Chapter 3. Conservation Background – Terrestrial and Riparian-Wetland Ecosystems

Relevant Required Elements:
#2 – Descriptions of locations and relative conditions of key habitats and community types essential to SGCNs.

Focus of Chapter 3:

The primary goal of the SDWAP is to present a strategic approach to provide for the needs of all fish and wildlife species and their associated habitats in the state. To meet this challenge, we have chosen a planning method that combines a coarse filter and fine filter approach. We can accommodate the needs of most species by providing at least some of the framework that helped nature build the combination of habitats and species prior to settlement and intensive change. That coarse filter is partnered with a fine filter approach. Some species may have declined to the point that they need additional support for recovery, possibly needing intensive measures such as captive rearing, reintroduction, or translocation from other areas. Perhaps the habitats they rely on no longer undergo the dynamic forces of the past, such as grasslands that no longer benefit from regular renovation through fire or bison grazing or forests that are not exposed to natural fires as during pre-European times. Later in this document, you will find suggested measures for conservation and maintenance of plant and animal species that follow the coarse or fine filter approach.

We describe the ecological framework for terrestrial ecosystems that defines South Dakota habitats in two primary ways. The MLRA framework developed by the NRCS matches our most critical terrestrial habitats by providing detailed descriptions and predictive species compositions for the many and varied grassland habitat types in the state. We present and describe the terminology and concepts associated with MLRA-based planning.

We also introduce a simple habitat classification system that may be more meaningful to those not familiar with MLRAs. We used various data sources and well-established landscape classification systems to sort the state's general habitat types into 8 categories. Also in this chapter is a description of natural disturbance factors, such as climate, fire, grazing, black-tailed prairie dogs and other herbivores, beaver, and flood events. These disturbances have been modified or controlled to suit modern land uses. Those management decisions have altered the habitats and dependent fish and wildlife, which is noted in later sections where conservation threats and actions are described for SGCNs.

We also describe the ecological concepts and data sources associated with understanding riparian-wetland ecosystems. The dynamic and complex nature of these systems is described due to the impact of South Dakota's extreme fluctuations in temperature and precipitation and other influences, such as beavers and herbivores.

Although an important and prevalent habitat type, grasslands are only one of South Dakota's crucial terrestrial, riparian-wetland, or aquatic ecosystem types. Rivers and streams support fish and wildlife and provide water for human consumption, irrigation, recreation, and livestock and wildlife use. The prairie potholes of eastern and northcentral South Dakota and the Missouri River riparian corridor provide critical habitat for migratory and breeding waterfowl and shorebirds. The Black Hills and Custer national forests provide critical habitat for a wide diversity plants and animals not found in other parts of South Dakota. This chapter introduces and describes the riparian-wetland systems by explaining well-established wetland habitat classification systems and associated habitat terminology, wetland inventory efforts, and the scope of wetland drainage in the state.

Terrestrial and riparian-wetland native ecosystems provide diverse habitats for plants and animals throughout South Dakota. The ecosystem diversity is a result of disturbance processes (e.g., grazing, fire, etc.) interacting with site conditions and climate. Ecosystem diversity, when adequately described, characterized, and conserved, should provide habitat for many species, both plant and animal, that have evolved and adapted to the conditions present in a defined area. While ecosystems can be distinct from each other, more frequently they have less clearly defined edges that transition from one ecosystem type to another. However, to describe and quantify the amounts of these ecosystems for assessment and management purposes, it is necessary to map ecosystem boundaries while recognizing that these delineations may not always be obvious to the naked eye without more detailed field surveys or assessments.

The combined, incremental effects of human activity on native ecosystem diversity and their associated wildlife since European settlement have led to this revised SDWAP, representing the state's conservation strategy. Natural resource managers have long recognized the difficulty in quantifying and describing these changes in meaningful ways to facilitate a reversal of their decline and loss across broad landscapes. To assist in that regard, a coarse-filter strategy based on native ecosystem diversity was selected as South Dakota's conservation strategy for terrestrial and riparian wetland systems. It is used as the scientific framework to describe the underlying basis and assumptions used to define and quantify ecological restoration to support all biological diversity across South Dakota. The following sections describe this conservation strategy in more detail and provide information on its implementation.

3.1 Conservation Strategy

The SDWAP incorporates a combined coarse-filter and fine-filter conservation strategy for biological diversity (TNC 1982 Haufler et al. 1996, Healy 2002, Samson 2002). The coarse-filter strategy seeks to preserve biological diversity by maintaining a variety of historically occurring and naturally functioning ecosystems across the landscape. The fine-filter strategy then uses our best understanding of a species habitat needs to evaluate whether the coarse-filter will provide the habitat conditions to meet that species' needs, or whether additional actions are required.

Many resource managers and agencies are accustomed to identifying species-specific limiting factors and implementing discrete projects to address them at a local level. The challenge with state wildlife action plans is the responsibility to examine and understand the complexity of habitats, how they are affected by human-made and natural processes, and the potential interactions of habitat and environmental changes on unstudied species and habitats. Much of this chapter lays the foundation for understanding the complexity of this task, made more challenging because principles of landscape ecology, disturbance ecology, and related fields are not always widely understood, even by natural resource practitioners.

South Dakota's conservation strategy is based on providing enough diverse terrestrial and riparian-wetland native ecosystems on the landscape to support the ever-evolving native biodiversity across the state. A conservation strategy that focuses on restoring, enhancing, and protecting native ecosystem diversity for terrestrial and riparian-wetland ecosystems provides a strong scientific foundation for the overall conservation of biological diversity and the flexibility to consider other land uses in the overall effort (Haufler 1999). This strategy evaluates ecosystem integrity and biological diversity relative to what has occurred historically at a specific site or location. For this purpose, the term "historical" is typically considered a period less than 1000 years before European settlement. There is a strong scientific foundation for using historical references to define ecosystem integrity and biological diversity (Morgan et al. 1994, Swetnam et al. 1999). The complex array and dynamic distribution of ecosystems across South Dakota shaped and influenced ecosystems for thousands of years, these influences are incorporated in a historical reference. It is the extent of human influence over the last 150 years that is of greatest conservation concern.

Native ecosystems (defined as the historical reference) have been lost from the conversion of land to row crop agriculture and urbanization. Loss has also occurred from the expansion of renewable energy features, such as solar fields, wind energy development, biofuel plants, and pipelines (Ott et al. 2021). Woody encroachment (meaning areas that were historically treeless such as grasslands are becoming wooded) and the intentional and accidental introduction of exotic species have further altered the landscape. However, there are also less obvious, yet in some instances more pervasive, human-induced changes. We have only recently begun to understand the implications of a century of European alterations to and interruptions of natural disturbance regimes once found across the landscape in South Dakota. Recent studies have shown that the suppression or cessation of natural processes such as fire and intensive grazing has gradually changed ecosystem processes and ultimately the composition, structure, and function of many ecosystems (Fuhlendorf and Engle2001, Kaye et al. 2010, Kucera 1978, Lett and Knapp 2005). These changes have also impacted the distribution and quality of habitat for many species.

A description of ecosystem diversity based on historical references for plant community compositions, structures, and dynamic processes provides the coarse-filter component of this strategy. A description of threats and habitat needs for individual SGCNs represents the fine-filter component. For most wildlife species, habitat needs will be provided by the ecosystem diversity resulting from the coarse filter. The SDWAP will use the coarse-filter/fine-filter strategy based on the historical reference to native ecosystems across a broad planning area. However, to be effective, it will need to consider relatively fine-scale information on ecosystem types and distributions to address the habitat needs of specific species (Flather et al. 2009, Poiani et al. 2000).

Combining a coarse-filter and fine-filter conservation strategy has several advantages.

- First, the coarse-filter strategy provides a sound scientific foundation for identifying and quantifying the cumulative effects of post-settlement activities on native ecosystem diversity, which in turn provides better information for the fine-filter assessment to evaluate the resulting impacts on species and their habitat (Haufler 1999).
- Second, it is more time and cost-effective to manage for desired ecosystem conditions than to manage for an ever-increasing number of endangered, threatened, or declining species scattered across the landscape.
- Third, a coarse filter provides the mechanism to make sense of conflicting habitat demands in a single landscape for multiple species of interest.
- Finally, for many SGCNs, little information on their distribution within South Dakota and specific habitat needs is currently available. By applying the coarse-filter strategy, we are increasing the likelihood that the habitat needs of these species will be addressed with the restoration or maintenance of historical ecosystems.

Application

Biological diversity is often assessed at four levels: 1) landscape, 2) ecosystem (sometimes also referred to as the community level), 3) species, and 4) genetic (Healy 2002, Hunter 1991, Noss and Scott 1995). The combination of a coarse-filter and fine-filter strategy provides the mechanism to address these four levels of biological organization. The coarse filter addresses the landscape and ecosystem levels while the fine- filter addresses the species level. Genetic analyses can be a component of the fine filter and may also provide insights into landscape and ecosystem-level functionality. However, the primary emphasis of the SDWAP is on the landscape, ecosystem, and species levels of scale. Genetic levels can be incorporated when needed to address specific questions such as connectivity within a population of a species.

For the SDWAP, we applied the coarse-filter/fine-filter strategy in the following sequence:

1. Delineate ecoregions using MLRAs for terrestrial ecosystems within South Dakota to facilitate ecosystem diversity characterization and management;
2. Delineate 8 habitat categories using the National Land Cover Database (NLCD) and MLI – Conservation Blueprint data to view current land uses to address threats and action items;
3. Identify riparian-wetland ecosystems with a combination of hydrogeomorphic classes and hydrology subclasses;
4. Classify terrestrial ecosystem diversity (by ecological sites) as it occurred under natural disturbance regimes within each ecoregion to describe the coarse filter;
5. Describe conservation challenges for maintaining or restoring native ecosystem diversity;
6. Develop ecosystem diversity goals that identify desired levels of representation for all historical ecosystems;

7. Identify and describe a process for implementing ecosystem diversity goals relative to existing conditions and for making recommendations for ecosystem restoration;
8. Evaluate species diversity within South Dakota and identify SGCNs;
9. Evaluate the habitat needs/requirements of SGCNs relative to the ecosystem diversity goals;
10. Identify those species requiring non-habitat-related management activities not addressed by the emphasis on ecosystem diversity;
11. Develop conservation actions to address the habitat and non-habitat-related needs of SGCNs;
12. Identify COAs to help direct conservation actions to the most appropriate locations; and
13. Identify opportunities for collaborative partnerships within the state, surrounding states, and national organizations to achieve the conservation goals.

