CHAPTER 5 CONSERVATION CHALLENGES

5.1 Terrestrial Systems

Introduction

Native ecosystems and habitats of South Dakota have and continue to be directly and indirectly altered by human activities. Although Native Americans interacted and influenced this landscape for thousands of years, those influences are incorporated in the historical reference. It is the extent of human influence over the last 100 years that is of primary interest when considering the cumulative impacts to native ecosystem diversity and the associated biodiversity of South Dakota. Better understanding the extent of these impacts can help guide conservation practitioners in designing actions to address conservation challenges. Land conversion to cropland, domestic pasture, urban uses, and roads are the most obvious changes. However, there are also less obvious changes. The implications of a century of alterations to and interruptions of natural disturbance regimes on native ecosystem diversity have only begun to be assessed and much is still unknown. As stated previously, studies have shown that the suppression, alteration, or cessation of natural disturbance has gradually changed ecosystem processes and the species composition, structure, and function of ecosystems.

More specifically, two primary types of human impacts have occurred across South Dakota and have contributed to the cumulative changes to native terrestrial ecosystem diversity observed in the landscape today. These are: 1) the direct conversion of native ecosystems to some other land type or use, and 2) the indirect alteration of native ecosystems through the suppression of natural disturbance processes or alteration of species compositions, structures, or functions resulting from human activities and spread of nonnative species. The primary causes for direct conversion of native ecosystems in South Dakota include agriculture and to a lesser extent urbanization (including roads and other infrastructure). Agriculture is sometimes used as a broad category to also include grazing and timber harvest but for this effort, agriculture is defined relative to those activities that essentially replace native ecosystems with a crop or domestic plant community. For riparian-wetland ecosystems, additional causes of direct conversion may include draining, surface water diversion, water impoundments, dams, ponds for water supply, and stream channelization. The primary causes of indirect alteration of ecosystems include fire suppression, altered grazing regimes, timber harvest as well as accidental or intentional introduction of nonnative species that degrade the quality and function of native species habitats and native ecosystems. Over the past century, the primary causes for indirect alteration of native ecosystems in South Dakota have been fire suppression, altered grazing regimes, timber harvest in forested ecosystems, prairie dog control, and additionally flood control and beaver control/dam removal in riparian-wetland ecosystems.

Both direct conversion and indirect alteration of native ecosystems can result in habitat loss to associated native wildlife species. Habitat loss and its effects on biological diversity can be viewed as having four aspects associated with it:

1. the actual loss or conversion of habitat from favorable conditions that support a species to unfavorable conditions that will not support a species (Ehrlich and Ehrlich 1981, Noss et al. 1995),
2. changes in ecosystem structure, function, or composition (Noss et al. 1995, Franklin et al. 1981) that severely reduce habitat quality of an ecosystem for a particular species,
3. the reduction in the size of the remaining patches that may not provide enough area in one patch to support a species (MacArthur and Wilson 1967), and
4. habitat changes that slowly or quickly cause a single population within the landscape to become a metapopulation, consisting of many independent populations that only interact with occasional dispersal of individuals; metapopulations may then be further influenced by continued habitat loss to the point that interruption of demographic or genetic support to the metapopulation occurs (Hanski and Gilpin 1997), resulting in the subsequent loss of the entire population.

Developing a better understanding of the ecosystem conditions present in South Dakota today is an important step toward identifying and quantifying cumulative changes to native ecosystem diversity and its corresponding influence on the habitat conditions of native wildlife species.

In the last 30 years, a growing recognition of the threat of climate change as a causal agent for indirect conversion has also accelerated. A conclusion of the report of the U.S. Global Change Research Program (2009) is that "global warming is unequivocal and primarily human-induced." While there is a preponderance of scientific evidence on the occurrence and causes of climate change, understanding its likely effects at state and local levels is more challenging. This is especially so for fish and wildlife populations as our knowledge of their habitat needs is often limited and understanding stressors to populations is difficult enough without having to incorporate the additional projected effects of climate change.

Responding to climate change will require considerations at multiple scales and collaborative approaches. Fish and wildlife habitat often encompasses large areas containing multiple ownerships. Management actions must consider not only site level conditions but also the influences of the surrounding landscape. As the effects of climate change make these considerations more complex, agencies such as SDGFP will need to work collaboratively with conservation partners and at larger scales to develop appropriate actions and strategies that emphasize adaptation and mitigation to minimize the potential negative consequences.

The SDWAP was approved in 2006. Climate change was a concern at that time but information on its likely effects and possible responses still contained enough uncertainty to preclude its incorporation in the SDWAP. However, when considering the various conservation strategies available at that time, South Dakota selected an ecosystem-based approach with the recognition that it would provide a good foundation for supporting adaptation and mitigation for climate change as more understanding of its effects emerged. Since 2006, modeling efforts have improved our understanding of the potential effects of climate change. This information is being combined with our understanding of ecosystem processes, community dynamics, and species needs to provide the information needed by South Dakota to incorporate climate change into its revised SDWAP.

The ability to fully quantify the changes to today's ecosystem diversity relative to historical ecosystem diversity (i.e. cumulative impacts) requires three essential layers of mapped information maintained in a geographic information system (GIS): 1) ecological site, 2) current land use categories, and 3) vegetation disturbance state. The ecological site layer overlaid with the current land use layer provides the ability to quantify direct conversion of native ecosystem diversity to other land uses. The ecological site layer overlaid with the vegetation disturbance state layer provides the ability to quantify today's potentially remaining native or altered ecosystem diversity.

The following sections present additional discussion on the conservation challenges associated with maintaining native ecosystem diversity in South Dakota. Further, the results of an assessment to quantify the changes to native ecosystem diversity relative to direct conversion, and a discussion of the challenges associated with trying to quantify the amount of native ecosystem diversity remaining in the landscape today using existing data and information are also presented for both terrestrial and riparian and wetland ecosystems.

Direct Conversion of Native Ecosystems

The primary causes for direct conversion of native ecosystems in South Dakota are identified as agriculture and to a lesser extent urbanization that includes roads and other infrastructure. To evaluate the level of direct conversion of native ecosystems in South Dakota, the National Land Cover Database (NLCD 2006) was overlaid with the ecological site layer developed for the SDWAP. NLCD 2006 is a Landsat-based, 30 meter resolution, land cover database developed for the entire United States. Overall accuracy levels for the NLCD are identified as 78% but it is considered less accurate when differentiating the context of grass, which is a large component of the South Dakota landscape.

Overall direct conversion of native ecosystems at the state-level is moderate at 15,967,072 acres or 38%, with agriculture representing 14,822,533 acres or 35.3% of that amount and urban development representing 1,144,538 acres or 2.7%. When evaluating the distribution of direct conversion by MLRA, a clear pattern exists for higher conversion occurring in eastern South Dakota relative to western South Dakota (Figure 5-1).

Table 5-1 presents the level of direct conversion that has occurred on each terrestrial ecological site within each MLRA. The table is further color coded to more easily identify those ecological sites that have received >=60% conversion (red shading), >=30% to 59% (yellow shading), and <30% (green shading). Not surprisingly, the most heavily converted ecological sites are those that also currently present the best conditions for agricultural productivity, particularly those MLRAs located in eastern South Dakota. The percent of direct conversion varied widely by MLRA with as much as 97.5% direct conversion in MLRA 56 to as low as 0.8% in MLRA 65.

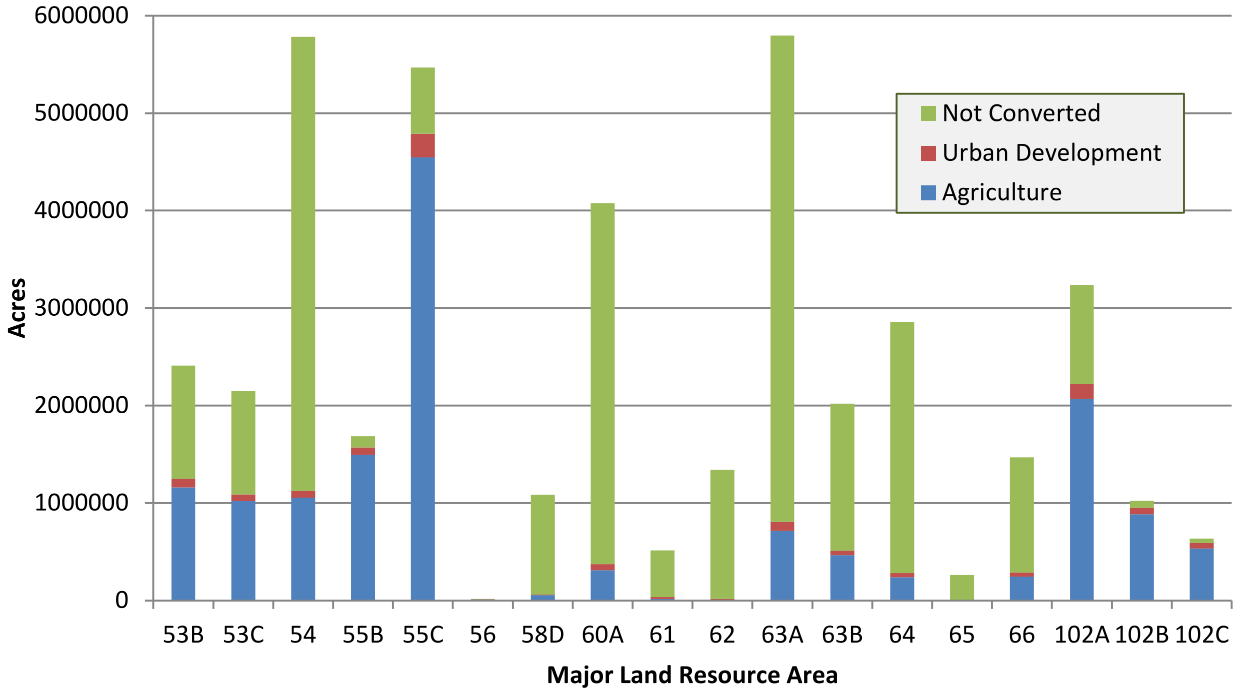

Figure 5-1. Amount of direct conversion of native terrestrial ecosystems resulting from agriculture and urban development by Major Land Resource Area. The "not converted" category may include native or altered ecosystem conditions.

Table 5-1. Percent direct conversion (both agriculture and urban development) for each terrestrial ecological site and Major Land Resource Area in South Dakota. Reddish shade highlights those sites where direct conversion of native ecosystems is >=60%, yellow highlights those sites where native ecosystem loss is >= 30% and <60%; and green highlights those sites where native ecosystem loss is <30%.

Ecological Site	53B	53C	54	55B	55C	56	58D	60A	61	62	63A	63B	64	65	66	102A	102B	102C
Grass/Shrub																		
LOAMY	49.0%	61.7%	36.7%	93.3%	90.6%	97.4%	13.4%	29.1%	19.3%	8.4%	32.6%	47.9%	20.3%	23.3%	45.9%	70.7%	94.6%	94.4%
CLAYEY	76.4%	37.9%	33.3%	97.1%	83.8%	98.8%	6.1%	7.7%	4.9%	1.4%	22.8%	36.1%	7.1%		23.4%	88.5%	88.9%	96.1%
SHALLOW CLAY			<1%		5.3%		<1%	1.3%	2.6%		1.0%	1.2%	<1%		2.8%			
SANDY	51.6%	10.9%	17.9%	89.8%	86.6%	97.2%	6.7%	28.2%	13.8%		20.6%	22.5%	12.8%	8.5%	17.4%	75.9%	95.1%	94.8%
THIN UPLAND	25.0%	17.5%	6.8%	48.3%	56.5%	93.1%	3.3%	4.5%	7.3%	7.3%	7.5%	23.2%	1.3%		7.2%	34.4%	76.8%	85.9%
THIN CLAYPAN	64.4%	26.3%	6.6%	90.6%	66.8%		4.4%	4.3%	20.7%		10.0%	17.1%	4.0%	9.3%	6.1%			
CLAYPAN	94.3%	41.4%	15.3%	95.1%	91.6%		7.6%	7.2%			28.8%	43.0%	10.7%	7.6%	25.5%	56.7%		
DENSE CLAY		2.4%						2.9%			2.7%	4.3%	2.1%					
SANDS	21.3%		3.7%	76.6%	40.7%	83.8%	1.9%	6.2%	1.6%		2.3%	13.9%	2.1%	<1%	3.7%	62.6%		65.0%
SHALLOW LOAMY			5.5%	13.0%			1.7%	2.1%	4.3%	7.3%			1.2%					
SHALLOW								1.1%		2.0%	<1%	2.4%	1.9%	5.1%	4.0%			
SHALLOW TO GRAVEL	41.9%	32.9%		92.0%	91.1%	95.4%					10.6%	10.5%	14.7%		8.8%	53.1%	94.2%	76.4%
SHALLOW SANDY			2.0%				<1%	1.2%										
VERY SHALLOW	24.3%	10.1%	9.0%	81.1%	55.6%		2.1%	6.1%	9.3%	5.0%	2.1%	2.9%	2.3%		3.9%	19.7%	83.9%	73.4%
SHALLOW DENSE CLAY								1.2%										
SHALLOW LIMY												<1%	3.1%	<1%	1.8%			
SANDY CLAYPAN	94.8%		5.7%	94.6%			4.8%	<1%										
SALINE UPLAND								1.6%										
SHALLOW POROUS CLAY								1.7%										
MOUNTAIN PRAIRIE										3.6%								
CHOPPY SANDS												<1%		<1%	<1%			
HIGH COUNTRY LOAMY										<1%								
POROUS CLAY								5.6%										
Forested																		
WARM SLOPES								<1%	<1%	<1%								
ROCKY SIDESLOPES										1.4%								
SHALLOW RIDGE								<1%	<1%	<1%								
MOIST WARM SLOPES										<1%								
COOL SLOPES			<1%				<1%	<1%	1.4%	<1%								
STONY HILLS			<1%				<1%	<1%	3.4%	5.1%								
SAVANNAH								<1%	7.3%	2.8%								
SILTY FOOTSLOPES								1.3%	1.1%									
Sparsely Vegetated																		
BADLANDS			<1%				<1%	<1%			1.5%	<1%	<1%					
ROCK OUTCROP		<1%	<1%		<1%		<1%	<1%	<1%	<1%	<1%	<1%						
SLICKSPOTS			5.6%	15.3%			<1%	2.5%			<1%							

A recent change in commodity prices for agricultural products has led to an increase in conversion of grasslands to corn and soy agricultural land use across South Dakota. Wright and Wimberly (2012) compared crop data layers for 2006 and 2011 and found that 1,561,706 acres of grasslands had been converted to corn or soy fields during that time in South Dakota. A higher rate of conversion is occurring in eastern South Dakota as compared to western. It was not possible to differentiate native grasslands from domestic grasslands with the data layers used but the results of this analysis suggest additional concern for maintaining native grassland ecosystems in South Dakota.

Alteration of Native Ecosystems

The ability to quantify the cumulative effects of indirect alteration on today's ecosystem diversity is currently not possible with existing information and data. While information on ecological sites has been developed and mapped for this effort, information on disturbance states as described for the SDWAP is not currently available. As better satellite imagery and processing methods become available, future SDWAP updates may be able to better assess cumulative impacts relative to indirect alteration of native ecosystem diversity. In the absence of this information, indirect alteration is discussed more generally in terms of the conservation challenges it presents to maintaining South Dakota's native terrestrial ecosystem diversity.

Natural disturbance processes

Since European settlement, many changes have occurred in the natural disturbance regimes that influence native ecosystem diversity across South Dakota. Fire still occurs, however the amount of land that is influenced by naturally occurring wildfire is greatly reduced due to fire suppression efforts. Where wildfire does occur today, a century of altered vegetation conditions have changed the magnitude and intensity of how wildfire now occurs in the landscape compared to what occurred historically. Future climate change is expected to exacerbate this problem. In some instances where feasible, managers are trying to use prescribed fire to reintroduce this natural process but there are considerable challenges to replicating the timing and intensity of natural fire regimes to reproduce the desired effects on vegetation.

