Chapter 4. Aquatic Ecosystems

Relevant Required Elements: **#2** – Descriptions of locations and relative condition of key habitats and community types essential to conservation of Species of Greatest Conservation Need.
Focus of Chapter 4: This chapter describes the goals of aquatic ecosystems, particularly related to meeting the needs of aquatic SGCNs. The aquatic COA process is introduced. The overall planning approach of using coarse and fine filters is reviewed. We describe steps involved in the aquatic COA process at a general level, with more detailed descriptions and illustrations found in Chapter 6 (Section 6.5). Changes to the aquatic COA approach included the incorporation of new data, a change in spatial scale (change from Aquatic Ecological Systems (AESs) to hydrologic unit-watersheds (HUC_10), and a resulting increase in total number of COAs from 39 to 73. The riverine ecosystems' hierarchical framework for the 14 major river basins is detailed, with additional descriptions provided to the Basin (HUC_6) level.

4.1 Aquatic Goals and Objectives

The main goal of the aquatic portion of the SDWAP is to maintain the integrity of aquatic communities by conserving the conditions and the processes that sustain them. A key component of this goal was to develop a strategy to focus conservation efforts on key aquatic landscapes called COAs to conserve the full array of biodiversity. These primarily riverine aquatic ecosystems adequately represent the full extent of distinct aquatic habitats across South Dakota and focus on SGCNs. Emphasis on riverine ecosystems was largely due to habitat preferences of aquatic SGCNs.

A function of this analysis was to provide spatial data that could be used by natural resource professionals, non-governmental organizations (NGOs), legislators, and the public to make more informed decisions when prioritizing opportunities to fill information gaps and identify specific areas as high priorities for conservation work.

Specific objectives were to:

1. Classify and map riverine ecosystems into distinct basins at multiple levels.
2. Develop statewide distribution maps for all known and probable occurrences for all fish and mussels listed as SGCNs.
3. Generate overall watershed ownership/stewardship statistics for aquatic basins.

Northern Redbelly Dace

4. Account for factors that negatively affect or threaten aquatic biodiversity in South Dakota.
5. Identify areas that represent the variety of unique habitats in South Dakota as a high priority for future conservation initiatives or protection.
6. Provide information to decision-makers to help with conservation planning efforts.

Topeka Shiner

4.2 Aquatic Conservation Strategy

Conserving the large variety of aquatic biological diversity in South Dakota is challenging. Detection of long-term changes to freshwater ecosystems and assemblages is often difficult, as historic documentation of range and density is often lacking or incomplete (McCartney 2002). Additionally, conservation and management are difficult due to multiple stressors and disturbances occurring concurrently, making it difficult to determine the exact causes of species decline and habitat loss (Cushing and Allan 2001, McCartney 2002).

Loss of habitat by land conversion and habitat degradation continues to be a leading cause of species loss and decline in South Dakota, while human and financial resources for conservation remain limited. In the past, conservation efforts to preserve biodiversity were primarily focused on individual species or isolated populations on the brink of extinction or local extirpation (Franklin 1993). This species-by-species approach to conservation has proved difficult, biased, and not cost-effective (Hutto et al. 1987, Margules 1989, Noss 1991). Therefore, we must improve the efficiency and effectiveness of conservation efforts by managing biodiversity through a systematic approach. This approach will allow us to identify and prioritize which species, assemblages, habitats, and unique watersheds to focus our conservation efforts on and propose for COAs.

The Aquatic portion of the SDWAP incorporates a combined coarse filter and fine filter strategy for the conservation of aquatic biodiversity. This filtering strategy along with incorporating data from the South Dakota Natural Heritage Database, MLI Conservation blueprint, and protected lands allows us to provide a sound scientific foundation for identifying the cumulative effects of threats and land use practices on species and their habitats. Additional explanations about coarse filter and fine filter approaches can be found in Section 3.1.

Application of the strategy

Biodiversity was assessed at two levels: ecosystem (community level) and species.

The combined filtering strategy provides the mechanism to address different levels of biological organization. The coarse filter addresses the ecosystem or community levels while the fine filter addresses the species level. In the future, when additional information becomes available through survey and research work, we plan to add additional levels of biodiversity, including more detailed links to the landscape and genetic structure.

