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Niobrara National Scenic River Condition Assessment

Natural Resource Report NPS/NRPC/NRR—2010/172

ON THE COVER
Niobrara National Scenic River
Photograph courtesy of the National Park Service

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Executive Summary

Niobrara National Scenic River spans a 122-km (76-mile) long reach of the Niobrara River in rural, north-central Nebraska. The scenic river encompasses 9,338 ha (23,074 acres) of land and water, all of which is in private ownership, except for about 320 ha (790 acres). Because the scenic river does not own land, it achieves management goals by coordinating and collaborating with federal, state, and local jurisdictions and private landowners.

The central Niobrara River Valley is often referred to as a "biological crossroads" with plant and animal species representative of northern boreal forest, eastern deciduous forest, rocky mountain coniferous forest, tallgrass prairie, Sand Hills prairie, and mixed-grass prairie. Important natural resources include the Niobrara River; tributary springs and waterfalls; diverse plant and animal communities including Pleistocene relicts; and sandy shorelines, sandbars, and wetlands.

This condition assessment was undertaken to provide NPS managers, interpreters, and planners with a concise synthesis, and "scorecard", of the most current information on the natural resources in and around the scenic river. The assessment is divided into four sections: (1) **Ecological Context** provides an overview of the natural resources of the scenic river and region; (2) **Natural Resource Condition** identifies habitat indicators and associated measures, assigning a condition and trend score to each indicator; (3) **Stressors and Management Strategies** discusses stressors and proposes management strategies; and (4) **Conclusion** determines an overall condition and trend score for major habitats.

The major habitats in the scenic river—as identified by natural resource studies—are **Niobrara River and tributaries**; **upland forest and savanna**; **spring branch canyon and riparian forest**; **grassland**; and **sandy shorelines**, **sandbars**, **and wetlands**. These habitats provide the ecological framework for this assessment, and their condition and trend are assessed by a suite of biodiversity and process indicators. Indicator condition was characterized as poor (red box) or good (green box) and trend was characterized as deteriorating (down arrow), stable (horizontal arrow), improving (upward arrow), or no trend or insufficient data (no arrow). These characterizations were based on a comparison of reference and existing values for the measures of each indicator. The scored indicators and their condition and trend are:

aquatic macroinvertebrates	good and no trend
cool-water fishes	good and no trend
fish community	good and stable
stream flow	poor and deteriorating
elk	good and improving
ponderosa pine	poor and deteriorating
land cover (upland forest and savanna)	good and improving
fire (upland forest and savanna)	poor and deteriorating
paper birch	poor and deteriorating
hybrid aspen	poor and deteriorating
Bailey's eastern woodrat	good and no trend
grassland birds	good and deteriorating
Sand Hills prairie	good and deteriorating

land cover (grassland)	good and improving
fire (grassland)	poor and deteriorating
interior least tern and piping plover	good and improving
purple loosestrife	poor and improving

In addition, five indicators, **river otter**, **spiny softshell turtle**, **bird hybridization**, **whooping crane**, and **sediment transport** were included but not scored due to lack of site-specific information. They were discussed to highlight rare or unique resources and important information needs.

The scenic river's long, narrow corridor and limited conservation ownership in the watershed makes it highly susceptible to stressors originating from adjacent lands. The major stressors emerging from this condition assessment are:

water diversion and withdrawal: water diversions from the Niobrara River and tributaries have significantly altered its runoff hydrology and may impact ecological processes and biota.
water quality degradation: fecal coliform and phosphorus are elevated in some tributaries possibly due to visitors hiking in streambeds.
visitor river floating: floater days in the scenic river increased substantially between 2005 and 2008 and recreational noise may impact waterbirds and other wildlife.
purple loosestrife infestation: herbicides and biocontrol appear to be successful in reducing infestations but the plant continues to invade new areas.
woodland expansion (fire suppression): fire suppression and changes in the grazing regime have allowed ponderosa pine and other woody plants to spread into grassland and to increase in woodland understory.
drought: with reduced stream flow due to water diversions, drought impacts on river ecological processes and biota may be more severe.
microclimate in birch stands: a key factor contributing to birch dieback may be increased frequency of thaw-freeze events.
spring branch hiking: visitors walking in the streambed of spring branch tributaries results in a variety of physical and biological impacts.

Other existing or potential stressors are **leafy spurge infestation**, **common reed infestation**, **mountain pine beetle infestation**, and **emerald ash borer infestation**.

Based on a subjective evaluation of the indicators of the major habitats, their condition and trend are:

Niobrara River and tributaries	good and no trend
upland forest and savanna	poor and deteriorating
spring branch canyon and riparian forest	poor and deteriorating
grassland	good and deteriorating
sandy shorelines, sandbars, and wetlands	good and stable

Priority management strategies to address stressors include pursuing instream flow rights to the Niobrara River to protect recreational and fish and wildlife resources, continuing herbicide

applications and biocontrol to reduce purple loosestrife infestations, supporting the use of prescribed fire and the monitoring of fire effects by cooperating private and public land owners, and stimulating birch seedling establishment via mechanical removal of surface litter and overstory canopy. Future stressors may include the mountain pine beetle and the emerald ash borer. Both species have the ability to substantially alter plant communities and their resident wildlife. In addition to the vital-signs monitoring that will be initiated in the near future by the Northern Great Plains Inventory and Monitoring Network, monitoring in cooperation with the Nebraska Game and Parks Commission should be considered for **river otter**, **cool-water fishes**, **fish community**, **spiny softshell turtle**, **elk**, **and Bailey's eastern woodrat**. Important research needs include recreation impacts on spiny soft-shell turtles, reduced stream flow impacts on river morphology and biota, changes in bird hybridization rates and locations, and impacts of existing and potential invasive plants and insects.

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Introduction

In response to increasing threats to the biological integrity of national parks, the U.S. Congress passed legislation in 2003 (Fiscal Year 2003 Appropriations Act) that instructed the National Park Service to assess environmental conditions in watersheds where park units are located. In response to this legislation, the Water Resources Division of the National Park Service initiated a multi-year program to fund natural resource condition assessments for each of the 270 park units with significant natural resources. These condition assessments synthesize existing research and inventory and monitoring data into a knowledge base for use in park resource planning, decision making, accountability reporting, and partnership and education efforts. Condition assessments answer this important question: what does the best available science say about overall condition of important park natural resources?

Each condition assessment results in a written report and maps that

- Characterize park natural resources within a larger ecosystem context;
- Convey resource condition status for a set of individual indicators as well as overall conditions by watershed, habitat types, or park management zones;
- Highlight data and knowledge gaps, and resource condition threats;
- Describe resources considered most at-risk;
- Recommend effective resource management strategies.

Condition assessments are likely to contribute to

- Strategies and priorities for a park's resource management program;
- Watershed or landscape scale partnership/education efforts;
- Mid to long-term park planning efforts including a General Management Plan and Resource Stewardship Strategy;
- Department of Interior "land health" goals and Office of the Management and Budget "natural resource condition" scorecards.

The condition of natural resources at Niobrara National Scenic River (referred to as "scenic river") is assessed based on a synthesis of preexisting data (i.e., data available before December 2009) identified in a review of the natural resource literature about the scenic river, the Niobrara Valley Preserve, Fort Niobrara National Wildlife Refuge, Nebraska state parks, and to a lesser extent, other national park units in the northern Great Plains. Interviews with scientists, inventory and monitoring specialists, and resource managers provided information not recorded in the literature. No new field data were collected for this condition assessment. This assessment uses a scorecard approach to present the condition of major habitats in the scenic river that is similar in approach and format to the State of the Parks reports for Canadian National Parks (Dobbie et al. 2006). Scorecards are a status assessment tool that reflect where a site or project is at a particular point in time and provide easy to understand feedback for management decisions (Stem et al. 2005).

This condition assessment includes five major sections:

***Ecological Context*:** This section includes a brief administrative history and management goals for the scenic river and provides an overview of its natural resources in the context of the central Niobrara River Valley.

Natural Resource Condition: This section describes the scorecard approach used to assess the condition of the major habitats in the scenic river. It identifies habitat indicators and associated measures and establishes reference and existing values for those measures. It provides a synthesis of existing information for each indicator and, when data are adequate, assigns a condition score and trend that is based on a comparison of the values of reference and existing measures.

Stressors and Management Strategies: This section identifies the stressors emerging from the condition assessment and proposes management strategies to deal with these stressors.

Conclusion: This section determines an overall condition and trend score for each habitat and discusses the rational for assigning that score.

Appendices A and B: Appendix A includes a summary of sampling method and data analysis for each indicator and Appendix B describes GIS file structure and products.

Ecological Context

Physical Setting

History, Location, and Management Direction

In 1991, Public Law 102-50, the Niobrara National Scenic River Designation Act, amended section 3(a) of the Wild and Scenic Rivers Act of 1968 to designate portions of the Niobrara River in Nebraska as a unit of the national Wild and Scenic Rivers System. The purpose of the Wild and Scenic Rivers Act is to protect selected American rivers and their adjacent terrestrial environments for the benefit and enjoyment of the American people. The segment of the scenic river located within the Fort Niobrara National Wildlife Refuge is managed by the U.S. Fish and Wildlife Service; the remainder is managed by the National Park Service as a unit of the National Park System.

The 122-km (76-mile) long scenic river is located in rural, north-central Nebraska and encompasses 9,338 ha (23,074 acres) (Fig.1). It is bounded on the north by plains and dissected plains and on the south by the Nebraska Sand Hills (Sand Hills is presented as two words as used in An Atlas of the Sand Hills, Ann Bleed and Charles Flowerday, editors, 1990). Valentine, Nebraska (population 2,820), is the largest town in the region. Access to the scenic river is by Nebraska State Highway 12 and U.S. Highway 20 which generally parallel the Niobrara River to the north and south, respectively, and by Nebraska State Highways 183, 7, and 137 and other unpaved roads which generally lie perpendicular to the Niobrara River. Fourteen bridges cross the Niobrara River within the scenic river boundaries (Fig. 2).

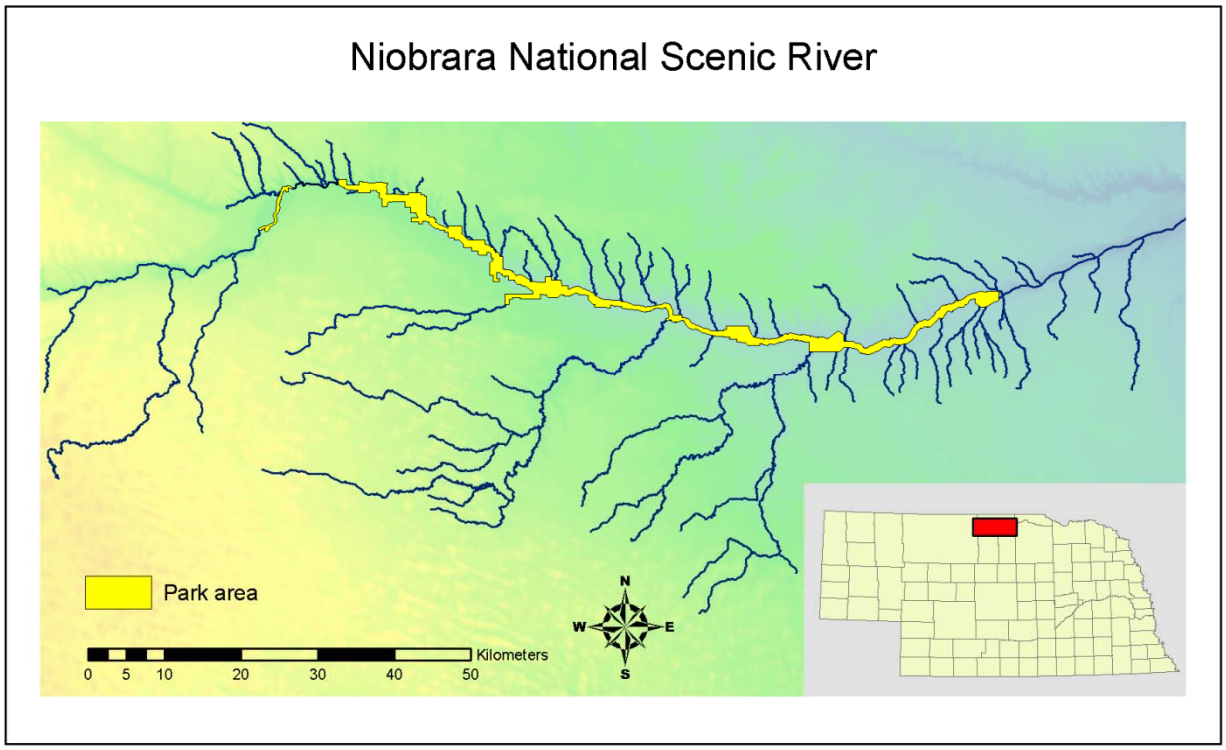


Figure 1. The location of Niobrara National Scenic River in Nebraska.

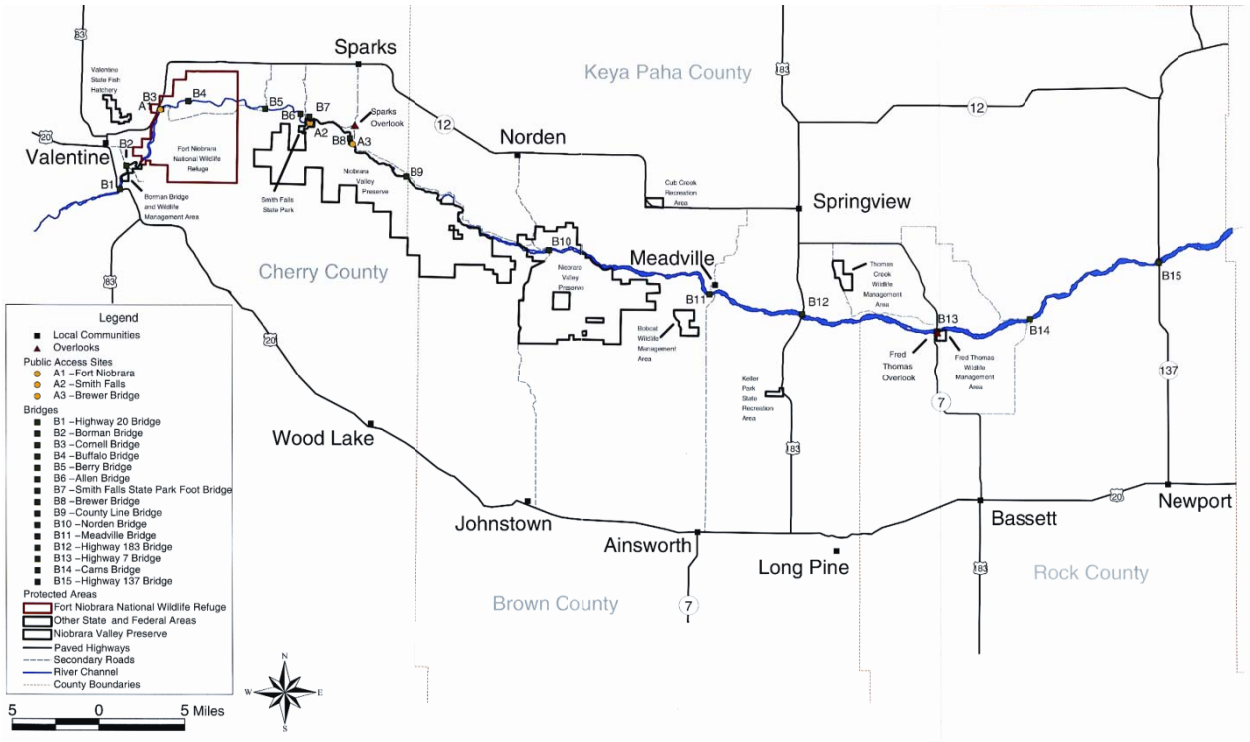


Figure 2. Existing conditions (Source: U.S. Department of Interior 2006).

Most of the land within the scenic river boundary is owned by private landowners or The Nature Conservancy (Niobrara Valley Preserve). Only 320 ha (790 acres) are federally administered by Fort Niobrara National Wildlife Refuge. The scenic river achieves its management goals by coordinating and collaborating with federal, state, and local jurisdictions and private landowners.

Management of the scenic river is directed toward the preservation of the Niobrara River's free-flowing condition, water quality, and five outstanding values: scenic, geologic, paleontologic, fish and wildlife, and recreational (U.S. Department of Interior 2006). The General Management Plan for the scenic river includes the following desired future conditions for natural resources:

- Natural processes and geologic features such as bluffs, waterfalls, and stream banks will retain their inherent natural qualities.
- Water quality and historic in-stream flows will be maintained to support wildlife, fisheries, agriculture, and the recreation values associated with the river.
- Wildlife, recreation, and agricultural interests will work cooperatively to ensure an adequate future supply of water.
- The wildlife resources and habitat of the Niobrara River Valley will be managed and some missing species will be restored where culturally and biologically feasible.
- The National Park Service will work with partners to ensure the continued good air quality of the valley.
- The biological diversity of the Niobrara River Valley, including its six major ecosystems, will be preserved and enhanced.
- The significant fossil resources inside the scenic river boundaries will be preserved and made available for scientific research.

Climate and Microclimate

The central Niobrara River Valley, the region encompassing the scenic river, has an intercontinental climate typical of the Great Plains (Rosenberg 1986). Average annual precipitation is about 51 cm (20 in) with 75 percent falling as rain during the growing season from April to September. Winter precipitation is usually snow with an average annual accumulation of 94 cm (37 in). Average monthly temperature ranges from -5°C (23°F) in January to 24°C (75°F) in July. Winds ranging from 8–24 kmph (5–15 mph) are common throughout the year and are generally out of the north in the winter and out of the south in the summer.

On north-facing slopes along the scenic river, water underlying the Sand Hills migrates along the relatively impervious Rosebud Formation to emerge in side canyons and valleys known as "spring branch canyons." The microclimate in the spring branches is significantly cooler than the surrounding landscape (Steuter and Steinauer 1993) (Table 1).

The Palmer Drought Severity Index for the Sand Hills shows the high variability of moisture conditions in the region including the long-term drought episodes in the 1930s and mid-1950s (Istanbulluoglu 2008) (Fig. 3). Long-term weather data for Nebraska indicates an increase in precipitation up to 10 percent has occurred for most of the state except the far west (U.S. Environmental Protection Agency 1998) (Fig. 4). By 2100, precipitation in eastern and central Nebraska could increase by an additional 10 percent (with a range of 5–20 percent) in spring, summer, and fall, and 15 percent in winter (with a range of 5–20 percent). Temperatures could increase by 1.6°C (3°F) in spring and summer and 2.2°C (4°F) in fall and winter (U.S. Environmental Protection Agency 1998).

Table 1. Average increase in near surface maximum temperature (°C) in associated habitats compared to paper birch stands in spring branch canyons in the summer of 1986 (*Source:* Steuter and Steinauer 1993).

Date	Associated habitats		
	Prairie	Pine/Oak	Deciduous forest
6/27	5.0*	4.8*	1.2
7/4	8.0*	5.8*	2.0
7/7	5.4*	4.4*	2.4
7/10	8.6*	2.8*	1.4
7/17	11.4*	6.0*	1.2
7/22	9.0*	3.6*	1.4
8/4	9.2*	8.8*	3.2
8/13	8.0*	4.6*	2.8*
8/15	9.6*	6.4*	3.0*
8/28	8.0*	8.0*	3.4*

*indicates a significant (P≤0.05) difference compared to birch stands (ANOVA, Tukey's test)

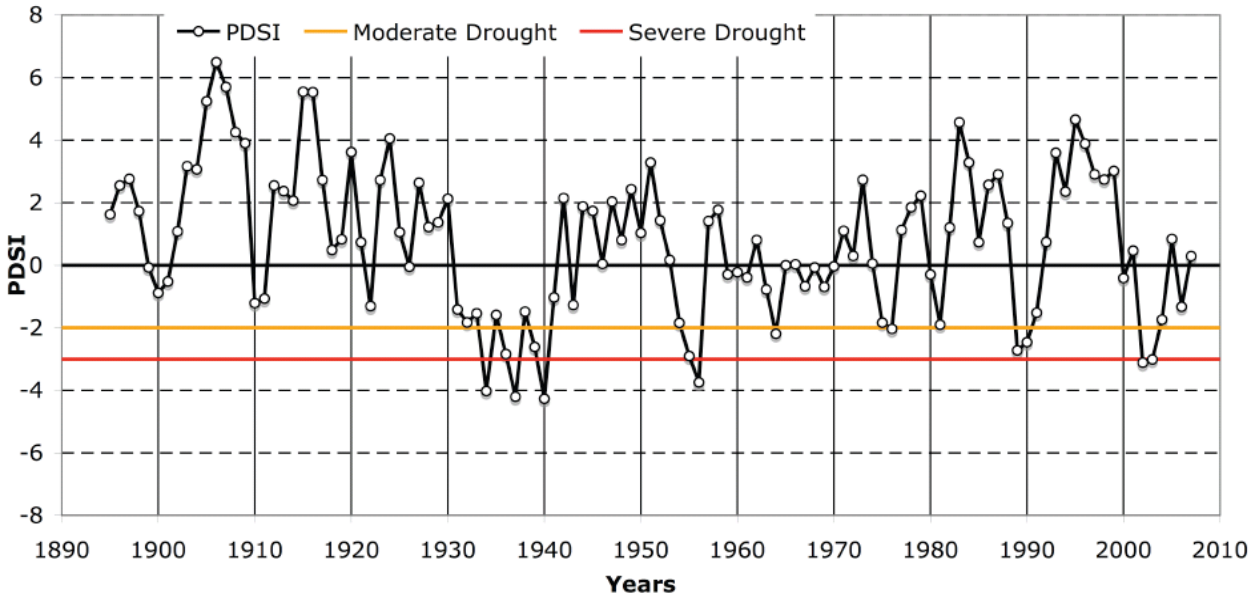


Figure 3. NOAA-PDSI calculated for the instrumented past, representing the spatially averaged conditions in the panhandle and north-central climatic regions of Nebraska (*Source*: Istanbulluoglu 2008).

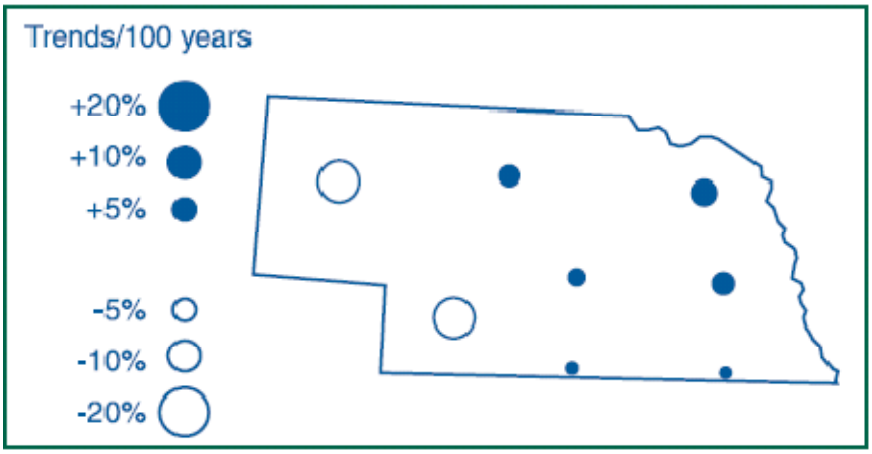


Figure 4. Precipitation trends from 1900 to present (*Source*: U. S. Environmental Protection Agency 1998).

Air Quality

The scenic river is a class II air quality area under the Clean Air Act. Air quality is not monitored in the scenic river or in the central Niobrara River Valley region but has been estimated for several parameters based on regional air quality monitoring data (http://www.nature.nps.gov/air/Maps/Air/atlas/IM_materials.cfm). Air quality is generally good but with significant concern over nitrogen deposition (Table 2).

Table 2. Air quality condition interpolation values, 2003–2007, Niobrara National Scenic River (*Source*: National Park Service 2007).

Ozone	Atmospheric Deposition	Atmospheric Deposition	Visibility Condition
(ppb) 4th Highest 8-Hour	(kg/ha/yr) Total-N Wet Deposition	(kg/ha/yr) Total-S Wet Deposition	(DV) Visibility Group 50 Minus Natural Conditions
66.34	4.22	1.51	7.83
Moderate Concern	Significant Concern	Moderate Concern	Moderate Concern

Topography and Geology

The topography of the scenic river is varied and ranges from 549 to 792 m (1,801 to 2,598 ft) above sea level (Mason 2005, U.S. Department of Interior 2006). East of Valentine, the Niobrara River is entrenched from 46 to 107 m (151 to 351 ft) below the uplands to the north and south. High terraces lie at different levels above the river channel and below the general level of the uplands. Steep valley sides or breaks occur on both sides of the river and along the lower course of its tributaries. The valley floor widens considerably as the river flows east of County Line Bridge and widens more east of Meadville.

The geologic framework of the upper scenic river (i.e., middle Niobrara River Valley) consists of four formations (Diffendal and Voorhies 1994) (Fig. 5). The Rosebud Formation is the bedrock of the Niobrara River channel, lower valley walls, and lower courses of its major tributaries. On the north side of the river, the Valentine Formation of sandy stream deposits overlies the Rosebud and forms gentle slopes. The Ash Hollow formation is hard, sandy deposits with layers of volcanic ash which forms a caprock on the north rim of the valley. On the south side of the valley, Eolian Sands rest on the Rosebud Formation and are the stabilized dunes of Pleistocene and Holocene ages. The lower scenic river is characterized by a broad valley, with the river flowing over a thick layer of Pierre Shale (Diffendal and Voorhies 1994).

Soils

Within the Niobrara River Valley, Sarpy (loamy fine sand) soils occur on bottomland along the river and its tributaries while Tripp (fine sandy loam) soils are generally found on the terraces. Little soil development exists on rough broken land and steep bluffs (Layton 1956).

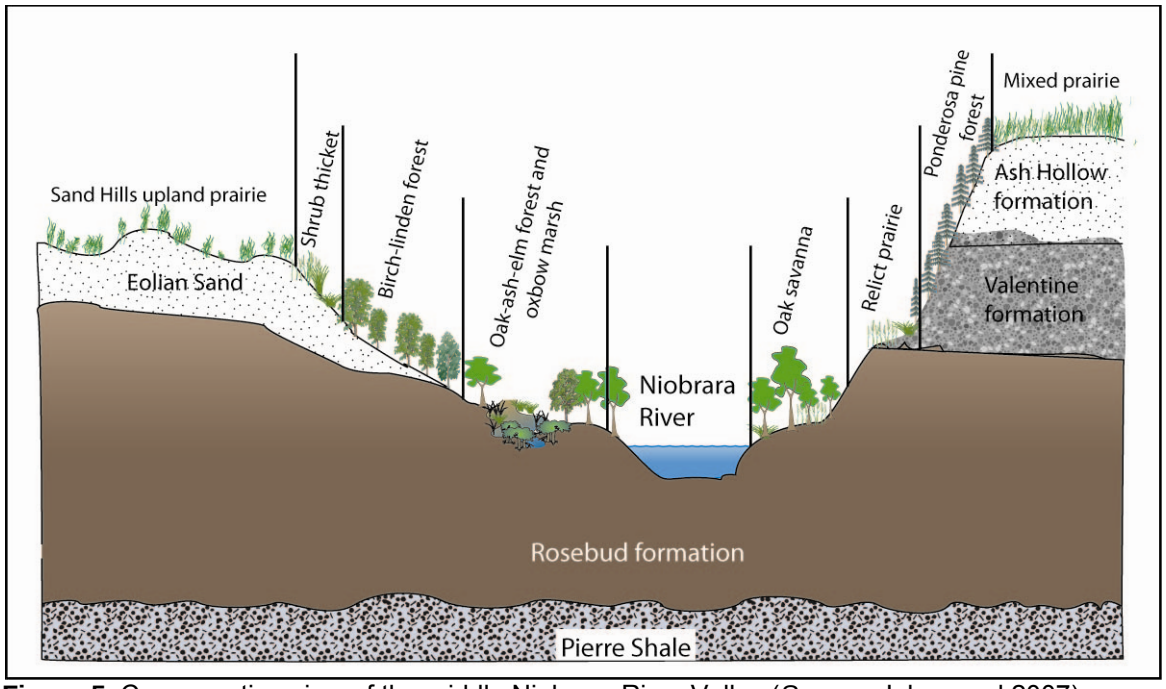


Figure 5. Cross-section view of the middle Niobrara River Valley (*Source*: Johnsgard 2007).

Watershed and Hydrology

The Niobrara River begins near Lusk, Wyoming, and flows some 861 kilometers (535 miles) across north-central Nebraska to its confluence with the Missouri River at the town of Niobrara (Istanbulluoglu 2008) (Fig. 6). Major tributaries include the Snake River, Minnechaduza Creek, Keya Paha River, and Long Pine Creek. The Niobrara River is primarily a groundwater-fed stream that drains approximately 19,312 km^2 (7,456 mi^2) of basin area (Istanbulluoglu 2008). The Nebraska Sand Hills play a dominant role in the hydrology of the Niobrara and Snake Rivers as the primary groundwater source (Bentall and Shaffer 1979). The word "Niobrara" means "running water" in the Dakota language and is descriptive of the river's constant year-around flow averaging about 236 m^3 (8,334 ft^3) per second. Four structures, Mirage Flats Project, Merrit Dam and Reservoir, Cornell Dam, and Spencer Dam either dam and/or divert water from the Niobrara River (Fig. 7). One of these, Cornell Dam, is located within the Fort Niobrara National Wildlife Refuge.

In the western portion of the scenic river, the Niobrara is confined to a single channel with few islands (Johnsgard 2007). East of County Line Bridge, the valley widens and the river spreads into multiple meandering channels with numerous sandbars. Primarily in the entrenched portion of the scenic river numerous waterfalls occur on the tributary creeks that drain groundwater from the Sand Hills (Mason 2005). The highest is Smith Falls, which drops 19 m (63 feet) into the river valley. The Niobrara is unique as a prairie river because for most of its middle section, its channel flows directly over bedrock, producing areas of riffles and rapids (Johnsgard 2007).

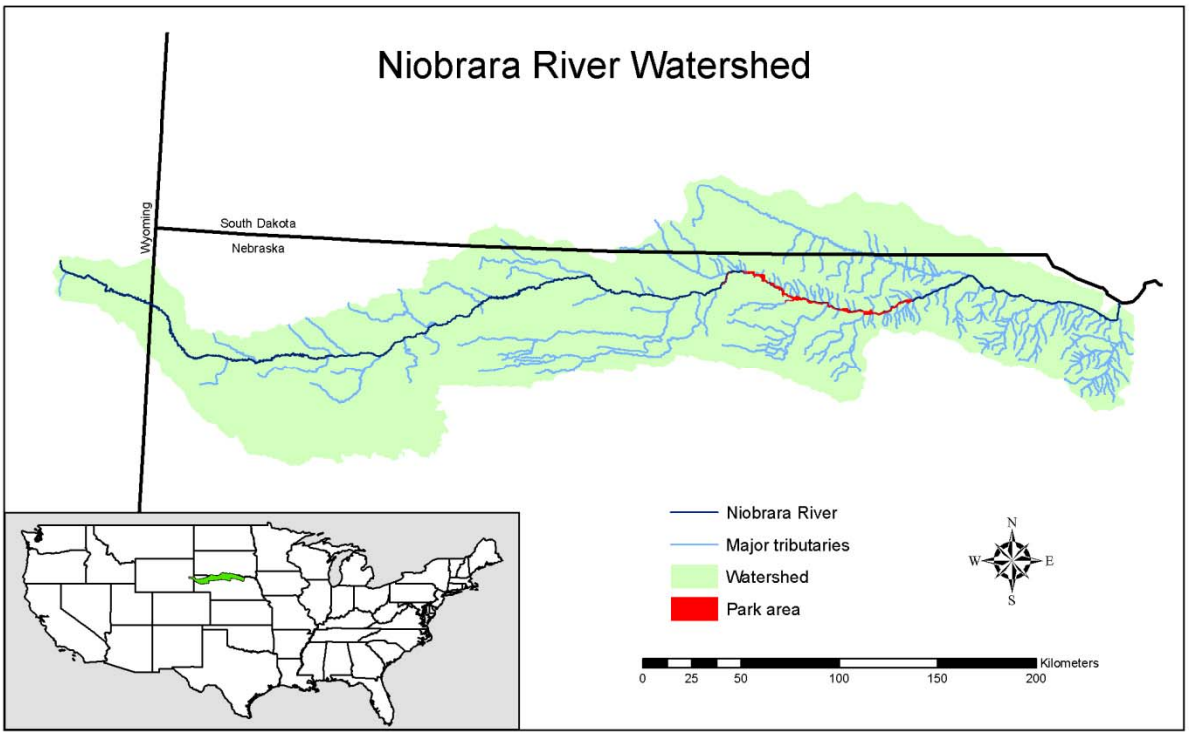


Figure 6. Niobrara River watershed.