In addition, the important interaction of fire and grazing animals has been altered. Historically, grazing animals like bison would preferentially select recently burned areas on grass-shrub ecological sites and graze these areas heavily for 1-2 seasons after a fire. This fire and grazing relationship is not typically used in current ranching practices for prescribed burning and cattle grazing programs. In general, fire suppression and grazing alteration have had a profound impact on landscape heterogeneity and dynamic ecosystem processes. Grazing trends on private land in the Great Plains, on average, have been toward moderate levels. Grasses that benefit from this grazing approach have increased, while grasses that require different levels or timing of grazing have been reduced (Truett 2003). The patchy mosaic of different grazing intensities interacting with natural fire regimes is all but gone from grass-shrub systems of South Dakota. In addition to changes in fire and grazing regimes, the loss of thousands of acres of prairie dog colonies has further impacted many wildlife species dependent on their disturbance influence for suitable habitat conditions.

In the forested systems of South Dakota, the suppression of natural fire regimes over the last 100 or more years coupled with the emphasis for timber production caused significant changes to the ecological processes, structure, and species composition, particularly in the low to mid-elevation ponderosa pine forests. The forest conditions documented by early explorers and trappers in their journals, drawings, and in some instances, black and white photographs, often depict conditions quite different from those observed today (Parrish et al. 1996). Starting in the late 1800s, several activities occurred that changed these ecosystems. First, intensive grazing by cattle and sheep reduced the understory vegetation that carried fires across the landscape. Second, logging began with an emphasis on removing the large ponderosa pines. Third, fire exclusion policies initiated in the early 1900s further reduced the occurrence of the high-frequency fires. The ponderosa pine ecosystems, characterized by large pine trees, were adapted to the short-interval fire regime, having thick bark that protected them from the frequent understory fires. The suppression of natural wildfire has resulted in a dramatic increase in the number of trees per acre occurring today, particularly ponderosa pine, on many low to mid elevation ecological sites. Timber harvest methods that emphasize clear-cutting also contribute to even-aged stands of dense ponderosa pine. Without the natural thinning effect of frequent wildfires, the favorable growing conditions for ponderosa pine will frequently lead to extremely dense stand conditions that exclude other plant species from occurring on these sites. Further, these dense stand conditions will stress the trees thereby making them more vulnerable to insect outbreaks such as the pine beetle. The result is an overall decrease in plant species and structure diversity on these ecological sites throughout low to mid elevation forest ecosystems. When fires do occur, they are usually lethal, stand replacing fires. As these fires burn the remaining stands containing remnant large trees, the ability to restore historical conditions in the near future decreases. Thus, the risk of further impacts and population declines for species dependent upon historical ponderosa pine forests is very high. Forest management and fire suppression programs that emphasize the return of the historical stand conditions are needed to provide the structure and plant species composition of native forest ecosystems in the short- and long-term as well as their spatial arrangement on the landscape.

Mid- to high-elevation forests have been less impacted by fire suppression activities as long-interval fires are more similar to their historical range of variability. However, the size and distribution of these fires have decreased with improvements in modern firefighting capabilities. While the patterns and distributions of stand-replacing fire may have arguably changed in the landscape, the impacts at the ecosystem level have been much less evident in terms of species composition and structure than those observed for low- to mid-elevation forests. In general, the heterogeneous conditions produced from the combined influences of short-, mixed-, and long-interval fire regimes have been significantly reduced on the landscape with the majority of fire occurring today as long-interval, stand replacing events. Forest management can help restore some landscape heterogeneity but frequently forest management objectives do not encompass all the historical structures and species compositions required to maintain native ecosystem and biological diversity.

Nonnative species

More recently, the accidental or intentional introduction of nonnative species has had major impacts on native species and ecosystems. Nonnative invasive plant species are a challenge in all South Dakota ecoregions and across all ecosystem types. They are of particular concern to maintaining the ecological integrity of historical ecosystems. Nonnative invasive species will often reduce the overall biodiversity of a vegetative community by displacing native species and altering the normal ecological processes (e.g., nutrient and water cycles) (Mack et al. 2000). Where heavy infestations of nonnative invasive plants occur, many of the habitat values of that ecosystem will be converted to conditions no longer favorable to native wildlife. For example, Canada thistle and leafy spurge are found throughout South Dakota and cover thousands of acres of previously native ecosystems.

Climate Change

While there are still many unknowns related to the effects of climate change, understanding how ecosystems will respond to climate change is important to evaluating the potential effects on fish and wildlife habitat (Saxon 2003). Terrestrial ecosystems are expected to change relative to plant species compositions, structures, and processes. Site-level changes to species compositions may result from temperature and/or precipitation changes that no longer allow a particular species to occur or through shifts in competitive advantages with other species at that site. Some ecosystems may become more vulnerable to invasion by nonnative invasive species. Primary productivity of ecosystems may increase or decrease depending on changes to available water or temperatures. Natural disturbance regimes will likely change in terms of frequency and severity in response to changes in temperature and precipitation as well. The presence or amounts of some plant communities may change as a result of these influences. Similarly, riparian and wetland ecosystems may change in amounts and types resulting from changes to available water and temperatures. While many potential changes from climate change may be difficult to predict with great accuracy, models of projected climate change can be used to inform future management planning.

Downscaled Global Climate Model (GCM) datasets were used for the updated SDWAP to develop a regional dataset of monthly average precipitation and temperature values for each of the 18 MLRAs in South Dakota for two future periods – 2021 to 2050 and 2070 to 2099. The methods used to develop this information and the results are summarized in the report (Appendix N) “Past, Present, and Future Climates for South Dakota: Observed climate variation from 1895-2010 and projected climate change to 2099” (Cochrane and Moran 2011). This Plan contains the executive summary only. The entire report can be found on the SDGFP website. The work conducted by Cochrane and Moran at South Dakota State University was funded by a grant from the Plains and Prairies Landscape Conservation Cooperative (LCC). In addition to being provided with the final results, the findings were presented to the LCC’s Steering Committee by EMRI Executive Director Jon Haufler.

The following charts (Figure 5-2 through Figure 5-6) represent the results of the predicted A2 climate change values as evaluated against present conditions. The charts represent annual and seasonal temperature and precipitation comparisons for past conditions representing 1961 to 1990 versus projected conditions representing 2021 to 2050 and 2070 to 2099. The A2 model results are considered the higher rate of change scenario and were utilized over the B1 data for these comparisons as this scenario more closely represents the current political environment that is influencing global response to moderating projected climate change impacts and the finding that recent monitoring of rates of change have generally exceeded even the A2 model predictions.

South Dakota's primary terrestrial ecosystems are grass dominated systems. This climate change assessment is conducted for terrestrial grass-shrub ecosystems through its emphasis on grass species, and does not include an assessment for forest ecosystems at this time. More information is available on the photosynthetic pathway of grass species than other lifeforms and most of the climate research in the Great Plains has emphasized grasses due to their dominance in plant communities. As more information becomes available on other lifeforms, such as forbs, shrubs, and trees, future WAP revisions will incorporate those results.

For the purposes of evaluating climate change impacts on the grass-shrub ecosystems of the Great Plains, one approach has concentrated on evaluating the response of species by traits such as photosynthetic pathway (Dukes 2007). There are two photosynthetic pathways, C_3 and C_4, which characterize most of the grass species in the Great Plains. The primary difference between these two functional types is the difference between the photosynthetic pathway where C_3 grasses produce 3 carbon molecules and C_4 grasses produce 4 carbon molecules during photosynthesis.

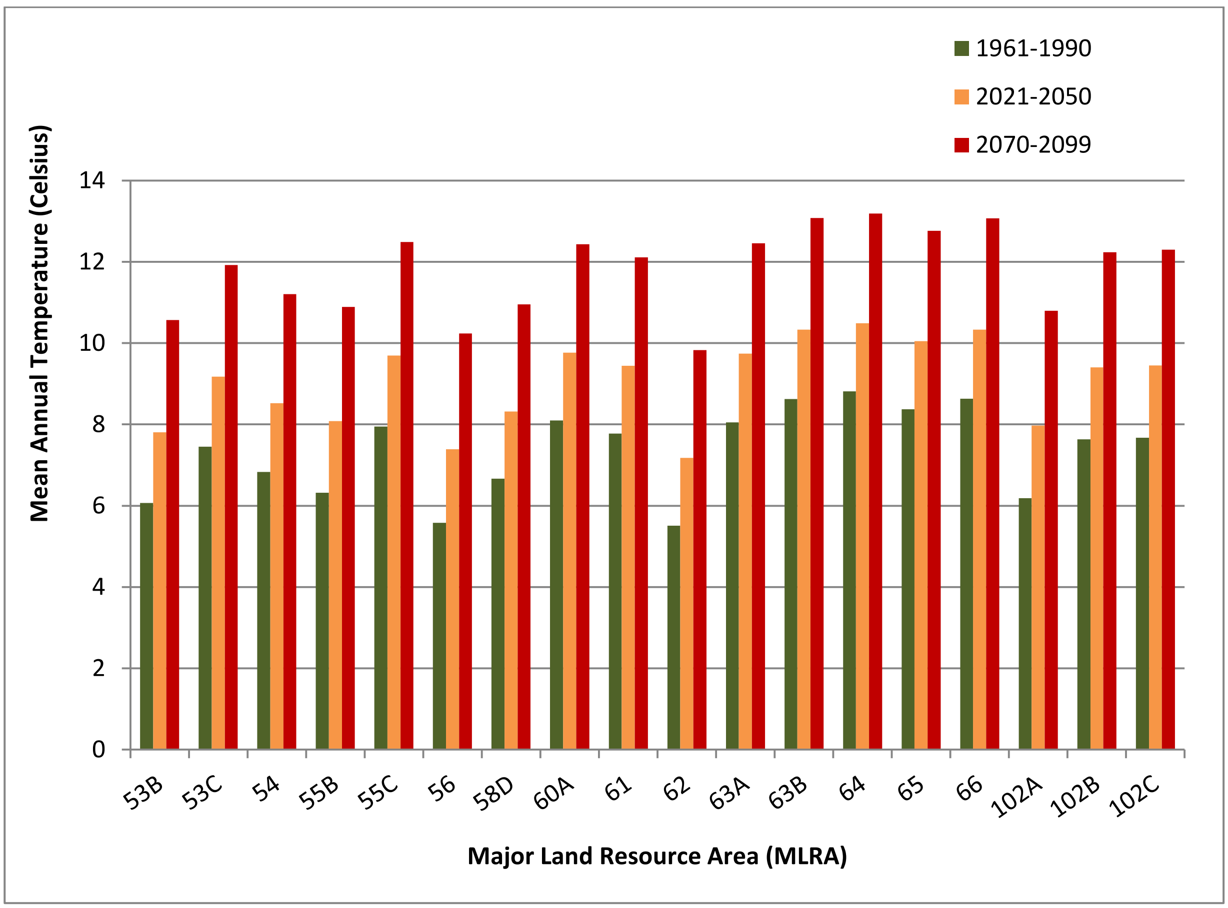

Figure 5-2. Predicted climate change values for mean annual temperatures by Major Land Resource Area relative to recent conditions.

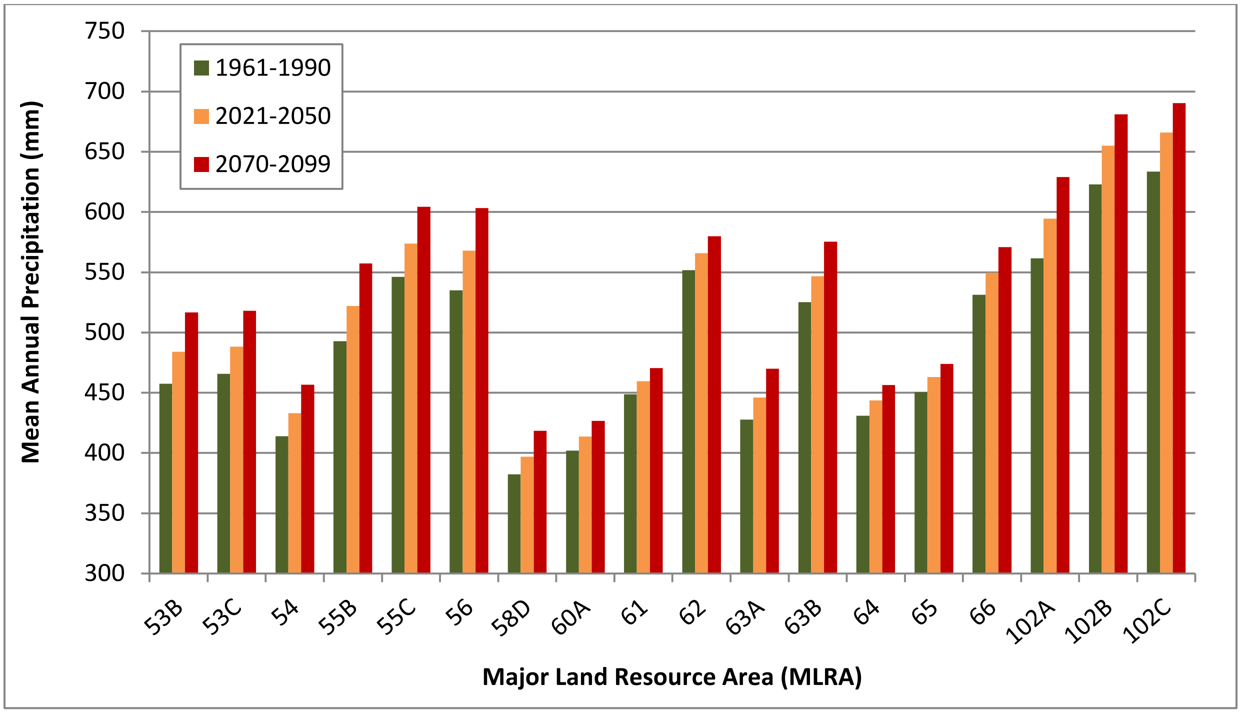

Figure 5-3. Predicted climate change values for mean annual precipitation by Major Land Resource Area relative to recent conditions.

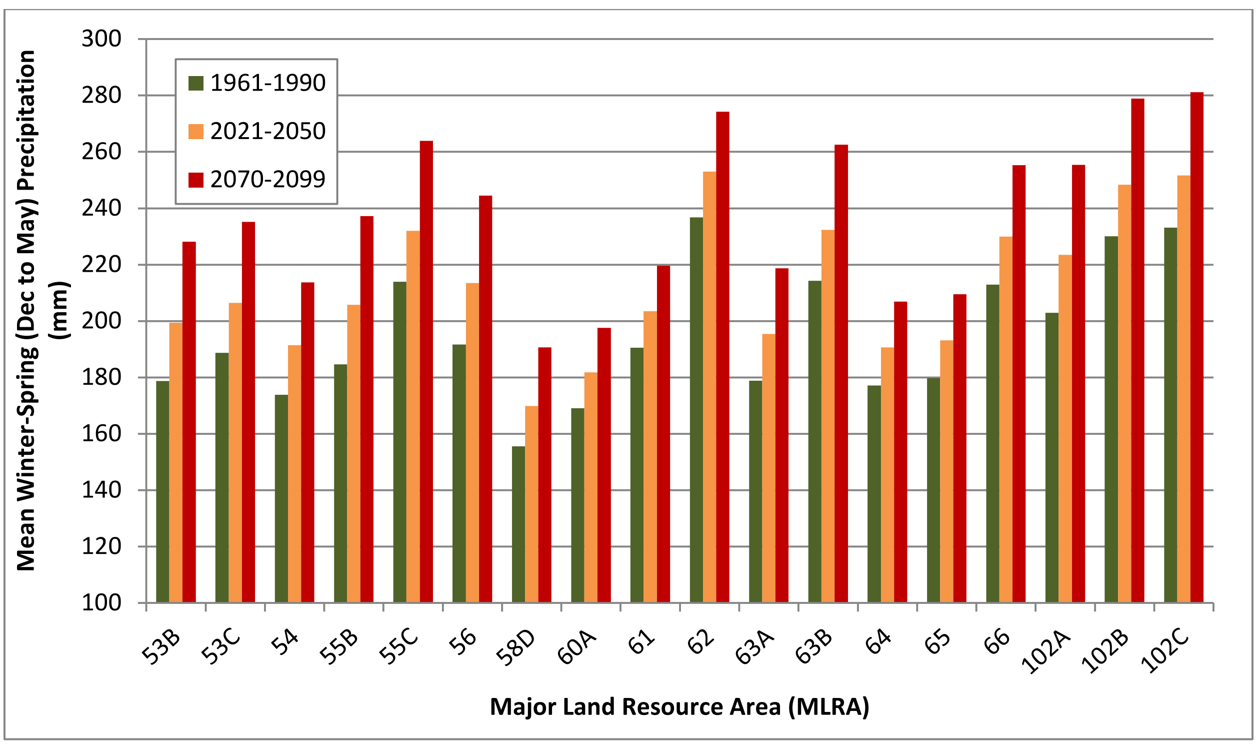

Figure 5-4. Predicted climate change values for mean winter and spring precipitation by Major Land Resource Area relative to recent conditions.