A systematic approach to conservation

- Identify components of biological diversity on which to focus conservation efforts
  (e.g., SGCNs, natural communities)
- Identify where to focus conservation efforts
  - Select areas based on highest known and probable occurrences of aquatic SGCNs and natural communities
    (i.e., highest species diversity; representing all aquatic SGCNs; giving special consideration to aquatic SGCNs with limited ranges)
  - Select areas with the highest probability for successful conservation of SGCNs
    (i.e., lowest known conservation challenges to aquatic ecosystems (i.e., lowest Human Stressor Index (HSI)); highest level of land stewardship and protection from conversion of natural land cover)
  - Select areas from across the state and SGCN ranges that represent unique watershed types to maintain variation
    (i.e., representing areas across basins (HUC_6))

4.3 Aquatic Diversity – Classification of Riverine Ecosystems

It is widely accepted that to conserve biological diversity, one must conserve the ecosystems that support them (Franklin 1993, Grumbine 1994). Ecosystems can be distinct regarding their structure, function, or composition (Noss 1990). Structural features in riverine ecosystems include factors such as depth, velocity, and substrate. Functional features include flow, thermal regime, and energy sources. Composition can refer to both abiotic and biotic factors such as habitat type or species. Ecological composition is usually closely associated with ecosystem structure and function (Noss 1990).

Taking geographic variation into consideration, our specific objective was to identify and map riverine ecosystems that are distinct at multiple levels regarding ecosystem structure, function, and evolutionary history. To accomplish this, we used hydrologic unit codes (HUCs) to delineate different level watersheds developed by the USGS (Table 4.1; Figure 4.1; Seaber et al. 1994, Jones et al. 2022). Levels within the hierarchy are delineated in a top-down fashion using landscape and stream features (i.e. basin boundaries, geology, soils, landform, sub-basin, watershed, etc.).

The Hudson Bay gulf primarily encompasses the central territories of Canada, but also extends south into Montana, North Dakota, South Dakota, and northern Minnesota. The Souris-Red Rainy region subsequently flows north into the Nelson River drainage before emptying into the Hudson Bay. In South Dakota, the Hudson Bay gulf only extends into the extreme northeastern corner of the state, encompassing the Souris-Red-Rainy region to the Upper Red River basin.