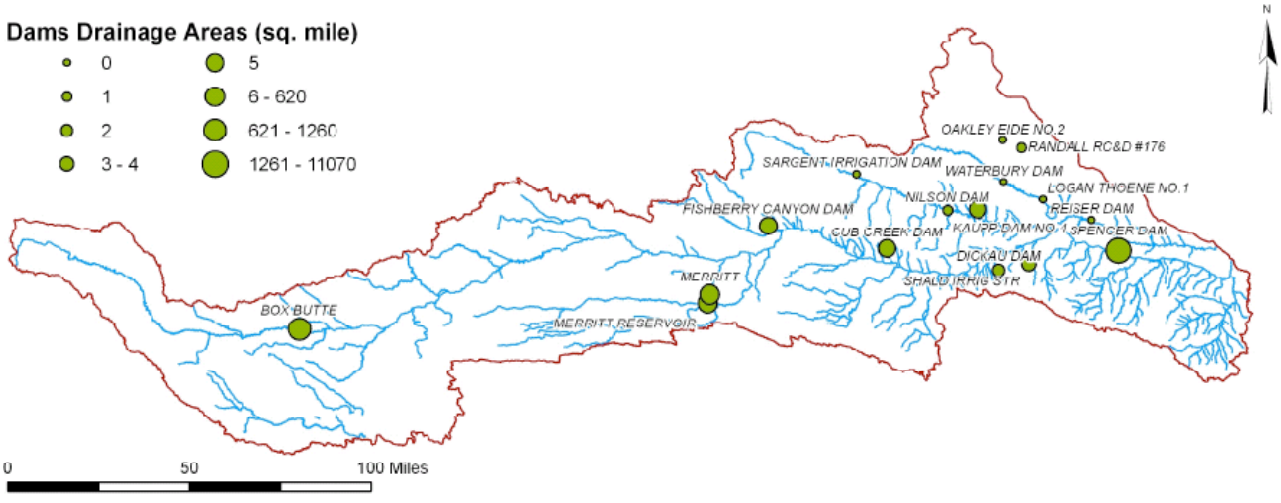


Figure 7. Dams on the Niobrara River and tributaries (Note: Cornell Dam is not shown. The reservoir behind the dam is completely filled with silt and provides no water storage) (*Source:* Istanbulluoglu 2008).

Water Quality

Water quality in the region is generally good, with some impacts from human activities such as recreation and agriculture (National Park Service 1995). During the years 1947 to 1994, 50 water quality monitoring stations in and around the scenic river provided baseline information for 281 different water quality parameters (National Park Service 1995). Ten stations are in the boundaries of the scenic river, five of which provide long-term records. A review of these historical records identified several water quality concerns. A small number (1.2 percent) of pH readings were found to be outside pH screening criteria for aquatic life uses. In addition, 5.5 percent of turbidity values, 32 percent of fecal coliform values, 20 percent of E. coli values, 0.3 percent of dissolved fluoride values, 4.5 percent of beryllium values, 8.5 percent of copper values, and 8.3 percent of lead values exceeded water quality screening criteria utilized by the Water Resources Division, NPS (Troelstrup 2006). In 2001, the scenic river started collecting water samples at major bridge crossings on the Niobrara River and from tributaries. Those samples have also suggested good water quality (National Park Service, P. Sprenkle, natural resource specialist, personal communication, 22 June 2009).

Biological Setting

Vegetation

Five hundred and eighty-one species of vascular plants are known from the central Niobrara River region, about one-third of the Nebraska flora (Churchill et al. 1988). South of the river valley, dune sands support Nebraska Sand Hills prairie with dominant grasses such as sand bluestem (*Andropogon hallii*) and prairie sandreed (*Calamovilfa longifolia*) (Pool 1914) (Fig. 5). Along the south slopes of the valley permanently flowing springs and seeps produce a moist forest habitat dominated by eastern deciduous trees including green ash (*Fraxinus pennsylvanica*), basswood (*Tilia americana*), and ironwood (*Ostrya virginiana*) (Tolstead 1942). In some sheltered spring branch canyons around tributary streams, paper birch (*Betula papyrifera*), hybrid aspen (*Populus tremuloides x P. grandidentata*) and associated ferns and club mosses are relicts of the Pleistocene ice age (Johnsgard 2007). Small patches of tallgrass prairie are found on the river bottoms. Characteristic tall grasses include big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), and indiangrass (*Sorghastrum nutans*). On the north side of the valley, mixed-grass prairie, dominated by little bluestem (*Schizachyrium scoparium*) and western wheatgrass (*Pascopyrum smithii*), covers the river terraces and the rolling uplands. Ponderosa pine (*Pinus ponderosa*) occurs primarily on the canyon slopes. Ponderosa pine is also found south of the river on steep slopes and cliffs and has invaded sandy upland sites. The central Niobrara River Valley is the eastern-most extent of the ponderosa pine community in the Great Plains (Johnsgard 2007).

Several highly aggressive, exotic plants are known from the region including purple loosestrife (*Lythrum salicaria*), leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), spotted knapweed (*Centaurea maculosa*), and non-native common reed (*Phragmites australis australis*). These species tend to partially or completely replace native plant communities. In addition, salt cedar (*Tamarix ramosissima and T. parvifora*), a shrub or small tree that has clogged and dewatered streams in western Nebraska, may pose the potential for similar ecological damage in the Niobrara River Valley (Johnsgard 2007).

Mammals

The diverse habitats of the central Niobrara River Valley support over forty species of mammals (Bogan 1997). The largest number of species are found in upland prairie followed by riparian forest (Johnsgard 2007) (Table 3). Bison (*Bison bison*) and elk (*Cervus elaphus*), extirpated in Nebraska in the late 1800s, were reintroduced (bison) or extended their range (elk) into the area by the mid-1900s. Both white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*) occur in the region, but in recent years, white-tailed deer have moved farther west replacing the more open-habitat, smaller, and less adaptable mule deer (Johnsgard 2007). Most predators were extirpated by the early 1900s but coyotes (*Canis latrans*) persist and are widespread. The mountain lion (*Felix concolor*) was extirpated from Nebraska by 1900 but several confirmed sightings in the Niobrara River Valley suggest a resident population may exist in the area (Nebraska Game and Parks Commission 2009a). The most biogeographically significant mammals are the eastern woodrat (*Neotoma floridana baileyi*), which occurs in the scenic river as a subspecies disjunct by 190 km (118 miles) from other subspecies, and the bog lemming (*Synaptomys* sp.), a Pleistocene relict now mostly found farther to the north and east (Johnsgard 2007).

Table 3. Ecological associations of mammals in the central Niobrara River Valley (*Source*: Johnsgard 2007).

Species	Upland prairie	Rock outcrop	Pine woods	Scrub thicket	Riparian forest	Dry meadow	Wet meadow	Swamp	Riparian edge
Masked shrew					x		x		
Hayden's shrew	x								
Northern short-tailed shrew				x	x	x	x		
Eastern mole				x	x	x			
Eastern cottontail	x	x		x	x				
Black-tailed jackrabbit	x								
White-tailed jackrabbit	x	x	x						
Black-tailed prairie dog	x								
Thirteen-lined ground squirrel	x								
Spotted ground squirrel	x			x					
Fox squirrel				x	x				
Plains pocket gopher						x			
Olive-backed pocket mouse	x								
Silky pocket mouse	x								
Hispid pocket mouse	x	x	x						
Ord's kangaroo rat	x								
Beaver									x
Plains harvest mouse	x								

Table 3. Ecological associations of mammals in the central Niobrara River Valley (continued) (*Source*: Johnsgard 2007).

Species	Upland prairie	Rock outcrop	Pine woods	Scrub thicket	Riparian forest	Dry meadow	Wet meadow	Swamp	Riparian edge
White-footed mouse	x	x	x						
Deer mouse	x	x		x	x	x	x		
Grasshopper mouse	x								
Prairie vole				x	x				
Meadow vole				x	x	x			
Muskrat									x
Meadow jumping mouse				x	x				
Porcupine			x						
Coyote	x		x	x	x	x			
Raccoon					x	x		x	x
Long-tailed weasel	x	x	x	x	x	x			
Least weasel				x	x	x			
Mink					x			x	x
Striped skunk	x	x	x						
Spotted skunk	x		x		x				
Badger	x								
Bobcat	x	x	x	x	x				
Elk	x		x	x	x	x			
Mule deer	x			x		x			
White-tailed deer	x		x		x				
Pronghorn	x								
Bison	x		x						

Birds

A total of 185 species of birds are known or believed to breed in the central Niobrara River Valley, which represents about 90 percent of the Nebraska breeding avifauna (Ducey 1989, Johnsgard 2007). These species occupy wetlands (23 percent), forests (22 percent), open woods or woody edges (20 percent), grasslands and old fields (19 percent), shrublands (five percent), urban (four percent), bank or cliff (four percent), and river shorelines or sandbars (three percent) (Johnsgard 2007) (Table 4). Birds found in the riparian floodplain forest are predominantly eastern or northeastern species including whip-poor-will (*Caprimulgus vociferus*), eastern phoebe (*Sayornis phoebe)*, eastern wood-pewee (*Contopus virens)*, eastern bluebird (*Sialia sialis*), wood thrush (*Hylocichla mustelina*), yellow-throated vireo (*Vireo flavifrons*), ovenbird (*Seiurus aurocapilla*), black-and-white warbler (*Mniotilta varia*), and scarlet tanager (*Piranga olivacea*). In the ponderosa pine stands on the north side of the river valley, western birds such as the black-billed magpie (*Pica hudsonia*) associate with more northern species such as the red-breasted nuthatch (*Sitta canadensis*) and red crossbill (*Loxia curvirostra)*. Upland prairie species whose breeding ranges center on the Great Plains and that commonly breed in the central Niobrara River Valley include Swainson's hawk (*Buteo swainsoni*) and lark bunting (*Calamospiza melanocorys*). In the central Niobrara River Valley, the range of the western and northern-oriented sharp-tailed grouse (*Tympanuchus phasianellus*) overlaps with the eastern-oriented greater prairie-chicken (*Tympanuchus cupido*) (Johnsgard 2007).

Table 4. Ecological associations of typical breeding birds of the central Niobrara River Valley (*Source*: Johnsgard 2007, Nebraska Game and Parks Commission, J. Jorgensen, non-game program manager, personal communication, 3 November, 2009).

Species	Upland prairie	Rock outcrop	Pine woods	Scrub thicket	Riparian forest	Dry meadow	Wet meadow	Swamp	Riparian edge
Total reported species	18	6	11	28	37	14	8	7	14
Characteristic species									
Long-billed curlew	B					J			
Lark bunting	B								
Western meadowlark	J					J			
Eastern meadowlark							J		
Chestnut-collared longspur	B					J			
Rock wren		B							
Red-tailed hawk	J	J	B		J				
Prairie falcon	J	J	B						
Say's phoebe		J							
Black-headed grosbeak			B		J				
Rose-breasted grosbeak					J				
Indigo bunting					J				
Lazuli bunting				J					
Bell's vireo					J				
Red-breasted nuthatch			J						
White-breasted nuthatch					J				
Loggerhead shrike				B					
Spotted towhee				B					
Eastern wood-pewee					J				
Red-headed woodpecker					B				
Hairy woodpecker					B				
Downy woodpecker					B				
Eastern kingbird					B				
American crow			J		B				
Black-capped chickadee					B				
House wren					B				
Black-and-white warbler					B				
Yellow warbler					B				

Table 4. Ecological associations of typical breeding birds of the central Niobrara River Valley (continued) (*Source*: Johnsgard 2007, Nebraska Game and Parks Commission, J. Jorgensen, non-game program manager, personal communication, 3 November, 2009).

Species	Upland prairie	Rock outcrop	Pine woods	Scrub thicket	Riparian forest	Dry meadow	Wet meadow	Swamp	Riparian edge
Common yellowthroat					B				
Orchard oriole					B				
Baltimore oriole					B				
Common grackle				J	B				
Upland sandpiper							B		
Black-crowned night heron								J	B
Mallard								J	B
Blue-winged teal								J	B
Wood duck					B				B
Spotted sandpiper									B
Least tern									J
Piping plover									J
Belted kingfisher									B

Note: Characteristic species shown with the letter B are those that Beed (1936) regarded as unique to that single community type. The ruddy duck, northern shoveler, American coot, least tern, and black tern have been excluded as not typical of most Niobrara riparian habitat. Where the letter J appears it refers to additional species or additional typical habitats as judged by Johnsgard (2007) and by Ducey (1989).

Reptiles and Amphibians

During 2003 and 2004, 22 species of reptiles and amphibians were found near bridges in the lower portion of the scenic river (Fogell and Cunningham 2005) (Table 5) and an additional seven species were previously collected in or near the scenic river (Lynch 1985). Species recorded in the central Niobrara River Valley and associated wetlands include Blanchard's cricket frog (*Acris crepitans blanchardi*), western chorus frog (*Pseudacris triseriata)*, bull frog (*Rana catesbeiana)*, northern leopard frog (*Rana pipiens)*, common snapping turtle (*Chelydra serpentina)*, and painted turtle (*Chrysemys picta)* (Johnsgard 2007). Species found in association with drier habitats include plains spadefoot toad (*Spea bombifrons)*, ornate box turtle (*Terrapene ornata)*, pale milk snake (*Lampropeltis triangulum)*, prairie rattlesnake (*Crotalus viridis)*, and six-lined racerunner (*Cnemidophorus sexlineatus viridis)*.

Table 5. Expected, encountered, and previously documented reptile and amphibian species in the Niobrara National Scenic River (*Source*: Fogell and Cunningham 2005).

Common name	Scientific name	Expected	Found	Previously documented
Blanding's turtle	*Emydoidea blandingii*	Y	N	Y
Bullfrog	*Rana catesbeiana*	Y	Y	Y
Common garter snake	*Thamnophis sirtalis*	Y	Y	Y
Common snapping turtle	*Chelydra serpentina*	Y	Y	Y
Eastern fence lizard	*Sceloporus consobrinus*	Y	Y	Y

Table 5. Expected, encountered, and previously documented reptile and amphibian species in the Niobrara National Scenic River (continued) (*Source*: Fogell and Cunningham 2005).

Common name	Scientific name	Expected	Found	Previously documented
Eastern hognose snake	*Heterodon platyrhihos*	Y	N	Y
Great Plains toad	*Bufo cognatus*	Y	Y	Y
Lesser earless lizard	*Holbrookia maculata*	Y	Y	Y
Many-lined skink	*Eumeces multivirgatus*	Y	N	Y
Milk snake	*Lampropeltis triangulum*	Y	Y	Y
Northern cricket frog	*Acris crepitans*	Y	Y	Y
Northern leopard frog	*Rana pipiens*	Y	Y	Y
Northern water snake	*Nerodia sipedon*	Y	N	Y
Ornate box turtle	*Terrapene ornata*	Y	Y	Y
Painted turtle	*Chrysemys picta*	Y	Y	Y
Plains garter snake	*Thamnophis radix*	Y	Y	Y
Plains leopard frog	*Rana blairi*	Y	Y	N
Plains spadefoot toad	*Spea bombifrons*	Y	Y	Y
Prairie rattlesnake	*Crotalus viridis*	Y	Y	Y
Racer	*Coluber constrictor*	Y	Y	Y
Ringneck snake	*Diadophis punctatus*	Y	Y	N
Six-lined racerunner	*Cnemidophorus sexlineatus*	Y	Y	Y
Smooth green snake	*Liochlorophis vernalis*	Y	N	Y
Smooth softshell turtle	*Apalone mutica*	Y	N	N
Spiny softshell turtle	*Apalone spinifera*	Y	N	Y
Tiger salamander	*Ambystoma tigrinum*	Y	N	Y
Western chorus frog	*Pseudacris triseriata*	Y	Y	Y
Western fox snake	*Elaphe vulpina*	Y	N	N
Western hognose snake	*Heterodon nasicus*	Y	Y	Y
Woodhouse's toad	*Bufo woodhousii*	Y	Y	Y
Total found/expected = 22/31 (71%)				

Fishes

More than 68 fish species are found in the Niobrara River drainage (Schainost 2008) including 30 species that have been reported in the central Niobrara River Valley which encompasses the scenic portion of the river. A recent (2003–2005) study of fish composition in the scenic portion of the river and its tributaries found 27 species of fish at 18 sites (Dietsch 2008) (Table 6, Fig. 8). The greatest number of unique species (17) was found at a site on the Niobrara River upstream from Smith Falls; however, the overall species richness was greater at sites downstream from

Norden Bridge (Dietsch 2008). The distribution and occurrence of these species varied along the river. Species such as the red shiner (*Cyprinella lutrensis*), sand shiner (*Notropis stramineus*), and bigmouth shiner (*Notropis dorsalis)* were numerous and widespread throughout the river. Long-nose dace were present at most sites, but generally found in higher numbers at sites upstream from Norden Bridge, and carpsuckers were confined to sites downstream of the bridge. Some native (brook stickleback [*Culaea inconstans*], plains topminnow [*Fundulus sciadicus*], western silvery minnow [*Hybognathus argyritis*]) and non-native species (brown trout [*Salmo trutta*], rainbow trout [*Oncorhynchus mykiss*]) were limited to just a few sites. Game fish such as largemouth bass (*Micropterus salmoides*), green sunfish (*Lepomis Cyanellus*), bluegill (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*) were found throughout the river, but were more commonly found downstream from Norden Bridge.

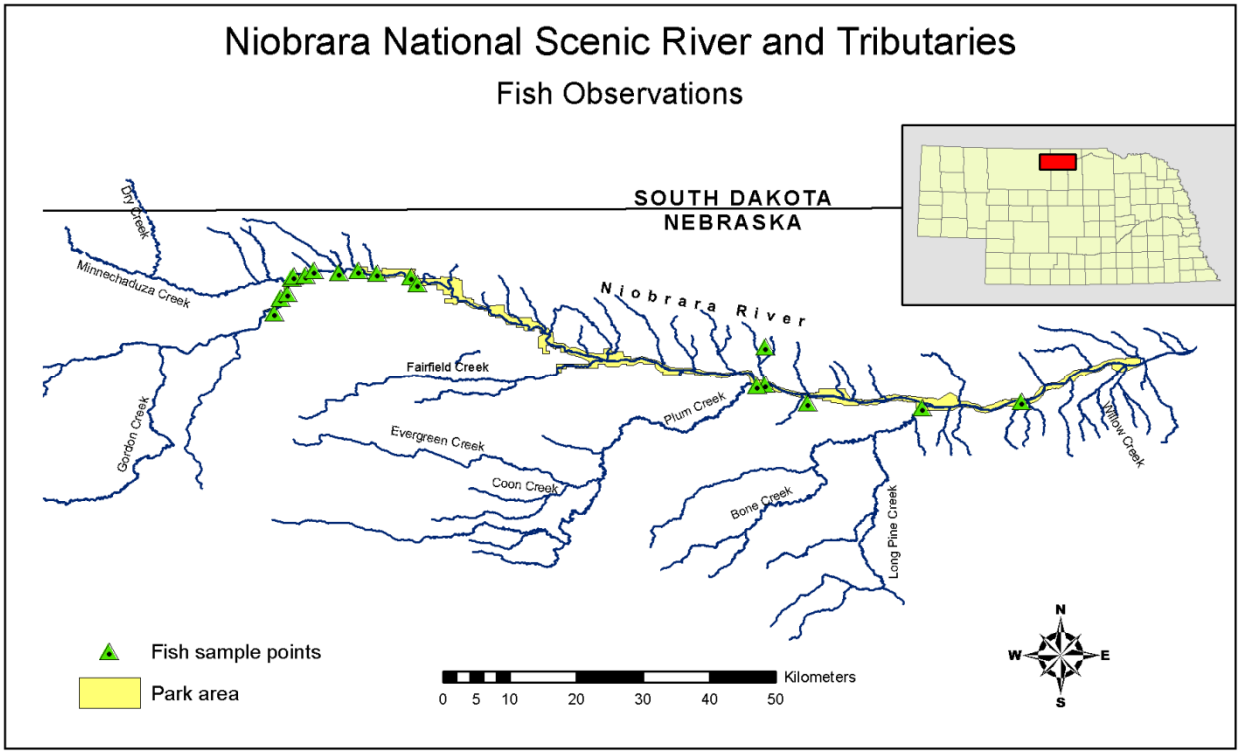


Figure 8. Fish observation sites in the Niobrara River and tributaries (*Source*: Dietsch 2008).

Table 6. Fish species collected using electroshocking and seining techniques at selected sites in the Niobrara River and tributaries (*Source:* Dietsch 2008).

Site Description	Species Identified
Niobrara R below Borman Bridge near Valentine, NE	BMS, BKT, CCF, CCA, GP, LND, NP, RSH, SSH, SRH, STC, WSK
Tributary below Borman Bridge	BKS, PTM
Niobrara Mainstem above Cornell Dam	BMS, BKT, FHM, GP, LND, NP, RSH, SSH, SRH, WSK
Minnechaduza Creek	CCH, LMB, LND, SRH, STC, WSK
Tributary downstream from Refuge Bridge-Tributary 2	None
Niobrara Mainstem just upstream from Fort Falls	BMS, CCA, CCH, GSF, LND, RSH, SSH, SRH, STC, WSK
Big Beaver Creek	BM, CCH, FHM, LND
Crooked Creek	CCH, LND
Kewanee Creek	None
Niobrara Mainstem 1 ½ miles upstream from Smith Falls	BMS, BM, CCA, CCH, FHM, GP, LMB, LND, MC, NP, RSH, SRH, STC, WSV, WSK, YWP
Smith Falls	RBT
Unnamed Tributary 3	None
Long Pine Creek	BMS, BM, BKT, CCH, FHM, LMB, LND, RSH, SSH, SRH, STC, WSK, FHC, BLG, RCS, QCS
Laughing Water Creek	BKT, LND, RSH
Niobrara Mainstem below Meadville Bridge	BMS, BM, CCF, CCH, FHM, LMB, LND, PTM, RSH, SSH, SRH, STC, WSK, FHC, BLG, RCS, QCS
Plum Creek	BMS, BM, CCH, FHM, GSF, LMB, LND, PTM, RSH, SSH, SRH, WSK, BLG, RCS
Niobrara River upstream from Carns Bridge	BMS, BM, CCF, CCA, CCH, FHM, LMB, RSH, SSH, SRH, STC, WSK, FHC, RCS, QCS
Niobrara River downstream of Eglehoff rapids	BMS, CCH, FHM, GSF, LMB, LND, RSH, SSH, SRH, STC, WSK

Note: BLG, bluegill; BMS, bigmouth shiner; BM, brassy minnow; BKS, brook stickleback; BKT, brown trout; CCF, channel catfish; CCA, common carp; CCH, creek chub; FHC, flathead chub; FHM, fathead minnow; GP, grass pickerel; GSF, green sunfish; LMB, largemouth bass; LND, longnose dace; MC, mirror carp; NP, northern pike; PTM, plains top minnow; QCS, quillback carpsucker, RBT, rainbow trout; RCS, river carpsucker; RSH, red shiner; SSH, sand shiner; SRH, shorthead redhorse; STC, stone cat; WSV, western silvery minnow; WSK, white sucker; YWP, yellow perch

Invertebrates

Invertebrate species are largely unknown in the central Niobrara River Valley except for the dragonflies and damselflies, butterflies and skippers, and mollusks (Johnsgard 2007). Forty-five species of dragonflies and damselflies have been reported in or near the Niobrara River Valley and are nearly equally divided between eastern and western geographic affinities (Johnsgard 2007). The butterflies and skippers of the Niobrara Valley Preserve include 148 species, more than 70 percent of the species of butterflies reported for the state of Nebraska and more than 90 percent of the 177 total species known from South Dakota (Dankert and Nagel 1988, Marrone 2002). A high proportion of these species are of widespread distribution (Johnsgard 2007). During a 1992 to 1996 inventory of molluscs at 20 sites on the Niobrara River or tributary streams, only two species of clams (*Anodonta grandis grandis* and *Stophitus undulates*) were collected at two sites (Freeman and Perkins 1997).

Listed Species

No federally-listed endangered or threatened plants are known from the scenic river (U.S. Department of Interior 2006). The small white lady's-slipper orchid (*Cypripedium candidum*), a State of Nebraska At-risk species, occurs in the central Niobrara River Valley (Schneider et al. 2005). Its status in the scenic river is not known.

In terms of animals, the federally-listed interior populations of the least tern (*Sternula antillarum athalassos*) and piping plover (*Charadrius melodus*) nest in the lower reaches of the Niobrara River including a portion of the scenic river (Adolf et al. 1998). Whooping cranes (*Grus americana*) rest and feed along the central Niobrara River Valley for short periods during their spring and fall migrations (Johnsgard 2007). The river otter (*Lontra canadensis*), a state threatened species, has expanded its range in Nebraska following reintroductions in the 1980s and is now occasionally seen in the scenic river (Johnsgard 2007, Nebraska Game and Parks Commission 2009). Three cool-water fishes that inhabit tributaries of the middle Niobrara River are state-listed as either state endangered (blacknose shiner [*Notropis heterolepsis*]) or state threatened (finescale dace [*Phoxinus neogaeus*] and northern redbelly dace [*P. eos*]). Two skippers (Iowa [*Atrytone arogos iowa*] and Ottoe [*Hesperia ottoe*]) and the regal fritillary butterfly (*Speyeria idalia*), At-risk species in Nebraska, are known from the middle Niobrara River Valley and may occur in the scenic river (Johnsgard 2007).

Land and Visitor Use

Cattle ranching is the dominant land use in the more arid western portion of the Niobrara River watershed, whereas row-crop agriculture dominates in the eastern portion. The town of Valentine is located at the western end of the scenic river and has an active tourism industry which is focused on river use. The upper reach of the Niobrara River is noted as one of the country's outstanding rivers for floating and is enjoyed by thousands of canoeists and tubers annually (Shultz 2009) (Fig. 9). A portion of the river flows through a federally designated wilderness in the Fort Niobrara National Wildlife Refuge (U.S. Department of Interior 2006). Hunting, fishing, and trapping also occur within the scenic river boundary although access is often limited by private landowners (U.S. Department of Interior 2006).

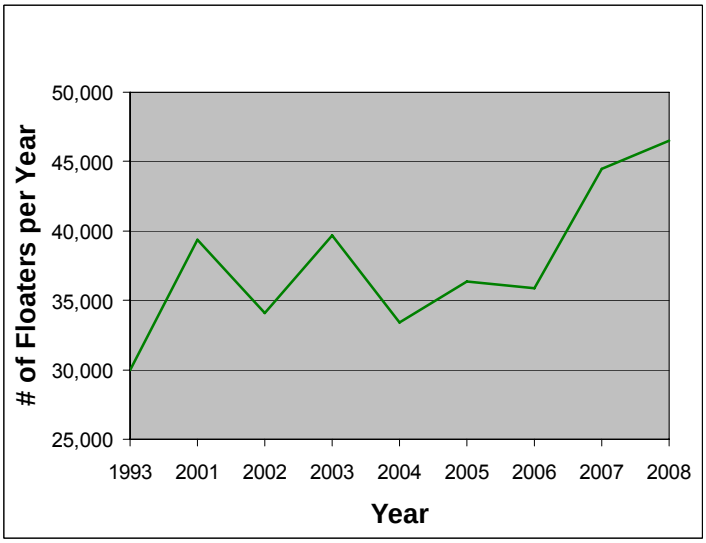


Figure 9. Number of floaters per year, 1993–2008, Niobrara National Scenic River (*Source:* Shultz 2009).

Important Natural Resources

Important natural resources of the scenic river were identified from the discussions of Outstanding Remarkable Values in the final General Management Plan (U.S. Department of Interior 2006). They follow:

Niobrara River water quantity and quality

The Niobrara River is primarily a groundwater-fed stream and has fairly stable flow throughout the year (Istanbulluoglu 2008). Dams constructed to generate power and to hold and divert water for irrigation may impact stream flow, especially in groundwater driven streams such as the Niobrara (Istanbulluoglu 2008). Although water use from the Niobrara River began in the 1940s, a very significant increase in annual diversion began in 1965. This has resulted in a decline in annual runoff and a decline in mean daily flows in all months except January (Istanbulluoglu 2008). The State of Nebraska has designated the Niobrara River as a Class A State Resource Water. Water quality degradation which would adversely affect existing use is not allowed (Nebraska Department of Environmental Quality 2009). This designation also extends to the tributaries of the river.

Tributary springs and waterfalls

Over 230 waterfalls exist on the southern spring branch tributaries of the Niobrara River along a 48-km (30-mile) section of the scenic river (Mason 2005). The spring branch tributaries are groundwater fed from the adjacent Sand Hills and form waterfalls as they erode to the resistant Rosebud Formation. Many of these waterfalls are convex and buttressed, a morphology highly unusual in North America (Mason 2005) (Fig. 10).

Figure 10. Tributary waterfall in the Niobrara National Scenic River (photo by National Park Service).

Diverse plant and animal communities including Pleistocene relicts

The central Niobrara River Valley has unusually diverse plant and animal communities including species representative of northern boreal forest, eastern deciduous forest, Rocky Mountain coniferous forest, tallgrass prairie, Sand Hills prairie, and mixed-grass prairie (Johnsgard 2007) (Tables 7 and 8). This high diversity is primarily due to the river valley providing an unbroken east/west riparian corridor connecting the dryer shortgrass and mixed-grass prairies in the west with the more humid tallgrass prairie and eastern deciduous forest to the east (Kaul et al. 1988). Plants and animals have migrated along this corridor and intermingle in a transition zone centered on the scenic river. Several of the overlapping eastern and western species pairs of birds produce hybrids with new plumage patterns, songs, mate-selection behavior, and breeding adaptations (Johnsgard 2007) (Table 7). Also, as climate changed over geologic time, plants and animals typical of past colder conditions survived due to the cool and wet microclimate of the spring branch canyons (Kaul et al 1988) (Table 8). Paper birch and hybrid aspen, both boreal disjuncts, have declined in recent years possibly due to regional climate variations and the lack of disturbance, such as fire, that provides sites for seed germination (Steuter and Steinauer 1993, Stroh and Miller 2009).

Table 7. Bird species of east-west biogeographic significance in the Niobrara River Valley (*Source*: Johnsgard 2007, Nebraska Game and Parks Commission, J. Jorgensen, non-game program manager, personal communication, 3 November, 2009).

Eastern species	Western species
Northern bobwhite	Western grebe
American woodcock	Clark's grebe
Barred owl (eastern population)	Eared grebe
Whip-poor-will	Cinnamon teal
Chimney swift	Ferruginous hawk*
Red-bellied woodpecker	Prairie falcon*
Blue jay	Golden eagle
Great crested flycatcher	Merlin

Table 7. Bird species of east-west biogeographic significance in the Niobrara River Valley (continued) (*Source*: Johnsgard 2007, Nebraska Game and Parks Commission, J. Jorgensen, non-game program manager, personal communication, 3 November, 2009).