3.2 Ecoregions

Ecological classification systems at the regional level, often called ecoregions, are developed to help stratify smaller-scale ecosystem complexity into discrete units. They describe areas of similar climate, physiography, hydrology, vegetation, and wildlife habitat potential. In addition, natural disturbances are often constrained by the underlying physical features of soils and topography characterizing a region. MLRAs have been delineated by the NRCS to characterize landscape patterns that combine soils, water, climate, vegetation, and land use. The MLRA classification is relatively well developed and is supported at higher resolutions by ecological site information and soil data. For this reason, MLRAs were selected as a terrestrial classification system to derive ecoregional boundaries. Figure 3.1 presents a map of the 21 MLRAs occurring in South Dakota. The number of acres for each MLRA ecoregion can be found in Table 3.1. These were derived using data layers provided by NRCS in 2022. NRCS (2022) provides more information on the methodology used to develop MLRAs and a more detailed description of characteristics and general features.

Two categories of ecological systems occur in South Dakota – terrestrial and riparian-wetland-aquatic. Grass-shrub systems and forested systems further broadly delineate the terrestrial systems. Grass-shrub systems are the most common in South Dakota, currently at roughly 40.5 million acres (16.4 million hectares) or 82% of the state while forested systems represent only 1.5 million acres (6.1 million hectares) or 3% of the state. Many facets of the SDWAP emphasize the importance of grassland habitats because of the prevalence of this habitat type in the Northern Great Plains (NGP); the importance of grasslands to other uses, such as supporting agricultural livelihoods, hosting pollinators, and controlling erosion; and documented grassland loss and companion declines in grassland-dependent plant and animal species. An area in need of additional study and analysis is the historical and ongoing loss of riparian and upland shrublands and forests and related impacts to wildlife and plants.

Riparian-wetland- aquatic systems represent approximately 7.4 million acres (3 million hectares) or 15% of the state. Figure 3.2 represents a map of 9 geographic land descriptions across South Dakota and represents current land uses throughout the state in 2021. The land use descriptions are intended

to assist readers not familiar with the MLRA system and will be used at various places in this document, such as for describing threats and action items. Figure 3.2 was derived from the NLCD and MLI – Conservation Blueprint. For more information, please visit:
https://www.usgs.gov/centers/eros/science/national-land-cover-database and
https://www.mlimidwest.org/.

The 2021 NLCD data have 87% accuracy as was true for the 2019 data (Wickham et al. 2023). The nine geographic land descriptions are: grasslands; cultivated land; urban/developed; forest; wetlands; badlands; shrublands; lakes and reservoirs; and streams and rivers (Table 3.2). The Midwest Landscape Initiative (MLI) was also used to delineate the wetlands portion of the map. Table 3.2 explain the nine classifications used along with specific examples. Figure 3.2 shows distribution of these habitat types to illustrate South Dakota's current landscape.

The NLCD classifications for each land cover were modified from the Anderson Level II classification system (Anderson 1976) to create 8 simple habitat classifications. Similar classifications were used in Johnson and Knight (2022). The 8 habitat categories are grasslands, forest, riparian areas, wetlands, badlands, shrublands, lake/reservoirs, and river/streams. The cultivated land and urban/developed categories were removed because they are not considered suitable habitat for our planning and conservation purposes.

Across South Dakota, aquatic systems play a critical part in maintaining species biodiversity and ecologic function. Three key aquatic habitats are discussed in the SDWAP including: lakes and reservoirs; streams and rivers; and wetlands occurring across South Dakota. Streams and Rivers are based on a clip of the National Hydrography Dataset Flowlines product (NHD), which can be found at
https://www.usgs.gov/national-hydrography/national-hydrography-dataset

South Dakota contains 14 different river basins. Each basin belongs to larger regions (Missouri, Upper Mississippi, and Souris-Red-Rainy), and gulfs (Hudson Bay and Gulf of Mexico), which eventually drain into different oceans (Table 3.3).

Figure 3.1. Map of Major Land Resource Areas for South Dakota (USDA NRCS 2022).

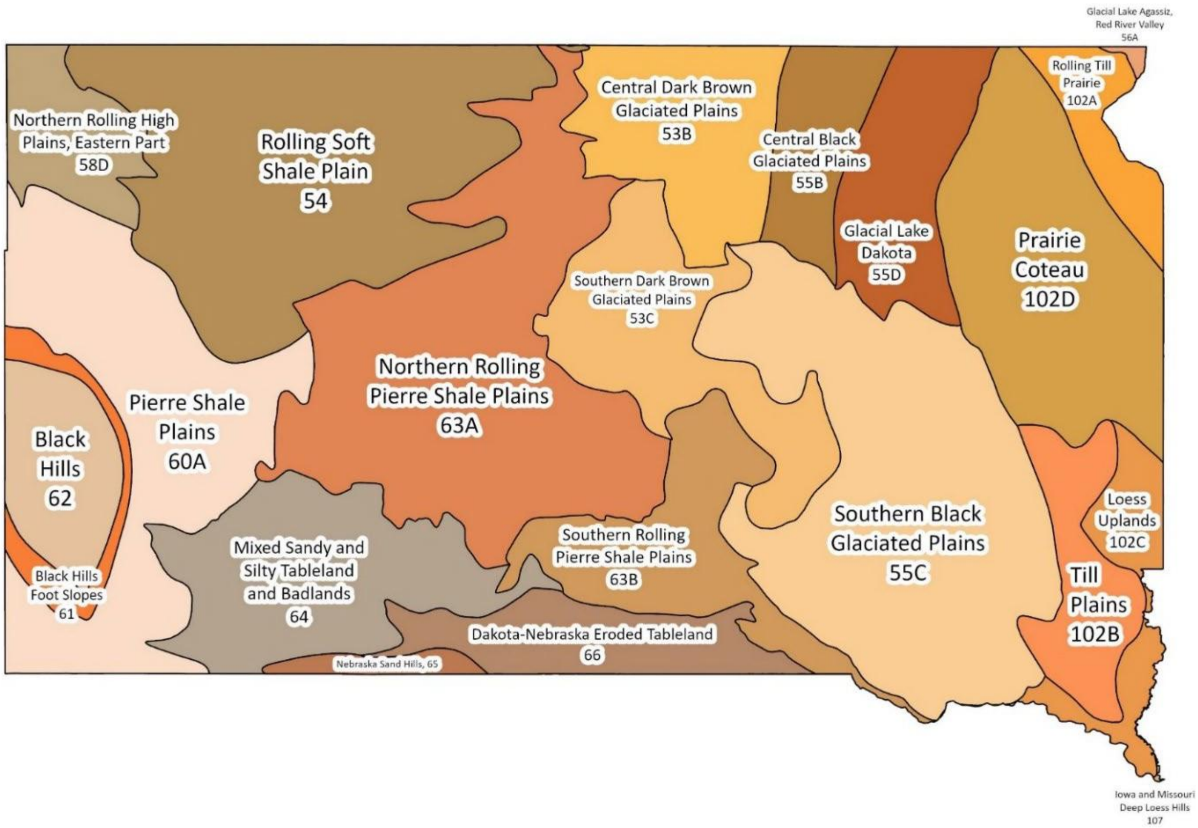


Table 3.1. Number of Acres Representing the 21 Major Land Resource Areas in South Dakota.

MLRA #	NAME	ACRES*	HECTARES
53B	Central Dark Brown Glaciated Plains	2,177,640	881,259
53C	Southern Dark Brown Glaciated Plains	2,621,840	1,061,021
54	Rolling Soft Shale Plain	6,172,600	2,497,963
55B	Central Black Glaciated Plain	1,137,360	460,273
55C	Southern Black Glaciated Plain	6,815,650	2,758,196
55D	Glacial Lake Dakota	1,806,450	731,044
56A	Glacial Lake Agassiz, Red River Valley	37,648	15,250
58D	Northern Rolling High Plains, Eastern Part	1,145,350	463,466
60A	Pierre Shale Plains	4,546,850	1,840,045
61	Black Hills Foot Slopes	541,362	219,081
62	Black Hills	1,388,710	561,991
63A	Northern Rolling Pierre Shale Plains	6,471,097	2,618,760
63B	Southern Rolling Pierre Shale Plains	2,307,150	933,670
64	Mixed Sandy and Silty Tableland and Badlands	3,195,600	1,293,213

65	Nebraska Sand Hills	285,923	115,708
66	Dakota-Nebraska Eroded Tableland	1,614,030	653,174
102A	Rolling Till Prairie	759,389	307,313
102B	Till Plains	1,400,640	566,818
102C	Loess Uplands	1,001,340	405,227
102D	Prairie Coteau	3,896,220	1,576,744
107	Iowa and Missouri Deep Loess Hills	4,750	1,922
TOTALS		**49,327,599**	**19,962,171**

*****Acres were calculated in ArcGIS® Pro 2.9 using MLRA GIS boundaries provided by NRCS.

Figure 3.2. Habitat Classification Using 2021 National Land Cover Database and the Midwest Landscape Initiative – Conservation Blueprint to Help Understand Current Land Uses Across South Dakota. MLI Wetlands Were Merged with the 2021 NLCD (MLI 2024, USGS 2021).

