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Physical Habitat, Water Quality and Riverine Biological Assemblages of Selected Reaches on the Sheyenne River, North Dakota, 2010

Scientific Investigation Report 2011–5178

U.S. Department of the Interior
U.S. Geological Survey

Cover. U.S. Geological Survey personnel preparing for fish data collection on the upper Sheyenne River near Maddock, North Dakota, July 12, 2010 (top). Canadian thistle along the banks of the upper Sheyenne River near Cooperstown, North Dakota, July 10, 2010 (lower, left). Wooden footbridge across the upper Sheyenne River near Maddock, North Dakota, July 12, 2010 (lower right). Photographs courtesy of Kathleen M. Macek-Rowland, U.S. Geological Survey.

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By Robert F. Lundgren, Kathleen M. Rowland, and Matthew J. Lindsay

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square foot (ft^2)	929.0	square centimeter (cm^2)
square foot (ft^2)	.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
	Mass	
kilogram (kg)	2.205	pound avoirdupois (lb)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F - 32)/1.8$$

All lake levels and elevations used in this report are referenced to the National Geodetic Vertical Datum (NGVD) of 1929.

Elevation, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Physical Habitat, Water Quality, and Riverine Biological Assemblages of Selected Reaches of the Sheyenne River, North Dakota, 2010

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Abstract

In 2010, data on physical habitat, water quality, and riverine biological assemblages were collected at selected reaches in four locations (Kleven, Sheyenne, Cooperstown, and West Fargo) on the Sheyenne River in east-central North Dakota. Three of the locations (Kleven, Sheyenne, and Cooperstown) are above Baldhill Dam and one location (West Fargo) is below Baldhill Dam on the Sheyenne River. The 2010 data provide information to establish a better understanding of the water-quality and ecological conditions of the Sheyenne River. Concerns were raised about the water-quality and ecological conditions of the Sheyenne River because of the interbasin transfer of water from nearby Devils Lake. The transfer of water from Devils Lake to the Sheyenne River occurs through the Devils Lake State Outlet near Peterson Coulee or, if lake elevations exceed 1,459 feet above National Geodetic Vertical Datum of 1929 (NGVD 29), through a natural outlet, Tolna Coulee.

The field measurements of water-quality characteristics and results of chemical analyses generally are comparable to summary statistics calculated for Sheyenne River for 1980 through 2006. Overall, water-quality results show differences between the Kleven, Sheyenne, Cooperstown, and West Fargo reaches. Sulfate concentrations were less than the State of North Dakota criterion of 750 milligrams per liter for the upper Sheyenne River above Baldhill Dam and less than the criterion of 450 milligrams per liter for the lower Sheyenne River below Baldhill Dam. Arsenic concentrations at most reaches exceeded the U.S. Environmental Protection Agency drinking-water standard of 10 micrograms per liter. Nutrient concentrations (nitrogen, phosphorus) were higher in the upper Sheyenne River above Baldhill Dam than below Baldhill Dam where concentrations decreased by about half.

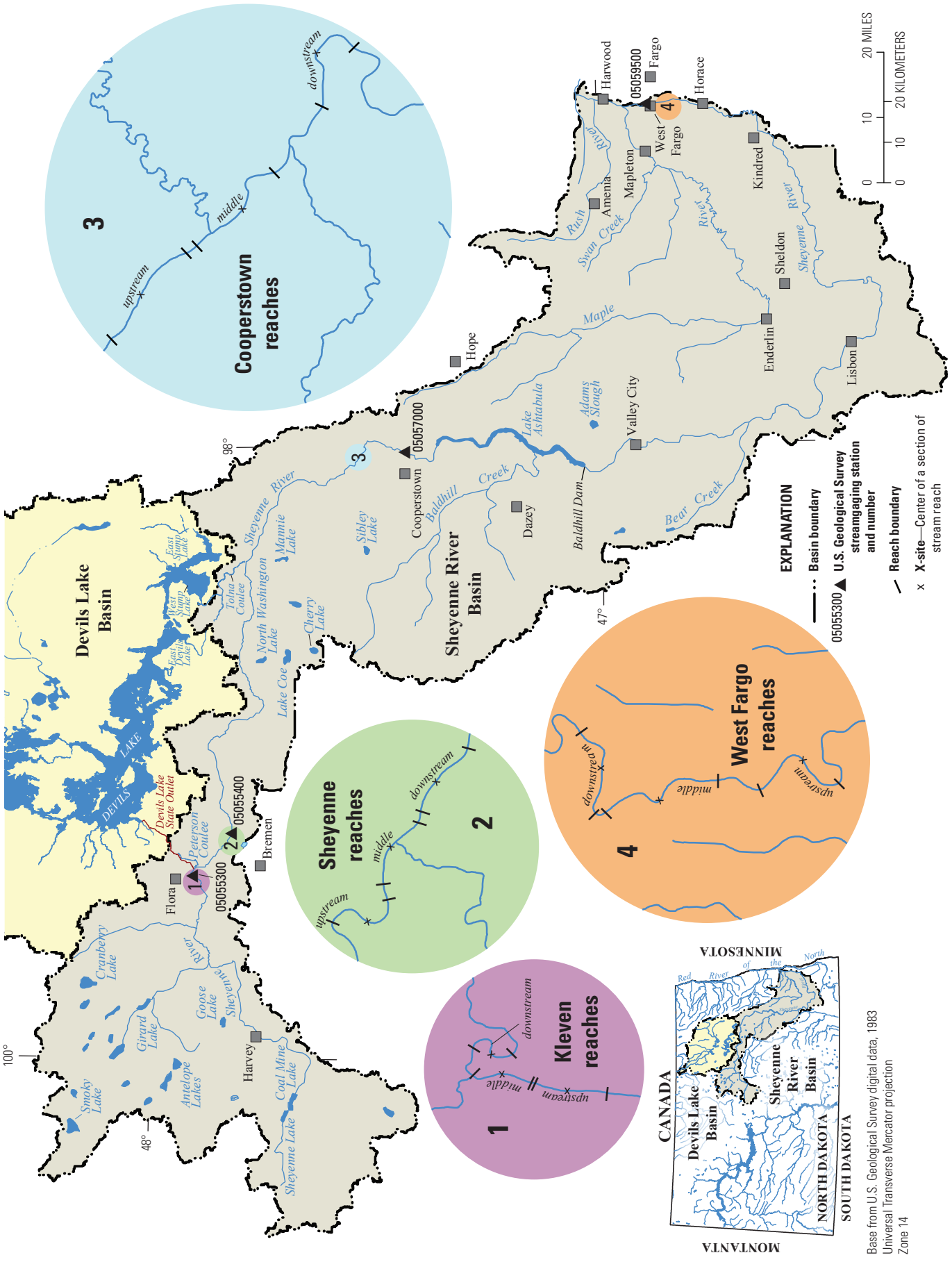
In 2010, 35 families and 44 genera of benthic macroinvertebrates were collected and identified. On the basis of the index of biotic intergrity scores for benthic macroinvertebrate communities present in the Sheyenne River, all the reaches were determined to have condition classes of moderately disturbed to most disturbed. The benthic macroinvertebrate communities at the Cooperstown reaches were classed as moderately disturbed, whereas benthic macroinvertebrate communities at the Kleven, Sheyenne, West and Fargo reaches were most disturbed.

During data collection, 37 genera and 165 species of periphyton (diatoms and soft-bodied algae) were collected and identified. In periphyton communities, similar taxa species were dominant in the Kleven, Sheyenne, and Cooperstown reaches, and different taxa species were dominant in the West Fargo reaches. For diatoms, the Kleven 3 reach had the lowest species richness value of 33.0, whereas the Cooperstown 8 reach had the highest species richness value of 57.0. For soft-bodied algae, the species richness values ranged from 8.0 at the Sheyenne 4 reach to 20.0 at the West Fargo 10 reach.

During the fish collection, 32 species, representing 10 families, were collected in the Sheyenne River. All but two species are native to the Sheyenne River system. Common carp and white crappie are the two introduced species. Of the 32 species, 29 are tolerant to moderately tolerant to changes in water quality and habitat degradation, 16 species are tolerant to moderately tolerant to turbidity, and 16 species are tolerant to moderately tolerant to sensitivity to total dissolved solids, sulfate, and chloride. All fish species were categorized into four trophic groups. The largest group of 19 species was the insectivores (both benthic and general). The predator group consisted of seven species, and the omnivores consisted of six species. More fish were found in the lower Sheyenne River below Baldhill Dam than in the upper Sheyenne River above Baldhill Dam.