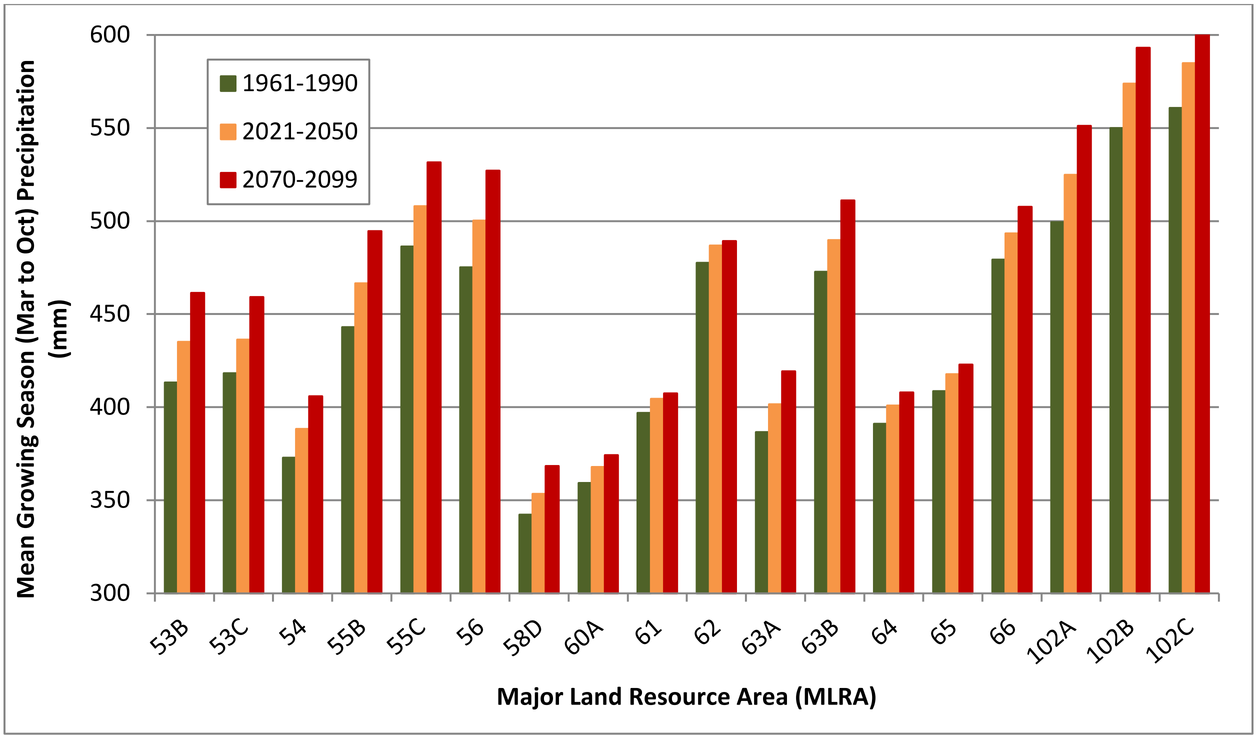

Figure 5-5. Predicted climate change values for mean growing season precipitation by Major Land Resource Area relative to recent conditions.

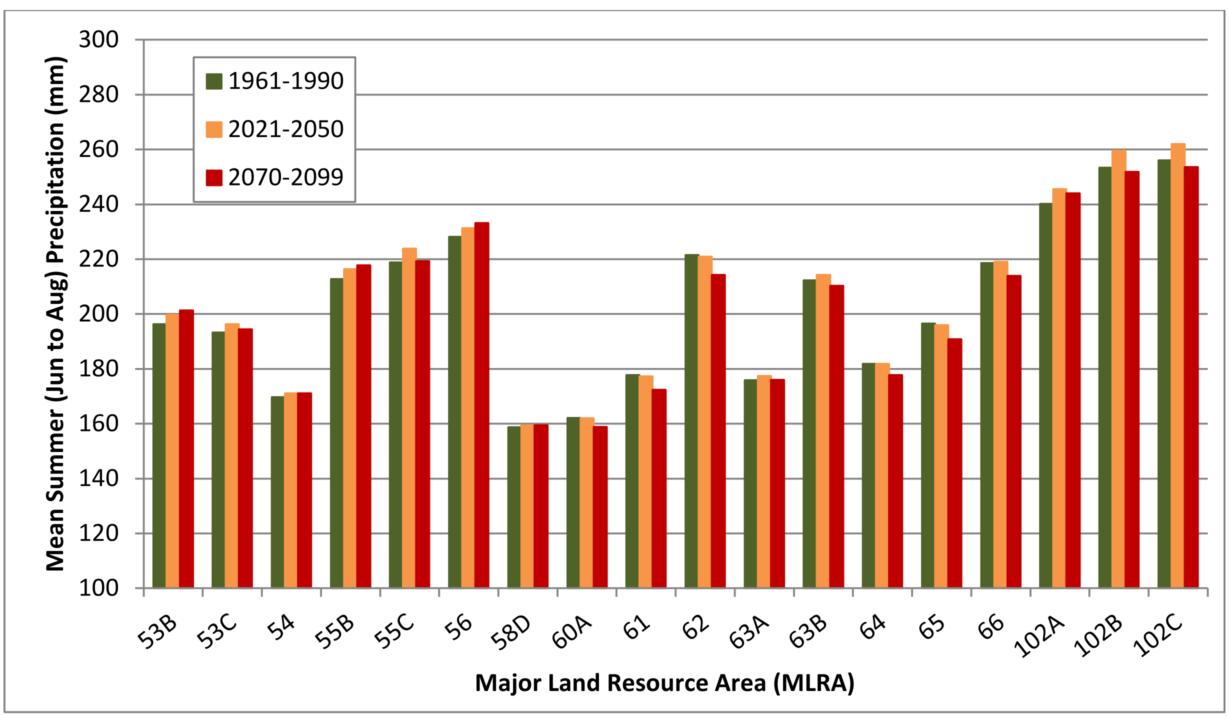

Figure 5-6. Predicted climate change values for mean summer precipitation by Major Land Resource Area relative to recent conditions.

C_3 grass species are also frequently referred to as cool season grasses and C_4 species are referred to as warm season grasses. Both cool and warm season grasses occur in South Dakota in what is often referred to as a mixedgrass condition. Today, the distribution of cool season to warm season grasses occurs within a general gradient within the state with cool season grasses increasing from south to north and warm season grasses increasing from north to south (Sage et al. 1999). Put more simply, warm season grasses generally occur in warmer locations and cool season grasses generally at cooler locations. In addition, the physical characteristics of each functional type also vary on a general gradient within the state with the warm season grasses appearing taller than the cool season grasses in the eastern portion of the state but then appearing shorter than the cool season grasses as they move westward across the state. Table 5-2 presents another view of these results by presenting the actual change in annual and seasonal temperature and precipitation values when comparing present day conditions to the projected 2070 to 2099 period.

As the balance between C_3 and C_4 dominance within a plant community is believed to be responsive to climate change, this is often the focus of discussions aiming to predict future climate change conditions in the Great Plains (Collatz et al. 1998, Hattersley 1983, von Fischer et al. 2008). In general, there are three primary consequences of climate change on plant communities, elevated levels of CO_2 in the atmosphere and changes in average temperatures and precipitation. Elevated CO_2 improves photosynthesis in C_4 plants but also leads to higher productivity in C_3 plants. However, increasing temperatures generally decrease productivity of C_3 plants, potentially counteracting the advantages of elevated CO_2 levels. Precipitation, depending on when it occurs, can have positive effects on productivity levels for both C_3 and C_4 species.

Table 5-2. Results of change in annual and seasonal temperature and precipitation values when comparing recent conditions to the projected 2070 to 2099 period.

MLRA	Mean Temperature (°C)				Mean Precipitation (mm)							
	ANNUAL		JULY		ANNUAL		SPRING[a]		GROW SEASON[b]		SUMMER[c]	
	1961-1990	2070-2099	1961-1990	2070-2099	1961-1990	2070-2099	1961-1990	2070-2099	1961-1990	2070-2099	1961-1990	2070-2099
53B	6.1	10.6	22.2	27.4	457.4	516.7	149.0	191.2	413.4	461.4	196.3	201.4
53C	7.5	11.9	23.5	28.7	465.7	517.9	155.9	194.5	418.3	459.2	193.3	194.4
54	6.8	11.2	22.5	27.7	414	456.7	144.6	177.3	372.9	405.9	169.7	171.1
55B	6.3	10.9	22.6	27.7	492.8	557.3	150.8	194.9	443.0	494.6	212.8	217.8
55C	8	12.5	23.8	29	546.1	604.4	174.9	216.2	486.3	531.6	218.8	219.3
56	5.6	10.2	22	27.1	535.1	603.2	151.8	194.0	475.2	527.2	228.2	233.1
58D	6.7	11	21.7	27	382.4	418.6	127.1	154.1	342.3	368.5	158.8	159.5
60A	8.1	12.4	23	28.3	402.1	426.6	139.1	159.8	359.3	374.2	162.1	158.9
61	7.8	12.1	21.9	27.3	448.7	470.5	154.6	174.2	397.0	407.4	177.8	172.4
62	5.5	9.8	18.6	24	551.9	579.9	182.6	206.0	477.7	489.3	221.6	214.3
63A	8	12.5	23.8	29.1	427.7	469.9	150.0	182.9	386.6	419.4	175.9	176.0
63B	8.6	13.1	24.2	29.5	525.2	575.3	178.5	218.2	472.8	511.0	212.3	210.4
64	8.8	13.2	23.7	29	431	456.3	149.6	172.6	391.2	407.9	181.9	177.8
65	8.4	12.8	23	28.3	450.7	473.9	150.9	173.5	408.7	423.0	196.5	190.8
66	8.6	13.1	23.6	28.9	531.3	570.8	178.4	212.6	479.4	507.6	218.6	214.0
102A	6.2	10.8	22.2	27.4	561.6	628.9	162.5	205.1	499.4	551.2	240.2	244.1
102B	7.6	12.2	23.3	28.6	623	681	183.7	223.0	550.0	593.1	253.4	251.9
102C	7.7	12.3	23.3	28.6	633.6	690.3	187.3	226.0	560.8	602.7	256.1	253.6

[a] December to May

[b] March to October

[c] June to August

Morgan et al. (2008) described the expected effects of climate change on North America and the Great Plains:

> *"Along with rising global temperatures, predictions are for more frequent and longer-lasting heat waves, higher atmospheric humidity, more intense storms, and fewer and less severe cold periods. Warming in North America is expected to be greater than for the overall planet. Precipitation will tend to increase in Canada and the northeastern United States, and decrease in the southwestern United States. Seasonality of precipitation is also predicted to change, with relatively more precipitation falling in winter and less in summer. The desiccating effect of higher temperatures is expected to more than offset the benefit of higher precipitation, resulting in lower soil water content and increased drought throughout most of the Great Plains."*

Review of the downscaled climate change data indicates that over the next 80 years precipitation will be greater in the winter for most MLRAs in South Dakota, variable but slightly reduced during the growing season especially summer, and temperatures will increase fairly significantly. The combination of higher temperatures during the growing season coupled with slightly decreasing precipitation will mean that available moisture for plants is likely to be reduced. An additional confounding effect is that weather events are expected to be more extreme (Ojima and Lackett 2002) including heavier but shorter rain storms and prolonged drought. All of these will add stressors to plant communities that make accurate projections of changes in plant compositions and structures difficult.

While some believe the ability to predict how climate change will impact plant community compositions is limited (Morgan et al. 2008), other researchers have been evaluating variables that may be used to help predict how change may occur. Common variables which have been and continue to be evaluated are the use of temperature and precipitation to predict the future balance of C_3 to C_4 plant communities in the Great Plains. Some researchers believe temperature plays a major role in determining the C_3/ C_4 balance of grasslands (Ehleringer 1978, Epstein et al. 1997). As an example, von Fischer et al. (2008) analyzed the soil organic matter (SOM) and fine roots from 55 native grassland sites widely distributed across the US and Canadian Great Plains to examine possible indicators of the relative production of C_3 vs. C_4 plants at the continental scale. They observed the following:

> *"Our results reveal that not all climate indices are equally strong predictors of %C_4. In particular, the results…. indicate that %C_4 in the North American Great Plains grasslands are especially sensitive to the climate in July, suggesting that the outcome of competition between C_3 and C_4 plants was particularly sensitive to climate during this narrow window of time. Mixed C_3 and C_4 systems persist in Great Plains grasslands where July average temperature is 70.7 $\pm$ 5.6 ^{O}F; systems* are *C_3 dominated (<33% C_4) below this range and C_4 dominated (>66% C_4) above it."*

Figure 5-7 identifies the recent and predicted average July temperatures by MLRA in South Dakota under climate change. Using von Fischer et al.'s (2008) range for C_3 vs. C_4 dominance, we see that presently nearly all MLRAs are within the mixed C_3 and C_4 ranges identified by 65.1 to 76.3 ^{O}F. This is consistent with the fact that South Dakota is presently considered primarily a mixedgrass C_3/C_4 condition.

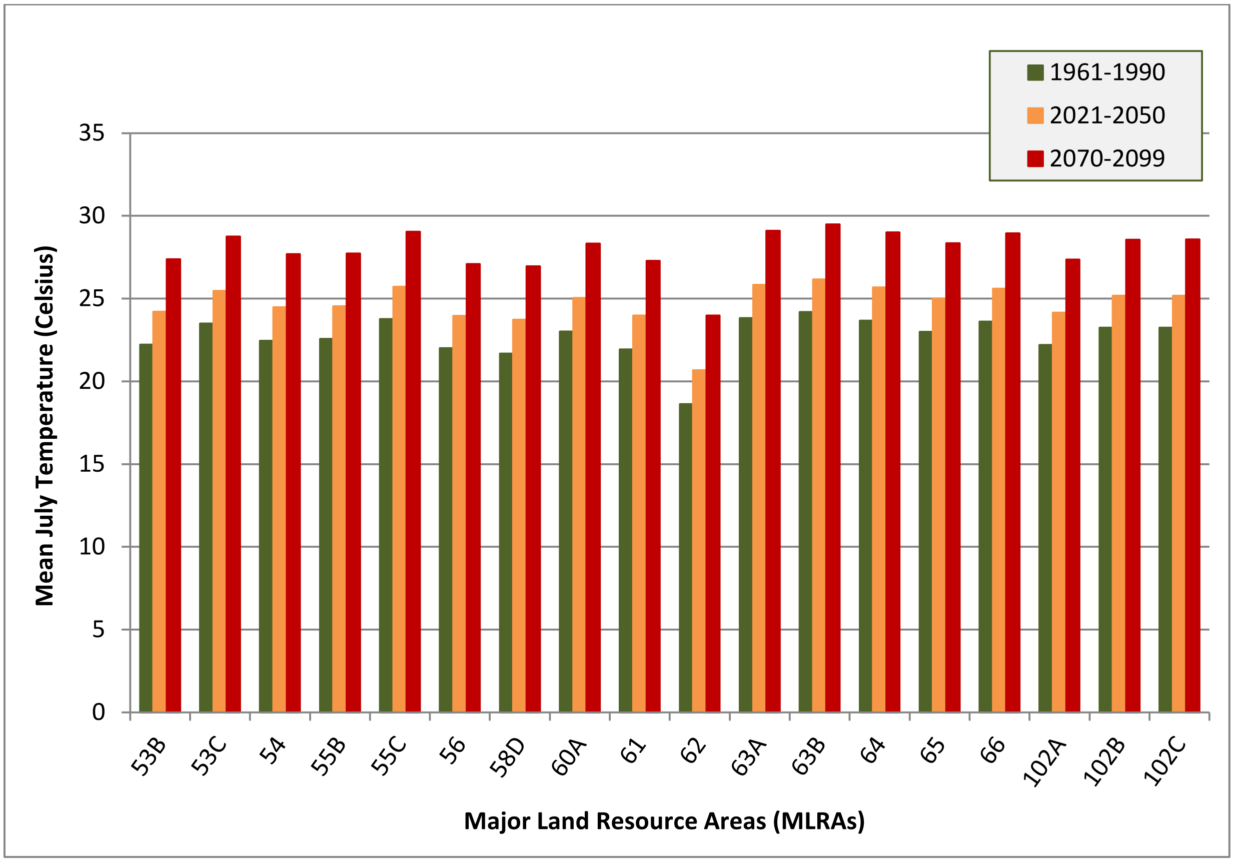

Figure 5-7. Predicted climate change values for average July temperatures by Major Land Resource Area relative to recent conditions.