Eastern species	Western species
Red eyed vireo	Long-billed curlew*
Purple martin	Willet
Blue-gray gnatcatcher	Wilson's phalarope
Wood thrush	Common poorwill
Brown thrasher	Black-billed magpie
Black-and-white warbler	Violet-green swallow
American redstart	Pygmy nuthatch
Ovenbird	Rock wren
Northern cardinal (eastern population)	Townsend's solitaire
Orchard oriole	Yellow-rumped warbler
Red-headed woodpecker	Cassin's sparrow*
	Brewer's blackbird
Greater prairie chicken	*Sharp-tailed grouse*
Eastern wood pewee	*Western wood pewee*
Eastern phoebe	*Say's phoebe*
Scarlet tanager	*Western tanager*
Eastern towhee	*Spotted towhee*
Rose-breasted grosbeak	*Black-beaded grosbeak*
Indigo bunting	*Lazuli bunting*
Eastern meadowlark	*Western meadowlark*
Baltimore oriole	*Bullock's oriole*

Note: Closely related (congeneric) species pairs are shown by italics; species with strong Great Plains affinities are indicated by asterisks.

Table 8. Mammals, reptiles, and amphibians of the east-west biogeographic significance in the Niobrara River Valley (*Source*: Johnsgard 2007).

Eastern species	Western species
Mammals	
Northern short-tailed shrew	Merriam's shrew
Least shrew	Little brown myotis
Eastern mole	Townsend's big-eared bat
Evening bat	Bushy-tailed wood rat
Southern bog lemming	Least chipmunk
Woodchuck	Black-tailed prairie dog*
Franklin's ground squirrel	Northern pocket gopher
White-footed mouse	Plains pocket mouse*
Meadow jumping mouse	Olive-backed pocket mouse*
Gray fox	Silky pocket mouse
	Swift fox (very rare)*
	Pronghorn (reestablished)
	Elk (reestablished)
	Bighorn sheep (reintroduced)
Northern myotis	*Western small-footed myotis*
Eastern cottontail	*Desert cottontail*
White-tailed deer	*Mule deer*

Table 8. Mammals, reptiles, and amphibians of the east-west biogeographic significance in the Niobrara River Valley (continued) (*Source*: Johnsgard 2007).

Eastern species	Western species
Reptiles	
Blanding's turtle	Wandering garter snake
Ornate box turtle	Prairie rattlesnake*
Yellow mud turtle	Short-horned lizard
Ringneck snake	
Common (northern) watersna	
Fox snake	
Smooth green snake	
Six-lined racerunner	
Eastern hognose snake	*Western hognose snake**
Amphibians	
Northern cricket frog	
Plains leopard frog	
Great Plains toad	

Note: Closely related (congeneric) species pairs are shown by italics; species with ranges centered on the Great Plains are indicated by asterisks.

Sandy shorelines, sandbars, and wetlands

The lower portion of the scenic river is characterized by a broad flood plain with multiple meandering channels of the river. Sandy shorelines, unvegetated sandbars, and wetlands are common. Endangered whooping cranes are occasionally seen feeding and roosting along this reach of the river during both fall and spring migrations (Austin and Richert 2001). These sightings have become more common in recent years perhaps as the population of migrating birds has increased (Johnsgard 2007) or to heightened awareness of the species by the public. The endangered interior least tern and threatened piping plover feed and nest on unvegetated sandbars and sandy islands from the lower portion of the scenic river downstream to the confluence of the Niobrara and Missouri Rivers (Adolf et al. 1998). Both species nest in exposed habitats often losing their nests to floods, predation, or human disturbance. Exotic plants, especially purple loosestrife, have infested river shorelines and wetlands along the lower scenic river (Narumalani and Swain 2009).

Natural Resource Condition

Condition Assessment Approach for Niobrara National Scenic River

The major habitats in the scenic river, as adapted from Johnsgard (1995) and Ducey (1989), are Niobrara River and tributaries; upland forest and savanna; spring branch canyon and riparian forest; grassland; and sandy shorelines, sandbars, and wetlands. These habitat types provide the ecological framework for the assessment, and their condition and trend are assessed by a suite of biodiversity and process indicators (Table 9). Stressors affecting the condition and trend of these habitats are presented in Table 9, but they are discussed more fully in the section titled "Stressors and Management Strategies."

Table 9. Habitat indicators and stressors.

Habitat	Biodiversity indicator	Process indicator	Stressor
Niobrara River and tributaries (36%)	• Aquatic macroinvertebrates • River otter • Cool-water fish • Fish community • Spiny softshell turtle	• Stream flow	• Water diversion and withdrawal • Water quality degradation • Visitor river floating • Purple loosestrife infestation
Upland forest and savanna (35%)	• Elk • Ponderosa pine	• Land cover • Fire	• Mountain pine beetle infestation (possible) • Woodland expansion (fire suppression) • Drought
Spring branch canyon and riparian forest (10%)	• Paper birch • Hybrid aspen • Bailey's eastern woodrat	• Bird hybridization	• Microclimate in birch stands • Spring branch hiking • Emerald ash borer infestation (possible) • Woodland expansion (fire suppression) • Drought
Grassland (8%)	• Grassland birds • Sand Hills prairie	• Land cover • Fire	• Woodland expansion (fire suppression) • Drought • Leafy spurge infestation
Sandy shorelines, sandbars, and wetlands (10%)	• Interior least tern and piping plover • Purple loosestrife • Whooping crane	• Sediment transport	• Purple loosestrife infestation • Common reed infestation

Note: Habitat percentages are based on land cover interpretations.

Vital signs (i.e., a subset of physical, chemical, and biological elements and processes of park ecosystems that represent the overall health or condition of park resources, see http://science.nature.nps/gov/im/monitor/glossary) of the scenic river that were identified in the Northern Great Plains Inventory and Monitoring Plan (Gitzen et al. 2009) are the basis for 13 of 20 indicators used in this condition assessment (Table 10). The other seven indicators are included based on recommendations in natural resource inventories of the scenic river, recent research reports, proposed research, and policy or legal mandates (i.e., listed species) (Table 10). Indicators are organized by habitat and their condition assessed in the next section.

For most indicators, one or more measures are identified and the existing values of these measures (i.e., existing conditions) are compared to reference conditions suggested by historical data, monitoring data from the scenic river or an environmentally similar area, or expert opinion (Table 11). Ideally, reference conditions should be based on the range of variation in natural ecosystems; but for the Niobrara River watershed, quantitative baselines that predate significant human disturbance do not exist except for pre-settlement fire histories. For five indicators, no condition assessment is possible due to inadequate, site-specific information. They are included to highlight rare or unique resources and important information needs.

An indicator is considered in good condition when 50% or more of its measures have values that correspond with or fall within a range of reference values (see Dobbie et al. 2006). Conversely, an indicator is considered in poor condition when less than 50% of its measures have values that correspond with or fall within a range of reference values (see Dobbie et al. 2006). Trend is noted for an indicator that has a measure or measures with multiple year data that are similar (stable) or different (deteriorating or improving). Indicator condition is summarized by a red box (indicating poor), a green box (indicating good), or an open box (no assessment). Trend is indicated by a downward arrow (deteriorating), a horizontal arrow (stable), an upward arrow (improving), or no arrow (no trend or insufficient data). Details of each indicator assessed, including a summary of sampling method and data analysis, are available in Appendix A. A summary of GIS (Geographic Information Systems) products derived from indicator sources are available in Appendix B.

Table 10. Indicators, corresponding vital signs, and primary information sources used in this condition assessment.

Indicator	Vital sign[a]	Information source[b]
Aquatic macroinvertebrates	Aquatic macroinvertebrates	Research
River otter	None	Monitoring
Cool-water fish	None	Monitoring
Fish community	None	Monitoring
Spiny softshell turtle	None	Proposed research
Stream flow	Surface water dynamics	Gauge record
Elk	None	Research
Ponderosa pine	Upland plant communities	Research
Land cover	Land cover and use	Satellite data

Table 10. Indicators, corresponding vital signs, and primary information sources used in this condition assessment (continued).

Indicator	Vital sign[a]	Information source[b]
Fire	Extreme disturbance	Research
Paper birch	Riparian/floodplain plant communities	Research
Hybrid aspen	Riparian/floodplain plant communities	Assessments of stand health
Bailey's eastern woodrat	None	Research
Bird hybridization	Land birds	Research
Grassland birds	Land birds	Research
Sand Hills prairie	Upland plant communities	Research
Interior least tern and piping plover	Interior least tern and piping plover	Monitoring
Purple loosestrife	Treatment of exotic infestations	Monitoring
Whooping crane	Land birds	Monitoring
Sediment transport	None	Research

[a] Vital signs not included as indicators are Stream/River Channel Characteristics, **Surface Water Chemistry**, Aquatic Contaminants, **Exotic Plant Early Detection**, **Visitor Use**, and Soundscape. The vital signs not included and in bold are discussed as stressors.
[b] Primary source of information used to assess the condition of indicators; see Table 11 for references for information sources.

Table 11. Niobrara National Scenic River natural resources summary.

Habitat	Indicator	Measure	Reference condition	Existing condition	Source
Niobrara River and tributaries (36%)	Aquatic macroinvertebrates (Niobrara River)	EPT richness HBI (0–10 index)	0–7 4.41–7.55	7 4.72	Troelstrup 2006, Rust 2006
	Aquatic macroinvertebrates (tributaries)	EPT richness HBI (0–10 index)	2–8 3.5–7.5	3 Berry Falls 4 Fort Falls 5 Smith Falls 5.13 Berry Falls 4.57 Fort Falls 3.53 Smith Falls	
	River otter	None			
	Cool-water fish	Presence (no. of tributaries)	1 (blacknose shiner) 2 (finescale dace) 3 (northern redbelly dace) 2 (pearl dace)	1 (blacknose shiner) 4 (finescale dace) 4 (northern redbelly dace) 3 (pearl dace)	Schainost 2008
	Fish community	Richness CPUE (fish/ft.)	24/30 0.467–3.035	27/30 0.612	Kantck and Churchill 1993, Gutzmer et al. 2002, Dietsch 2008
	Spiny softshell turtle	None			
	Stream flow (Niobrara River)	Mean annual flow (acre ft.) Mean daily discharge (cfs)	434,448–659,742 ~750 (July) ~700 (Aug.) ~720 (Sept.)	491,086 ~570 (July) ~520 (Aug.) ~550 (Sept.)	Wen and Chen 2006, Istanbulluoglu 2008
Upland forest and savanna (35%)	Elk	Calf:cow ratio Cow survival (%) Ave. rate of increase	0.30–0.35 89–91% 0.20–0.31	0.31–0.57 92% 0.21	Stillings 1999, Frickle et al. 2008, Rapid City Journal 2009
	Ponderosa pine	Mean fire interval (yrs.) Density (trees/ha) Fire type Extent (ha/study site)	8.6 380 Surface 83–123 (1939)	36.0 2,250 Crown 235–219 (2003)	Tolstead 1947, Steinaur and Bragg 1987, Guyette 2005, Narumalani 2009a

Table 11. Niobrara National Scenic River natural resources summary (continued).

Habitat	Indicator	Measure	Reference condition	Existing condition	Source
Upland forest and savanna (35%) (continued)	Land cover	Contagion index ShDI index	68.68 0.8551	70.58 0.8255	Narumalani 2009b
	Fire	Mean fire interval (yrs.) Fire type	8.6 Surface	36.0 Crown	Guyette 2005
Spring branch canyon and riparian forest (10%)	Paper birch	Saplings (no./ha) Seedlings (no./ha) Dead trees (no./ha) Live trees (no./ha) Basal area (m^2/ha)	19,760 30,000 ? ? 1,235-1,482	0.64 0 19.5 17.6 6.0	Uchyll 1991, Steuter and Steinauer 1993, Stroh and Miller 2009
	Hybrid aspen	Mature trees (no.) Root suckers (no.)	Many? Many?	Few Few or none	Schlarbaum 2008, Shepperd 2008
	Bailey's eastern woodrat	Density (no./ha)	0.5–2.2	0.72	Rainey 1956, Barbour and Humphry 1982, Frost 2007
	Bird hybridization	None			
Grassland (8%)	Grassland birds	Density (no./ha)	1.25–2.68	1.08–1.16	Frost 2007
	Sand Hills prairie	Mean fire interval (yrs.) Woodland extent (ha/study site)	8.6 83–123 (1939)	36.0 235–219 (2003)	Guyette 2005, Narumalani 2009a
	Land cover	Contagion index ShDI index	68.68 0.8551	70.58 0.8255	Narumalani 2009b
	Fire	Mean fire interval (yrs.) Fire type	8.6 Surface	36.0 Crown	Guyette 2005

Table 11. Niobrara National Scenic River natural resources summary (continued).

Habitat	Indicator	Measure	Reference condition	Existing condition	Source
Sandy shoreline, sandbars, and wetlands (10%)	Interior least tern and piping plover	Monitoring reach census (no.) Clutch size (mean no./nest) Nest success (%) Fledging success (%)	150–321 (tern) 79–207 (plover) 2.3–2.6 (tern) 3.5–3.7 (plover) 36–69 (tern) 25–83 (plover) 13–88 (tern and plover)	289 (tern) 207 (plover) 2.6 (tern) 3.6 (plover) 52 (tern) 35 (plover) 37 (tern) 36 (plover)	Adolf et al. 2001, Ferland and Haig 2002, Jorgensen 2006, Wilson 2007
	Purple loosestrife	Area (ha)	0 (pre-settlement) 954 (2002)	469	Narumalani and Swain 2009
	Whooping crane	None			
	Sediment transport	None			

Indicator Assessment

Habitat: Niobrara River and Tributaries

Indicator: Aquatic Macroinvertebrates (water quality)
Source for Reference Condition: Macroinvertebrate Sampling in Similar Streams in Parks of the Northern Great Plains


Macroinvertebrate sampling in a tributary of the Niobrara River

Aquatic macroinvertebrates can reveal whether a body of water is healthy or unhealthy based on the presence or absence of certain sensitive species, as well as the overall diversity of organisms. Different species show different sensitivity to pollution and changing stream conditions, with Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddis fly) (referred to as EPT) being among the most sensitive orders and Chironomidae, worms and midges, being less sensitive (U.S. Environmental Protection Agency 1997). Macroinvertebrates have been collected from several sites encompassing the entire Niobrara River basin in 1998, 2000, and 2008 by the Nebraska Department of Environmental Quality, however, study sites within the boundaries of the scenic river were limited (Nebraska Department of Environmental Quality, K. Bazata, surface water section, personal communication, 20 November, 2009). In 2004 and 2005, Rust (2006) sampled macroinvertebrates in the mainstream Niobrara River and three of its tributaries (Berry Falls, Fort Falls, and Smith Falls) within the scenic river (Fig. 11), and in aquatic systems in parks of the Northern Great Plains (Fig. 12). Several metrics were compared including EPT richness and the modified Hilsenhoff Biotic Index (HBI). EPT richness is the number of taxa (genera or species) in these three pollution sensitive orders, and HBI is a measure of water quality based on the tolerance of specific organisms to organic pollution and associated decline in dissolved oxygen concentrations. High EPT values and low HBI values are indicators of better water quality (U.S. Environmental Protection Agency 1997).

The Niobrara River was dominated by Ephemeroptera and non-insects, and intolerant organisms (22 percent) outnumbered tolerant (17 percent) in both abundance and richness. EPT richness was seven, and EPT was a dominant 54.4 percent (Rust 2006). Compared to other medium and large rivers in the Great Plains, the composition of the macroinvertebrate community of the Niobrara River indicates it is in excellent condition (Troelstrup 2006). Richness metrics were all higher than median values for other large rivers in the northern Great Plains parks. Furthermore, percent contribution of EPT was high and contribution of Chironomidae and average tolerance to organic pollution (HBI) was lower than median values for other rivers (Troelstrup 2006) (Fig. 13).

Berry Falls, Fort Falls, and Smith Falls tributaries were similar to the Niobrara River in that the macroinvertebrate communities all had greater numbers of intolerant than tolerant organisms. Smith Falls had the highest EPT richness (5) and lowest HBI (3.53), suggesting it had the best water quality to support sensitive macroinvertebrate species. Berry Falls had the lowest EPT richness (3) and highest HBI (5.13), indicating signs of impairment (or not able to support designated uses) compared to the other tributaries studied. Fort Falls had an EPT richness of 4, and a HBI of 4.57. Comparing median values of the tributaries to other small streams in the

Northern Great Plains, Berry Falls is somewhat impaired, Fort Falls is slightly impaired, and Smith Falls is in moderately good condition (Troelstrup 2006) (Fig. 14).

This indicator is in good condition and the trend is unknown.

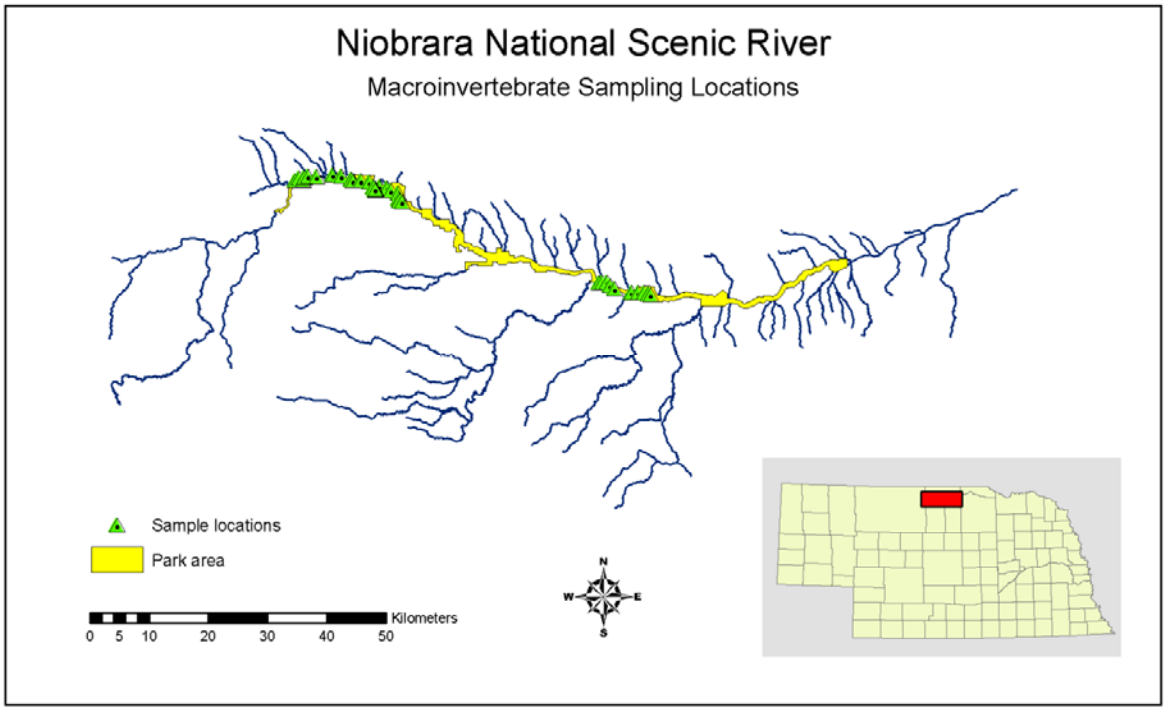


Figure 11. Aquatic macroinvertebrate sampling sites in Niobrara National Scenic River (*Source*: Rust 2006).

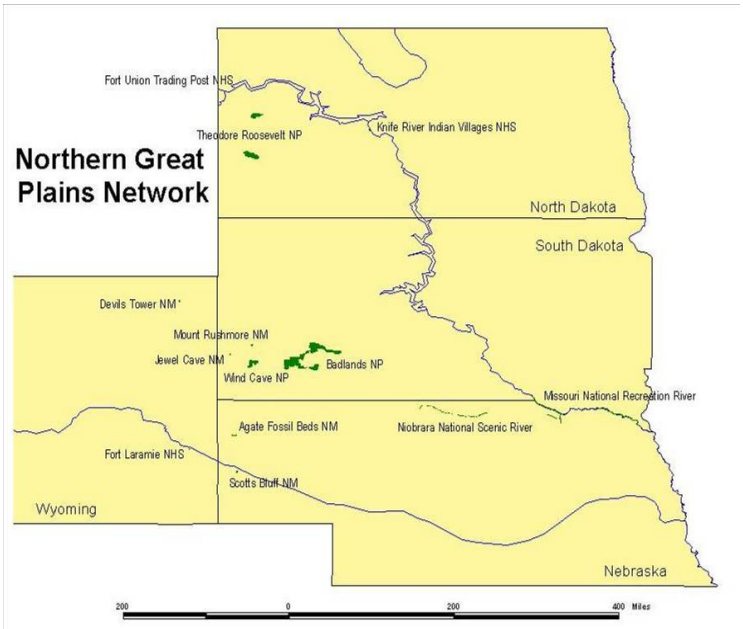


Figure 12. National park units of the Northern Great Plains Network sampled for aquatic macroinvertebrates (*Source:* Rust 2006).

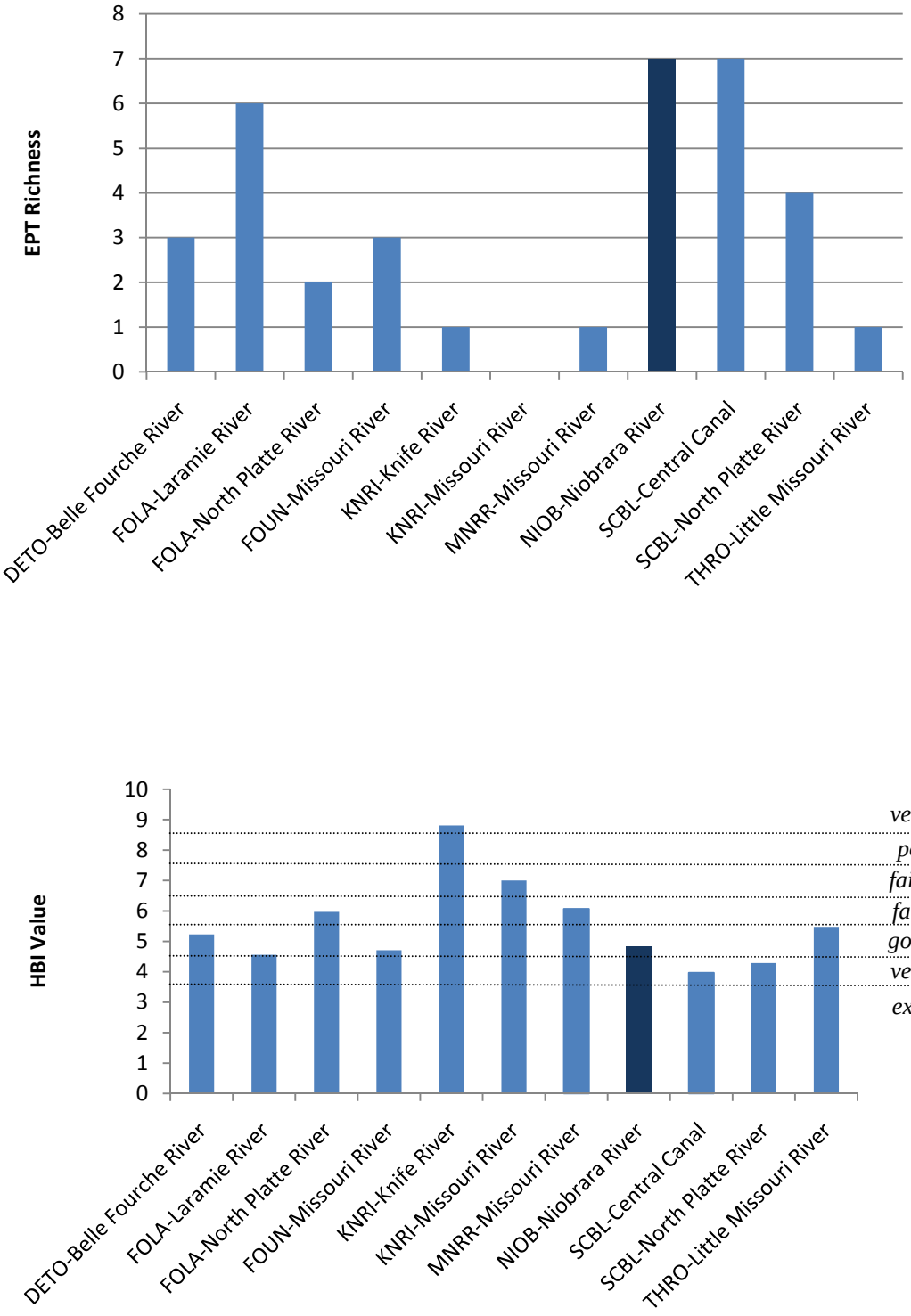
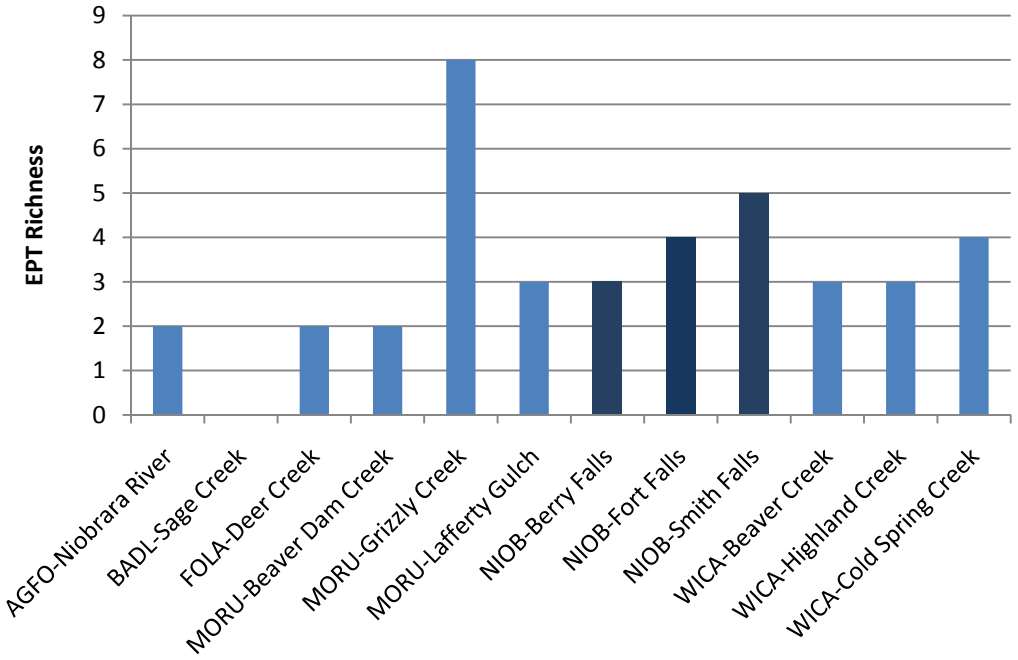


Figure 13. Median EPT richness and HBI value for medium and large rivers of the Northern Great Plains Network. *Note:* The median EPT Richness for KNRI-Missouri River equals zero. DETO=Devil's Tower National Monument; FOLA=Fort Larned National Historic Site; FOUN=Fort Union Trading Post National Historic Site; KNRI=Knife River Indian Villages National Historic Site; MNRR=Missouri National Recreation River; NIOB=Niobrara National Scenic River, SCBL=Scotts Bluff National Monument; THRO=Theodore Roosevelt National Park (*Source:* Rust 2006, Troelstrup 2006).



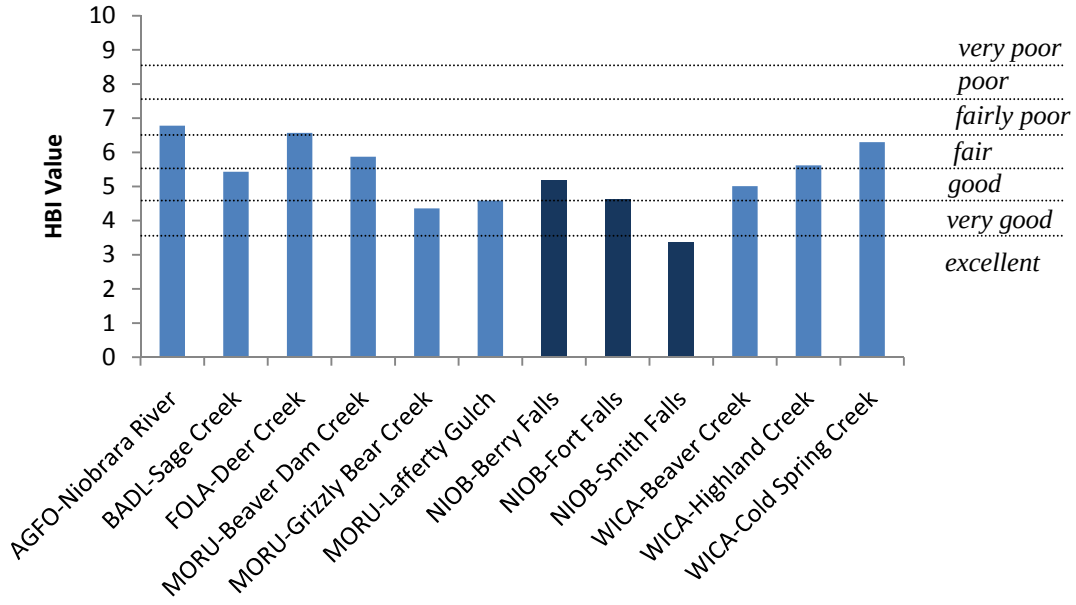


Figure 14. Median EPT richness and HBI value for small streams of the Northern Great Plains Network. NOTE: the median EPT Richness for BADL equals zero. AGFO=Agate Fossil Beds National Monument; BADL=Badlands National Park; FOLA=Fort Larned National Historic Site; MORU=Mount Rushmore National Memorial; NIOB=Niobrara National Scenic River; WICA=Wind Cave National Park (*Source:* Rust 2006, Troelstrup 2006).

Indicator: River Otter
Source for Reference Condition: Not Established

The river otter is widely distributed across North America in a variety of aquatic habitats including marine coasts, lakes, marshes, reservoirs, and streams (Toweill and Tabor 1982, Larivere and Walton 1998). The primary habitat requirement for river otters is permanent water with abundant fish or crustacean prey and relatively high water quality. In addition, river otters require riparian vegetation as cover when they are feeding, denning, and moving on land. Because of their high mobility and low densities, river otters require relatively long reaches of streams and rivers.


River otter

In Nebraska, the river otter was historically common in all major river drainages (Jones 1962, 1964) but they were rare by 1908 and apparently were extirpated from the state in the early 1900s (Jones 1964). Unregulated trapping was most likely the primary cause (Nebraska Game and Parks Commission 2009b). Between 1986 and 1991, more than 150 river otters were released at seven sites across the state including a site on the Niobrara River in Sheridan County (upstream from the scenic river) (Nebraska Game and Parks Commission 2009b). River otters were listed as endangered in Nebraska in the 1980s and reclassified as state threatened in 2005.

The State of Nebraska conducts annual monitoring for river otters by searching for otter signs at bridge crossings that are located near release sites. The results of these surveys and sightings of otter family groups suggest that viable populations have become established in portions of several watersheds (Nebraska Game and Parks Commission 2009b) (Fig. 15). Biologists expect river otters to expand their ranges from the release sites into other suitable habitats. River otters have been sighted in the scenic river portion of the Niobrara River (Johnsgard 2007) but these may be transient individuals. Although suitable habitat exists within the scenic river, river otters may avoid these areas because of high human use. High density recreational use along waterways may adversely affect river otters by altering their habitat use and daily activity patterns (Giere and Eastman 2000).

The river otter population is likely increasing in the Niobrara River watershed but a resident population has not been found in the scenic river. This indicator is not assessed due to lack of information.