Introduction

The Sheyenne River in east-central North Dakota is a tributary to the Red River of the North (Red River) which flows northward into Canada (fig. 1). To the north of Sheyenne River is Devils Lake (fig. 1). Devils Lake is a terminal lake, meaning that water will leave the lake only through evaporation, plant uptake, ground infiltration, or overflow if the lake elevation gets high enough (North Dakota State Water



Base from U.S. Geological Survey digital data, 1983
Universal Transverse Mercator projection
Zone 14

Figure 1. Location of the Sheyenne River with selected reaches, Devils Lake, and data-collection sites in North Dakota.

Commission, 2011). At an elevation of 1,446.5 feet above National Geodetic Vertical Datum of 1929 (NGVD 29), Devils Lake spills into Stump Lake, and at a elevation of about 1,459 feet above NGVD 29, the combined Devils Lake and Stump Lake system spills from Stump Lake, through Tolna Coulee (a natural outlet), to the Sheyenne River (fig. 1) (North Dakota State Water Commission, 2010a). The interbasin transfer of water from Devils Lake Basin into the Sheyenne River Basin is a concern for water-resource managers and citizens living along the Sheyenne River and Red River because the interbasin transfer may affect water-quality and ecological conditions downstream from this outlet discharge location and, if not regulated, may increase streamflows downstream. In an effort to slow rising water levels and reduce the chance of an uncontrolled spill, the North Dakota State Water Commission (NDSWC) constructed an outlet (hereafter Devils Lake State Outlet) at the west end of Devils Lake near Peterson Coulee, about 40 miles west of Tolna Coulee (fig. 1).

The State of North Dakota monitors conditions existing in the Sheyenne River so that water-quality conditions continue to meet applicable Clean Water Act requirements. In order for NDSWC to develop a sound management plan for the Devils Lake State Outlet, data on water-quality and ecological conditions of the Sheyenne River were needed prior to the release of substantial amounts of water from Devils Lake. During 2004 and 2005, studies were conducted by High Plains Consortium, Inc., to collect data on physical habitat, water quality, and riverine assemblages (benthic macroinvertebrates, periphyton, and fish) in the Sheyenne River (High Plains Consortium, Inc., 2007). In 2006, operation of the Devils Lake State Outlet began, and water was transferred from Devils Lake to the Sheyenne River. In 2010, the USGS, in cooperation with the NDSWC, conducted a study similar to the 2004 and 2005 studies to contribute to the knowledge of water-quality and ecological conditions of the Sheyenne River after operation of the Devils Lake State Outlet began.

Purpose and Scope

The purpose of this report is to describe the physical habitat and present water-quality and biological data collected by the USGS from the Sheyenne River during July and August 2010. Current data provide information for a better understanding of the water quality and biological integrity at selected reaches on the Sheyenne River.

Study Area

The Sheyenne River, which is about 506 miles long and has a drainage area of about 6,910 square miles (not including the closed Devils Lake Basin), is the longest river within North Dakota and is used for water supply, irrigation, recreation, small industry, and mining (North Dakota State Water Commission, 2005). The Sheyenne River originates in Sheridan County in central North Dakota and flows northeasterly toward Devils Lake. The Sheyenne River then flows east near the southern border of Devils Lake before turning south toward Valley City, North Dakota. North of Valley City, the river flows into Lake Ashtabula, the largest reservoir in the basin (fig. 1). The Sheyenne River continues in a southeasterly direction before looping back northward to the confluence with the Red River just north of Fargo, North Dakota.

In 2010, data collection was conducted at three reaches in each of the following areas of the Sheyenne River: Kleven, Sheyenne, Cooperstown, and West Fargo (fig. 1, table 1). The Kleven reaches are located south of Flora, North Dakota, about 2 miles upstream from the Devils Lake State Outlet near Peterson Coulee (fig. 1, table 1). The reaches are located on a crop and cattle farm operation just west of the USGS streamgaging station Sheyenne River above Devils Lake State Outlet near Flora, North Dakota (station number 05055300).

The Sheyenne reaches are located northwest of Bremen, North Dakota, about 1 mile downstream from the Devils Lake State Outlet near Peterson Coulee (fig. l, table 1). The reaches are located on a crop and cattle farm operation just west of the USGS streamgaging station Sheyenne River below Devils Lake State Outlet near Bremen, North Dakota (station number 05055400).

The Cooperstown reaches are located northeast of Cooperstown, North Dakota, about 7 miles upstream from the USGS streamgaging station Sheyenne River near Cooperstown, North Dakota (station number 05057000) and about 12 miles upstream from Lake Ashtabula (fig. 1, table 1). The reaches are located in an area of cultivated fields with some pastures and wetlands nearby.

The West Fargo reaches are located about 13 miles upstream from the confluence of the Sheyenne River with the Red River and 3 miles upstream from the USGS streamgaging station Sheyenne River at West Fargo, North Dakota (station number 05059500) (fig. l, table 1). All three reaches are near semi-rural residential areas. A few small irrigation pumps with pipes running to the river were observed at some residential properties along the river during data collection. This area is undergoing development because of the increasing population growth in Fargo and West Fargo, North Dakota; however, some cultivated fields are present in this area.

Methods

Physical-habitat, water-quality, and biological samples were collected once in July or August 2010, generally during periods of low flow when conditions were relatively stable and problems with access were minimized. The data-collection methods were developed during previous Environmental Monitoring and Assessment Program (EMAP) studies conducted by the U.S. Environmental Protection Agency (USEPA) and their cooperators (Peck and others, 2003; Lazorchak and others, 2000). Methods used for 2010 were in accordance with

Table 1. Data-collection reaches on the Sheyenne River, North Dakota.

[SE., southeast; W., west]

Reach number (fig. 1)	U.S. Geological Survey site number	Reach name	U.S. Geological Survey study reach designation
1	475422099251100	Sheyenne River Kleven site 1 SE. of Maddock, N. Dak.	Kleven reach downstream[1]
2	475420099252100	Sheyenne River Kleven site 2 SE. of Maddock, N. Dak.	Kleven reach middle[1]
3	475405099252700	Sheyenne River Kleven site 3 SE. of Maddock, N. Dak.	Kleven reach upstream
4	474922099170700	Sheyenne River Sheyenne site 1 W. of Sheyenne, N. Dak.	Sheyenne reach downstream
5	474933099173200	Sheyenne River Sheyenne site 2 W. of Sheyenne, N. Dak.	Sheyenne reach middle
6	474941099180000	Sheyenne River Sheyenne site 3 W. of Sheyenne, N. Dak.	Sheyenne reach upstream
7	473139098011800	Sheyenne River Cooperstown site 1 Cooperstown, N. Dak.	Cooperstown reach downstream
8	473158098021400	Sheyenne River Cooperstown site 2 Cooperstown, N. Dak.	Cooperstown reach middle
9	473222098024400	Sheyenne River Cooperstown site 3 Cooperstown, N. Dak.	Cooperstown reach upstream
10	465036096540800	Sheyenne River West Fargo site 1 West Fargo, N. Dak.	West Fargo downstream
11	465022096541900	Sheyenne River West Fargo site 2 West Fargo, N. Dak.	West Fargo middle
12	464947096540700	Sheyenne River West Fargo site 3 West Fargo, N. Dak.	West Fargo upstream

[1]The middle and downstream reach locations are reversed in the High Plains Consortium, Inc. (2007), study.

EMAP protocols and were used during the 2010 data collection at the request of the State.

Data Collection

Physical-habitat, water-quality, and biological samples were collected in a stream reach according to the methods documented in Peck and others (2003) for wadeable streams and in Lazorchak and others (2000) for non-wadeable streams. Fish samples were collected from all 12 reaches in July 2010, and all other field sampling was conducted in August 2010. Streamflows were measured at the nearest USGS streamgaging station (table 2).

For each stream reach, the mean wetted width was determined, then multiplied by 40 to get the total length to be assessed (fig. 2). The stream reach was then divided into 11 equally spaced transects, five upstream and five downstream from the center, creating 10 segments. The 11 transects were subsequently labeled A to K. The A transect represents the most downstream transect and K represents the most upstream transect. The center or F transect represents the location of the X-site, which is the centroid of streamflow. If the mean wetted width was less than 4 meters a minimum sample reach length of 150 meters was used, as indicated in the EMAP methods, to adequately sample fish (Kaufmann and others, 1999).

Physical-habitat data were collected using EMAP methods (Peck and others, 2003). Several physical-habitat attributes that affect or provide substance to organisms were measured at each reach (Karr and others, 1986) to characterize stream morphology, ecology, physical make-up, and area surroundings.

Measurements of bank characteristics were made at both banks of each transect and include estimated bank angle, extent of bank undercutting, channel incised height, and height of bankfull flow above the present water-surface elevation. Measurements of channel depth were made at five equally spaced points within the wetted width throughout the reach. When coupled with depth measurements, bank-characteristic data can provide a mechanism for estimating streamflow through the reach. The depth measurements provide information about stream size and channel complexity, as well as the location and relative size of riffles and pools. At the time of measurement, the occurrence, location, and width of sand or gravel bars also were recorded.