However, predicted climate change models indicate that all but one MLRA will move above the 76.3 ^{O}F (24.6 ^{O}C) upper bounds by 2099. Although precipitation appears to play a secondary role in determining competitive advantage, C_4 grasses are also able to use the reduced summer moisture resources more effectively than C_3 species, indicating that C_4 species will likely become more dominant under the von Fischer et al. (2008) model.

Where available, information was compiled from ecological site descriptions on plant communities for each ecological site within each MLRA as described in Section 3.4. This information provides the basis for identifying desired restoration conditions for each ecological site. Given the above discussion of possible effects of climate shifts on plant community species composition, it would seem prudent to be aware of these possible impacts so we can evaluate whether to plan for including species that will be supportable in the future, while maintaining similar function and habitat structures for wildlife species.

The goal of the SDWAP for terrestrial ecosystems is to maintain and restore large blocks of native vegetation in appropriate locations throughout the state. Ecological sites provide the basis for identifying desired reference plant communities, and climate change analysis can suggest shifts in conditions to provide for sustainable plant communities in the future. Some SGCN will be able to use these adjusted conditions, as efforts should be made to maintain similar structures to their current reference communities even with a shift in species compositions. Other SGCN may be fully dependent on the specific C_3 plant compositions, and these species may not be able to persist in their current locations. However, if similar shifts in restoration practices are followed in neighboring states or provinces, then these species may be able to use new areas representing favorable plant communities where they will occur in the future under climate change.

5.2 Riparian-Wetland Systems

Direct Conversion of Native Ecosystems

Using the same methods described for evaluating direct conversion of terrestrial systems in South Dakota, estimates of direct conversion of riparian and wetland systems were also developed. Statewide, direct conversion of riparian and wetland ecosystems is estimated at 43% or 3,157,642 acres due to agriculture and 3% or 236,598 acres due to urban development. Acres that have not been converted to another land use and represent native or altered conditions are estimated at 54% or 3,990,211 acres. Figure 5-8 further presents these estimates for each of the 18 MLRAs in South Dakota. Similar to the results observed for terrestrial systems, more direct conversion of riparian and wetland ecosystems has occurred in the eastern half of the state where crop-based agriculture is more prevalent. Depressional wetlands in particular were historically a common feature in eastern South Dakota. For many years, these wetlands were drained, filled, and plowed to increase the amount of farmable acreage. Riparian and wetland areas adjacent to agricultural fields were often degraded by agricultural runoff and sedimentation. In recent years, the Wetland Reserve Program and Swampbuster provisions of the Farm Bill have helped to reduce the rate of conversion and some of the impacts from adjacent runoff. Excavation, to increase water storage capacity for livestock and irrigation purposes, can also change the hydrology and vegetation communities.

The methods used in the direct conversion assessment for riparian and wetland ecosystems do not provide the ability to quantify the impacts of water control structures such as dams on riverine systems in South Dakota. Water control structures, in many instances, have had the effect of converting flowing water to non-flowing water systems on some of the larger rivers and streams, while also inundating the adjacent riparian ecosystems. For example, many of the historical riparian and wetland ecosystems of the Missouri River system have been inundated and lost to the series of dams and large reservoirs present today. The river has also been impacted by channelization and maintenance dredging activities, as well as construction of impoundments by private interests and government agencies that have isolated the river from its historical floodplain. Water impoundment and channelization activities have led to a:

- 98% reduction in the number of islands and sandbars,
- elimination of riparian forests and stream channels in areas of flooded reservoirs,
- reduction in channel diversity through the loss of side channels, backwater sloughs, and meandering,

- change in shoreline substrate in some areas from a dominance of silt, sand, and wood to rock riprap (rock and concrete),
- decline in suspended sediment causing channels to deepen and banks to erode, and drainage of remnant backwaters downstream from dams, and
- modification to the natural flow regime - eliminating the periodic flood pulse thereby substantially changing the annual hydrograph, sediment loads, temperature regime, and nutrient budgets.

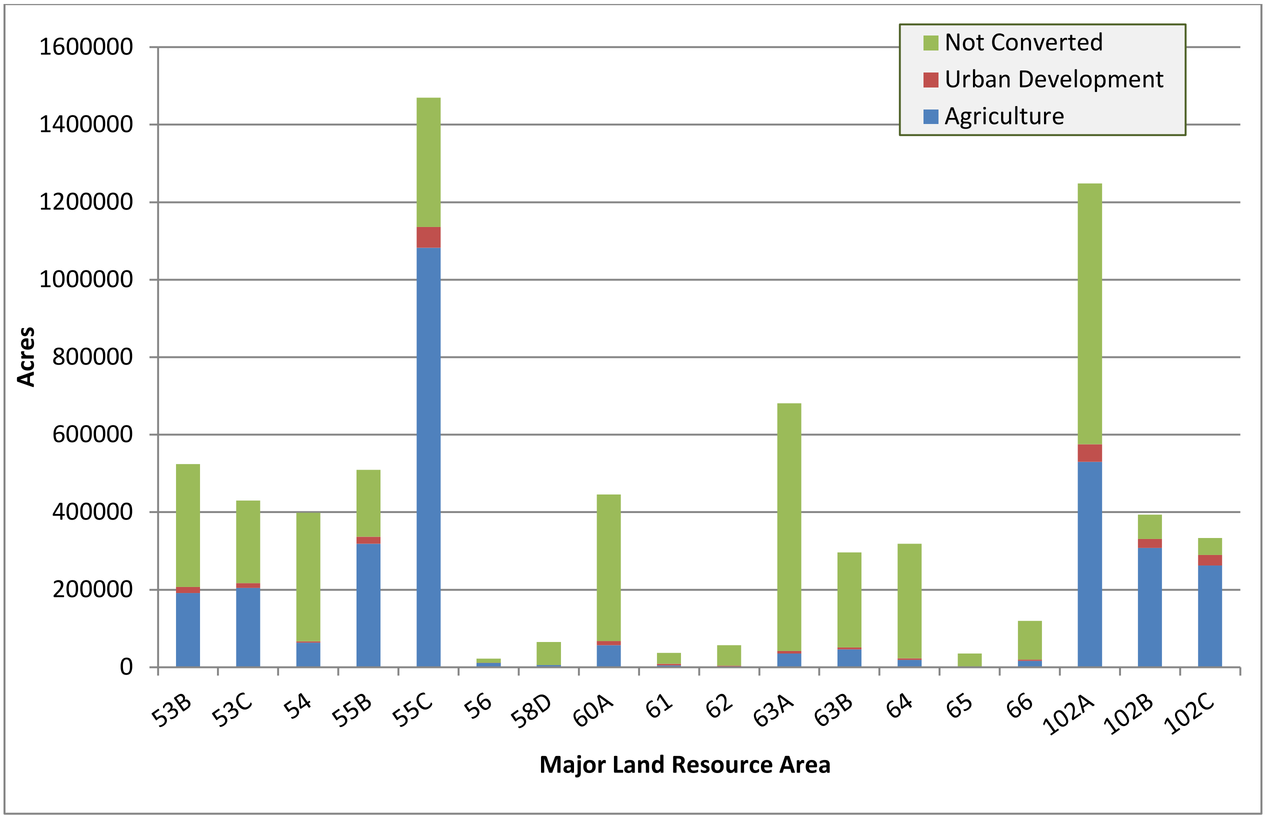

Figure 5-8. Amount of direct conversion of native riparian and wetland ecosystems resulting from agriculture and urban development by Major Land Resource Area. The "not converted" category may include native or altered ecosystem conditions.

Table 5-3 presents the level of direct conversion that has occurred on each riparian and wetland ecological site within each MLRA. The table is further color coded to more easily identify those ecological sites that have received >=60% conversion (reddish shading), >=30% to 59% (yellow shading), and <30% (green shading). Again, the most heavily converted sites are those that also currently present the best conditions for agricultural productivity, particularly those MLRAs located in eastern South Dakota.

Alteration of Native Ecosystems

As with terrestrial systems, the ability to quantify the cumulative effects of indirect alteration on today's riparian and wetland ecosystem diversity is currently not possible with existing information and data. While information on ecological sites has been developed and mapped for this effort, information on disturbance states is currently not available. As better information on the effects of natural disturbance processes on native ecosystem diversity is developed and better satellite imagery and processing methods become available, future SDWAP updates may be able to better assess cumulative impacts relative to indirect alteration of riparian and wetland systems. In the absence of this information, indirect alteration is discussed more generally in terms of the conservation challenges it presents to maintaining South Dakota's native riparian and wetland ecosystem diversity.

Natural Disturbance Processes

Similar to the discussion of impacts to terrestrial ecosystems, the suppression or alteration of natural disturbance processes in South Dakota has reduced the heterogeneity of riparian and wetland ecosystems. Dams have been placed on some streams to provide livestock water, control flooding and store water for irrigation, and other human uses. Water management programs reduce the effects of flood events and thereby prevent many flood adapted plant species from regenerating. The result is more homogenous riparian and wetland ecosystems. Channelization and water diversion projects can impact the extent, species composition, and structure of the remaining ecosystems. Cottonwood reproduction has been significantly impacted due to a river's inability to flood its banks, as well as meander and create new land for cottonwoods to colonize. Those remaining cottonwood stands, historically the most abundant and ecologically important species on the floodplain, are maturing and new groves are not appearing to replace them. In addition, the loss of the river - floodplain connection has reduced the amount of shallow water riparian and wetland ecosystems remaining that supports emergent and shrub plant communities that, in turn, support many wildlife species.

Off-stream water impounding and diversion for stock ponds and urban areas have also led to changes in levels and timing of in-stream flows. Reduced in-stream flow impacts the function and integrity of vegetation communities as well as the size and extent of the riparian zone adjacent to streams and drainages. The cumulative effects of thousands of small impoundments (such as stock dams) in arid environments are poorly understood but may be having major impacts on the hydrologic regime of thousands of miles of small, intermittent prairie streams (Sauer and Masch 1969). Potential groundwater recharge into an aquifer is expected to occur primarily in intermittent alluvial stream channels. Therefore, reducing the amount of water that enters a downstream alluvial channel implies a loss of potential groundwater recharge. Further, the introduction of nonnative fish/aquatic species to these stock ponds can also negatively impact native species in the event of a dam blow-out or overflow that enables stock pond waters to enter streams and rivers during heavy precipitation events.

A review of National Wetland Inventory data indicates beaver ponds are relatively rare in the landscape today. Although beaver numbers have been increasing in recent years, beaver populations and their impoundments have been reduced on perennial systems from historical levels resulting in the loss of associated pond habitat for many plant and animal species, and a reduction in the amount of surrounding vegetation influenced by a higher water table. For some MLRAs, particularly those in eastern South Dakota, grazing by herbivores is no longer as common as it was historically, further reducing the diversity of plant species and structures within riparian and wetland communities. Where cattle grazing occurs today, land use objectives frequently utilize a season-long moderate grazing level that also contributes to reducing the diversity of species and structures within riparian and wetland ecosystems when compared to historical conditions (Fuhlendorf and Engle 2001). Bison grazing is known to have historically caused streambank erosion where herds congregated near water but they were typically migratory, so it is believed that revegetation occurred periodically. Today's cattle herds are often re-grazing the same pastures over and over again often contributing to continuous or frequently recurring streambank erosion in riparian and wetland areas, so the long-term impact to water quality is expected to be greater. In addition to groundwater pumping and water diversion projects, fire suppression efforts have increased the adjacent woodland areas, or in the case of the Black Hills region, increased tree densities of surrounding forests, resulting in a reduction to in-stream flows. Consequently, the water available to adjacent riparian vegetation has been reduced and the width of the riparian zone has decreased in response to reduced soil moisture.

Nonnative species

The accidental or intentional introduction of invasive nonnative species has had a major impact on native riparian and wetland ecosystems in South Dakota. Nonnative invasive plant species are a cause for concern in all South Dakota ecoregions and across all ecosystem types. They are of particular concern to maintaining the ecological integrity of native ecosystems. Nonnative invasive species will often reduce the overall biodiversity of a vegetative community by displacing native species and altering the normal ecological processes (e.g., nutrient and water cycles) that occur there. Where heavy infestation/populations of nonnative invasive plants occur, many of the habitat values of that ecosystem will be altered to conditions no longer favorable to native wildlife. For example, European common reed and purple loosestrife have invaded thousands of acres of previously native ecosystems (Deneke et al. 2010).

Table 5-3. Percent direct conversion (both agriculture and urban development) for each riparian and wetland ecological site and Major Land Resource Area in South Dakota. Reddish shade highlights those sites where direct conversion of native ecosystems is >=60%, yellow highlights those sites where native ecosystem loss is >= 30% and <60%; and green highlights those sites where native ecosystem loss is <30%.

Ecological Site	53B	53C	54	55B	55C	56	58D	60A	61	62	63A	63B	64	65	66	102A	102B	102C
DEPRESSION																		
EPHEMERAL	53.4%	75.7%	49.4%	96.0%	95.7%		9.2%	26.1%	11.6%	<1%	57.9%		28.0%	11.1%	68.1%	85.1%	95.3%	97.4%
TEMPORARY	58.9%	63.4%	35.7%	91.9%	92.6%	98.0%	3.8%	23.4%	32.4%	6.2%	44.0%	40.7%	30.1%	<1%	46.4%	83.3%	97.6%	96.6%
SEASONAL	37.6%	45.8%	31.4%	79.0%	81.8%	92.0%	4.5%	21.4%	5.4%	9.4%	30.3%	37.3%	51.7%	<1%	35.9%	54.7%	91.4%	88.2%
SEMI-PERMANENT	29.5%	45.4%	40.7%	67.7%	75.5%	91.4%	7.0%	8.0%	6.7%	5.6%	19.9%	21.0%	14.8%	<1%	17.5%	25.5%	72.8%	70.6%
PERMANENT	15.1%	70.6%	8.3%	61.3%	67.4%	100.0%	1.7%	6.0%	7.2%	<1%	7.1%	7.4%	2.4%	<1%	3.6%	12.7%	57.6%	57.0%
INTERMITTENT	14.9%	60.5%	<1%	44.6%	75.1%	74.1%				<1%	3.6%	13.7%		<1%		48.7%	34.1%	48.3%
LACUSTRINE																		
EPHEMERAL					<1%							<1%					<1%	
TEMPORARY	25.0%	<1%	37.5%	100.0%	6.7%		<1%	37.9%			<1%			<1%	<1%		45.0%	100.0%
SEASONAL	50.0%	16.7%	2.4%	<1%	46.8%		<1%	20.1%			9.1%	<1%						
SEMI-PERMANENT	8.2%	11.7%	24.6%	70.5%	26.6%		<1%	<1%			<1%	6.7%	<1%	<1%	<1%	3.6%	24.8%	
PERMANENT	6.9%	10.4%	6.6%	7.7%	13.1%	<1%	<1%	1.8%	3.6%	1.4%	<1%	1.3%	1.8%	<1%	4.6%	7.6%	13.5%	13.9%
RIVERINE																		
INTERMITTENT	52.5%	40.4%	15.2%	68.8%	78.6%	49.6%	5.4%	11.9%	21.9%	6.8%	7.3%	34.7%	5.1%	<1%	12.8%	55.8%	84.7%	93.3%
PERMANENT	39.7%	51.3%	14.4%	33.1%	54.3%		11.9%	20.1%	33.0%	31.5%	7.2%	21.6%	5.3%	2.9%	11.1%	73.3%	90.4%	83.6%

Climate Change

As with terrestrial ecosystems, understanding how riparian and wetland ecosystems will respond to climate change is important to evaluating the potential effects on fish and wildlife habitat. To evaluate the potential effects of climate change on riparian and wetland ecosystems in South Dakota, the Downscaled Global Climate Model (DGCM) datasets and results (Cochrane and Moran 2011 – Appendix N) – see Figures 5-2 through 5-6 for summary charts of temperature and precipitation by MLRA – were again used for this evaluation. Further, existing literature was reviewed for its applicability to the DGCM results and is summarized as follows.