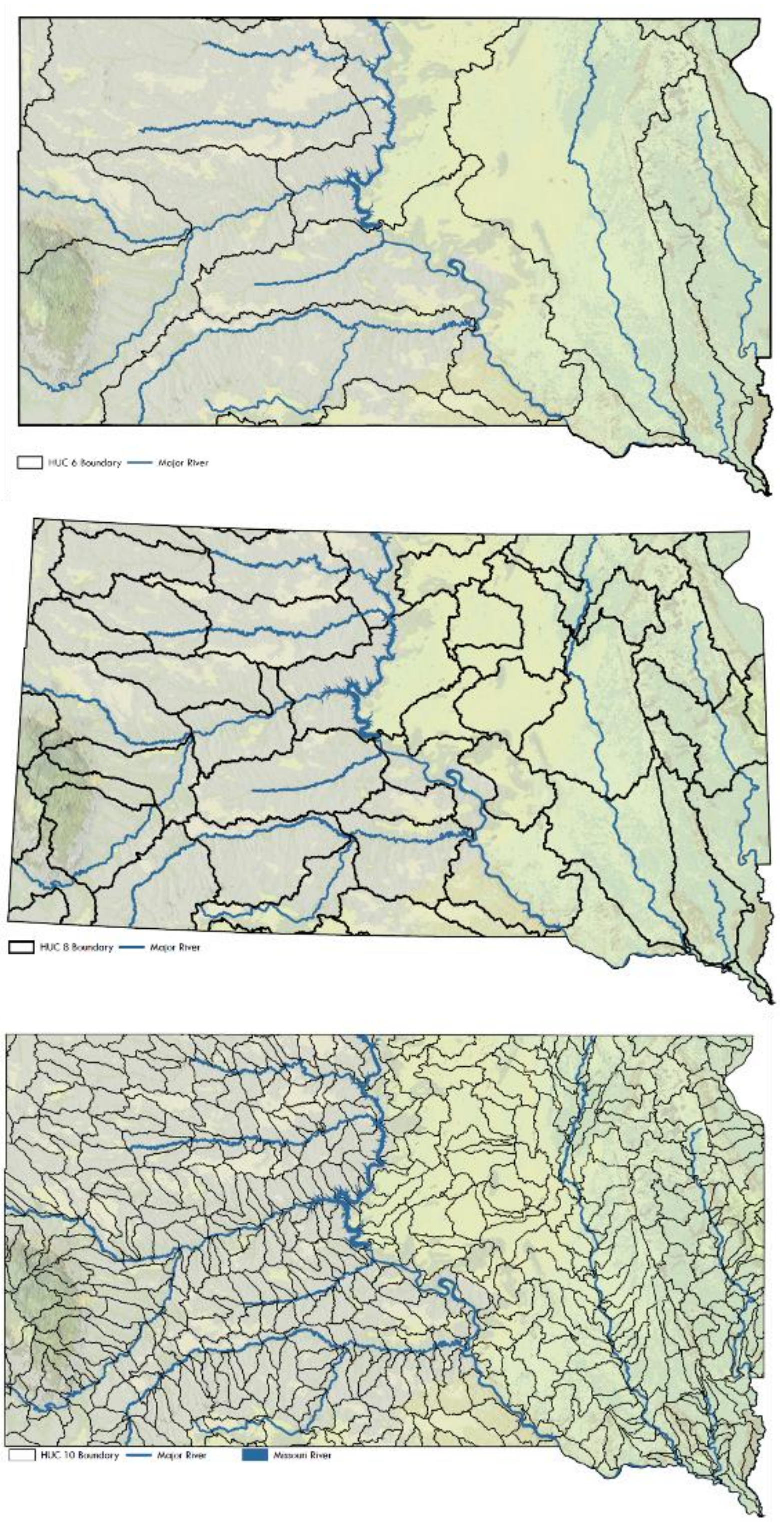
The Gulf of Mexico gulf contains the Mississippi River drainage and most of the United States. The Mississippi River drainage in South Dakota contains the Upper Mississippi River region and the Missouri River region. The Upper Mississippi River region covers less than three percent of South Dakota and is drained by the Minnesota River basin (Hoagstrom et al. 2007). The remainder of South Dakota is part of the Missouri River region (Goolsby et al. 1999, Hoagstrom et al. 2007).

South Dakota contains 14 major river basins (HUC_6; Figure 4.2). Each basin belongs to a larger region (Missouri, Upper Mississippi, and Souris-Red Rainy; HUC_2) and gulf (Hudson Bay and Gulf of Mexico), which eventually drain into different oceans. Table 3.3 (see Chapter 3) details the classification of rivers within South Dakota.

Table 4.1. Hierarchical Framework, with Basic Descriptions, Used for Classifying and Mapping Riverine Ecosystems. Hierarchy for HUC_2 through HUC_10 digit Hydrologic Units: The Numbering Scheme of the Hydrologic Unit Codes Increases by Two Digits as the Hydrologic Units Are Successively Subdivided. Optional 12-, 14-, and 16-digit Delineations Are Not Shown But Follow the Same Hierarchical Hydrologic Unit Coding Scheme. Note: Levels in Red Account for the Levels Used in South Dakota's Selection Process for Identifying Conservation Opportunity Areas.

LEVEL	DESCRIPTION
Gulf	A portion of the ocean that penetrates land where hydrologic units drain into various oceans.
Drainage	A drainage is an area of land where all flowing surface water converges to a single point such as a river mouth and drains into a gulf which in turn drains into an ocean.
Regions (HUC_2)	A region (or hydrologic region) is the 2-digit, "first level" hydrologic unit and is the largest in the hydrologic unit hierarchy. This includes major geographic areas based on topography. These contain either the drainage area of a major river, such as the Missouri River region, or the combined drainage areas of a series of rivers, such as the Souris-Red-Rainy region, which includes several rivers draining into the Hudson Bay Gulf.
Sub-Regions (HUC_4)	A name commonly used to describe the first subdivision of a hydrologic region. A subregion is the second-level, 4-digit unit of the hydrologic unit hierarchy. A subregion includes the area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage area.
Basins (HUC_6)	A subdivision of subregion. A basin is the third-level, 6-digit unit of the hydrologic unit hierarchy. Basins were formerly named "accounting units" in USGS terminology. This term is no longer used to describe 6-digit hydrologic units.
Sub-Basins (HUC_8)	A subdivision of a basin. A subbasin is the fourth-level, 8-digit unit of the hydrologic unit hierarchy. Subbasins were formerly named "cataloging unit" in USGS terminology. This term is no longer used to describe 8-digit hydrologic units.
Watersheds (HUC_10)	In the hierarchy of hydrologic units, a 10-digit or "fifth level" hydrologic unit historically is known as a "watershed." The hydrologic term "watershed" refers to the divide that separates one drainage basin from another or to a combination of hydrologic units of any size.