Table 2. U.S. Geological Survey streamgaging stations on the Sheyenne River, North Dakota, at which streamflow values were measured.

Study reaches (fig. 1)	U.S. Geological Survey station number	U.S. Geological Survey station name
Kleven reaches	05055300	Sheyenne River above Devils Lake State Outlet near Flora, N. Dak.
Sheyenne reaches	05055400	Sheyenne River below Devils Lake State Outlet near Bremen, N. Dak.
Cooperstown reaches	05057000	Sheyenne River near Cooperstown, N. Dak.
West Fargo reaches	05059500	Sheyenne River at West Fargo, N. Dak.

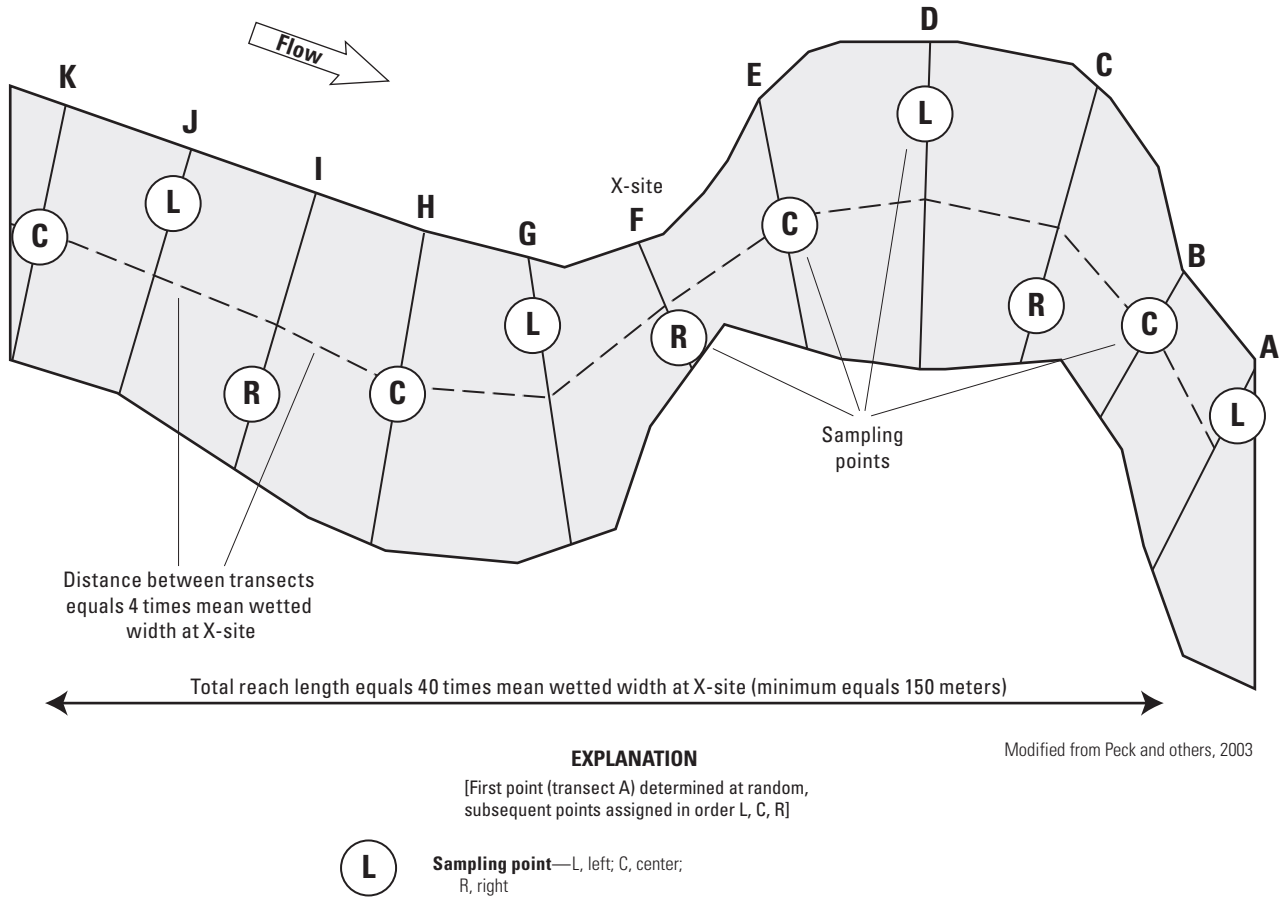


Figure 2. A stream reach layout for the Sheyenne River, North Dakota.

Characterization of the channel substrate is an important component of any stream biological assessment because the substrate size and type (silt, sand, gravel, and cobbles) have a great effect on the composition and diversity of aquatic invertebrates and fish inhabiting a stream. Substrate size also has a direct effect on hydraulic roughness and stream velocity. Substrate with a large percentage of fine sediments can provide an indication that erosion has occurred. Substrate size and type were estimated visually or by feel using the tip of the surveyor rod at five equally spaced points along the wetted width of the individual transect (table 3).

Riparian vegetation has important effects on stream condition (Kaufmann and others, 1999). Tall trees provide a canopy over the stream that provides shade and lowers water temperatures. Leaves from over-hanging trees fall into the stream and become food for aquatic insects and provide a source of particulate organic material for other organisms. Limbs from these trees also fall into the stream and provide additional organic material and habitat for insects, algae, and fish.

Canopy density was measured at the five equally spaced transect points using a spherical convex canopy densiometer. At each of the points, four readings were made with the densiometer 0.3 meter above the water surface and facing upstream, right bank, downstream, and left bank. Woody debris tallies were made along the full length of a reach to obtain estimates of the number, size, total volume, and distribution of wood. Woody debris are defined as woody material with small-end diameter of at least 10 centimeters and length of at least 1.5 meters (Peck and others, 2003).

Table 3. Substrate particle size classification codes.

[Data from Peck and others, 2003; >, greater than; ≤, less than or equal to]

Code	Substrate type	Size range (millimeter)	Substrate description/size
CB	Cobbles	>64 to 250	Tennis ball to basketball
GC	Gravel, coarse	>16 to 64	Marble to tennis ball
GF	Gravel, fine	>2 to 16	Ladybug to marble
SA	Sand	>0.06 to 2	Smaller than ladybug size, gritty feel
FN	Fines	≤0.06	Silt clay muck

Water-quality characteristics were measured, and water-quality samples were collected, using EMAP methods (Peck and others, 2003). Water-quality data were obtained prior to other field sampling. Water-quality characteristics, including pH, specific electrical conductance (conductivity), water temperature, and dissolved oxygen, were measured at the approximate location of the centroid of flow at the X-site (fig. 2) using submersible multi-probe water-quality instrumentation. Water-quality instruments were calibrated before each use following guidelines for field measurements outlined in Wilde (variously dated).

At each river reach, a single water-quality sample was collected from the centroid of flow at the X-site. Each sample was collected in a 4-liter acid-rinsed container that was completely filled to remove any trapped air (Peck and others, 2003). Each water sample was then split into two bottles—one for analysis of constituents in whole water and the other for analysis of dissolved constituents in water filtered through a 0.45-micron (µm) filter. All samples were preserved, labeled, placed immediately on ice, and delivered to the North Dakota Department of Health (NDDH) Division of Laboratory Services, Bismarck, North Dakota. Water-quality data obtained during this study are available on the World Wide Web from the USGS National Water Information System (NWISWeb, *http://waterdata.usgs.gov/nd/nwis*).

Benthic macroinvertebrates were sampled during August 2010 using EMAP methods (Peck and others, 2003). Benthic macroinvertebrates sampling started at the most downstream (A) transect and proceeded to the upstream (K) transect of each reach. The starting position on the A transect was randomly selected from one of three positions (right bank,left bank, center of channel) and the starting position for transects B through K alternated as sampling progressed upstream. Thus, if the right bank was randomly selected for the A transect, benthic macroinvertebrates would be collected from the B transect at the left bank position and from the C transect at the center channel position alternating until all 11 transects were sampled. Samples were collected using a 500-mesh (µm) modified D-frame kick net, then composited with reach-wide samples obtained from the other transects. All benthic macroinvertebrate samples collected were sent to Valley City State University Macroinvertebrate Laboratory in Valley City, North Dakota, for genus and species identification.

