CHAPTER 3 NATIVE ECOSYSTEM DIVERSITY – TERRESTRIAL AND RIPARIAN-WETLAND ECOSYSTEMS

South Dakota's native ecosystem diversity strategy is based on providing sufficient amounts of terrestrial and riparian-wetland native ecosystems on the landscape to support the native biodiversity that has evolved with those conditions. Native ecosystems represent the combination of communities of living organisms with the physical environment in which they live. The range of ecosystem conditions, or native ecosystem diversity, occurring across a landscape and available as habitat for plants and animals is the result of disturbance processes (e.g., grazing, fire, etc.) interacting with site conditions and climate. Native ecosystem diversity is usually described by the range of vegetation communities occurring on similar sites, as these are often the most obvious characteristic to the observer when trying to delineate differences among sites. While ecosystems can be clearly 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 a line between ecosystems while recognizing that these delineations may not always be obvious to the naked eye without more detailed field surveys or assessments.

Native ecosystem diversity can be defined as the variety of plant communities (each similar community is considered a functional ecosystem) and their associated animal populations that would occur within a defined area as a result of the combined influences of the abiotic environment, climate, and natural disturbance processes. **Ecosystem diversity, when adequately described, characterized and conserved, should provide habitat for the majority of species, both plant and animal, that have evolved and adapted to the conditions present in a defined area.**

The combined, incremental effects of human activity on native ecosystem diversity and their associated wildlife since Euro-American settlement, have given rise to the need for development of South Dakota's wildlife 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

A conservation strategy that focuses on restoring native ecosystem diversity for terrestrial and riparian-wetland systems provides a strong scientific foundation for overall conservation of biological diversity as well as 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, historical is typically considered a time-period of less than 1000 years prior to European settlement. There is a strong scientific foundation for using an historical reference for defining ecosystem integrity and biological diversity (Morgan et al. 1994, Swetnam et al. 1999). It was the complex array and dynamic distribution of ecosystems across South Dakota that shaped and sustained the biological diversity of the region. Most of the wildlife present in South Dakota today is the product of historical ecosystems that existed on the Great Plains for thousands of years. Understanding the types, distribution, and dynamics of these ecosystems is fundamental to understanding and managing South Dakota's wildlife.

Terrestrial and riparian-wetland ecosystems and habitats have and continue to be directly altered by human actions. Although Native Americans interacted and influenced ecosystems for thousands of years, these influences are incorporated in an historical reference. It is the extent of human influence over the last 150 years that is of greatest conservation concern. Native ecosystem conversion to agricultural, urban, and suburban uses, are the most obvious impacts. However, there are also less obvious, yet in some instances more pervasive, human-induced changes as well. We have only recently begun to understand the implications of a century of European alterations to and interruptions of natural disturbance regimes in the Great Plains. Recent studies have shown that the suppression or cessation of natural disturbance has gradually changed ecosystem processes and ultimately the composition, structure, and function of many ecosystems (Kucera 1978, Fuhlendorf and Engle 2001, Lett and Knapp 2005, Jackson et al. 2010). These changes have also impacted the distribution and quality of habitat for many species. Therefore, important reference information for the identification of ecosystems or habitats in need of conservation includes a description and assessment of historical conditions as influenced by natural disturbance regimes. With such information, departure from historical amounts and distributions of ecosystems and corresponding species habitats can be mapped and quantified. Such information can be used to identify critical remaining areas of intact or "natural" ecosystems, highlight areas with greatest restoration potential, and describe historical habitat connectivity for selected species.

The SDWAP incorporates a combined coarse-filter and fine-filter strategy for conservation of biological diversity (TNC 1982, Haufler et al. 1996, Samson 2002, Haufler et al. 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.

A description of ecosystem diversity that is 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 wildlife species of concern 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, across its broad planning area, but to be effective, it will need to consider relatively fine scale information on ecosystem types and distributions to address the habitat needs of many species (Poiani et al. 2000, Flather et al 2009).

Combining a coarse-filter and fine-filter strategy has several advantages. First, the coarse-filter 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 to species and their habitat (Haufler et al. 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 SGCN, little information on their distribution within South Dakota and specific habitat needs is available at this time. 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 (Noss 1990, Hunter 1991, Haufler et al. 2002). 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. The primary emphasis for the purpose of the SDWAP, however, is on the landscape, ecosystem, and species level of scale. Genetic levels can be incorporated at future times when needed to address specific questions such as connectivity within a population of a species.

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

1. Delineate ecoregions (using MLRAs for terrestrial and riparian-wetland ecosystems and ecological drainage units for aquatic ecosystems) within South Dakota to facilitate ecosystem diversity characterization and management;
2. Classify ecosystem diversity (by ecological sites) as it occurred under natural disturbance regimes within each ecoregion to describe the coarse-filter;
3. Describe conservation challenges for maintaining or restoring native ecosystem diversity;
4. Develop ecosystem diversity goals that identify desired levels of representation for all historical ecosystems;
5. Identify and describe a process for implementing ecosystem diversity goals relative to existing conditions and for making recommendations for ecosystem restoration;
6. Evaluate species diversity within South Dakota and identify SGCN;
7. Evaluate the habitat needs/requirements of SGCN relative to the ecosystem diversity goals;

8. Identify those species requiring non-habitat related management activities not addressed by the emphasis on ecosystem diversity;
9. Develop conservation actions to address the habitat and non-habitat related needs of SGCN;
10. Identify Conservation Opportunity Areas to help direct conservation actions to the most appropriate locations; and
11. Identify opportunities for collaborative partnerships within the state to achieve the conservation goals.

3.2 Ecoregions – Major Land Resource Areas

Ecological classification systems at the regional level, often referred to as ecoregions, are developed to 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. Major Land Resource Areas (MLRAs) (USDA NRCS 2006) have been delineated by the Natural Resources Conservation Service to characterize landscape patterns that combine soils, water, climate, vegetation, and land use. The MLRA classification is relatively well developed and is supported at greater resolutions by ecological site information and soils data. For this reason, MLRAs were selected as the primary terrestrial classification system to derive ecoregional boundaries. Section 3.1 presents a map of the 18 MLRAs occurring in South Dakota. Table 3-1 provides a summary of their acreage. For more information on the methodology used to develop MLRAs as well as more detailed descriptions of their characteristics and general features, see the NRCS handbook developed for that purpose (USDA NRCS 2006).

Two categories of ecological systems occur in South Dakota – terrestrial and riparian-wetland-aquatic. The terrestrial systems are further broadly delineated by grass-shrub systems and forested systems. Grass-shrub systems are the most common in South Dakota at roughly 40.5 million acres or 82% of the state while forested systems represent only 1.5 million acres or 3% of the state. Riparian-wetland-aquatic systems represent approximately 7.4 million acres or 15% of the state. Figure 3-2 presents a map of the distribution of these primary ecological systems in South Dakota.

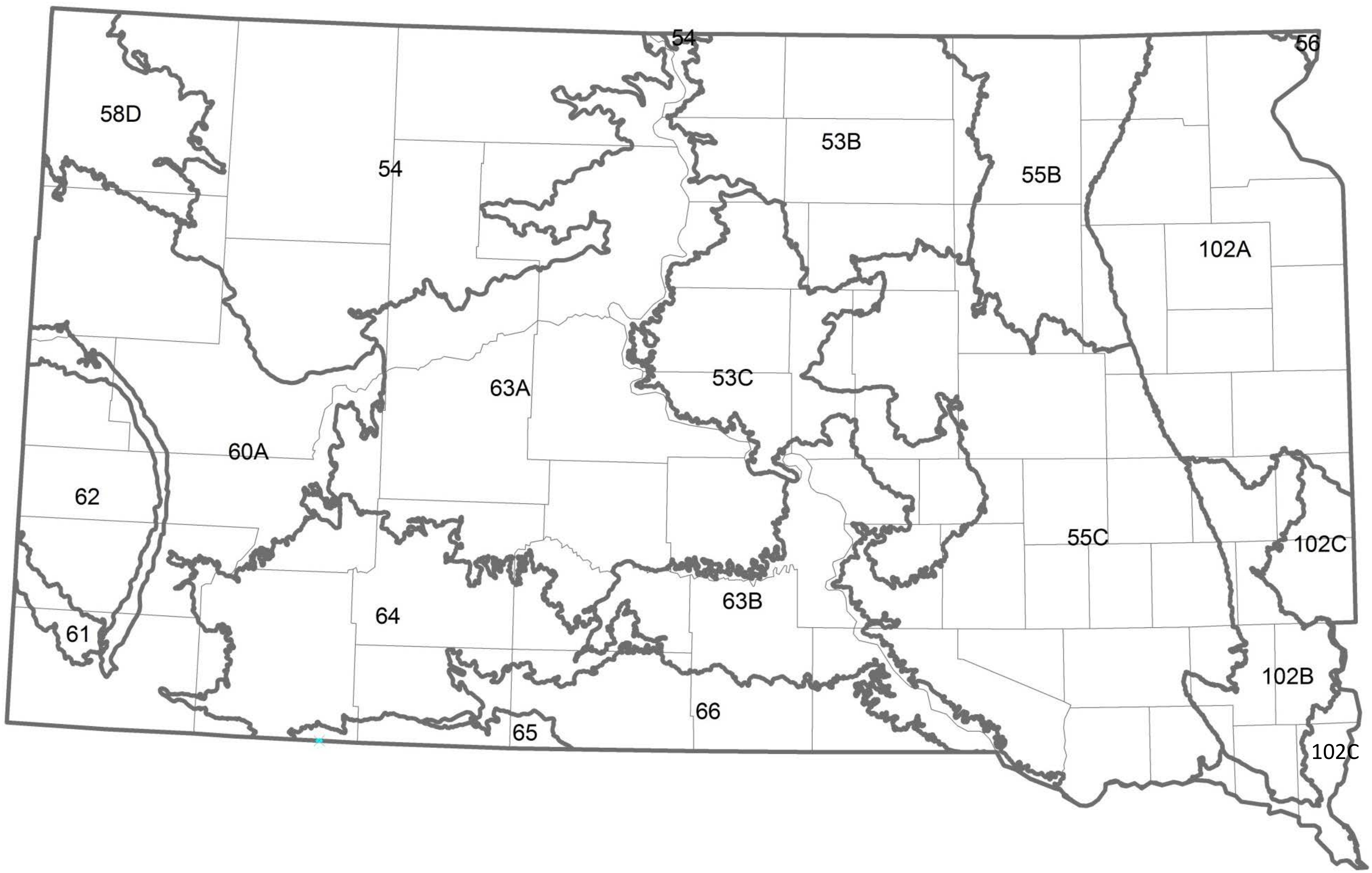


Figure 3-1. Map of Major Land Resource Areas for South Dakota (USDA NRCS 2006).

Table 3-1. Number of acres representing the 18 Major Land Resource Areas occurring in South Dakota.

MLRA #	NAME	ACRES
53B	Central Dark Brown Glaciated Plains	2,947,816
53C	Southern Dark Brown Glaciated Plains	2,581,928
54	Rolling Soft Shale Plain	6,185,838
55B	Central Black Glaciated Plain	2,201,465
55C	Southern Black Glaciated Plain	6,948,318
56	Red River Valley of the North	35,505
58D	Northern Rolling High Plains, Eastern Part	1,148,276
60A	Pierre Shale Plains	4,518,607
61	Black Hills Foot Slopes	549,299
62	Black Hills	1,394,761
63A	Northern Rolling Pierre Shale Plains	6,497,132
63B	Southern Rolling Pierre Shale Plains	2,324,982
64	Mixed Sandy and Silty Tableland and Badlands	3,179,007
65	Nebraska Sand Hills	298,073
66	Dakota-Nebraska Eroded Tableland	1,590,464
102A	Rolling Till Prairie	4,563,626
102B	Till Plains	1,418,212
102C	Loess Uplands	969,396
		49,325,705

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. But what do we mean by the terms historical reference and natural disturbance and why are they important?

