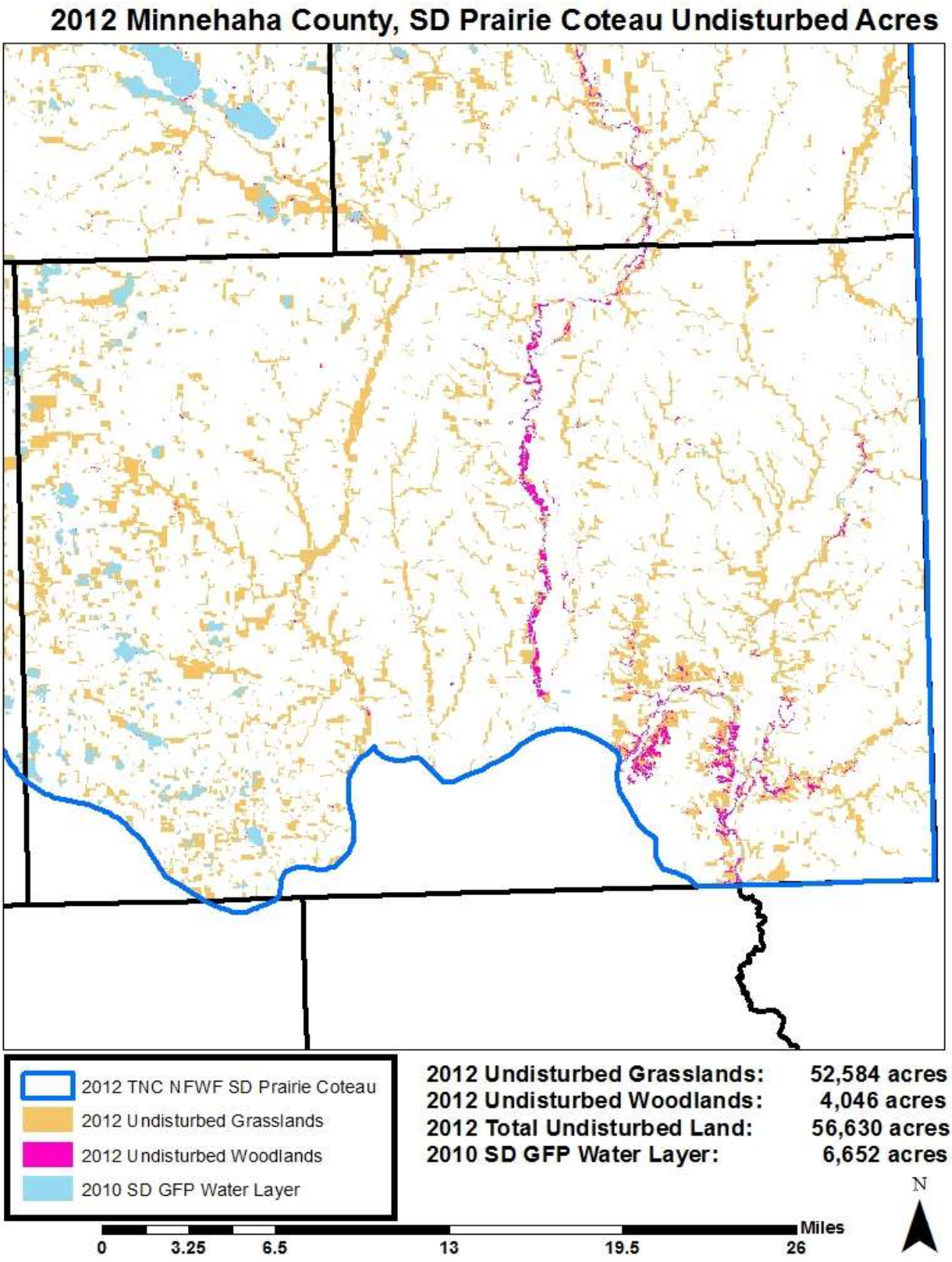

2012 Lake County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 28,626 acres
2012 Undisturbed Woodlands: 371 acres
2012 Total Undisturbed Land: 28,997 acres
2010 SD GFP Water Layer: 13,005 acres
N
Miles
0
2.25
4.5
9
13.5
18

2012 Marshall County, SD Prairie Coteau Undisturbed Acres

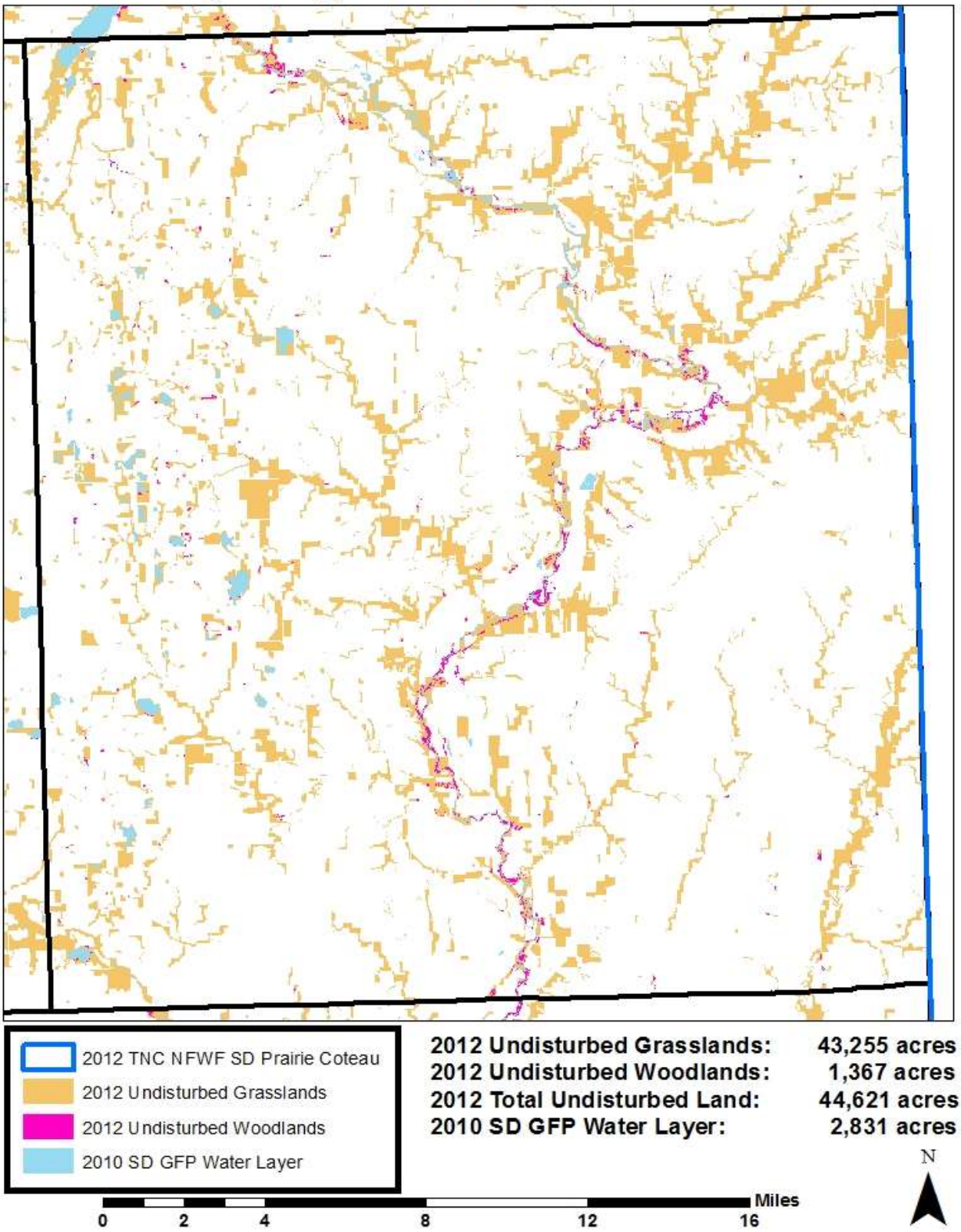


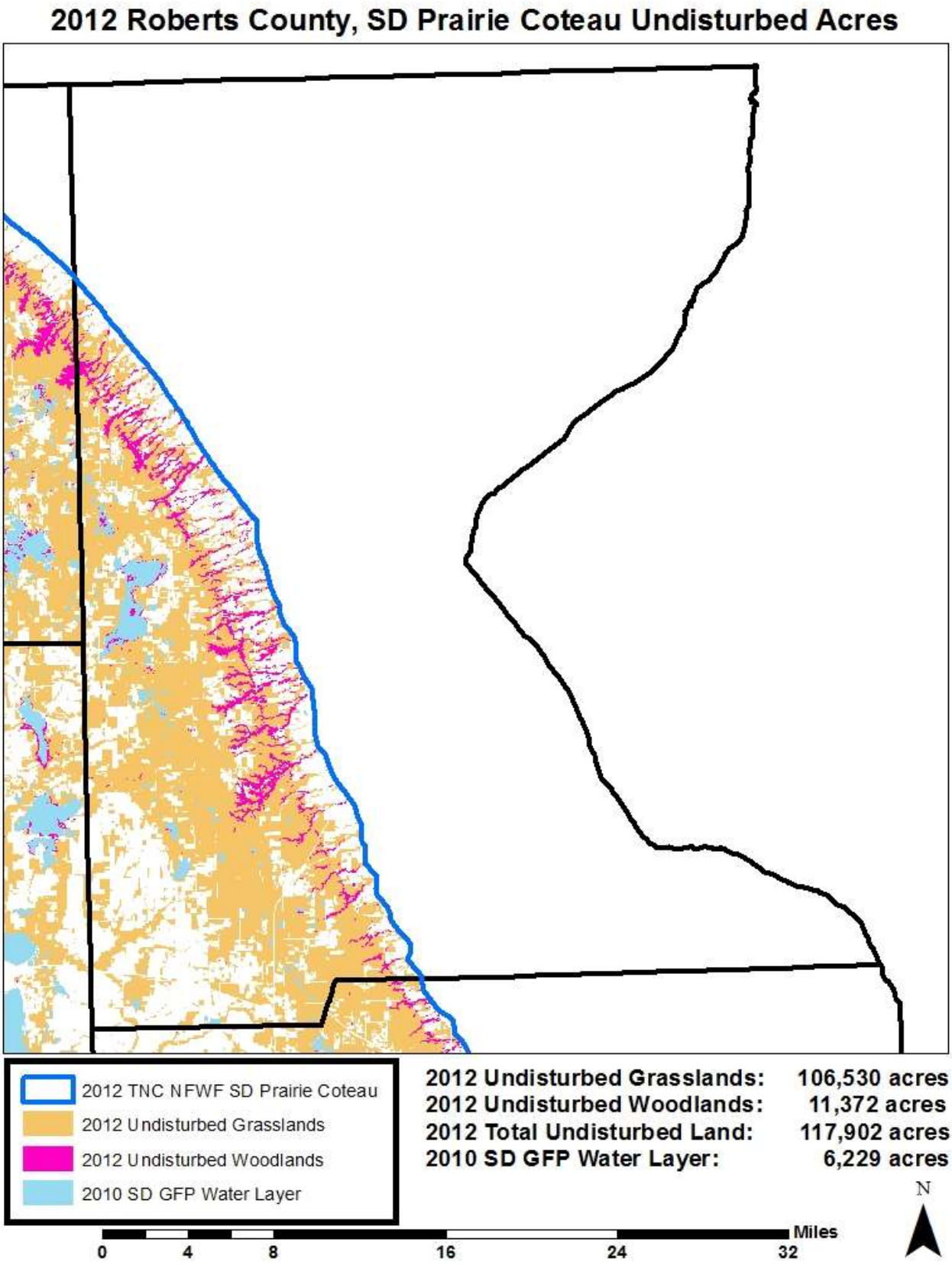

2012 McCook County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 5,815 acres
2012 Undisturbed Woodlands: 320 acres
2012 Total Undisturbed Land: 6,135 acres
2010 SD GFP Water Layer: 800 acres
N
0 2.25 4.5 9 13.5 18
Miles

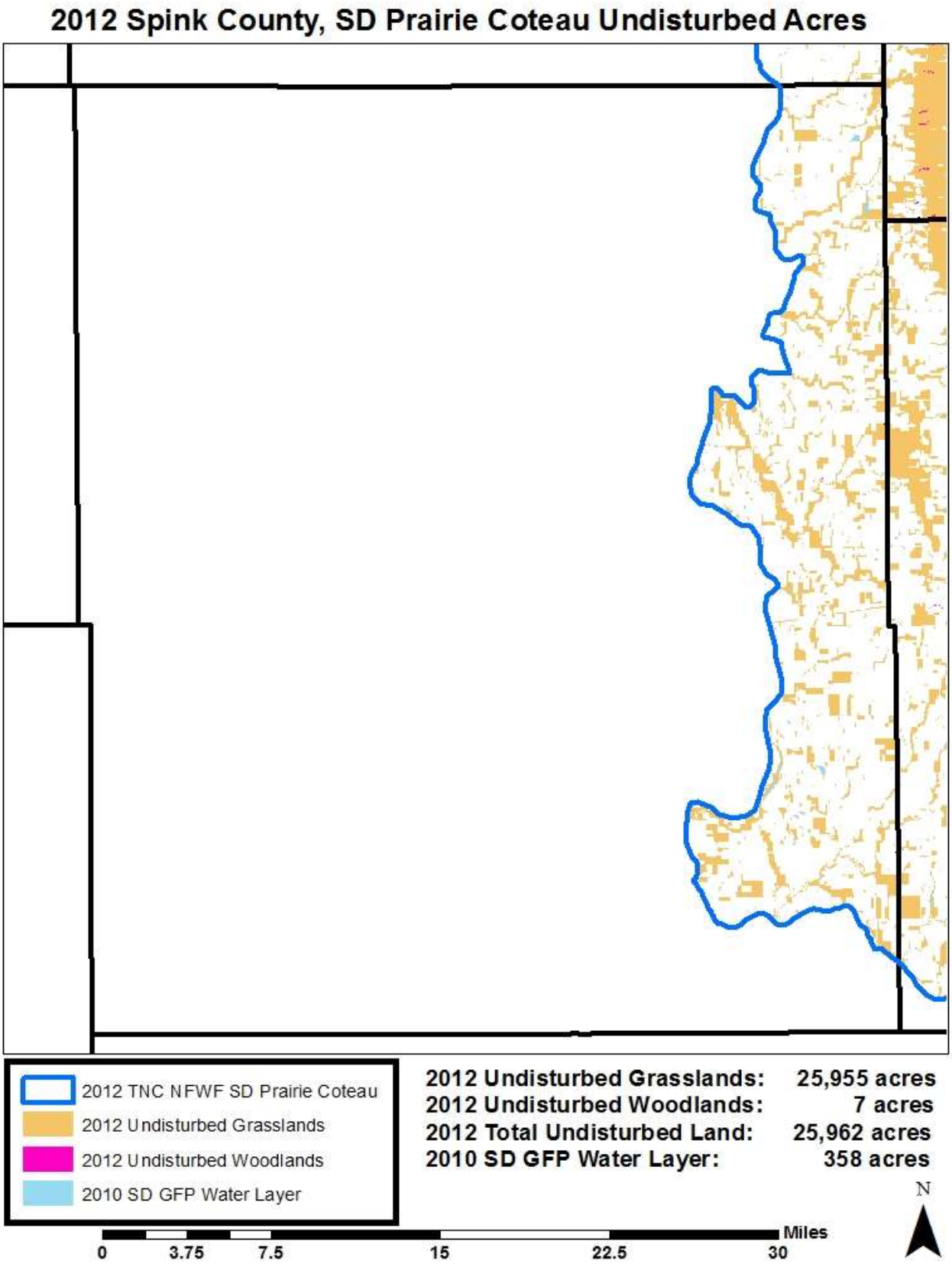

2012 Miner County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 159 acres
2012 Undisturbed Woodlands: 0 acres
2012 Total Undisturbed Land: 159 acres
2010 SD GFP Water Layer: 42 acres
N
Miles
0
2.25
4.5
9
13.5
18


2012 Minnehaha County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 52,584 acres
2012 Undisturbed Woodlands: 4,046 acres
2012 Total Undisturbed Land: 56,630 acres
2010 SD GFP Water Layer: 6,652 acres
N
Miles
0
3.25
6.5
13
19.5
26

2012 Moody County, SD Prairie Coteau Undisturbed Acres




2012 Roberts County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 106,530 acres
2012 Undisturbed Woodlands: 11,372 acres
2012 Total Undisturbed Land: 117,902 acres
2010 SD GFP Water Layer: 6,229 acres
N
0 4 8 16 24 32 Miles