Figure 4.1. Map Showing HUC levels 6, 8, and 10 Used in South Dakota's Selection Process for Identifying Conservation Opportunity Areas.

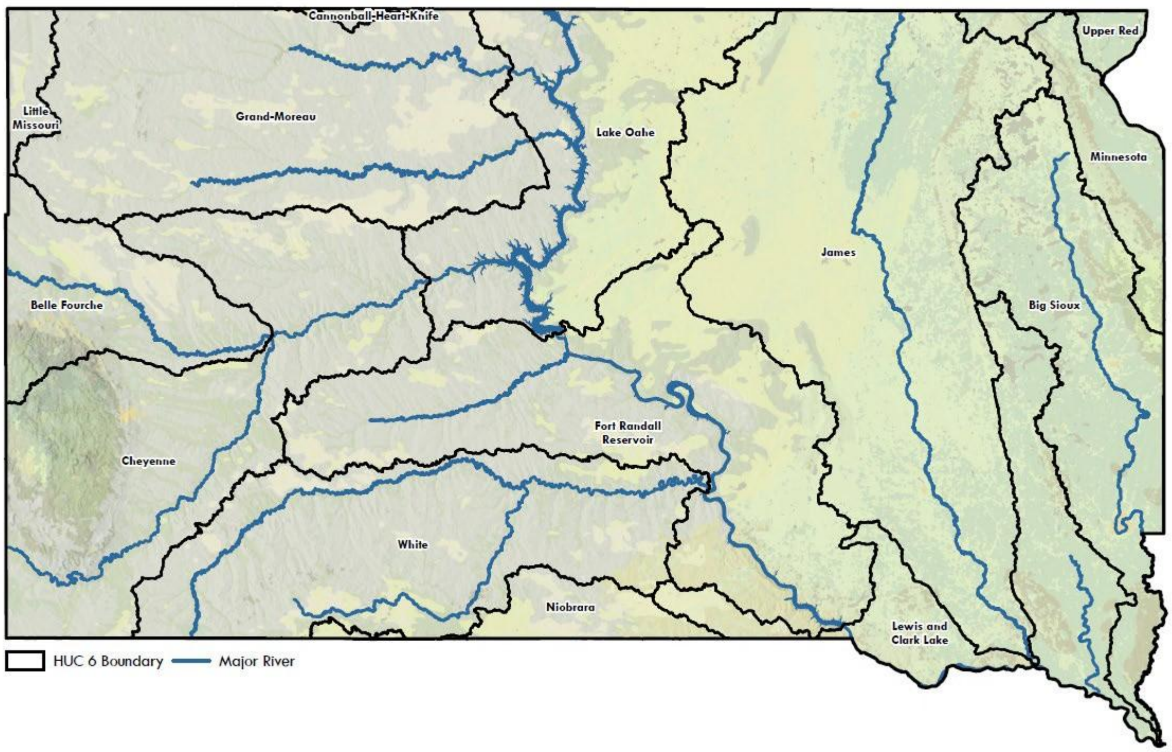


HUC_6 Basins

HUC_8 Sub-basins

HUC_10 Watersheds

Figure 4.2. Map Showing the Boundaries of the Fourteen River Basins (HUC_6) of South Dakota, Including the Minnesota and Upper Red Basins from the Upper Mississippi and Souris-Red-Rainy Regions, Respectively.