We define historical reference as the ecosystem conditions that resulted from natural (i.e. fire, herbivory, etc.) and human-influenced (i.e. Native American) disturbance that created the dynamic conditions species relied upon for their habitat. 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 is an important concept because it emphasizes that many ecosystems varied in amounts, compositions, and structures due to variations in climate and stochastic events (Aplet et al. 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 that are present today (Morgan et al. 1994). In some areas of the country quantifying historical reference may be a difficult task 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 historical range of variability (White and Walker 1997, Egan and Howell 2001). However, in some ecosystems historical information is less available, and historical ecosystem dynamics require use of models based on best available information. The use of models to describe and quantify historical conditions will be discussed further in a later section of this Plan.

It is recognized that 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

The past Northern Great Plains climatic pattern is cyclical between wet and dry periods (Woodhouse and Overpeck 1998). Cold winters and hot summers are typical, along with low humidity, desiccating winds, light rainfall, and plenty of sunshine. South Dakota is near the geographic center of North America and with few natural barriers on the northern Great Plains, air masses move freely across the plains and account for rapid changes in temperature. The South Dakota climate is an integral process that can cause changes in plant species composition between years and among seasons (Collins and Barber 1985). The cycle of wet and dry periods can also influence periodic increases and decreases in the tall and short grasses (Truett 2003), as well as in woody plants (Sieg 1997).

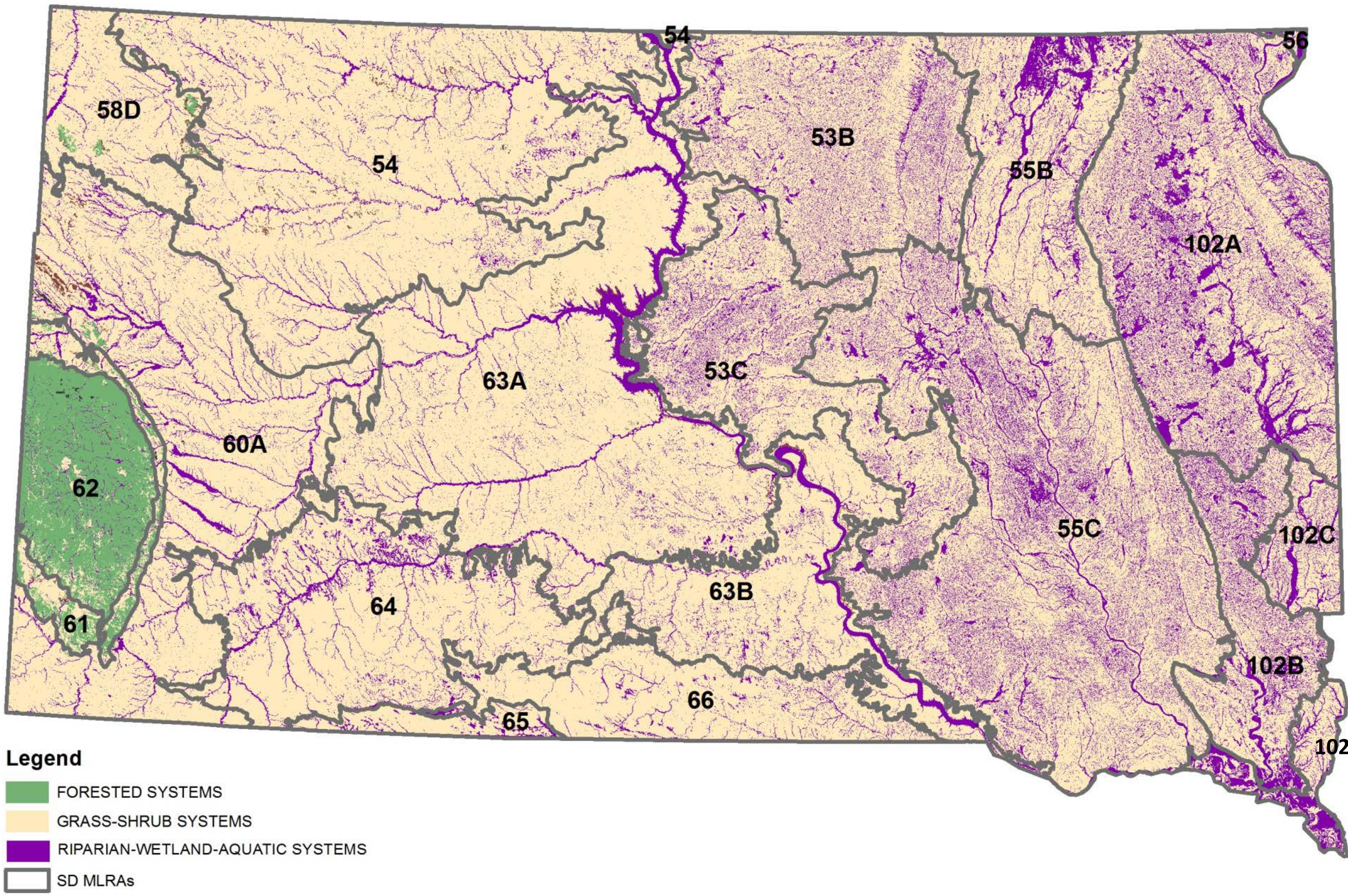
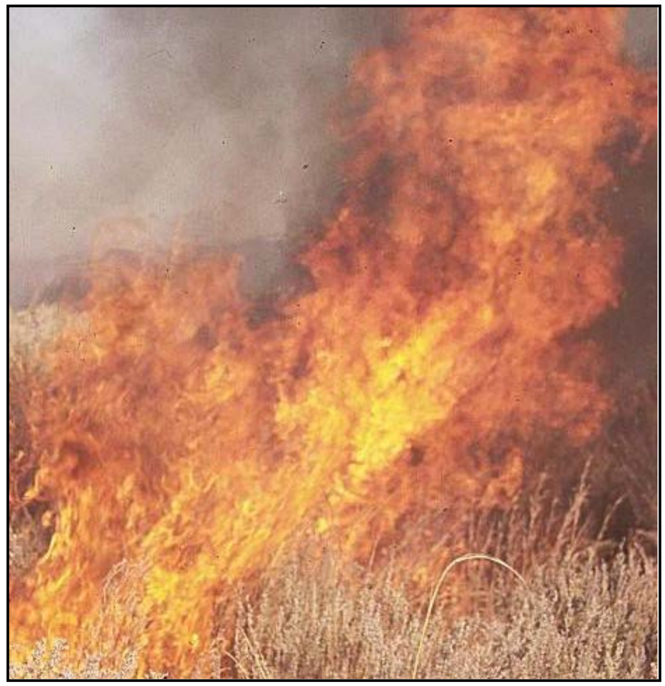


Figure 3-2. Location of primary ecological systems in South Dakota.

Fire

"A cloudy morning, and smoky all day from the burning of the plains, which were set on fire by the Minetares for an early crop of grass, as an inducement for the buffalo to feed on……" Captain Clark, Fort Mandan, North Dakota, 1805.

"The effect of fire must be regarded as having been always operative in the Great Plains region. Fires are started by lightning during almost every thunderstorm, and the advent of man, has, if anything, tended to check rather than to increase their ravages." (Shantz 1911)



Fire in South Dakota was a relatively common disturbance event prior to European settlement (Higgins 1986). Many anecdotal and scientific reports have documented the widespread occurrence of fire throughout the State and the 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 climatic cycles as even brief dry periods can provide conditions that favor fire, particularly in grassland-dominated systems. For thousands of years on the Great Plains, 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 (Daubenmire 1968a, Anderson 1990).

Grassland species exhibit a number of characteristics and strategies that are suited to a fire-prone landscape, where low humidity, drying winds, and low soil moisture are common (Daubenmire 1968a). In general, fire-dependent ecosystems are expected to burn more easily than non-fire dependent ecosystems, as they have traits that make them more flammable (Mutch 1971). For example, grassland ecosystems often produce biomass that may not decompose in a given year or a multitude of years. If a site is not grazed to remove the year's growth, it will become more vulnerable to fire. Many studies have documented the significance of fire in maintaining the grassland's equilibrium (Collins and Barber 1985, Heisler et al. 2003, Anderson 1982). Yet, it is important to note that even in a single landscape, the differences between abiotic conditions characterizing ecological sites contribute to different fire regime characteristics in terms of frequency, severity, and patch size (Nichols et al. 1998).

The effects of fire on grassland ecosystems are a function of the fire's frequency and intensity, as well as the season that the fire occurred. Fire return intervals may have varied widely due to climate, site conditions or previous grazing disturbance. Lightning is a primary cause of naturally occurring wildfire events in South Dakota. Higgins (1984) reviewed lightning-caused fire records (1940-1981) and found an average of 6 fires per year per 10,000 km^2 in eastern North Dakota grasslands, 22 per year per 10,000 km^2 in southcentral North Dakota, 25 per year per 10,000 km^2 in western North Dakota grasslands, and 92 per year per 10,000 km^2 in pine-savanna lands in northwestern South Dakota. Lightning strikes appeared to be more prevalent in areas with trees. Fires caused by lightning occurred more frequently west of the Missouri River than east of the river. However, overall fire return intervals are lower west of the Missouri River, likely due to lower fuel loadings that carry fire across the landscape and beyond the immediate strike location.

Lightning caused fires can occur from March to December but the majority occurred from mid-to late summer (Higgins 1984). Specific information on the spatial extent of historical fires is not available but fires occurring during the growing season are expected to have been limited in spread by green vegetation and higher levels of humidity. Those fires occurring during drought conditions or after the growing season may have had the greatest spatial extent. Even within these fire-dominated landscapes, microhabitats exist in riparian zones, badlands, ravines, and other fire-protected locations where fire-intolerant species could persist.

Fire influences grassland vegetation in a number of 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 occurring during the growing season generally limit spread or occurrence of woody vegetation outside of riparian/wetland areas (Kucera 1978). Fire also releases important nutrients into the soil for root uptake as well as releases 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).

Forest Ecosystems – Based on historical accounts (Parrish et al. 1996, Grafe and Horsted 2002) 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 and bunch grasses were dominant in the understory. The potential for destructive wildfire, insect, or disease events were low. Stand history studies in fire-influenced forest ecosystems have demonstrated that stands occurring within the short-interval fire regime had relatively predictable species composition and vegetative structure (Sheppard and Battaglia 2002). They 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 consumes both the forest understory and overstory as it moved across the landscape. These stand replacing events resulted in a short term, severe effect on stand conditions, in contrast to the persistent, yet less obvious 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. That is, 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. Whereas under average site conditions, this ecological site would more typically be influenced by a long-interval fire regime.