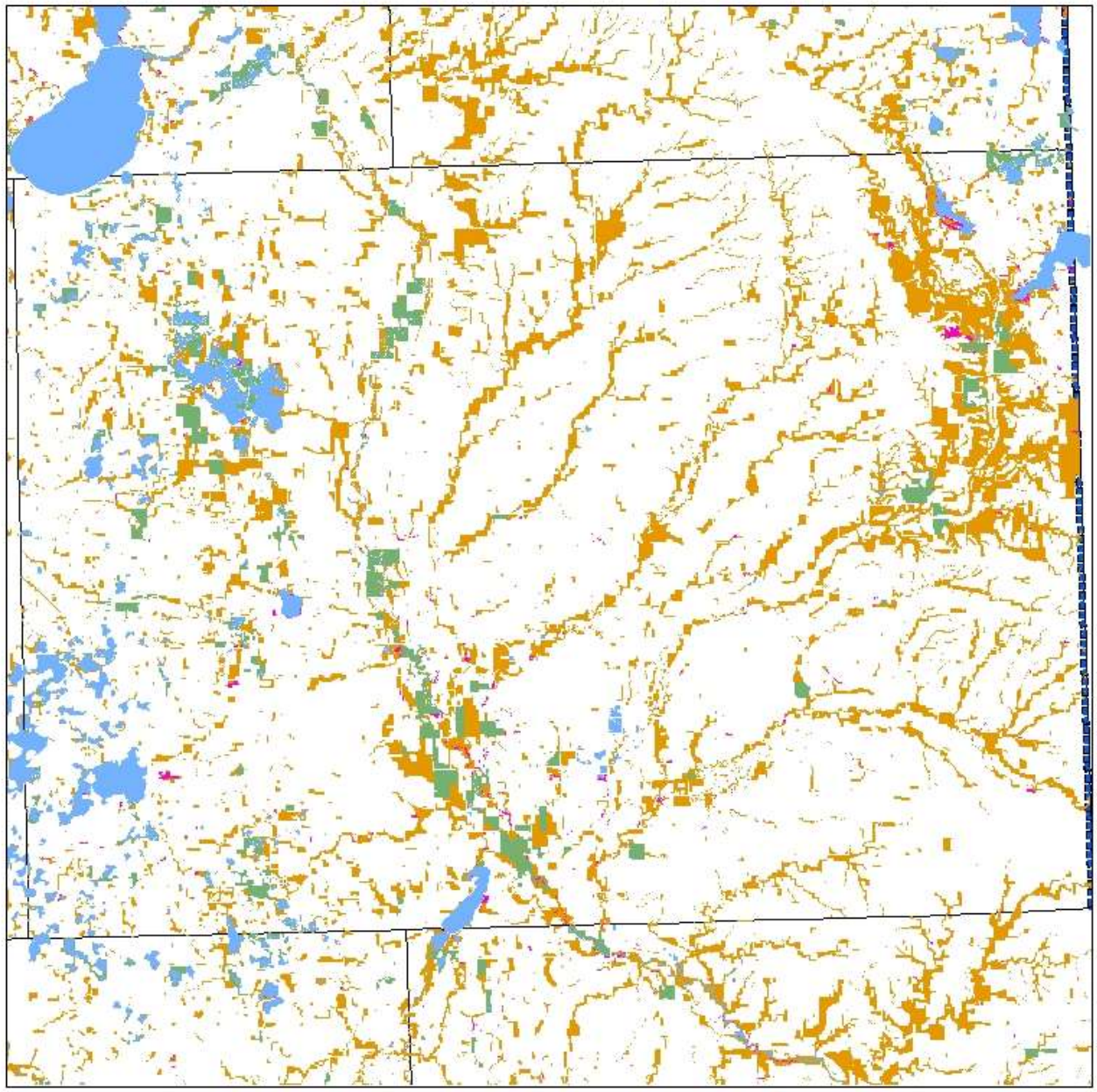

2012 Spink County, SD Prairie Coteau Undisturbed Acres
2012 TNC NFWF SD Prairie Coteau
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
2012 Undisturbed Grasslands: 25,955 acres
2012 Undisturbed Woodlands: 7 acres
2012 Total Undisturbed Land: 25,962 acres
2010 SD GFP Water Layer: 358 acres
N
Miles
0
3.75
7.5
15
22.5
30

Appendix B:

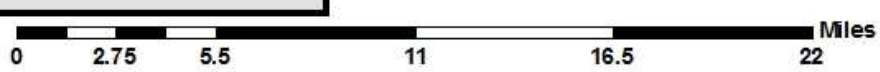
Undisturbed Grasslands and Woodlands in the South Dakota Prairie Coteau *with* Permanent Conservation Protection Status, by County.

The 'protection' layer includes: US Fish and Wildlife Service fee ownership lands (refuges and waterfowl protection areas) and grassland easements; SD Game, Fish, and Parks fee ownership lands (parks and game production areas); Nature Conservancy grassland preserves; USDA Natural Resources Conservation Service Wetland Reserve Program easement acres; and Northern Prairies Land Trust easement acres.

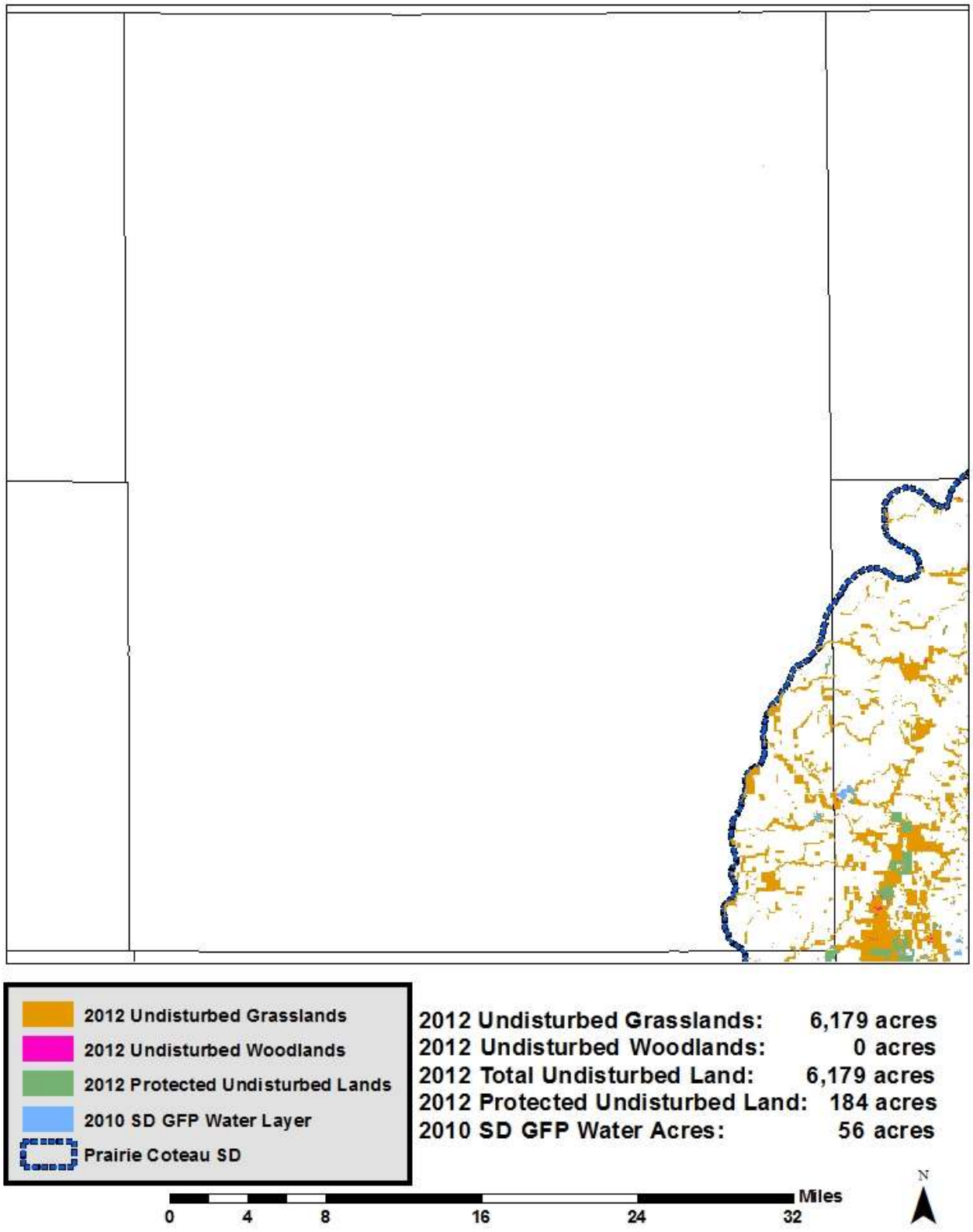
2012 Brookings County, SD Undisturbed Acres with Protection Status



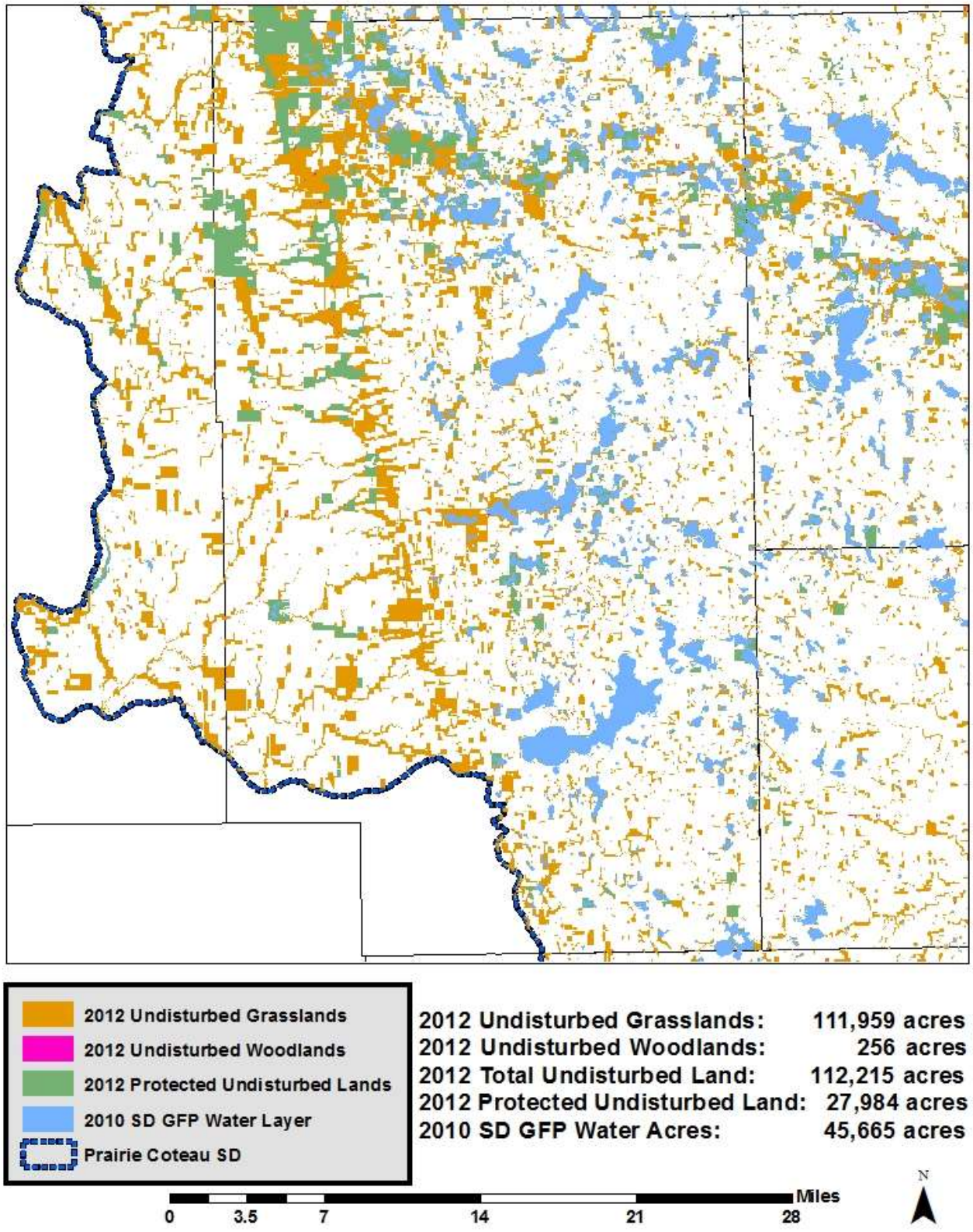
2012 Undisturbed Grasslands:	76,958 acres
2012 Undisturbed Woodlands:	1,659 acres
2012 Total Undisturbed Land:	78,617 acres
2012 Protected Undisturbed Land:	11,671 acres
2010 SD GFP Water Acres:	14,635 acres



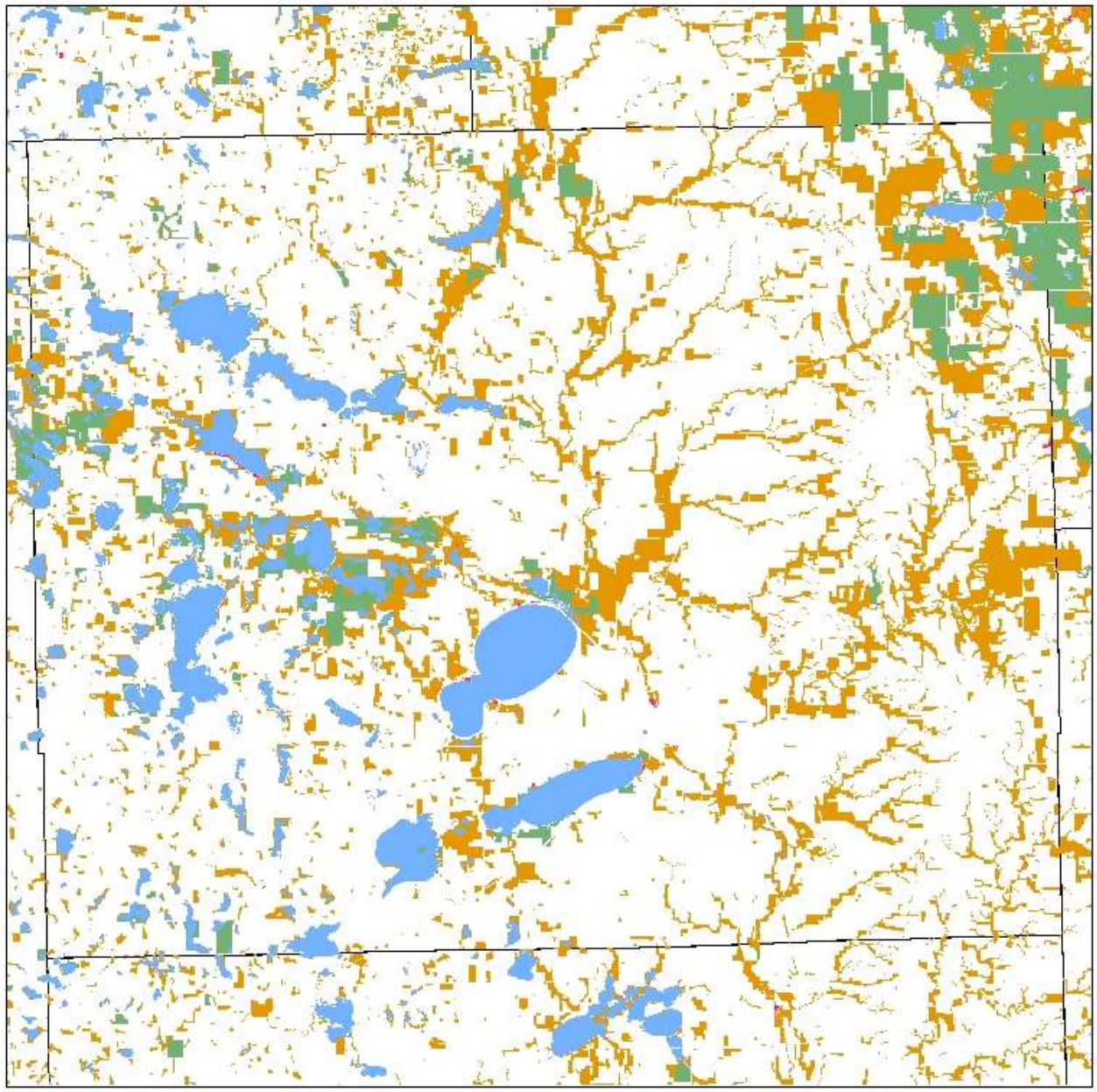
2012 Brown County, SD Undisturbed Acres with Protection Status