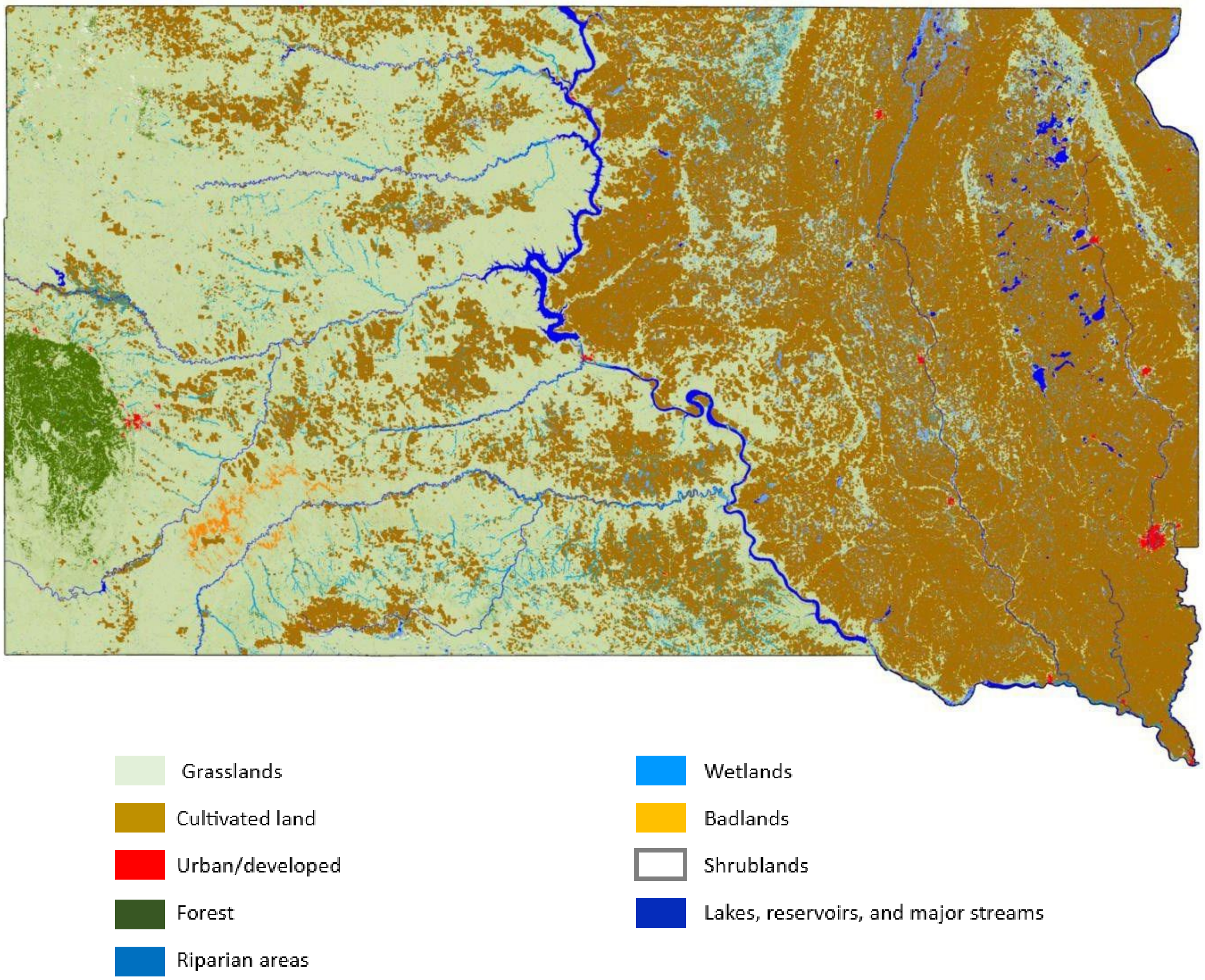


Table 3.2. National Land Cover Data Classification (Derived from Anderson 1976).

Level 1 Classification	Level 2 Classification	South Dakota examples
Grasslands	– Grassland/herbaceous – Pasture/hay	• Tallgrass prairie • Mixed-grass prairie • Shortgrass prairie
Cultivated land	– Cultivated cropland	• Corn • Sunflowers • Oats
Urban/developed	– Developed, high-intensity – Developed, medium-intensity – Developed, low-intensity – Developed, open space	• Sioux Falls, SD • Rapid City, SD • Wall, SD • Golf courses
Forest	– Deciduous forest – Mixed forest – Evergreen forest	• Black Hills • Sica Hollow State Park
Wetlands	– Woody wetlands – Emergent herbaceous wetlands	• Prairie Pothole Region
Badlands	– Barren land (Rock, Sand, Clay)	• Badlands • Gravel pits
Shrublands	– Shrub/scrubland	• NW South Dakota – Big Sagebrush
Lakes/reservoirs	– Open water	• Lake Poinsett • Pactola Reservoir • Missouri River reservoirs
Streams/rivers	– Linear water	• Minnesota River • James River • Cheyenne River

Table 3.3. Classification of Rivers Within South Dakota.

Gulf	Drainage	Region (HUC_2)	Sub-Region (HUC4)	Basin (HUC_6)	Watershed (HUC_10) *not comprehensive list
Gulf of Mexico	Mississippi	Missouri	Missouri-Little Missouri	Little Missouri	
			Missouri -Oahe	Lake-Oahe	
				Grand-Moreau	
				Cannonball-Heart-Knife	Plum Creek
					Hay Creek
			Cheyenne	Cheyenne	Rapid Creek
					Cherry Creek
					Fall River
				Belle Fourche	Spearfish Creek
					Redwater Creek
			Missouri-White	White	
				Fort Randall Reservoir	Bad River
			Niobrara	Niobrara	Keya Paha River
			Missouri-Big Sioux	Big Sioux	
				Lewis and Clark Lake	Vermillion River
					Ponca Creek
			James	James	
		Upper Mississippi	Minnesota	Minnesota	
Hudson Bay	Nelson	Souris-Red-Rainy	Red	Upper Red	Wild Rice River
					Bois de Sioux River

*Watersheds is not a comprehensive list as there are more than 450 HUC_10 watersheds in South Dakota. This table does not include sub-basins (HUC_8) in South Dakota.

3.3 Natural Disturbance Processes

The SDWAP selected a conservation strategy that uses the historical reference and understanding of natural disturbance regimes to maintain or restore biological diversity in the state. Understanding the terms historical reference and natural disturbance and their importance is important to understanding the selected conservation strategy.

We define historical reference as the ecosystem conditions that resulted from natural (i.e. fire, herbivory, etc.) disturbances and disturbances created by humans prior to European settlement (i.e. Native American times) that created the dynamic conditions species relied upon for habitats. Natural disturbance regimes are the patterns of frequency and intensity that can be quantified using ecological evidence (Morgan et al. 1994. White and Walker 1997). For example, both fire and flood regimes are frequently described relative to frequency of occurrence and relative intensity. Another term frequently used in relation to historical conditions is the historical or natural range of variability. Historical range of variability (HRV) is an important concept because it emphasizes that many ecosystems vary in amounts, compositions, and structures due to variations in climate and stochastic events (Aplet and Keeton 1999. Keane et al. 2009).

The historical reference is usually confined to a period less than 1,000 years prior to European settlement, as these reflect the habitat conditions most relevant to the wildlife species present today (Morgan et al. 1994). In some areas of the country quantifying historical reference may be difficult due to a lack of ecological information to help describe historical conditions. Depending on the area of South Dakota in question, specific types of historical information can be available to help reconstruct the HRV (Egan and Howell 2005, White and Walker 1997). However, in some ecosystems historical information is less available, and historical ecosystem dynamics require the use of models based on the best available information.

Ecosystems were not static during any defined reference period. Species distributions were changing, human activities were changing, and species themselves were adjusting to these changes through behavioral and genetic alterations. However, providing an understanding of the ecosystem diversity that occurred during an identified timeframe prior to European settlement provides critical reference information for defining and quantifying a baseline of what should be considered “natural” for an area. The following sections discuss the primary natural disturbance processes influencing the ecosystem and biological diversity of South Dakota prior to European settlement.

Climate

Climatic patterns are cyclical between wet and dry periods throughout most of South Dakota (Woodhouse and Overpeck 1998). Because of South Dakota’s geographic location, the climate and weather events it experiences are heavily influenced by its proximity to the Rocky Mountains to the west, direct link to Artic air masses to the north, and moisture conveyance from the Gulf of Mexico to the south. The South Dakota climate is an integral process that can cause changes in plant species composition between years and among seasons (Collins and Barber 1986). The terrestrial structure, especially vegetation cover, is highly driven by precipitation. The yearly precipitation gradient shifts from an average of 17 inches (432mm) in the west to greater than 26 inches (660mm) in the east (Sanyal et al. 2023). Precipitation events can also influence periodic increases and decreases in the extent of tall grasses, short grasses (Truett 2003), and woody plants (Sieg 1995).

Fire

Fire in South Dakota was a relatively common disturbance event before European settlement (Higgins 1986). Many anecdotal and scientific reports have documented the widespread occurrence of fire throughout the State and region. The causes of these fires were both natural (i.e. lightning) and human-initiated (i.e. Native Americans). Native Americans were observed on many occasions initiating fires to improve habitat, hunting, or travel conditions (Higgins 1986).

Grass/Shrub Ecosystems – Fire is closely linked with climate cycles as even brief dry periods can provide conditions that favor fire, particularly in grassland-dominated systems. For thousands of years, fire events have been an integral part of the grassland ecosystem (Daubenmire 1968a). Many plant species have developed strategies to benefit from fire, thereby contributing to a landscape mosaic of greater species and structural diversity resulting from the fire regime (Anderson 1990, Daubenmire 1968a).

The effects of fire on grassland ecosystems are a function of the fire's intensity, duration, and seasonality. Fire return intervals may have varied widely due to climate, site conditions, or previous grazing disturbance. Whether a fire was started by lightning or Native Americans, fire return intervals were essential for creating conditions that enhance the resilience of plant communities in the face of disturbance challenges, such as the invasion of exotic species. Along with plants, many other grassland species exhibit several characteristics and strategies suited to a fire-prone landscape where low humidity, drying winds, and low soil moisture are common (Daubenmire 1968a).