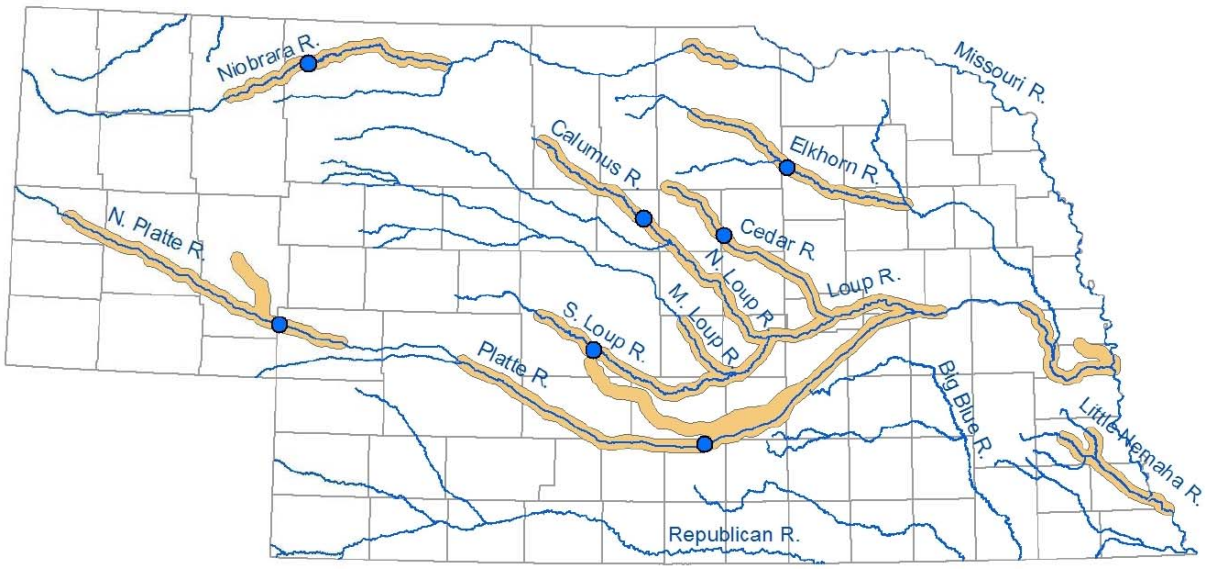


Figure 15. River otter distribution in Nebraska (*Source*: Nebraska Game and Parks Commission 2009).

Indicator: Cool-water Fishes
Source for Reference Condition: Historic Sampling in Tributary Streams to the Niobrara River and State Listing


Blacknose shiner, photo by National Park Service

Four rare, cool-water fish species are native to the Niobrara River watershed in north-central Nebraska. The blacknose shiner is state-endangered, the finescale dace and northern redbelly dace are state-threatened, while the pearl dace (*Margariscus margarita*) is a Species At-risk (Tier 1) (Schneider et al. 2005). Populations of these species are glacial relicts of more typical northern species that persist outside of their primary geographic range following repeated glaciations (Hrabik 1990). The spring-fed Niobrara River and its tributaries provide cool, clear, slow-moving, and well-vegetated waters that are critical for survival of these species in Nebraska.

Historically, the blacknose shiner was one of the most common fish species sampled in north-central Nebraska (Schainost 2008). However, it is now documented at infrequent intervals and in very low abundance; it was last recorded in 1995 (Schainost 2008). The finescale dace and northern redbelly dace have been sampled more frequently and consistently, but in relatively small numbers. The pearl dace is quite common in localized areas (Schainost 2008), but its preferred habitat is limited (Cunningham 2006). None of these species have been recorded directly in the scenic portion of the Niobrara River. However, they have been found in multiple tributaries to the scenic river (Schainost 2008) (Fig.16). Several additional streams within a 10-mile radius of the scenic river also support these species.

Between 1893 and 2004, the Niobrara River and its tributaries were sampled for fish species numerous times but sample sites and methods used varied during this period of monitoring

(Schainost 2008). Therefore, it is impossible to identify statistical population trends for cool-water species based on occurrence data (Table 12). However, three of these fishes inhabit the same tributaries that they were found in historically (1893–1939), and they were discovered in other tributaries in recent years (these tributaries may not have been previously sampled). The blacknose shiner is found in only one of the tributaries that it occupied historically, but like the other species, it was discovered in additional tributaries.

This indicator is in good condition based on the long-term persistence of these species in a few tributaries and the greater number of tributaries in which they now occur. Indicator trend is not known. However, this assessment is tenuous given that these fish species are of conservation concern in Nebraska due to their restricted habitat which faces a variety of threats such as increased turbidity, siltation, introduction of non-native fish, increased groundwater pumping, and climate change (Schneider et al. 2005).

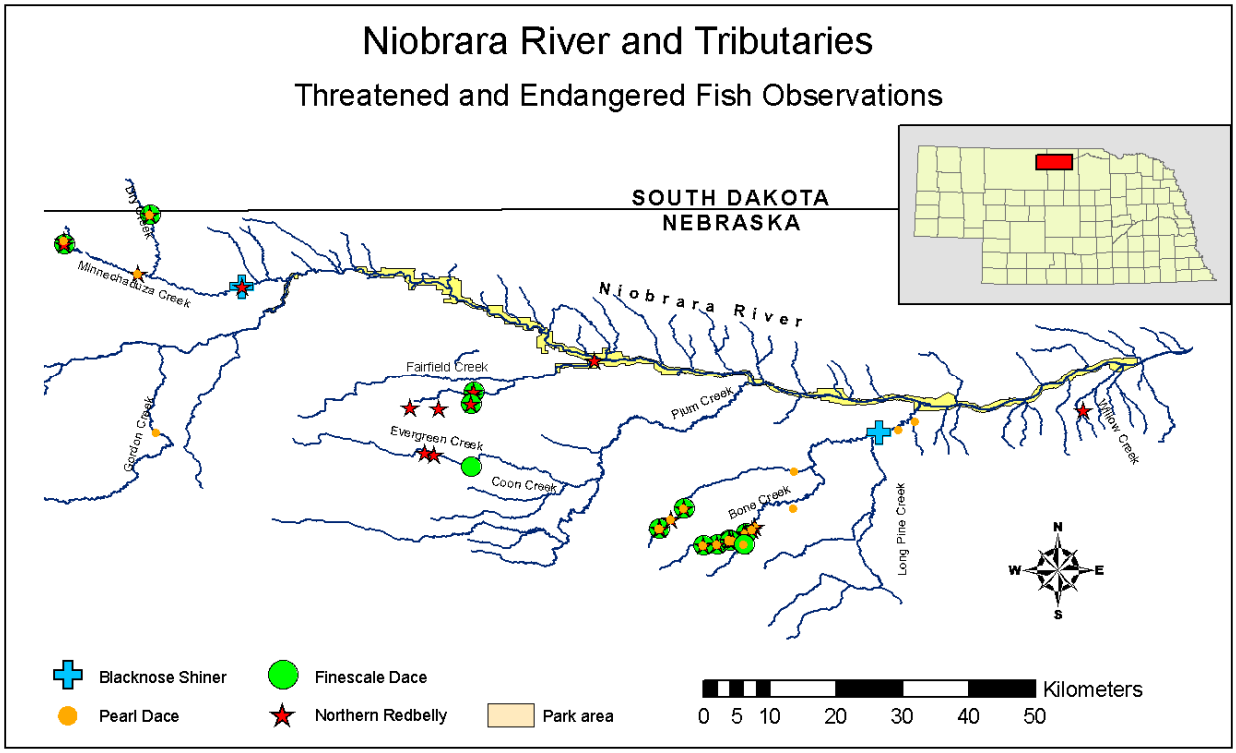


Figure 16. Location of cool-water fish collection sites in tributary streams of the Niobrara River (*Source:* Schainost 2008).

Table 12. Presence of blacknose shiner (b), finescale dace (f), northern redbelly dace (n), and pearl dace (p) in tributary streams of the Niobrara River (*Source*: Schainost 2008).

Streams	1893-1939	1963-1973	1974-1985	1986-2004
Bone Creek		n	fnp	fnp
Coon Creek				n
Cottonwood Creek		p		bfnp
Dry Creek				fnp
Evergreen Creek				fn
Fairfield Creek				n
Gordon Creek	bfnp			bfp
Long Pine Creek	b			p
Minnechuduza Creek	bn		fn	fnp
Niobrara River			b	
Sand Creek				f
South Fork Fairfield Creek		n		nf
Spring Branch				p
Willow Creek				bfnp

Indicator: Fish Community
Source for Reference Condition: Fish Species Sampling in 1982 and Fish Population Trends Below Spencer Dam


Channel catfish

The first significant study of the fishes of the Niobrara River and its tributaries occurred in 1973 as part of a Nebraska statewide stream basin survey (Mestl 1993). A total of 41 species were collected by seining. The second major study occurred from 1976 through 1978 when the Niobrara River was intensively sampled (by seining, hoopnetting, and explosives) above and below Spencer Dam (located about 62 km [38 miles] downstream of the scenic river) (Mestl 1993). That inventory was repeated in 1991 using the same sampling methods used during the 1976-1978 study. Between 1978 and 1991, some species, mainly habitat and/or food specialist such as the sand shiner, declined (as measured by catch per unit of effort or CPUE) while others, mainly generalist such as the channel catfish, increased (Mestl 1993) (Table 13).

In a study to determine fish population trends below Spencer Dam, sampling (seining and electroshocking) was conducted each fall from 1993 through 2001, except no sampling was done in 1993 (Gutzmer et al. 2002). Over the nine years of the study, the species most observed were the sand shiner, red shiner, and flathead chub (*Platygobio gracilis*). The CPUE for all species ranged from 0.467 fish/foot to 3.035 fish/foot and was not significantly different between years for shocking ($p=0.4879$), seining ($p=0.4879$), and total number of fish sampled ($p=0.1164$) (Gutzmer et al. 2002).

Specific to the scenic river, fish species were sampled in a 50-km (31-mile) reach of the Niobrara River (Niobrara Valley Preserve) in 1982 (Kantak and Churchill 1993) and a 56-km (35-mile)

reach of the river from Borman Bridge to Carns Bridge in 2003–2005 (Dietsch 2008). Twenty-four species were collected in the earlier study and twenty-seven in the later study. Neither study reported fish abundance or CPUE but Dietsch (2008) noted that several fish species were widespread and several others were confined to reaches downstream from the Norden Dam.

This indicator is in good condition and steady based on the high diversity of fish species in the scenic river (27 of 30 known species) and no significant difference among years in fish species richness below the Spencer Dam.

Table 13. Catch per unit effort (CPUE) of fish species from the Niobrara River in 1978 and 1991 (*Source:* Mestl 1993).

Species	1978	1991
Sand Shiner	37.8	1.2
Red Shiner	15.1	10.9
Flathead Chub	11.5	5.0
Channel Catfish	5.4	10.8
Green Sunfish	0.9	< 0.1
River Carpsucker	0.8	6.0
Bluegill	0.3	0.2
Shorthead Redhorse	0.2	< 0.1
Emerald Shiner	1.0	1.8
Silvery Minnow	1.0	< 0.1
Carp	< 0.1	< 0.1
Spotfin Shiner	< 0.1	0.2
Sauger	< 0.1	0.2

Indicator: Spiny Softshell Turtle
Source for Reference Condition: Not Established

The spiny softshell turtle is found in both lakes and rivers, especially those with mud or sand bottoms, throughout Nebraska (Freeman 1998). The species is known to inhabit much of the Niobrara River Valley but information is lacking on population size and distribution, habitat characteristics, and response to disturbance (Allen 2008).

Spiny softshell turtle

The spiny softshell turtle is long-lived with a life expectancy of 50 years or more (Freeman 1998). Individuals are active during the day and feed on aquatic plants, a variety of invertebrates, and some small vertebrates. The spiny softshell turtle is the most aquatic of turtles in Nebraska, preferring to bask on logs or banks and to nest on banks close to the water. The turtle is sensitive to disturbance and will quickly abandon basking sites when approached (Allen 2008). Additionally, turtles rest buried in sand in shallow water. These activity patterns make this turtle especially sensitive to disturbance from canoes and other recreation activities on the Niobrara River (Allen 2008). In addition, decreasing stream flow of the Niobrara River threatens to limit the habitat available to this species (Allen 2008).

This indicator is not assessed due to the lack of site-specific information. A study to evaluate the potential effects of recreational use of the Niobrara River on the species is proposed for 2009–2011 (Allen 2008).

Indicator: Stream Flow
Source for Reference Condition: An Analysis of Long-Term Gauge Records of Stream Flow

The Niobrara River and its tributaries are in hydraulic connection with the aquifers in the region and, in most years, groundwater seepage accounts for 90 to 95 percent of the river's total discharge (Nebraska Department of Natural Resources 2004). Stream flow is affected by both climatic factors (precipitation and temperature) and groundwater withdrawal. Stream flow, sediment load, and other factors determine channel morphology which acts as a template for aquatic and bottomland ecological processes (Naiman et al. 1993, Scott at al. 1996).


Niobrara River, photo by National Park Service

In 2005, a study conducted in Nebraska and northwestern Kansas, analyzed trends in precipitation and temperature for 28 weather stations, and stream flow for 110 gauging stations in eight major river basins (Wen and Chen 2006). Analyses of precipitation and temperature showed no significant trends over a 50-year period. For 12 stream flow gauges in the Niobrara River Basin, three showed significant downtrends in stream flow, two showed significant uptrends, and the remaining seven showed no trends (Table 14). The analysis used in this study (Mann-Kendall test) was appropriate for detecting monotonic, or gradual and continuing, trends in stream flow over an extended period of time but not for detecting sudden changes (U.S. Geological Survey, R. Zelt, associate director NAWQA, personal communication, 7 October 2009). Two of the stations with decreasing trends are located in Box Butte County in northwestern Nebraska, a region that has experienced a large decline in the water table likely due to heavy irrigation use (Wen and Chen 2006). Only one of the 12 gauges with a complete record is located on the Niobrara River within the scenic river boundary (station 6461500 near Sparks, Nebraska) (Fig. 17). That station showed no significant trend in stream flow over the 58-year gauge record (Table 14).

Table 14. Annual mean stream flow trend results in the Niobrara River using Mann-Kendall test (*Source*: Wen and Chen 2006).

Basin	Station ID	Drainage (mile^2)	Period	Z-score	P-value	Trend
Niobrara	6444000	313	1947–2003	2.361	0.018	Increasing
	6453500	505	1949–1994	-1.086	0.278	Insignificant
	6453600	812	1957–2003	1.212	0.226	Insignificant
	6454500	1,400	1946–2003	-2.912	0.004	Decreasing
	6455500	1,460	1946–2003	-3.428	0.001	Decreasing
	6457500	4,290	1945–1991	-2.708	0.007	Decreasing
	6459500	660	1947–2003	-1.675	0.094	Insignificant
	6461000	390	1948–1994	-0.757	0.449	Insignificant

Table 14. Annual mean stream flow trend results in the Niobrara River using Mann-Kendall test (continued) (*Source*: Wen and Chen 2006).

Basin	Station ID	Draingage ($mile^2$)	Period	Z-score	P-value	Trend
Niobrara	6461500	7,150	1945–2003	-1.529	0.126	Insignificant
	6463500	458	1948–2003	2.367	0.018	Increasing
	6465000	11,070	1940–2001	1.699	0.089	Insignificant
	6465500	11,580	1938–2003	1.804	0.071	Insignificant

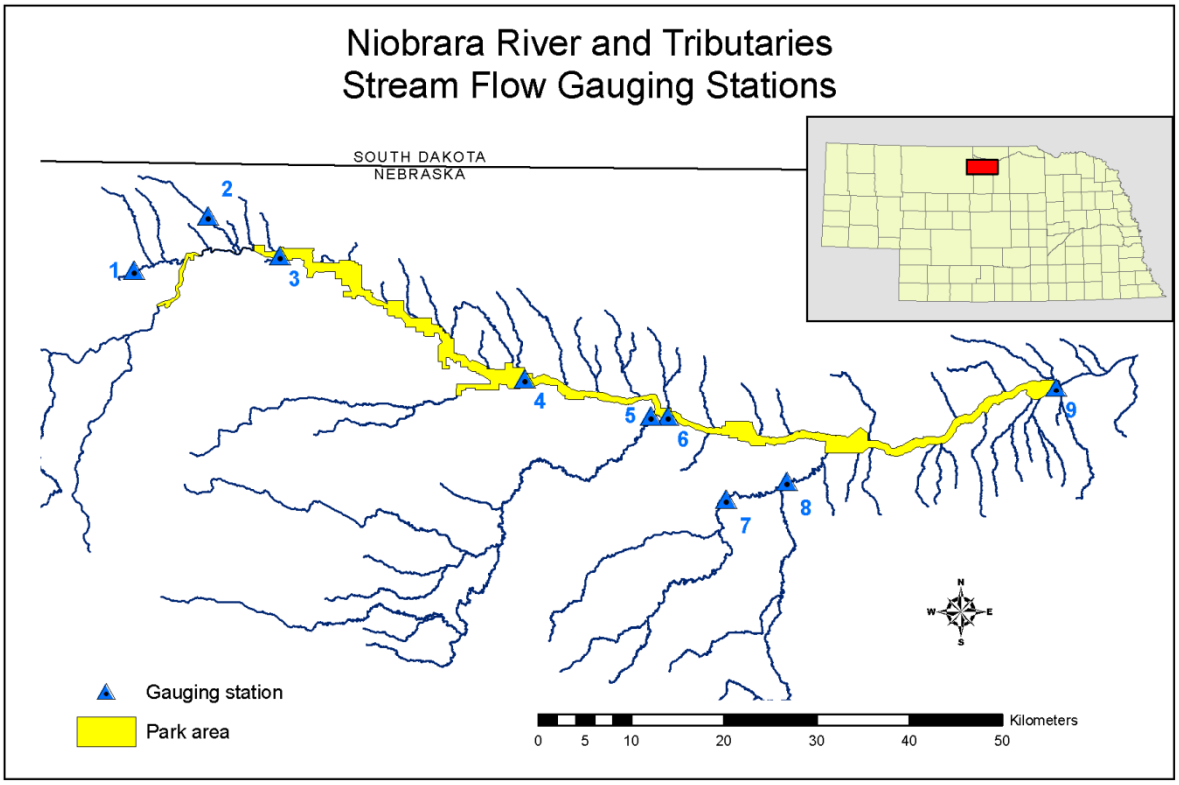


Figure 17. Location of nine stream flow gauges in or near the Niobrara National Scenic River. The gauge near Sparks is indicated by the number 6 (*Source*: Istanbulluoglu 2008).

Merritt Dam on the Snake River (a tributary of the Niobrara River upstream of the Sparks gauge) began storing water in February 1964 for the Ainsworth irrigation project. In a recent study, hydrological implications of water storage and diversion on the Snake River to stream flow in the Niobrara River were investigated by separating the Niobrara River flow data into before 1965 and after 1964 periods (Istanbulluoglu 2008). This study showed a significant downward step trend (sudden change) in annual runoff in the Niobrara River at the Sparks gauge after 1964 but no difference in precipitation for the same periods (i.e., before 1965 and after 1964) (Istanbulluoglu 2008) (Fig. 18). Also, in all months except January, mean daily flows declined after 1964 with the greatest declines occurring in the summer months of July (24.4 percent), August (25.0 percent), and September (24.7 percent) (Fig. 19). Standard deviation of the mean daily flows in each month were also altered following major water storage and diversion in the watershed (Fig. 19).

A demonstration study of hydraulic microhabitats at the Sparks gauge on the Niobrara River found deeper hydraulic niches are only available during periods of higher stream discharge (Alexander et al. 2009). However, a more detailed analysis is needed before determining what effects future water deletions in the Niobrara River watershed might have on higher stream discharge and deeper microhabitats and associated aquatic organisms (Alexander et al. 2009). This indicator is in poor condition and declining based on a sudden and ongoing decrease in annual and daily flows at the Sparks gauge and uncertainty over the effects of these decreases on aquatic habitats and organisms. This assessment is supported by American Rivers 2008 designation of the Niobrara River as one of America's most endangered rivers based on irrigation diversions and lack of an in-stream flow water right for the scenic river (American Rivers 2008).

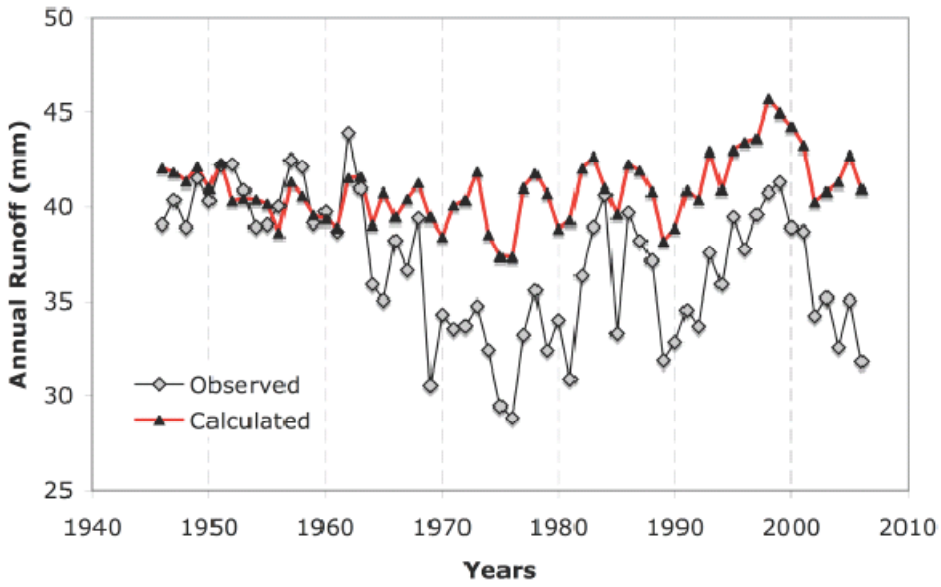


Figure 18. Annual model run without water diversions from the Niobrara River. Observed is annual runoff as measured by the gauge at Sparks. Calculated is modeled annual runoff without water diversions in the Niobrara River Basin (*Source*: Istanbulluoglu 2008).

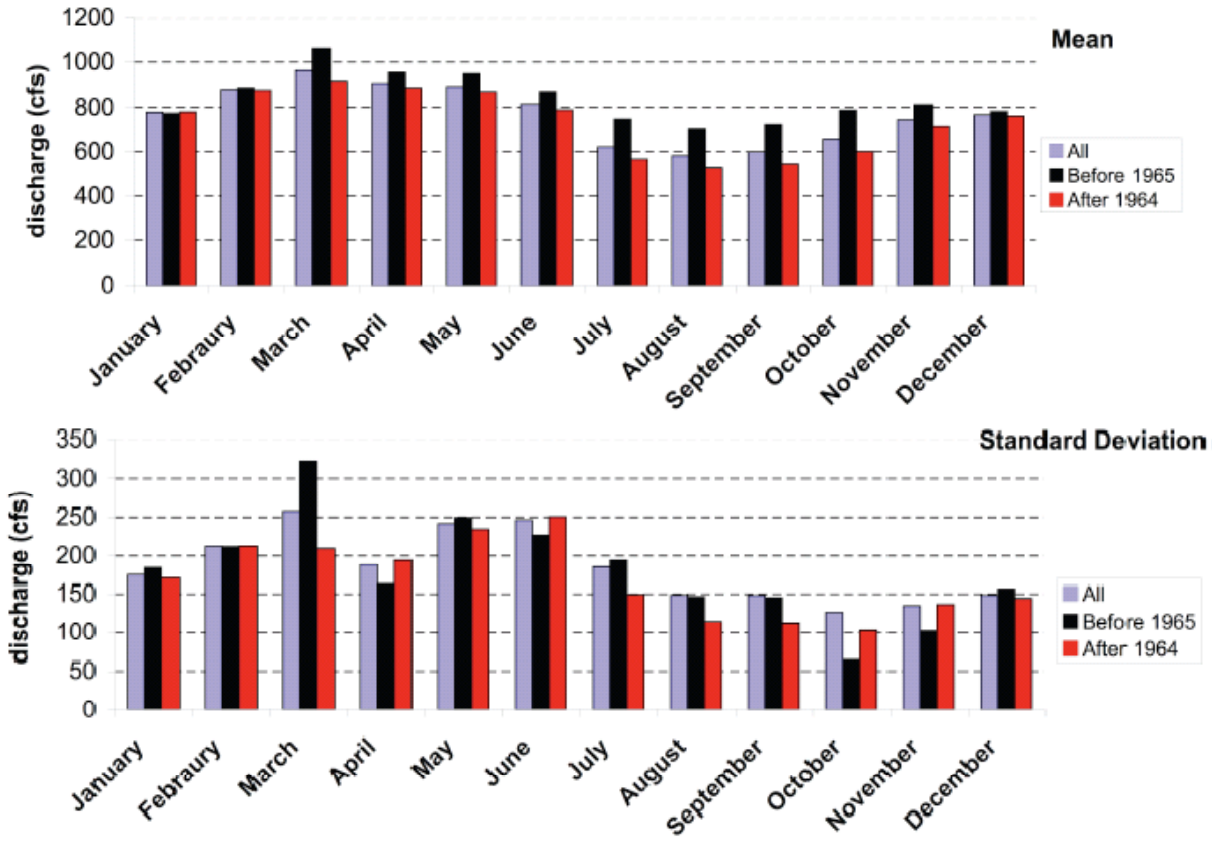


Figure 19. The mean and standard deviation of daily stream flow at Sparks, Nebraska (Source: Istanbulluoglu 2008).

Habitat: Upland Forest and Savanna

Indicator: Elk
Source for Reference Condition: Demographic Measures of Elk in Re-established Herds

Elk

Elk are native to Nebraska but were extirpated from the state in the early 1880s as a result of unregulated market and subsistence hunting (Frickle et al. 2008). Elk began to migrate into western Nebraska in the 1950s and 1960s from reestablished herds in Wyoming, and by the early 1970s, a herd had become established in the Pine Ridge of Northwestern Nebraska. In addition to the Pine Ridge, elk re-colonized four other areas in northern and central Nebraska after the late 1980s. Elk herds are now found along the length of the North Platte River from the Wyoming border to Lake McConaughy, in Lincoln County in central Nebraska, in Boyd County in northeast Nebraska, and along the Niobrara River in Cherry and Sheridan counties (Frickle et al. 2008) (Fig. 20). Individuals from the herds in northern Nebraska are occasionally observed within the boundary of the scenic river (U.S. Department of Interior 2006).

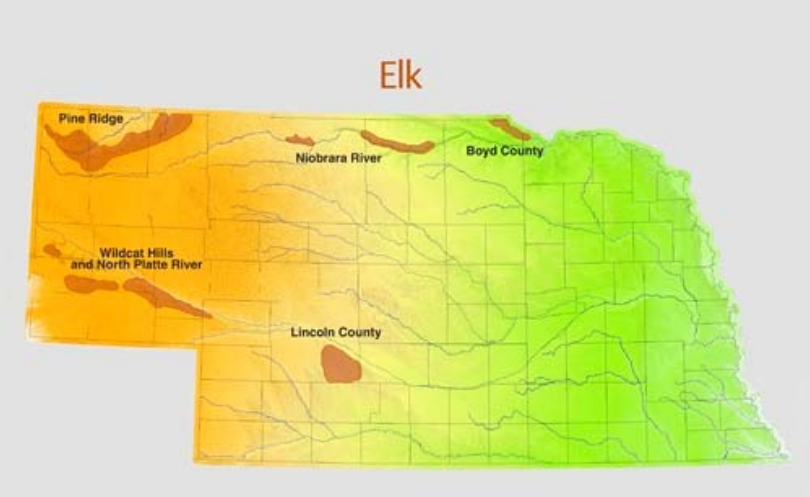


Figure 20. Elk distribution in Nebraska (*Source:* Nebraska Game and Parks Commission 2008).

The distribution and number of elk in Nebraska will likely increase due to the availability of suitable habitat, highly regulated hunting, and increasing landowner tolerance (Frickle et al. 2008). Demographic measures (average calf:cow ratio of 0.31:0.57, adult cow survival of 92 percent), and average rate of increase (r) of 0.21 for herds in the Pine Ridge indicate a growing population (Stillings 1999). Most herds in the state are expected to double in size in the next five years as annual population growth of 15 percent to 20 percent is likely under the current harvest limits (Frickle et al. 2008). This indicator is in good condition and increasing. Future threats include chronic wasting disease (CWD), a fatal disease of the central nervous system of white-tailed deer, mule deer, and elk that has infected free-roaming deer and captive elk primarily in western and north-central counties in Nebraska (Nebraska Game and Parks Commission 2009c) (Figure 21).

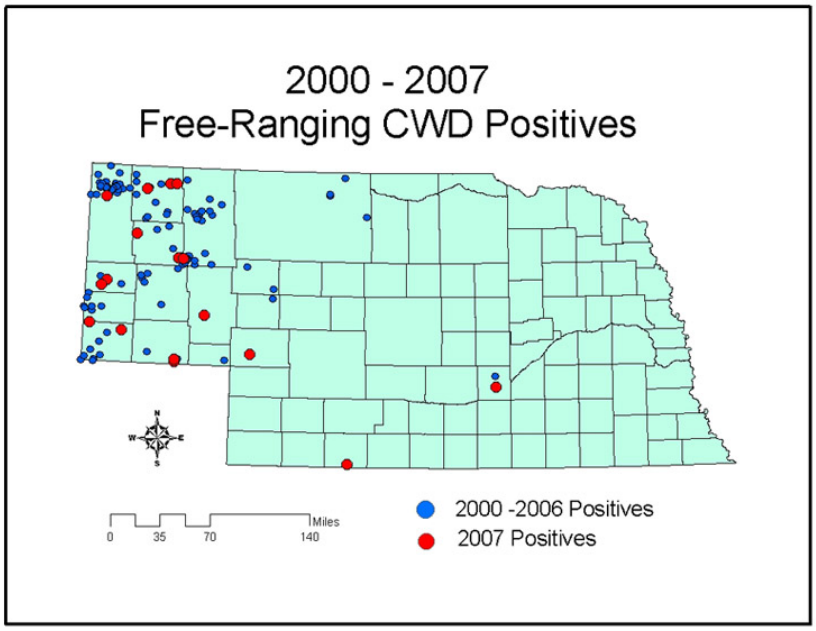


Figure 21. Free-ranging chronic wasting disease (CWD) positives in Nebraska (*Source*: Nebraska Game and Parks Commission 2009c).

Indicator: Ponderosa Pine
Source for Reference Condition: Historic Density of Ponderosa Pine in the Pine Ridge, Historic Photographs, and Fire History


Ponderosa pine

Ponderosa pine and associated shrubs, forbs, and grasses characteristic of the Rocky Mountains occur in continuous and isolated stands in Nebraska as far east as the transition zone between the mixed and tallgrass prairies (Tolstead 1947). In the central Niobrara River Valley, ponderosa pine occurs on the north side of the river on steep cliffs and rocky soils on the eroded edge of the Crookston Table; and on the south side in scattered stands between the deciduous forest of the valley walls and the prairies of the Sand Hills (Steinauer and Bragg 1987) (Fig. 22).