2012 Clark County, SD Undisturbed Acres with Protection Status



2012 Codington County, SD Undisturbed Acres with Protection Status



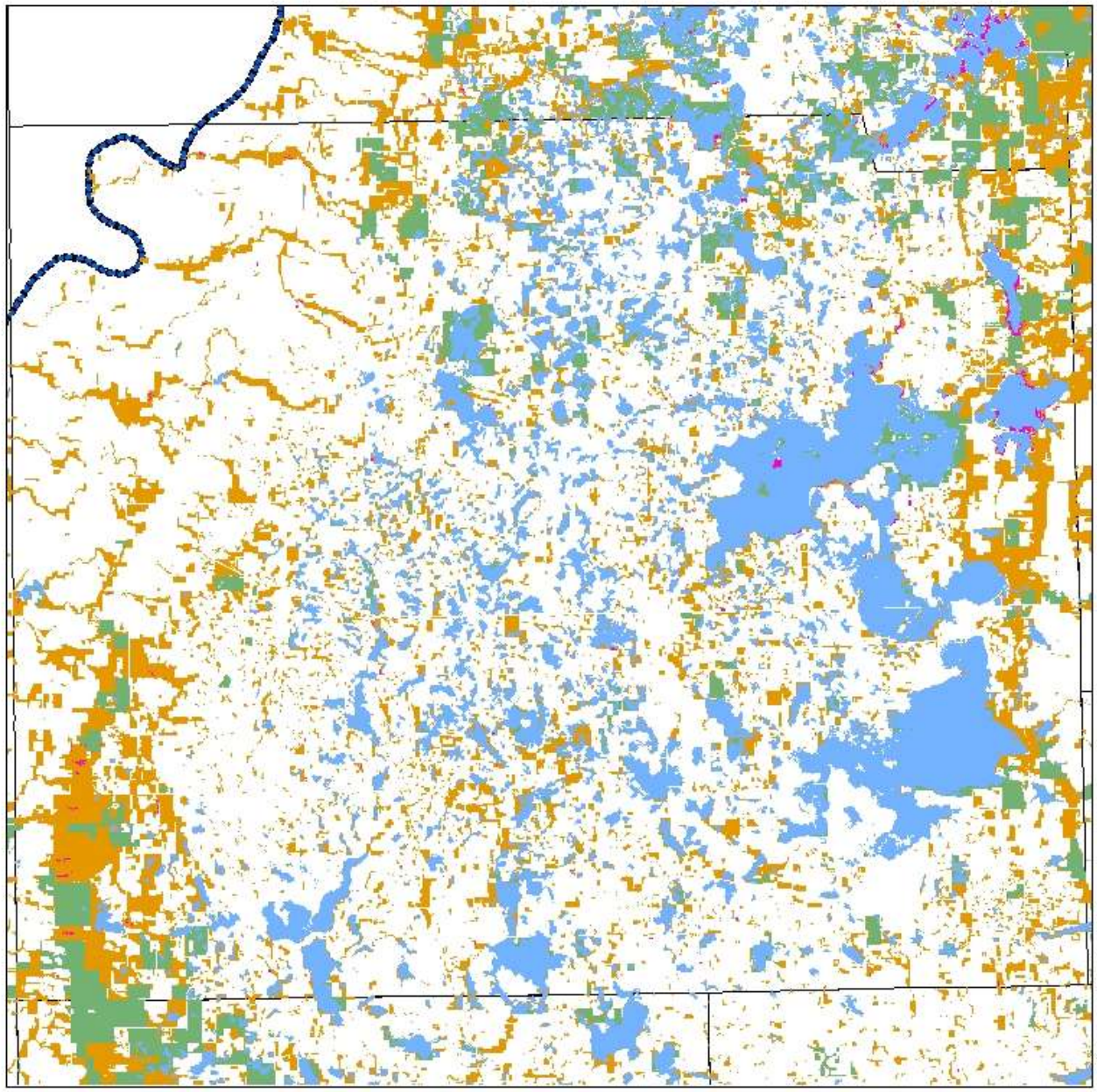
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2012 Protected Undisturbed Lands
2010 SD GFP Water Layer
Prairie Coteau SD

2012 Undisturbed Grasslands:	80,478 acres
2012 Undisturbed Woodlands:	157 acres
2012 Total Undisturbed Land:	80,635 acres
2012 Protected Undisturbed Land:	13,447 acres
2010 SD GFP Water Acres:	32,693 acres

0 2.5 5 10 15 20 Miles

N

2012 Day County, SD Undisturbed Acres with Protection Status



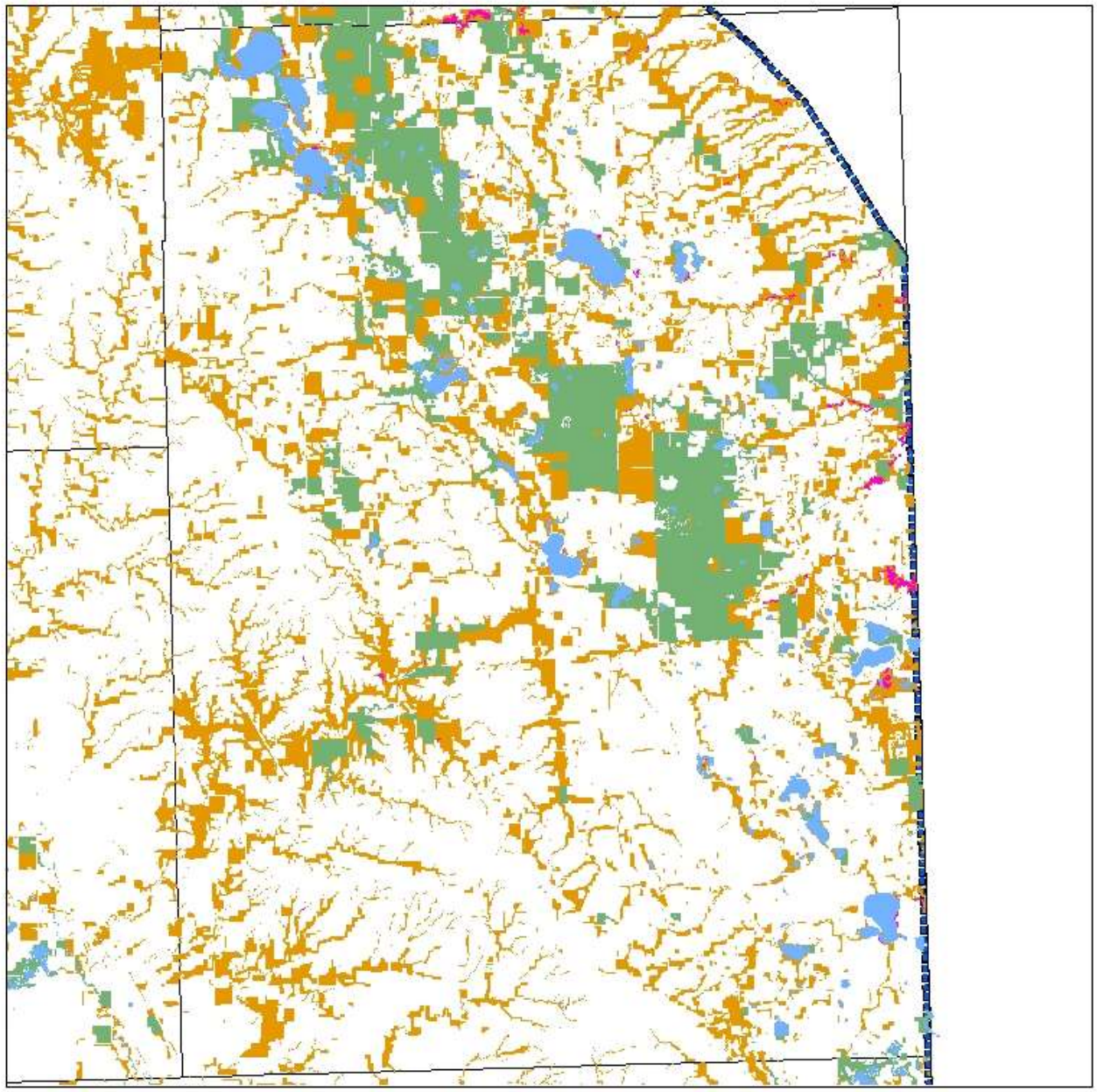
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2012 Protected Undisturbed Lands
2010 SD GFP Water Layer
Prairie Coteau SD

2012 Undisturbed Grasslands:	120,000 acres
2012 Undisturbed Woodlands:	2,040 acres
2012 Total Undisturbed Land:	122,040 acres
2012 Protected Undisturbed Land:	28,049 acres
2010 SD GFP Water Acres:	108,939 acres

0 3 6 12 18 24 Miles

N

2012 Deuel County, SD Undisturbed Acres with Protection Status



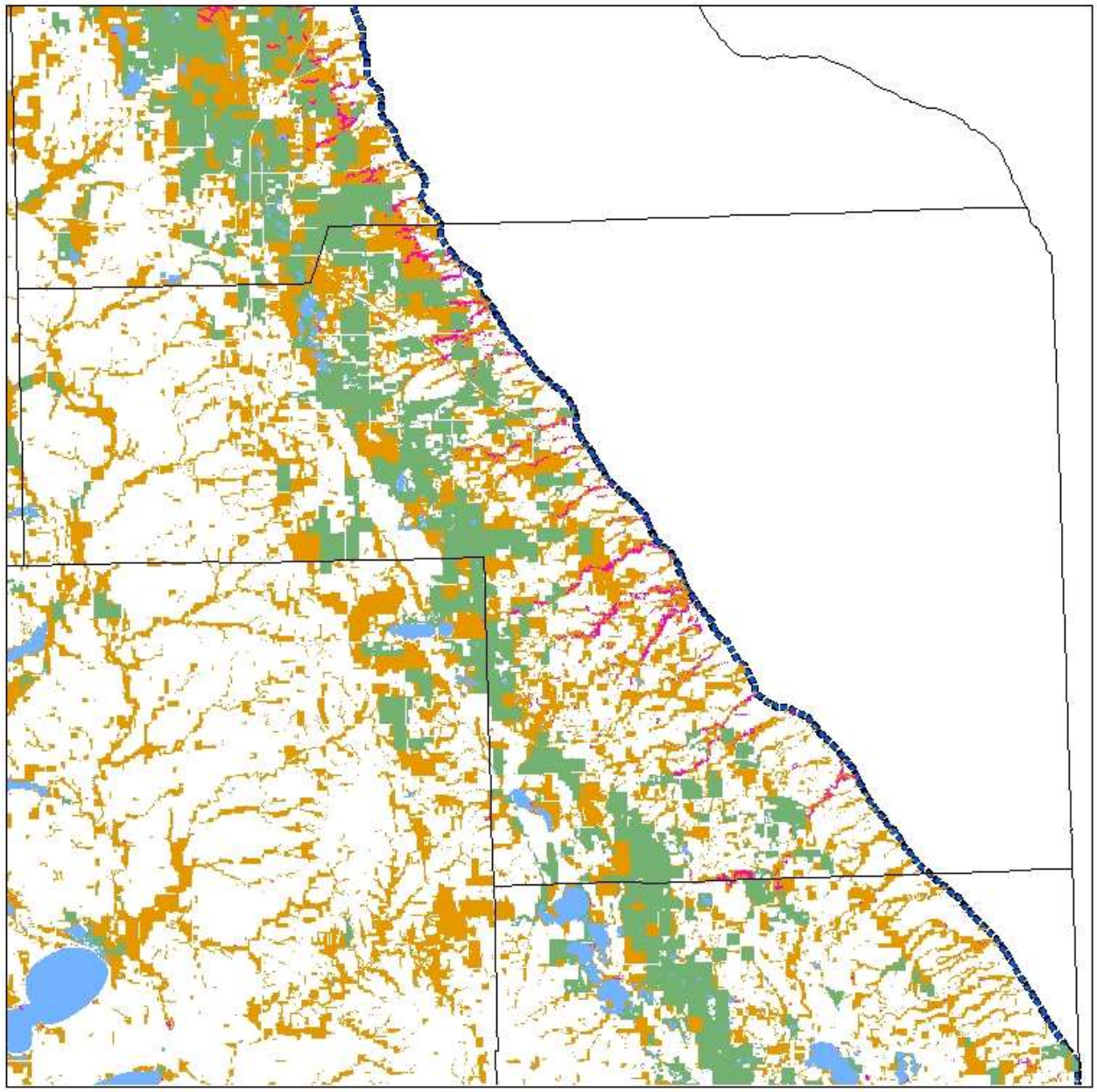
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2012 Protected Undisturbed Lands
2010 SD GFP Water Layer
Prairie Coteau SD

2012 Undisturbed Grasslands:	109,162 acres
2012 Undisturbed Woodlands:	1,122 acres
2012 Total Undisturbed Land:	110,283 acres
2012 Protected Undisturbed Land:	39,633 acres
2010 SD GFP Water Acres:	10,344 acres

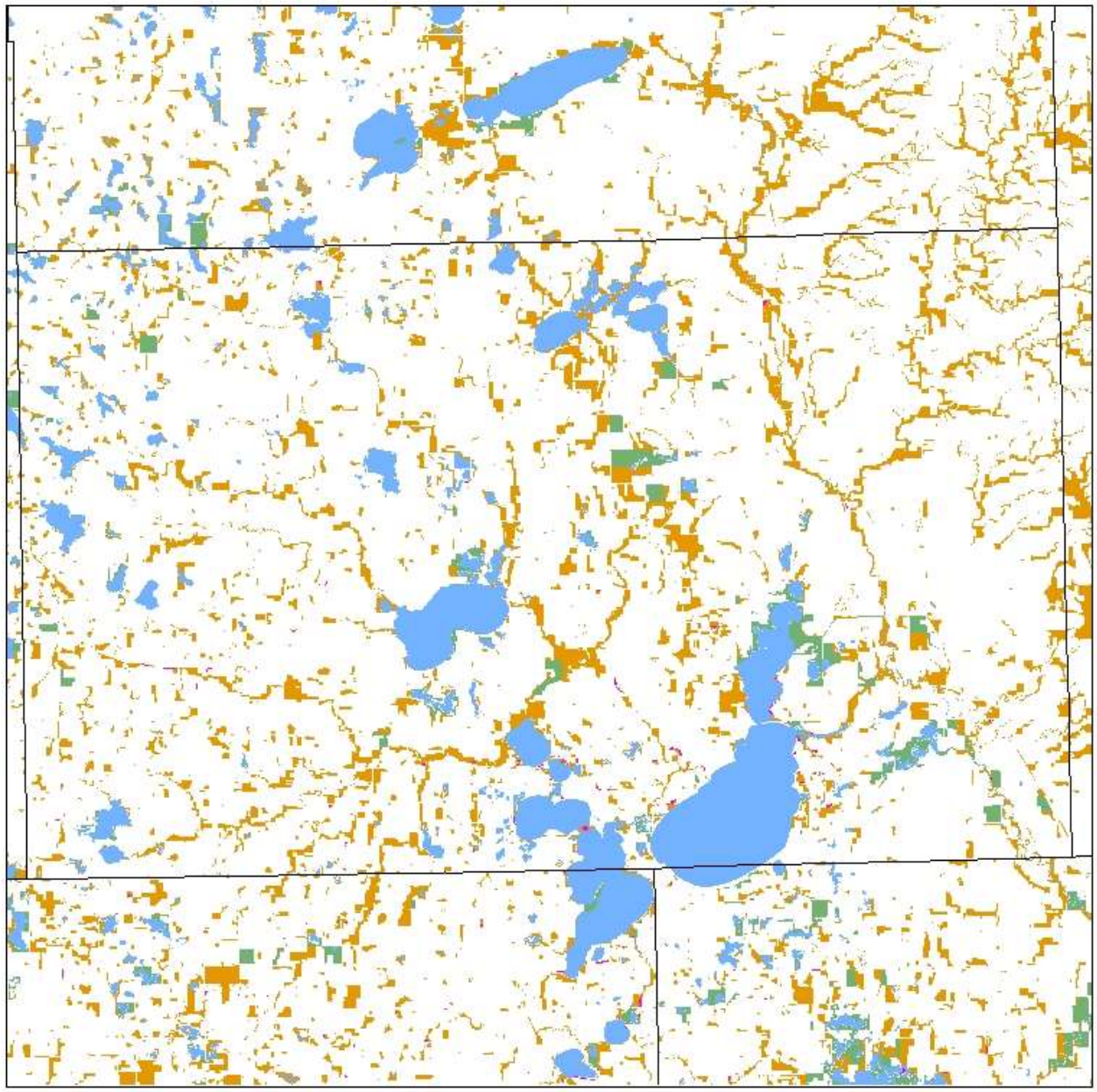
0 2.5 5 10 15 20 Miles

N

2012 Grant County, SD Undisturbed Acres with Protection Status



2012 Hamlin County, SD Undisturbed Acres with Protection Status



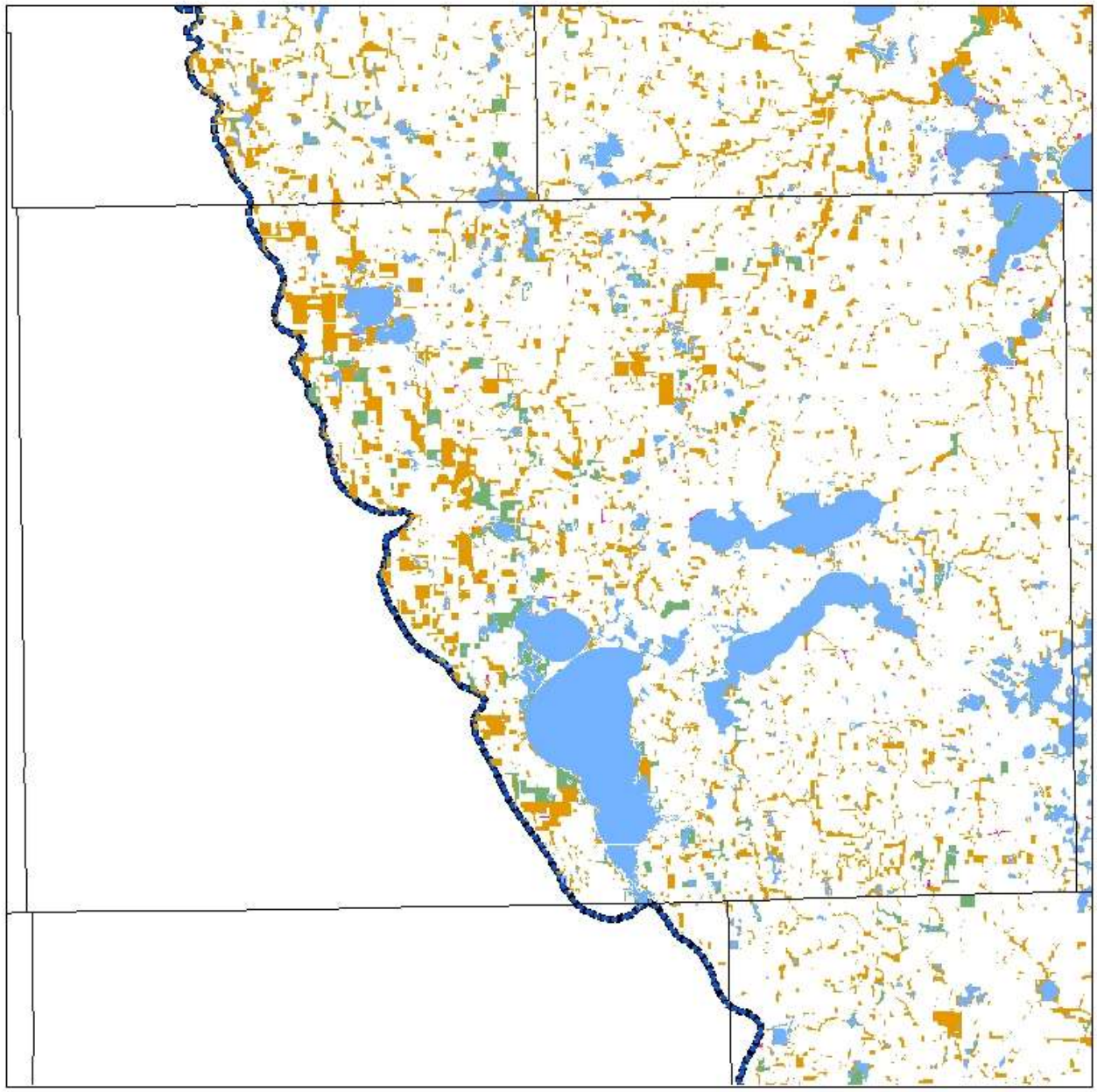
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD

2012 Undisturbed Grasslands:	37,379 acres
2012 Undisturbed Woodlands:	296 acres
2012 Total Undisturbed Land:	37,675 acres
2012 Protected Undisturbed Land:	4,656 acres
2010 SD GFP Water Acres:	27,444 acres

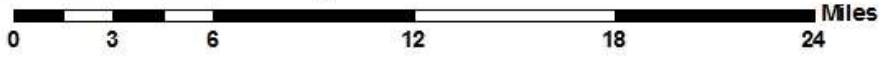
0 2.5 5 10 15 20 Miles

N

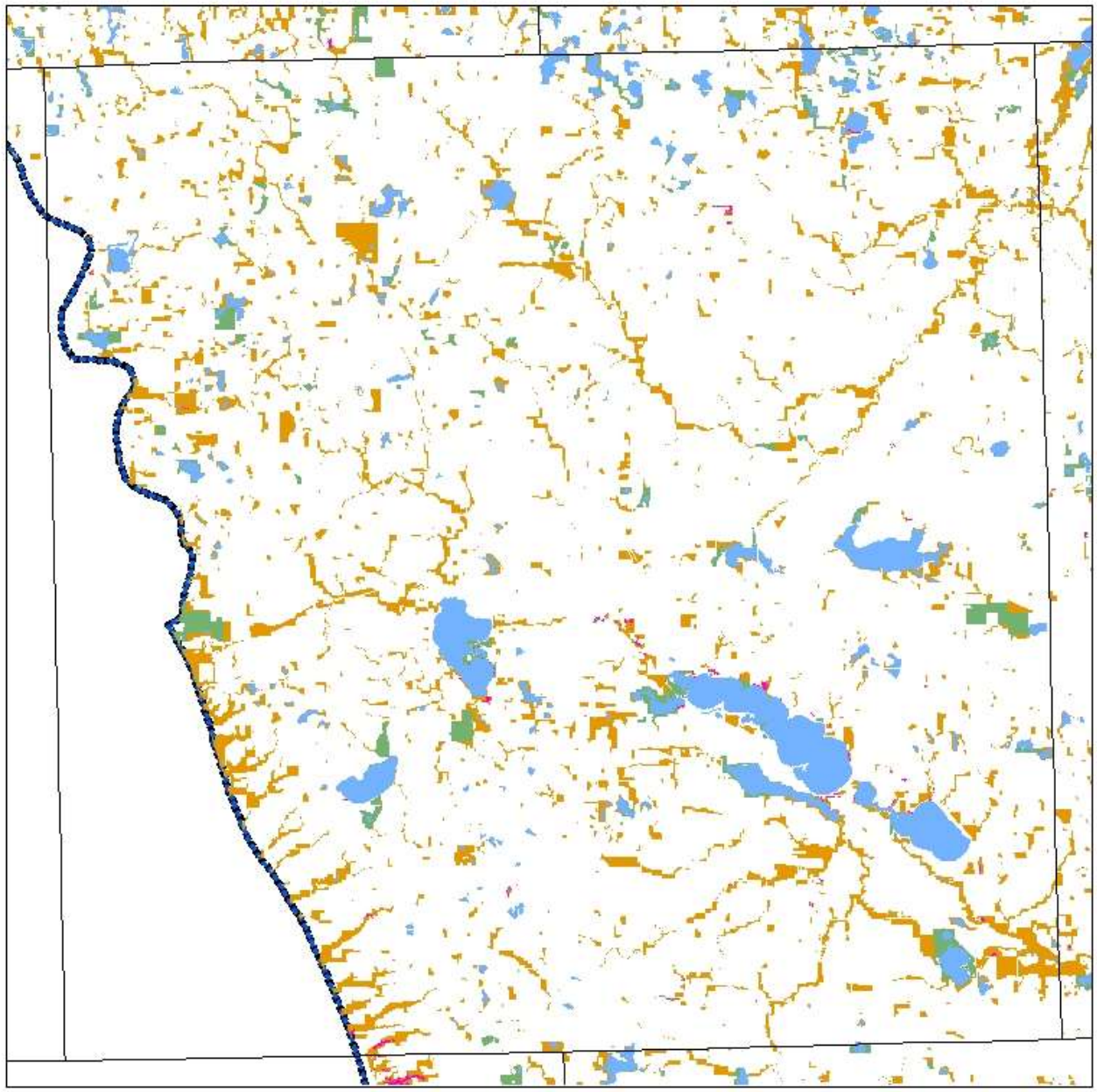
2012 Kingsbury County, SD Undisturbed Acres with Protection Status



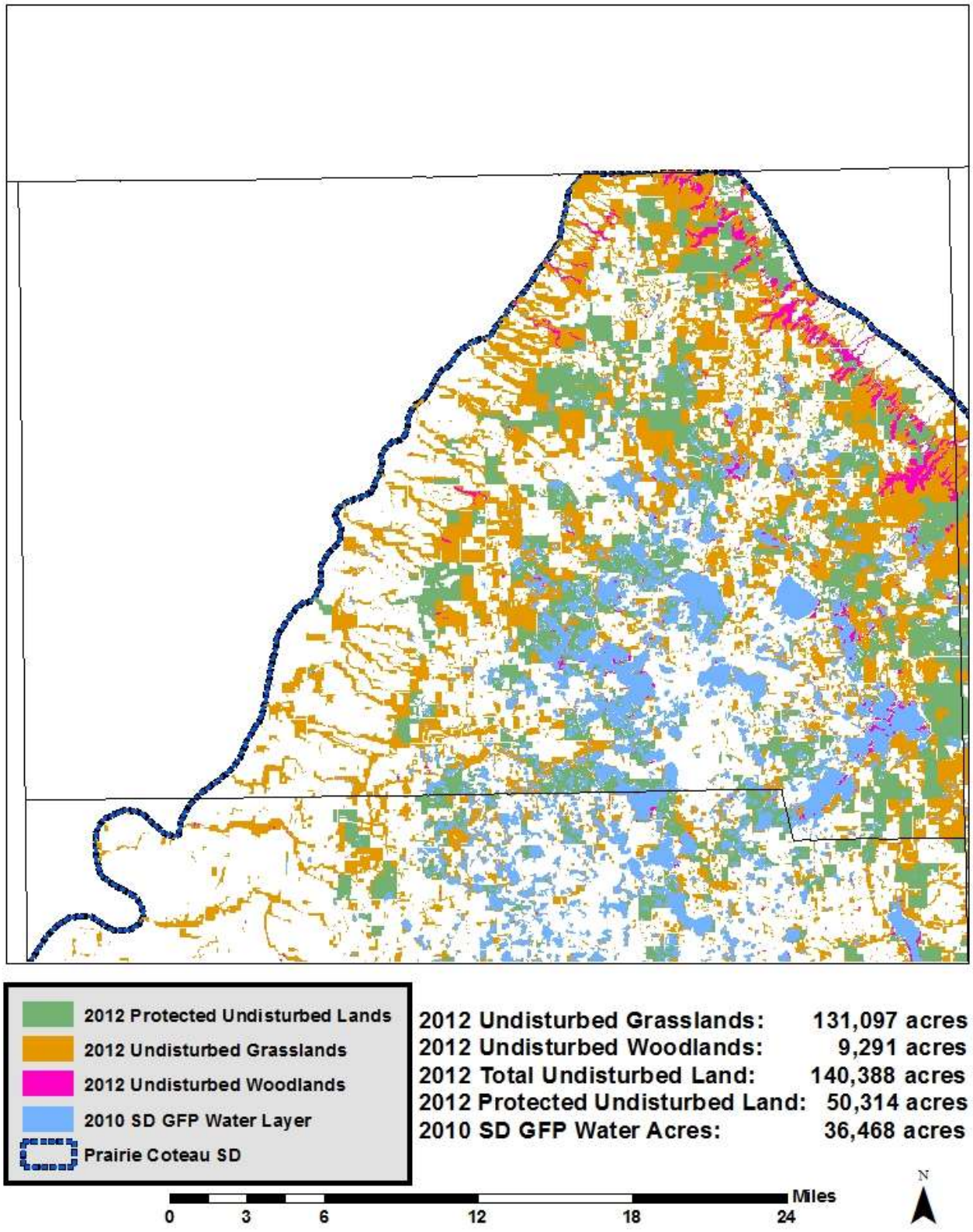
2012 Undisturbed Grasslands:	43,446 acres
2012 Undisturbed Woodlands:	420 acres
2012 Total Undisturbed Land:	43,867 acres
2012 Protected Undisturbed Land:	7,093 acres
2010 SD GFP Water Acres:	41,727 acres



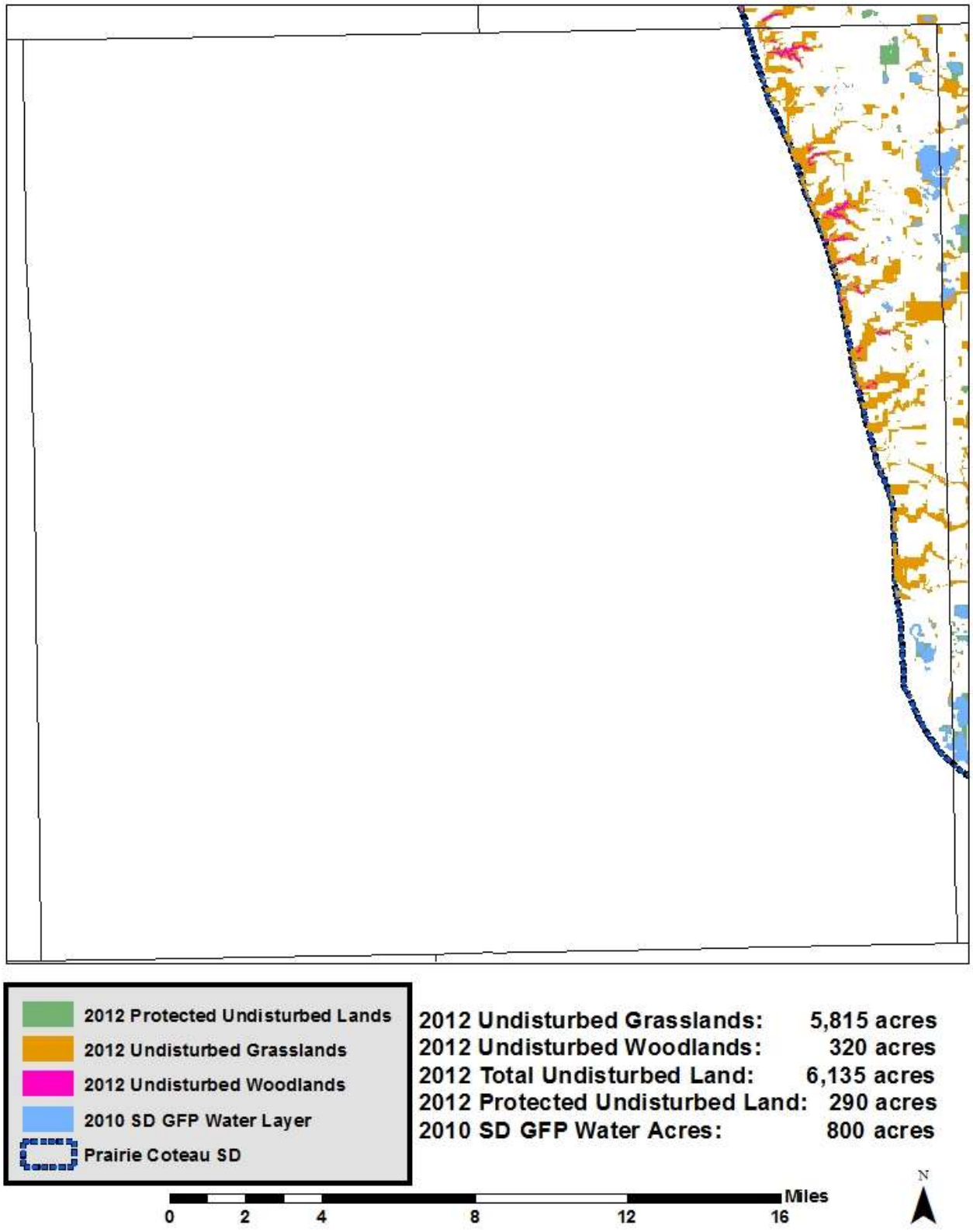
2012 Lake County, SD Undisturbed Acres with Protection Status



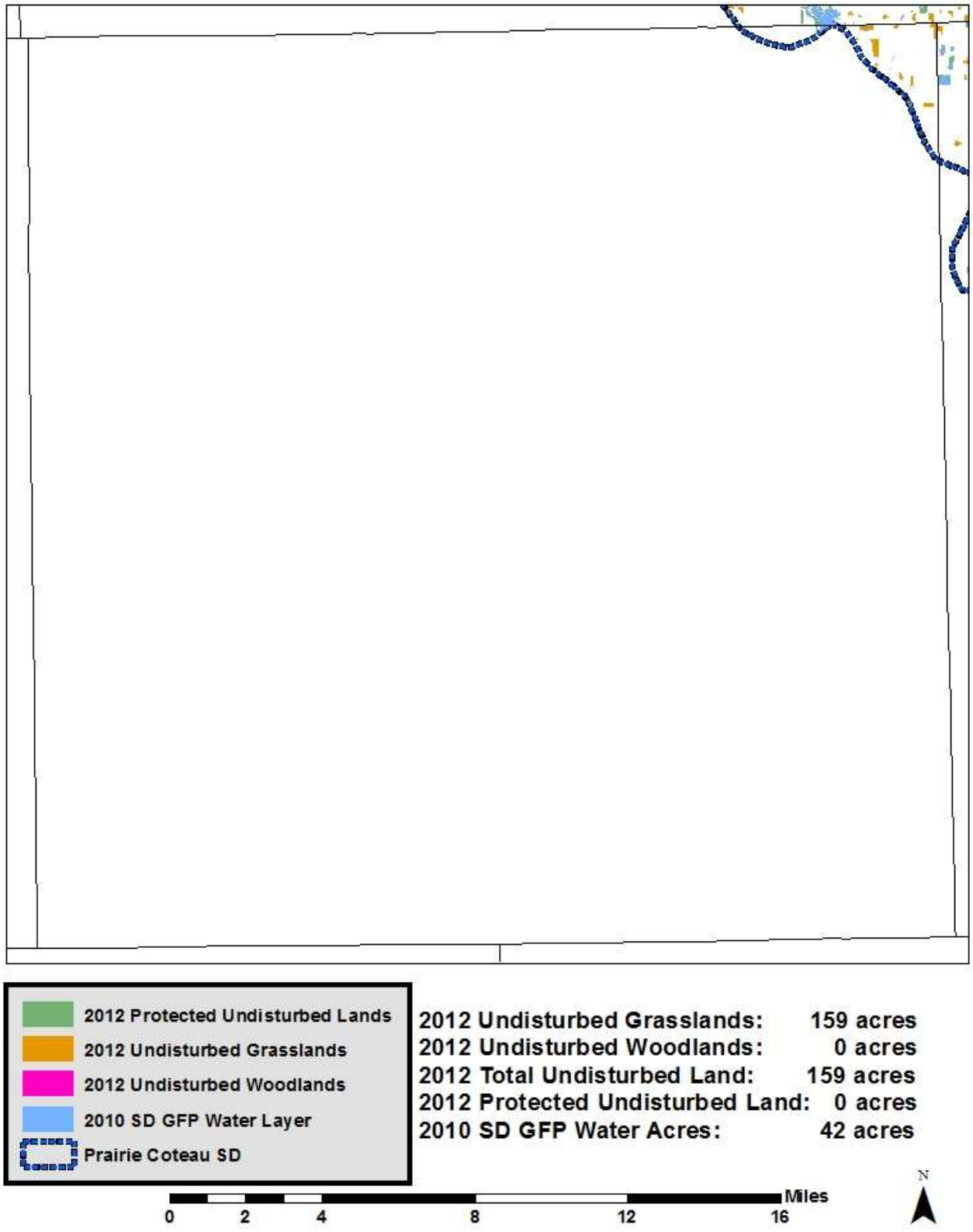
2012 Marshall County, SD Undisturbed Acres with Protection Status