Grazing

“This scenery already rich, pleasing, and beautiful was still farther heightened by immense herds of buffalo, deer, elk, and antelope which we saw in every direction feeding on the hills and plains.” Meriwether Lewis, 1804

Although the Great Plains grasslands were grazed by a multitude of herbivores, no single species was more influential than bison in shaping the grassland ecosystems of South Dakota. Bison were the largest herbivore both in size and numbers, prior to European settlement. Historic population numbers of 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 Great Plains grasslands occurred before any meaningful research could be conducted on their foraging habits and movement patterns. Much of the information we have today is extrapolated from ungulate studies of similar grazing systems around the world or from research conducted on the remaining small bison herds that are confined within relatively small portions of a landscape. The historical movement pattern of free-ranging bison has been a contentious topic for researchers. However, the dominant view is that bison had two distinct, but not mutually exclusive bison populations; resident herds and migrant herds. Migrant herds of bison are estimated to have outnumbered resident herds by more than four to one (Shaw 1995). In fact, grazing ecosystems around the world are dominated by migratory herbivores (Isenberg 2000, Epp and Dyck 2002). Migratory grazers 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, 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 was dependent on the availability of high-quality forage. This long evolutionary history between grasslands and migratory grazers has resulted in an interdependent web of energy and nutrient flows. Removal of migratory grazers from the Great Plains has likely altered the functional character of these grassland ecosystems.

The levels of 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 due to 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 (Frank et al. 1998, Bamforth 1987, Biondini et al. 1999). The release of soil nutrients and the corresponding rapid new growth represent high-quality forage for several seasons following a fire event. At the landscape level, historical fire and grazing disturbance regimes interacted to provide a mosaic of structural and successional conditions across South Dakota’s grassland ecosystems. Within native grasslands throughout the world, it is a rare event for herbaceous regrowth to go ungrazed following a fire (Coppock and Detling 1986). The amount of forage removed from a site and its distribution in the landscape determine the probability and intensity of the next fire event. Thus, the combination of fire and grazing yields the dynamic habitat mosaic and landscape heterogeneity to which prairie wildlife species are well adapted (Hartnett et al. 1996).

Ecologists frequently characterize grassland ecosystems of the Great Plains by the ungrazed height or stature of the dominant grass species (e.g., tallgrass, mixedgrass, 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 mixedgrass 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 (Hartnett et al. 1996, Hartnett et al. 1997, 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 then moved on to the mixedgrass 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.

Black-tailed Prairie Dogs

> *The barking squirrels "appear here in infinite numbers and the shortness and virdue of grass gave the plain the appearance throughout its whole extent of beautiful bowling-green in fine order." Lewis, 1804.*

The black-tailed prairie dog is the only species of prairie dog found in South Dakota. They were historically distributed throughout the shortgrass and mixedgrass 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 only a fraction of their former range.

Black-tailed prairie dogs are considered a natural disturbance component in South Dakota due to the effect of their colonies on grassland ecosystems. 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 2001). Prairie dogs are primarily herbivores and feed on 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 1985). 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, since vegetation 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 1985).

Prairie dog colonies are used by a number of wildlife species, such as burrowing owls, which prefer unoccupied prairie dog burrows for nesting and denning (Miller et al. 1994, Agnew et al. 1986). The endangered black-footed ferret depends 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. 1974). 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 the percentage of forbs versus grass species are often different than the surrounding grassland ecosystem, as well as different 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 be variable by ecological site and length of colony establishment.

Beaver

> *"We saw many beaver….today. (They) dam up the small channels of the river between the islands and compel the river in these parts to make other channels; which as soon as it has effected that which was stopped by the beaver becomes dry and is filled up with mud sand gravel and driftwood. The beaver is then compelled to seek another spot for his habitation where he again erects his dam. Thus the river in many places among the clusters of islands is constantly changing the direction of such sluices…..This animal in that way I believe to be very instrumental in adding to the number of islands with which we find the river crowded." Lewis and Clark, 1804*

Prior to European settlement, beaver were found in nearly all aquatic habitats throughout North America that supported adequate water and food resources (Naiman et al. 1988). Current beaver populations in the Great Plains are substantially less than numbers present at the time of the early

French-Canadian trappers (late 1600's) (Jenkins and Busher 1979). Beaver 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 (Naiman et al. 1988, Ford and Naiman 1988, McDowell and Naiman 1986, Medin and Torquemada 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 1986). However, the cumulative disturbance of many beaver ponds can result in extensive alteration to aquatic and riparian/wetland ecosystems.

Beaver pond creation is limited by geomorphology and food supply of an area. Most beaver dams occur on 1st to 4th order streams, as dams on larger streams are often removed by high flow events (Naiman et al. 1988). Beaver preferentially select areas for dam building that create the largest ponds with the greatest potential for expansion (Johnston and Naiman 1990a). As beaver numbers increase, more and more of the preferential sites become occupied and new ponds are then 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 wildlife diversity of an area has also been well-documented (Dieter and McCabe 1989, Schlosser 1995, Johnston and Naiman 1990b, Barnes and Dibble 1988). Dam building and feeding activities often result in removal of trees and shrubs adjacent to streams. Riparian zones dominated by deciduous tree species that are preferred by beaver may be essentially clear-cut. The 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 contributes 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 the fact 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

"In order for a river to look the same, it must change" (Merigliano 1996).

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 (Ward et al. 1999, Junk et al. 1989, Tockner et al. 1999, Reeves et al. 1995). Short-duration flood events of high stream-power result in channel and sediment movement, increased vegetation and 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 the plants and animals of flood-prone systems have adapted to flood disturbance, and many even require flood events to regenerate or complete their life cycle (Merigliano 1996, Pollock 1998). Flood events play a critical role in ecological succession and determining the structure and composition of the affected ecosystem (Sparks and Spink 1998).

Floods are frequently characterized by five primary components: 1) the magnitude of the discharge, 2) the velocity of the discharge, 3) the duration of the flood, 4) the season of the flood, and 5) the frequency of flooding (Poff and Ward 1989). When taken together, these components are frequently referred to as the "flood regime". The flood regime is influenced ecoregionally by geologic and climatic factors such as precipitation levels, sediment inputs, and stream gradient.

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 would be more common in the eastern part of the state whereas braided channels would be 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 re-deposited in other locations downstream, thereby perpetuating the heterogeneity of the system as well as the mosaic of associated vegetation stages with each flood event (Merigliano 1996, Friedman et al. 1997, Miller et al. 1995). Meandering channels have on-going dynamic channel processes even outside of intermittently occurring flood events. A meandering channel is constantly eroding and re-depositing 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 re-depositing 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 (Reeves et al. 1995, Benda et al. 1998).

3.4 Ecological Sites

A primary objective of the coarse filter strategy is to identify and characterize native ecosystem diversity for terrestrial and riparian-wetland systems for the entire state of South Dakota based on the 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, USDA NRCS 2006) and disturbance states represent the vegetation communities that can occur on an ecological site in response to natural disturbance regimes. The following sections provide a more detailed discussion of the importance of delineating ecological sites and identifying disturbance states to efforts at describing the native ecosystem diversity of a region as well as the methods used to describe and map ecological sites and disturbance states.

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 Natural Resources Conservation Service (1997). NRCS 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 (USDA NRCS 1997, Bestelmeyer et al. 2009). They are based on the assumption that the differences in potential plant communities are influenced by these abiotic differences among sites (Bestelmeyer et al. 2006, Fuhlendorf and Smeins 1998).

Ecological sites may contain multiple soil types provided they exhibit similar properties that produce and support a characteristic plant community in response to similar disturbance processes. The soils characterizing an ecological site have developed over time through the interaction of parent material, climate, living organisms, and topography. This, in turn, influences the kind of plants that can occur and the combination of the plants and soils further influence the hydrology of a site, more specifically the amount of runoff and infiltration. The development of the soil, vegetation, and hydrology are therefore all interrelated and each influences and is influenced by the other. Each site responds similarly to drivers of ecosystem change such as climate, disturbance regimes, land-use practices, and management activities. For classification purposes, ecological sites are differentiated from each other based on several considerations including differences in plant species composition and productivity, differences in management response, and the processes of degradation and restoration (Bestelmeyer et al. 2009).

Plant communities change along environmental gradients. Ecological sites help delineate these gradients. Where changes in soil, geomorphic setting, or moisture conditions are abrupt, plant community boundaries can be distinct. Where boundaries are more gradual, plant community change will be less distinct and occur along wider environmental gradients of soils and topography.

Terrestrial Systems

The NRCS ecological site classification is correlated to existing NRCS soil maps (NRCS, Soil Survey Geographic Database (SSURGO; online)) and can therefore be displayed and mapped in a geographic information system (GIS). While the NRCS ecological site classification is suitable for the objectives of the ecosystem diversity framework described here, some limitations should be noted. A primary limitation is the fact that current soil mapping methodologies are often based on groupings of soils and may include minor inclusions of other soil types that may in fact represent another ecological site occurring within the larger soil type. As with most classification systems, the issue of mapping resolution is a common theme. While soil mapping may produce finer resolution data than most existing vegetation classification systems, it is still likely to represent less diverse conditions than actually occur on the landscape and the user should be aware of this limitation.

To map the ecological sites of South Dakota, the NRCS SSURGO data layers were obtained for the entire state of South Dakota. Approved ecological site descriptions were also obtained from South Dakota NRCS representatives (Stan Boltz, personal communication). In some instances, the SSURGO data had not been updated to include all of the approved ecological site labels so this was completed by project personnel with input from state NRCS representatives, where possible. The resulting map of ecological sites and MLRAs for terrestrial systems in South Dakota is provided in Figure 3-3. In some MLRAs, ecological sites were further described by precipitation zones but this variable was not included in this figure to reduce map complexity for display purposes. Table 3-2 identifies the number of acres for each of the terrestrial system ecological sites, by MLRA.

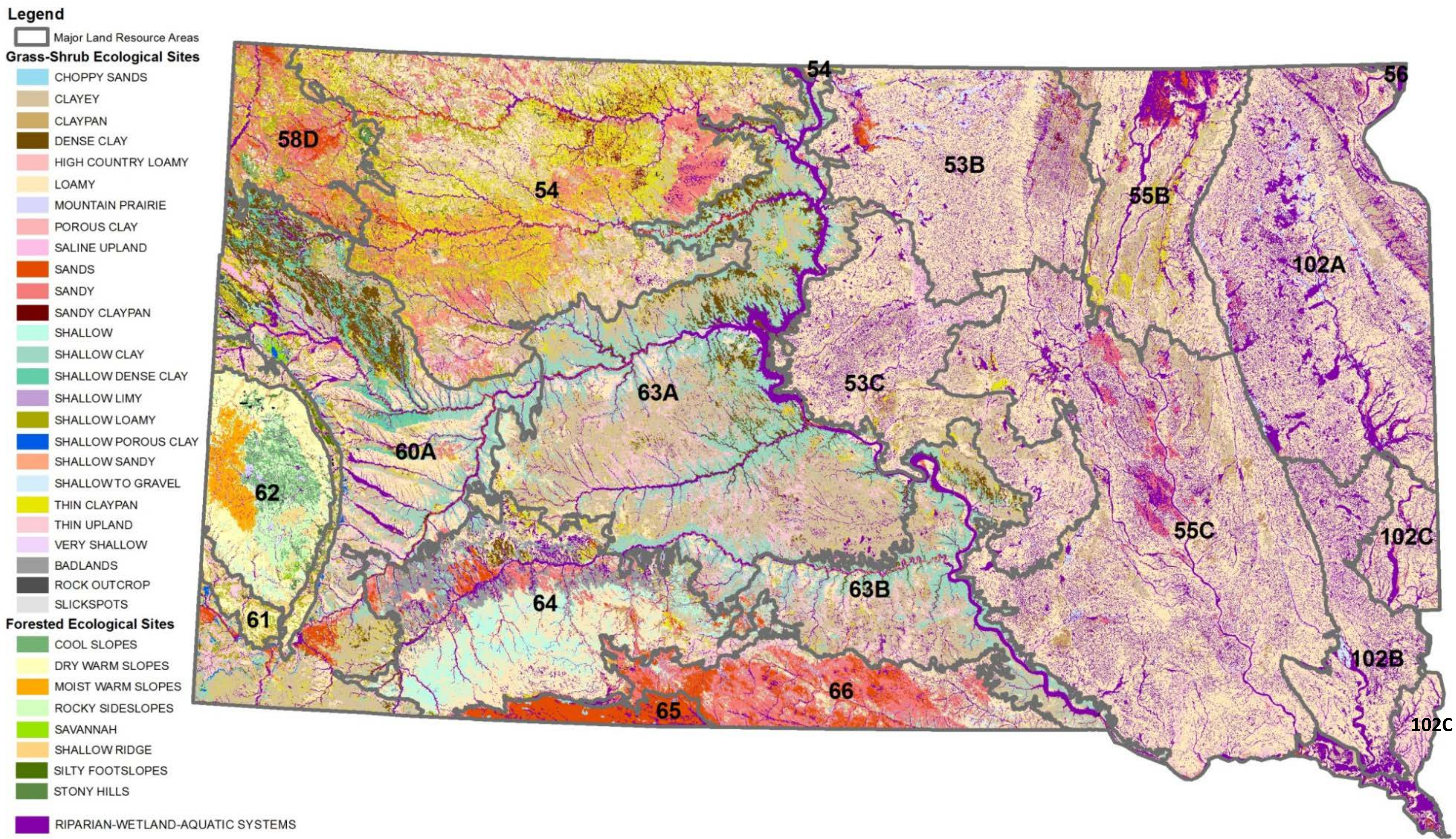


Figure 3-3. Location of primary terrestrial – grass-shrub and forested – ecological sites in South Dakota. Riparian-wetland-aquatic systems are lumped into one category for the purpose of this map.