Fires occurred all season long, but the majority occurred from mid-to-late summer (Higgins 1984). Fire influences grassland vegetation in several ways. Depending on the season, fire can have a substantial effect on species diversity. For example, spring burning increased the dominance of tall-statured bunchgrasses and reduced the cover of short-statured sodgrasses (Kucera 1978). Fires during the growing season generally limit the spread or occurrence of woody vegetation outside riparian/wetland areas (Kucera 1978). Fire also releases important nutrients into the soil for root uptake and nutrients bound in litter. Removal of plant litter also changes light and temperature levels at the ground level, influencing plant productivity and growth conditions (Vinton and Collins 1997).

Shrublands respond differently than grasslands to fire especially sagebrush areas in western South Dakota. Fires were more common in grasslands and there is less evidence of fires in shrublands during pre-European settlement. One study looking only at sagebrush areas found a fire interval of 138 years, indicating fire was less frequent in shrubland areas (Baker 2006, Miller and Rose 1999).

Forest Ecosystems – Based on historical accounts (Grafe and Horsted 2002, Parrish et al. 1996) and recent studies (Brown and Sieg 1996, Brown and Sieg 1999), the Black Hills' forested landscape was likely influenced by three primary fire regimes: short-interval, long-interval, and mixed-severity. The short-interval fire regime was predominantly characterized by relatively frequent, low to moderate-intensity fires that burned along the ground and remained within the forest understory. The frequency of these fires influenced both the species composition and vegetation structure within these forests. Fire-tolerant species such as ponderosa pine and bur oak were usually dominant in the overstory, with bunch grasses dominant in the understory. Stand history studies in fire-influenced forest ecosystems have demonstrated stands occurring within the short-interval fire regime had relatively predictable species composition and vegetative structure (Shepperd 2002). These stands were also less likely to move through a typical successional progression of age classes. Instead, fire maintained a multi-age structured stand, characterized by saplings to old-growth trees with relatively low numbers of trees per acre.

The long-interval fire regime was characterized by infrequent, high-intensity fire that consumed both the forest understory and overstory as it moved across the landscape. These large stand replacing events resulted in a short-term, severe effect on stand conditions, in contrast to the persistent, predictable vegetative structure effects of the short-interval fire regime. The result of this impact was to set the stand back to an early successional stage and release plant species stimulated by severe fire events. Typically, the stand proceeded along a successional trajectory for many years, depending on the ecological site, before another high-intensity fire would again set the stand back to an early successional stage.

A “mixed-severity” fire regime also occurred in landscapes with both short- and long-interval fire regimes. Depending on site conditions or position on the landscape, low, moderate, and high severity fires could occur within the same forest stand, resulting in a mosaic of diverse stand conditions. This fire regime is more common through the transitional portion of the environmental gradient where the lower elevation and drier sites were dominated by the short-interval fire regime and higher elevation or moister sites were dominated by the long-interval fire regime. Consequently, where a transitional site occurred primarily adjacent to the drier types, it was predominantly influenced by a short-interval fire regime with pockets of long-interval fire influences. Where it occurred primarily adjacent to the moister types, it was predominantly influenced by a long-interval fire regime with pockets of short-interval fire influences. Topographic features also influenced the occurrence of a mixed-severity fire regime. For example, dry south aspect slopes and ridges within a cool and moist ecological site (e.g., cool, moist white spruce) were predominantly influenced by a short-interval fire regime. Under average site conditions, this ecological site would more typically be influenced by a long-interval fire regime.

Grazing

Although a multitude of herbivores grazed the Great Plains grasslands, no single species was more influential than bison in shaping the grassland ecosystems of South Dakota. Before European settlement, bison were the largest herbivore both in size and numbers. Historically, bison in North America have been estimated at 30 million individuals. However, by 1890, bison were functionally and physically extirpated from the wilds of South Dakota (Shaw 1995). Today, several thousand bison exist in relatively small herds within fenced boundaries of parks or private lands.

Loss of bison from the grasslands occurred before any scientific research could be conducted on their foraging habits and movement patterns. Relatively recent studies have found that bison track high-quality forage across a large geographic region. Since the nutritional content of plants is highest during the early stages of growth, grazers tend to seek areas where plants are actively growing; this new growth is sometimes referred to as the “green wave” (Stelfox et al. 1986). At the landscape level, the location and seasonal extent of the “green wave” are primarily controlled by annual climate variability. Grazing is often intense in the path of a herd but usually does not last long because the animals are continually moving. The time a bison herd would remain in an area depended on the availability of high-quality forage. Removal of bison from the grasslands to be replaced by stationary herds of domesticated livestock (i.e. cattle) has altered the functional character of these grassland ecosystems.

The levels of bison grazing within the “green wave” were further influenced by juxtaposition to water sources and recent fire events. Bison, like most herbivores, require a regular supply of water. Those sites surrounding rivers, lakes, and ponds would receive a disproportionate amount of heavy grazing by the congregating herd of animals. Those sites farthest from water sources would receive the least amount of grazing (Soper 1941). Many researchers have also found that recently burned sites will attract bison (Bamforth 1987, Biondini et al. 1999, Frank et al. 1998). The release of soil nutrients and the corresponding rapid new growth represent high-quality forage for several seasons following a fire event. Thus, the combination of fire and grazing yields the dynamic habitat mosaic and landscape heterogeneity to which grassland species are well adapted (Hartnet et al. 1997). Ecologists frequently characterize grassland ecosystems by the ungrazed height or stature of the dominant grass species (e.g., tallgrass, mixed-grass, and shortgrass systems). The dominant grass species, and consequently grass height, are functions of both precipitation and grazing (Truett 2003). In general, the height and stature of dominant grasses within South Dakota decrease from east to west with corresponding levels of precipitation, as well as drought cycles. The height and stature of dominant grasses will also decrease with increased grazing intensity. Therefore, the boundaries of the tallgrass versus mixed-grass versus shortgrass systems, as we delineate them today, would have changed over time in response to drought cycles and grazing intensity.

At the ecosystem level, bison grazing influenced the grassland community in many ways (Hartnet et al. 1997. Hartnett et al. 1996. Knapp et al. 1999). Overall, bison consume more warm-season grasses. However, early in the season, cool-season grasses and sedges represent a higher percentage of the forage. As the season progresses, warm-season grasses are preferred. For this reason, it has been suggested that bison may have grazed the tallgrass prairies in the dormant and early growing season and moved on to the mixed-grass and shortgrass prairies as the growing season progressed. This pattern exists in other grazing systems of the world containing both short and tallgrass systems. Bison prefer grasses over forbs, with greater than 90% of the diet consisting of graminoids (grasslike plants), thereby increasing the ratio of forbs in the community. Many of the dominant tall-statured bunchgrass species, such as bluestems or Indiangrass, decrease with increasing bison grazing while many of the short-statured sodgrass species, such as blue grama and buffalograss, increase.

Shrublands were notably used for livestock in the late 1800s and early 1900s and historic overgrazing occurred at an alarming rate (Daubenmire 1970). Rangelands were slowly converted from diverse shrublands to areas dominated by cheatgrass and other species. Overgrazing has ultimately led to areas that lack diversity and species that are on the verge of disappearing (Thomas et al. 2022).

Black-tailed prairie dogs

The black-tailed prairie dog is the only species of prairie dog found in South Dakota. They were historically distributed throughout the short and mixed-grass prairie regions of South Dakota but were unlikely to be found in the tall-grass region of eastern South Dakota, as site productivity limited their ability to keep grass heights low for colony safety (Virchow and Hygnstrom 2002). Prairie dogs are highly social animals and can live in colonies that range in size from one acre to thousands of acres. They have been estimated to occupy nearly several million acres of grasslands prior to European settlement in South Dakota (Van Pelt 1999). Nationwide and within South Dakota, they are currently estimated to occupy a fraction of their former range.

Black-tailed prairie dog colonies are a natural disturbance component on grassland ecosystems in South

Dakota. Prairie dogs construct ground burrows for their shelter and protection from predators. As many as 30 to 60 occupied and unoccupied burrows could occur in one acre of prairie dog colony (Clippinger 1989, May 2003). Prairie dogs are primarily herbivores and eat grasses and forbs surrounding their burrows. They modify their surrounding environment in many ways. They change the grassland community structure and species composition by continuously cropping the vegetation surrounding their burrows very close to the ground (Collins and Barber 1986. Prairie dog disturbances create habitat that directly benefits SGCNs. The effect of the high burrow densities, digging activities, and heavy grazing action over the entire colony creates a unique ecosystem both structurally and compositionally within the grassland matrix. Prairie dog colonies have been characterized as the most severely disturbed sites in the grassland matrix relative to the other disturbances of fire and bison grazing, due to vegetation that is: 1) subjected to above and below-ground grazing by prairie dogs; 2) favored for grazing by certain ungulates; 3) subjected to mound building; and 4) subjected to increased wallowing by bison (Collins and Barber 1986).

Prairie dog colonies are used by several wildlife species. Burrowing owls use unoccupied prairie dog burrows for nesting and denning (Agnew et al. 1986, Miller et al. 1994). Black-footed ferrets depend on prairie dogs and prairie dog colonies for both food and shelter, as it is the primary historical predator in the prairie dog ecosystem (Henderson et al. 1969). Numerous bird species have been found to prefer the open, bare ground of the prairie dog colony for nesting (Agnew et al. 1986, Clark et al. 1982).

Prairie dog ecosystems are frequently characterized as active or inactive. While fewer wildlife species may be associated with inactive prairie dog colonies, an inactive colony has important structural and compositional differences from active prairie dog colonies for many years after abandonment (Klatt and Hein 1978). The slowly collapsing burrows continue to provide habitat for various wildlife species. In addition, the plant species composition and percentage of forbs versus grass species are often different than the surrounding grassland ecosystem, as well as from active colonies. The length of time a prairie dog colony can influence the vegetation and habitat structure of a grassland ecosystem after abandonment can vary by ecological site and length of colony establishment.