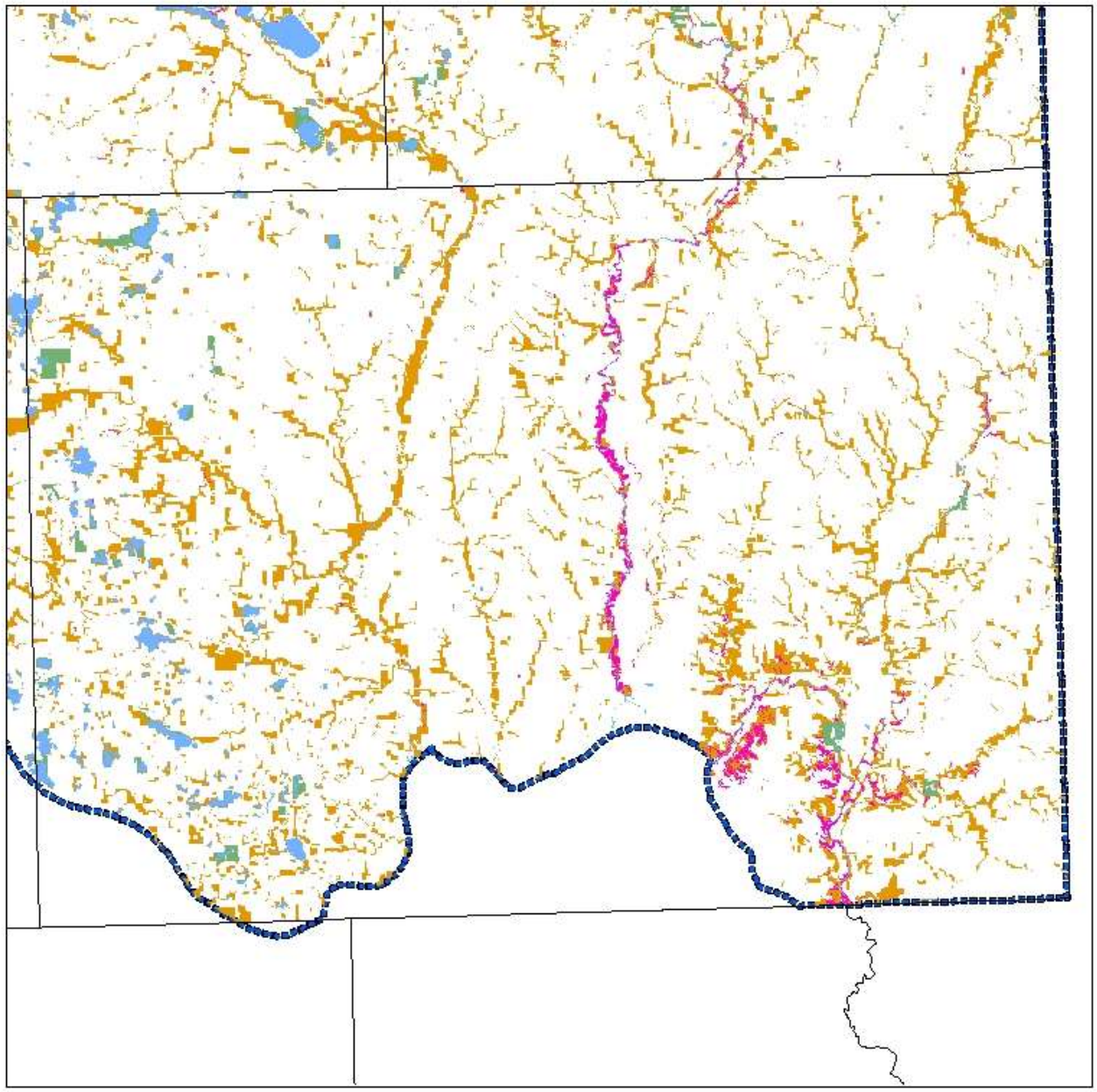
2012 McCook County, SD Undisturbed Acres with Protection Status



2012 Miner County, SD Undisturbed Acres with Protection Status



2012 Minnehaha County, SD Undisturbed Acres with Protection Status



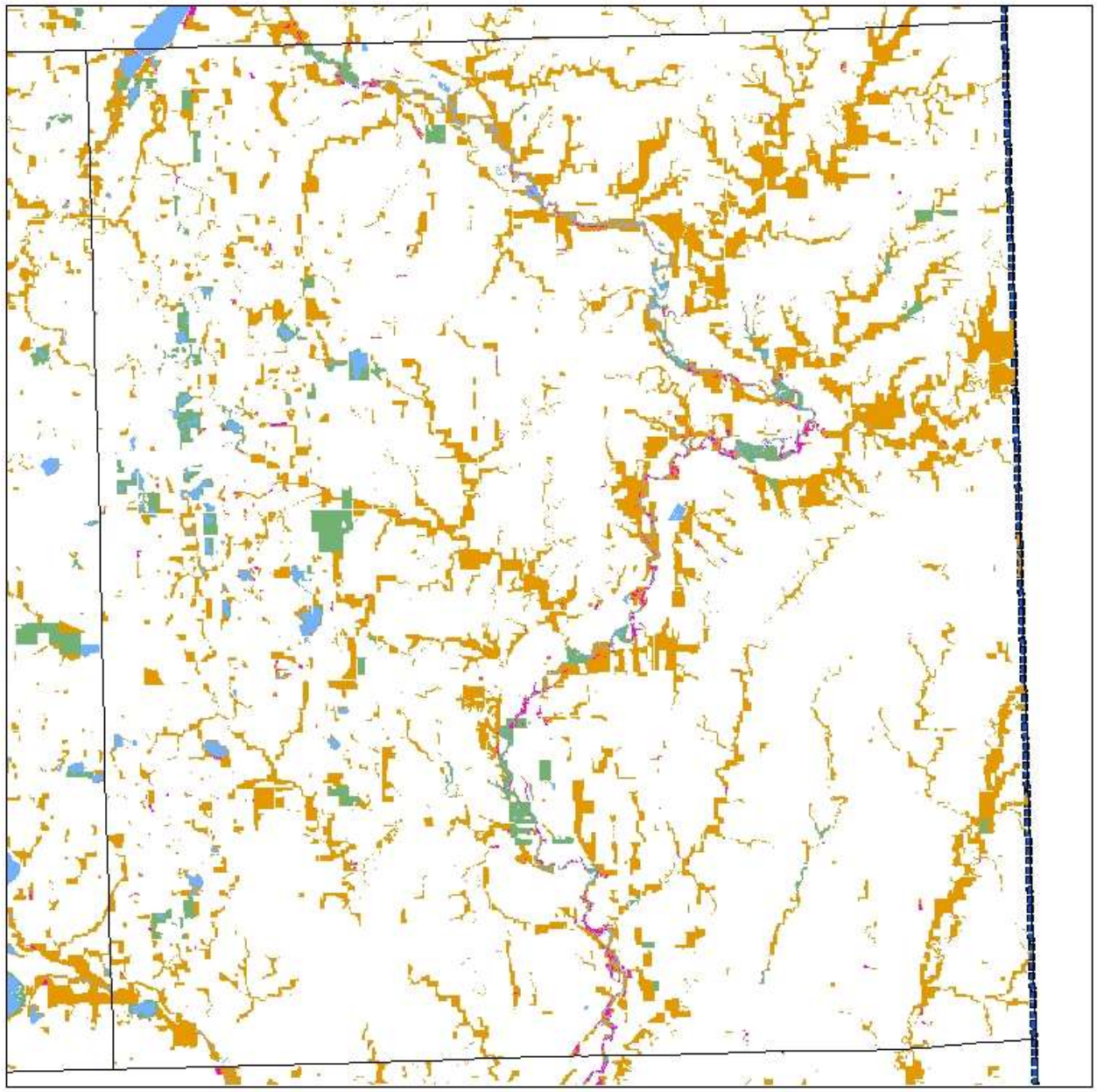
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD

2012 Undisturbed Grasslands:	52,584 acres
2012 Undisturbed Woodlands:	4,046 acres
2012 Total Undisturbed Land:	56,630 acres
2012 Protected Undisturbed Land:	2,970 acres
2010 SD GFP Water Acres:	6,652 acres

0 2.75 5.5 11 16.5 22 Miles

N

2012 Moody County, SD Undisturbed Acres with Protection Status



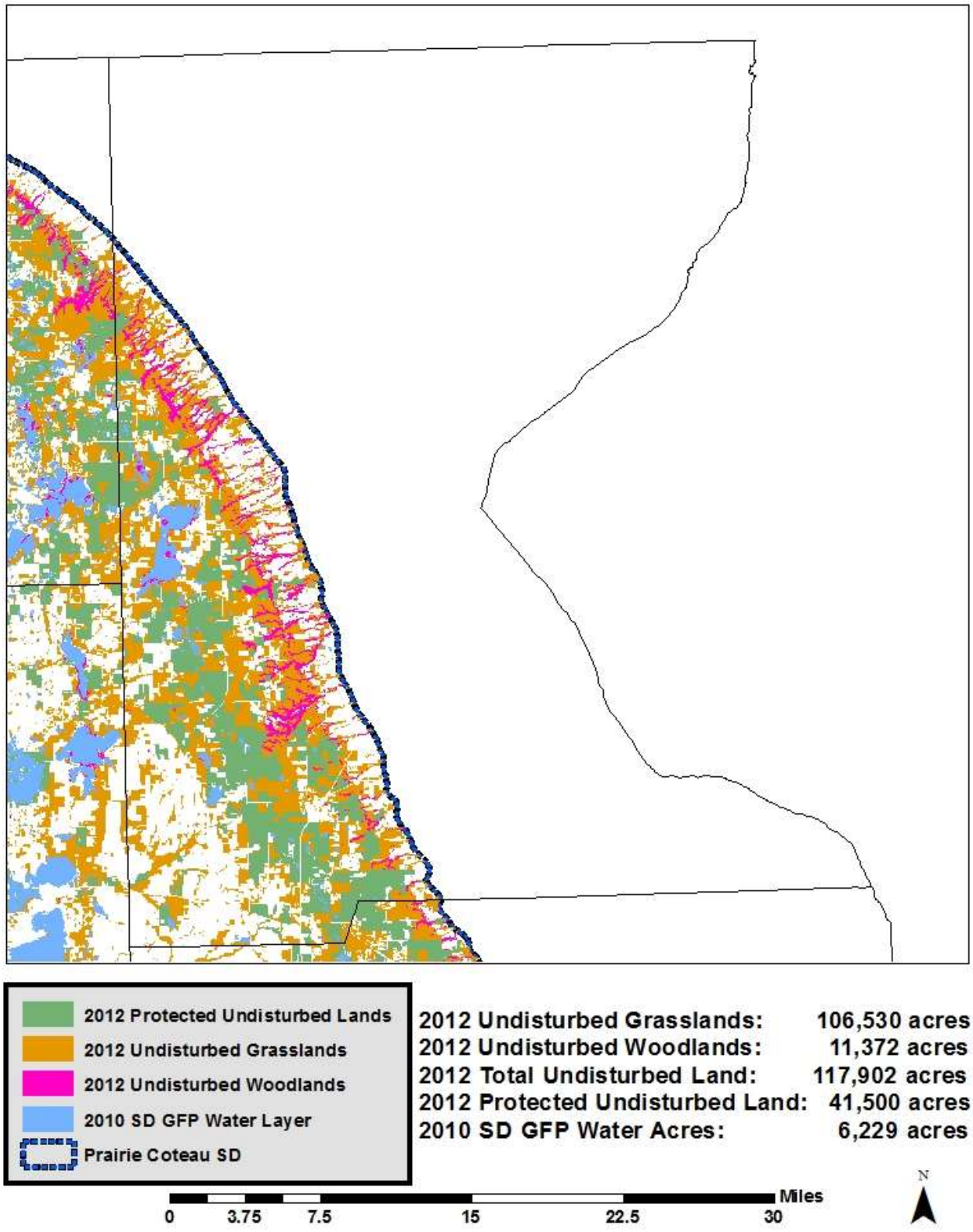
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD

2012 Undisturbed Grasslands:	43,255 acres
2012 Undisturbed Woodlands:	1,367 acres
2012 Total Undisturbed Land:	44,621 acres
2012 Protected Undisturbed Land:	4,733 acres
2010 SD GFP Water Acres:	2,831 acres