Several studies have investigated the significance of temperature increases on wetlands, with the following findings:

- An increase in spring precipitation and snowmelt runoff amounting to 10% of the total growing season precipitation was the only condition that compensated for increased water loss from evapotranspiration due to a 2°C temperature increase. (Poiani et al. 1995)
- "It is apparent from this simulation that a 20% increase in precipitation would generally compensate for a 3°C rise in temperature if applied uniformly" (Johnson et al. 2005), which is consistent with the findings of Johnson et al. (2010) "simulations showed that all three permanence types of wetlands lost significant hydroperiod under both 2°C and 4°C warming scenarios, unless accompanied by a minimum increase in precipitation of 5% to 7% per degree of warming."

When these relationships are graphed in comparison to the projected climate conditions, in terms of both temperatures and precipitation amounts across MLRAs in South Dakota, overall effects on wetlands can be evaluated. Figure 5-9 shows the relationship of wetlands based on the projected downscaled climate conditions for MLRAs from this report compared to a 2°C rise in temperature and a 10% increase in spring precipitation (Poiani et al. 1995), while Figure 5-10 shows a comparison to a 3°C increase in temperature with a 20% increase in precipitation (Johnson et al. 2010).

Understanding the influence of the HGM class on riparian and wetland ecosystems within South Dakota is critical to understanding some of the potential impacts of climate change. Results of the DGCM evaluation indicate precipitation levels across South Dakota will be higher overall, particularly during winter and spring, but slightly lower than or similar to present levels for most MLRAs during the summer months. A pattern of slightly greater precipitation increases in the eastern part of the state and smaller increases in the western portions is expected. This, coupled with much higher temperatures during the growing season, will lead to higher levels of evaporation/evapotranspiration occurring during the summer months. What this will mean for South Dakota riparian-wetland ecosystems within each MLRA will likely vary depending on the HGM class and hydrology sub-class. The increase in winter-spring precipitation levels should result in more runoff to riparian-wetland ecosystems. For those wetlands such as depressional-ephemeral, temporary, and seasonal, whose hydroperiods primarily span the spring or early summer time-frames, the increased winter-spring precipitation could result in additional

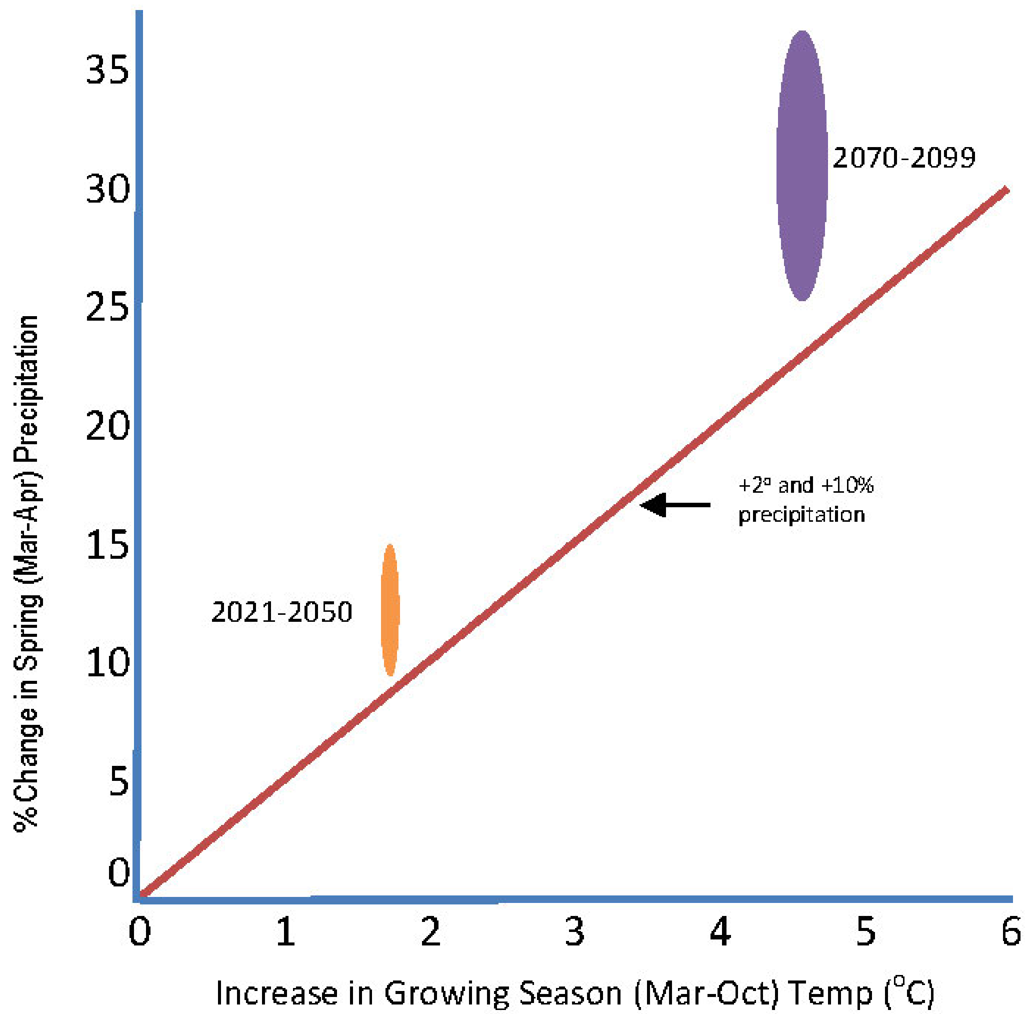

Figure 5-9. Comparison of projected climate change for the range of conditions projected for 2021-2050 and 2070-2099 from the downscaled climate change analysis of this report compared to the findings that a 10% increase in spring precipitation is needed to offset effects on wetlands of a 2°C increase in temperature reported by Poiana et al. (1995).

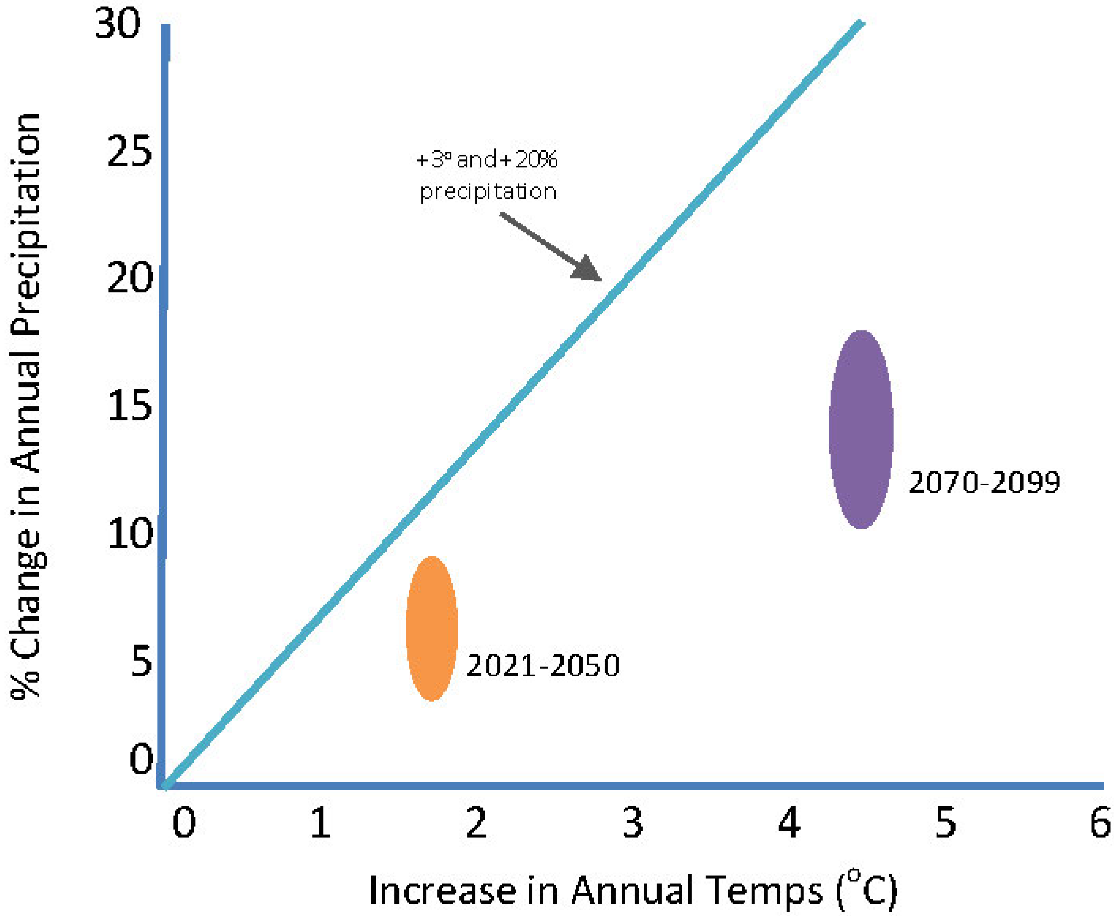

Figure 5-10. Comparison of projected climate change for the range of conditions projected in 2021-2050 and 2070-2099 from the downscaled climate change analysis of this report compared to the findings that a 20% increase in overall precipitation is needed to offset effects on wetlands of a 3°C increase in temperature reported by Johnson et al. (2005), and similar to the relationship reported by Johnson et al. (2010).

water inputs to those basins that have the capability to capture and hold additional water, possibly even pushing a basin into the next hydrology sub-class of greater size and depth. Wetlands that have terrain features that allow for greater water capture would fall into this category. For those wetlands that do not have terrain features that would allow capture of the additional winter-spring water, the effects are likely to be an increased rate of drying as the increased evaporation rates are expected to occur mid- to late summer with the increasing temperatures (Johnson et al. 2010). For those wetlands with hydroperiods that span the full summer, such as depressional semi-permanent and permanent, higher temperatures and similar or reduced precipitation in the summer may result in more rapid rates of evaporation and a shortening of the overall hydroperiod for these sub-classes (Johnson et al. 2010) unless they are able to capture the increased winter-spring precipitation.

Depressional basins receiving groundwater inputs may benefit from the increased winter-spring precipitation rates especially during periods of drought. Likewise, riparian-wetland ecosystems that are associated with the riverine and lacustrine HGM class will potentially have additional surface and sub-surface water inputs from increased winter-spring precipitation that may ameliorate the increased evaporative rate during the summer months and moderate the effects of drought on surface wetlands.

These findings are generally consistent with modeling results of Johnson et al. (2010). They found reduced hydroperiods for temporary and seasonal wetlands, and a reduction in functional semipermanent wetlands in much of the Prairie Pothole Region under a potential 4^{o} C rise in temperature. When combined with a 10% increase in precipitation, there was a shift in location of functional wetlands. In their modeling, they did not analyze the different projected amounts of precipitation increases across MLRAs. If the projections of greater increases in precipitation amounts in MLRAs in the eastern part of South Dakota prove to be correct, the impact on wetlands in the western part of the state is likely to be even more pronounced (similar to the 4^{o} C rise in temperature without the 10% increase in precipitation as modeled by Johnson et al. 2010), while changes to wetlands in the eastern part of South Dakota may be similar to the predictions of Johnson et al. (2010).

Thus, projected increases in temperatures coupled with the projected increases and decreases in seasonal precipitation amounts are likely to have substantial effects on wetlands in South Dakota. Negative effects to biodiversity and waterfowl productivity are likely in the western part of South Dakota. Effects in the eastern part of the state are likely to be ameliorated by increases in precipitation amounts particularly in the spring (Poiani et al. 1995), but only in those wetland complexes that are able to capture and hold this additional precipitation and runoff. More rapid evaporation during the summer will shorten the hydroperiod of wetlands not able to capture the additional precipitation or that are not fed from groundwater or riparian sources, reducing the productivity and functionality of these wetlands. Protecting and restoring wetlands in the eastern part of the state, particularly in locations that can capture and hold additional spring precipitation, are important conservation activities to help address projected climate change effects.

5.3 Species-level Conservation Challenges

There are two primary challenges associated with the persistence of species in South Dakota: 1) the loss or degradation of habitat resulting from impacts to native ecosystem diversity, and 2) non-habitat related impacts. Conservation actions are needed to address the many conservation challenges facing South Dakota's biodiversity. To facilitate this discussion, conservation challenges and actions will be discussed relative to the categories of habitat related or non-habitat related.

Habitat Related

For terrestrial and riparian/wetland habitat dependent SGCN, habitat-based conservation challenges were described earlier in this section, and habitat-based conservation challenges for aquatic SGCN will be described later in this section.

For the SDWAP, a goal for representation will be identified as maintaining more than or restoring at least 10% of the primary historical ecosystems for each ecological site within each of South Dakota's ecoregions (MLRAs). By providing a minimum of 10% of the historical/native ecosystem diversity across South Dakota's ecoregions as described in Chapter 3, habitat conditions for the majority of SGCN dependent on terrestrial or riparian-wetland systems will be improved. Habitat conditions for SGCN dependent on aquatic systems will benefit from the conservation actions identified for aquatic GAP strategy. Although 10% is not necessarily a recommended level of representation, it has often been used as a conservation goal under various national and international programs. Empirical studies of ecosystem loss and resulting effect on species viability reveal that at very high levels of loss (>95%), loss of species is likely. A level of 10 – 12% representation is consistent with several recommendations. The initial goal of 10% representation will require on-going evaluation and monitoring to determine its effectiveness in conserving South Dakota's biological diversity."

Table 5-4 identifies those SGCN that are expected to benefit from the native ecosystem diversity strategy for terrestrial systems and that will benefit from the aquatic GAP strategy. Although aquatic COAs were developed using location data for SGCN that were aquatic insects, freshwater mussels, and fishes, it is assumed that additional species tied to aquatic habitats will also benefit from this approach. Two species, the peregrine falcon and the black-footed ferret, are not included in this table. Peregrine falcons are not considered habitat limited but rather limited by human impacts such as pesticides in the environment. Black-footed ferrets are considered dependent on prairie dog colonies for their habitat. Restoration goals relative to prairie dog colonies are not a component of the SDWAP but are addressed through a separate South Dakota Black-tailed Prairie Dog Conservation and Management Plan (Cooper and Gabriel 2005).