Periphyton samples were collected at the same time and from the same transects as the benthic macroinvertebrate samples were collected. Samples were obtained from depositional habitats, which are mostly pools where flows were diminished. For depositional habitats, an area delimiter was used to define a 12-square-centimeter area that was placed on the streambed, and the top 1 centimeter of bottom material within the delimited area was extracted into a 60-milliliter (mL) syringe. From each of the transects, one sample was collected, then all samples were placed in a 500-mL bottle and composited for the reach. After sampling, a 50-mL aliquot of the composite was put into a small sealable container and preserved with a 10-percent formalin solution. All the preserved periphyton samples collected were sent to EcoAnalysts, Inc., in Moscow, Idaho, for identification and enumeration.

Fish data were collected in July 2010 at each reach using boat-mounted electrofishing because of non-wadeable stream conditions (Lazorchak and others, 2000). All areas between transects were sampled unless they were too small and shallow to hold any targeted specimens. Netted fish were temporarily placed in holding tanks, and fish from different sampling transects were kept separate. Following collection, fish were identified, inspected, counted, and measured in the field, then released to the stream as soon as possible to keep mortality rates low. Specimens not identified in the field were preserved for later identification by personnel from the USGS and the NDDH and for permanent cataloging. Upon identification of specimens, fish data were entered into the North Dakota Game and Fish online fish database (*http://gf.nd.gov/gnfapps/index.asp*).

Data Analysis

The limited amount of data collected from one set of samples per reach during the 2010 study restricted the types of analyses that could be performed. Basic measurements were often the best means of describing the physical habitat, streamflow, and selected water-quality constituents.

Physical-habitat data for individual transects of the 12 reaches on the Sheyenne River were evaluated. A list of associated data-reporting criteria used for reporting water-quality characteristics and constituents is presented in appendix 1. Streamflows measured at the USGS streamgaging stations and water-quality data were compiled. For nutrients (nitrogen, phosphorus), only data from unfiltered water are reported.

Benthic macroinvertebrate candidate metrics underwent a series of reduction steps to select the final metrics used to calculate the index of biotic integrity (IBI). Once the final metrics were determined, raw metric values were transformed into standardized metric scores (MS) using equations developed by Minns and others (1994) that standardized metrics on a scale of 0 to 100. The following standardization equations for the various metric scores were applied:

Metrics that decrease with impairment,

$$M_S = (M_R/M_{MAX}) \times 100, \quad (1)$$

Metrics that increase with impairment,

$$M_S = (M_{MAX} - M_R) / (M_{MAX} - M_{MIN}) \times 100, \quad (2)$$

where

M_R is equal to the raw metric value,
M_{MAX} is equal to the maximum metric value, and
M_{MIN} is equal to the minimum metric value.

Maximum (M_{MAX}) and minimum (M_{MIN}) values were obtained from the entire data set. The overall IBI score was

then determined from the mean of all standardized metric scores.

The benthic macroinvertebrate final metrics include Hilsenhoff's Biotic Index, percent Ephemeroptera-Plecoptera-Trichoptera (EPT), percent non-insect, percent univoltine, swimmer taxa, tolerant taxa, diptera taxa, scraper taxa, Shannon-Weiner index, sprawler taxa, and total taxa. The raw metric values are provided in appendix 2. The final metrics, standardized metrics, and preliminary IBI scores were calculated using the Ecological Data Application System (EDAS) (A. Larsen, North Dakota Department of Health, written commun., 2011). Biological criteria thresholds, including preliminary IBI scores, are currently (2011) being developed and refined by the NDDH for the Sheyenne River and other areas of North Dakota (A. Larsen, North Dakota Department of Health, written commun., 2011). The preliminary IBI scores for benthic macroinvertebrate indicators were used to determine condition classes of least disturbed, moderately disturbed, and most disturbed.

Periphyton metrics, including abundance measures, dominance measures, richness, and Shannon-Weiner H' (log e) index, were calculated by Eco Analyst, Inc., Moscow, Idaho.

Metrics calculated for fish include the number of species and individuals, native species, and number of fish tolerant or sensitive to certain habitat or water-quality changes. On the basis of results from previous water-quality and fish studies of the Sheyenne River or eastern North Dakota, each of the fish species collected in 2010 were classified by the species' tolerance to water quality and habitat degradation (Barbour and others, 1999); tolerance to turbidity (Becker, 1983; Peterka and Koel, 1996); sensitivity to total dissolved solids, sulfate, and chloride (Koel, 1997); and trophic group designation (Goldstein, 1995).

Physical Habitat, Water Quality, and Riverine Biological Assemblages

Information on physical habitat, water-quality, and riverine biological assemblages were obtained from data collected on the Sheyenne River during the July and August 2010. This information provides a look at the status of current conditions at selected reaches on the river.

Physical Habitat

Natural physical habitat structure and associated hydraulic characteristics can contribute to variations in species composition and abundance within a zoogeographic area (Peck and others, 2003). Physical characteristics of the stream affect water quality and the type and variety of habitat that is available to support aquatic life. Stressor indicators derived from data on the quality of the physical habitat may be used to help explain or diagnose stream conditions relative to various condition indicators (Kaufmann, 1993).

Channel depths (appendix 3) and wetted widths (appendix 4) varied among the reaches with both channel depths and wetted widths mostly increasing from the upstream reaches to the downstream reaches. The average maximum channel depth for all transects at the Kleven reaches was 67.3 centimeters, and the average maximum wetted width was 17.0 meters. The average maximum channel depth for all transects at the Sheyenne reaches was 160 centimeters, and the average maximum wetted width was 51.3 meters. The average maximum channel depth for all transects at the Cooperstown reaches was 143 centimeters, and the average maximum wetted width was 23.3 meters. The average maximum channel depth for all transects at the West Fargo reaches was 314 centimeters, and the average wetted width was 21.2 meters.

Average substrate particle-size composition generally consisted of coarse to fine gravels that gradually transitioned to fines in the upper Sheyenne River above Baldhill Dam. Substrate particles were predominately fines in the lower Sheyenne River below Baldhill Dam (appendix 3). Riparian (canopy) cover consisted of moderate densities of grasses and sparse small trees in the reaches in the upper Sheyenne River above Baldhill Dam, which transitioned to big overhanging trees in the reaches in lower Sheyenne River above Baldhill Dam (appendix 3).

The stream channel throughout the study reaches is characterized predominately as consisting of glides typically found in most low to moderate gradient landscapes, such as prairie streams. The only backwater pools were present in the Kleven reach (appendix 4).

Water Quality

Water-quality data are used to describe changes in water-quality conditions, and describe differences among, the Kleven, Sheyenne, Cooperstown, and West Fargo reaches (appendix 5). The water-quality data from this study generally are comparable with summary statistics calculated for the Sheyenne River from 1980 through 2006 by Ryberg (2007).

Concentrations of dissolved oxygen in the Kleven reaches were lower than the North Dakota water-quality standard of 5 milligrams per liter (mg/L) as a daily minimum (North Dakota Department of Health, 2010). The dissolved oxygen standard allows up to 10 percent of representative samples collected during any 3-year period to be less than this value. The number of samples and short time frame for this study limited the findings for dissolved oxygen.

The mean sulfate concentration is 263 mg/L for the Kleven reaches (above the Devils Lake State Outlet), 508 mg/L in the Sheyenne reaches (below the Devils Lake State Outlet), 465 mg/L for the Cooperstown reaches, and 280 mg/L for the West Fargo reaches. Sulfate concentrations were less than the State criterion of 750 mg/L in the upper Sheyenne River above Baldhill Dam and were less than the downstream

criterion of 450 mg/L in the lower Sheyenne River below Baldhill Dam (North Dakota State Water Commission, 2010b). The measured sulfate concentrations were similar to seasonal averages and sulfate concentrations simulated for the Sheyenne River by Vecchia (2011).

The trace-metals analysis was limited because of a large percentage of censored values, a small number of samples, or both. Most zinc concentrations in samples from the reaches were less than 15.0 µg/L, but higher zinc concentrations were reported for each of the reaches. The arsenic concentrations at most reaches (10 of 12) exceeded the USEPA drinking-water standard of 10 µg/L.

Nutrient concentrations were greatest in the upper Sheyenne River above Baldhill Dam and decreased by about 50 percent below Baldhill Dam. Land use in the upper Sheyenne River above Baldhill Dam is predominately agricultural, whereas the land use in the West Fargo reaches is predominately urban (Opdahl and others, 1990; Prochnow and others, 1985). In addition, dilution caused by increased streamflow from downstream tributaries in the West Fargo reaches may contribute to the decreased nutrient concentrations in those reaches. Nutrient and streamflow data are presented in appendix 5.

Benthic Macroinvertebrates

In August 2010, 35 families and 44 genera of benthic macroinvertebrates were collected from selected reaches on the Sheyenne River and identified. The presence of benthic macroinvertebrates was evaluated to determine, in part, the health of the selected reaches on the basis of benthic macroinvertebrate communities found within the reach. Metrics such as Hilsenhoff Biotic Index and the percent of EPT were used to quantify benthic macroinvertebrates in the upper and lower Sheyenne River; however, several other metrics also were used which best defined the biological integrity of either the upper or lower Sheyenne River, but not both (table 4).