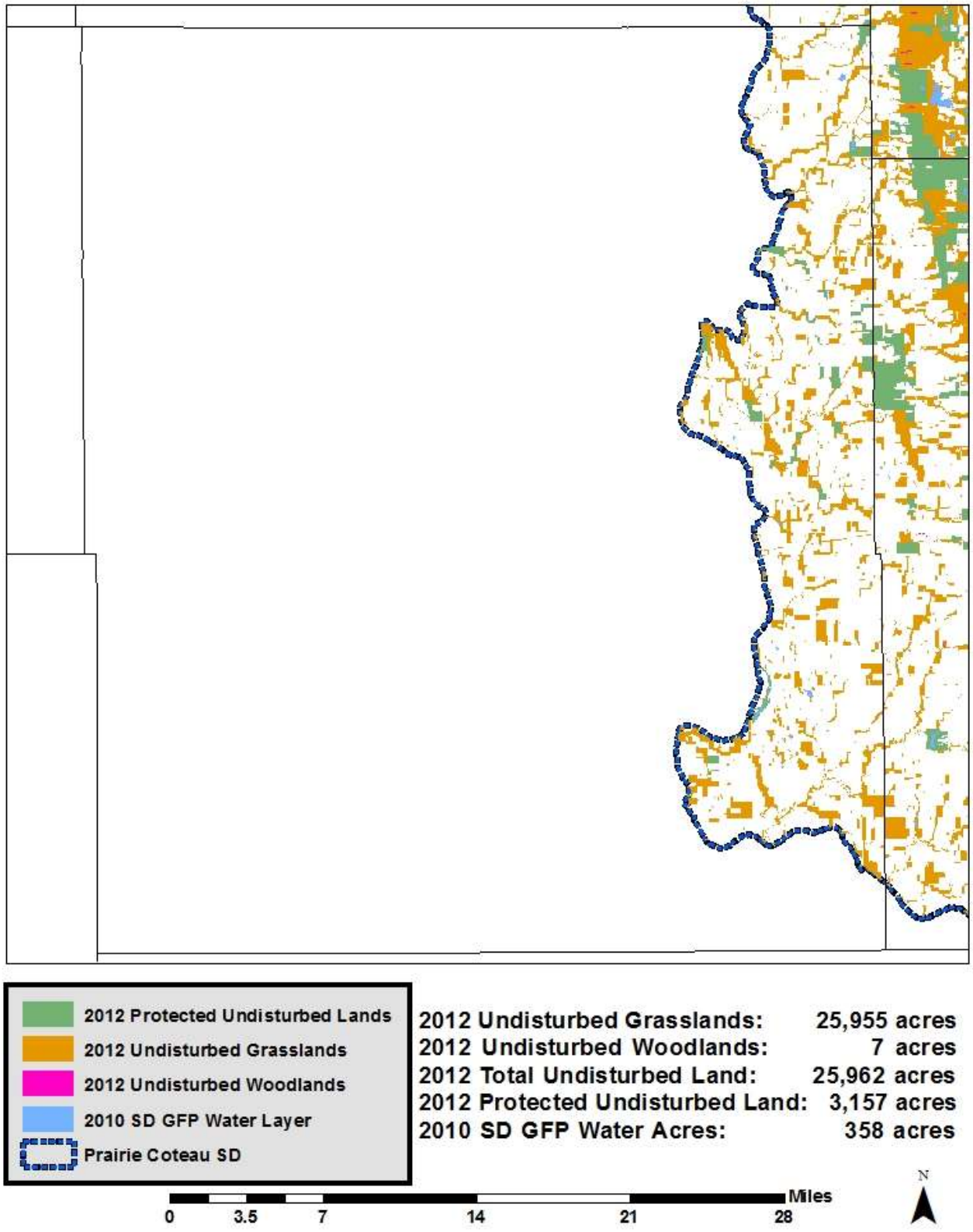
0 2 4 8 12 16 Miles

N

2012 Roberts County, SD Undisturbed Acres with Protection Status

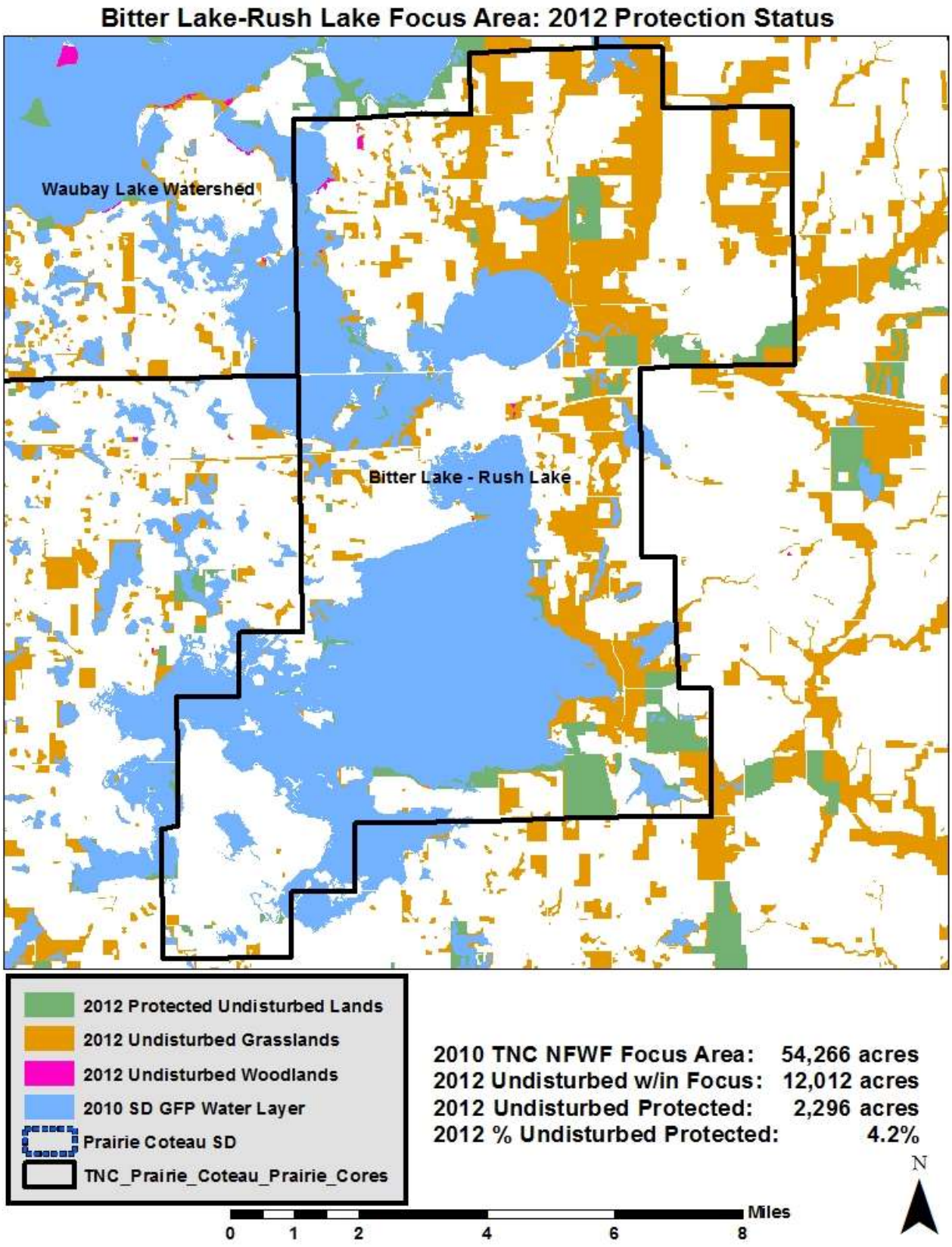


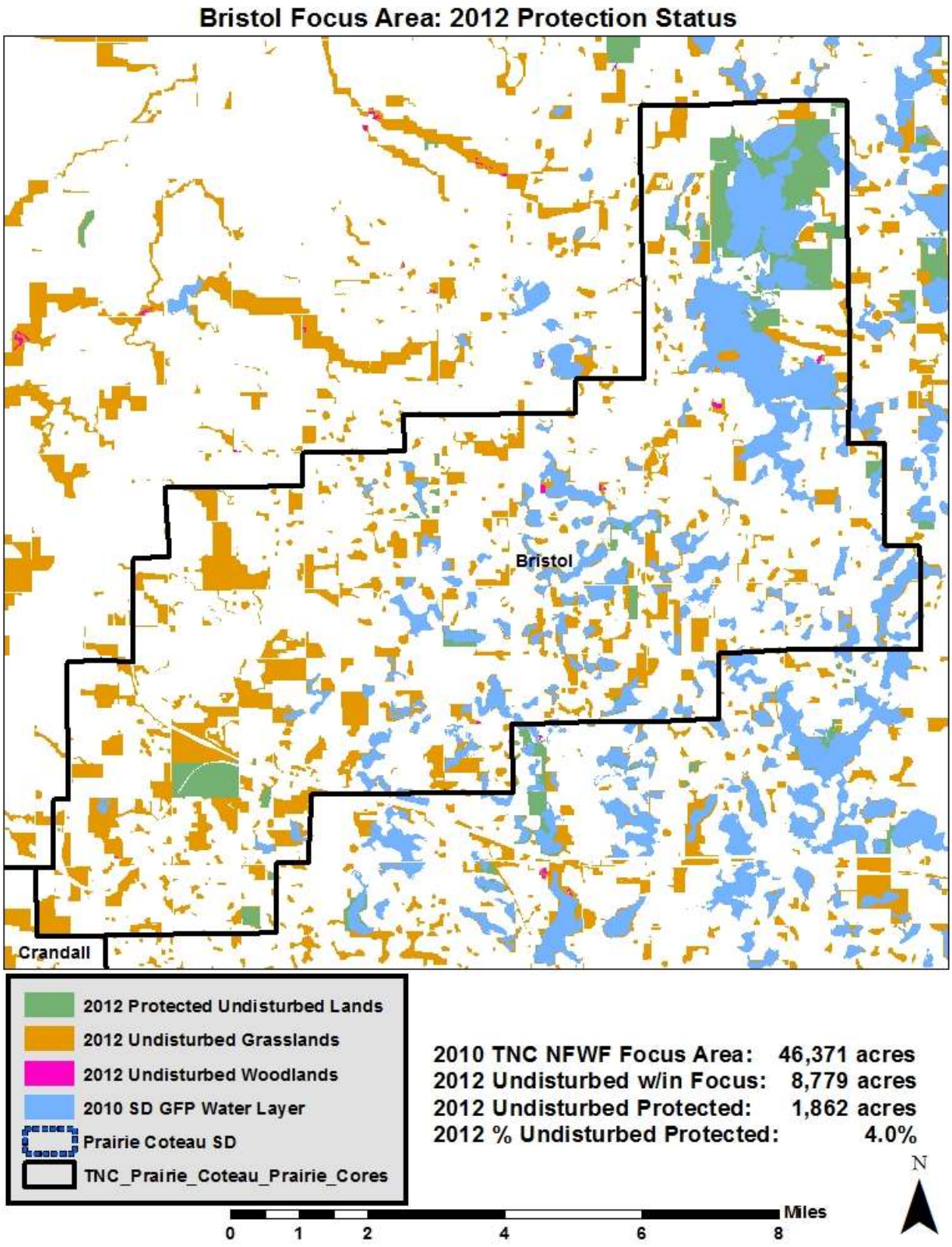
2012 Spink County, SD Undisturbed Acres with Protection Status

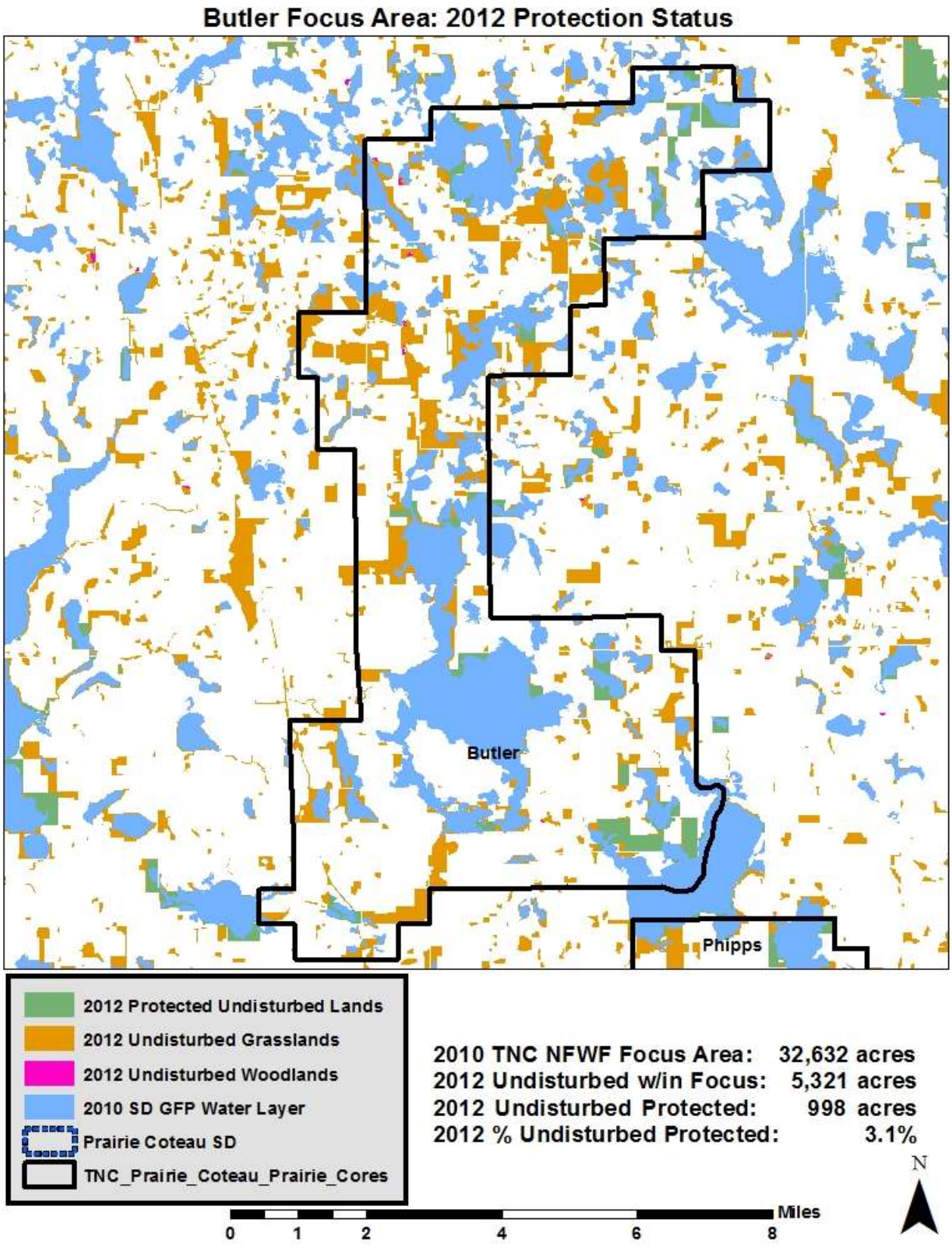


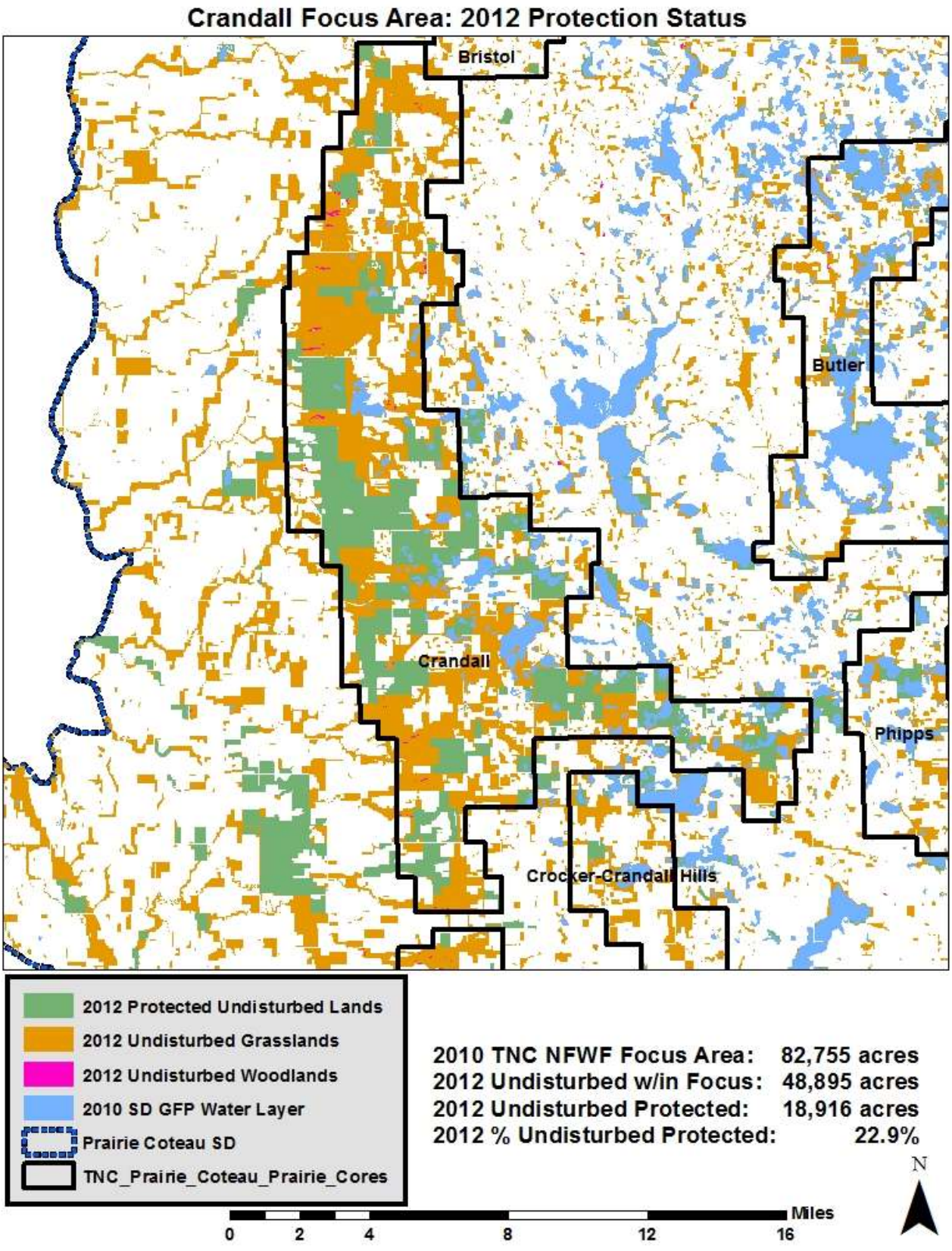
Appendix C:

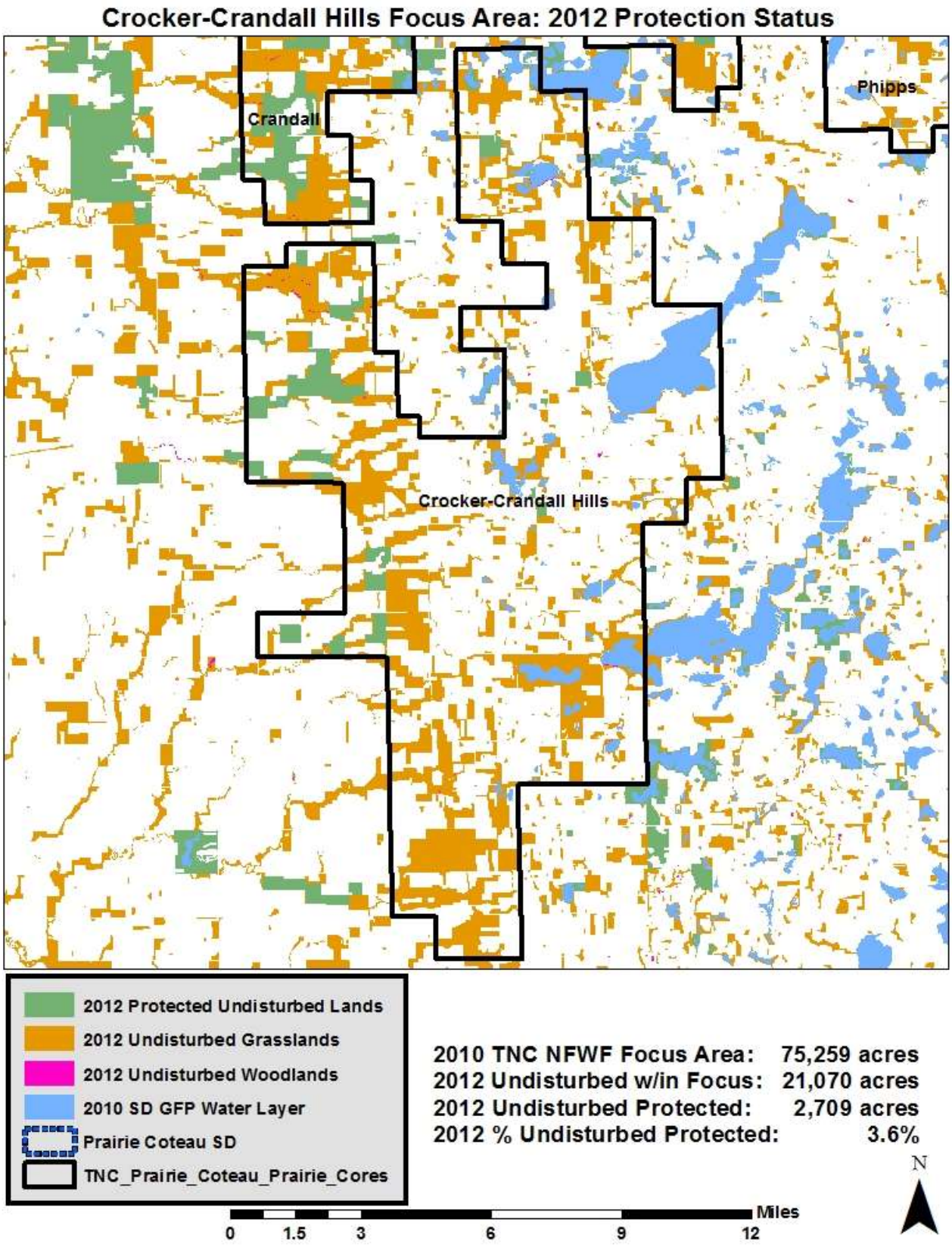
Updated TNC NFWF Focus Area Maps of Undisturbed Grasslands and Woodlands *With* Permanent Protection Status in the South Dakota Prairie Coteau, Based on 2012 Analysis.