Other herbivores

Bison and prairie dogs were not the only herbivores occupying the Great Plains. Pronghorn, elk, white-tailed deer, and mule deer had significant impacts on the resiliency and resistance of the grasslands we see today. Elk, pronghorn, and deer accompanied bison as the four most abundant herbivores throughout the Great Plains, and they were able to travel long distances to find quality forage (Berger 2004, Lott 2002). These large herbivores grazed, browsed, trampled, and defecated as they traveled the Great Plains. They altered the vegetation species composition, soil biology, nutrient cycling, and fire regimes, creating a mosaic of habitats and structural heterogeneity (Derner et al. 2009, Fuhlendorf and Engle 2001). Other species of Great Plains herbivores, such as insects and pocket gophers, contributed in some capacity to the grasslands we see today (Knopf and Samson 1996).

Beavers

Prior to European settlement, beavers were found in nearly all the aquatic habitats throughout North

America that provided adequate water and food resources (Naiman et al. 1988). Current beaver populations in the Great Plains are substantially less than the numbers present at the time of the early French-Canadian trappers of the late 1600s (Jenkins and Busher 1979). Beavers are well known for their disturbance effects in aquatic and riparian/wetland ecosystems. The beaver's ability to influence and, in some instances, drastically modify ecosystem structure and dynamics through dam-building and wood cutting activities has been well-documented (Ford and Naiman 1988, George et al. 1988, McDowell and Naiman 1986, Naiman et al. 1988). These activities alter stream morphology and patterns of discharge, decrease current velocity, increase retention of sediment and organic matter, and expand areas of flooded soil. Spatially and temporally, the effects of beaver fluctuated with population dynamics that were influenced by food supply, disease, flood disturbance, and predation (Naiman et al. 1988). These population dynamics were not only important at the ecosystem level but also at the landscape level. The overall area disturbed by an individual beaver pond is often small relative to disturbance processes such as fire (Johnston and Naiman 1990a). However, the cumulative disturbance of many beaver ponds can result in extensive alteration to aquatic and riparian/wetland ecosystems. Beaver disturbances create habitat that directly benefits other SGCNs.

Beaver pond creation is limited by the geomorphology and food supply of an area. Most beaver dams occur on first- to fourth-order streams, as dams on larger streams are often removed by high-flow events (Naiman et al. 1988). Beaver preferentially selects areas for dam building that create the largest ponds with the greatest potential for expansion (Johnston and Naiman 1990b). As beaver numbers increase, more and more of the preferential sites become occupied and new ponds become limited to less desirable sites where only small ponds are possible. While a small pond may be less desirable for a beaver, the diversity in pond sizes creates a corresponding diversity in riparian/wetland and aquatic ecosystems across the landscape. Historically, beaver population fluctuations would have primarily affected the number of smaller ponds on the landscape. With low populations, the number of small ponds would decrease, as more preferred sites were available. With high populations, the number of small ponds would increase, as preferred sites were already taken.

The importance of beaver dam building and feeding activities to plant and animal wildlife diversity of an area has also been well-documented (Barnes and Dibble 1988, Dieter and McCabe 1989, Johnston and Naiman 1990b, Schlosser 1995). Dam building and feeding activities often result in the removal of trees and shrubs adjacent to streams. Riparian zones dominated by deciduous tree species preferred by beavers may be essentially clear-cut. Beaver dams also impound water that expands existing wetlands or creates and maintains new wetlands. With the increased soil moisture, the existing upland vegetation will likely die and be replaced by moisture-loving trees and shrubs such as cottonwoods, dogwoods, and willows. These are also the preferred foods of the beaver. In this way, beaver can reset the ecological development of the riparian or wetland ecosystem and often modify habitat to the point of creating an entirely different environment. At the aquatic level, beaver activities change invertebrate community structure from running-water taxa to pond taxa (Merigliano 1996). While these pond invertebrate communities may not be unique to the overall watershed, they represent added aquatic diversity to smaller streams. The permeability of the boundaries between beaver ponds and adjacent streams contribute to greater abundance and diversity in the fish community at the watershed level

(Naiman et al. 1988).

One confounding factor to our understanding of beaver disturbance in riparian/wetland and aquatic ecosystems is that attributes of many stream ecosystems have changed with the removal or reduction in beaver populations and the alteration of many flood regimes associated with European settlement. Consequently, much of our understanding of these ecosystems has been developed from sites that lack the influence of this previously abundant and ecologically important disturbance element.

Flood events

Flood disturbance has been an important part of the natural cycle of riparian/wetland ecosystems throughout South Dakota and has played an important role in maintaining ecosystem function and biological diversity within these systems. Flood events help maintain ecosystem productivity and diversity through both above- and below-ground processes that transport sediments, nutrients, and organisms between river channels and floodplains (Junk et al. 1989, Reeves et al. 1995, Tockner et al. 2000, Ward et al, 1999). Short-duration flood events of high stream-flows result in channel and sediment movement, increased vegetation, deadwood in the channel, and upwelling of groundwater. The interaction of these influences on riparian ecosystems promotes successional stages, overall biodiversity, and complex food webs (Reeves et al. 1995). Both plants and animals of flood-prone systems have adapted to flood disturbance and may even require flood events to regenerate or complete their life cycle (Merigliano 1996, Pollock et al. 1998). Flood events play a critical role in ecological succession and in determining the structure and composition of the affected ecosystem (Sparks and Spink 1998).

Flood events that are part of the natural flood regime are necessary to ensure the long-term viability of the plants and animals adapted to flood-prone environments and the functioning of these ecosystems. To understand how floods influence ecosystems, one must first understand the effects of channel morphology. Channel morphology is primarily characterized as braided or meandering in South Dakota, depending on the locally dominant fluvial processes. Braided channels usually result from steep gradients, high flows, and sediments dominated by coarse or sandy particles (Friedman et al. 1997). Meandering channels, on the other hand, usually result from shallow gradients, low flows, and sediments dominated by silt and fine particles. The proportion of braided channels to meandering channels in the landscape increases with variable topography and decreasing precipitation patterns. Due to the geomorphology of South Dakota, meandering channels are more common in the eastern part of the state whereas braided channels are more common in the western part of the state.

Braided channels frequently have highly variable flows and easily eroded banks (Merigliano 1996). Sediment is deposited along the way and forms bars and islands that are exposed in the channel during periods of normal to low flows. Water then flows in a braided manner around these islands and bars, dividing and integrating as it flows downstream. During a flood event, the islands and bars can erode and become redeposited in other locations downstream, thereby perpetuating the heterogeneity of the system as well as the mosaic of associated vegetation stages with each flood event (Friedman et al. 1997, Merigliano 1996, Miller et al. 1995). Meandering channels have ongoing dynamic channel processes even outside of intermittently occurring flood events. A meandering channel is constantly eroding and redepositing material along the channel. Erosion takes place on the outer parts of the meander bends where stream velocity is highest. Sediment is then deposited along the inner meander bends, where velocity is low. This deposition results in exposed bars called point bars. Because meandering stream channels are constantly eroding and redepositing sediment along their channel, they tend to slowly migrate back and forth across their floodplain. During a flood event, however, the erosion and deposition process is magnified and can result in a more dramatic and immediate change in the stream channel location within the floodplain (Miller et al. 1995). The constant and sometimes dramatic movement of a meandering channel within the floodplain contributes to greater heterogeneity at the landscape level and species and structural diversity at the ecosystem level (Benda et al. 1998, Reeves et al. 1995).

3.1. Ecological Sites and Disturbance States

A primary objective of the coarse filter strategy is to identify and characterize native ecosystem diversity for terrestrial and riparian-wetland systems for South Dakota based on historical reference. To accomplish this requires understanding two primary drivers of native ecosystem diversity, ecological sites and disturbance states. Ecological sites represent the physical environment component of an ecosystem (Daubenmire 1968b, NRCS 2006). Disturbance states represent the vegetation communities that can occur on an ecological site in response to natural disturbance regimes. The following section provides a more detailed discussion of the importance of delineating ecological sites and identifying disturbance states to support efforts at describing the native ecosystem diversity of a region.

The term ecological site has been used in various capacities by different ecological disciplines for many years. For the purpose of the ecological framework described in this document, we are using ecological sites as defined and developed by the NRCS. These ecological sites are a type of potential-based landscape classification system that identifies the different abiotic conditions (e.g., soils, aspect, elevation, temperature, moisture, etc.) that influence disturbance patterns and the potential plant communities that can occur on a site (Bestelmeyer et al. 2009, NRCS 1997). They assume that the differences in potential plant communities are influenced by these abiotic differences among sites (Bestelmeyer et al. 2006, Fuhlendorf and Engle 2001). Corresponding ecological sites respond similarly to drivers of ecosystem change such as climate, disturbance regimes, land-use practices, and management activities (Bestelmeyer et al. 2006). Terrestrial ecological site classification is correlated to existing NRCS soil maps (NRCS, Soil Survey Geographic Database (SSURGO; online)). To characterize ecological systems of South Dakota, the NRCS SSURGO data layers were obtained for South Dakota. Appendix J presents ecological site acreages for the state and for conservation opportunity areas (COA). For more information on the soils data provided by NRCS please visit https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo.

A disturbance state describes a potential plant community or ecosystem that may occur on an ecological site in response to natural disturbance regimes. However, because it is a generalization, it may include a certain amount of variation both spatially and temporally. The transition between disturbance states is due to the interaction of disturbance with the abiotic characteristics of an ecological site, along with climate influences. A disturbance state can be transient or relatively persistent on an ecological site. Although ecological sites provide valuable information on the interaction of the physical environment with vegetation, they are combined with a classification of disturbance states to identify the full range of vegetative conditions or ecosystem diversity possible on an ecological site, as influenced by natural disturbance events and processes.