Several SGCN are on the fringe of their historical range in South Dakota. The habitat needs of these species should be provided through ecosystem representation, but providing sufficient habitat to assure population viability within South Dakota alone may be problematic for these species. Providing sufficient habitat to ensure habitat viability for a species on the fringe of its range may actually be counterproductive to native species at the core of their range and may conflict with the conservation goals for native ecosystem diversity. Intensive habitat management programs to increase a relatively rare species on the fringe of its range may meet with marginal success and use limited, valuable resources in the process. To address these species needs, South Dakota will monitor the progress of adjacent states more centrally located to a species' historical range, in their recovery efforts, to determine the appropriate level of participation by South Dakota.

Table 5-4. South Dakota species of greatest conservation need and their relationship to the native ecosystem diversity strategy and/or the aquatic gap analysis project strategy used in the South Dakota Wildlife Action Plan to improve or maintain habitat for a respective species.

Common Name	Native Ecosystem Diversity Strategy		Aquatic GAP Strategy
	Terrestrial	Riparian-Wetland	
BIRDS			
American Dipper		X	X
American Three-toed Woodpecker	X		
American White Pelican		X	X
Baird's Sparrow	X	X	
Bald Eagle	X	X	X
Black Tern		X	
Black-backed Woodpecker	X		
Burrowing Owl	X		
Chestnut-collared Longspur	X		
Ferruginous Hawk	X		
Greater Prairie-Chicken	X	X	
Greater Sage-Grouse	X	X	
Interior Least Tern		X	
Lark Bunting	X		
Le Conte's Sparrow	X	X	
Lewis's Woodpecker	X		
Long-billed Curlew	X	X	
Marbled Godwit	X	X	
Northern Goshawk	X		
Osprey	X	X	X
Piping Plover		X	
Ruffed Grouse	X	X	
Sprague's Pipit	X		

Table 5-4 (continued). South Dakota species of greatest conservation need and their relationship to the native ecosystem diversity strategy and/or the aquatic gap analysis project strategy used in the South Dakota Wildlife Action Plan to improve or maintain habitat for a respective species.

Common Name	Native Ecosystem Diversity Strategy		Aquatic GAP Strategy
	Terrestrial	Riparian-Wetland	
Trumpeter Swan		X	X
White-winged Junco	X		
Whooping Crane		X	
Willet	X	X	
Wilson's Phalarope	X	X	
GASTROPODS			
Cooper's Rocky Mountainsnail	X	X	
Dakota Vertigo	X		
Frigid Ambersnail	X		
Mystery Vertigo	X		
AMPHIBIANS AND REPTILES			
Black Hills Redbelly Snake	X		
Blanchard's Cricket Frog		X	X
Cope's Gray Treefrog		X	X
Eastern Hognose Snake	X	X	
False Map Turtle		X	X
Lesser Earless Lizard	X	X	
Lined Snake	X		
Many-lined Skink	X		
Sagebrush Lizard	X		
Short-horned Lizard	X		
Smooth Softshell		X	X
Western Box Turtle	X		

Table 5-4 (continued). South Dakota species of greatest conservation need and their relationship to the native ecosystem diversity strategy and/or the aquatic gap analysis project strategy used in the South Dakota Wildlife Action Plan to improve or maintain habitat for a respective species.

Common Name	Native Ecosystem Diversity Strategy		Aquatic GAP Strategy
	Terrestrial	Riparian-Wetland	
MAMMALS			
Black Hills Red Squirrel	X		
Franklin's Ground Squirrel	X		
Fringe-tailed Myotis	X	X	
Northern Flying Squirrel	X	X	
Northern Myotis	X	X	
Northern River Otter		X	X
Richardson's Ground Squirrel	X		
Silver-haired Bat	X	X	
Swift Fox	X		
Townsend's Big-eared Bat	X	X	
TERRESTRIAL INSECTS			
American Burying Beetle	X	X	
Dakota Skipper	X		
Great Plains Tiger Beetle	X		
Indian Creek Tiger Beetle		X	X
Iowa Skipper	X		
Little White Tiger Beetle	X	X	
Northern Sandy Tiger Beetle	X		
Ottoe Skipper	X		
Pahasapa Fritillary	X	X	
Poweshiek Skipperling	X		
Regal Fritillary	X		

Table 5-4 (continued). South Dakota species of greatest conservation need and their relationship to the native ecosystem diversity strategy and/or the aquatic gap analysis project strategy used in the South Dakota Wildlife Action Plan to improve or maintain habitat for a respective species.

Common Name	Native Ecosystem Diversity Strategy		Aquatic GAP Strategy
	Terrestrial	Riparian-Wetland	
AQUATIC INSECTS			
A Mayfly			X
Dakota Stonefly			X
Dot-winged Baskettail			X
Elusive Clubtail – A Dragonfly			X
FRESHWATER MUSSELS			
Creek Heelsplitter			X
Elktoe			X
Hickorynut			X
Higgins Eye			X
Mapleleaf			X
Pimpleback			X
Rock Pocketbook			X
Scaleshell			X
Yellow Sandshell			X
FISHES			
Banded Killifish			X
Blacknose Shiner			X
Blackside Darter			X
Blue Sucker			X
Carmine Shiner			X
Central Mudminnow			X
Finescale Dace			X
Hornyhead Chub			X

Table 5-4 (continued). South Dakota species of greatest conservation need and their relationship to the native ecosystem diversity strategy and/or the aquatic gap analysis project strategy used in the South Dakota Wildlife Action Plan to improve or maintain habitat for a respective species.

Common Name	Native Ecosystem Diversity Strategy		Aquatic GAP Strategy
	Terrestrial	Riparian-Wetland	
FISHES (continued)			
Lake Chub			X
Logperch			X
Longnose Sucker			X
Mountain Sucker			X
Northern Pearl Dace			X
Northern Redbelly Dace			X
Pallid Sturgeon			X
Shovelnose Sturgeon			X
Sicklefin Chub			X
Southern Redbelly Dace			X
Sturgeon Chub			X
Topeka Shiner			X
Trout-perch			X

Climate Change

South Dakota's SGCN will each have different responses to climate change and will require an individual assessment of possible outcomes based on expected changes to native ecosystem diversity. Some species may have a positive response and expand their range in South Dakota in response to climate change. Others may have a neutral response without any realized changes in a species' range and yet other species may have a negative response with a contraction or shift in their range of occurrence in South Dakota. While these changes depend on many variables, the use of the coarse-filter provides the foundation for making an informed prediction of possible outcomes while also providing opportunities to identify possible mitigations that could reduce or minimize overall impacts.

Using the results of the climate change assessment developed for the SDWAP, Table 5-5 provides a summary of the projected effects of climate change on terrestrial and riparian-wetland SGCN for South Dakota. See Table 5-6 for a summary of expected effects of climate change on aquatic SGCN. This information was developed using the projected changes to native ecosystem diversity resulting from climate change predictive models as described earlier in this section. The projected effect is described as positive, neutral, or negative for each species. A reason for the assessment is provided and is dependent on the expected change in habitat conditions for that species within South Dakota. Conservation actions that may help mitigate negative impacts to a species are also presented in this table.

Non-habitat Related - Overview

A number of SGCN have additional, non-habitat related conservation challenges. These non-habitat related conservation challenges have been summarized in each of the SGCN profiles presented in Appendix C. Non-habitat related impacts are typically characterized by direct human-influences on a species normal life cycles, reproduction, or existence. A summary of these challenges is presented later in this section, following challenges to aquatic systems.

Table 5-5. Expected effects of climate change on native ecosystems and habitat of terrestrial and riparian-wetland species of greatest conservation need in South Dakota and suggested mitigation actions where possible impacts are identified.

Common Name	Expected Effects	Reason	Possible Mitigation Actions
American Burying Beetle	Neutral	Soil structure appears to be more important than vegetation structure or composition	Not Needed
American Dipper	Positive	In-stream flows may increase with increased winter/spring precipitation, improving early-mid nesting season habitat quality and quantity	Not Needed
American Three-toed Woodpecker	Positive	Increasing fire frequency and severity will increase habitat, at least for the short-term	Not Needed
American White Pelican	Neutral to negative	Neutral on riverine/lacustrine systems; negative on depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Bald Eagle	Neutral	More closely associated with riverine and lacustrine systems	Not Needed
Baird's Sparrow	Negative	Prefers cool season grass (C3) dominated conditions or mixed-cool/warm (C4) season conditions	Where possible, select for native warm season (C4) grass species that are taller in stature
Black-backed Woodpecker	Positive	Increasing temperatures will lead to increased fire frequency and severity resulting in more habitat for this species, at least for the short-term	Not Needed
Blanchard's Cricket Frog	Neutral to negative	Neutral for riverine/lacustrine systems; negative for depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Black-footed Ferret	Variable	This species is associated with prairie dog and ground squirrel populations, therefore, effect is dependent on applicable rodent species response	See black-tailed prairie dog, Richardson's ground squirrel, and Franklin's ground squirrel for possible actions
Black Hills Redbelly Snake	Negative	Prefers cool season grass (C3) dominated conditions or mixed-cool/warm (C4) season conditions	Where possible, select for native warm season (C4) grass species that are taller in stature

Table 5-5 (continued). Expected effects of climate change on native ecosystems and habitat of terrestrial and riparian-wetland species of greatest conservation need in South Dakota and suggested mitigation actions where possible impacts are identified.

Common Name	Expected Effects	Reason	Possible Mitigation Actions
Black Hills Red Squirrel	Negative	Increasing fire frequency; forest management policies that do not allow adequate thinning will reduce late seral conditions and large trees in the landscape	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition
Black Tern	Neutral to negative	Neutral for riverine/lacustrine systems; negative for depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Burrowing Owl	Variable	This species is associated with prairie dog and ground squirrel populations, therefore, climate change effect is dependent on their response	See black-tailed prairie dog, Richardson's ground squirrel, and Franklin's ground squirrel for possible actions
Chestnut-collared Longspur	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Cope's Gray Treefrog	Neutral to negative	Neutral for riverine/lacustrine systems; negative for depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Cooper's Rocky Mountainsnail	Negative	Increasing temperatures will lead to increased fire frequency and severity, resulting in less habitat for this species	Forest stands that have the best potential for calcareous soils and future moist forest conditions should be protected
Dakota Skipper	Positive	Prefers moist and dry prairies containing warm (C4) season grasses, particularly little bluestem	Not needed
Dakota Vertigo	Negative	Increasing fire frequency; forest management policies that do not allow adequate thinning will reduce late seral conditions and large trees in the landscape	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition
Eastern Hognose Snake	Neutral to negative	Prey base: Neutral on riverine/lacustrine systems; negative on depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Ferruginous Hawk	Positive	More closely associated with warm season grass (C4) dominated conditions	Not Needed
Franklin's Ground Squirrel	Negative	Prefers cool season grass (C3) dominated conditions or mixed-cool/warm (C4) season conditions	Where possible, select for native warm season (C4) grass species that are taller in stature

Table 5-5 (continued). Expected effects of climate change on native ecosystems and habitat of terrestrial and riparian-wetland species of greatest conservation need in South Dakota and suggested mitigation actions where possible impacts are identified.

Common Name	Expected Effects	Reason	Possible Mitigation Actions
False Map Turtle	Neutral to negative	Neutral for riverine/lacustrine systems; negative for depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Frigid Ambersnail	Negative	Increasing temperatures will lead to increased fire frequency and severity, resulting in less habitat for this species	Moist forest stands that are associated with limestone talus should be protected from fire or disturbance
Fringe-tailed Myotis	Negative	Increasing fire frequency; forest management policies that do not allow adequate thinning will reduce late seral conditions and large trees in the landscape	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition
Greater Prairie-Chicken	Neutral	Associated with both warm (C4) and cool (C3) season grass dominated conditions	Not Needed
Greater Sage-Grouse	Negative	Prefers cool season grass (C3) dominated conditions	Where possible, select for taller stature native warm season (C4) grass species and/or allow only intermittent heavy grazing
Great Plains Tiger Beetle	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Indian Creek Tiger Beetle	Neutral	Increased winter/spring precipitation may reduce impacts to intermittent streams	Not Needed
Iowa Skipper	Negative	Prefers cool season grass (C3) dominated conditions or mixed-cool/warm (C4) season conditions	Where possible, select for native warm season (C4) grass species that are taller in stature
Lark Bunting	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Long-billed Curlew	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Le Conte's Sparrow	Neutral to negative	Neutral for riverine/lacustrine systems; negative for depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Lesser Earless Lizard	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed

Table 5-5 (continued). Expected effects of climate change on native ecosystems and habitat of terrestrial and riparian-wetland species of greatest conservation need in South Dakota and suggested mitigation actions where possible impacts are identified.

Common Name	Expected Effects	Reason	Possible Mitigation Actions
Interior Least Tern	Neutral to negative	Neutral on riverine/lacustrine systems; negative on depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Lewis's Woodpecker	Negative	Increasing fire frequency; forest management policies that do not allow adequate thinning will reduce late seral conditions and large trees in the landscape	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition
Lined Snake	Negative	Prefers cool season grass (C3) dominated conditions or mixed-cool/warm (C4) season conditions	Where possible, select for native warm season (C4) grass species that are taller in stature
Little White Tiger Beetle	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Marbled Godwit	Neutral	Associated with both warm (C4) and cool (C3) season grass dominated conditions	Not Needed
Many-lined Skink	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Mystery Vertigo	Negative	Increasing temperatures will lead to increased fire frequency and severity, resulting in less habitat	Moist forest stands associated with limestone or schist substrates should be protected from fire or disturbance
Northern Flying Squirrel	Negative	Increasing fire frequency; forest management policies that do not allow adequate thinning will reduce late seral conditions and large trees in the landscape	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition
Northern Goshawk	Negative	Increasing fire frequency; forest management policies that do not allow adequate thinning will reduce late seral conditions and large trees in the landscape	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition

Table 5-5 (continued). Expected effects of climate change on native ecosystems and habitat of terrestrial and riparian-wetland species of greatest conservation need in South Dakota and suggested mitigation actions where possible impacts are identified.

Common Name	Expected Effects	Reason	Possible Mitigation Actions
Northern Myotis	Negative	Increasing fire frequency; forest management policies that do not allow adequate thinning will reduce late seral conditions and large trees in the landscape	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition
Northern River Otter	Neutral	More closely associated with riverine and lacustrine systems	Not Needed
Northern Sandy Tiger Beetle	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Osprey	Neutral	More closely associated with riverine and lacustrine systems	Not Needed
Ottoe Skipper	Negative	Prefers cool season grass (C3) dominated conditions or mixed-cool/warm (C4) season conditions	Where possible, select for native warm season (C4) grass species that are taller in stature
Pahasapa Fritillary	Negative	Mid-to late summer depressional systems may be impacted	Known key depressional sites should be individually evaluated for possible mitigation actions; beaver ponds should be encouraged
Peregrine Falcon	Neutral	Associated with both warm (C4) and cool (C3) season grass dominated conditions	Not Needed
Piping Plover	Neutral	More closely associated with riverine and lacustrine systems	Not Needed
Poweshiek Skipperling	Positive	Prefers moist and dry prairies containing warm (C4) season grasses, particularly bluestems	Not needed
Regal Fritillary	Negative	Prefers cool season grass (C3) dominated conditions	Where possible, select for native warm season (C4) grass species that are taller in stature as well as violets and nectar producing forbs
Richardson's Ground Squirrel	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Ruffed Grouse	Positive	Increasing fires will create better aspen regeneration and multiple age-class conditions, at least for the short-term	Not Needed

Table 5-5 (continued). Expected effects of climate change on native ecosystems and habitat of terrestrial and riparian-wetland species of greatest conservation need in South Dakota and suggested mitigation actions where possible impacts are identified.