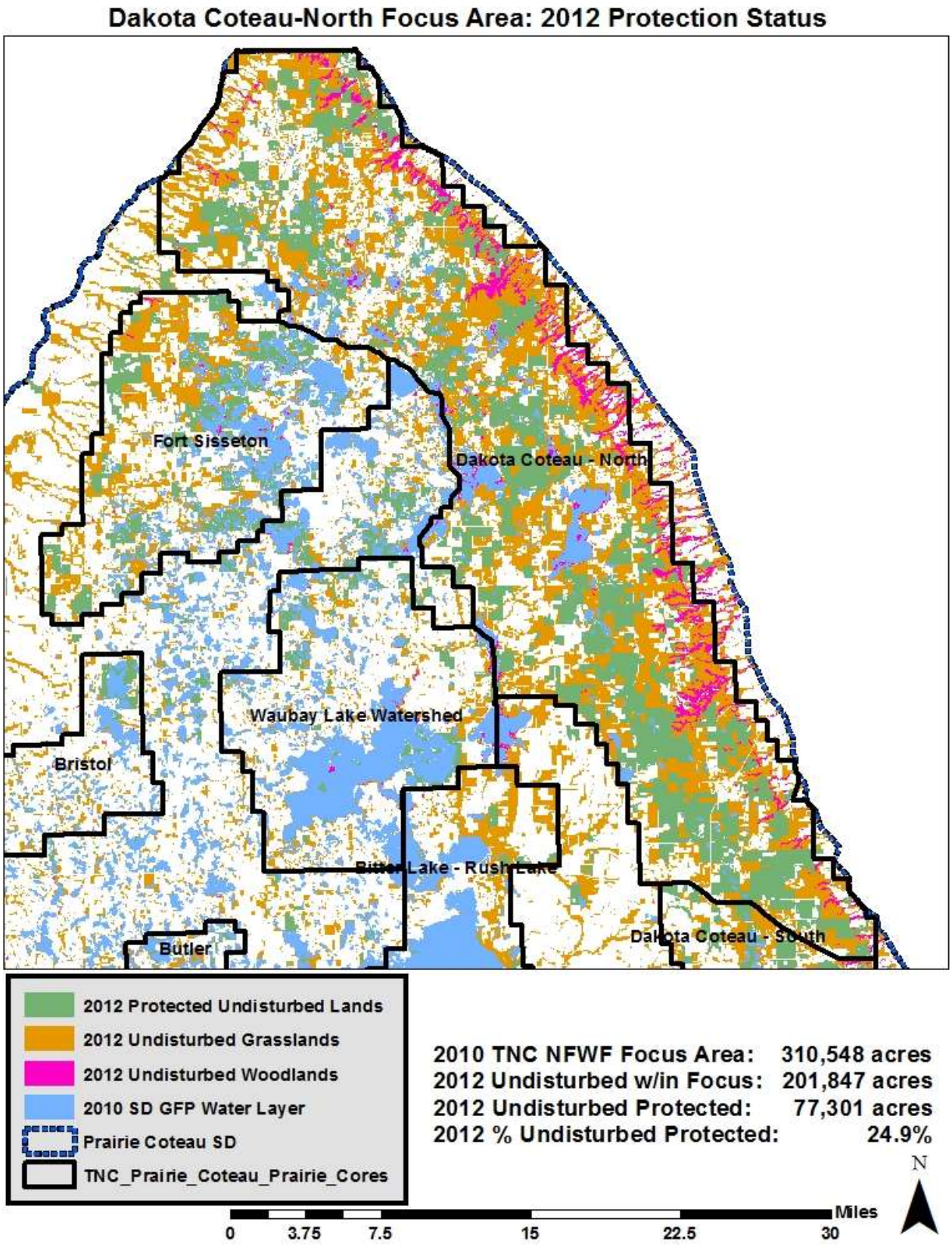

Bitter Lake-Rush Lake Focus Area: 2012 Protection Status
Waubay Lake Watershed
Bitter Lake - Rush Lake
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 54,266 acres
2012 Undisturbed w/in Focus: 12,012 acres
2012 Undisturbed Protected: 2,296 acres
2012 % Undisturbed Protected: 4.2%
N
Miles
0 1 2 4 6 8

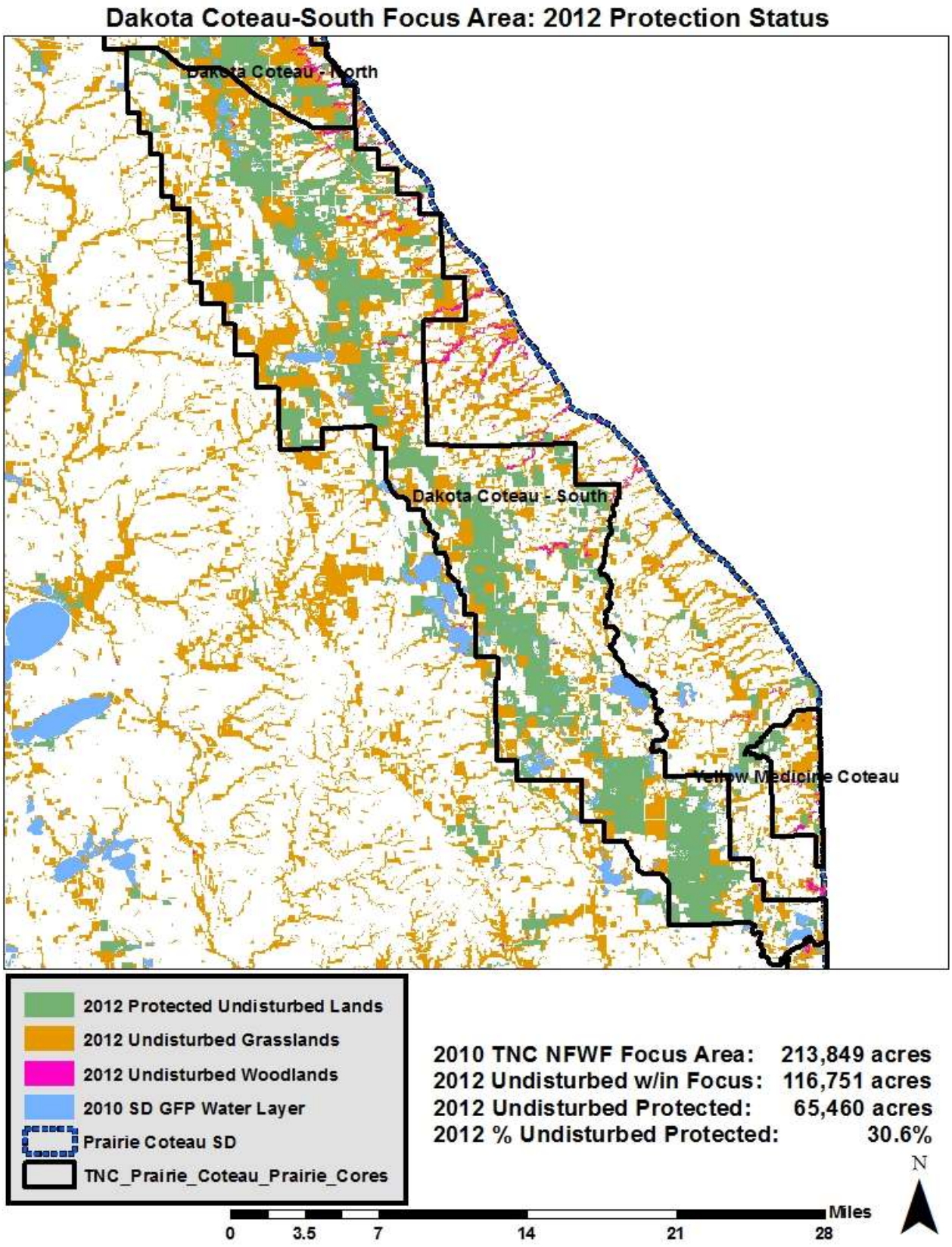

Bristol Focus Area: 2012 Protection Status
Bristol
Crandall
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 46,371 acres
2012 Undisturbed w/in Focus: 8,779 acres
2012 Undisturbed Protected: 1,862 acres
2012 % Undisturbed Protected: 4.0%
N
Miles
0 1 2 4 6 8


Butler Focus Area: 2012 Protection Status
Butler
Phipps
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 32,632 acres
2012 Undisturbed w/in Focus: 5,321 acres
2012 Undisturbed Protected: 998 acres
2012 % Undisturbed Protected: 3.1%
N
0 1 2 4 6 8 Miles

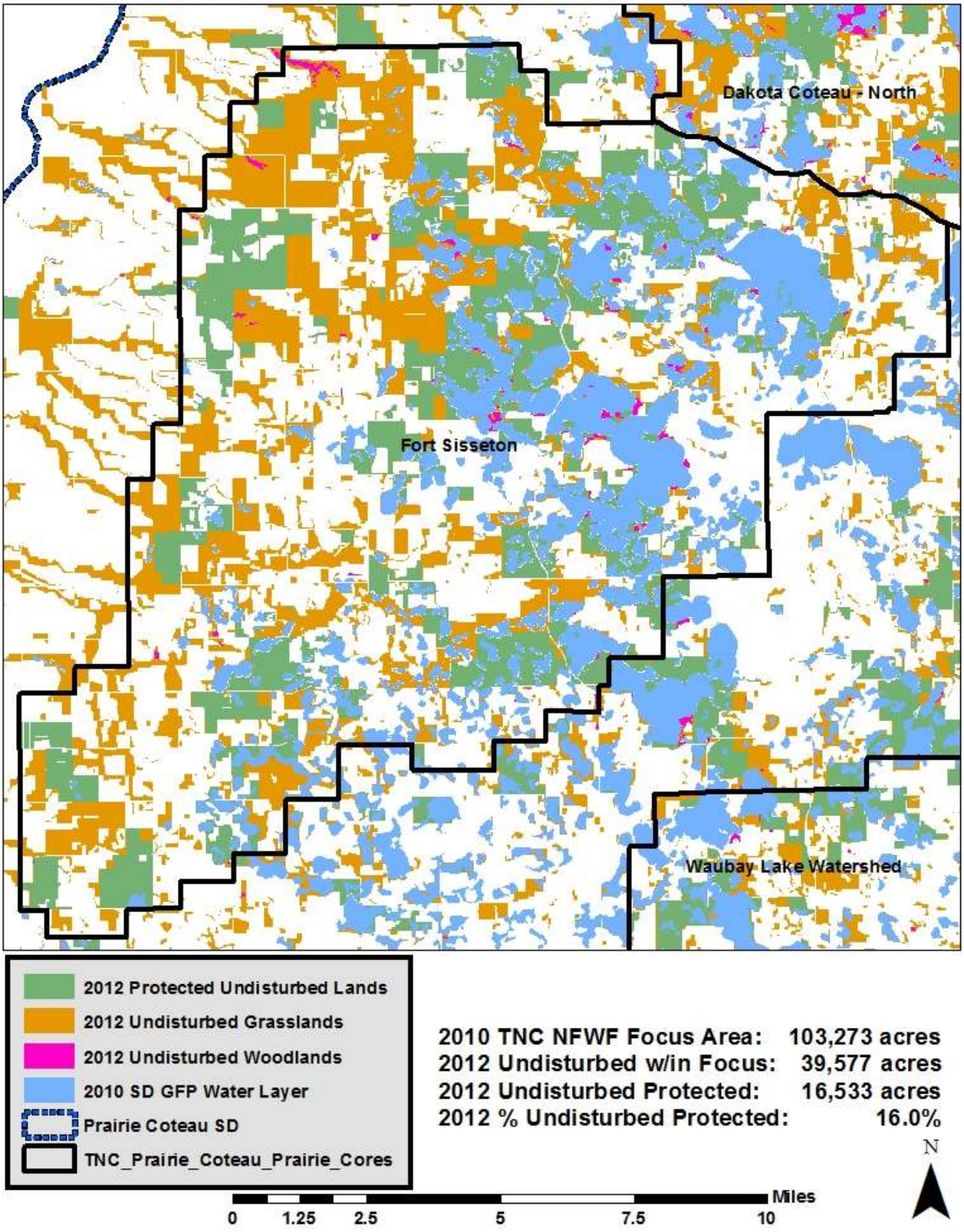

Crandall Focus Area: 2012 Protection Status
Bristol
Butler
Crandall
Phipps
Crocker-Crandall Hills
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 82,755 acres
2012 Undisturbed w/in Focus: 48,895 acres
2012 Undisturbed Protected: 18,916 acres
2012 % Undisturbed Protected: 22.9%
N
Miles
0 2 4 8 12 16

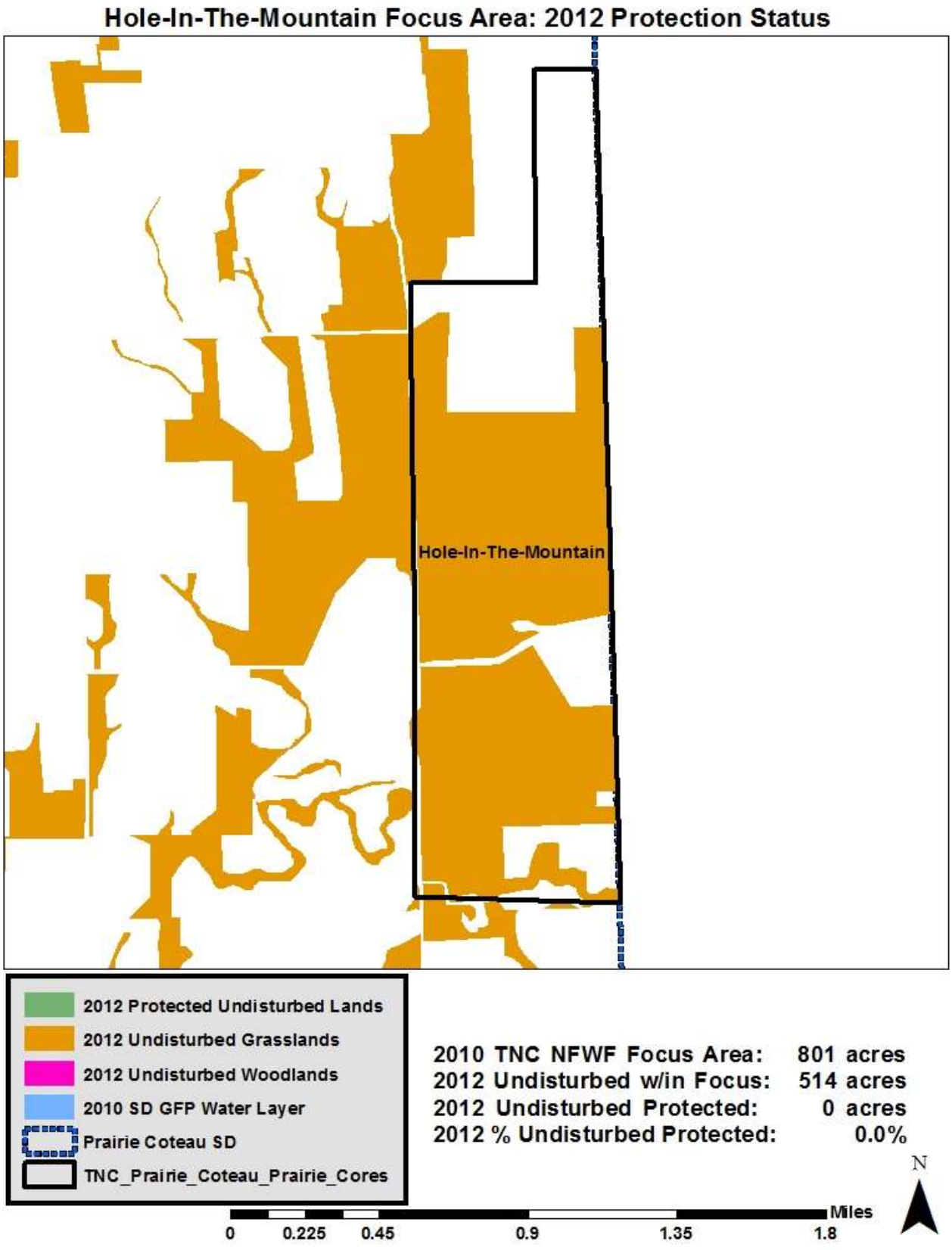

Crocker-Crandall Hills Focus Area: 2012 Protection Status
Crandall
Phipps
Crocker-Crandall Hills
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 75,259 acres
2012 Undisturbed w/in Focus: 21,070 acres
2012 Undisturbed Protected: 2,709 acres
2012 % Undisturbed Protected: 3.6%
N
Miles
0 1.5 3 6 9 12