Table 3-2. Number of acres representing each of the terrestrial ecological sites occurring within each of the eighteen South Dakota's Major Land Resource Areas.

ECOLOGICAL SITES	53B	53C	54	55B	55C	56	58D	60A	61	62	63A	63B	64	65	66	102A	102B	102C	TOTAL
Grassland/Shrub	2,421,457	2,150,807	5,741,376	1,689,675	5,473,773	13,621	1,031,167	3,939,576	325,459	114,044	5,783,550	2,013,920	2,516,210	263,000	1,470,169	3,282,696	1,023,294	634,935	39,888,729
LOAMY	1,868,040	1,391,119	1,555,879	996,855	4,267,806	4,685	96,586	731,664	106,906	28,737	414,611	244,360	1,033,802	1,358	275,295	2,479,640	892,008	509,420	16,898,772
CLAYEY	267,372	382,435	691,097	372,771	353,073	4,828	11,716	1,038,725	21,740	1,673	2,508,544	841,732	226,458		84,957	241,647	1,200	18,845	7,068,814
SHALLOW CLAY			86,544		6,275		3,147	497,667	6,357		1,617,371	493,773	117,403		9,983				2,838,520
SANDY	40,740	1,257	858,665	55,364	175,831	2,216	319,256	68,984	2,064		25,115	39,968	204,092	11,916	666,216	66,170	3,399	16,133	2,557,385
THIN UPLAND	32,761	252,470	200,913	29,032	369,202	537	9,722	268,788	68,008	4,301	454,068	195,657	68,522		30,990	267,962	102,805	77,999	2,433,740
THIN CLAYPAN	11,125	19,515	1,160,643	77,209	20,546		169,812	256,954	359		167,623	35,241	69,544	1,025	5,665				1,995,262
CLAYPAN	34,204	64,515	261,800	120,113	204,904		186,958	25,184			40,719	39,548	89,239	461	30,981	557			1,099,183
DENSE CLAY		3,558						423,146			403,106	60,577	48,172						938,560
SANDS	19,967		54,856	22,770	1,608	90	89,520	79,218	1,324		18,423	10,991	75,606	233,204	263,758	2,094		8,427	881,857
SHALLOW LOAMY			456,564	1,395			105,379	118,016	112,535	2,814			1,603						798,307
SHALLOW								9,580		47,020	41,137	18,451	548,582	598	9,957				675,327
SHALLOW TO GRAVEL	85,657	19,068		12,148	65,878	1,265					5,443	12,902	1,936		27,770	193,750	21,088	3,645	450,551
SHALLOW SANDY			333,171				25,442	2,456											361,069
VERY SHALLOW	53,692	16,869	32,938	745	8,650		5,480	34,872	6,165	1,017	87,391	19,445	25,772		448	30,875	2,793	465	327,617
SHALLOW DENSE CLAY								308,507											308,507
SHALLOW LIMY												234	5,480	895	63,403				70,012
SANDY CLAYPAN	7,898		48,304	1,274			8,148	299											65,922
SALINE UPLAND								38,030											38,030
SHALLOW POROUS CLAY								34,870											34,870
MOUNTAIN PRAIRIE										21,461									21,461
CHOPPY SANDS												1,040		13,542	747				15,329
HIGH COUNTRY LOAMY										7,021									7,021
POROUS CLAY								2,616											2,616
Forested			2,262				24,989	21,658	180,307	1,219,467									1,448,684
DRY WARM SLOPES								2,905	90,279	412,759									505,943
ROCKY SIDESLOPES										282,859									282,859
SHALLOW RIDGE								2,153	59,206	134,642									196,000
MOIST WARM SLOPES										185,501									185,501
COOL SLOPES			792				12,012	587	2,771	165,918									182,082
STONY HILLS			1,470				12,976	153	12,397	31,140									58,136
SAVANNAH								14,650	799	6,648									22,098
SILTY FOOTSLOPES								1,209	14,855										16,064
Sparsely Vegetated		36	41,675	90	315		26,939	108,213	5,374	937	28,572	12,411	344,306						568,867
BADLANDS			11,579				14,046	10,305			1,992	56	344,306						382,284
ROCK OUTCROP		36	29,996		315		12,352	33,643	5,374	937	25,733	12,355							120,742
SLICKSPOTS			99	90			542	64,265			846								65,842
Unknown [a]	2,062	1,009	2,399	1,754	3,467	71	149	4,515	1,564	3,811	3,571	1,874	87		281	4,972	936	1,221	33,742
DISTURBED SITES	2,062	1,009	2,399	1,754	3,467	71	149	4,515	1,564	3,811	3,571	1,874	87		281	4,972	936	1,221	33,742
Total	2,423,519	2,151,852	5,787,711	1,691,519	5,477,556	13,692	1,083,244	4,073,963	512,703	1,338,259	5,815,693	2,028,205	2,860,602	263,000	1,470,450	3,287,668	1,024,229	636,156	41,940,022

Riparian-Wetland Systems

The SDWAP has been revised to include a more detailed classification of riparian-wetland ecological sites to provide the foundation for better understanding potential native ecosystem diversity. For this purpose, a combination of existing classification systems are used including Stewart and Kantrud (1971), Cowardin et al. (1979), and the hydrogeomorphic (HGM) system (Brinson 1993). The following sections summarize how these classification systems were combined to meet the objectives for describing native ecosystem diversity in riparian-wetland ecosystems. First, a brief description of each classification system is needed to provide the foundation for this discussion.

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. They grouped wetland vegetation into zones characterized by distinctive plant community compositions and 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 hydrogeomorphic (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 both 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 hydrogeomorphic classes were identified including Lacustrine, Depressional, Riverine, and Slope classes. The four HGM classes are defined using slight modifications to NRCS (2008) definitions (Table 3-3). In addition, 7 hydrology sub-classes were identified to capture important drivers and attributes which 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 3-4).

Table 3-3. Description of the hydrogeomorphic classes identified for wetland and riparian ecological sites of South Dakota (as definitions modified from NRCS 2008 and Brinson et al. 1995). Due to current mapping limitations, the Slope Hydrogeomorphic Class is not represented in the 2014 South Dakota Wildlife Action Plan mapping efforts.

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 occur • 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 3-4. Seven hydrology sub-classes utilized for wetland and riparian ecological sites of South Dakota. Due to current mapping limitations, the seep/saturated hydrology subclass is not represented in the 2014 South Dakota Wildlife Action Plan mapping efforts (based on 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 is 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.

While not required as part of the ecological site framework, vegetation zones as defined by Stewart and Kantrud (1971, 1972) (Table 3-5) 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. For the purpose of describing native ecosystem diversity, each disturbance state was characterized using expected species compositions relative to defined vegetation zones.

Using this ecological classification system, a map of riparian and wetland hydrogeomorphic classes was developed (Figure 3-4) and a map of riparian and wetland ecological sites, or the combination of hydrogeomorphic class and hydrology sub-classes (Figure 3-5) were mapped throughout South Dakota. Data sources used in this mapping effort include a combination of NRCS ecological sites and National Wetlands Inventory (USFWS 2010). For a description of methods used in this assessment, see Appendix L. The NRCS ecological site and NWI information were available as GIS layers with associated attribute data. However, the ability to map the Slope HGM Class and the Seep Hydrological Subclass from existing

Table 3-5. Seven vegetation zones 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. Due to current mapping limitations, the Fen vegetation zone is not represented in 2014 mapping efforts.

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.

data sources was not possible at this time. In addition, the ability to map fresh from saline systems using existing data sources was also lacking at this time.

The fluctuation of water levels resulting from changes in precipitation or evaporation is the primary driving force influencing the species composition and structure of riparian and wetland ecosystems. Fluctuating water levels can increase the amount of open water and bare soils that are 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 dirt and leads to emergent species colonizing or re-colonizing 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 moister vegetation zone during above average precipitation or losing a vegetation zone during below average precipitation.

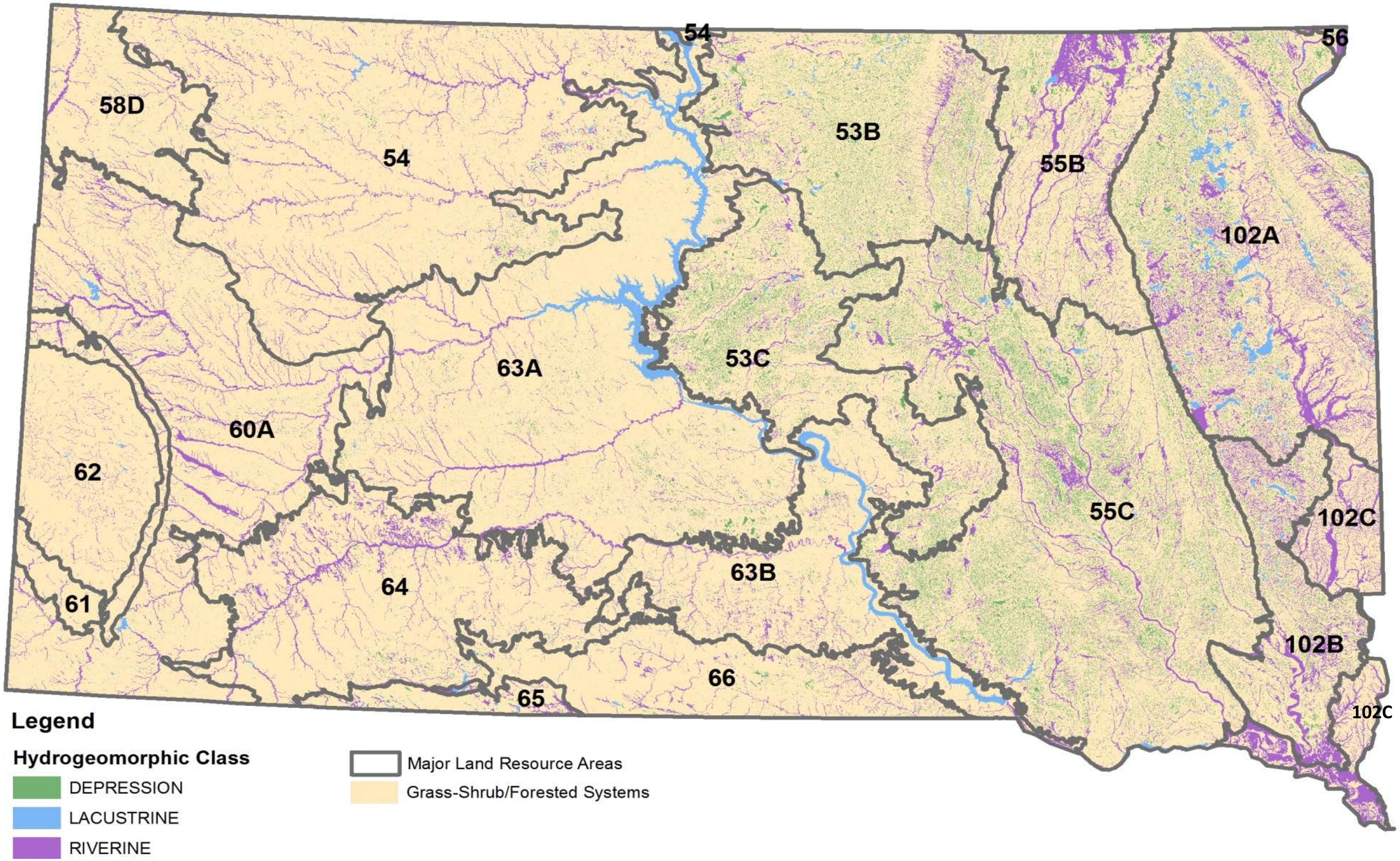


Figure 3-4. Location of riparian-wetland hydrogeomorphic classes in South Dakota.