The metrics that were standardized and used to calculate the IBI scores for each reach are provided in table 5. The IBI scores for benthic macroinvertebrate indicators used to determine conditions classes (least disturbed, moderately disturbed, and most disturbed) for the upper and lower Sheyenne River are presented in table 6 (A. Larsen, North Dakota Department of Health, written. commun., 2011). All Sheyenne River reaches had some degree of disturbance. The Cooperstown reaches were the only reaches to be classified as moderately disturbed with IBI scores ranging from 64 to 70. The Kleven reaches had IBI scores ranging from 38 to 47; the Sheyenne reaches had IBI scores ranging from 23 to 40; and the West Fargo reaches had IBI scores ranging from 27 to 41, indicating a classification for these reaches of most disturbed.

Periphyton

Periphyton (benthic algae including diatoms and soft-bodied cells) found in rivers and streams are an integral component of aquatic ecosystems because they provide food for invertebrates and fish in local and downstream environments. Periphyton growth and diversity can be biotic indicators of ecological conditions or responses to disturbances in the environment. Increases or decreases in periphyton communities can severely affect benthic macroinvertebrate communities and, thus, affect the abundance and type of larger invertebrates and fish.

Many factors contribute to the increase or decrease of periphyton communities and the abundance of different taxa found within the communities. Physical, chemical, and biological factors, such as habitat disturbances, temperature, pH, salinity, nutrients, feeders, and light, contribute to the periphyton community's biomass and species composition. During Sheyenne River sampling in 2010, 37 genera and 165 species of periphyton were identified (EcoAnalysts, Inc., written commun., 2011). Data on periphyton were evaluated for species richness, number of valves counted, total cells counted, and dominant taxa (table 7).

Species richness for diatoms and soft-bodied algae did not vary greatly among the 12 reaches (table 7). For diatoms, Kleven 3 reach had the lowest species richness value of 33.0, whereas Cooperstown 8 reach had the highest species richness value of 57.0. In the upper Sheyenne River below Baldhill Dam, the most prevalent species in the Kleven reaches was *Cocconeis placentula*; this was also a more prevalent species in both the Sheyenne and Cooperstown reaches. *Nitzschia girdle* was the most prevalent species in the Sheyenne reaches and was one of the more prevalent species in the Kleven and Cooperstown reaches. In the lower Sheyenne River below Baldhill Dam, the most prevalent species in the West Fargo reaches were *Cyclotella comensis* and *Cyclotella girdle*.

For soft-bodied algae, the species richness values ranged from 8.0 at Sheyenne 4 reach to 20.0 at West Fargo 10 reach. In the upper Sheyenne River above Baldhill Dam, the most prevalent species in the Kleven and Sheyenne reaches were *Cocconeis* sp. and *Gomphoema* sp. The prevalent species for Cooperstown 7, 8, and 9 reaches were *Phormidium* sp., *Nitzschia* sp., and *Cladohora* sp., respectively. In the lower Sheyenne River below Baldhill Dam, the most prevalent species in the West Fargo reaches was *Melsoira* sp.

For both diatoms and soft-bodied algae, two of the more prevalent species were the *Cocconeis* sp. and the *Nitzschia* sp. The *Cocconeis* sp. is a relatively small genus whose members are very widespread in both marine and freshwater habitats, and the *Nitzschia* sp. is a genus often associated with colder waters (Bauer, 1999).

Another indicator of biodiversity is the Shannon-Weaver H' (log e) index. The advantage of this index is that it takes into account the number and evenness of the species. The index will increase either by having additional unique species or by having greater species evenness. Typically, the values of

Table 4. Benthic macroinvertebrate metric measures and minimum and maximum metric values for the upper and lower Sheyenne River, North Dakota, August 2010.

[EPT, Ephemeroptera–Plecoptera–Trichoptera]

Final metric	Definition of measure[1]	Measure[1]	Predicted response to increasing perturbation[1]	Minimum value[2]	Maximum value[2]
Upper Sheyenne River above Baldhill Dam					
Hilsenhoff Biotic index	Calculated value base on average tolerance value of individuals	Tolerance	Increase	4.52	7.31
Percent EPT	Percent of the composite of mayfly, stonefly, and caddisfly larvae	Composition	Decrease	2.37	75.59
Percent non-insect	Percent of the total sample count that are worms, mollusks, crustacans, etc.	Composition	Increase	.97	78.23
Percent univoltine	Percent of organisms relatively long-lived (life cycles of 1 or more years)	Life cycle/ composition	Decrease	3.48	76.69
Swimmer taxa	Number of taxa that swims freely in the water column	Habit	Increase	0	8
Tolerant taxa	Measures the overall variety of the macroinvertebrate assemblage	Tolerance	Increase	1	12
Lower Sheyenne River below Baldhill Dam					
Diptera taxa	Number of true fly taxa, including midges	Richness	Decrease	3	8
Hilsenhoff Biotic Index	Calculated value base on average tolerance value of individuals	Tolerance	Increase	4.34	7.09
Percent EPT	Percent of the composite of mayfly, stonefly, and caddisfly larvae	Composition	Decrease	.86	68.03
Scraper taxa	Number of taxa that scrape substrate to remove food particles	Trophic	Decrease	0	8
Shannon-Weiner index	An index of the richness and the distribution of individuals within each taxon	Composition	Decrease	1.27	2.82
Sprawler taxa	Number of taxa that inhabit surfaces of leaves and sediment	Habit	Decrease	1	5
Total taxa	Measures the overall variety of the macroinvertebrate assemblage	Richness	Decrease	14	35

[1] Metric descriptions from DeShon, 1995; Barbour and others, 1996; Fore and others, 1996; Hayslip, 1993; Smith and Voshell, 1997.

[2] Minimum and maximum values based on benthic mcaroinvertebrate data compiled for U.S. Environmental Protection Agency Ecoregions 46 and 48 from Aaron Larsen (North Dakota Department of Health, written commun., 2011).

the index range from 1.50 (low species richness and evenness) to 3.50 (high species richness and evenness) (MacDonald, 2003). The Shannon-Weaver H' (log e) index for all the reaches ranged from 2.08 for West Fargo 11 reach to 3.39 for Cooperstown 8 reach. Overall, the West Fargo reaches had the lowest Shannon-Weaver H' (log e) index values, whereas the Cooperstown reaches had the highest values (table 8).

Fish

The fish communities of the Red River Basin (including the Sheyenne River) have changed since the retreat of the last glacier (Goldstein, 1995). Current communities of fish are composed of fish that migrated into the area or fish that were introduced for sport or recreational fishing.

During the July 2010 fish collection, 32 fish species were identified within the selected reaches of the Sheyenne River. Each fish species was classified by family, scientific, and common names. In addition, the 32 species were classified by tolerance to water quality and habitat degradation (Barbour and others, 1999); tolerance to turbidity (Becker, 1983; Peterka and Koel, 1996); sensitivity to total dissolved solids, sulfate, and chloride (Koel, 1997); and trophic group designation (Goldstein, 1995) (table 9). All but two species were native to the Sheyenne River system; the two introduced species are common carp and white crappie (Goldstein, 1995).

The 32 species of fish collected in the Sheyenne River belong to 10 families. The most prevalent fish family was Cyprinidae *(*shiners, minnows, and carp). Ten species of this family were found in the Sheyenne River. Cyprinidae is one

Table 5. Standardized metric scores and index of biotic integrity for benthic macroinvertebrates in selected reaches on the upper and lower Sheyenne River, North Dakota, August 2010.

[Data values from metrics compiled by Aaron Larsen (North Dakota Department of Health, written commun., 2011. Not all the same metrics were used in determining the index of biotic integrity for the upper and lower Sheyenne River. EPT, Ephemeroptera–Plecoptera–Trichoptera]

Reach number	Hilsenhoff's Biotic index	Percent EPT	Percent non-insect	Percent univoltine	Swimmer taxa	Tolerant taxa	Index of biotic integrity
Reaches in the Upper Sheyenne River above Baldhill Dam							
Kleven							
1	52.42	33.63	11.31	35.36	75.00	54.55	44
2	30.78	26.45	49.48	64.63	62.50	45.45	47
3	61.06	10.84	1.53	21.38	62.50	72.73	38
Sheyenne							
4	14.12	5.05	3.44	6.97	62.50	45.45	23
5	50.58	3.70	0	2.19	62.50	63.64	30
6	46.95	16.25	19.51	9.15	87.50	63.64	40
Cooperstown							
7	43.74	66.15	97.45	69.03	62.50	81.82	70
8	63.24	56.12	46.34	51.37	75.00	90.91	64
9	63.25	66.15	42.42	53.34	75.00	90.91	65

	Hilsenhoff's Biotic index	Percent EPT	Diptera taxa	Scraper taxa	Shannon-Weiner index	Sprawler taxa	Total taxa	
Reaches in the Lower Sheyenne River below Baldhill Dam								
West Fargo								
10	62.71	5.65	25.00	25.00	31.55	20.00	22.86	28
11	71.59	13.36	0	37.50	29.98	20.00	17.14	27
12	77.91	28.37	25.00	37.50	57.45	20.00	40.00	41

Table 6. Percentile and index of biotic integrity scores for benthic macroinvertebrate indicators used to determine condition class for the upper and lower Sheyenne River, North Dakota.