A state and transition model (STM) is a framework often used to summarize and describe the range of disturbance states for an ecological site. STMs help describe patterns and mechanisms of vegetation response to identified disturbance processes on an ecological site by identifying the triggers, drivers, and mechanisms of transition among states (Bestelmeyer et al. 2009). They provide a record of the knowledge of disturbance states to date while also allowing for future adjustment as new information becomes available. Typically, STMs have been implemented through simple printed flowcharts that identify the range of disturbance states that can occur on an ecological site and the disturbance processes that will influence the transition from one state to another. Transitions can occur rapidly (e.g., a fire event) or more slowly (e.g., a change to the grazing regime). Sometimes multiple disturbance changes must occur simultaneously to trigger a transition to a different state. To learn more about STMs, please visit the NRCS Ecosystem Dynamics Interpretive Tool (https://edit.jornada.nmsu.edu/).

3.2. Riparian-Wetland Systems

A combination of existing classification systems was used, including Stewart and Kantrud (1971), Cowardin et al. (1979), and the hydrogeomorphic (HGM) system (Brinson 1993) to define the riparian-wetland systems in South Dakota.

Stewart and Kantrud (1971) developed a regional classification system for ponds and lakes of the glaciated prairie region of South Dakota. The primary objective of this classification system was to allow for the inventory of existing wetland plant communities. The authors grouped wetland vegetation into zones characterized by distinctive plant community compositions, structure, and ponding regime (i.e. hydrology). Cowardin et al. (1979), hereinafter referred to as the Cowardin system, is similar in several respects to Stewart and Kantrud’s system but was developed as a national classification system. The Cowardin system has become the most widely used wetland classification system in the United States. The overall emphasis of the Cowardin system also remains on the inventory of existing plant communities. More recently, the HGM wetland classification system was introduced by Brinson (1993) to provide a tool for measuring functional changes in wetland ecosystems. The HGM system emphasizes the geomorphic setting and hydrologic attributes of a site rather than the existing biological characteristics of the plant communities. The geomorphic setting identifies the topographic location of the site within the surrounding landscape and the hydrological attributes that characterize the sources of water to the site.

The importance of identifying and classifying the underlying abiotic conditions and primary drivers responsible for the functional and vegetative differences between ecological sites cannot be overstated. The HGM system was developed to capture these underlying abiotic conditions and has the most applicability in this regard relative to the other classifications. While both Stewart and Kantrud and the Cowardin systems resemble the HGM system in some components, they lack the ability to capture the underlying interaction of geomorphic and hydrological drivers that represent the abiotic influence on wetland and riparian ecological sites.

To apply the HGM system for ecological site classification within South Dakota, four HGM classes were identified including Lacustrine, Depressional, Riverine, and Slope classes. The four HGM classes are defined using slight modifications to NRCS (2008) definitions (Table 3.4). In addition, 7 hydrology sub-classes were identified to capture important drivers and attributes that influence the native functional and vegetative characteristics of wetland and riparian ecological sites. The hydrology sub-classes are primarily described and defined relative to the Cowardin system's "modifier" level of classification, with the addition of ephemeral and considerable overlap to Stewart and Kantrud's "class" level (Table 3.5).

While not required as part of the ecological site framework, vegetation zones, as defined by Stewart and Kantrud (1971, 1972) (Table 3.6), provide a useful tool in identifying the hydrological subclass and for describing vegetation communities as influenced by hydrological and water chemistry subclasses. Vegetation zones are presented as a useful tool for determining average hydrological conditions for an ecological site. To describe native ecosystem diversity, each disturbance state was characterized using expected species compositions relative to defined vegetation zones.

Prairie wetlands are dynamic, everchanging systems. Fluctuating water levels caused by periodic drought and deluge are the primary driving forces influencing species composition and structure of riparian and wetland ecosystems. These periodic hydrologic swings can increase the amount of open water and bare soils present during a growing season (LaBaugh et al. 1998). Open water generally increases immediately following a precipitation event. As water runs off, discharges, or evaporates from the site, a drawdown phase may occur that exposes bare soil and leads to emergent species colonizing or recolonizing portions of the wetland (Stewart and Kantrud 1971).

Water depths and related stages of cover interspersion often change drastically from year to year and season to season due to these fluctuating water levels (Stewart and Kantrud 1971). This may also influence the amounts and types of vegetation zones over time such as gaining a deeper marsh zone during above-average precipitation or losing a vegetation zone during below-average precipitation. Removal of wetland vegetation by large grazing animals and muskrats can also have a profound impact on wetland and riparian plant communities and structure, often opening up monotypic stands of hybrid cattails.

Vegetation zones within riparian and wetland ecological sites, as described by Stewart and Kantrud (1971), typically occur as concentric peripheral bands in response to different water levels. The central rings usually represent the wettest portions of the site and the outer rings represent the progressively drier margins. The number of concentric bands present will depend on the hydrology sub-class for the ecological site. Figure 3.3 provides a generalized example of the typical vegetation zones occurring within each of the six hydrology sub-classes for the depressional HGM class under average precipitation conditions.

Figures 3.4 A and B provide a generalized example of the typical vegetation zones occurring within the two hydrology subclasses for the lacustrine HGM class. Figures 3.5 A and B provide a generalized example of the typical vegetation zones occurring within the two hydrology subclasses for the riverine HGM class. Not all vegetation zones may be present on every ecological site but the figures present a general pattern that is frequently observed. Fen vegetation zones in particular require the associated groundwater input to be present. Many riparian and wetland ecological sites have been altered in the last century by extensive cropland conversion, large and small dam creation, draining, filling, etc. (Dahl 1990, Dahl and Johnson 1991), all of which have potentially altered historical hydrology subclasses.

Historical grazing played an important role in influencing the structure and species composition of most vegetation zones within ecosystems on riparian and wetland ecological sites. Within the open water zone, grazing pressure had little to no influence on plant species composition. Within the deep marsh and shallow marsh zones, bison grazing likely influenced the vegetation community structure in terms of creating patchy openings by trampling vegetation or grazing heavily in this zone during drought years. The frequent fire return interval in the adjacent uplands also played an important role in shaping the structure and species composition of riparian and wetland ecological sites. Fire, particularly during drought cycles, could remove the build-up of organic matter and release nutrients to the wetland system. For the low prairie zone in particular, grass species were the dominant component and shrubs and trees were more minor components in this vegetation zone due to the frequency of fire. Browsing and rubbing by bison and other herbivores likely further reduced the coverage of shrubs and trees in these ecological sites. Where shrub and tree species occurred, they were more commonly associated with the low prairie and fen vegetation zones. Flood events further influenced the diversity of plant communities. In addition, flood events associated with riverine ecological sites create a favorable condition for some plants to regenerate (e.g., plains cottonwood and willows) where the scouring action can create alluvial bars and other features that promote regeneration.

The effects of beaver activity on South Dakota's riparian and wetland ecological sites have not been well documented. For the purposes of describing ecological sites, some assumptions are necessary. It is assumed that beaver activity would be associated with riverine ecological sites with a longer mean fire return interval to allow the growth of trees and shrubs necessary to sustain a beaver population. Where damming occurs, the water table typically rises, further influencing the hydrology of the adjacent riparian vegetation communities and probably benefitting tree and shrub species. This change can be relatively temporary or more long-term, if there are sufficient food supplies to support a population. Beaver typically feed and build dams from the surrounding trees and shrubs. If the food supply is exhausted, the beaver will move on to a new site with better food sources. Vegetation within or near the floodplain is expected to be the most heavily influenced by beaver activity. Where dams occur, the result of going from a flowing water system to a pond system is expected to affect species composition and structure, as well as the associated biodiversity, but this change has not been evaluated or documented in South Dakota.

Table 3.4. Description of the Hydrogeomorphic Classes Identified for Wetland and Riparian Ecological Sites of South Dakota (As Definitions Modified from NRCS 2008 and Brinson 1995).

HGM Class	Definition
LACUSTRINE	• adjacent to lakes (>20 acres) where the water elevation of the lake maintains the water table in the wetland • additional sources of water are precipitation and ground water discharge, the latter dominating where intergrade with uplands or slope wetlands occurs • lose water by flow returning to the lake after flooding, by saturation surface flow, and by evapotranspiration • organic matter normally accumulates in areas sufficiently protected from shoreline wave erosion • historically rare in South Dakota but are more frequent today due to the damming of permanent stream courses
DEPRESSIONAL	• occur in topographic depressions (<20 acres) • dominant water sources are precipitation, groundwater discharge, and both interflow and overland flow from adjacent uplands with direction of flow normally from the surrounding uplands toward the center of the depression • elevation contours are closed, thus allowing the accumulation of surface water • may have any combination of inlets and outlets or lack them completely • dominant hydrodynamics are vertical fluctuations, primarily seasonal • may lose water through intermittent or perennial drainage from an outlet, by evapotranspiration, and, if they are not receiving ground water discharge, may slowly contribute to ground water discharge • common examples in South Dakota are prairie potholes
RIVERINE	• occur in floodplains and riparian corridors in association with stream channels • dominant water sources are often overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands • sources may be interflow and return flow from adjacent uplands, occasional overland flow from adjacent uplands, tributary inflow, and precipitation • at their headwater, often are replaced by slope or depressional wetlands where the channel morphology may disappear • may intergrade with poorly drained flats or uplands • perennial flow in the channel is not a requirement

SLOPE	• normally found where groundwater discharges to or near the land surface • normally occur on sloping land; elevation gradients may range from steep hillsides to slight slopes • usually incapable of depressional storage because they lack closed contours • principle water sources are usually ground water return flow and interflow from surrounding uplands, as well as precipitation • hydrodynamics are dominated by downslope unidirectional water flow • can occur in nearly flat landscapes if ground water discharge is a dominant source to the wetland surface • lose water primarily by saturation subsurface and surface flows by evapo-transpiration, but may develop channels that function as outlet • common examples in South Dakota are fens

Table 3.5. Seven Hydrology Sub-classes Utilized for Wetland and Riparian Ecological Sites of South Dakota (Cowardin et al. 1979 and Stewart and Kantrud 1971).