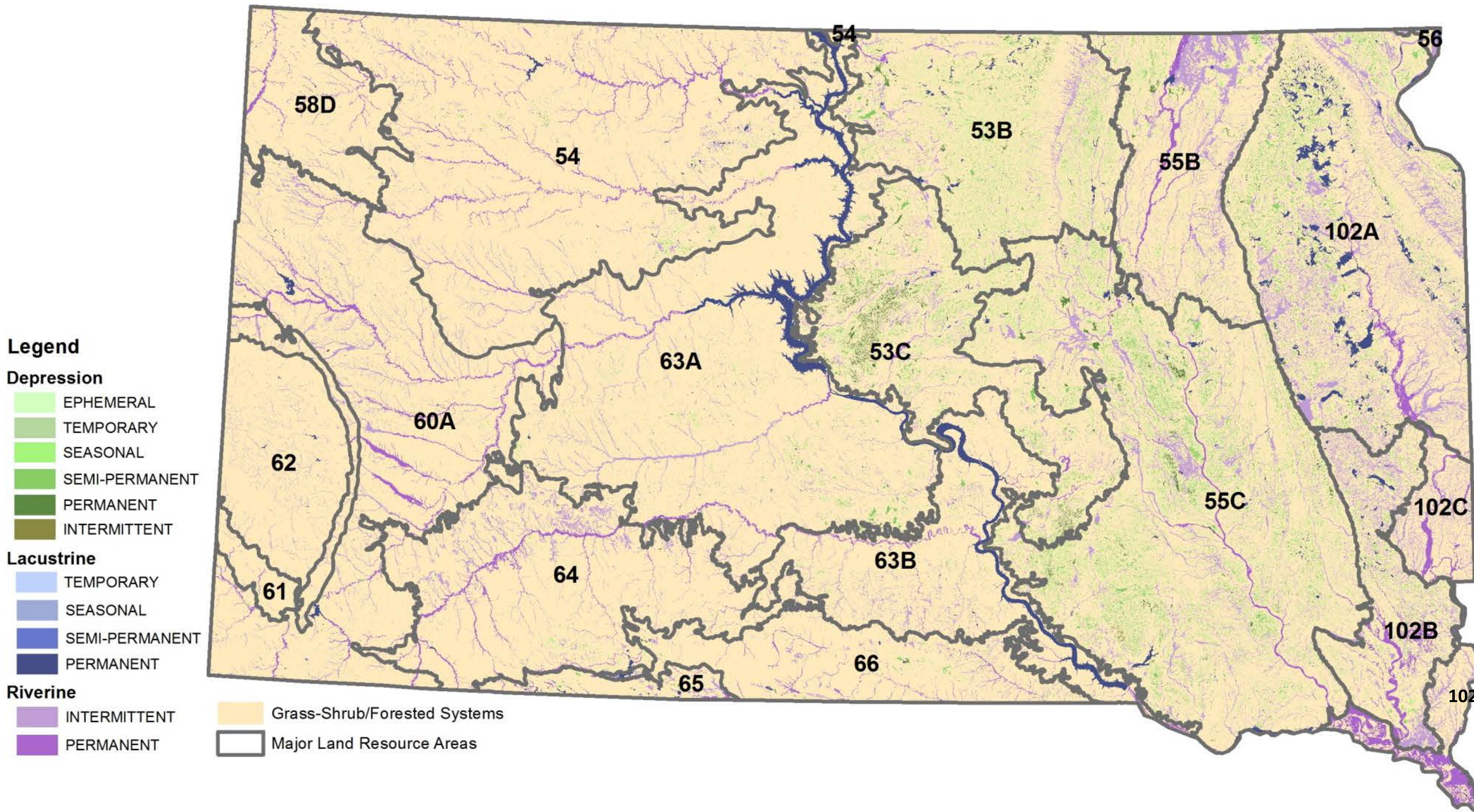


Figure 3-5. Location of riparian-wetland ecological sites, or the combination of hydrogeomorphic class and hydrology subclasses, in South Dakota.

Usually, vegetation zones within riparian and wetland ecological sites and as described by Stewart and Kantrud (1971) occur as concentric peripheral bands in response to different water levels, with the central ring usually representing the wettest portion of the site and the outer rings usually representing the progressively drier margins. The number of concentric bands present will depend on the hydrology sub-class for the ecological site. Figures 3-6 through 3-11 provide 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 3-12 and 3-13 provide a generalized example of the typical vegetation zones occurring within the two hydrology subclasses for the lacustrine HGM class. Figures 3-14 and 3-15 provide a generalized example of the typical vegetation zones occurring within the two hydrology subclasses for the riverine HGM class. It is important to note that 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 ground water input to be present. It is also important to note that many riparian and wetland ecological sites have been altered by extensive cropland conversion, draining, filling, etc. that has occurred in the last century (Dahl 1990, Dahl and Johnson 1991) and potentially altering 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 also influenced the vegetation community structure in terms of creating patchy openings by knocking down 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 a more minor component 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 this ecological site. 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 such as 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 riparian and wetland ecological sites have not been well documented. For the purposes of describing ecological sites, some assumptions are necessary. In particular, 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 on 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 close to the floodplain is expected to be the most heavily influenced by beaver activity. Where dams do occur, the result of going from a flowing water system to a pond system is expected to have an effect on the species composition and structure, as well as the associated biodiversity, but this change has not been evaluated or documented South Dakota.

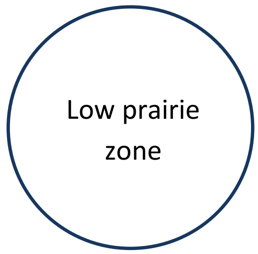


Figure 3-6. Depressional-Ephemeral Ecological Site. Typical vegetation zones under average precipitation conditions for the depressional class- ephemeral sub-class (as adapted from Stewart and Kantrud 1971).

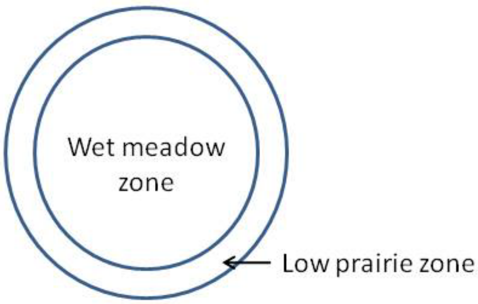


Figure 3-7. Depressional-Temporary Ecological Site. Typical vegetation zones under average precipitation conditions for the depressional class- temporary sub-class (as adapted from Stewart and Kantrud 1971).

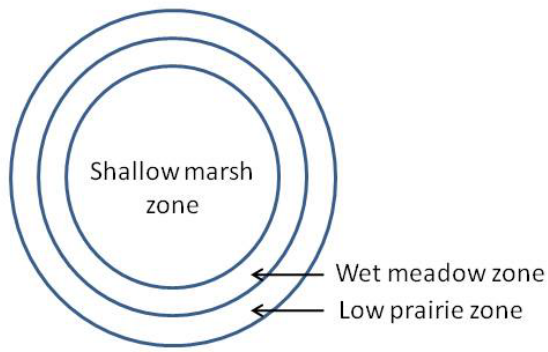


Figure 3-8. Depressional-Seasonal Ecological Site. Typical vegetation zones under average precipitation conditions for the depressional class- seasonal sub-class (as adapted from Stewart and Kantrud 1971).

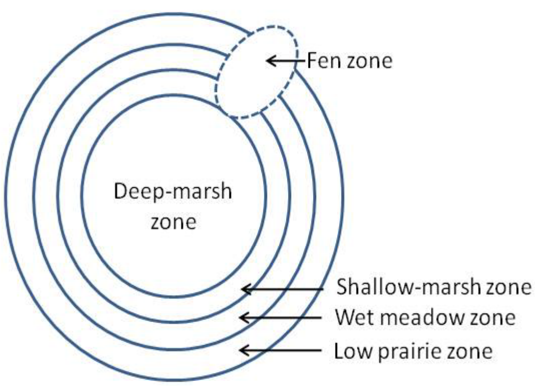


Figure 3-9. Depressional-Semipermanent Ecological Site. Typical vegetation zones under average precipitation conditions for the depressional class- semipermanent sub-class (Stewart and Kantrud 1971).

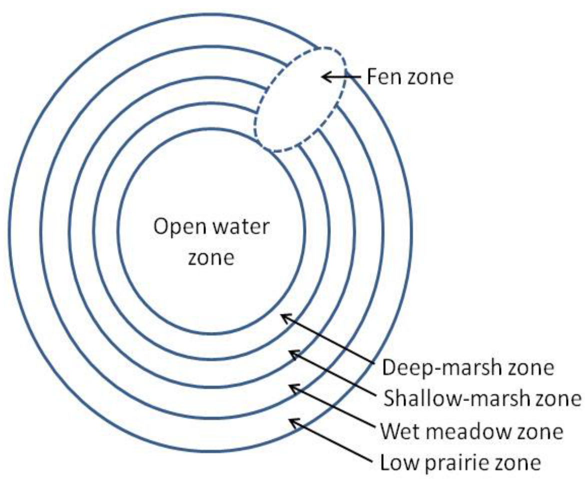


Figure 3-10. Depressional-Permanent Ecological Site. Typical vegetation zones under average precipitation conditions for the depressional class-permanent sub-class (as adapted from Stewart and Kantrud 1971).

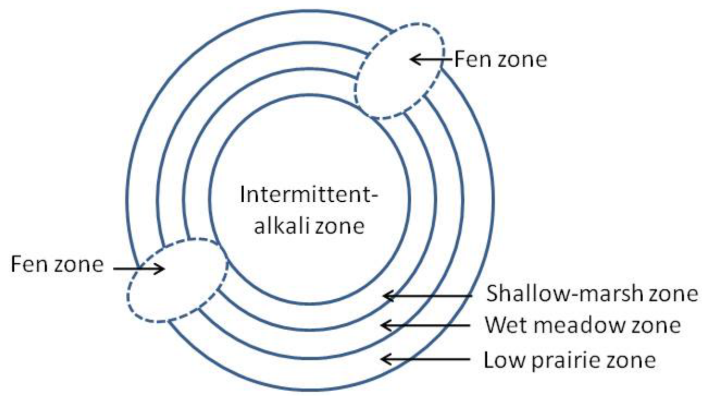


Figure 3-11. Depressional-Intermittent Ecological Site. Typical vegetation zones under average precipitation conditions for the depressional class-intermittent sub-class (as adapted from Stewart and Kantrud 1971).