[IBI, index of biotic integrity; >, greater than; <, less than]

	Least disturbed	Moderately disturbed	Most disturbed
Upper Sheyenne River above Baldhill Dam			
Percentile[1]	50th	49–6th	5th
IBI Score[1]	>71	<71 and >60	<60
Lower Sheyenne River below Baldhill Dam			
Percentile[1]	25th	24th–6th	5th
IBI Score[1]	>70	<70 and >9	<59

[1]Percentile and preliminary IBI score calculations were derived from benthic mcaroinvertebrate data compiled for U.S. Environmental Protection Agency Ecoregions 46 and 48 from Aaron Larson (North Dakota Department of Health, written commun., 2011).

Table 7. Abundance and dominance measures for periphyton (diatoms and soft-bodied algae) in selected reaches on the Sheyenne River, North Dakota, August 2010.

	Kleven			Sheyenne			Cooperstown			West Fargo		
Reach number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Diatoms												
Abundance measures												
Species richness	47.0	43.0	33.0	36.0	35.0	35.0	51.0	57.0	52.0	36.0	37.0	36.0
Number of valves counted	607.0	612.0	627.0	604.0	606.0	607.0	605.0	634.0	609.0	616.0	633.0	603.0
Total cells counted	303.5	306.0	313.5	302.0	303.0	303.5	302.5	317.0	304.5	308.0	316.5	301.5
Dominance measures												
Dominant taxon	*Cocconeis placentula* var. *euglypta*	*Cocconeis placentula* var. *euglypta*	*Nitzschia girdle* sp.	*Nitzschia girdle* sp.	*Cocconeis placentula* var. *euglypta*	*Nitzschia girdle* sp.	*Nitzschia girdle* sp.	*Nitzschia frustulum*	*Nitzschia frustulum*	*Cyclotella comensis*	*Cyclotella girdle* sp.	*Stephanodiscus hantzschii*
Dominant taxon abundance	175.0	188.0	190.0	165.0	159.0	162.0	103.0	77.0	115.0	190.0	253.0	225.0
Second dominant taxon	*Nitzschia girdle* sp.	*Nitzschia girdle* sp.	*Nitzschia frustulum*	*Navicula tripunctata*	*Nitzschia frustulum*	*Nitzschia frustulum*	*Cocconeis placentula* var. *euglypta*	*Nitzschia girdle* sp.	*Cyclotella comensis*	*Cyclotella girdle* sp.	*Cyclotella comensis*	*Cyclotella comensis*
Second dominant taxon abundance	60.0	98.0	108.0	76.0	104.0	62.0	88.0	59.0	68.0	169.0	176.0	77.0
Soft-body algae												
Abundance measures												
Species richness	16.0	19.0	19.0	8.0	10.0	15.0	19.0	18.0	12.0	20.0	19.0	19.0
Number of valves counted	289.0	310.0	323.0	308.0	301.0	310.0	201.0	270.0	22.0	257.0	282.0	266.0
Total cells counted	144.5	155.0	161.5	154.0	150.5	155.0	100.5	135.0	11.0	128.5	141.0	133.0
Dominance measures												
Dominant taxon	*Cocconeis* sp.	*Cocconeis* sp.	*Coconeis* sp.	*Cocconeis* sp.	*Cocconeis* sp.	*Gomphonema* sp.	*Phormidium* sp.	*Nitzschia* sp.	*Cladophora* sp.	*Melosira* sp.	*Melosira* sp.	*Melosira* sp.
Dominant taxon abundance	109.0	116.0	81.0	127.0	86.0	92.0	95.0	54.0	284.0	138.0	151.0	145.0
Second dominant taxon	*Navicula* sp.	*Navicula* sp.	*Melosira* sp.	*Gomphonema* sp.	*Nitzschia* sp.	*Navicula* sp.	*Gomphonema* sp.	*Gomphonema* sp.	*Cyclotella* sp.	*Fragilaria* sp.	*Cyclotella* sp.	*Nitzschia* sp.
Second dominant taxon abundance	55.0	48.0	77.0	52.0	65.0	64.0	61.0	50.0	4.0	39.0	31.0	44.0

Table 8. Shannon-Weaver H′ (log e) index for periphyton species richness and evenness of species in selected reaches on the Sheyenne River, North Dakota, August 2010.

	Kleven			Sheyenne			Cooperstown			West Fargo		
Reach number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Shannon-Weaver H′ (log e)[1]	2.85	2.63	2.49	2.65	2.55	2.70	2.95	3.39	3.00	2.26	2.08	2.33

[1] The values of the index range from 1.50 (low species richness and evenness) to 3.50 (high species richness and evenness) (MacDonald, 2003).

of the largest fish families found in North America; fish in this family can live in cold or warm temperatures in a variety of habitats, making many of these fish tolerant to moderately tolerant to changes in water quality or habitat degradation (Earth Tech Inc., 2002).

The next most prevalent fish families collected in the Sheyenne River were Catastomidae and Percidae. Both of these families were represented by five species. Catastomidae includes some species that may be forage for sport fish. The Percidae family consists of many species of "bony" fish, such as perch, darters, saugers, and walleyes. Species in the families Catastomidae and Percidae are found in a wide range of habitats making several of these fish tolerant to moderately tolerant to changes in water quality and habitat degradation (Earth Tech Inc., 2002).

Of the 32 species collected in 2010 from the twelve reaches on the Sheyenne River, 29 species are tolerant to moderately tolerant to changes in water quality and habitat degradation, 16 species are tolerant to moderately tolerant to turbidity, and 16 species are tolerant to moderately tolerant to sensitivity to total dissolved solids, sulfate, and chloride (Barbour and others, 1999; Becker, 1983; Peterka and Koel, 1996; and Koel, 1997).

All fish species were categorized into four trophic groups—predators, omnivores/generalists, benthic insectivores, and general insectivores (table 9; Goldstein, 1995). The largest group, 19 species, consists of insectivores (both benthic and general). The predator group consists of seven species and the omnivores, six species.

More species were found in the Cooperstown and West Fargo reaches than in the Kleven and Sheyenne reaches in 2010 (table 10). The species of fish with the largest count of specimens, 488 individuals, is the spotfin shiner (insectivore). Spottail shiners are moderately tolerant to poor water quality and habitat degradation but sensitive to total dissolved solids, sulfate, and chloride. All of the spotfin shiners were found in the West Fargo reaches. The species with the next largest count is the black bullhead (insectivore), consisting of 370 individuals, of which 301 specimens were collected from the Sheyenne 6 reach. Black bullheads are moderately tolerant to poor water quality and habitat degradation. The third largest species group with 149 individuals is the sand shiner. Most of the sand shiners were collected from the Cooperstown 7 and Kleven 1 reaches. Sand shiners are moderately tolerant to poor water quality, habitat degradation, and turbidity. In 2010, the species that appeared in all of the reaches, except the West Fargo 10 reach, was the white sucker (benthic insectivore); white sucker is known to be tolerant to poor water quality and habitat degradation. During the 2010 study, only one specimen was collected from each of the species bluntnose minnow, brook stickleback, brown bullhead, freshwater drum, goldeye, quillback carpsucker, river carpsucker, rock bass, and white crappie.

Relative abundance of fish species along with species richness helps to describe the biodiversity of the stream. Relative abundance of fish refers to how common or rare a species is relative to other species in a given stream environment. The relative abundance, in percent, of fish in each river reach (table 11) is as follows: Kleven 1, sand shiner (37.9 percent); Kleven 2, white sucker (59.1 percent); Kleven 3, black bullhead (78.9 percent); Sheyenne 4, spottail shiner (47.6 percent); Sheyenne 5, spottail shiner (41.6 percent); Sheyenne 6, black bullhead (92.9 percent); Cooperstown 7, sand shiner (53.0 percent); Cooperstown 8, sand shiner (40.0 percent); Cooperstown 9, sand shiner (23.4 percent); West Fargo 10, spotfin shiner (78.7 percent); West Fargo 11, spotfin shiner (84.6percent); and West Fargo 12, spotfin shiner (92.8percent). The fish present in the greatest abundance in upper Sheyenne River above Baldhill Dam and lower Sheyenne River below Baldhill Dam are the black bullhead and the spotfin shiner, respectively.