Prior to European settlement, ponderosa pine was restricted to the steep slopes of the Niobrara River Valley and spring branch tributaries by frequent prairie fires that originated primarily in the Sand Hills to the south (Steinauer and Bragg 1987, Ortmann et al. 1996). The recent spread of ponderosa pine into adjacent prairie and an increase in the density of trees in established stands is likely due to a longer fire return interval as a result of almost complete fire suppression (Steinauer and Bragg 1987, Guyette 2005). In 1947, mature stands of ponderosa pine in the Pine Ridge of Nebraska (about 100 km [62 miles] west of the

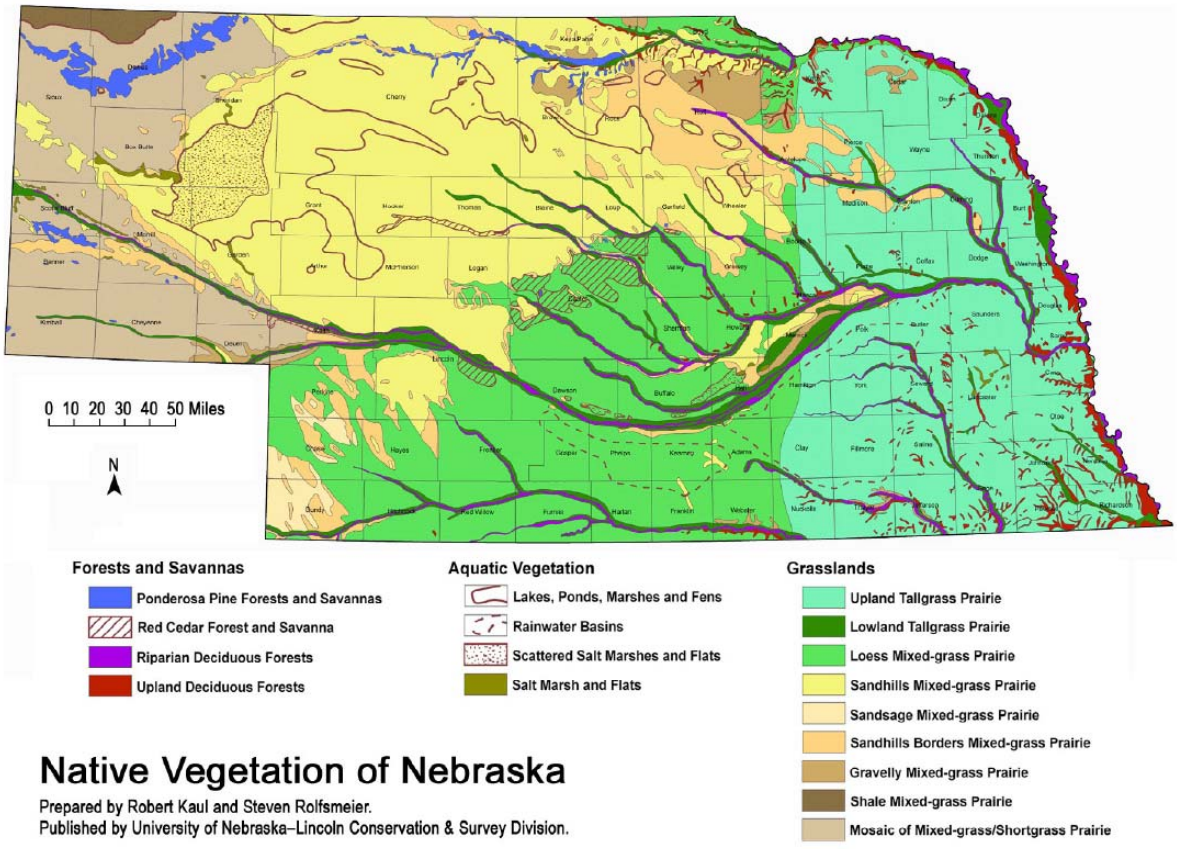


Figure 22. Ponderosa pine distribution in Nebraska (*Source*: Kaul and Rolfsmeier 1993).

central Niobrara River Valley) averaged about 380 trees/ha (Tolstead 1947). At that date, the Pine Ridge was presumably still subject to recurrent fire. This is in contrast to the results of a more recent study in the Niobrara Valley Preserve that found a density of 2,250 trees/ha in a stand protected from fire (Steinauer and Bragg 1987).

Recent mapping of woodland cover (primarily ponderosa pine), in two, five-km (three-mile) study reaches along the Niobrara River within the scenic river, found a 248 ha (613 acre) increase in woodland cover over a 64-year period (Narumalani 2009a) (Figs. 23 and 24). The increase in ponderosa pine extent and stand density is likely to continue in the future. Recent large fires in western Nebraska have involved crown fire that killed all of the trees in dense stands of ponderosa pine (Nebraska Forest Service 2007). As the density of ponderosa pine increases in the central Niobrara River Valley, crown fires that kill stands of pine are likely to occur. This indicator is in poor condition and decreasing.

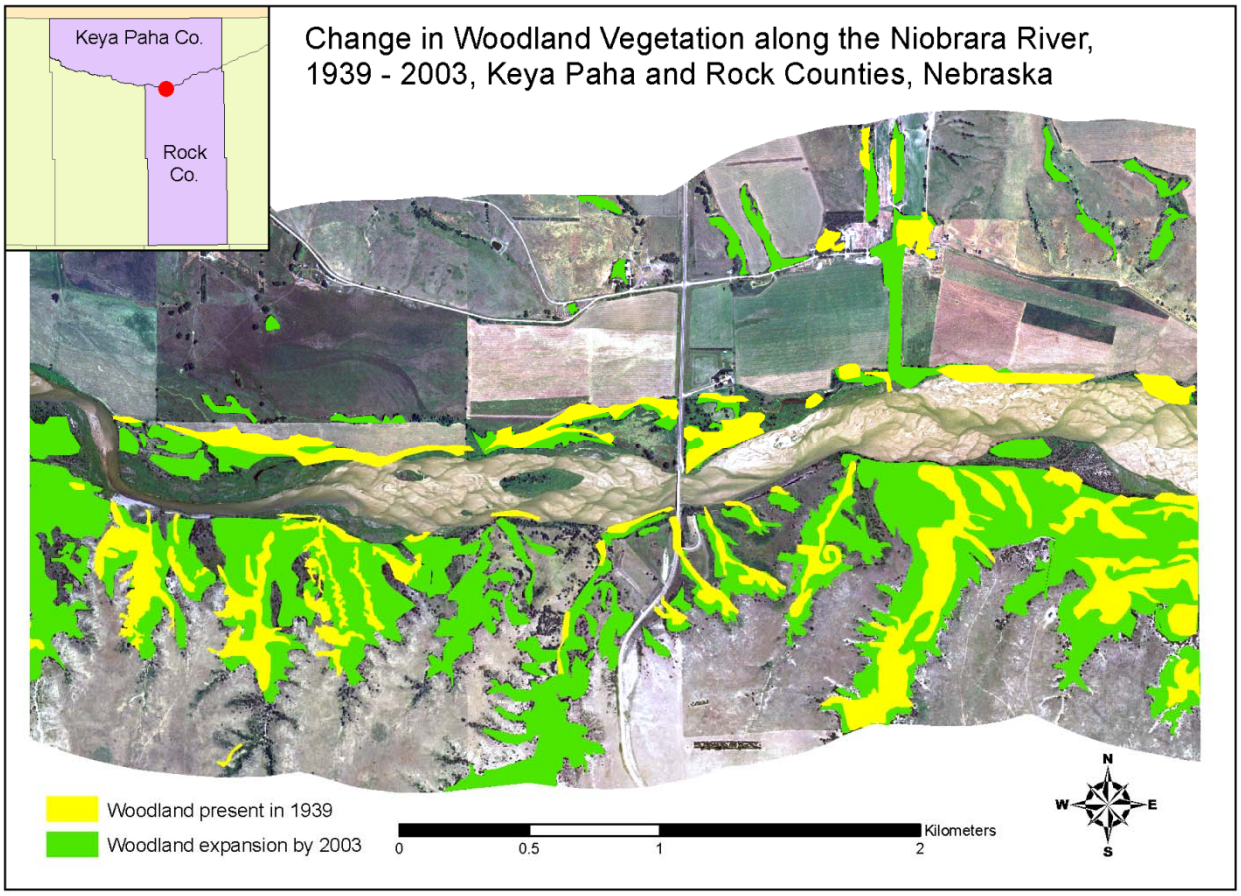


Figure 23. Change in woodland vegetation along the Niobrara River, 1939–2003, Keya Paha and Rock Counties, Nebraska (*Source:* Narumalani 2009a).

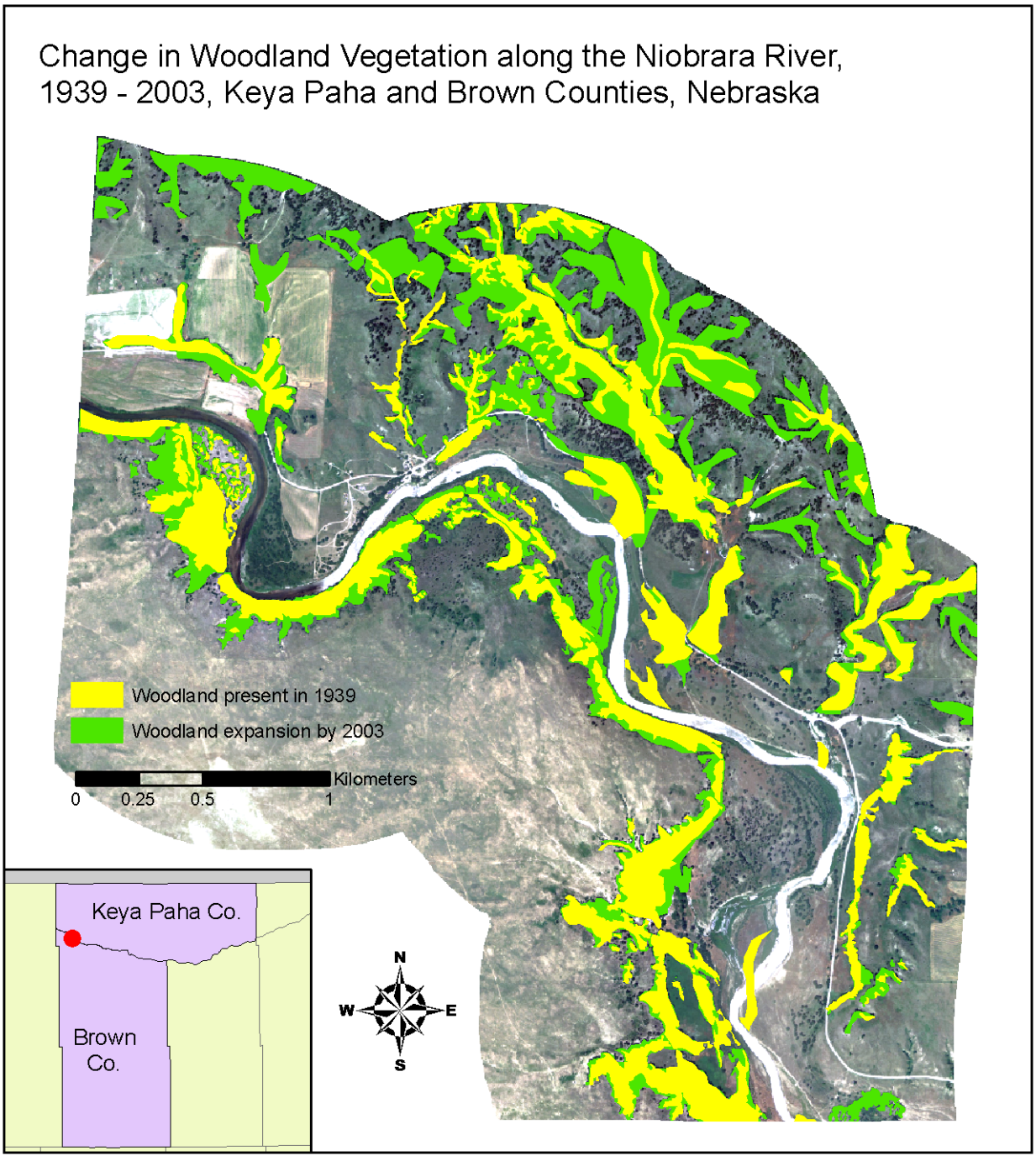


Figure 24. Change in woodland vegetation along the Niobrara River, 1939–2003, Keya Paha and Brown Counties, Nebraska (*Source:* Narumalani 2009a).

Indicator: Land Cover
Source for Reference Condition: Based on Analysis of 1992 and 2001 Land Use and Land Cover Datasets

The National Land Cover Dataset (NLCD) 1992 was the first land cover mapping project with a national scope. NLCD 1992 provides 21 land cover classes that were derived from unsupervised classification, modeling, and ancillary data (see Vogelmann et al. 1998). The NLCD 1992 effort was completed in December 2000, and it is one of the most widely used land cover datasets in the United States with applications including environmental reporting, climate change modeling, Clean Water Act studies, and biodiversity and conservation assessments. The success of NLCD 1992 initiated the process for developing NLCD 2001. This effort provided additional information beyond land cover, including impervious surface and canopy density.

Because of the differences in methodologies used and the land cover categories, a direct, pixel-to-pixel comparison of NLCD 1992 and 2001 is not recommended. In 2008, the NLCD 1992/2001 Retrofit Land Cover Change Product was developed as a stopgap measure to offer a more accurate and useful guide to change analysis than was possible by direct comparison of the two land cover products. A comparison of the NLCD 1992 and 2001, using the retrofit change product, identified changes in the number of patches and percent land cover for seven land cover classes in a 3,977 km^2 (1,535 sq. mile) area that is centered on the scenic river (Narumalani 2009b) (Table 15, Fig. 25). The entire Niobrara watershed was not chosen because the Niobrara River extends 861 km (535 miles) from Wyoming to northeast Nebraska. The scenic river comprises only 122 km (76 miles) of this extent, lying closer to the mouth of the river, and land use changes concentrated around the scenic river area would have a greater impact than those that would occur upstream.

The retrofit product calculated the percent land cover and landscape indices, including a Contagion Index and Shannon Diversity Index (ShDI). Percent land cover in the grassland/shrub class showed the largest relative increase while percent land cover in the agriculture class showed the largest relative decrease. The Contagion Index refers to the tendency of patch types to be spatially aggregated—that is, to occur in large, contiguous distributions. Contagion Index values increased from 1992 to 2001, indicating that larger continuous patches of land cover were detected for the later date. This may be due to the increase in percent land cover of grassland/shrub cover types from 75.28 to 78.67. Grasslands increased during this time period possibly because of the implementation of the U.S. Department of Agriculture's Conservation Reserve Program (CRP) whereby landowners were rewarded for seeding large tracts of agricultural land with native grasses (Drummond 2007). This is supported by the substantial decrease in percent land cover of agricultural lands from 11.08 to 5.23. The ShDI supports this observed decrease. ShDI is one of several indices that are often used to measure biodiversity. A decrease in ShDI from 0.86 in 1992 to 0.83 in 2001 is indicative of an increased dominance of a land cover class (i.e., grassland/shrub).

This indicator is in good condition and improving based on the increase in land cover in the grassland/shrubs class. Although this increase results in a less diverse land cover, more land cover is in natural or restored habitat. There is also the possibility that because two methods of classification were used, the results may be misleading. For example, a visual examination

between the two dates indicates a definitive presence of a road network in 2001 because ancillary data were used (e.g., U.S. Census Bureau TIGER files) to force the inclusion of a road network. Inclusion of area of roads would reduce the area of the landscape classes. Other possible explanations for the decline in agricultural land pertains to the use of five agricultural land cover categories for the 1992 NLCD and only two cover categories for 2001. Similarly, for the 1992 NLCD only two wetland classes were identified, whereas ten were delineated in 2001.

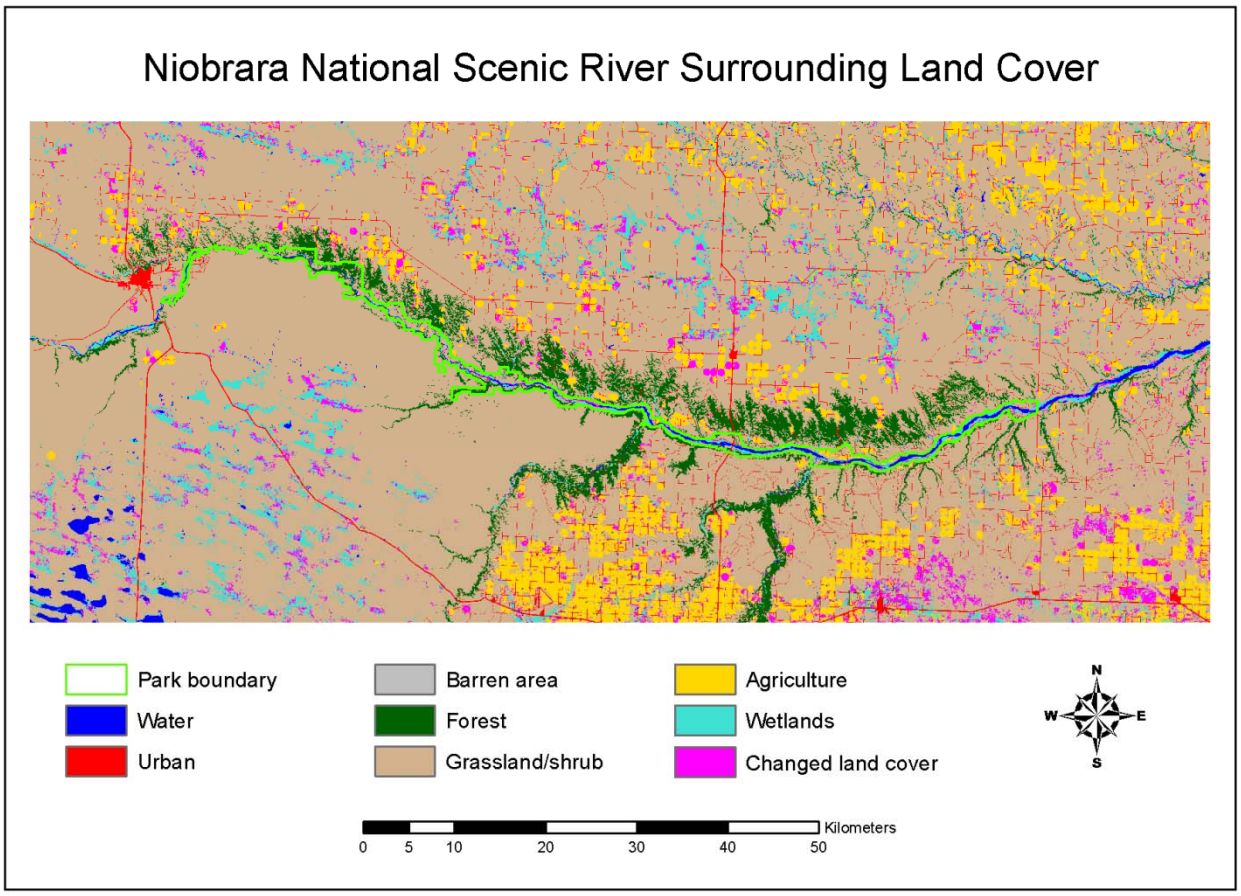


Figure 25. Niobrara National Scenic River and surrounding land cover change, 1992–2001 (*Source:* Narumalani 2009b).

Table 15. Number of patches, percent land cover, and changes, 1992–2001, for Niobrara National Scenic River and surrounding area. Contagion and Shannon Diversity Indices for 1992 and 2001 are for the same area (Source: Narumalani 2009b).

	1992		2001			
	Contagion 68.68	ShDI 0.8551	Contagion 70.58	ShDI 0.8255		
Class	# of patches	% land cover	# of patches	% land cover	Change in # of patches	Change in % land cover
Water	2,140	1.08	434	0.86	-1,706	-0.22
Urban	197	0.14	767	2.37	570	2.23
Barren	746	0.06	78	0.02	-668	-0.04
Forest	13,113	8.55	2,152	7.42	-10,961	-1.13
Grassland/Shrub	12,221	75.28	719	78.67	-11,502	3.39
Agriculture	15,004	11.08	475	5.23	-14,529	-5.85
Wetlands	9,554	3.81	4,253	5.42	-5,301	1.61

Indicator: Fire
Source for Reference Condition: Fire History of Ponderosa Pine Stand

See discussion of fire frequency and effects in the Ponderosa Pine Indicator (page 43).

Habitat: Spring Branch Canyon and Riparian Forest

Indicator: Paper Birch
Source for Reference Condition: Stand Conditions in Northern Populations of Paper Birch

Paper birch is a northern tree species that rarely occurs naturally where average July temperatures exceed 21°C (70°F) (Steuter and Steinauer 1993, Stroh and Miller 2009). Over thirty stands of paper birch are known within the central Niobrara River Valley, a region with a warmest monthly average of 23°C (73°F). These stands are relicts that have persisted since the end of Wisconsin glaciation when the regional flora was dominated by boreal plants. They occur primarily along spring branch tributaries to the Niobrara River within and near the scenic river, where maximum summer temperatures are cooler than those in the surrounding landscape owing to a combination of north-facing slopes, overstory canopy, and proximity to cool spring water (Steuter and Steinauer 1993).

Paper birch in the Niobrara National Scenic River, photo by Esther Stroh, U.S. Geological Survey

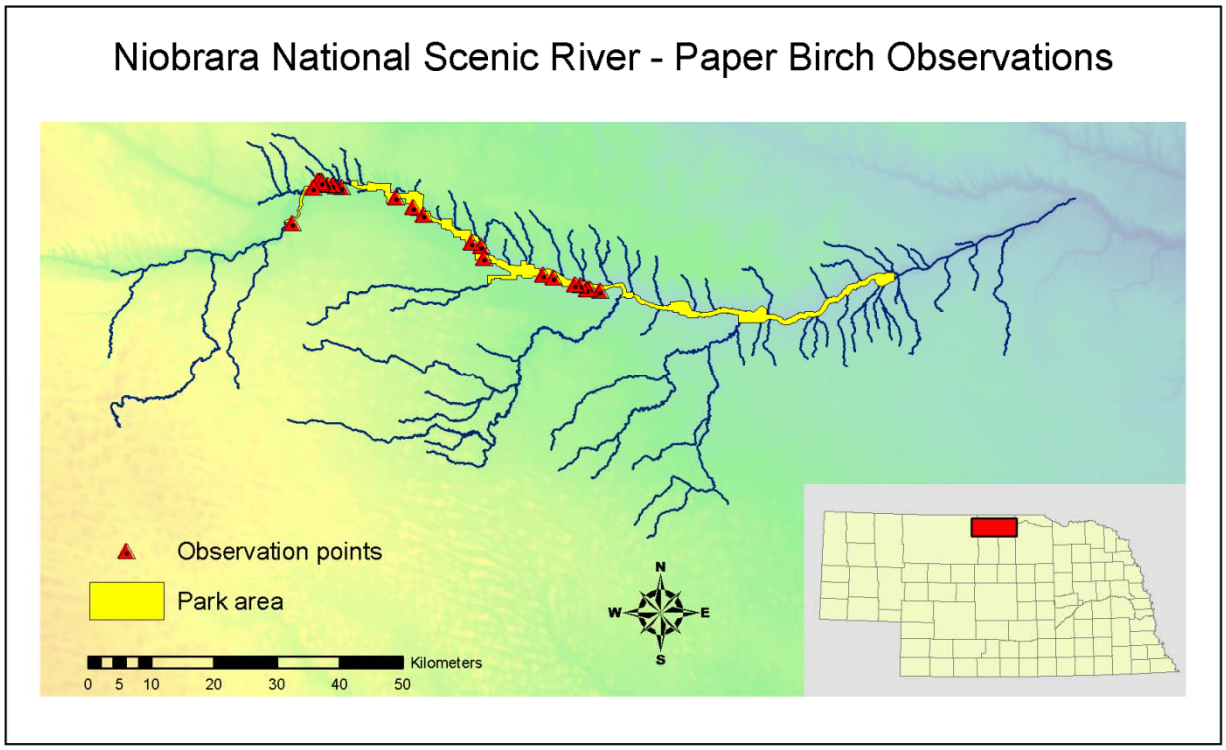


Figure 26. Sampling locations of paper birch along the Niobrara River (*Source*: Stroh and Miller, 2009).

Regeneration of paper birch in the Niobrara River Valley is primarily by sprouting of mature trees, as stands produce a low percent of viable seeds (Steuter and Steinauer 1993). Beginning in the early 1980s, resource managers noted a dieback of canopy-sized trees—over 90 percent of trees in some stands—and the lack of resprouts and seedlings (Stroh and Miller 2009). Reasons for the dieback may include changes in microclimate, shading by canopy trees, pest or pathogen infestations, or loss of genetic diversity (Stroh and Miller 2009). In addition, some forest trees including paper birch exhibit unexplained cyclic population diebacks (Auclair 2005). Lack of seedling recruitment may be due to the lack of disturbances, such as fire, that provide suitable establishment sites. In 2007, an investigation of the health of the population found high tree mortality, very few saplings, and no seedlings (Stroh and Miller 2009) (Table 16, Fig. 26). Mean basal area (6.0 m^2/ha) of trees in the Niobrara River Valley is considerably lower than the range of basal areas found in populations within the primary range of paper birch (Uchytil 1991).

The paper birch population will continue to decline as aged or deceased rootstocks fail to resprout and few microsites support conditions (e.g., mineral soil exposed by landslide or fire) for seedling establishment (Steuter and Steinauer 1993). This decline may accelerate in the future with regional temperature variations and microclimate changes. For example, early spring thaw-freeze conditions that can contribute to birch canopy dieback have increased in frequency in Niobrara River stands in recent years (Stroh and Miller 2009). The paper birch population is in poor condition and its future persistence uncertain due to the lack of nearby populations for immigration and recruitment (Stroh and Miller 2009).

Table 16. Summary of paper birch stand conditions along the Niobrara River (*Source*: Stroh and Miller 2009).

Site Name	Total trees (no).	Dead Trees (no).	Saplings	Seedlings
Borman Bridge	37	18	0	0
Fort Falls	48	17	0	0
Upper Coon Creek	10	7	0	0
Coon Creek West	7	5	0	0
Coon Creek East	10	7	0	0
Buffalo Bridge	24	3	0	0
Box Canyon	10	8	0	0
Side Canyon	8	6	0	0
Small Canyons	36	30	0	0
Buffalo Fence	58	14	0	0
Tyler Falls	34	17	1	0
Wide Bend	-	-	0	0
Smith Falls SP	41	19	0	0
Brewer Bridge	94	34	0	0
Sharp's Camp	81	52	0	0
Rocky Ford	57	35	6	0
Cross country	44	32	0	0
Dog Town	29	16	0	0
Nature Trail	53	33	0	0
Norden/Huddle	14	7	0	0
Garden Creek	49	33	0	0
Kirtpatrick	14	10	0	0
Jeff Creek	80	30	0	0
Hartman Island	34	23	0	0
Lowest Site	20	14	0	0
Total	892	468	**7**	0

Indicator: Hybrid Aspen
Source for Reference Condition: Assessment of Stand Health

Hybrid aspen stand, photo by Wayne Shepperd

A hybrid (*Populus x smithii*) of quaking aspen (*Populus tremuloides*), the most widely distributed tree in North America, and bigtooth aspen (*Populus grandidentata*), a tree native to the northeast and north-central United States and Canada, occurs on steep, north-facing slopes and benches along a half mile stretch of Niobrara River in and near Smith Falls State Park (Shepperd 2008). Stands of the hybrid aspen grow in association with several hardwood trees and shrubs typical of the eastern deciduous forest. Paper birch (see Paper Birch Indicator on page 48) also grow in the area and both paper birch and hybrid aspen are considered relicts that have persisted in cool and moist sites following post-glacial warming of the climate.

In 2007, six hybrid aspen stands were located and mapped (Downing 2007) (Fig. 27). A recent assessment of the health of these stands found few mature trees but a large number of aspen logs among the surviving trees indicating that aspen was more prevalent in the past (Sheppard 2008). Some aspen saplings were present in gaps in the overstory canopy but root spouts were mostly missing due to shading by competing trees and shrubs (Sheppard 2008). Scale insects were present on the bark of many of the mature trees and may be partly responsible for the low number of saplings (Sheppard 2008).

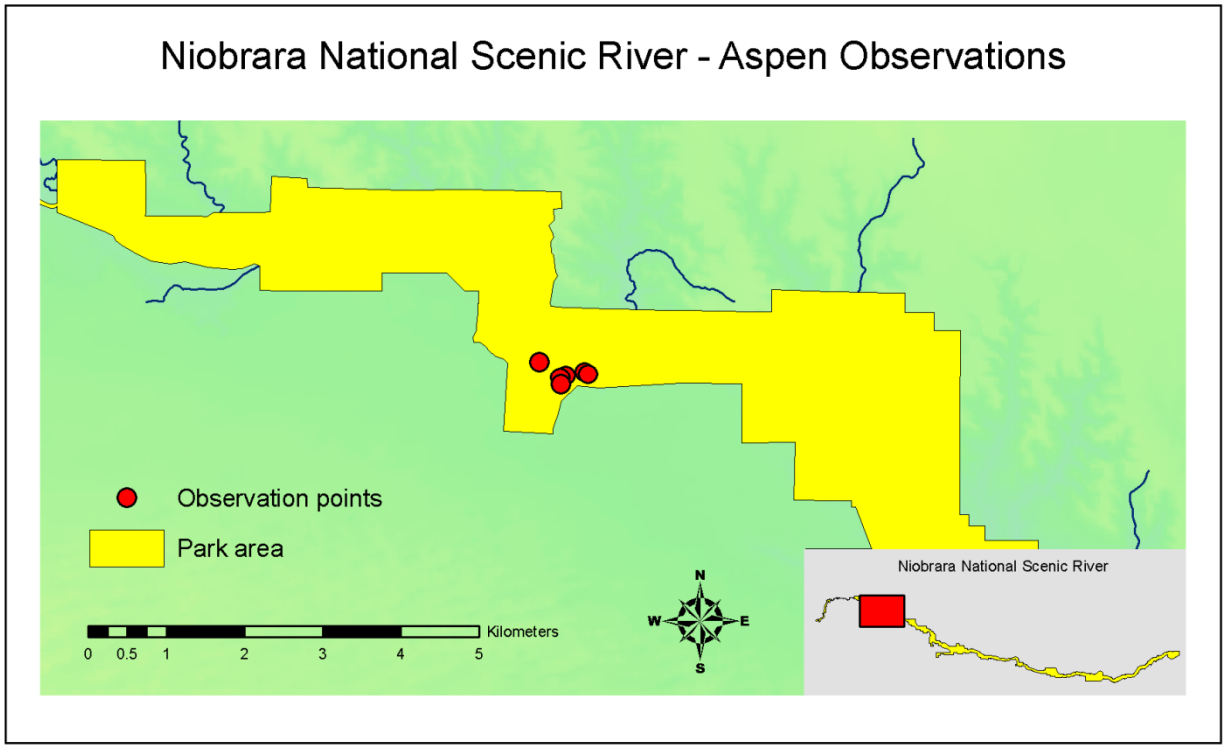


Figure 27. Observation points of hybrid aspen in the Niobrara National Scenic River (*Source*: Shepperd 2008).

Aspen is a relatively short-lived tree that regenerates primarily from root suckers following a disturbance, such as fire, that kills overstory stems (Uchytil 1991). Fire also kills competing vegetation and exposes the soil to sunlight and warmth which stimulates sucker growth. The suppression of fire likely resulted in the closed tree canopies at the hybrid aspen sites along the Niobrara River. A closed canopy appears to be the primary factor limiting successful aspen regeneration (Schlarbaum 2008, Shepperd 2008).

Resource managers removed some competing canopy trees and understory shrubs at two of the hybrid aspen sites beginning about 10 to 15 years ago (Table 17). This has stimulated some suckering and seed germination. However, the suckers and seedlings/saplings that regenerate may be damaged or killed by deer browsing and scale insects (Shepperd 2008). This indicator is in poor condition and in decline although continuing treatments (i.e., competing tree and shrub removal) may prevent the complete loss of these stands.

Table 17. Health and management of select hybrid aspen stands along the Niobrara River (*Source:* Schlarbaum 2008, Shepperd 2008).

Site	Mature Trees	Saplings	Suckers	Management Actions
1	yes	yes	yes	clearing competing plants
2	yes (a few)	yes	yes (a few)	?
3	yes (a few)	no	no	none
4	yes	no	yes (a few)	none
5	yes	yes	?	clearing competing plants
6	yes	no	no	?

Indicator: Bailey's Eastern Woodrat
Source for Reference Condition: Woodrat Densities in Other Habitats


Bailey's eastern woodrat, photo by Matt Stephenson, Iowa State University

Bailey's eastern woodrat, a subspecies of the eastern woodrat, is restricted to a 140-km (87-mile) section of the Niobrara River Valley (Jones 1964). The subspecies is believed to be a relict of the Pleistocene (Jones 1964) and is listed as At-risk in Nebraska (Schneider et al. 2005). Bailey's eastern woodrat prefers wooded spring branch canyons and adjacent riparian areas with rocky outcrops along the Niobrara River (Jones 1964); although the species has expanded into the northern Sand Hills where it inhabits isolated groves of cedar trees (Niobrara Valley Preserve, J. Luchsinger, personal communication, 7 August, 2009). The Niobrara population of Bailey's eastern woodrat is the only known population to make heavy use of needles and bark of eastern red cedar as preferred food in the summer (Genoways et al. 1997).