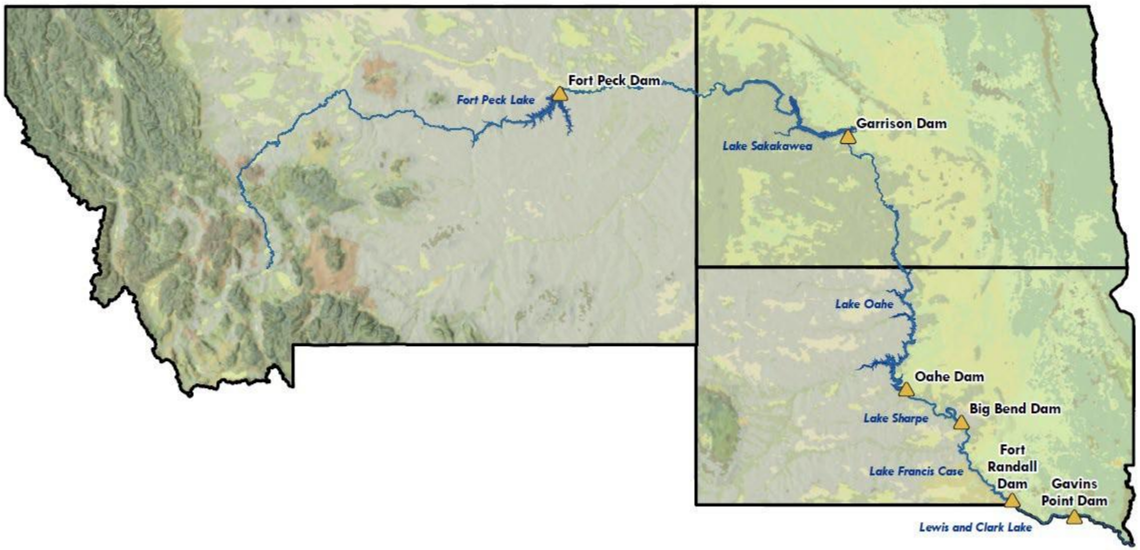


Missouri River Region (Mississippi River Drainage)

The Missouri River Region is the second largest in the United States, draining about one-sixth of the continental United States (Pegg et al. 2003). In the United States, the Missouri River drainage is 1,371,017 km^2, and in Canada it is 25,122 km^2 (USACE 1998, Galat et al. 2005). At 3,768 km, the Missouri is the longest river in North America, 224 km longer than Mississippi River (Benke and Cushing 2005, Galat et al. 2005). Nicknamed the "Big Muddy" because of high turbidity from frequent flooding and shifting channels, the Missouri originates near Three Forks, Montana at the confluence of the Madison, Jefferson, and Gallatin rivers (Galat et al. 2005). It then flows southeast across the continent until merging with the Mississippi River near St. Louis, Missouri.

The Missouri River is no longer a free-flowing river. Between the late 1930s and the early 1960s, six mainstem dams were constructed for flood control, commercial navigation, power generation, irrigation, water quality management, and recreation (Galat et al. 1996; Figure 4.3). Fort Peck Dam occurs in northeastern Montana, Garrison Dam is in North Dakota, and the four remaining dams are in South Dakota. The reservoirs created by the six dams impound approximately half of the upper 2,500 km of the Missouri River (Morris et al. 1968). The natural flow regime of the Missouri River, particularly within the Dakotas, has been significantly altered by these dams and impacts of channelization (Pegg et al. 2003).

Figure 4.3: Locations of Six Missouri River Mainstem Dams.



Lake Oahe Basin (Oahe Dam)

Oahe Dam is located just north of Pierre in central South Dakota. Construction by the U.S. Army Corps of Engineers (USACE) began in 1948, the dam was closed on August 3, 1958, and official operations began in 1962. Excluding the spillway, Oahe Dam spans a length of 2.8 km and impounds Lake Oahe, the fourth largest reservoir in the United States. Lake Oahe extends from central South Dakota north into North Dakota. Named after the 1874 Oahe Indian Mission, it is 372 km long and 62 m deep, with a surface area of 834 km^2 and a shoreline length of 3,621 km (USACE 2012e).

Fort Randall Reservoir Basin (Big Bend Dam and Fort Randall Dam)

Fort Randall Reservoir basin encompasses two Missouri River dams and associated reservoirs as well as the Bad River.