Table 9. Fish type, tolerance to water-quality and habitat degradation; tolerance to turbidity; sensitivity to total dissolved solids, sulfate, and chloride; and trophic group for fish collected from the Sheyenne River, North Dakota, July 2010.

[--, not given; O, omnivore/generalist; M, moderately tolerant; np; no preference; T, tolerant; BI, benthic insectivore; I, intolerant; P, predator; S, sensitive; G, general insectivore; gray shade indicates number of species per each group]

Family	Scientific name	Common name	Tolerance to water-quality and habitat degradation[1]	Tolerance to turbidity[2]	Sensitivity to total dissolved solids, sulfate, and chloride[3]	Trophic group[4]
Catastomidae	*Carpiodes carpio*	River carpsucker	--	--	--	O
Catastomidae	*Carpiodes cyprinus*	Quillback carpsucker	M	np	M	O
Catastomidae	*Catostomus commersoni*	White sucker	T	--	M	BI
Catastomidae	*Moxostoma erythrurum*	Golden redhorse	M	I	S	BI
Catastomidae	*Moxostoma macrolepidotum*	Shorthead redhorse	M	T	M	BI
Centrarchidae	*Ambloplites rupestris*	Rock bass	M	I	M	P
Centrarchidae	*Lepomis humilis*	Orange-spotted sunfish	M	T	S	G
Centrarchidae	*Pomoxis annularis*	White crappie	M	T	T	P
Cyprinidae	*Cyprinella spiloptera*	Spotfin shiner	M	T	--	G
Cyprinidae	*Cyprinus carpio*	Common carp	T	T	T	O
Cyprinidae	*Luxilus cornutus*	Common shiner	M	--	--	G
Cyprinidae	*Notemigonus crysoleucas*	Golden shiner	T	--	S	O
Cyprinidae	*Notropis atherinoides*	Spottail shiner	M	--	S	G
Cyprinidae	*Notropis stramineus*	Sand shiner	M	M	--	BI
Cyprinidae	*Pimephales notatus*	Bluntnose minnow	T	--	M	O
Cyprinidae	*Pimephales promelas*	Fathead minnow	T	--	--	O
Cyprinidae	*Rhinichthys atratulus*	Blacknose dace	T	M	--	BI
Cyprinidae	*Semotilus atromaculatus*	Creek chub	T	M	--	G
Esocidae	*Esox lucius*	Northern pike	M	--	--	P
Gasterosteidae	*Culaea inconstans*	Brook stickleback	M	--	--	G
Hiodontide	*Hiodon alosoides*	Goldeye	I	T	T	G
Ictaluridae	*Ameirus melas*	Black bullhead	M	T	T	G
Ictaluridae	*Ameiurus nebulosus*	Brown bullhead	T	--	M	G
Ictaluridae	*Ictaluras punctatus*	Channel cat	M	T	T	P
Ictaluridae	*Noturus syrinus*	Tadpole madtom	M	--	M	G
Percidae	*Etheostoma nigrum*	Johnny darter	M	T	M	BI
Percidae	*Perca flavescens*	Yellow perch	M	--	--	P
Percidae	*Percina maculata*	Blackside darter	M	M	M	BI
Percidae	*Sander canadensis*	Sauger	M	T	T	P
Percidae	*Sander vitreus*	Walleye	M	T	--	P
Percopsidae	*Percopsis omiscomaycus*	Trout perch	--	--	--	G
Sciaenidae	*Aplodinotus grunniens*	Freshwater drum	M	T	T	G
		Number of species per tolerance, sensitivity, and trophic group	T (8) M (21) I (1) -- (2)	T (12) M (4) I (2) -- (13) np (1)	T (7) M (9) S (4) -- (12)	BI (7) G (12) O (6) P (7)

[1] Barbour and others (1999).

[2] Becker (1983), and Peterka and Koel (1996).

[3] Koel (1997).

[4] Goldstein (1995).

Table 10. Number of individual fish collected from selected reaches on the Sheyenne River, North Dakota, July 2010.

[Number of individuals caught during electrofishing; reaches where a seine net was used are noted; --, none collected; E, estimated; gray shade indicates number of species, total individuals, and level of effort]

		Number of individuals caught, by reach number											
		Kleven			Sheyenne[1]			Cooperstown			West Fargo		
Scientific name	Common name	1	2	3	4	5	6	7	8	9	10	11	12
Ameirus melas	Black bullhead	3	2	56	1	--	301	--	2	3	2	--	--
Rhinichthys atratulus	Blacknose dace	--	--	2	--	--	--	12	--	--	--	1	--
Percina maculata	Blackside darter	9	1	2	1	3	--	--	14	12	--	--	1
Pimephales notatus	Bluntnose minnow	--	--	--	--	--	--	--	--	--	--	1	--
Culaea inconstans	Brook stickleback	--	--	--	--	--	--	--	--	1	--	--	--
Ameiurus nebulosus	Brown bullhead	--	--	--	--	--	--	--	--	1	--	--	--
Ictaluras punctatus	Channel cat	--	--	--	--	--	--	--	--	--	2	3	1
Cyprinus carpio	Common carp	--	--	--	--	--	--	--	--	--	--	2	1
Luxilus cornutus	Common shiner	1	--	--	1	1	--	4	9	4	--	--	--
Semotilus atromaculatus	Creek chub	3	--	1	--	21	--	3	--	--	--	--	--
Pimephales promelas	Fathead minnow	--	--	--	2	2	1	--	--	--	7	--	1
Aplodinotus grunniens	Freshwater drum	--	--	--	--	--	--	--	--	--	--	--	1
Moxostoma erythrurum	Golden redhorse	--	--	--	--	--	--	--	--	--	6	1	--
Notemigonus crysoleucas	Golden shiner	--	--	--	1	1	1	--	--	--	--	--	--
Hiodon alosoides	Goldeye	--	--	--	--	--	--	--	--	--	--	1	--
Etheostoma nigrum	Johnny darter	--	--	--	--	--	--	--	1	1	--	--	--
Esox lucius	Northern pike	4	3	--	--	3	2	2	3	6	1	--	--
Lepomis humilis	Orange-spotted sunfish	--	--	--	--	--	--	--	--	--	13	1	--
Carpiodes cyprinus	Quillback carpsucker	--	--	--	--	--	--	--	--	--	--	1	--
Carpiodes carpio	River carpsucker	--	--	--	--	--	--	--	--	--	--	1	--
Ambloplites rupestris	Rock bass	--	--	--	--	--	--	--	--	--	--	1	--
Notropis stramineus	Sand shiner	25	1	--	--	7	--	53	34	19	2	4	4
Sander canadensis	Sauger	1	--	--	--	--	--	1	--	1	3	1	--
Moxostoma macrolepidotum	Shorthead redhorse	--	--	--	--	--	--	--	--	--	--	9	3
Cyprinella spiloptera	Spotfin shiner	--	--	--	--	--	--	--	--	--	137	171	180
Notropis atherinoides	Spottail shiner	1	--	1	20	42	6	8	2	3	--	--	--
Noturus syrinus	Tadpole madtom	1	--	--	--	--	--	1	--	--	--	--	--
Percopsis omiscomaycus	Trout perch	2	--	1	--	--	--	13	11	14	--	--	--
Sander vitreus	Walleye	2	2	1	2	--	--	--	2	4	--	--	1
Pomoxis annularis	White crappie	--	--	--	--	--	--	--	--	--	1	--	--
Catostomus commersoni	White sucker	14	13	7	14	21	13	1	6	12	--	4	1
Perca flavescens	Yellow perch	--	--	--	--	--	--	2	1	1	--	--	--
	Number of species	12	6	8	8	9	6	11	11	14	10	15	10
	Total individuals	66	22	71	42	101	324	100	85	82	174	202	194
	Level of effort (seconds)	E1,500	1,444	1,431	1,543	1,586	1,822	1,839	2,218	2,085	1,733	2,674	2,051

[1]Fish collection methods included boat electrofishing and verification with seine net because of heavy vegetation on stream banks.

Table 11. Relative abundance of fish collected from selected reaches on the Sheyenne River, North Dakota, July 2010.