In the scenic river, Bailey's eastern woodrat is found in a matrix of forest and grassland habitats but is more abundant in wooded habitat (Frost 2007) (Fig. 28). In this habitat, woodrat density was estimated at 0.72/ha in both 2004 and 2005 (Frost 2007), which is within the range of woodrat densities found in other populations (Rainey 1956, Barbour and Humphrey 1982).

The population of the subspecies has likely increased due to fire suppression and cedar infestation of riparian and spring branch forest habitats (The Nature Conservancy1999, Sand Hills Prairie Indicator this assessment). This indicator is in good condition. However, managers are currently restoring bottomland forest, oak and pine savanna, and grassland along the Niobrara River through a combination of cedar harvest and prescribed burns. Although these activities are necessary to restore plant community diversity and species composition, they have the potential to negatively impact the woodrat population (Frost 2007).

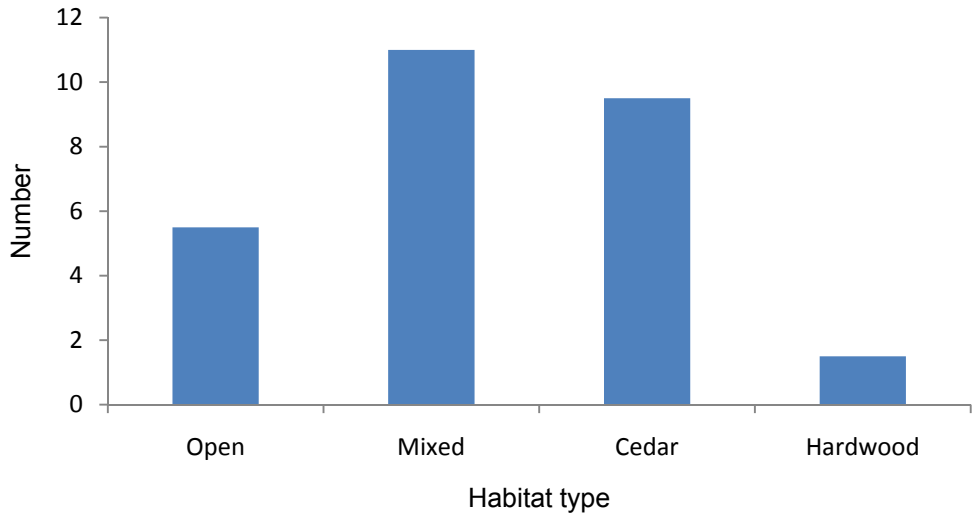


Figure 28. Average number of Bailey's eastern woodrat captured in 2004 and 2005 in four habitat types in the Niobrara Valley Preserve. Note: Mixed is a combination of cedar, cut cedar, and grassland (*Source*: Frost 2007).

Indicator: Bird Hybridization
Source for Reference Condition: Hybridization Indices Developed in the Late 1950s


Bullock's-Baltimore oriole

In the Niobrara River Valley and adjacent uplands, hybridization between western and eastern members of the following pairs of bird taxa occurs primarily in floodplain forest and associated shrubby woodlands: northern (red-shafted and yellow-shafted) flickers (*Colaptes auratus*), black-headed (*Pheucticus melanocephalus*) and rose-breasted (*P. ludovicianus*) grosbeaks, lazuli (*Passerina amoena*) and indigo (*P. cyanea*) buntings, spotted (*Pipila maculates*) and eastern (*P. erythrophthalmus*) towhees, and Bullock's (*Icterus bullock*) and Baltimore (*I. galbula*) orioles (Johnsgard 2007). Ancestors of these species pairs were probably geographically separated to the east and west of the Great Plains during the last glaciation (Mengel 1970; Sibley and Short 1959, 1964; Sibley and West 1959).

Two of these species, the indigo bunting and Baltimore oriole, expanded their ranges rapidly west across the Great Plains during the early to mid 1900s possibly due to tree plantings in shelterbelts and fire suppression that allowed riparian forest and woodland to mature (Johnsgard 2007). The range of the indigo bunting spread westward in Nebraska by as much as 226-km (140-miles) between 1955 and 1969 (Emlen et al. 1975). The Baltimore oriole was mostly confined to eastern Nebraska in the early 1900s, but by the 1980s, its range had expanded west to Sheridan County in the Niobrara River drainage (Mollhoff 2001). Based on a male plumage index of 0 (eastern) to 12 (western) the center of the hybrid zone for the Bullock's-Baltimore orioles was near Valentine in the Niobrara River Valley (Sibley and Short 1959, 1964). A similar hybrid zone existed for the lazuli-indigo buntings (Sibley and Short 1959, 1964) (Table 18).

Changes in the zones of sympatry and rates of hybridization for these species pairs (see Table 23 in Johnsgard 2007) may indicate underlying changes in riparian forest and woodland habitats such as the die-off of mature eastern cottonwood trees (Nebraska Forest Service 2007). The hybrid bird indicator is not assessed because of the absence of temporal data on trends in hybrid index values for inter-breeding species in the central Niobrara River Valley. A repeat of the studies by Sibley and Short (1959, 1964) should be conducted to provide data that would determine status and trend.

Table 18. Hybrid index of two inter-breeding species pairs along the Niobrara River (*Source*: Sibley and Short 1959, 1964).

Species Hybrid Index	Location				
	Chadron	Valentine	Bassett	Spensor	Blair
Bullock's-Baltimore oriole	10.9	5.0	1.8	2.0	-
Lazuli-indigo bunting[1]	11.9	3.4	-	1.7	-
[1]total index value – 12 western species to 0 eastern species					

Habitat: Grassland

Indicator: Grassland Birds
Source for Reference Condition: Grassland Bird Densities in Four Habitat Types

Grassland birds have shown steeper, more consistent, and more geographically widespread declines than any other group of North American birds (Knopf 1994). Of the 29 species of endemic grassland birds of the Great Plains, 23 have been observed or are known to nest in or near the scenic river (Ducey 1989). Of the 23 species, 13 have declining population trends (Knopf 1994) (Table 19). Human activities that have altered grassland bird habitat and depressed populations include cultivation of grains and pasture grasses, elimination of native grazers, drainage of wetlands, and planting of trees in shelterbelts. Also, following fire suppression in the east and central plains, woody plants have invaded grasslands from developing riparian forests.


Western meadowlark

In the central Niobrara River Valley, eastern red cedar (*Juniperus virginiana*) was originally restricted to steep slopes, but with the suppression of fire has expanded into hardwood savannas and forests, ponderosa pine forest, and grassland (Ortmann et al. 1996, Johnsgard 2007). This species has also spread due to extensive plantings in shelterbelts and other areas. Eastern red cedar is characterized by rapid growth, high reproductive output, and widespread dispersal of seeds by birds (Briggs et al. 2002). In a recent study of the birds of the Niobrara River Valley, within or near the scenic river, species richness estimates were highest in open and mixed habitats and lowest in cedar-dominated habitat (Frost 2007). Results of the study suggest that cedar invasions cause decreases in overall species richness and shifts in species composition

from grassland and shrubland birds to woodland and forest birds (Fig. 29).

With the widespread suppression of fire, eastern red cedar will continue to expand into grassland in the Niobrara River Valley (see Grassland Indicator). As a result, eastern woodland birds will replace grassland birds. This indicator is in good condition but declining based on the initial research in the scenic river and the general decline in grassland birds throughout the Great Plains.

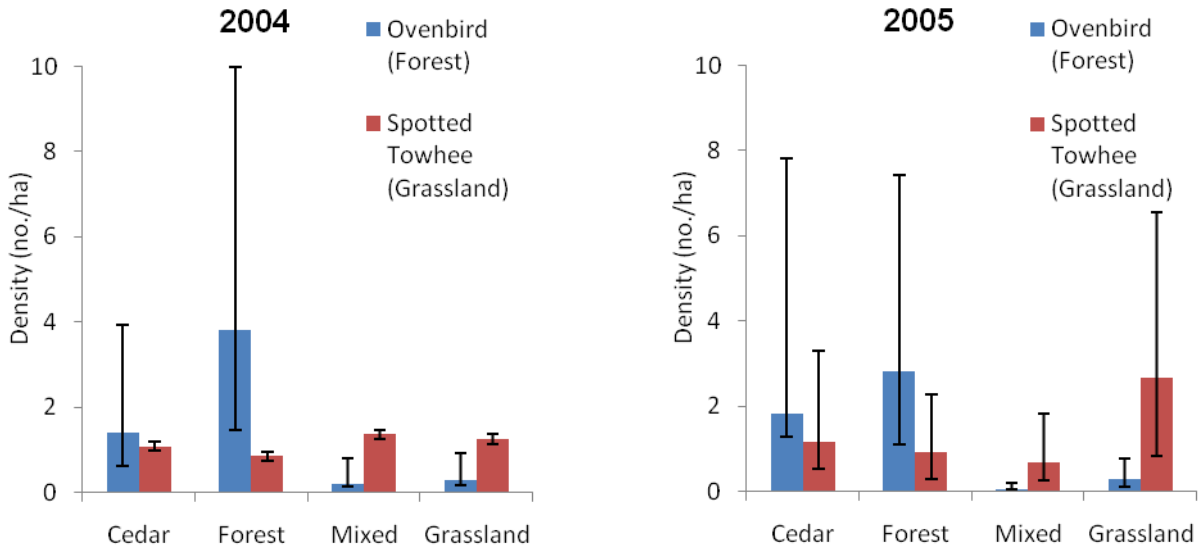


Figure 29. Mean density (no./ha) and 95 percent confidence interval during 2004 and 2005 for two songbird species in four habitat types in the Niobrara Valley Preserve (*Source*: Frost 2007).

Table 19. Population trends of endemic and secondary grassland birds and their status in the Niobrara River Valley (*Source*: Ducey 1989, Knopf 1994).

Species	Population Trend[a]	Niobrara River Valley[b]
Endemics		
Ferruginous hawk	+1.64**	O
Mountain plover	-3.69***	-
Long-billed curlew	-1.67	B
Sprague's pipit	-3.63***	-
Cassin's sparrow	-2.54***	-
Baird's sparrow	-1.75	O
Lark bunting	-2.13*	-
McCown's longspur	+7.30***	O
Chestnut-collared longspur	+0.44	O
Secondary (more widespread)		
Mississippi kite	+0.88	-
Swainson's hawk	+1.37*	B
Northern harrier	-0.36	O
Prairie falcon	+0.33	O

Table 19. Population trends of endemic and secondary grassland birds and their status in the Niobrara River Valley (continued) (*Source*: Ducey 1989, Knopf 1994).

Species	Population Trend[a]	Niobrara River Valley[b]
Greater prairie chicken	-6.85	B
Lesser prairie chicken	-	-
Sharp-tailed grouse	+1.05	B
Upland sandpiper	+2.67***	B
Burrowing owl	-0.18	B
Short-eared owl	-0.57	O
Horned lark	-0.70**	B
Eastern meadowlark	-2.25***	B
Western meadowlark	-0.52*	B
Dickcissel	-1.63***	O
Savannah sparrow	-0.53	B
Grasshopper sparrow	-4.11***	B
Henslow's sparrow	-4.96**	-
Vesper sparrow	-0.29	B
Lark sparrow	-3.45***	B
Clay-colored sparrow	-1.20***	O

[a] Annual rate (expressed as a percent) of change in population numbers;
* = P < 0.10 ** = P < 0.05 *** = P < 0.01.
[b] O = species observed or B = species nest in Niobrara River Valley

Indicator: Sand Hills Prairie
Source for Reference Condition: Historic and Recent Aerial Photographs and Fire History

The central Niobrara River Valley is bordered on the south by Sand Hills prairie and to the north by mixed-grass prairie (Johnsard 2007). Ponderosa pine, eastern red cedar, and bur oak (*Quercus macrocarpa*) dominate the woodlands near the top of the valley slopes on the south and north sides of the river (Fig. 5).


Woodland invading Sand Hills Prairie, photo by National Park Service

Invasion of trees, primarily ponderosa pine, into Sand Hills prairie has occurred since European settlement of the region in the mid-1800s (Steinauer and Bragg 1987, Steuter et al. 1990). A study of ponderosa pine in the Niobrara Valley Preserve found that pine stands closest to the Niobrara River were older and denser than stands at greater distances from the river (Steinauer and Bragg 1987) (Table 20). Prior to settlement in the late 1800s, pine was restricted to the valley slopes due to frequent prairie fires that originated in the Sand Hills to the south (Pool 1914). Following settlement, fire frequency declined from an average of one fire every 8.6 years between 1572 and 1900 to one fire every 36 years between 1900 and 1997 (Guyette 2005). Longer fire-free periods have permitted the establishment of ponderosa pine trees of sufficient size to withstand subsequent fire (Steinauer and Bragg 1987).

More recently, eastern red cedar, a species highly sensitive to fire, increased in the understory of pine woodland and invaded adjacent prairie as almost all fires in the region were suppressed after 1900 (Guyette 2005). In addition, grazing by cattle promoted establishment of cedar and pine by reducing native grasses that compete with woody seedlings and saplings (Steinauer and Bragg 1987). Cattle may also contribute to increases in cedar by dispersing seeds. Furthermore, global increases in atmospheric CO_2 may favor the growth of C_3 woody plants, such as cedar, over C_4 grasses (Polley et al. 1994).

Managers are attempting to re-establish and maintain Sand Hills prairie at priority sites with prescribed fire, herbicides, and cutting of woody vegetation (The Nature Conservancy 1999). Without widespread application of these management techniques, woodland will continue to expand into prairie (see Ponderosa Pine Indicator, this section). Considering the vast extent of Sand Hills prairie (5 million ha, 12.3 million acres), this indicator is in good condition but declining near the Niobrara River.

Table 20. Age and density of ponderosa pines by site. Site A is closest to the Niobrara River (*Source*: Steinauer and Bragg 1987).

Sites	Age (mean yrs.)	Density (no./.01 ha)
A	104	22.5
B	89	3.7
C	78	2.4
D	75	1.2

Indicator: Land Cover
Source for Reference Condition: Based on Analysis of 1992 and 2001 Land Use and Land Cover Datasets

See discussion of Land Cover under the Upland Forest and Savanna Habitat (page 46).

Indicator: Fire
Source for Reference Condition: Fire History of Ponderosa Pine Stands

See discussion of fire frequency and effects in the Ponderosa Pine Indicator (page 43).

Indicator: Interior Least Tern and Piping Plover
Source for Reference Condition: Long-Term Monitoring of Adult Terns and Plovers


Interior least tern (left) and piping plover (right), photos by Nebraska Game and Parks Commission

The interior least tern and piping plover are federally endangered and threatened species, respectively. These two species commonly nest together throughout the northern Great Plains, primarily on bare or sparsely vegetated sandbars (Ziewitz et al. 1992). Availability of this essential nesting habitat has declined along most rivers in the northern Great Plains due to dam construction, channelization projects, altered flow regimes, and reduced sediment loads (Ziewitz et al. 1992). The Niobrara River is one of the least modified rivers in the northern Great Plains that currently supports breeding populations of both species (Adolf 1998) (Fig. 30). Most nests are found downstream of the scenic river where open sandbar habitat is more common.

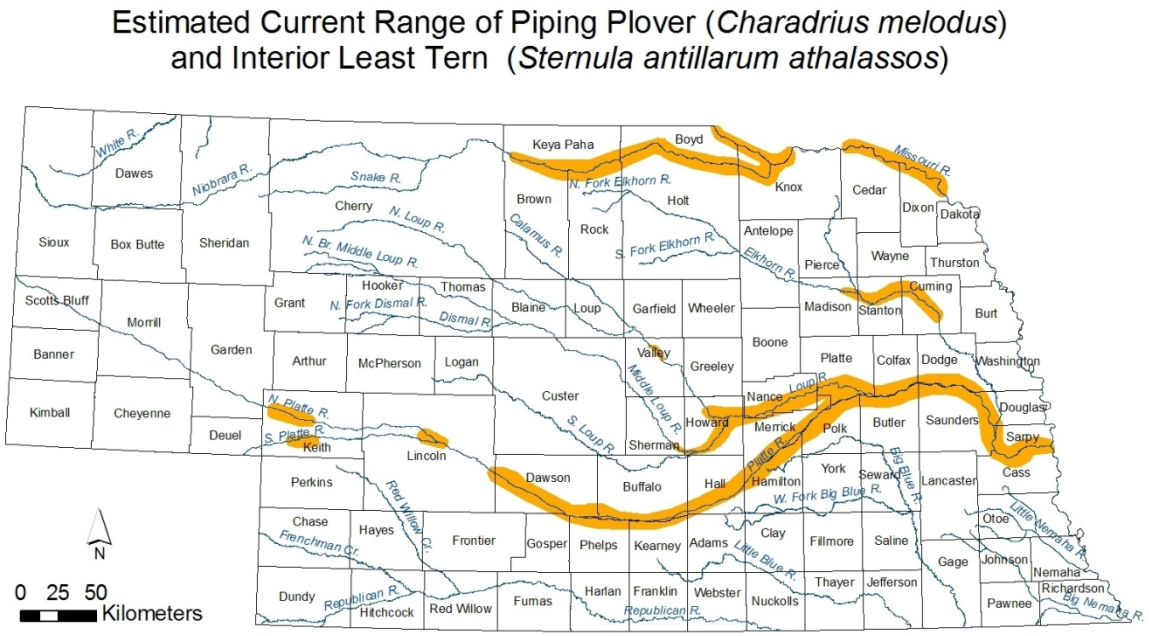


Figure 30. Interior least tern and piping plover distribution by county in Nebraska (*Source*: Nebraska Game and Parks Commission 2007).

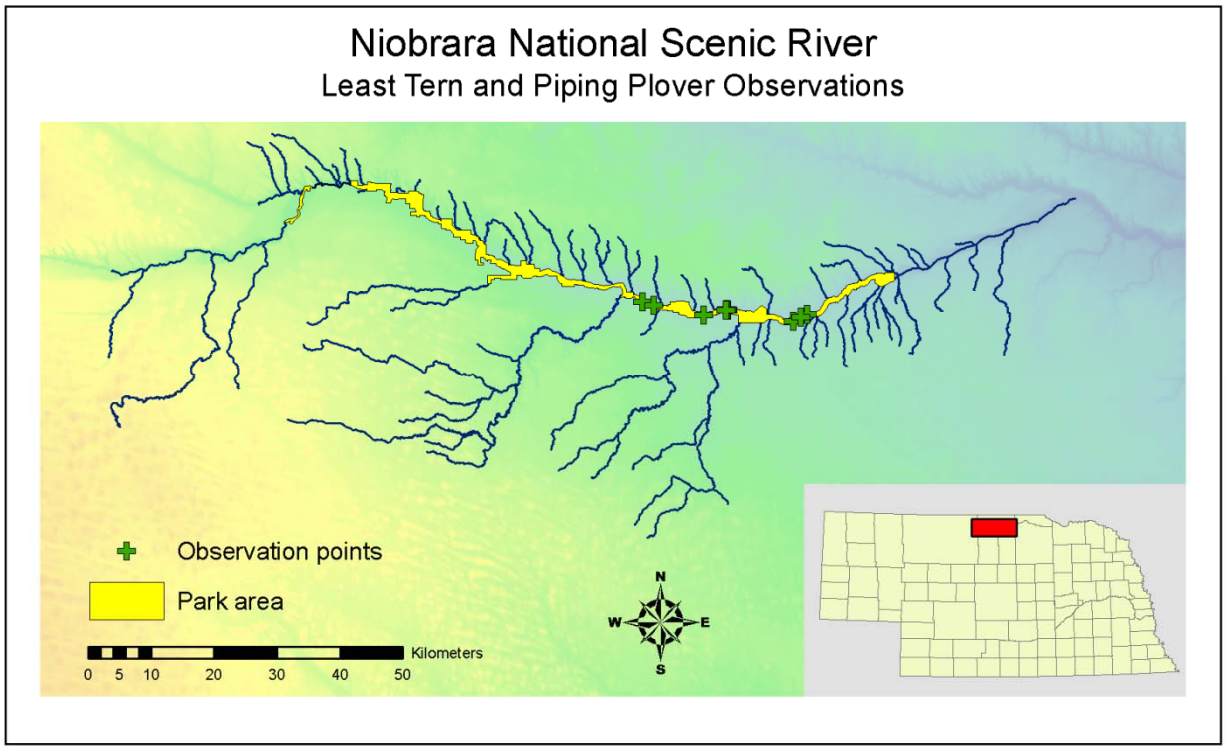


Figure 31. Interior least tern and piping plover observation points within Niobrara National Scenic River (*Source*: Blausey 2002, 2003, 2004).

In 1975, the Nebraska Game and Parks Commission began annual monitoring of the Niobrara River (confluence with the Missouri River [river mile 0] to Norden Bridge [river mile 120]) for adult interior least terns and piping plovers (Wingfield 1978, Wingfield 1984). In 1991, 1996, 2001, and 2006, the International Piping Plover Census (IPPC) coordinated the monitoring of both species on the Niobrara River and elsewhere in the Great Plains (Ferland and Haig 2002, Lott 2006). The IPPC monitoring includes areas within the scenic river boundary (Fig 31). Counts of adults of both species on the Niobrara River have varied considerably among monitoring years (Lott 2006, National Park Service, S. Wilson, natural resource specialist, personal communication, 25 September, 2007) although numbers appear to increase over time (Adolf et al. 2001) (Fig. 32). In 2002, the scenic river began systematic annual monitoring of adults and nests of interior least terns and piping plovers usually from Norden Bridge to the Highway 137 Bridge. As with the IPPC monitoring, counts of adults of both species in the scenic river boundary vary considerably from year to year whereas nests of both species appear to increase (Blausey 2002, 2003, 2004) (Fig. 33).

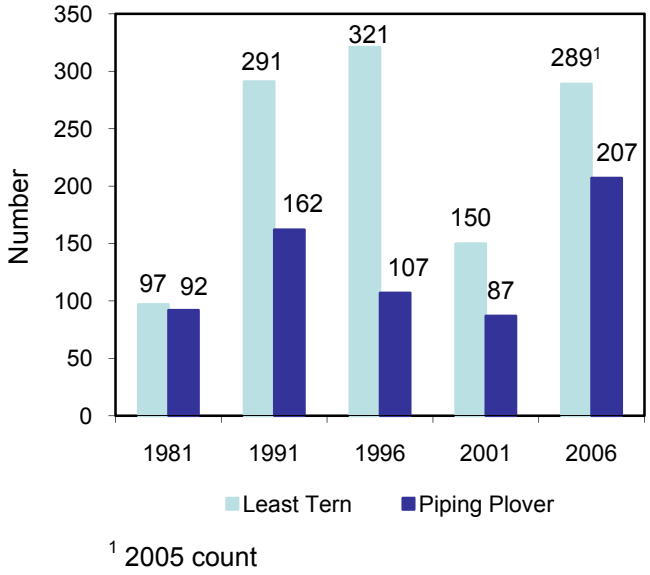


Figure 32. Interior least tern and piping plover adults counted on the Niobrara River (*Source*: Ferland and Haig 2002, Lott 2006, Jorgensen 2006).

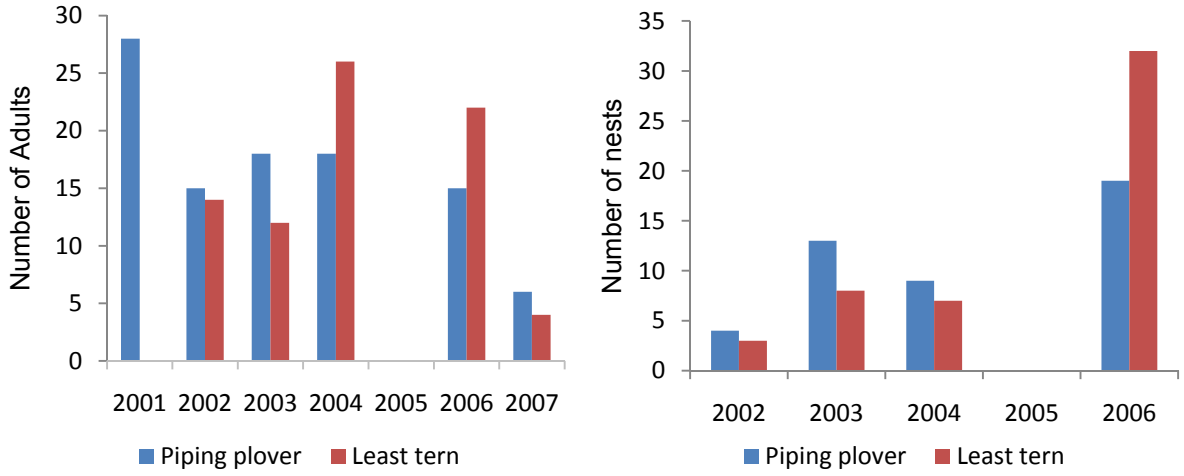


Figure 33. Interior least tern and piping plover adults and nests counted in the Niobrara National Scenic River (*Source*: Blausey 2002, 2003, 2004; National Park Service, S. Wilson, natural resource specialist, personal communication, 25 September, 2009).

In 1996 and 1997, a study was conducted over the same Niobrara River reach as the IPPC monitoring to determine the reproductive success of interior least terns and piping plovers (Adolf et al. 2001). Average clutch size, nest success, hatching success, and fledgling success for both species on the Niobrara River were similar to the findings of other researchers for these species along the central Platte River Valley in Nebraska (Lingle 1988) and the Missouri and Cheyenne

Rivers in South Dakota (Dirks 1990, Kruse 1993). In addition, the reproductive success of both species on the Niobrara River compared favorably to that of the Gavins Point reach of the Missouri River where piping plover nests are protected by cages and numerous nesting islands were roped off to restrict visitor access (Adolf et al. 2001) (Table 21).

Most interior least tern and piping plover nests are destroyed by predators (Dirks 1990, Kruse 1993), flooding (Lingle 1993), and humans. Predators and flooding cause some of the nest losses on the Niobrara River but sandbar erosion and human interference are also substantial factors (Adolf et al. 2001). In the summer, decreased flows and reduced sediment transport cause sandbars to erode which results in loss of nest sites and forage habitat for chicks (Adolf et al. 2001). Humans, usually not maliciously, destroy nests and chicks by stepping on them, dragging their canoes/tubes over them, and keeping adults away from the nests letting eggs and chicks chill or overheat (Tern and Plover Conservation Partnership, M. Bomberger Brown, coordinator, personal communication, 11 October, 2009).

This indicator is in good condition and improving based on monitoring results which document increasing numbers of tern and plover nests in the scenic river and high reproductive success for both species on the Niobrara River. However, reduced stream flow (see Stream Flow Indicator), invasive plants (purple loosestrife), recreation (all-terrain vehicle use), and livestock pose serious long-term threats to both species.

Table 21. Comparison of piping plovers and interior least terns average clutch size and nest, hatching, and fledgling success between the Niobrara and Missouri Rivers in 1996 and 1997 (*Source*: Adolf et al. 2001).

	Piping Plover			Least Tern		
	1996	1997	Combined	1996	1997	Combined
Average clutch size[a]						
Niobrara River	3.58	3.75	3.64	2.51	2.68	2.57
Missouri River	2.90	3.79	3.21	1.93	2.40	2.16
Gavins Point Reach	2.43	3.74	3.05	1.89	2.55	2.27
Nest success (%)[bc]						
Niobrara River	32.00	39.70	34.71	53.50	49.60	52.00
Missouri River	18.00	45.70	27.78	13.10	50.00	31.49
Gavins Point Reach	00.00	58.06	27.27	5.83	52.86	32.92
Hatching success (%)[d]						
Niobrara River	35.30	39.20	36.70	54.60	49.40	52.55
Missouri River	19.41	43.77	29.56	13.97	51.27	34.57
Gavins Point Reach	00.00	54.31	31.34	4.62	55.18	37.32
Fledgling success (%)[e]						
Niobrara River	23.40	55.00	35.66	32.30	44.90	37.00
Missouri River	51.39	43.97	46.81	61.84	45.93	48.81
Gavins Point Reach	0.00	31.75	31.75	22.22	50.25	53.40

[a]Gavins Point Reach is a combination of the Lewis and Clark lake and Missouri River below the dam and does not include captive rearing data.
[b]Total number of nests hatched/total number of nests initiated.
[c] Nest success on the Missouri River and Gavins Point Reach was the result of multiple management techniques i.e., caging of nests, no management was done on the Niobrara River.
[d] Percent of eggs hatched per 100 eggs per species.
[e] Percent of chicks fledged per 100 eggs per species.

Indicator: Purple Loosestrife
Source for Reference Condition: Maps of infestations in 2002 and 2008

Originally introduced from Europe in the 1800's, purple loosestrife has spread across many parts of North America mostly through inter-connected canals and road systems, populating many of North America's wetlands (Stuckey 1980). The species out-competes native vegetation and will eventually alter a wetland's structure and biogeochemical processes (Thompson et al. 1987, Fickbohm and Zhu 2006). While purple loosestrife is considered an invasive species and has negative impacts on wetland communities, it is also an indicator of sandbar and wetland conditions. Ecologists and managers must assess loosestrife stands to determine if underlying factors such as nutrient pollution and hydrological alteration have stressed native plants and allowed loosestrife to invade before attempting control and restoration (Kiviat 1999).


Purple loosestrife

In the central Niobrara River Valley, purple loosestrife occurs along portions of the scenic river, inhabiting sandbars and other wetland areas (Narumalani and Swain 2009). In 2008, purple loosestrife in the scenic river was quantified and mapped using hyperspectral airborne remote sensing data and geographic information technology (Fig. 34). Previously, in 2002, distribution of the species was mapped by ground survey crews (Fig. 35). The Middle Niobrara Weed Awareness Group (see http://www.mnwag.org/content/view/14/27/) administers a cooperative weed management effort within the scenic river corridor, and has funded biological and chemical control projects. Comparison of purple loosestrife stands in 2008 with those in 2002 suggest that biocontrol measures have been successful in reducing the area infested by purple loosestrife by as much as 80 percent in some areas (Narumalani and Swain 2009) (Fig. 36).

This indicator is in poor condition but improving based on the success of weed control efforts since 2002. While control measures, both biological and chemical, have proven to be effective in reducing or even eliminating purple loosestrife, it is important to recognize that invasion of this species in a particular wetland may be a manifestation of underlying stressors to the ecosystem. If these stressors persist, the species will invade new areas and re-invade those where control efforts were initially successful.