Big Bend Dam is located near Fort Thompson in south-central South Dakota. The USACE began construction in 1959; closed the dam on July 24, 1963; and began official operation in 1964. Excluding the spillway, the Big Bend Dam spans a length of 3.2 km and impounds Lake Sharpe, the 54^{th} largest reservoir in the United States. Lake Sharpe is named after the 17^{th} South Dakota governor, Merrill Q. Sharpe. Lake Sharpe is the first reservoir below Lake Oahe, and is 129 km long, 24 m deep, with a surface area of 230 km^2, and a shoreline length of 322 km (USACE 2012a).

Fort Randall Dam is downstream from Big Bend Dam near Pickstown in southeastern South Dakota. The USACE began construction of the dam in 1946; closed the dam on July 20, 1952; and began operations in 1953. Including the spillway, Fort Randall Dam spans a length of 3.3 km and impounds Lake Francis Case, the 11^{th} largest reservoir in the United States. Lake Francis Case is named after Francis Higbee Case, a former US Senator from South Dakota. The reservoir is 172 km long, 43 m deep, with a surface area of 413 km^2, and a shoreline length of 869 km (USACE 2012c).

The Bad River drains 8,622 km^2 in west-central South Dakota. The mainstem Bad River is primarily characterized by having little to no continuous flow (Pirner 2018). The Bad River flows east into the Missouri River near Fort Pierre, SD (Hoagstrom et al. 2007). Major tributaries of the Bad River system include Dry Creek, Plumb Creek, and White Willow Creek (Hoagstrom et al. 2007).

Lewis and Clark Lake Basin (Gavins Point Dam)

Fort Randall Reservoir basin encompasses one Missouri River dam and associated reservoir as well as the Vermillion River and Ponca Creek.

Gavins Point Dam is downstream from Fort Randall Dam just west of Yankton in southeastern South Dakota. The USACE began construction of the dam in 1952; closed the dam on July 31, 1955; and began operations the same year. Gavins Point Dam, including the spillway, spans a length of 2.7 km and impounds Lewis and Clark Lake. The reservoir was named after the explorers Meriwether Lewis and William Clark. Lewis and Clark Lake, located on the border of South Dakota and Nebraska, is the smallest of the Missouri River reservoirs. It is 40 km long, 14 m deep, with a surface area of 125 km^2, and a shoreline length of 144 km (USACE 2012d).

A 63 km section of Missouri National Recreational River stretches eastward from just below Fort Randall Dam to the upper end of Lewis and Clark Lake. Another section of the Missouri National Recreational River begins downstream from Gavins Point Dam and extends 95 km eastward toward Ponca State Park in northeastern Nebraska. These two stretches of the Missouri River are the only sections of the entire Missouri River that remain undammed or unchannelized.

The Vermillion River drains land east of the Missouri River in southeastern South Dakota. Once entirely glaciated, the river valley was formed around 12,000 years ago by melting ice (Christensen and Stephens 1967, Hoagstrom et al. 2007).

Ponca Creek drains land west of the Missouri River in south-central South Dakota and northern Nebraska.

Little Missouri River Basin

The Little Missouri River basin is west of the Missouri River in North Dakota, Montana, South Dakota, and Wyoming, with only a small portion in northwestern South Dakota. These areas are unglaciated with landscapes of dissected hills, level to rolling plains, isolated buttes, badland formations, salt pans, and mounds. This area was once documented as having several natural springs but today has many intermittent streams.

Cannonball-Heart-Knife Basin

The Knife and Heart Rivers are found only in North Dakota. The Cannonball River drains land west of the Missouri River in southwest-central North Dakota with a small portion in northwest-central South Dakota. The landscape of this area was not glaciated and is composed of dissected, level to rolling plains and hills, with an occasional sandstone butte.

Grand-Moreau Basin

The Grand and Moreau Rivers drain land west of the Missouri River in northwestern South Dakota, with the Grand extending into southern North Dakota. The landscape has not been glaciated and is composed of dissected hills, rolling plains, forested buttes, badland formations, and salt pans. This area has some headwater areas derived from springs, as well as intermittent streams in shallow valleys.