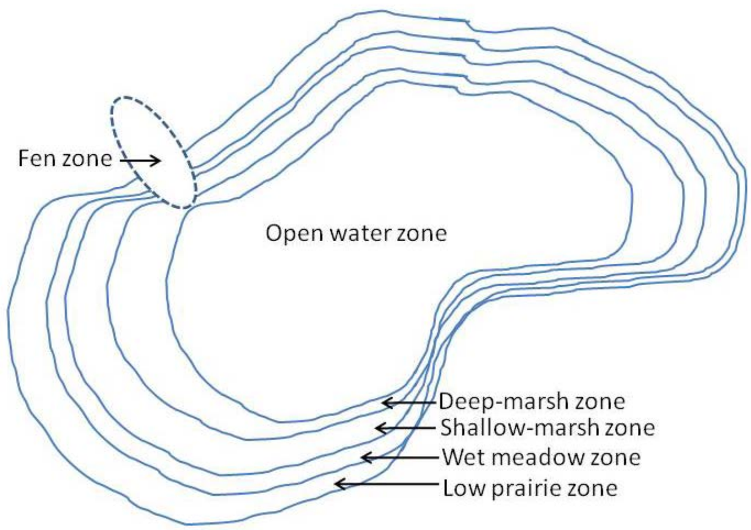


Figure 3-12. Lacustrine-Permanent Ecological Site. Typical vegetation zones under average precipitation conditions for the lacustrine class–permanent subclass (as adapted from Stewart and Kantrud 1971).

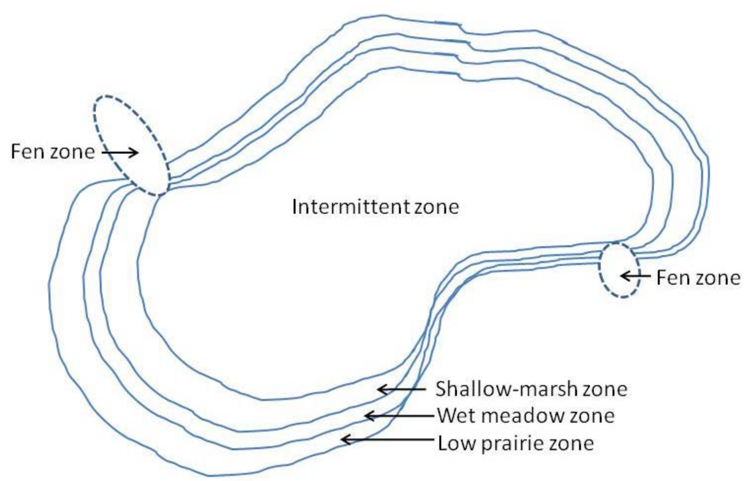


Figure 3-13. Lacustrine-Intermittent Ecological Site. Typical vegetation zones under average precipitation conditions for the lacustrine class -intermittent subclass (as adapted from Stewart and Kantrud 1971).

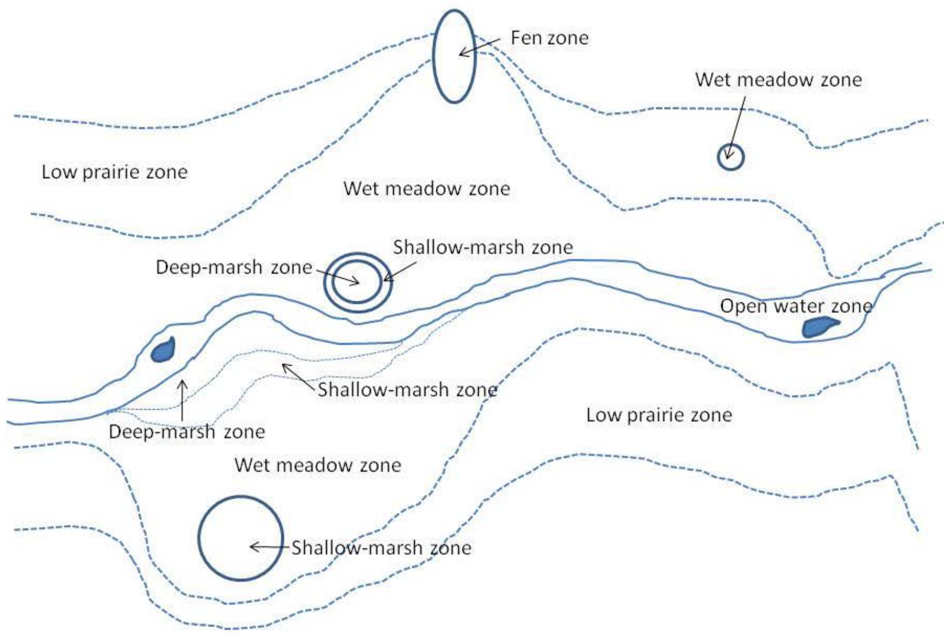


Figure 3-14. Riverine-Permanent Ecological Site. Typical vegetation zones under average precipitation conditions for the riverine class-permanent sub-class (as adapted from Stewart and Kantrud 1971).

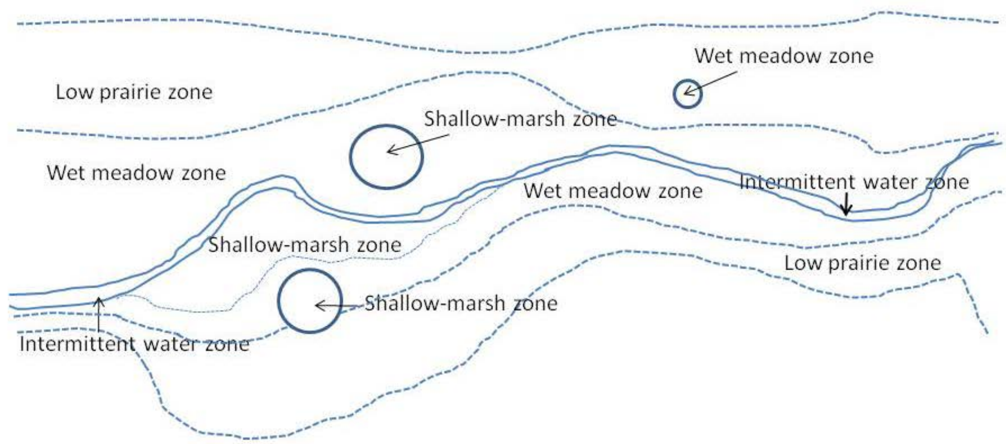


Figure 3-15. Riverine-Intermittent Ecological Site. An example of vegetation zones that might occur under average precipitation conditions for the riverine class-intermittent sub-class (as adapted from Stewart and Kantrud 1971).

The number of acres mapped for each of the riparian and wetland hydrogeomorphic classes is provided in Table 3-6. The number of acres mapped for riparian and wetland ecological sites by MLRA is provided in Table 3-7. It is important to note that these acres were calculated based on existing NWI and NRCS SSURGO/ecological site data that do not fully capture the historical extent of these sites prior to the extensive cropland conversion, draining, filling, etc. that has occurred in the last century (Dahl 1990 and Dahl and Johnson 1991). In addition, some depressional sites such as depressional-permanent may have expanded in acreage due to excavation activities. Some lacustrine ecological sites may have been created from damming and impounding activities that occurred in the last century. Reservoirs and impoundments occurring on historically riverine or depression ecological sites would have reduced those acres as they were historically and identify them today as lacustrine systems.

Table 3-8 identifies a rough approximation of the number of distinct or isolated depressional and lacustrine ecological sites occurring in each MLRA.

Table 3-6. Number of acres representing the hydrogeomorphic classes in South Dakota.

	HYDROGEOMORPHIC CLASS			
	DEPRESSION	**RIVERINE**	**LACUSTRINE**	**TOTAL**
EPHEMERAL	105,435		32	105,469
TEMPORARY	423,714		133	423,846
SEASONAL	764,218		1,011	765,230
SEMI-PERMANENT	851,425		10,282	860,728
INTERMITTENT	5,036	3,122,060		3,127,096
PERMANENT	191,763	1,125,104	785,471	2,102,335
TOTALS	**2,341,591**	**4,247,164**	**796,929**	**7,385,684**

Table 3-7. Number of acres representing riparian and wetland ecological sites, or the combination of hydrogeomorphic class and their hydrology sub-class, for each of the Major Land Resource Areas occurring in South Dakota.

Ecological Site	53B	53C	54	55B	55C	56	58D	60A	61	62	63A	63B	64	65	66	102A	102B	102C	TOTAL
DEPRESSION	**350,743**	**288,883**	**42,972**	**133,882**	**877,643**	**2,607**	**7,891**	**27,278**	**1,054**	**480**	**78,724**	**24,508**	**22,873**	**5,101**	**24,990**	**349,119**	**97,679**	**5,164**	**2,341,591**
EPHEMERAL	8,281	22,342	5,086	2,427	26,597		1,781	1,636	241	126	6,333		8,477	120	2,886	9,454	7,847	1,801	105,435
TEMPORARY	42,544	26,994	5,182	43,700	200,305	548	1,868	2,227	113	86	5,219	1,658	1,930	516	4,446	54,345	30,164	1,869	423,714
SEASONAL	166,548	72,674	17,538	43,003	268,595	528	1,909	9,262	248	67	26,350	9,089	9,956	862	9,363	97,749	29,772	705	764,218
SEMI-PERMANENT	112,638	91,086	13,751	37,983	333,617	1,334	1,244	6,875	363	147	27,017	8,969	1,178	2,622	6,228	177,973	27,979	421	851,425
PERMANENT	20,247	75,473	1,411	6,671	45,356	1	1,089	7,278	89	17	13,799	4,750	1,332	821	2,067	9,214	1,878	270	191,763
INTERMITTENT	485	314	4	98	3,173	196				37	6	42		160		384	39	98	5,036
LACUSTRINE	**24,934**	**12,514**	**14,423**	**9,431**	**44,435**	**522**	**1,172**	**15,629**	**118**	**2,005**	**323,036**	**129,707**	**4,750**	**3,727**	**6,984**	**187,048**	**14,969**	**1,525**	**796,929**
EPHEMERAL					15							15					2		33
TEMPORARY	1	1	1	14	4		31	69			2			2	2		5	1	133
SEASONAL	1	3	508	2	35		86	237			138	1							1,011
SEMI-PERMANENT	959	4,278	449	188	2,931		43	291			2	36	18	454	42	339	252		10,282
PERMANENT	23,973	8,232	13,465	9,227	41,450	522	1,012	15,032	118	2,005	322,894	129,655	4,732	3,271	6,940	186,709	14,710	1,524	785,471
RIVERINE	**148,620**	**128,679**	**340,732**	**366,633**	**548,684**	**18,684**	**55,969**	**401,737**	**35,424**	**54,017**	**279,679**	**142,562**	**290,782**	**26,245**	**88,040**	**712,791**	**281,335**	**326,551**	**4,247,164**
INTERMITTENT	139,424	116,048	181,631	304,517	482,677	18,684	16,934	213,813	28,304	53,574	219,803	93,305	198,147	18,555	57,889	656,510	197,122	125,123	3,122,060
PERMANENT	9,196	12,631	159,101	62,116	66,007		39,035	187,924	7,120	443	59,876	49,257	92,635	7,690	30,151	56,281	84,213	201,428	1,125,104
Total	**524,297**	**430,076**	**398,127**	**509,946**	**1,470,762**	**21,813**	**65,032**	**444,644**	**36,596**	**56,502**	**681,439**	**296,777**	**318,405**	**35,073**	**120,014**	**1,248,958**	**393,983**	**333,240**	**7,385,684**

Table 3-8. Number of individually mapped depression and lacustrine ecological sites for each of the Major Land Resource Areas in South Dakota.