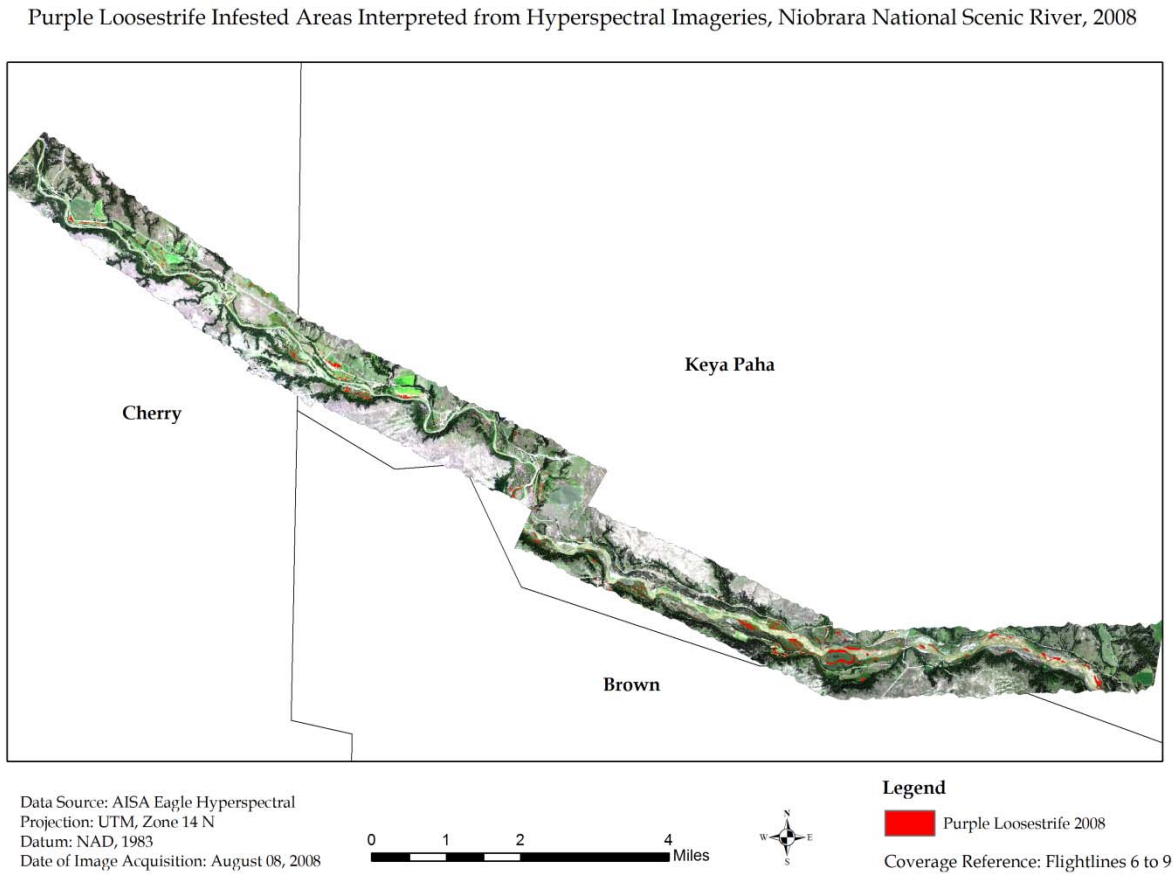


Figure 34. Purple loosestrife infested areas interpreted from hyperspectral imageries, Niobrara National Scenic River, 2008 (*Source:* Narumalani and Swain 2009).

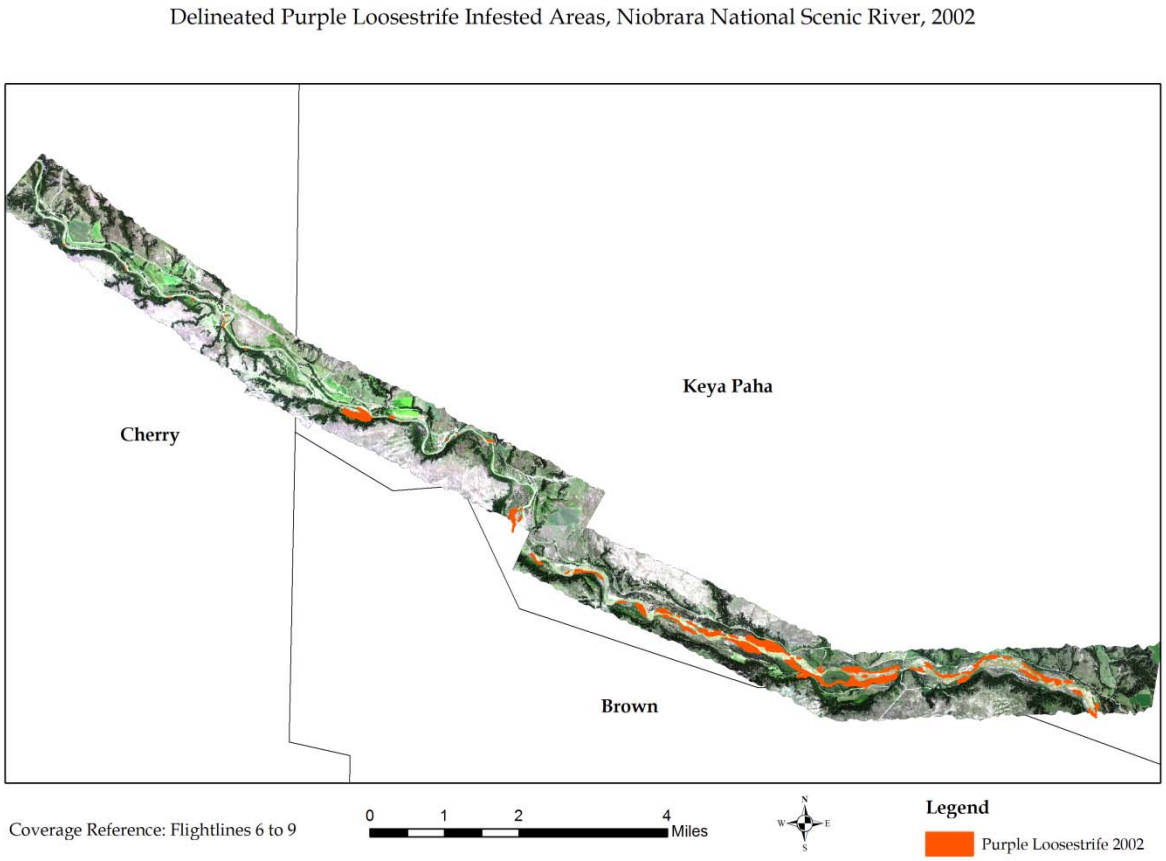


Figure 35. Delineated purple loosestrife infested areas, Niobrara National Scenic River, 2002 (*Source:* Narumalani and Swain 2009).

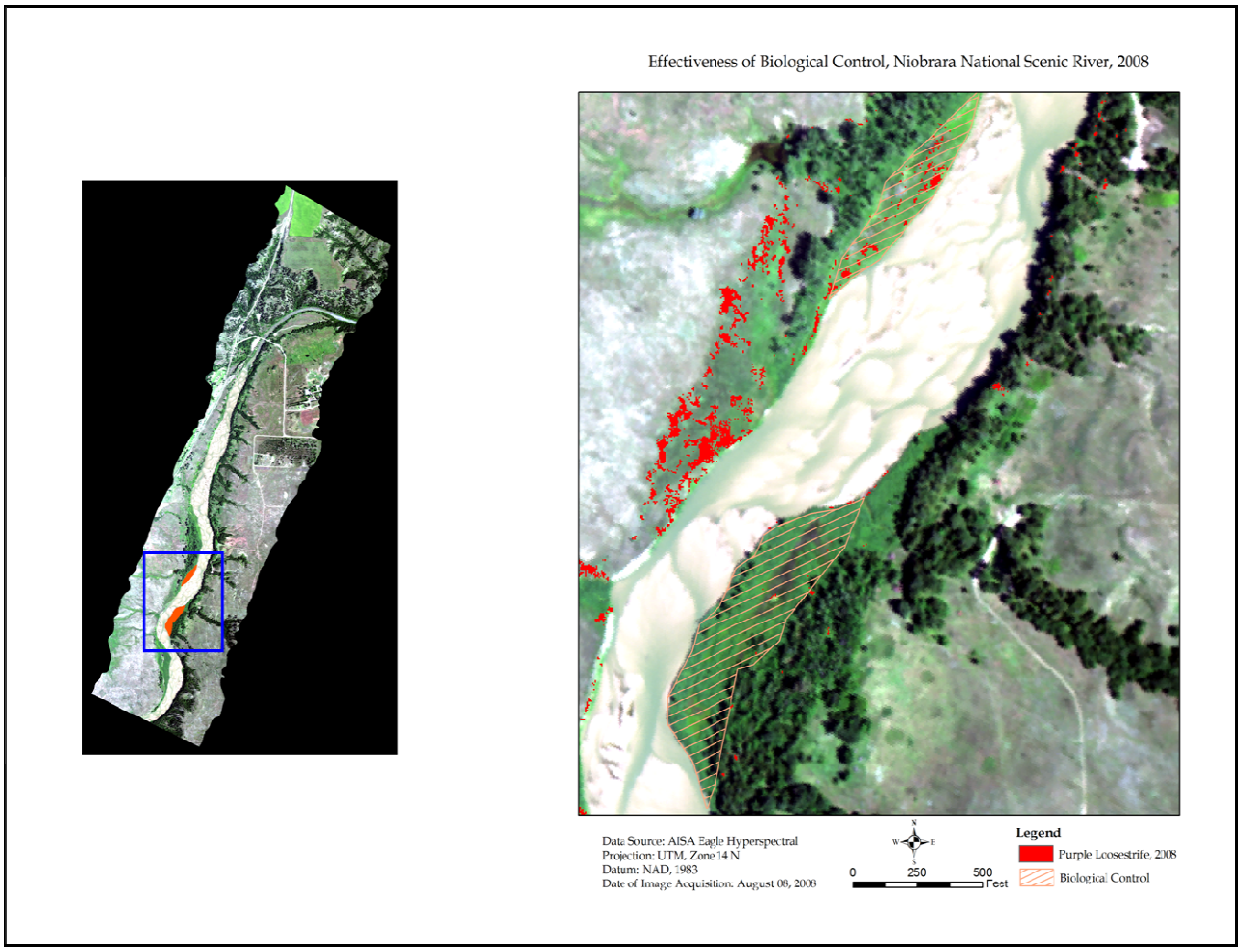


Figure 36. Effectiveness of biological control, Niobrara National Scenic River, 2008 (*Source:* Narumalani and Swain 2009).

Indicator: Whooping Crane
Source for Reference Condition: Not Established

Whooping crane

The whooping crane is the rarest of the world's crane species and is federally endangered in the United States and Canada (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007). The species was listed because of low population numbers, low reproductive potential, cyclic nesting and wintering habitat suitability, a hazardous 4,000-km (2,492 -mile) migration in the central Great Plains that is traversed twice annually, and many human pressures on the wintering grounds. Currently, the only self-sustaining, wild population consists of 215 individuals (2006 count) that nests in Wood Buffalo National Park and adjacent areas in Canada, and winters in coastal marches in Texas (Fig. 37). This population is threatened by collisions with power lines and fences, shooting, predators, disease, habitat destruction, severe weather, and loss of genetic diversity. From 60 to 80 percent of the annual mortality in the wild population occurs during migration, a time when cranes are exposed to manmade hazards such as utility lines. Whooping cranes begin migrating in late March reaching

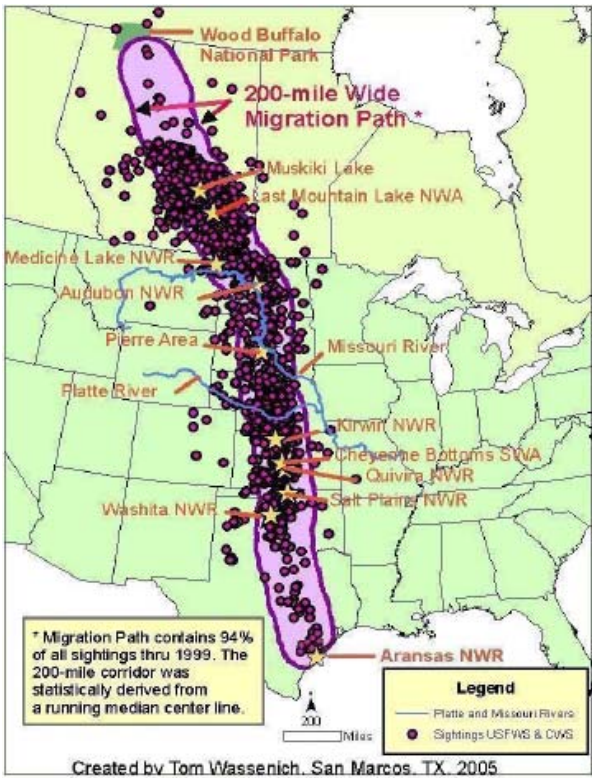


Figure 37. Breeding and wintering areas and primary migration pathway of the whooping crane (*Source*: Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007).

the nesting grounds in 2–4 weeks; the fall migration is protracted with most birds arriving on the wintering grounds by mid-November (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007). Whooping cranes are diurnal migrants that make regular stops to feed and roost. During migration, whooping cranes prefer to feed in freshwater marshes, wet prairies, and shallow portions of rivers, lakes, and reservoirs. They typically roost on unvegetated or submerged sandbars in wide, unobstructed channels that are isolated from human disturbance (Armbruster 1990). In Nebraska, whooping cranes often are recorded feeding and roosting in riverine habitats, especially the central Platte River bottoms (designated as critical habitat) and the central Niobrara River Valley (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007) (Fig. 38).

The number of sightings of whooping cranes on the central Niobrara River Valley has increased in recent years although most preferred feeding and roosting habitat (i.e., sandbars in shallow water) occurs downstream in the wider reaches of the river (Johnsgard 2007). In Nebraska, confirmed whooping crane sightings when compared with roosting habitat, suggest that whooping cranes select roosting sites by recognizing local and larger-scale land cover composition (Richert 1999). However, the availability of roosting sites with these characteristics in the central Niobrara River Valley, and specifically in the scenic river, is not known. As much as 97 percent of the suitable crane (whooping and sandhill) roosting habitat has been lost in some segments of the Platte River in Nebraska as a result of encroachment of the channel by woody vegetation following diversion and storage of water for irrigation and power generation (U.S. Fish and Wildlife Service 1981). Reductions in stream flow of the Niobrara River (see Stream Flow Indicator) may have a similar affect on the availability of roosting and feeding habitat for migrating whooping cranes. This indicator is not assessed due to the lack of site-specific information on habitat availability and use.

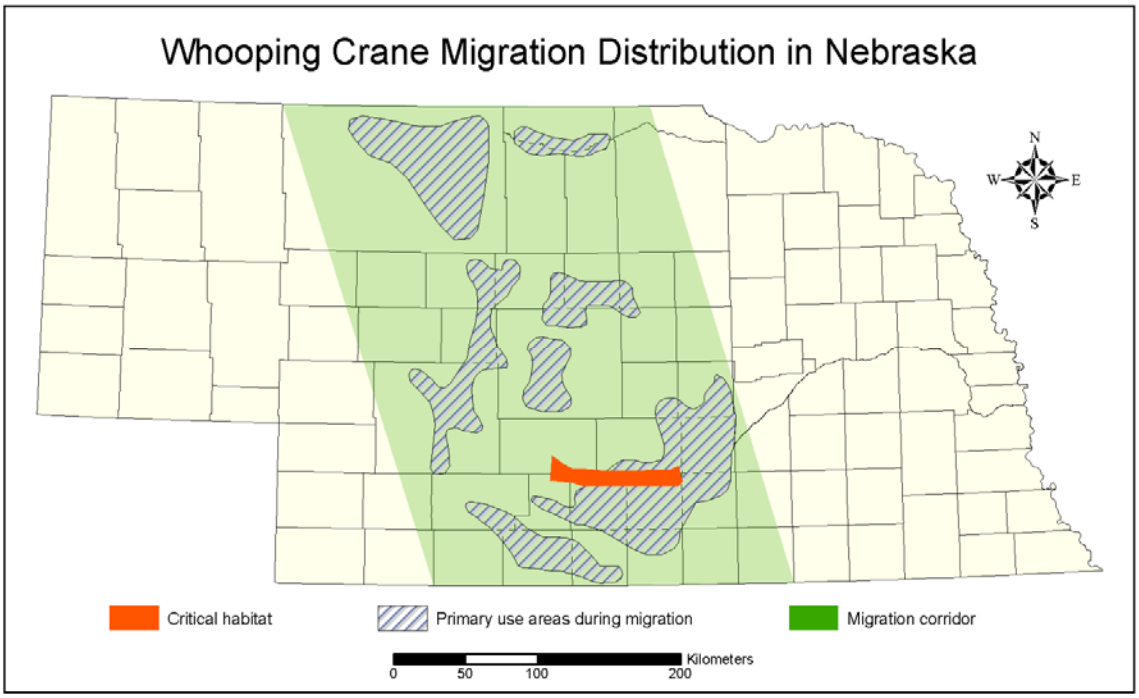


Figure 38. Whooping crane migration pathway in Nebraska (*Source*: Platte River Whooping Crane Maintenance Trust, Inc. 2009).

Indicator: Sediment Transport
Source for Reference Condition: Not Established

The Niobrara River downstream from Norden, Nebraska—within the scenic river—to its confluence with the Missouri River is characterized by a braided, sand-bed channel with a relatively steep gradient varying from about 5.3 m/km (9 ft/mile) upstream to about 3.4 m/km (7 ft/mile) downstream (Buchanan and Schumm 1990). The braided pattern and steep gradient are indicative of a very high sediment load. The long-term average annual total sediment load of the Niobrara River is approximately 2.9 million tons of which about 2 million tons is sand (Livesey 1976).

Niobrara River, photo by National Park Service

River processes, including sediment transport, are influenced by climate, geology, and vegetation and land use conditions of the watershed and riparian zone (Inglis 1993). With reduced flows of the Niobrara River due to water diversion and withdrawal (see Stream Flow Indicator), aggradation features may dominate river processes leading to widening of the channel, increased tendency of the river to meander, and decreases in gradient resulting in reduced flow velocities and sediment transport (Inglis 1993). A recent hydrogeomorphic analysis of the Niobrara River found that flow velocity changes were the primary hydraulic adjustment to discharge changes (Alexander et al. 2009). This study did not address the affects of changes in discharge on sediment transport or, more specifically, the affects on sandbar erosion and creation. Thus, this indicator is not assessed.

Stressors and Management Strategies

The scenic river's long, narrow corridor and limited conservation ownership in the watershed makes it highly susceptible to stressors originating from adjacent lands (Fig. 39). The major stressors and management strategies emerging from this condition assessment follow:

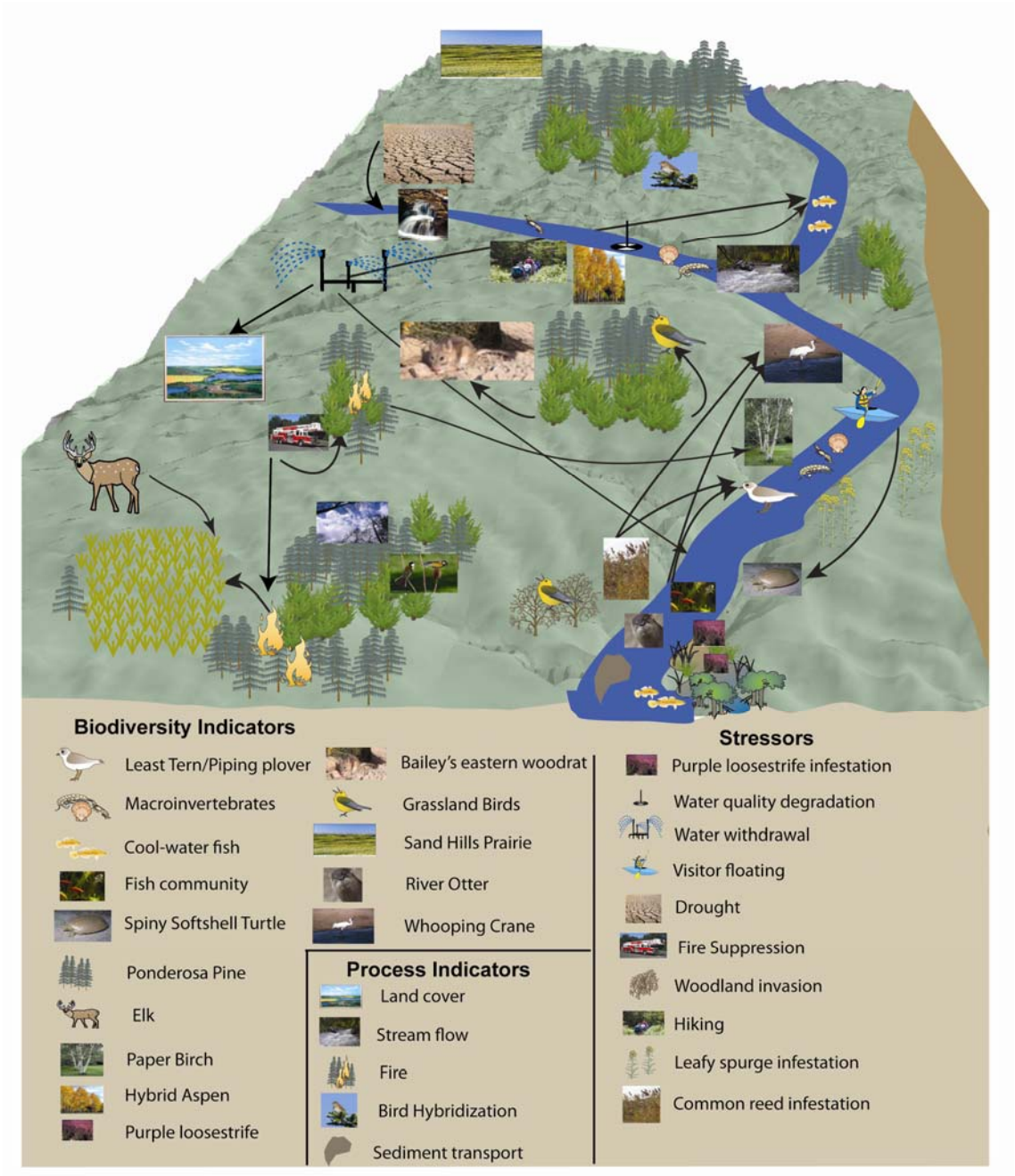
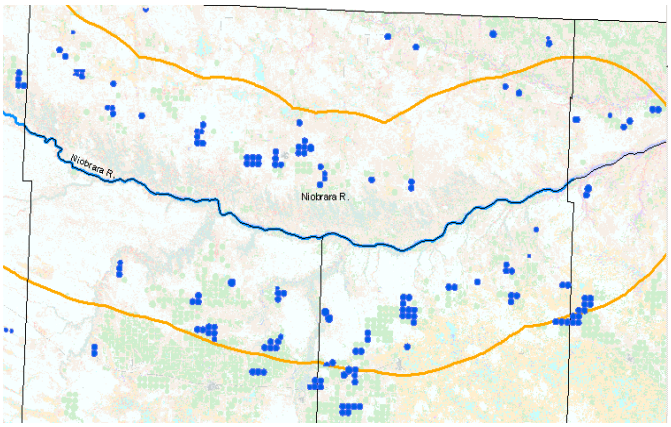


Figure 39. Niobrara National Scenic River conceptual diagram: existing and possible relationship of stressors to biodiversity and process indicators.

Water diversion and withdrawal

With the completion of the Merritt Dam in 1965, water diversions from the Niobrara River increased significantly, and have altered its runoff hydrology (i.e., decreased flows) (Istanbulluogla 2008) and may impact ecological processes and biota (Alexander et al. 2009). In addition, the use of center-pivot irrigation in north-central Nebraska has increased substantially over the last three decades (Fig. 40). As of December 31, 2004, a total of 6,822 ground water wells and an additional 837 surface water appropriations were registered in the lower Niobrara River Basin, a surface drainage area that includes the scenic river (Nebraska Department of Natural Resources 2004). A majority of these wells and surface water appropriations are for crop irrigation. Groundwater withdrawal from center-pivot use also contributes to decreased flows. In response, in January 2008, the State of Nebraska determined that ground and surface water within the Niobrara Basin is fully appropriated and placed a moratorium on the issuance of new surface water permits (Alexander et al. 2009).

(a)



(b)

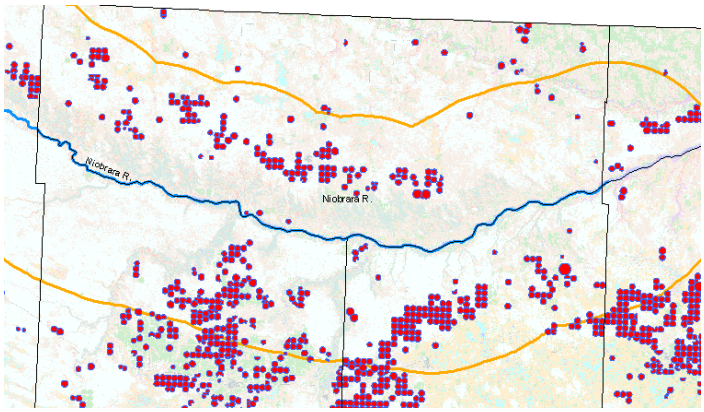


Figure 40. Center-pivots located within 16 km (10 miles) of the Niobrara National Scenic River in 1975 (a) and 2005 (b) (*Source*: Remote Sensing Center 1976, Center for Advanced Land Management Information Technologies 2006).

Management strategy should

- Conduct research to assess the effects of groundwater diversions and withdrawals on Niobrara River flow, physical and ecological processes, and biota.
- Pursue in-stream flow rights to protect recreational and fish and wildlife resources.
- Investigate the effects of the possible removal of Cornell Dam on river hydrology and sediment transport.
- Monitor river flows from U.S. Geological Survey gauge data.

Water Quality Degradation

During 2004 and 2005, reaches of the Niobrara River were sampled and no significant water quality concerns were identified from the assessment data (Troelstrup 2006). Similar results were documented in 2003–2005 when water quality data was collected from three sites on the Niobrara River and one site on Minnechaduza Creek (Dietsch 2008). However, forty-five of 51 samples collected exceeded the EPA recommendation of 0.1 mg/L phosphorus for avoiding algal blooms. Also, *E. coli* was detected in all of the collected samples, however only two exceeded the density of 298 colonies/100 ml which is the standard for streams designated as moderately used recreational water. Given that these were individual sample collections rather than repeated samples, they do not necessarily indicate that *E. coli* exceeded the water quality standards for Nebraska (Dietsch 2008).

Three tributaries of the Niobrara River—Berry Falls, Fort Falls, and Smith Falls—were also sampled during 2004 and 2005 (Troelstrup 2006). All three had low turbidity and good levels of dissolved oxygen. However, mean fecal coliform values for Berry Falls exceeded the standard (200/100 ml), while Smith Falls had individual readings exceeding the standard. Total phosphorus concentrations were also elevated in all three tributaries, although they did not violate the standard. These impacts may be the result of spring branch hiking (see Spring Branch Hiking, this section).

Management strategy should

- Monitor aquatic habitat and macroinvertebrates in the Niobrara River and its tributaries.
- Monitor physical and chemical water quality parameters of the tributaries to the Niobrara River.

Visitor River Floating

Recreation occurs on the entire length of the Niobrara River but floating (i.e., canoeing, tubing, and kayaking) dominates use on a 48-km (30-mile) stretch of the scenic river just east of Valentine, Nebraska (Shultz 2009). Several factors contribute to the scenic river being a major recreation resource including, season-long flows with adequate water depth for floating, clear water, a hard rock streambed, scenic values including high landform and plant diversity, and easy river access with riverfront camping opportunities (Shultz 2009). In addition, the scenic river is a single site destination for visitors because of the absence of comparable rivers with similar recreation opportunities in the region (Shultz 2009). Possibly due to the promotion of these amenities by a mix of federal, state, and private landowners, floater days on the scenic river increased by 8.5 percent per year from about 36,000 in 2005 to over 46,000 in 2008 (Fig. 9).

About 70 percent of these river activities occur during July and August, with the greatest use on Saturdays when as many as 800 canoes are on the river (Johnsgard 2007).

In 2000, bird communities in riparian forest along the Niobrara River that were exposed to river recreation were compared to communities in riparian forest lacking recreation to determine if recreation activities altered bird community composition and spatial distribution and the flushing behavior of waterbirds. No apparent shift in bird species composition or spatial distribution was observed (at recreation use levels of 15,000 to 18,000 people) (Anderson et al. 2000). However, waterbirds responded by moving away from areas with recreational noise and were more than twice as common in areas where river use was not allowed. The interior least tern and piping plover are not likely affected as their nesting sites are not in a river reach that is primarily used for recreational floating. However, spiny softshell turtles may be vulnerable to recreational impacts because their peak daily activity period occurs during the daytime when recreational use is highest and because they utilize basking and nesting sites in areas of high human use (Allen 2008). In addition, expansion of river otters into the scenic river may be curtailed as they avoid areas of high human use.

Management strategy should

- Continue to estimate annual river recreation use.
- Determine the effects of human recreation activities on the spiny softshell turtle in terms of population recruitment, home range, and energy expenditures.
- Document river otter presence; if present, determine individual habitat use and movement.

Purple Loosestrife Infestation

Purple loosestrife is an invasive exotic plant believed to have been introduced to the northeastern United States by European settlers in the early 1800s (Stuckey 1980). Purple loosestrife can have a major negative impact on wetlands habitats resulting in reduced productivity of native plants and loss of biodiversity. Currently, the species is documented in 40 states including Nebraska with the most severe infestations occurring around the Great Lakes and in the northeast. The species is a prolific seed producer – each plant can produce up to two million seeds. Seeds are spread by wind, water, birds, and people.

Based on a survey in 2001, about 12,000 acres of Nebraska's wetlands are infested with purple loosestrife, mostly along the main rivers and waterways (Knezevic 2003) (Fig. 41). Purple loosestrife infests river shoreline flats and nearby wetlands along the central and lower Niobrara River (Fig. 41) where it has displaced native plants and impacts nesting sites for interior least terns and piping plovers and feeding and roosting sites for whooping cranes. Currently, The Nature Conservancy has initiated a biological control program on the Niobrara Valley Preserve by introducing *Galerucella* spp. beetles to control purple loosestrife. A National Park Service exotic plant management team has treated purple loosestrife in the scenic river with herbicides and biocontrol and is monitoring the effectiveness of those treatments. These efforts appear to be successful in reducing purple loosestrife infestations but the plant continues to invade new areas (Narumalani and Swain 2009).

Management strategy should

- Treat areas of purple loosestrife infestation and monitor results.
- Determine the effects of purple loosestrife encroachment on wildlife habitat and species.

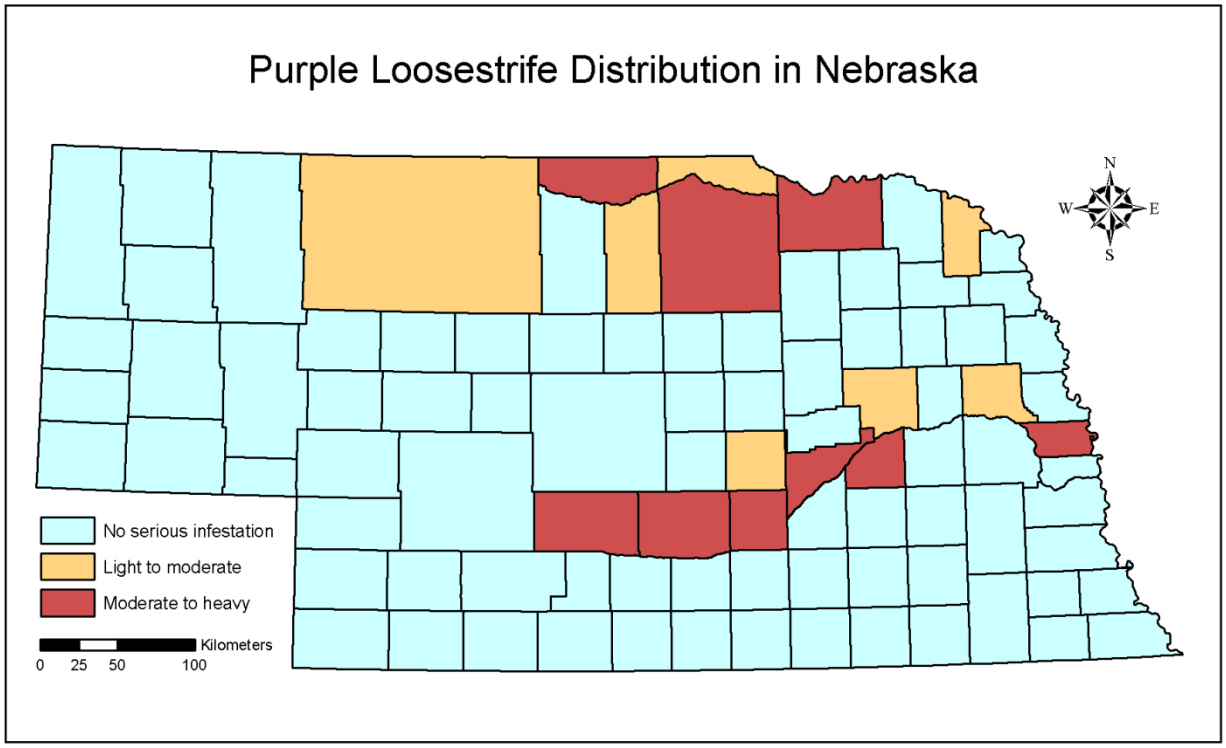


Figure 41. Purple loosestrife distribution in Nebraska (*Source:* Knezevic 2003*)*.