Belle Fourche Basin

The Belle Fourche basin drains land west of the Missouri River in South Dakota, Montana, and Wyoming. The Belle Fourche River ("beautiful fork" in French) is the largest tributary of the Cheyenne River. The landscape of this area has not been glaciated and is composed of dissected hills, rolling plains, isolated buttes, badland formations, and salt pans. This area has many intermittent streams.

Cheyenne Basin

The Cheyenne River drains west of the Missouri River in southwestern South Dakota, Wyoming, and Nebraska. Within South Dakota, the basin extends through diverse landscapes, including the Black Hills and the Badlands, with many intermittent streams. Water quality is generally poor because of highly erodible soils that contribute to high levels of sedimentation during heavy rainfall and agricultural practices (Pirner 2018). Fall River, a unique tributary to the Cheyenne River basin, is fed by hot springs that maintain water temperatures above 21°C throughout the year (Schlafke et al. 2024).

White Basin

The White River basin drains west of the Missouri River in southcentral South Dakota. Much of the White River system receives runoff from the soils of the western Badlands, creating very high turbidity. This area has not been glaciated, and the landscape is composed of dissected hills, level to rolling plains, isolated buttes, badland formations, mounds, and salt pans.

Niobrara Basin

The Niobrara River basin originates in eastern Wyoming and runs along the unglaciated terrain of the northern border of Nebraska. A small portion extends into southcentral South Dakota. This area has a landscape of flat and rolling hills, ridges and valleys, areas of sand dunes, and canyons along streams. Most of the streams are intermittent, with a few large perennial streams.

James Basin

The James River basin drains land east of the Missouri River. The landscape of this area has been glaciated and is composed of rolling plains, moraines, and some sand dunes. This area has many lakes, wetlands, and is cut by steep perennial streams. The James River is one of the lowest gradient rivers in the US, making it particularly prone to flooding (Benson 1983, Shearer and Berry 2002).

Big Sioux Basin

The Big Sioux River basin drains eastern South Dakota and is the most populated river basin in the state (Hoagstrom et al. 2007, Pirner 2018). This area changes from floodplains near the Missouri River to low rolling hills and plains with some bluffs and glaciations. The northern half of this basin has many lakes and wetlands.

Upper Mississippi Region (Mississippi River Drainage)

The Upper Mississippi River region drains 491,894 km^2, which includes the floodplain emerging from Lake Itasca and all the Mississippi River tributaries north of the confluence of the Mississippi and Ohio rivers near Cairo, Illinois (IL). Although most of the Upper Mississippi River drainage is in Minnesota, Wisconsin, Iowa, Illinois, and Missouri, it also includes a small area in northeastern South Dakota. As part of the Minnesota River basin, this is the only major river belonging to the Upper Mississippi River drainage in South Dakota.

Minnesota Basin

The Minnesota River basin drains east of the Missouri River in northeastern South Dakota. The Minnesota River originates from Big Stone Lake on the Minnesota-South Dakota border and flows southeastward through Minnesota, eventually converging with the Mississippi River at Fort Snelling, Minnesota. Primary tributaries of the Minnesota River basin in South Dakota include the Little Minnesota, Whetstone, Yellow Bank, and Lac qui Parle rivers.

Souris-Red-Rainy Region (Nelson River Drainage)

The Souris-Red-Rainy region drains parts of four Canadian provinces (British Columbia, Saskatchewan, Manitoba, and Ontario) and four states (Montana, North Dakota, South Dakota, and Minnesota). The region includes Lake of the Woods and the Rainy, Red, and Souris River basins that ultimately discharge into Lake Winnipeg, and the Nelson River drainage before feeding into Hudson Bay.

Upper Red Basin

The Upper Red Basin includes the Bois de Sioux River of the Red River of the North in South Dakota. The basin is part of the Souris-Red-Rainy region and the Nelson River drainage, encompassing much of eastern North Dakota and a small portion of northeastern South Dakota. The Red River of the North flows north into Lake Winnipeg in Manitoba, Canada, and the Nelson River drains Lake Winnipeg into Hudson Bay. The Red River of the North system was entirely glaciated and formed when melting ice created a deep channel within the broad, flat valley of the basin (Horton and Follansbee 1906). The Red River of North originates at the confluence of the Bois de Sioux River and Otter Tail River near Wahpeton, North Dakota and forms the border between Minnesota and North Dakota.