Common Name	Expected Effects	Reason	Possible Mitigation Actions
Sagebrush Lizard	Positive	Increasing temperatures will lead to drier conditions, sparse vegetation, and increasing blowouts on sandy sites	Not Needed
Silver-haired Bat	Negative	Increasing fire frequency; forest management policies that do not allow adequate thinning will reduce late seral conditions and large trees in the landscape	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition
Short-horned Lizard	Positive	Prefers warm season grass (C4) and shrub dominated conditions	Not Needed
Smooth Softshell	Neutral	More closely associated with riverine systems	Not Needed
Sprague's Pipit	Negative	Prefers cool season grass (C3) dominated conditions	Where possible, select for taller stature native warm season (C4) grass species and/or allow only intermittent heavy grazing
Swift Fox	Positive	Prefers warm season grass (C4)/shrub conditions	Not Needed
Townsend's Big-eared Bat	Positive	Forages over warm season grass (C4) and shrub conditions	Not Needed
Trumpeter Swan	Neutral to negative	Neutral on riverine/lacustrine systems; negative on depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Western Box Turtle	Positive	Prefers warm season grass (C4) dominated conditions	Not Needed
Whooping Crane	Neutral	Prefers riverine systems	Not Needed

Table 5-5 (continued). Expected effects of climate change on native ecosystems and habitat of terrestrial and riparian-wetland species of greatest conservation need in South Dakota and suggested mitigation actions where possible impacts are identified.

Common Name	Expected Effects	Reason	Possible Mitigation Actions
Willet	Neutral to negative	Neutral for riverine/lacustrine systems; negative for depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
Wilson's Phalarope	Neutral to negative	Neutral for riverine/lacustrine systems; negative for depressional systems	Known key depressional sites should be individually evaluated for possible mitigation actions
White-winged Junco	Negative	Increasing fire frequency; forest management policies	Implement forest policy to allow ecosystem restoration based on historical reference conditions and climate change adjustments for species composition

5.4 Aquatic Systems

Many stressors directly and indirectly impact aquatic ecosystems and habitats (Richter et al. 1997). Considering the multitude of stressors and disturbances affecting riverine ecosystems, their cumulative nature, and the fact that they are often greatly removed from the site of interest, determining the primary causes for species loss and decline is difficult (McCartney 2002).

Three main stressors or challenges associated with maintaining aquatic ecosystem diversity in South Dakota include the direct alteration or conversion of ecosystems, the indirect alteration and/or suppression of natural disturbance processes, and the indirect alteration caused by human activities.

Direct alteration/conversion of ecosystems

The direct alteration or conversion of lands in South Dakota is primarily linked to the conversion of natural grasslands and prairies into agricultural practices and to a lesser degree, urbanization (including roads, impervious surfaces and other infrastructure). In South Dakota, approximately 80% of the landscape is privately owned. From 2007 to 2011, slightly more than 2.7 million acres of grassland were converted into agricultural croplands (Fry et al. 2011). With agriculture and livestock production as the predominant land use types, agricultural runoff of nutrients and sediment into streams affects aquatic habitats. In areas of intense cultivation, streams are often channelized for irrigation, reducing their habitat value for aquatic communities as temperature, aquatic vegetation, and stream flow are significantly altered. In addition, watersheds dominated by row-crop agriculture, hay production, and cattle grazing have increased sedimentation and nutrient loads to aquatic ecosystems. Stream flow alteration also includes flooding reduction, control or cessation, which may negatively impact aquatic species that require effects of a more natural hydrograph.

In particular, stressors that directly affect aquatic ecosystems include surface water diversion, impoundments, dams, stream channelization, and hydrologic modifications. These stressors degrade, alter, and fragment aquatic habitats and can eventually lead to species loss and extirpation (Williams et al. 1989, Ricciardi and Rasmussen 1999, Fischer and Paukert 2008).

Indirect alteration and/or suppression of historical disturbance processes

The primary causes of indirect alteration and/or suppression of historical disturbance processes include fire suppression, altered grazing regimes, flood control, and removal of beaver and beaver dams in aquatic ecosystems.

Both direct and indirect alterations to aquatic ecosystems negatively impact aquatic habitats and communities. Loss of natural grasslands to agricultural practices and increased grazing along riparian areas has resulted in degradation of aquatic habitats due to increased sedimentation and agricultural runoff. Flood control has resulted in migration barriers for fish and has led to the channelization of rivers and loss of important spawning, feeding, and natal nursery grounds. Removal of beaver and beaver dams has limited critical pool and backwater habitats.

Indirect alteration caused by human activities

Indirect alterations caused by human activities in South Dakota are linked primarily to the accidental and intentional introduction of nonnative species and more recently climate change. Aquatic nonnative species, commonly called aquatic invasive species (AIS), have had major impacts on native species and ecosystems (Collares-Pereira et al. 2000, Rahel and Thel 2004, Fischer and Paukert 2008). The introduction of nonnative species increases competition with and predation on native species and may expose native species to new parasites and diseases, for which they may lack defenses (Soule 1990, Richter et al. 1997). The invasion of Silver Carp, *Hypophthalmichthys molitrix*, in South Dakota has the potential to negatively impact native fish and invertebrate communities through competition for food resources.

Climate Change

In more recent years, greater emphasis has been put on climate change as an indirect alteration caused by human activities. While scientific evidence supporting climate change and its causes continues to grow, understanding the impacts that climate change will have on aquatic biodiversity is more challenging, due to the limited understanding of individual habitat needs and limiting factors. It is expected that lakes, rivers, and streams will become warmer and water levels will change. For cold water species, we may see a decline in distribution; however for warmer water species on the northern edge of their distribution we may see a range expansion. Stronger storms are expected to bring short duration, high intensity precipitation, which will increase flooding and increase nutrient runoff from agricultural lands. Along with these short duration storms, we are also likely to see an increase in drought and an increase in human demands for water. The resulting habitat loss will affect nursery grounds and spawning areas for aquatic communities.

In addition, combining the impacts of climate change with other stressors such as structural migration barriers may prohibit some species from making the necessary distributional shifts in response to the warmer and drier conditions predicted for South Dakota (Burgess 2013). Additional information on individual aquatic species vulnerability to climate change can be found in Table 5-6. A full draft of the aquatic species vulnerability to climate change (Burgess 2013) is available on the SDGFP website. An Executive Summary of the report can be found in Appendix O.

Table 5-6. Expected effects of climate change on aquatic species of greatest conservation need (SGCN) in South Dakota.

Common Name	Scientific Name	Global Rank[a]	State Rank[a]	SD range relative to Global range	CCVI Score[b]	Reason
FRESHWATER MUSSELS						
Creek Heelsplitter	*Lasmigona compressa*	G5	S1	Southern edge	PS	NA
Elktoe	*Alasmidonta marginata*	G4	S1	Western edge	MV	Anthropogenic barriers to dispersal
Hickorynut	*Obovaria olivaria*	G4	S1	Northern edge	MV	Anthropogenic barriers to dispersal
Higgins Eye	*Lampsilis higginsii*	G1	S1	Northern edge	HV	Natural & anthropogenic barriers to dispersal
Mapleleaf	*Quadrula quadrula*	G5	S2	Western edge	PS	NA
Pimpleback	*Quadrula pustulosa*	G5	S1	Western edge	PS	NA
Rock Pocketbook	*Arcidens confragosus*	G4	S1	Western edge	PS	NA
Scaleshell	*Leptodea leptodon*	G1	S1	Western edge	HV	Anthropogenic barriers to dispersal
Yellow Sandshell	*Lampsilis teres*	G5	S1	Northern edge	PS	NA
AQUATIC INSECTS (not included due to limited data)						
A Mayfly	*Analetris eximia*	G3	SNR	Eastern edge	IE	NA
A Stonefly	*Perlesta dakota*	G3	SNR	South Dakota Only	IE	NA
Dot-winged Baskettail - A Dragonfly	*Epitheca petechialis*	G4	SNR	Northern edge	IE	NA
Elusive Clubtail - A Dragonfly	*Stylurus notatus*	G3	SNR	Western edge	IE	NA
FISHES						
Banded Killifish	*Fundulus diaphanus*	G5	S1	Western edge	PS	NA
Blacknose Shiner	*Notropis heterolepis*	G4	S1	Western edge	MV	Anthropogenic barriers to dispersal, sensitivity to historical & physiological hydrological niche
Blackside Darter	*Percina maculata*	G5	S2	Western edge	PS	NA
Blue Sucker	*Cycleptus elongatus*	G3G4	S3	Northern edge	MV	Anthropogenic barriers to dispersal
Carmine Shiner	*Notropis percobromus*	G5	S2	Western edge	MV	Natural barriers to dispersal
Central Mudminnow	*Umbra limi*	G5	S2	Western edge	MV	Sensitivity to historical hydrological niche

Table 5-6. (continued). Expected effects of climate change on aquatic species of greatest conservation need (SGCN) in South Dakota.

Common Name	Scientific Name	Global Rank[a]	State Rank[a]	SD range relative to Global range	CCVI Score[b]	Reason
FISHES						
Finescale Dace	*Chrosomus neogaeus*	G5	S1	Southern edge	EV	Natural & anthropogenic barriers to dispersal, sensitivity to physiological thermal & hydrological niche, dependence on other species to generate habitat
Hornyhead Chub	*Nocomis biguttatus*	G5	S3	Center	PS	NA
Lake Chub	*Couesius plumbeus*	G5	S1	Southern edge	EV	Natural & anthropogenic barriers to dispersal, sensitivity to physiological hydrological niche
Logperch	*Percina caprodes*	G5	S3	Western edge	MV	Sensitivity to historical hydrological niche
Longnose Sucker	*Catostomus catostomus*	G5	S1	Center	HV	Natural & anthropogenic barriers to dispersal, sensitivity to physiological thermal niche
Mountain Sucker	*Catostomus platyrhynchus*	G5	S3	Eastern edge	EV	Natural & anthropogenic barriers to dispersal
Northern Pearl Dace	*Margariscus nachtriebi*	G5	S2	Southern edge	EV	Natural & anthropogenic barriers to dispersal, sensitivity to physiological hydrological niche, dependence on other species to generate habitat
Northern Redbelly Dace	*Chrosomus eos*	G5	S2	Southern edge	EV	Anthropogenic barriers to dispersal
Pallid Sturgeon	*Scaphirhynchus albus*	G2	S1	Center	MV	Anthropogenic barriers to dispersal
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	G4	S4	Center	PS	NA
Sicklefin Chub	*Macrhybopsis meeki*	G3	S1	Northern edge	MV	Anthropogenic barriers to dispersal, sensitivity to historical hydrological niche
Southern Redbelly Dace	*Chrosomus erythrogaster*	G5	S1	Northwestern edge	EV	Anthropogenic barriers to dispersal, sensitivity to physiological thermal niche
Sturgeon Chub	*Macrhybopsis gelida*	G3	S2	Center	HV	Anthropogenic barriers to dispersal
Topeka Shiner	*Notropis topeka*	G3	S2	Northern edge	PS	NA

Table 5-6. (continued). Expected effects of climate change on aquatic species of greatest conservation need (SGCN) in South Dakota.

Common Name	Scientific Name	Global Rank[a]	State Rank[a]	SD range relative to Global range	CCVI Score[b]	Reason
FISHES						
Trout-perch	*Percopsis omiscomaycus*	G5	S2	Western edge	PS	NA
TURTLES (included in terrestrial climate change table)						
False Map Turtle	*Graptemys pseudogeographica*	G5	S3	Western edge	NA	NA
Smooth Softshell	*Apalone mutica*	G5	S2	Western edge	NA	NA

[a]NatureServe Global and State Conservation Status Ranks

- G1, S1 = Critically imperiled globally or in the state because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as a steep population decline making it especially vulnerable to extirpation.
- G2, S2 = Imperiled globally or in the state because of rarity due to very restricted range, very few populations (often 20 or less), steep population declines, or other factors making it very vulnerable to extirpation.
- G3, S3 = Vulnerable globally or in the state due to restricted range, relatively few populations (often 80 or less), recent and widespread declines, or other factors making it vulnerable to extinction.
- G4, S4 = Apparently secure species are uncommon but not rare but there is some cause for concern due to declines or other factors.
- G5, S5 = Secure species are common, widespread, and abundant globally or in the state.

[b]CCVI Vulnerability Index Scores

- EV = Extremely Vulnerable – Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050.
- HV = Highly Vulnerable – Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050.
- MV = Moderately Vulnerable – Abundance and/or range extent within geographical area assessed likely to decrease by 2050.
- PS = Not Vulnerable/Presumed Stable – Available evidence does not suggest that abundance and/or range extent within geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change.
- IL = Not Vulnerable/Increase Likely – Available evidence suggests that abundance and/or range extent within geographical area assessed is likely to increase by 2050.
- IE = Insufficient Evidence – Available information about a species' vulnerability is inadequate to calculate an Index score.

Human Stressor Index (HSI)

The selection process for identifying aquatic COAs considered a number of relevant threats. The quantified data on human stressors assisted in identifying relatively high quality locations for future conservation efforts and helped identify areas where the biological diversity and associated habitats are more threatened in South Dakota.

Working primarily with the Missouri Aquatic GAP (MOGAP) dataset and working with a team of GIS and aquatic staff, a list was generated of the primary human activities known to negatively impact the ecological integrity of South Dakota rivers and streams (Annis et al. 2010). From this dataset the highest resolution and most recent geospatial data were assembled for each of those stressors (Table 5-7). Most of the geospatial data were acquired from the U.S. Environmental Protection Agency (US EPA), U.S. Army Corps of Engineers, U.S. Geological Survey (USGS), South Dakota Department of Environment and Natural Resources (SD DENR), South Dakota Game, Fish and Parks (SDGFP), and MOGAP.

Table 5-7. List of the global information system (GIS) coverages and their sources obtained or created to identify existing and potential future stressors to the aquatic species of greatest conservation need in South Dakota.

HUMAN STRESSOR DATA LAYER	DESCRIPTION	SOURCE
Impervious surfaces	Artificial structures (i.e. pavement, roads, sidewalks, driveways, parking lots).	MOGAP (Modified from 2001 NLCD data)
% Land cover in cropland	% of the land that is used in the cultivation of crops (i.e. corn, soybeans, etc.).	MOGAP (USGS, 2006 NLCD data), http://www.mrlc.gov/nlcd06_data.php
Confined Animal Feeding Operations (CAFOs)	An animal agricultural facility that concentrates a large number of animals in a relatively small and confined place.	SD DENR
Road stream crossings	Man-made, stabilized structures (i.e. culverts, bridges, dams, etc.) that allow livestock, people, vehicles, etc. to cross streams via roadways.	MOGAP
Major hydrologic modifications	Major physical alterations to small or larger river (i.e. small, medium, large, and grand rivers) channels and their associated corridors (i.e. widening, and channelizing rivers, reservoir construction, etc.).	MOGAP
Dams	Federally licensed barriers reported to the USACE that impound, collect or store water.	MOGAP (US Army Corps of Engineers, USACE)
Permitted discharges	Permits for companies to discharge wastewater into rivers. Permits detail what is allowed to be discharged and monitors how much.	MOGAP (2012 EPA), http://www.epa.gov/enviro/html/frs_demo/geospatial_data/geo_data_state_single.html
Active oil & gas wells	Currently producing wells designed to acquire and find petroleum oil and gas.	MOGAP (2012 SD DENR), http://www.sdgs.usd.edu/pubs.og/SDOILexport.zip
Gravel mining	Currently open pits (i.e. river floodplains) or streams being mined for gravel or sand.	SDGFP

Statistics for the 9 individual human stressors (i.e. % cover, degree of fragmentation, density per km^2) for each of the 298 Aquatic Ecological System (AES) units in South Dakota were generated. All metrics were calculated for each individual unit. Relativized rankings (range 1 to 4) were then developed for each of the 9 stressors (Table 5-8). These rankings are relative to the range of values obtained throughout South Dakota. A rank 1 denotes a relatively low disturbance value for that particular stressor, while a rank 4 indicates a relatively high level of disturbance. These rankings were based on information contained within MOGAP, literature, or equal intervals when no empirical evidence on thresholds was available (i.e. cropland land cover).

Table 5-8. Nine stressor metrics included in the human stressor index (HSI) and the specific criteria used to define the four relative ranking categories for each metric used to calculate the HSI for each aquatic ecological system (AES) unit.