Woodland Expansion (Fire Suppression)

Woodland expansion in and adjacent to the Niobrara River Valley has occurred since European settlement of the region (Steuter et al. 1990). This is most likely due to fire suppression resulting in longer fire-free intervals and a change in the grazing regime from free-ranging bison to confined cattle herds that reduces grass competition with pine seedling (Steuter et al. 1990). These changes have allowed ponderosa pine to establish patches in the grassland matrix (Steinauer and Bragg 1987). Eastern red cedar has also increased in woodland understory and spread into savanna and grassland from seeds spread by birds and cattle. As woodland increases, grassland and shrubland birds are replaced by woodland birds.

Fire suppression has also impacted paper birch and hybrid aspen regeneration. Although historically, fire frequency in the spring branch canyons was very low, hot fires followed by below normal temperature likely occurred every 100–500 years which allowed abundant birch and aspen seed production and local seedling establishment (Steuter and Steinauer 1993).

Management strategy should

- Complete a comprehensive fire history of the scenic river and central Niobrara River

Valley region.

- Measure woodland expansion along the entire length of the scenic river.
- Determine the status of remnant tallgrass prairie.
- Support mechanical cedar thinning.
- Support the use of prescribed fire and the monitoring of fire effects by cooperating private and public land owners within the scenic river boundary.
- Determine the effects of eastern cedar removal (through prescribed fire and mechanical means) on Bailey's eastern woodrat.

Drought

The Palmer Drought Severity Index was developed in the 1960s and uses temperature and precipitation in a formula to determine dryness. Index values range from 0 (normal) to -4 (extreme drought). For the historic period (1895–1995), the scenic river was subject to severe drought (PDSI = -3) from 10 to 14.9 percent of the time period (Fig. 42). With reduced stream flow due to water diversion, drought impacts on river physical and ecological processes and biota may be more severe. Water diversions and drought may reduce river flows to levels not acceptable to river users (Shultz 2009).

Management strategy should

- Monitor drought occurrence in relation to river flows and sandbar development and persistence and possible affect on recreation use.

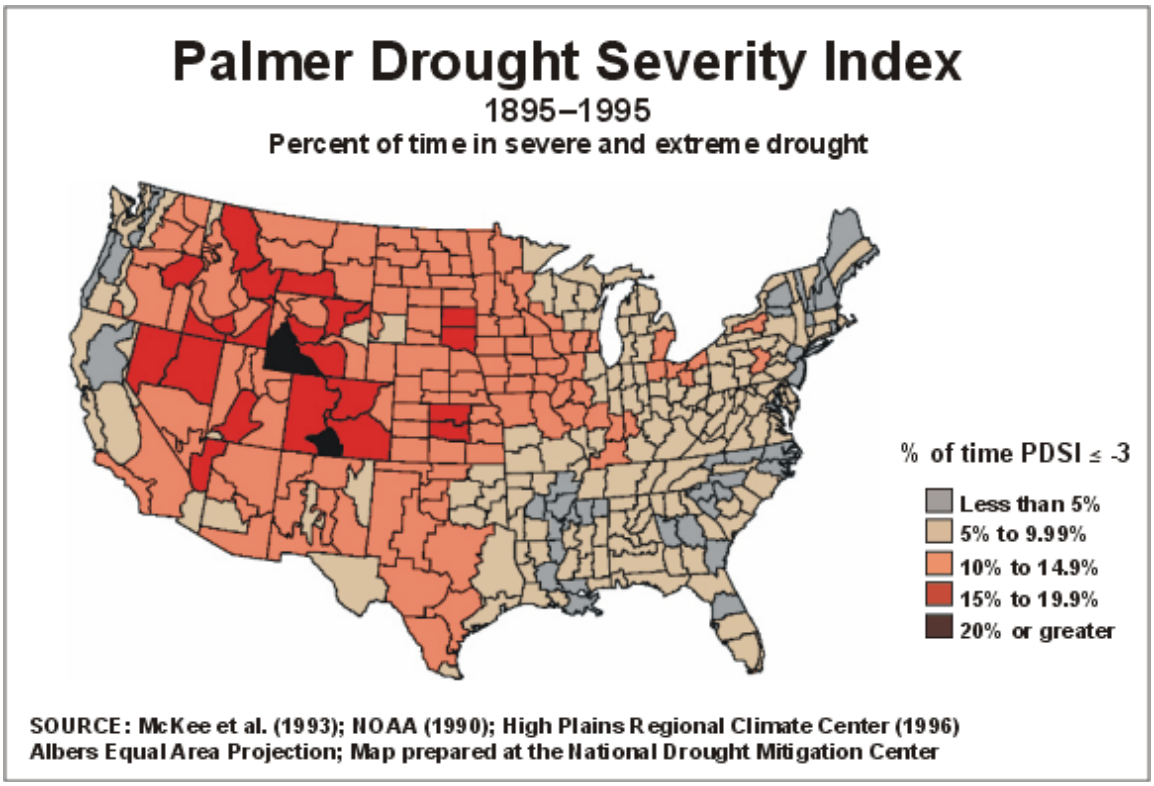


Figure 42. Palmer Drought Severity Index (*Source:* National Drought Mitigation Center 2008).

Microclimate in Birch Stands
Summer maximum temperature in birch stands are within the tolerance range for the species and suggest that it should continue to persist at these sites. However, other climate factors besides summer maximum temperature can affect birch health, especially spring weather conditions (Stroh and Miller 2009). A key factor contributing to dieback may be increased frequency of thaw-freeze events over the past thirty years (Stroh and Miller 2009).

Management strategy should

- Stimulate birch seedling establishment via mechanical removal of surface litter and overstory canopy.
- Monitor birch stand condition and microclimate including the frequency of thaw-freeze events.
- Consider propagation and planting of birch seedlings into existing stands.

Spring Branch Hiking
A majority of the scenic river's visitors come to enjoy aquatic activities such as canoeing, tubing, kayaking, swimming, and fishing. While on the river, floaters often stop to visit several of the more than 230 waterfalls that occur on tributary streams. To reach the falls, visitors often must hike in the streambed itself. A study performed in the summer of 2006 (Laing 2008) investigated the effects of human disturbance (i.e. visitors walking in the streambed) on a number of tributaries to the Niobrara River within the scenic river boundary. The macroinvertebrate communities in disturbed streams showed declines in both the total number (abundance) and types (richness) of organisms compared to undisturbed streams (Fig. 43). Sensitive species were lost as the physical disturbance increased. However, in general, the macroinvertebrate communities in disturbed streams appear to recover after the fall, winter, and early spring when visitor use is low (Laing 2008).

Management strategy should

- Collect additional years of physical disturbance data to provide insights regarding long-term effects on invertebrates, as well as on periphyton.
- Monitor aquatic macroinvertebrates; restrict visitor use if impacts persist.

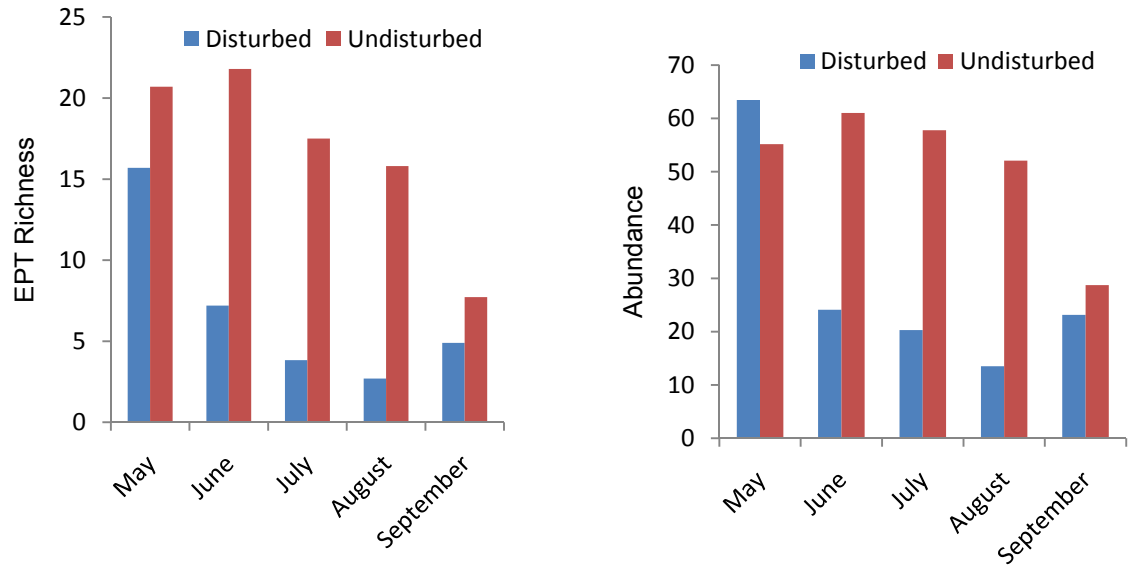


Figure 43. Mean aquatic macroinvertebrate EPT richness and abundance in disturbed and undisturbed tributaries within Niobrara National Scenic River (*Source*: Laing 2008).

Other existing or potential stressors identified through this condition assessment include:

Leafy Spurge Infestation

Leafy spurge is an invasive plant that infests over three million acres in the northern Great Plains. In Nebraska, leafy spurge currently infests at least 793,184 ha (321,000 acres) mostly in the northeast and north central parts of the state (Masters and Kappler 2002) (Fig. 44). It is widespread in the scenic river region (Johnsgard 2007). Leafy spurge reproduces by both seed and by adventitious shoot buds. Effective seed dispersal mechanisms (animals and humans), high seed viability, and rapid seedling development lead to new infestations. Prolific vegetative reproduction maintains dense, long-lived infestations that reduce or eliminate native plant diversity.

Common Reed Infestation

The non-native common reed, which was introduced from Europe in the 1800s, is distributed across the United States and southern Canada. Over the past several decades, populations of the plant have increased in freshwater and brackish wetlands. Once established, populations can expand rapidly to form dense, monoculture stands that reduce plant species diversity and create unsuitable habitat for wildlife including migrating wading birds and waterfowl. In Nebraska, the most problematic infestations of the species are along the Niobrara, Platte, and Republican rivers (Knezevic 2008) (Fig. 45).

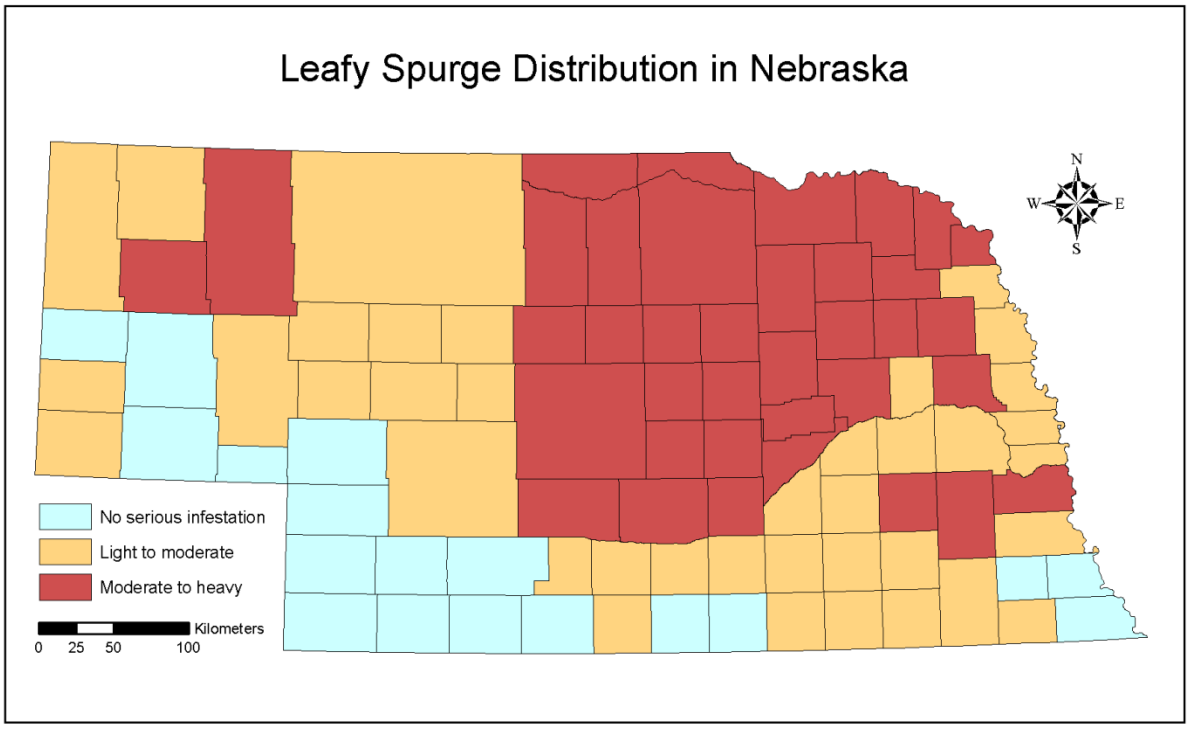


Figure 44. Leafy spurge distribution in Nebraska (*Source*: Masters and Kappler 2002).

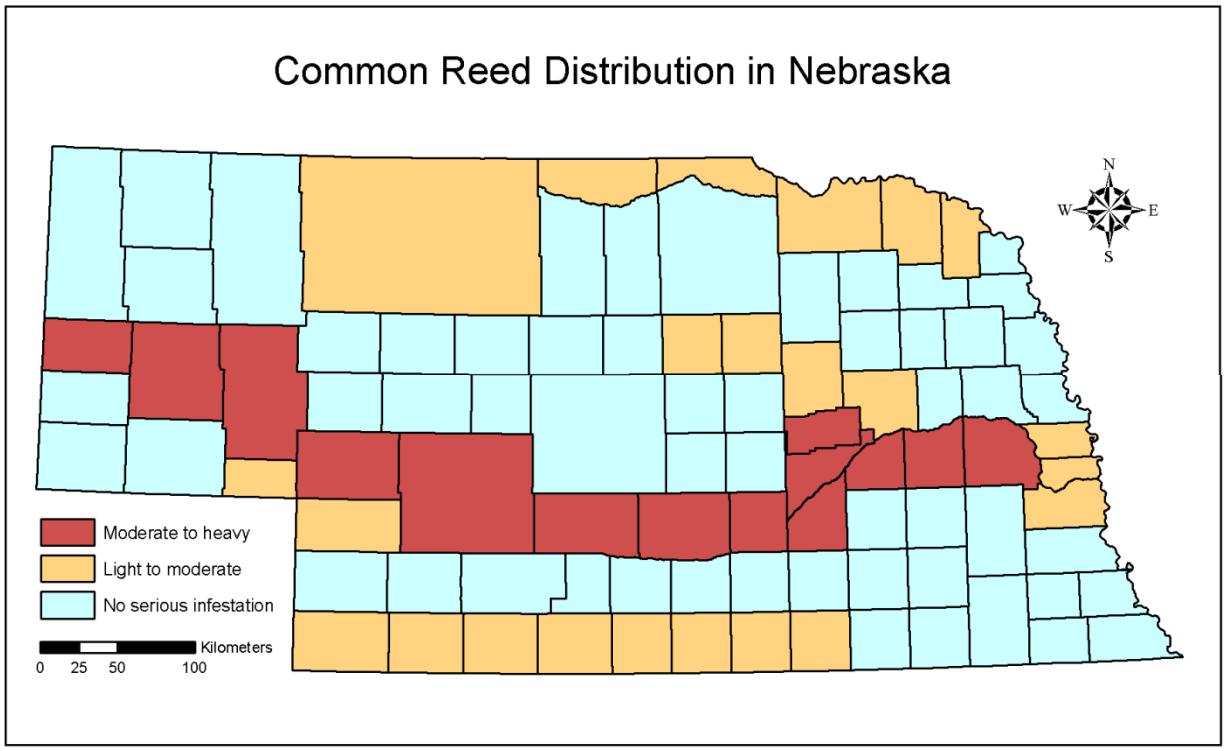


Figure 45. Common reed distribution in Nebraska (*Source*: Knezevic et al. 2008).

Mountain Pine Beetle Infestation
The mountain pine beetle (*Dendroclonus ponderosae*) is native to the forest of western North America, but was not known to occur in Nebraska until the summer of 2009 when adult beetles were found at several locations in the panhandle of the state (Institute of Agriculture and Natural Resources 2009). The beetle attacks and kills all species of pine, although ponderosa pine is more resistant. Based on the spread and effect of the beetle in the Black Hills over the past ten years, dense stands of ponderosa pine in Nebraska's Pine Ridge are at risk. In the future, the mountain pine beetle may spread to increasingly dense stands of ponderosa pine in the scenic river region.

Emerald Ash Borer Infestation
In 2002, the emerald ask borer (*Agrilus plaipennis*), an exotic beetle from Asia, was discovered in southeastern Michigan (Cooperative Emeral Ash Borer Project 2009). Since its discovery, the species has killed millions of ash trees and is now known from Illinois, Indiana, Ohio, Pennsylvania, Maryland, West Virginia and Ontario, Canada (Fig. 46). The emerald ash borer is spread primarily through the transport of infected nursery stock and firewood.

Experts believe it is only a matter of time before the species is found throughout eastern and central North America. In the Great Plains, green ash dominates riparian ecosystems, native forests, woodlots and conservation plantings, such as windbreaks (U.S. Department of Agriculture 2008) (Fig. 47). In the scenic river, green ash is one of the dominant trees of the riparian hardwood forest which is considered an outlier of the eastern deciduous forest (Johnsgard 2007). This riparian forest exhibits the greatest vertebrate diversity of any of the habitats in the central Niobrara River Valley (Beed 1936). With the invasion of the borer and the subsequent die-off of ash, changes in the riparian plant community would undoubtedly affect the resident wildlife.

Management Strategy should

- Map and treat infestation of leafy spurge and common reed.
- Track the spread of mountain pine beetle in western Nebraska.
- Participate with the State of Nebraska and U.S. Department of Agriculture in efforts to detect ash borers in Nebraska.

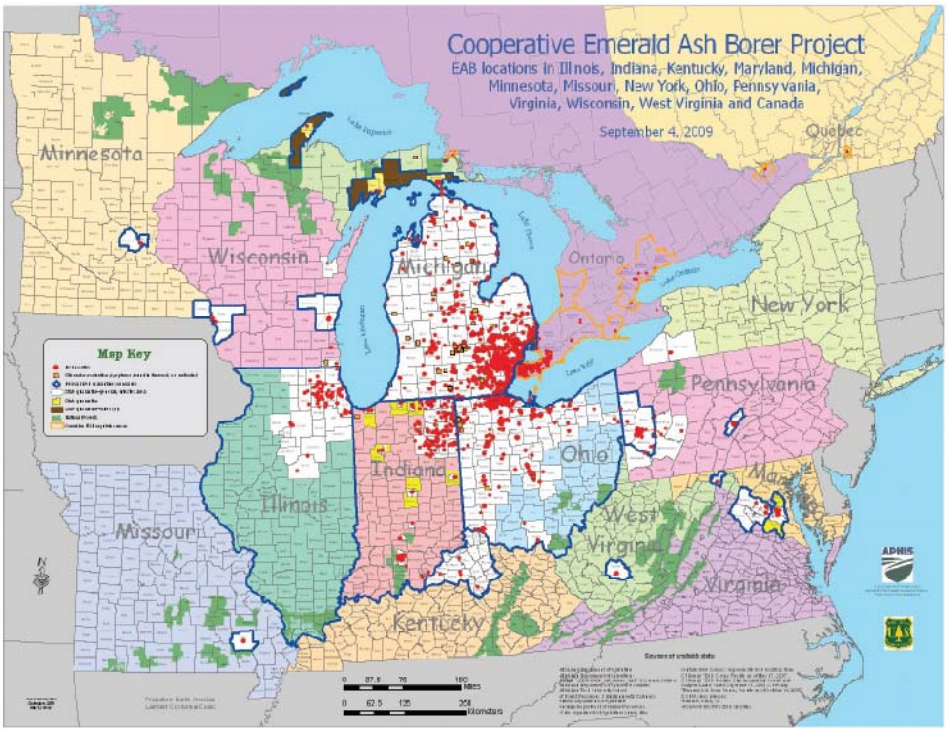


Figure 46. Emerald ash borer locations in the United States and Canada (*Source*: Cooperative Emerald Ash Borer Project 2009).

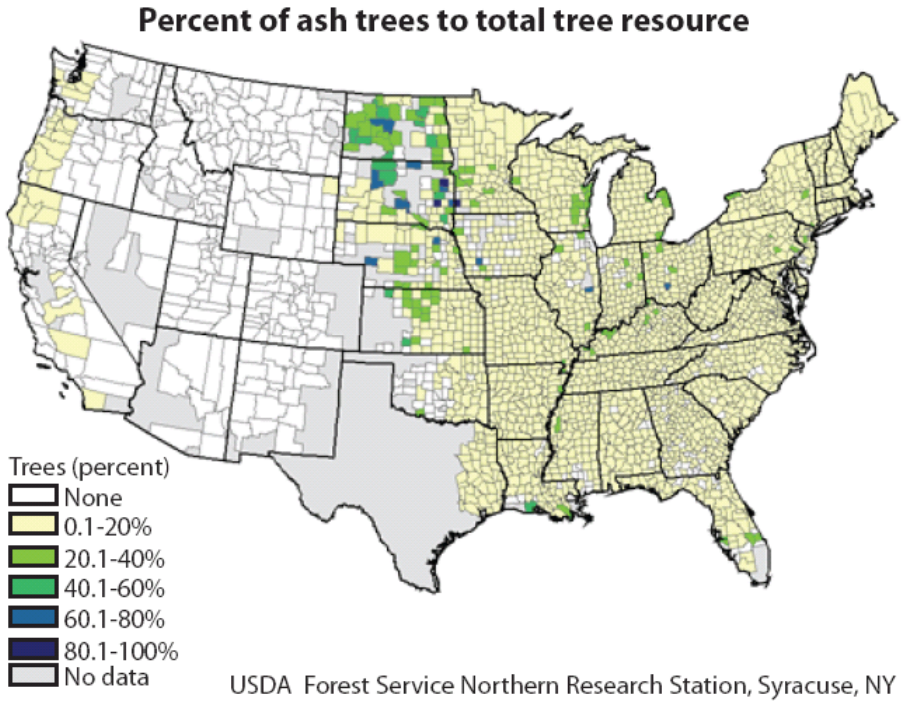


Figure 47. Percent of ash trees to total tree resources (*Source*: U.S. Department of Agriculture 2008).

Conclusion

The overall condition and trend of each major habitat in the scenic river is based on a subjective appraisal of the condition and trend of its indicators. They follow:

Niobrara River and Tributaries
The Niobrara River and tributaries habitat is in good condition. Annual and daily decreases in stream flows have occurred following operation of the Merritt Dam in 1965, but water quality of the river is generally good based on the presence of pollution intolerant aquatic macroinvertebrates and the results of chemical water quality sampling. The fish community remains species diverse and stable. Furthermore, recreation use of the river continues to increase. This suggests that although flows have decreased, these changes have not as yet impacted water quality, important biota, or recreation. However, the population status of spiny softshell turtles, a species sensitive to stream flow variations, is not known. Concern about possible future impacts of reduced stream flows has lead the State of Nebraska to impose a moratorium on issuing new surface water permits in the Niobrara River basin.

Water quality in Niobrara River tributaries is also good. However, visitors hiking in the streambed of several of the tributaries has led to the seasonal loss of some aquatic species although these species tend to recover during periods of low visitor use. Several of the tributary streams have populations of rare cool-water fishes although the status and trend of these populations is unclear due to inconsistent monitoring.

Upland Forest and Savanna
The upland forest and savanna habitat is in poor condition and deteriorating, largely due to the increased density of ponderosa pine and eastern red cedar; and the spread of these species from protected sites into savanna and open grassland. This is a result of a longer fire return interval that followed almost complete fire suppression beginning around 1900. Dense stands of pine and cedar are prone to crown fire and insect attack. A land cover change analysis that compared land classes between 1992 and 2001 did not detect an increase in woodland, but that may be due to the short time span between the dates used in the analysis. In contrast, elk are increasing in this habitat and in grassland due to the availability of suitable habitat and increased landowner tolerance.

Spring Branch Canyon and Riparian Forest
The Spring Branch Canyon and Riparian Forest habitat is in poor condition and deteriorating based on the condition and trend of its two major indicators—paper birch and hybrid aspen. Both of these species require sheltered microhabitats for persistence, and disturbance for seedling establishment and root sprouting. Long-term persistence of these species is in doubt considering recent changes in microclimate (increased thaw-freeze conditions) and lack of natural disturbance. In addition, the possible infestation of this habitat by the emerald ash borer would remove green ash, a dominant tree, and have secondary adverse effects on the diverse wildlife of the habitat. In contrast, Bailey's eastern woodrat is in good condition and may have benefited from an increase in eastern red cedar, a primary food source of the woodrat. Bird hybridization rates and areas of sympatry may also indicate changes in this habitat, but temporal data are lacking.

Grassland
The Grassland habitat is in good condition in the central Niobrara River Valley region and has benefitted from the planting of native grasses in former crop fields. However, it is deteriorating in upland areas near the river. This is the result of fire suppression and the resulting invasion of grassland by ponderosa pine and eastern red cedar. Cedar invasion of grassland causes a decrease in overall bird species richness and shifts in species composition from grassland and shrubland to woodland and forest birds. A land cover change analysis found an increase in grassland/shrub from 1992 to 2001. This increase may be the result of conversion of agricultural fields to grassland which may have masked a small loss of native grassland to invading trees. Leafy spurge, an aggressive exotic, is widespread in this habitat but its site-specific impacts are unknown. The free-ranging elk population is increasing.

Sandy Shorelines, Sandbars, and Wetlands
The Sandy Shorelines, Sandbars, and Wetlands habitat is in good condition and stable based on the interior least tern and piping plover and purple loosestrife indicators. The number of adult terns and plovers counted on the Niobrara River has increased in recent years, however, past monitoring has shown population numbers to be highly variable. The nesting and foraging habitats of these species in the scenic river may be affected by reduced stream flow, reduced sediment transport, and exotic plants, especially purple loosestrife and common reed. In recent years, biocontrol has reduced purple loosestrife infestations by as much as 80 percent in some areas, but common reed may have increased in extent and density. Migrating whooping cranes appear to be using this habitat in greater numbers but this may be an artifact of greater public awareness.

A variety of existing data sources were used to assess the condition and trend of the five major habitats in the scenic river. Most important were inventory and analysis of gauge records of stream flow, inventory and assessment of paper birch and hybrid aspen, and assessment of water quality based on aquatic macroinvertebrates. Also important were a number of inventories (e.g., birds) that were initiated in the 1970s to assess the environmental impacts of the proposed Norden Dam. Several of the habitat indicators were suggested by research, including studies of paper birch decline, elk demography, woodland expansion into grassland, and visitor impacts on water quality of tributary streams. Currently, resource monitoring by the scenic river is limited primarily to water quality, rare species (i.e., interior least terns and piping plovers), and recreational use. In the future, monitoring protocols being developed by the Northern Great Plains Inventory and Monitoring Network will include upland and riparian plant communities. In addition, inventories and/or monitoring in cooperation with the Nebraska Game and Parks Commission should be considered for river otter, cool-water fishes, fish community, spiny softshell turtle, elk, and Bailey's eastern woodrat. Important research needs include recreation impacts on spiny softshell turtles, reduced stream flow impacts on river morphology and biota, changes in bird hybridization rates and locations, and impacts of existing and potential invasive plants and insects.

Table 22. Habitat conditions and trends.

Habitat	% of park area	Condition and trend of habitat indicators		Condition and trend of habitat
Niobrara river and tributaries	36		Aquatic macroinvertebrates	
			River otter	
			Cool-water fishes	
			Fish community	
			Spiny softshell turtle	
			Stream flow	
Upland forest and savanna	35		Elk	
			Ponderosa pine	
			Land cover	
			Fire	
Spring branch canyon and riparian forest	10		Paper birch	
			Hybrid aspen	
			Bailey's eastern woodrat	
			Bird hybridization	
Grassland	8		Grassland birds	
			Sand Hills prairie	
			Land cover	
			Fire	

Table 22. Habitat conditions and trends (continued).

Habitat	% of park area	Condition and trend of habitat indicators		Condition and trend of habitat
Sandy shorelines, sandbars, and wetlands	10		Least tern and piping plover	
			Purple loosestrife	
			Whooping crane	
			Sediment transport	

Note: Green box = good condition; Red box = poor condition; Open box = no assessment; Upward arrow = improving; Downward arrow = deteriorating; Horizontal arrow = stable; and No arrow = no or insufficient data to determine trend.

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Appendix A: Sampling design and data analysis[1]

Habitat	Indicator	Source	Metric	Statistic/test
Niobrara River and tributaries	Aq. macroinvert.	Rust 2006	EPT richness; HBI	mean; std dev/ANOVA
	Fish community	Gutzmer 2002	CPUE	mean/ANOVA
	Stream flow	Wen and Chen 2006	annual flow	mean/Mann-Kendall test
	Stream flow	Istanbulluoglu 2008	daily discharge	mean/t-test
Upland forest and savanna	Ponderosa pine	Guyette 2005	fire interval	mean/K-S test
Spring branch canyon and riparian forest	No studies			
Grassland	Grassland birds	Frost 2007	density	mean/conf.int.
	Fire	Guyette 2005	fire interval	mean/K-S test
Sandy shorelines, sandbars, and wetlands	No studies			

[1] only Indicator studies that have statistically compared data for reference and existing conditions are shown

Appendix B: GIS data sources for Niobrara National Scenic River

Figure	Type	Year Produced	Producer	Description
1	Shapefile	2009	CALMIT[1]	Location map of scenic river along the Niobrara River
6	Shapefile	2009	CALMIT	Niobrara River watershed from US EPA
8	Shapefile	2009	CALMIT, Adapted from Dietsh 2008	Fish observations derived from sample points.
11	Shapefile	2009	CALMIT, Adapted from Rust 2006	Aquatic macroinvertebrate sampling sites.
16	Shapefile	2009	CALMIT, Adapted from Schainost 2008	Location of cool-water fish sampling sites in tributary streams.
17	Shapefile	2009	CALMIT, Adapted from Istanbulluoglu 2008	Location of nine streamflow gauges in or near the scenic river.
23	Shapefile	2009	CALMIT	Change in woodland vegetation interpreted from historic aerial photography
24	Shapefile	2009	CALMIT	Change in woodland vegetation interpreted from historic aerial photography
25	Grid	2008	USGS	Land Cover change as produced by the USGS using NLCD 1992 and 2001 Retro-fit products
26	Shapefile	2009	CALMIT, Adapted from Stroh and Miller 2009	Sampling locations of paper birch along the Niobrara River.
27	Shapefile	2009	CALMIT, Adapted from Shepperd 2008	Observation points of hybrid aspen.
31	Shapefile	2009	CALMIT, Adapted from Blausey 2002, 2003, 2004	Interior least tern and piping plover observations.
34	ENVI[2]	2009	CALMIT, Narumalani and Swain 2009	Areas of purple loosestrife infestations interpreted from hyperspectral imagery.
35	ENVI	2002	NPS	Areas of purple loosestrife infestation delineated by NPS.
36	ENVI	2002, 2008	CALMIT, NPS	Effectiveness of biological control on a selected area of the scenic river.
38	Shapefile	2009	CALMIT, Adapted from Platte River Whooping Crane Maintenance Trust, Inc. 2009	Depiction of whooping crane migration pathways.
42	Shapefile	2008	NDMC[3] 2008	Historical Palmer Drought Severity Index 1895-1995

[1] Center for Advanced Land Management Information Technologies
[2] Environment for Visualizing Images
[3] National Drought Mitigation Center

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