Ecological Site	54	56	61	62	64	65	66	102A	102B	102C	53B	53C	55B	55C	58D	60A	63A	63B	TOTAL
DEPRESSION	**21,841**	**512**	**1,582**	**779**	**9,232**	**1,779**	**19,074**	**199,025**	**48,558**	**2,738**	**214,185**	**130,552**	**101,766**	**652,264**	**6,921**	**33,135**	**50,045**	**25,690**	**1,519,678**
EPHEMERAL	303	0	31	15	468	14	305	1373	1,383	177	953	2,066	315	3,183	91	101	447	0	11,225
TEMPORARY	6,231	177	248	111	2,399	447	6,763	52,449	21,789	1,351	58,358	27,718	49,436	223,572	2,673	3,275	4,687	3,167	464,851
SEASONAL	8,070	182	408	230	3,917	518	9,133	77,410	14,492	403	109,676	47,309	31,127	21,5886	1,781	6,656	11,714	6,420	545,332
SEMI-PERMANENT	5,348	136	654	348	983	558	2,271	64,925	10,258	499	40,726	35,140	18,559	188,383	1,472	7,409	9,982	6,804	394,455
PERMANENT	1,886	1	241	20	1,464	219	601	2,737	631	278	4,355	18,223	2,297	20,106	904	15,694	23,206	9,283	102,146
INTERMITTENT	3	16	0	55	1	23	1	131	5	30	117	96	32	1,134	0	0	9	16	1,669
LACUSTRINE	**3,798**	**16**	**21**	**67**	**1,126**	**621**	**659**	**15,643**	**1,305**	**97**	**2,642**	**3,953**	**4,334**	**8,375**	**178**	**1,608**	**32,620**	**5,561**	**82,624**
EPHEMERAL	0	0	0	0	0	0	0	0	7	0	0	0	0	1	0	0	0	2	10
TEMPORARY	5	0	0	0	0	1	2	0	5	3	2	4	11	15	2	3	4	1	58
SEASONAL	132	0	0	0	1	0	1	0	1	0	2	6	3	30	5	14	19	3	217
SEMI-PERMANENT	104	0	0	0	1	98	12	53	45	0	157	1,419	125	980	12	5	6	8	3,025
PERMANENT	3,557	16	21	67	1,124	522	644	15,590	1,247	94	2,481	2,524	4,195	7,349	159	1,586	32,591	5,547	79,314
TOTAL	**25,639**	**528**	**1,603**	**846**	**10,358**	**2,400**	**19,733**	**214,668**	**49,863**	**2,835**	**216,827**	**134,505**	**106,100**	**660,639**	**7,099**	**34,743**	**82,665**	**31,251**	**1,602,302**

3.5 Disturbance States

As discussed previously, natural disturbance regimes are often responsible for maintaining the dynamic landscape processes that are important drivers of ecosystem diversity as well as the persistence of biodiversity. With an understanding of natural disturbance regimes, recognizable patterns emerge that allow us to describe and predict a given plant community's response to the frequency or intensity of a disturbance type. For the purposes of the ecological framework, the term disturbance state is used to refer to a specific plant community that could occur on a specific ecological site in response to disturbance processes. A disturbance state describes a potential plant community or ecosystem that may occur on an ecological site in response to natural disturbance regimes but, 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, combined 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. We use the term disturbance state to refer to all distinct plant communities that we identify. Others may include the terms plant community or plant community phase as subsets of disturbance states, but we chose to not identify such distinctions.

A state and transition model (STM) is a framework that is used to summarize and describe the range of disturbance states for an ecological site. STMs help to 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, state and transition models 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 such as in the event of a fire or more slowly such as in the event of changes to the grazing regime. Sometimes multiple disturbance changes must occur simultaneously to trigger a transition to a different state.

It should be noted that most STMs in use today have been developed by NRCS to provide a scientific framework to evaluate and describe today's conditions. In that context, NRCS STMs include additional information that is not being used in this effort. Typically NRCS STMs include both native and today's impacted states. In addition, they may include only one native disturbance state, referred to as the Historical Climax Plant Community (HCPC). For the SDWAP, the goal for STMs is to identify the full range of native ecosystems that can occur on an ecological site in response to natural disturbance, where any one of these native ecosystems could be considered a reference condition. For this purpose, each native ecosystem occurring on an ecological site is considered a natural disturbance state. So while existing NRCS STMs were used to inform the development of the STMs for this project, the framework, assumptions, and results may differ from NRCS descriptions due to these primary differences in objectives.

One of the limiting factors in the use of STMs relative to native ecosystem diversity is the lack of quantitative data available to evaluate their accuracy and refine their content. Their development should be based on the best information available on plant species and community response to natural disturbance, with recognition that this information can sometimes be subjective and based on expert opinion. Strategies are in place to strengthen the quantitative data available to support the development of STMs in the future (Bestelmeyer et al. 2009). However, it may be impossible to collect empirical data on many historical states that simply do not exist today because of changes to natural disturbance processes or conditions. These limitations however should not detract from their usefulness today in efforts to describe native ecosystem diversity with recognition of the need to acquire additional data to support and strengthen them in the future.

Terrestrial Systems

Grass-Shrub Ecosystems

To describe the influences of natural disturbance on the vegetation of an ecological site, fire and bison and black-tabled prairie dog grazing, and where appropriate their interactions, were included as the primary mechanisms historically influencing the vegetation of terrestrial ecosystems (Table 3-9). While we recognize the diversity of grazing/herbivory that may have occurred historically in South Dakota, we are primarily interested in the effects of bison and black-tailed prairie dog grazing as they are considered keystone species where they historically occurred. Climate influences are primarily incorporated at the ecoregional classification level but more extreme cycles, such as drought, are also an important stochastic process that should be considered in discussions of disturbance states and overall planning but are difficult to incorporate into a classification of disturbance states due to the complexity and randomness of possible influences. Eight disturbance states were developed for grass-shrub ecosystems of South Dakota to describe the most common potential ecosystem conditions based on the combined influence of bison grazing, as defined along a gradient of lighter to heavier grazing pressure, and fire, as defined along a gradient of more frequent to less frequent fire.

Figure 3-16 presents the state and transition model framework used to characterize disturbance states for terrestrial grass-shrub ecosystems in South Dakota for the purpose of the SDWAP. These disturbance states were developed to capture the range of native grass-shrub vegetation conditions important to most biodiversity in the region, resulting from the influence of historical bison grazing, fire regimes, and prairie dog colonies that may occur on an ecological site. In some instances, not all of these disturbance states will occur on all ecological sites. While bison grazing and fire were likely to have occurred on most grass-shrub ecosystems in South Dakota, prairie dog colonies were less likely to occur in eastern South Dakota where soil productivity challenged a colony's ability to maintain heavily grazed conditions for predator visibility and safety of the colony (Virchow and Hygnstrom 2002). In addition, some ecological sites were also poor prairie dog habitat due to high water tables, shallow soil depth, or soil conditions, such as sandy and heavy clay soils, that were unfavorable for belowground burrow development.

Table 3-9. Expected combined influence of historical bison grazing, fire frequency, and black-tailed prairie dog on creating eight vegetation disturbance states on grass-shrub ecological sites in South Dakota.

Disturbance State	*Bison Grazing Pressure*[a]	*Fire Frequency*[b]	*Prairie Dog Colony*[c]
A	Light	More frequent	
B	Moderate	More frequent	
C	Heavy	More frequent	
D	Light	Less frequent	
E	Moderate	Less frequent	
F	Heavy	Less frequent	
G	Heavy	Less frequent	Active
H	Light to moderate	More frequent	Inactive

[a] LIGHT grazing - <30% utilization of grass by bison and other herbivores; MODERATE grazing - $\geq$30% and <50% utilization; HEAVY grazing - $\geq$50% utilization;

[b] MORE FREQUENT - <15 year mean fire return interval; LESS FREQUENT - $\geq$15 year mean fire return interval

[c] ACTIVE prairie dog colony – prairie dogs present, maintaining/creating burrows, heavily grazing; INACTIVE prairie dog colony – prairie dogs absent, burrows still present and being used by some wildlife species but deteriorating, lighter grazing levels

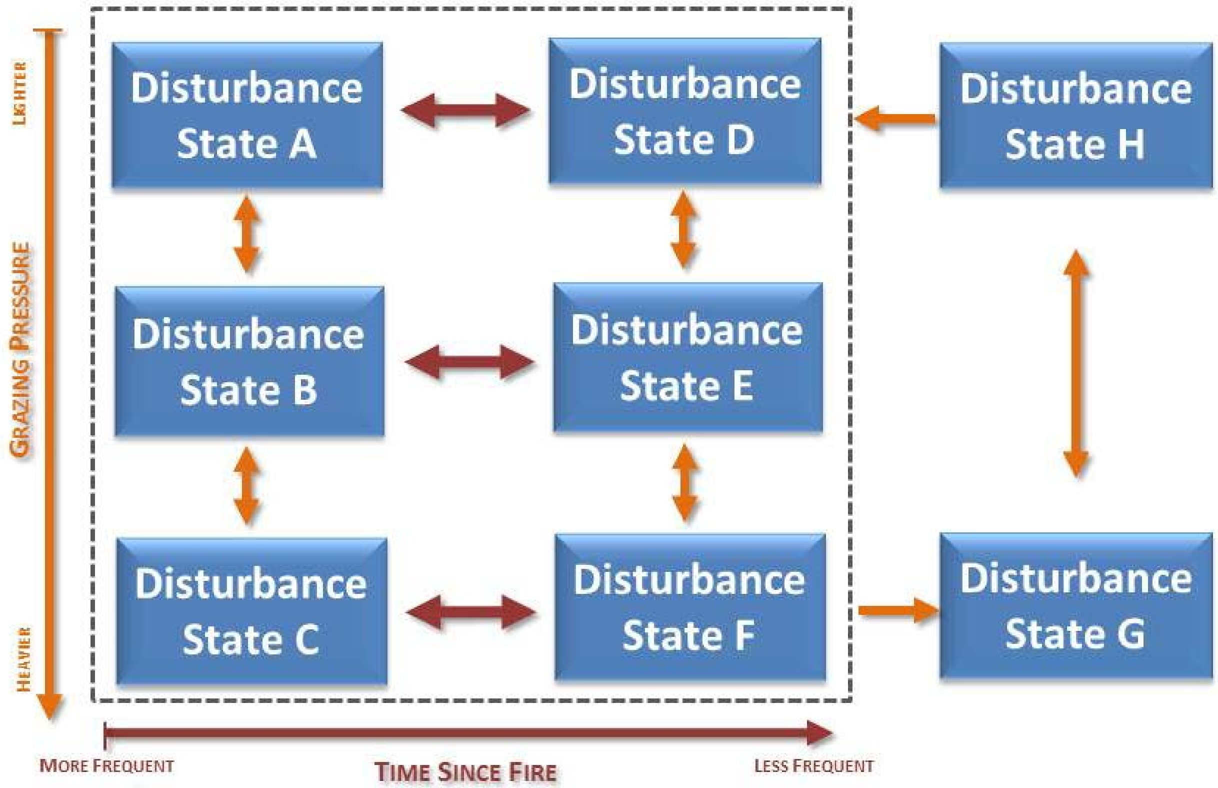


Figure 3-16. State and transition model framework to identify historically occurring disturbance states for terrestrial grass-shrub ecosystems of South Dakota, as influenced by the natural disturbance regimes of bison grazing, fire, and prairie dog colonization. Disturbance states A, B, C, G, and H were much more common historically and disturbance states D, E, and F are considered less common in South Dakota historically.