	Relative Ranks			
Human Stressor Metric	**1**	**2**	**3**	**4**
% Impervious surfaces	0-5% of AES	6-10% of AES	11-20% of AES	>20% of AES
% Land cover in cropland	0-25% of AES	26-50% of AES	51-75% of AES	76-100% of AES
Confined Animal Feeding Operations (CAFOs) (#/km^2)	0	0.01-1.22	1.23-1.83	≥1.84
Density of road stream crossings (#/km^2)	0-0.17	0.18-0.29	0.3-0.49	≥0.5
**Degree of hydrologic modification and/or fragmentation by major impoundments	1	2-3	4-5	6
# of federally licensed dams	0	1-5	6-14	>14
Density of permitted discharges (#/km^2)	0	0.01-0.31	0.32-0.92	>0.92
Density of active oil & gas wells (#/km^2)	0	0.01-1.07	1.08-7.93	>7.93
Density of active gravel mining (#/km^2)	0	0.006-0.01	0.011-0.019	>0.019

**Note: A major impoundment was defined as those that occur on rivers classified as small or larger (i.e. small river, medium river, large river, or great river) and did not include waters classified as unclassified, headwater, or creek. The codes used to categorize the degree of hydrologic modification and/or fragmentation can be interpreted as follows.

1: No hydrologic alteration or fragmentation.

2: Externally fragmented: obligate aquatic biota could reach one or more adjacent watersheds, but not the MO or MS Rivers without passing through a major impoundment.

3: Hydrologically modified: included all inundated AES units and any area downstream of the dam known to have a significantly modified hydrologic regime.

4: Both externally fragmented and hydrologically modified: includes those AES units that contain stream segments situated in the interceding area between two major impoundments on the same stream.

5: Isolated: obligate aquatic biota could not reach any adjacent watershed without passing through a major impoundment.

6: Both isolated and hydrologically modified.

The relativized rankings for each of the 9 stressors were then combined into a three digit Human Stressor Index (HSI). The first number reflects the highest ranking across all 9 stressors (range 1 to 4). The last two numbers reflect the sum of the 9 stressors (range 9 to 36). This index value allows us to evaluate both individual and cumulative impacts. For example, a value of 412 indicates relatively low cumulative impacts (i.e. last two digits = 12 out of a possible 36), however, the first number is a 4, which indicates that one of the stressors is relatively high and potentially acting as a major human disturbance within that individual AES unit.

Figure 5-11 shows a map of the 298 AES units by the first value in the HSI (range 1 to 4). More than 75% of the AES polygons received a relative ranking value of 3 or 4, indicating that the vast majority of AESs are to some degree disturbed or impaired from at least one of the 9 human stressors in the HSI. Four AESs received the lowest value of 1 and just over 50 received a ranking of 2. The majority of these AESs occur west of the Missouri River in South Dakota, the area of the largest federal and state land holdings in South Dakota. The greatest stressor affecting the ecological integrity of riverine ecosystems in South Dakota is dams, second is hydrologic modification/fragmentation due to both large reservoirs and small impoundments. These stressors are spread fairly evenly across South Dakota with some higher concentrations of larger reservoirs along the Missouri River. Most of the AES units that contain multiple human stressors with a ranking of 4 occur within and adjacent to large towns (i.e. Sioux Falls, Rapid City) and along the Missouri River.

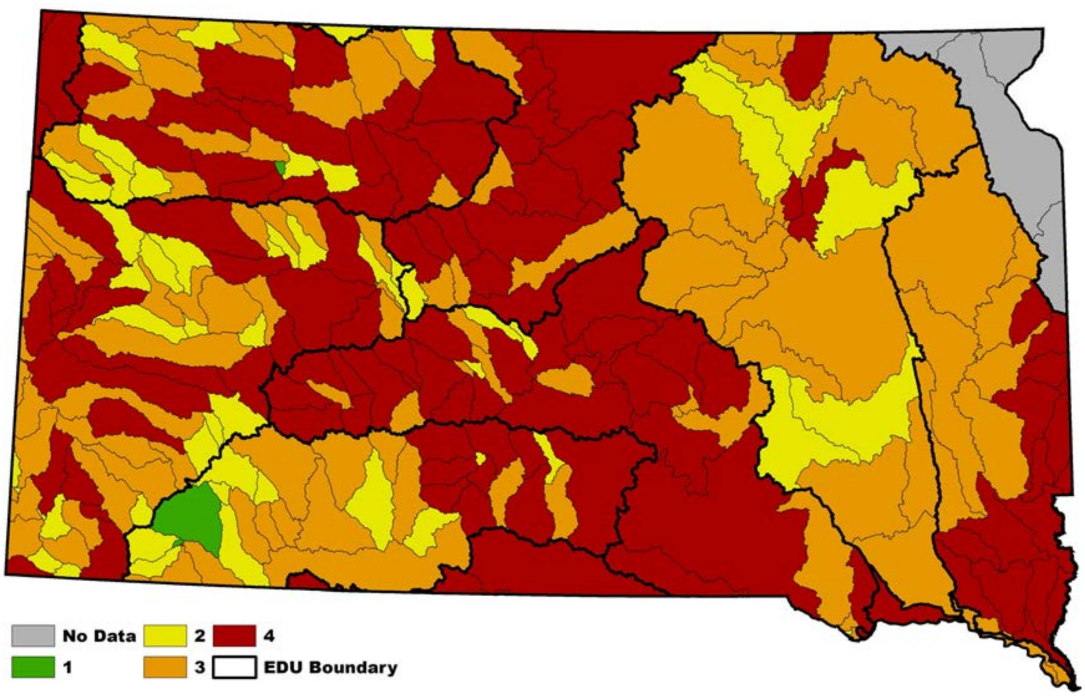

Figure 5-11. Map showing the first value in the human stressor index (HSI) for each of the aquatic ecological systems (AESs) in South Dakota. A value of 1 indicates relatively low human disturbance, while a value of 4 indicates a relatively high human disturbance. Only 4 AES polygons received a value of 1.

When examining the spatial pattern of the last two values in the HSI, we find that cumulative disturbance tends to be highest in southeastern South Dakota and along the Missouri River (Figure 5-12). The AES with the highest cumulative value of 21 lies within the most populated region of the state (i.e. Sioux Falls). This similar pattern holds true for the full 3-digit HSI across South Dakota (Figure 5-13). Whether examining the individual components of the HSI or the overall index value, western South Dakota appears to be less disturbed or more ecologically intact when compared to eastern South Dakota. Specifically, the White River EDU stands out as a major drainage that is relatively undisturbed. This may be partly explained by the fact that a large portion of this EDU is within public and tribal ownership, which illustrates the importance of public lands to the long-term protection of aquatic biodiversity.

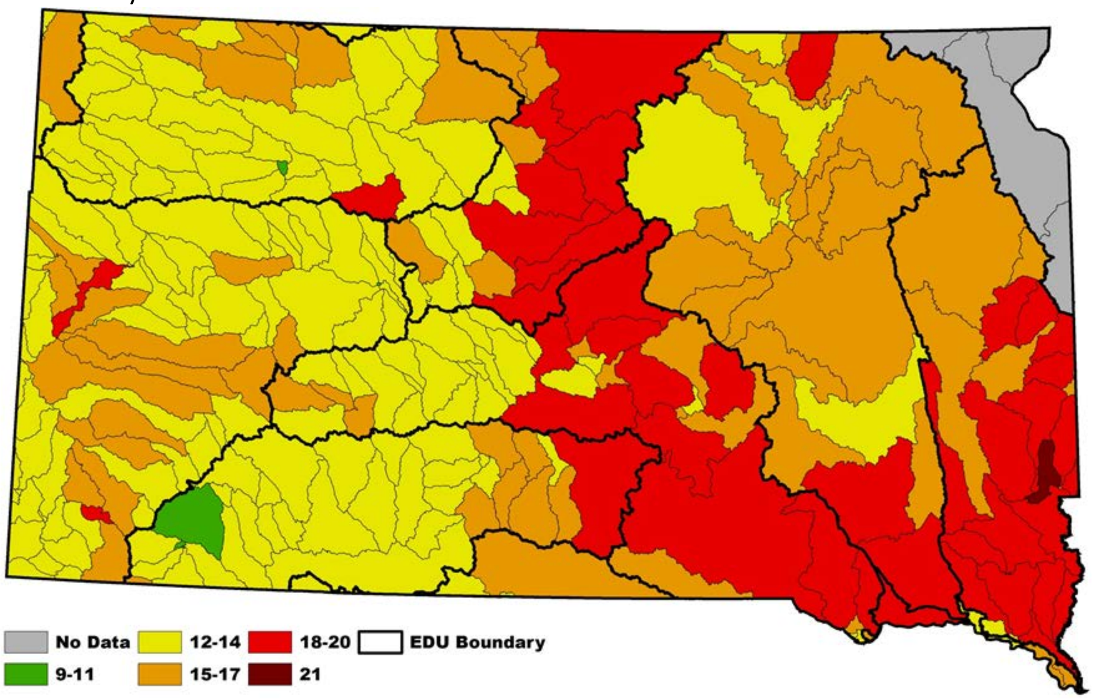

Figure 5-12. Map showing the last two values in the human stressor index (HSI) for each of the aquatic ecological systems in South Dakota. A value of 9 indicates an extremely low level of cumulative stress. The highest possible value was a 36; however the highest value in South Dakota was 21. The higher the value for the last two digits, the higher the degree of cumulative disturbance.

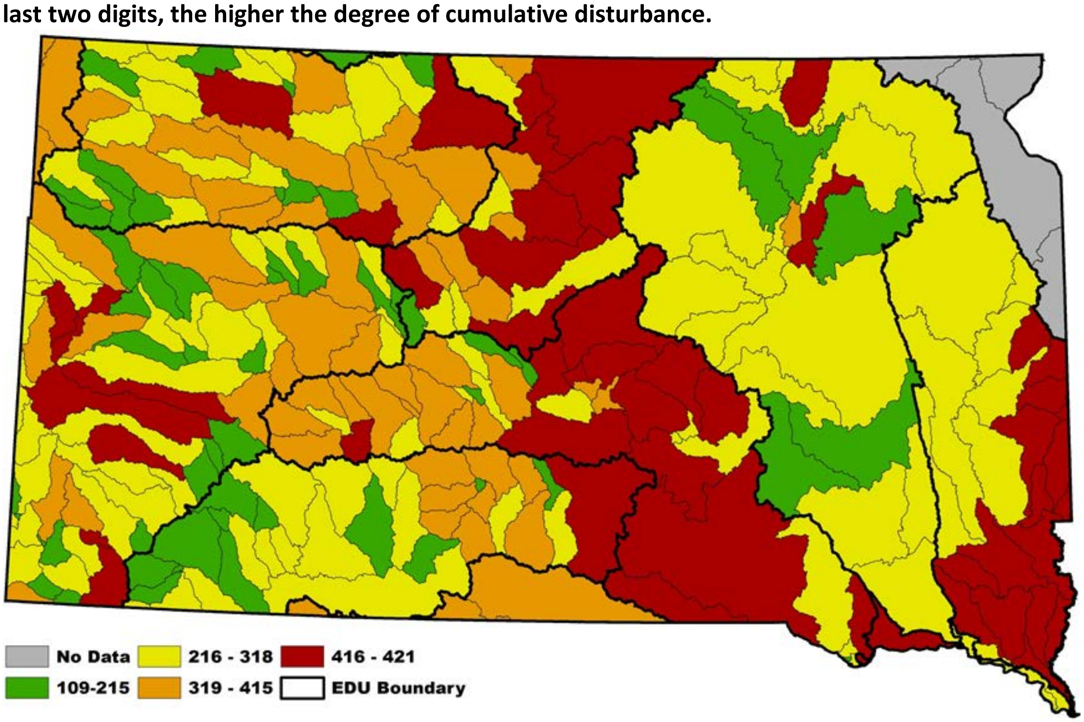

Figure 5-13. Map showing the cumulative human stressor index (HSI) for each of the aquatic ecological systems in South Dakota. The first number represents the highest value received across all 9 human stressor metrics, while the last two numbers represent the sum of the scores received for each of the 9 metrics.

5.5 Conservation Challenges Summary - Terrestrial and Aquatic Systems

Changing environments and resource demands present serious challenges to the future conservation of terrestrial and aquatic ecosystems and necessary disturbance regimes. In addition to the broader challenges previously described, the following section presents conservation challenges that may affect both terrestrial and aquatic resources. Many practices are land-based, but impacts affect both terrestrial and aquatic habitats.

Some of the practices listed below are components of cooperative programs between landowners and state, tribal, or federal land and resource agencies. Negative impacts of these practices vary with location and intensity. For example, managed grazing can be used to sustain a particular grassland, while overstocking leads to plant health decline and loss of native species diversity. Riparian restoration may require tree planting, whereas invasive or planted trees on the prairie negatively impact grassland-dependent birds. Ideally, use of these practices considers specific and compatible land management objectives, rare species occurrences, and threats to ecosystem health.

Land Use Practices

Agriculture:

- cultivating or mowing during nesting season can cause direct destruction of nests and mortality of adults
- poisons, pesticides and/or herbicides that impact the species directly or impact the prey a species feeds upon
- the distribution of agriculture on the landscape that isolates or fragments a species' habitat by impacting a species' normal movement or dispersal patterns due to the various stressors associated with crossing "non-habitat"
- increase in predatory species that adapt well to agricultural systems and structures such as red fox, raccoons, rats, skunks, and free-ranging domestic cats
- windbreak/shelterbelt plantings in native grassland environments

Grazing:

- concentrated grazing in critical nesting areas during the nesting season can result in trampled nests and/or eggs
- stock tanks that do not provide an appropriate escape mechanism for birds and mammals that are attracted to the water and may fall or fly into the tank
- contaminants from feedlot run-off
- increase in the numbers of cowbirds, a nest parasite of prairie bird species, that benefit from well-distributed domestic cattle

Forestry:

- direct disturbance by logging equipment and related activities in critical breeding areas during the breeding and nesting season

Mining:

- disturbance in critical breeding areas during the breeding and nesting season
- closure of old mine shafts and caves that can provide habitat to cave-dependent species
- contaminants from mining sites

Energy development:

- disturbance in critical breeding areas during the breeding and nesting season
- contaminants from developed sites
- increased densities of roads into undeveloped areas
- increased bird mortality associated with wind turbines placed in high-use or high-quality habitats
- bat mortality associated with wind turbines

Water level control:

- unnatural increases in water levels during the nesting season
- unnatural decreases in water levels during the nesting season that allow predators to reach nest sites

Soil Erosion

Accelerated soil erosion due to lack of conservation practices impacts terrestrial and aquatic resources. Examples include soil erosion into surrounding riparian/wetland and aquatic habitats caused by surface soil disturbance by logging equipment, road construction, heavy grazing along streams, row crop plantings immediately adjacent to streams, and increased erosion caused by wild fires. Examples of specific impacts to aquatic resources include pesticide runoff, increased turbidity, decreased aquatic vegetation, and increased water temperatures.

Movement barriers

Barriers to movement that are structural (e.g., dams, levees) or environmental (e.g., thermal or pollution) can disrupt normal life cycles (e.g. spawning) or the dispersal and interchange of individuals among populations.

Exotic/Introduced nonnative species

The accidental or intentional introduction of nonnative species that impact native species by: 1) being in direct competition for limited resources, 2) preying on a native species and/or their young, or 3) being a genetic threat through hybridization (cross-breeding) with a native species.

Recreational disturbance

Recreational activities that are disruptive during critical seasons/life cycles (e.g., nesting season) may cause a species to abandon an area or nest and possibly result in decreased reproductive capacity or overall fitness. For a species that is already struggling with low numbers or reproductive rates, recreational disturbance at key periods could be a stressor that prevents a species from recovering or contributes to its further decline.

Diseases

Infectious diseases that can “spill-over” from domestic animals into wild animal populations (e.g., canine distemper and parvovirus, feline leukemia) are particular threats to species of concern. Species with already low population numbers are particularly vulnerable to stochastic events such as disease outbreaks. Introduced diseases (e.g., sylvatic plague and West Nile virus) can also have devastating effects on low or declining populations and may, in some instances, completely wipe out local populations.