Hydrology Subclass	Definition
Permanent	Water covers the land surface or flows throughout the year, except under very extreme drought conditions.
Intermittent	Surface water is present but variable due to evapotranspiration throughout the year or absent in years of extreme drought.
Semi-permanent	Surface water persists throughout the growing season but is absent by late summer to early fall in most years.
Seasonal	Surface water is typically present from spring to early summer but absent by the end of the season in most years.
Temporary	Surface water is present for brief periods, a few weeks in spring or a few days after a heavy rain or the channel contains flowing water for only a few weeks in the spring or after a heavy rain, and when not flowing may remain in isolated pools or surface water may be absent altogether.
Ephemeral	Surface water is present for only a short period of time after snowmelt or storm events in early spring. Because of the porous condition of the soils, the rate of water seepage is very rapid after thawing of the underlying frost seal. Water is only retained long enough to establish some wetland or aquatic processes.
Seep	Groundwater saturated soils on gently sloping terrain; rarely ponded; may be slightly flowing early in the growing season but with no recognizable channel.

Table 3.6. Seven Vegetation Zones Were Identified by Stewart and Kantrud (1971, 1972) and Used in the Wetland and Riparian Ecological Sites of South Dakota to Help Describe Vegetation Communities by Hydrological Subclass.

Vegetation Zones	Description
Low Prairie/Shrub/Forest	Characterized by moist site prairie grasses, forbs, shrubs, and trees. The hydrology influencing this zone is typically ephemeral, i.e. moist for a few days in spring.
Wet Meadow	Characterized by fine-textured grasses, rushes, and sedges of relatively low stature. The hydrology influencing this zone is typically temporary.
Shallow marsh	Characterized by a mix of 3 phases depending on annual, seasonal, or site-specific water levels: normal emergent phase of intermediate height grasses/grass-like plant species, open-water phase with submerged aquatic plants, and a drawdown phase of emergent/pioneering species or bare dirt. The hydrology influencing this zone is typically seasonal.
Deep marsh	Characterized by a mix of 3 phases depending on annual, seasonal, or site-specific water levels: normal emergent phase of coarser and taller grasses/grass-like plant species, open-water phase with submerged or floating aquatic plants, and a drawdown phase of emergent/pioneering species or bare dirt. The hydrology influencing this zone is typically semi-permanent.
Open Water	Characterized by water areas completely devoid of vegetation and areas where two species of vascular plants (widgeongrass and pondweed) may be present. The hydrology influencing this zone is typically permanent.
Fen	Characterized by floating or surface mats of emergent vegetation; may be intermixed with small open water areas. Springs may be present. The hydrology influencing this zone is typically seep.
Intermittent	Characterized by highly saline and relatively shallow water. The hydrology of this zone is typically intermittent.

Figure 3.3. Spatial Relation of Vegetational Zones in Major Classes of Natural Ponds and Lands (Stewart and Kantrud 1971).

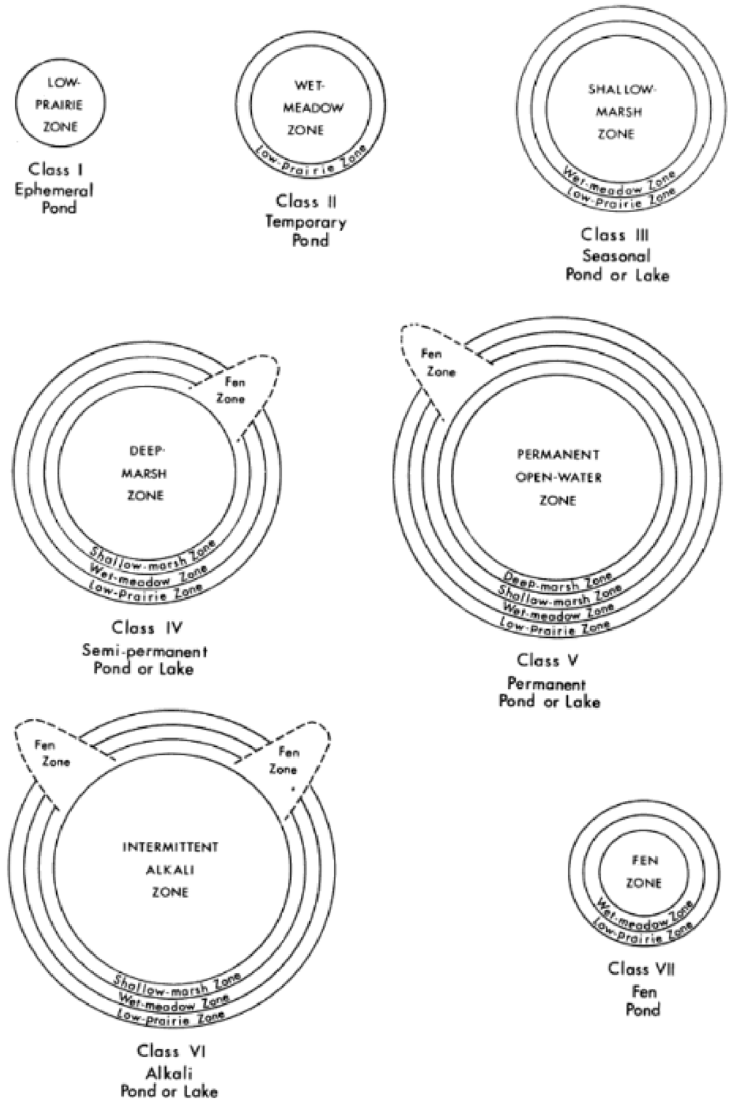


Figure 3.4. A). Lacustrine-Permanent Ecological Site. Typical Vegetation Zones Under Average Precipitation Conditions for the Lacustrine Class-Permanent Subclass. B) . Lacustrine-Intermittent Ecological Site. Typical Vegetation Zones Under Average Precipitation Conditions for the Lacustrine Class-Intermittent Subclass, Adapted from (Stewart and Kantrud 1971).

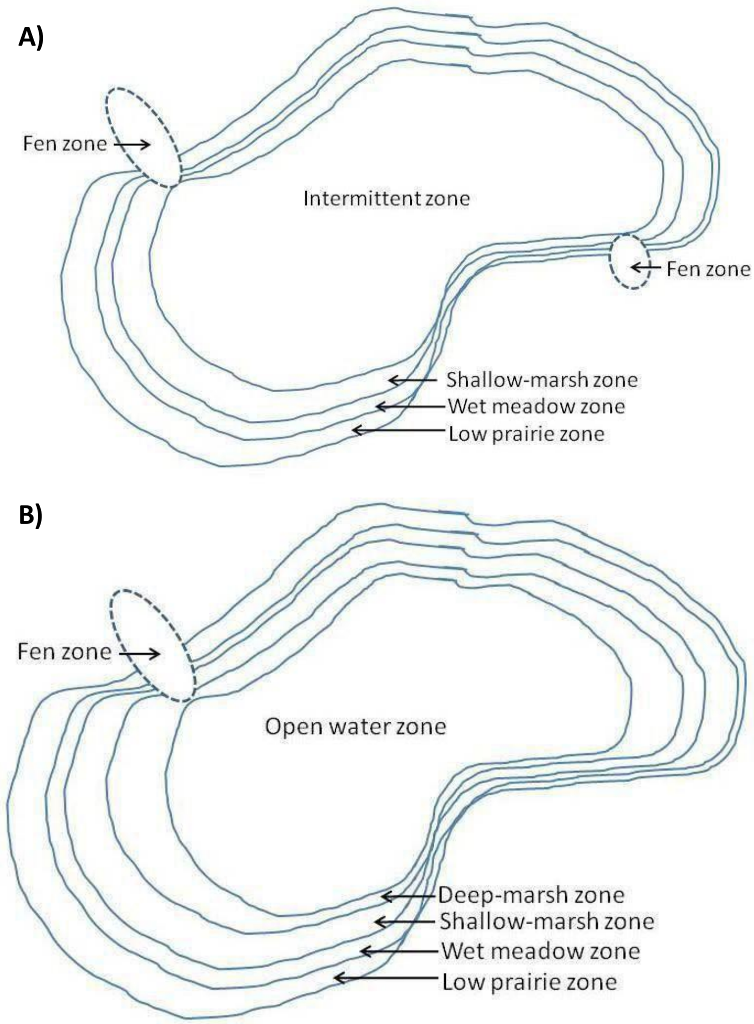
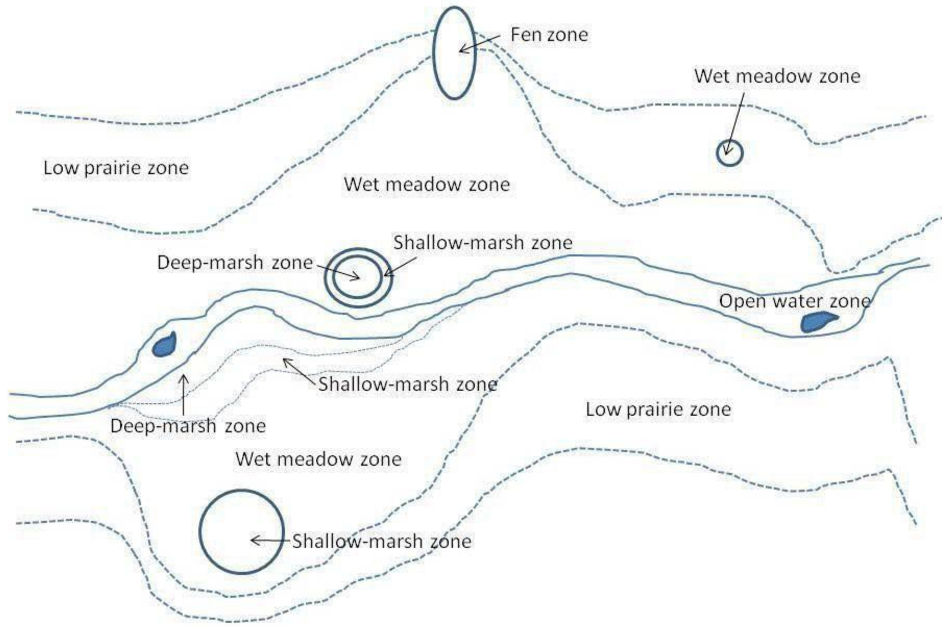
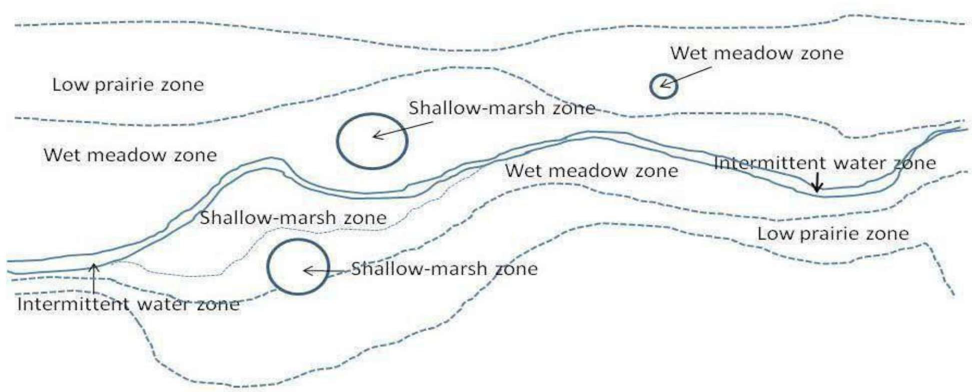