For most grass-shrub ecological sites in South Dakota, the majority of acres would have occurred as disturbance states A, B, C, and where prairie dog colonies could occur, disturbance states G and H. In general, disturbance states D, E, and F were relatively rare except on sparsely vegetated ecological sites under average conditions, where the discontinuity of vegetation discourages fire spread and leads to less frequent fire regimes. Table 3-10 presents the disturbance states expected to have historically occurred on an ecological site within each of the 18 MLRAs for South Dakota.

Forest Ecosystems

Information on disturbance states for forest ecosystems of South Dakota was not developed for the 2014 update because information is not currently available by ecological site. If this information is compiled by the NRCS, it can be considered in future Plan updates.

Riparian-Wetland Systems

Information on disturbance states for riparian-wetland ecosystems across South Dakota was not developed for the 2014 update. More detailed information on riparian and wetland disturbance states was developed for MLRA 53B (Mehl et al. 2009) as part of an effort to describe native ecosystem diversity for this region. Some riparian and wetland ecological site descriptions have been developed for parts of South Dakota and provide state and transition models using NRCS methodology.

Table 3-10. Disturbance states (Table 3-9; Figure 3-16) believed to have historically occurred in South Dakota for each grass-shrub ecological site by Major Land Resource Area. The projected historical relative abundance of these disturbance states are further characterized as "common" and "rare".

ECOLOGICAL SITES		53B	53C	54	55B	55C	56	58D	60A	61	62	63A	63B	64	65	66	102A	102B	102C
LOAMY	Common	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C	A, B, C	A, B, C
	Rare	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F
CLAYEY	Common	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H		A, B, C, G, H	A, B, C	A, B, C	A, B, C
	Rare	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F
SHALLOW CLAY	Common			A, B, C		A, B, C		A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C		A, B, C			
	Rare			D, E, F		D, E, F		D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F			
SANDY	Common	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H		A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C	A, B, C	A, B, C
	Rare	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F
THIN UPLAND	Common	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H		A, B, C, G, H	A, B, C	A, B, C	A, B, C
	Rare	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F
THIN CLAYPAN	Common	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H		A, B, C, G, H	A, B, C, G, H	A, B, C, G, H		A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H			
	Rare	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F	D, E, F			
CLAYPAN	Common	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H		A, B, C, G, H	A, B, C, G, H			A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H	A, B, C, G, H			
	Rare	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F			D, E, F	D, E, F	D, E, F	D, E, F	D, E, F			
DENSE CLAY	Common		A, B, C						A, B, C			A, B, C	A, B, C	A, B, C					
	Rare		D, E, F						D, E, F			D, E, F	D, E, F	D, E, F					
SANDS	Common	A, B, C		A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C		A, B, C	A, B, C	A, B, C	A, B, C	A, B, C			A, B, C
	Rare	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F	D, E, F			D, E, F
SHALLOW LOAMY	Common			A, B, C	A, B, C			A, B, C	A, B, C	A, B, C				A, B, C					
	Rare			D, E, F	D, E, F			D, E, F	D, E, F	D, E, F				D, E, F					
SHALLOW	Common								A, B, C		A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C			
	Rare								D, E, F		D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F			
SHALLOW TO GRAVEL	Common	A, B, C	A, B, C		A, B, C	A, B, C	A, B, C				A, B, C	A, B, C	A, B, C	A, B, C		A, B, C	A, B, C	A, B, C	A, B, C
	Rare	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F				D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F
SHALLOW SANDY	Common			A, B, C				A, B, C	A, B, C										
	Rare			D, E, F				D, E, F	D, E, F										
VERY SHALLOW	Common	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C		A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C		A, B, C	A, B, C	A, B, C	A, B, C
	Rare	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F	D, E, F		D, E, F	D, E, F	D, E, F	D, E, F
SHALLOW DENSE CLAY	Common								A, B, C										
	Rare								D, E, F										
SHALLOW LIMY	Common												A, B, C	A, B, C	A, B, C	A, B, C			
	Rare												D, E, F	D, E, F	D, E, F	D, E, F			
SANDY CLAYPAN	Common	A, B, C, G, H		A, B, C, G, H	A, B, C, G, H			A, B, C, G, H	A, B, C, G, H										
	Rare	D, E, F		D, E, F	D, E, F			D, E, F	D, E, F										
SALINE UPLAND	Common								A, B, C, G, H										
	Rare								D, E, F										
SHALLOW POROUS CLAY	Common								A, B, C										
	Rare								D, E, F										
MOUNTAIN PRAIRIE	Common										A, B, C								
	Rare										D, E, F								
CHOPPY SANDS	Common												A, B, C		A, B, C	A, B, C			
	Rare												D, E, F		D, E, F	D, E, F			
HIGH COUNTRY LOAMY	Common										A, B, C								
	Rare										D, E, F								
POROUS CLAY	Common								A, B, C										
	Rare								D, E, F										

3.6 Native Ecosystem Plant Community Descriptions

As described previously, an ecosystem is the result of the combined interaction of ecological site and natural disturbance processes. To achieve the goal of ecological restoration using a coarse-filter it is very important to understand that every ecological site can produce different plant communities and thereby, different habitat conditions for associated wildlife species. Using the ecological site database developed by NRCS and providing slight modifications to these data to meet the objectives of the SDWAP, a database of plant community descriptions has been assembled for ecological sites and disturbance states for grass-shrub ecosystems, where data were available. Slight modifications included removing nonnative species from the species list. These plant community descriptions can be used to develop and conduct native ecosystem restoration activities on appropriate ecological sites.

Added to this information is the evaluation of future potential effects under projected climate change assessment through 2099. A description of the terrestrial climate change assessment is provided in Section 5-1. Specifically, each grass species was evaluated on whether it is a C_3 or C_4 species and characterized by whether it will likely decrease or increase with projected climate change for the ecosystem in question. This information will provide the landowner or land manager with the capability to assess the potential effects of these changes on the restoration objectives for a particular site. In the case of providing habitat for a particular wildlife species or SGCN, the possible future decrease of a dominant grass species may warrant the inclusion of another grass species that could provide similar habitat benefits such as height and structure preferred by the targeted species, and which is expected to increase with projected climate change.

More than 900 plant community descriptions are available in this database for both grass-shrub and riparian and wetland ecosystems. Each plant community description in the database identifies the expected disturbance state as described in Tables 3-9 and 3-10, and Figure 3-16 for each ecological site, where available. As stated previously, riparian and wetland plant community descriptions have not been developed for all disturbance states and ecological sites but where information is available, it is included in the database. Table 3-11 provides an example of a plant community description for the clayey ecological site – disturbance state A, for MLRA 53B. These data will be available to the public through the SDWAP web-tool. A description of the web-tools and their use for restoring native ecosystem diversity are provided in Appendix M and described more fully in a later section.

Table 3-11. Example of a plant community description developed for the clayey ecological site – disturbance state A for Major Land Resource Area (MLRA) 53B. The climate change effect information is described in a later section. MFRI = mean fire return interval.

MLRA 53B ECOSITE NAME: CLAYEY
ECOSITE ID: R053BY001ND
PLANT COMMUNITY NAME: Green Needlegrass/Western Wheatgrass
DISTURBANCE STATE: A
FIRE REGIME- MFRI <15 YEARS
GRAZING REGIME- Variable but occurring most years as sporadic or light bison grazing
AVERAGE ANNUAL PRODUCTIVITY (lbs/acres): 2300

COMMON NAME	SCIENTIFIC NAME	SYMBOL	MINIMUM % COMPOSITION BY WEIGHT	MAXIMUM % COMPOSITION BY WEIGHT	CLIMATE CHANGE EFFECT BY 2099
Grasses & Grass-likes			**90**	**95**	
western wheatgrass	*Pascopyrum smithii*	PASM	25	35	DECREASE
green needlegrass	*Nassella viridula*	NAVI4	10	25	DECREASE
shortbristle needle and thread	*Hesperostipa curtiseta*	HECU9	0	15	DECREASE
blue grama	*Bouteloua gracilis*	BOGR2	5	10	INCREASE
thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	ELLAL	0	10	DECREASE
big bluestem	*Andropogon gerardii*	ANGE	0	5	INCREASE
buffalograss	*Bouteloua dactyloides*	BODA2	1	5	INCREASE
needle and thread	*Hesperostipa comata ssp. comata*	HECOC8	1	5	DECREASE
other perennial grasses		2GP	1	5	
plains muhly	*Muhlenbergia cuspidata*	MUCU3	0	5	INCREASE
porcupinegrass	*Hesperostipa spartea*	HESP11	0	5	DECREASE
prairie dropseed	*Sporobolus heterolepis*	SPHE	1	5	INCREASE
sideoats grama	*Bouteloua curtipendula*	BOCU	1	5	INCREASE
slender wheatgrass	*Elymus trachycaulus*	ELTR7	1	5	DECREASE
plains reedgrass	*Calamagrostis montanensis*	CAMO	1	3	DECREASE
prairie Junegrass	*Koeleria macrantha*	KOMA	1	3	DECREASE
sedge	*Carex*	CAREX	1	2	DECREASE
saltgrass	*Distichlis spicata*	DISP	0	1	INCREASE
Forb/Herbs			**2**	**5**	
goldenrod	*Solidago*	SOLID	1	3	
white sagebrush	*Artemisia ludoviciana*	ARLU	1	3	
blazing star	*Liatris*	LIATR	0	2	
common yarrow	*Achillea millefolium*	ACMI2	1	2	
leafy wildparsley	*Musineon divaricatum*	MUDI	1	2	
milkvetch	*Astragalus*	ASTRA	0	2	
other perennial forbs		2FP	0	2	
purple locoweed	*Oxytropis lambertii*	OXLA3	1	2	
scarlet beeblossom	*Gaura coccinea*	GACO5	1	2	
scarlet globemallow	*Sphaeralcea coccinea*	SPCO	1	2	
scurfpea	*Psoralidium*	PSORA2	1	2	
upright prairie coneflower	*Ratibida columnifera*	RACO3	1	2	
white heath aster	*Symphyotrichum ericoides*	SYER	1	2	
American vetch	*Vicia americana*	VIAM	1	1	
autumn onion	*Allium stellatum*	ALST	1	1	
desertparsley	*Lomatium*	LOMAT	1	1	
false boneset	*Brickellia eupatorioides*	BREU	1	1	
other annual forbs		2FA	0	1	
prairie clover	*Dalea*	DALEA	0	1	
pussytoes	*Antennaria*	ANTEN	0	1	
wavyleaf thistle	*Cirsium undulatum*	CIUN	1	1	
white prairie aster	*Symphyotrichum falcatum*	SYFA	0	1	
Shrubs			**1**	**3**	
prairie rose	*Rosa arkansana*	ROAR3	1	2	
prairie sagewort	*Artemisia frigida*	ARFR4	1	2	
western snowberry	*Symphoricarpos occidentalis*	SYOC	1	2	
other shrubs		2SHRUB	0	1	
plains pricklypear	*Opuntia polyacantha*	OPPO	0	1	