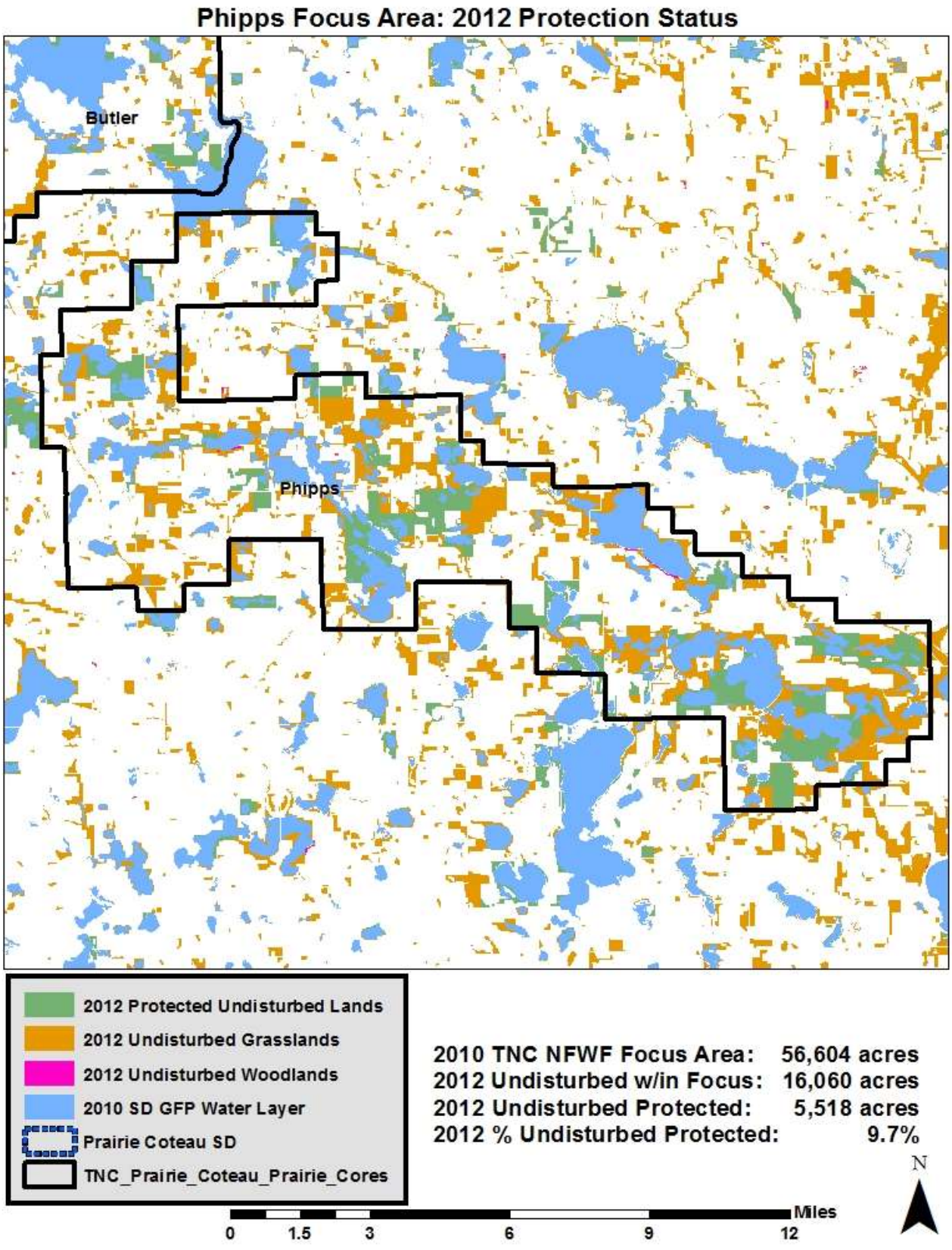

Dakota Coteau-North Focus Area: 2012 Protection Status
Fort Sisseton
Dakota Coteau - North
Waubay Lake Watershed
Bristol
Bitter Lake - Rush Lake
Dakota Coteau - South
Butler
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 310,548 acres
2012 Undisturbed w/in Focus: 201,847 acres
2012 Undisturbed Protected: 77,301 acres
2012 % Undisturbed Protected: 24.9%
N
0 3.75 7.5 15 22.5 30 Miles

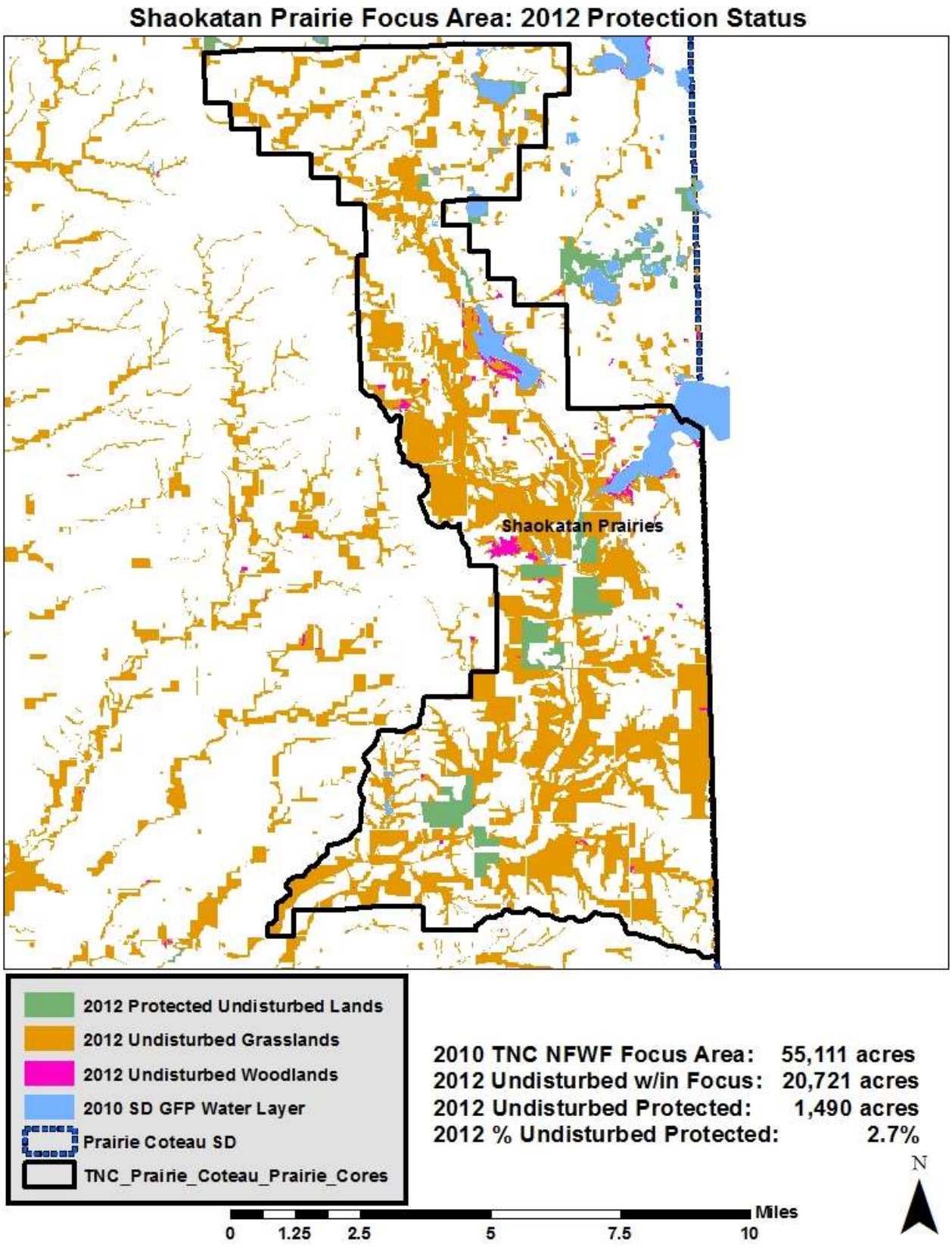

Dakota Coteau-South Focus Area: 2012 Protection Status
Dakota Coteau - North
Dakota Coteau - South
Yellow Medicine Coteau
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 213,849 acres
2012 Undisturbed w/in Focus: 116,751 acres
2012 Undisturbed Protected: 65,460 acres
2012 % Undisturbed Protected: 30.6%
N
Miles
0
3.5
7
14
21
28

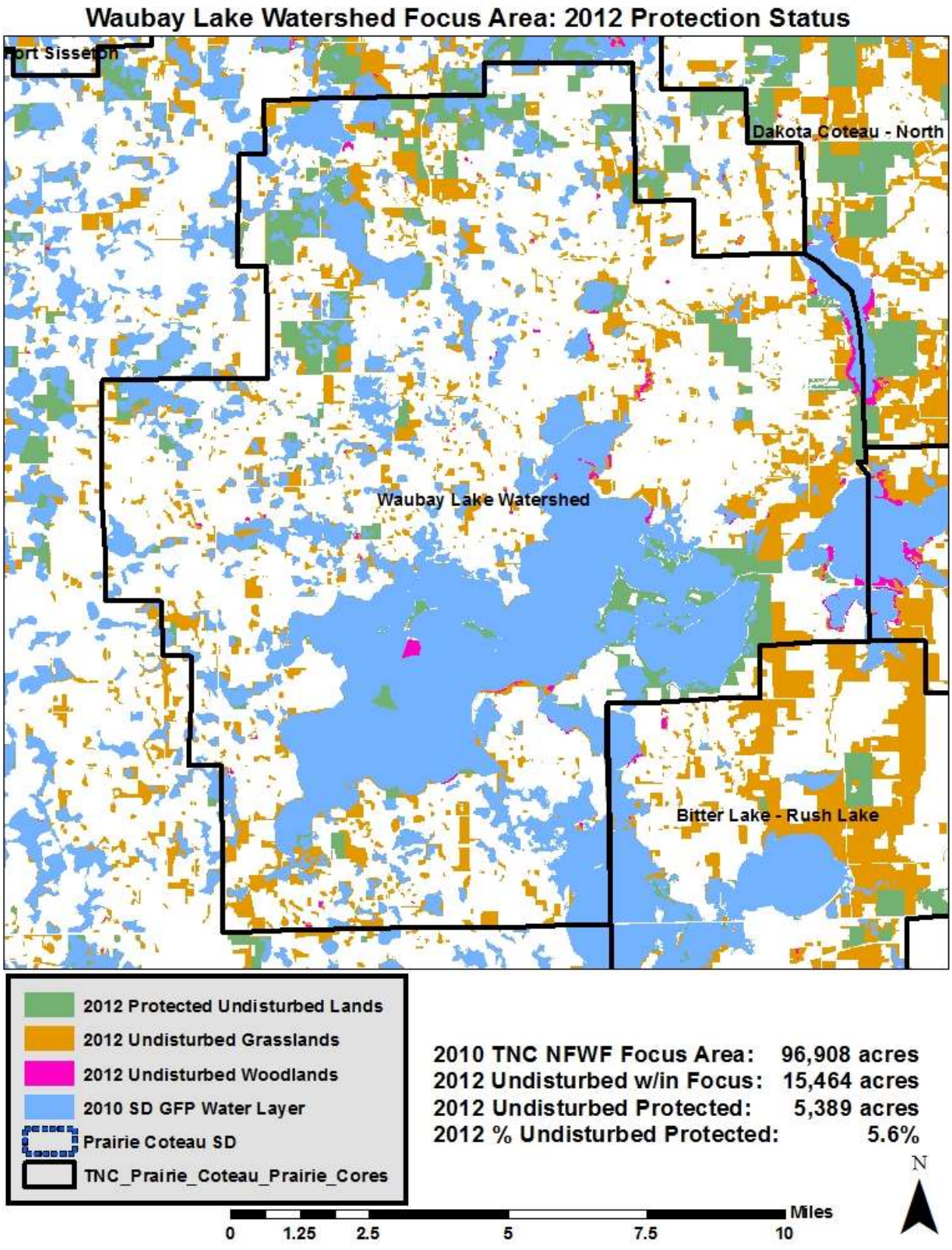
Fort Sisseton Focus Area: 2012 Protection Status

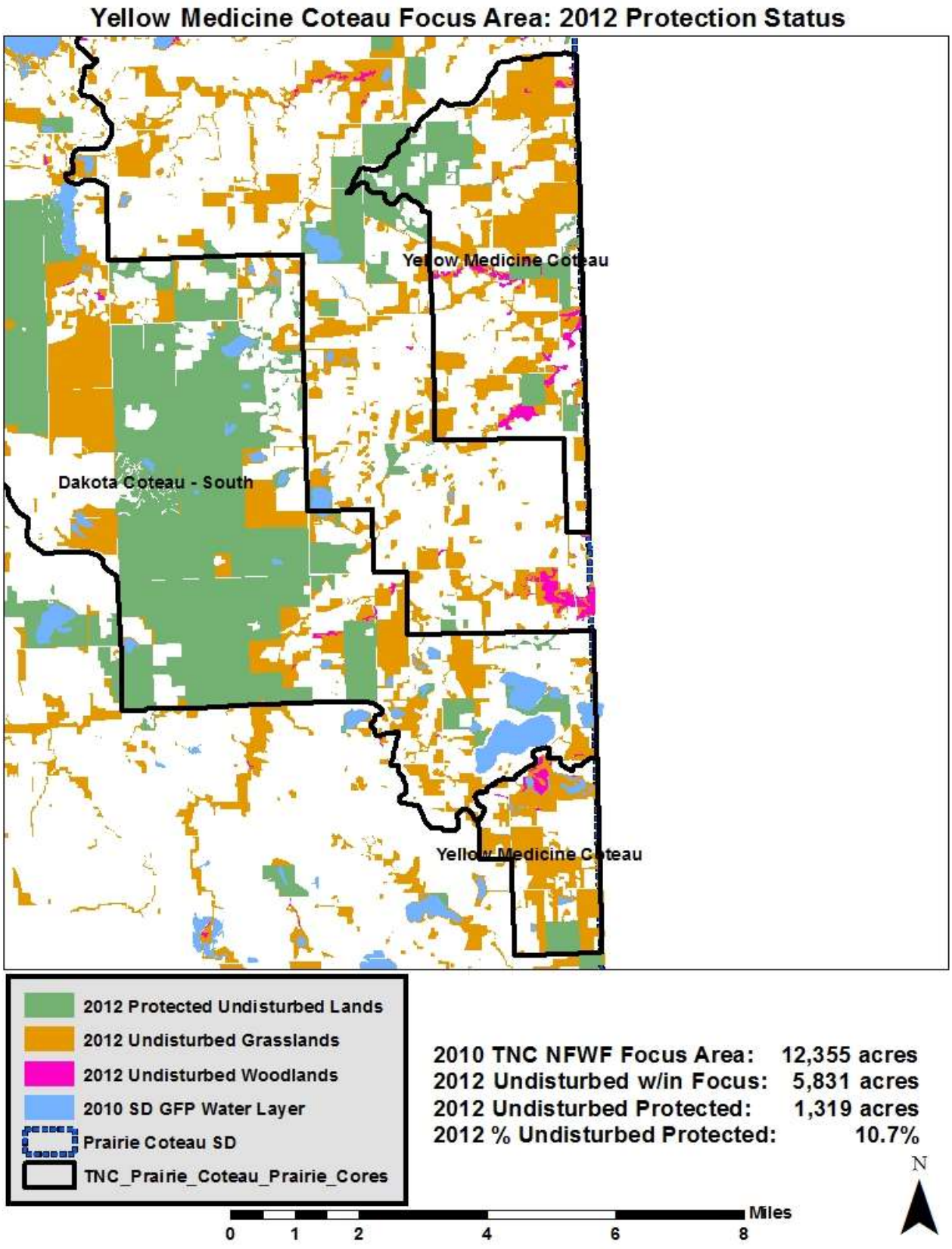



Hole-In-The-Mountain Focus Area: 2012 Protection Status
Hole-In-The-Mountain
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 801 acres
2012 Undisturbed w/in Focus: 514 acres
2012 Undisturbed Protected: 0 acres
2012 % Undisturbed Protected: 0.0%
N
0 0.225 0.45 0.9 1.35 1.8
Miles


Phipps Focus Area: 2012 Protection Status
Butler
Phipps
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 56,604 acres
2012 Undisturbed w/in Focus: 16,060 acres
2012 Undisturbed Protected: 5,518 acres
2012 % Undisturbed Protected: 9.7%
N
Miles
0 1.5 3 6 9 12


Shaokatan Prairie Focus Area: 2012 Protection Status
Shaokatan Prairies
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 55,111 acres
2012 Undisturbed w/in Focus: 20,721 acres
2012 Undisturbed Protected: 1,490 acres
2012 % Undisturbed Protected: 2.7%
N
0 1.25 2.5 5 7.5 10
Miles


Waubay Lake Watershed Focus Area: 2012 Protection Status
Fort Sisseton
Dakota Coteau - North
Waubay Lake Watershed
Bitter Lake - Rush Lake
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 96,908 acres
2012 Undisturbed w/in Focus: 15,464 acres
2012 Undisturbed Protected: 5,389 acres
2012 % Undisturbed Protected: 5.6%
N
0 1.25 2.5 5 7.5 10
Miles


Yellow Medicine Coteau Focus Area: 2012 Protection Status
Yellow Medicine Coteau
Dakota Coteau - South
Yellow Medicine Coteau
2012 Protected Undisturbed Lands
2012 Undisturbed Grasslands
2012 Undisturbed Woodlands
2010 SD GFP Water Layer
Prairie Coteau SD
TNC_Prairie_Coteau_Prairie_Cores
2010 TNC NFWF Focus Area: 12,355 acres
2012 Undisturbed w/in Focus: 5,831 acres
2012 Undisturbed Protected: 1,319 acres
2012 % Undisturbed Protected: 10.7%
N
Miles
0 1 2 4 6 8