Figure 3.5. A) Riverine-Permanent Ecological Site. Typical Vegetation Zones Under Average Precipitation Conditions for the Riverine Class-Permanent Dub-class. B) Riverine-Intermittent Ecological Site. An Example of Vegetation Zones That Might Occur Under Average Precipitation Conditions for the Riverine Class-Intermittent Sub-class, Adapted from (Stewart and Kantrud 1971).

A)



B)



The USFWS provides the public with the status of wetland and deepwater habitats throughout the United States by providing an online National Wetlands Inventory (NWI) that shows the status, extent, and characteristics of wetlands, riparian, and deepwater habitats as shown in Figure 3-6. Figure 3.7 was generated by using a center point for each wetland feature in the NWI GIS layer to create a heat map. The heat map helps further portray the density of wetlands in the Prairie Pothole Region (PPR) of eastern South Dakota. Table 3.7 and Figure 3.8 show the number and acres of drained wetlands in South Dakota. Data within the layer is continuously being updated and more information can be found here https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper.

Figure 3.6. United States Fish and Wildlife Service National Wetlands Inventory (Data as of 2024).

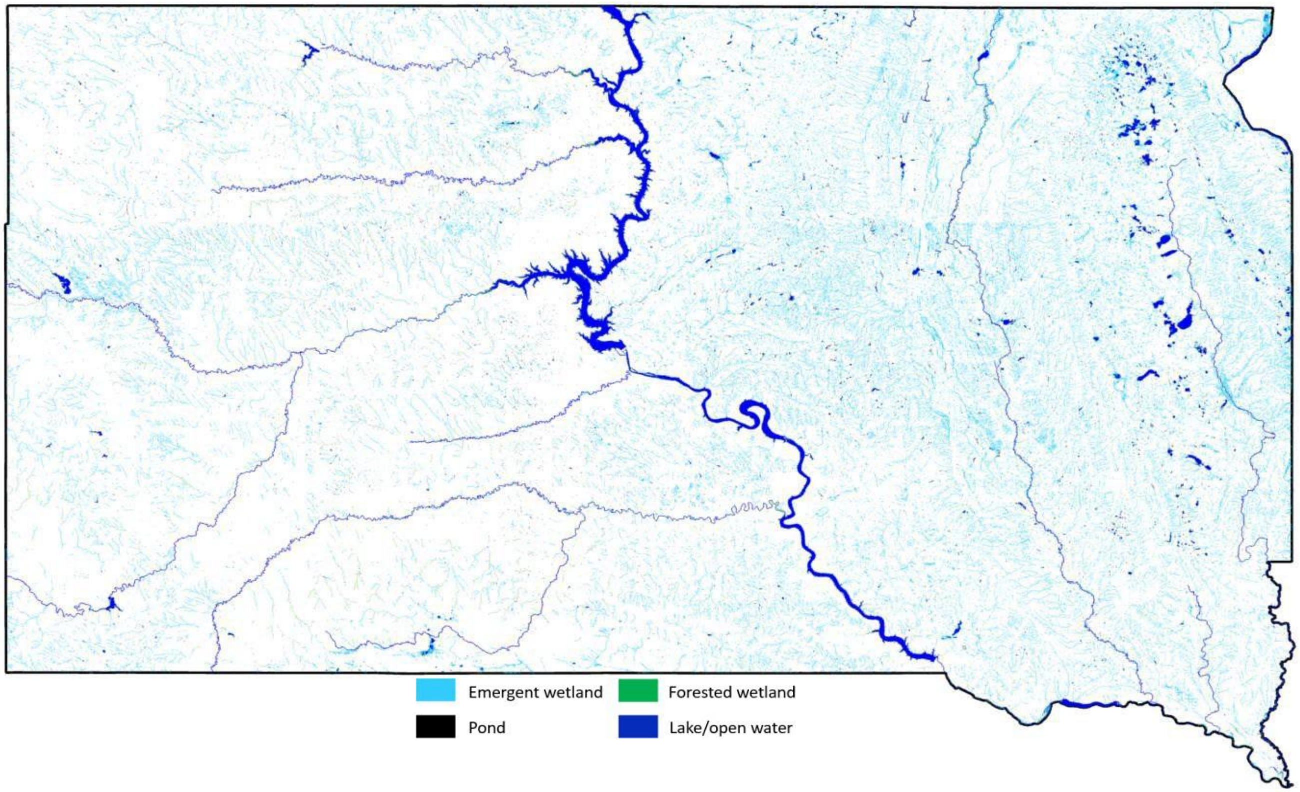


Figure 3.7. Heat Map of the Number of Wetlands Developed from United States Fish and Wildlife Service National Wetlands Inventory (Data as of 2024).

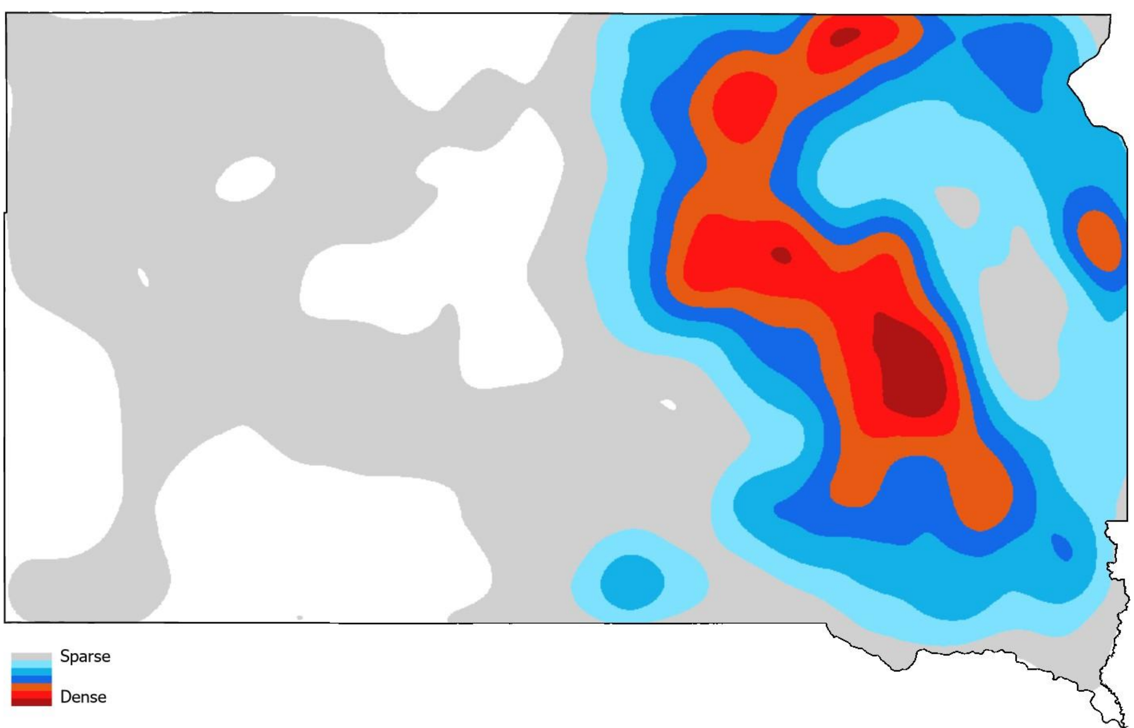


Table 3.7. United States Fish and Wildlife Service National Wetlands Inventory Identifying the Number and Acres of Drained Wetlands in South Dakota. https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/.

Classification	Acres	Hectares	Number
Freshwater emergent wetlands	1,574,359	637,120	1,147,425
Drained freshwater emergent wetlands	211,974	85,782	96,970
Freshwater forested/shrub wetland	56,101	22,703	35,960
Drained freshwater forested/shrub wetland	2,086	844	1,456
Freshwater pond	190,966	77,281	147,457
Drained freshwater pond	2,640	1,068	174
Lake	674,230	272,851	4,806

Figure 3.8. Drained Wetlands in South Dakota. Data Acquired from the US Fish and Wildlife National Wetlands Inventory.