[Relative abundance is the number of fish collected per reach divided by the total number of fish collected per reach, as a percentage; --, none collected, E, estimated; gray shade indicates number of species, total specimens, and level of effort]

		Relative abundance, in percent, by reach number											
		Kleven			Sheyenne[1]			Cooperstown			West Fargo		
Scientific name	Common name	1	2	3	4	5	6	7	8	9	10	11	12
Ameirus melas	Black bullhead	4.5	9.1	78.9	2.4	--	92.9	--	2.4	3.7	1.1	--	--
Rhinichthys atratulus	Blacknose dace	--	--	2.8	--	--	--	--	--	--	--	0.5	--
Percina maculata	Blackside darter	13.6	4.5	2.8	2.4	3.0	--	12.0	16.5	14.8	--	--	0.5
Pimephales notatus	Bluntnose minnow	--	--	--	--	--	--	--	--	--	--	.5	--
Culaea inconstans	Brook stickleback	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus nebulosus	Brown bullhead	--	--	--	--	--	--	--	--	1.2	--	--	--
Ictaluras punctatus	Channel cat	--	--	--	--	--	--	--	--	--	1.1	1.5	.5
Cyprinus carpio	Common carp	--	--	--	--	--	--	--	--	--	--	1.0	.5
Luxilus cornutus	Common shiner	1.5	--	--	2.4	1.0	--	4.0	10.6	4.9	--	--	--
Semotilus atromaculatus	Creek chub	4.5	--	1.4	--	20.8	--	3.0	--	--	--	--	--
Pimephales promelas	Fathead minnow	--	--	--	4.8	2.0	.3	--	--	--	4.0	--	.5
Aplodinotus grunniens	Freshwater drum	--	--	--	--	--	--	--	--	--	--	--	.5
Moxostoma erythrurum	Golden redhorse	--	--	--	--	--	--	--	--	--	3.4	.5	--
Notemigonus crysoleucas	Golden shiner	--	--	--	2.4	1.0	.3	--	--	--	--	--	--
Hiodon alosoides	Goldeye	--	--	--	--	--	--	--	--	--	--	.5	--
Etheostoma nigrum	Johnny darter	--	--	--	--	--	--	--	1.2	1.2	--	--	--
Esox lucius	Northern pike	6.1	13.6	--	--	3.0	.6	2.0	3.5	7.4	.6	--	--
Lepomis humilis	Orange-spotted sunfish	--	--	--	--	--	--	--	--	--	7.5	.5	--
Carpiodes cyprinus	Quillback carpsucker	--	--	--	--	--	--	--	--	--	--	.5	--
Carpiodes carpio	River carpsucker	--	--	--	--	--	--	--	--	--	--	.5	--
Ambloplites rupestris	Rock bass	--	--	--	--	--	--	--	--	--	--	.5	--
Notropis stramineus	Sand shiner	37.9	4.5	--	--	6.9	--	53.0	40.0	23.4	1.1	2.0	2.1
Sander canadensis	Sauger	--	--	--	--	--	--	1.0	--	1.2	1.7	.5	--
Moxostoma macrolepidotum	Shorthead redhorse	--	--	--	--	--	--	--	--	--	--	4.4	1.5
Cyprinella spiloptera	Spotfin shiner	--	--	--	--	--	--	--	--	--	78.7	84.6	92.8
Notropis atherinoides	Spottail shiner	1.5	--	1.4	47.6	41.6	1.9	8.0	2.4	3.7	--	--	--
Noturus syrinus	Tadpole madtom	1.5	--	--	--	--	--	1.0	--	--	--	--	--
Percopsis omiscomaycus	Trout perch	3.0	--	1.4	--	--	--	13.0	12.9	17.3	--	--	--
Sander vitreus	Walleye	3.0	9.1	1.4	4.8	--	--	--	2.4	4.9	--	--	0.5
Pomoxis annularis	White crappie	--	--	--	--	--	--	--	--	--	0.6	--	--
Catostomus commersoni	White sucker	21.5	59.1	9.9	33.3	20.8	4.0	1.0	7.0	14.8	--	2.0	.5
Perca flavescens	Yellow perch	--	--	--	--	--	--	2.0	1.2	1.2	--	--	--

[1]Fish collection methods included boat electrofishing and verification with seine net because of heavy vegetation on stream banks.

Implications

Water-quality dynamics and ecological conditions in the Sheyenne River are controlled by activities in the basin and processes that occur in the stream. Point and nonpoint sources of pollutants or disturbances can affect the water quality and ecological conditions occurring in the Sheyenne River. In addition, Baldhill Dam affects both streamflow regulation and water quality downstream from the dam.

Evaluation of the data on physical habitat, water quality, benthic macroinvertebrates, periphyton, and fish collected during this study leads to the following observations.

- With only one water sample collected in 2010 from each river reach, the types of analyses that could be performed on the data are restricted and more comprehensive evaluations, including correlations among the reaches, are limited;
- Sulfate concentrations in the Sheyenne River may be affected by streamflow through the Devils Lake State Outlet (Vecchia, 2011); however, mean sulfate concentrations determined from the 2010 data were lower than the State criteria for the upper and lower Sheyenne River.

In addition, the State changed or is currently (2011) refining some standards.

- In 2011, the sulfate concentration criterion was raised by the State from 450 mg/L to 750 mg/L for the upper Sheyenne River above Baldhill Dam.
- Biological criteria thresholds are currently being developed and refined by the North Dakota Department of Health for the Sheyenne River, and thresholds for other areas of North Dakota and are planned for completion in the next few years (A. Larsen, North Dakota Department of Health, written commun., 2011).
- Preliminary IBI scores for benthic macroinvertebrate data in this study indicate class conditions of most disturbed and moderately disturbed for the reaches, but these may be revised when biological criteria thresholds are finalized.

Data collected during the 2010 study were compared to data collected in 2004 and 2005 by the High Plains Consortium, Inc. (2007). Overall, comparisons of the data from the 2010 study with the previous 2004 and 2005 studies did not indicate major differences in water-quality and ecological conditions. Several minor differences between the studies are indicated below.

- Data collected in 2010 and 2005 were treated as a separate entity for each reach area, whereas the 2004 data were combined for each set of reaches for one total value per each set.
- In 2010, streamflows ranged from 31 ft^3/s in the upper Sheyenne River to 485 ft^3/s in lower Sheyenne River. In 2005, streamflows ranged from 260 ft^3/s in the upper Sheyenne River to 712 ft/s in the lower Sheyenne River. Streamflows in 2004 ranged from 9.8 ft^3/s in the upper Sheyenne River to 133.4 ft^3/s in lower Sheyenne River.
- The differences in streamflow determined whether wadeable or non-wadeable data-collection methods were used and also affected stream geometry and physical measurements, such as channel depth and wetted width. In 2004, wadeable data-collection methods were used where stream reaches were narrowest and shallowest. In 2005, non-wadeable data-collection methods were used where stream reaches were widest and deepest.
- Sulfate concentrations were greater in 2010 than in 2004 and 2005 in the upper Sheyenne River above Baldhill Dam. The 2010 mean sulfate concentration was 263 mg/L for the Kleven reaches (above the Devils Lake State Outlet), 508 mg/L in the Sheyenne reaches (below the Devils Lake State Outlet), 465 mg/L for the Cooperstown reaches, and 280 mg/L for the West Fargo reaches. The 2005 mean sulfate concentrations were 221, 224, 207 and 288 mg/L at these reaches, respectively. The 2004 sulfate concentrations ranged from 276 mg/L in the upper Sheyenne River to 238 mg/L in lower Sheyenne River. Nutrient concentrations were generally similar for 2010, 2005, and 2004 and were greatest in the upper Sheyenne River above Baldhill Dam and decreased below Baldhill Dam.
- The number of benthic macroinvertebrates collected for the 2010 study was generally less than the number collected in 2004 and 2005. The 2010 data was analyzed using the NDDH biological criteria thresholds, including IBI scores, for selected ecoregions in North Dakota. These IBI scores help determine the effect that disturbances have on the health of a reach. Benthic macroinvertebrates for the 2004 and 2005 data were analyzed using basic metrics that may not provide the best quantitative answer as one of the determinate indicators for the ecological health of a reach.
- The number of periphyton varied between 2010 data and 2004 and 2005 data. In the 2010 study, 165 species representing 37 genera were identified; in 2005, 68 species representing 24 genera were identified and; in 2004, 29 species representing 10 genera were identified. The variation between the periphyton data collected in 2004 and 2005 were a result of changes in taxonomy and in reporting by the laboratory conducting the analyses (High Plains Consortium, Inc., 2007).

- In the 2010 study, 32 species of fish from 10 families were identified. In 2005, 12 fish species from 7 families were identified, and in 2004, 12 fish species from 6 families were identified. The difference in fish counts between the studies may be attributed to when the fish were collected or the difficulty in identification between closely related species at certain stages in their development.
- During 2010, fish data were collected at each reach in July and other data were collected in August. Fish data in 2004 and 2005 were the last data collected at each reach. Disturbance in the reaches by the field crew prior to fish collection in the 2004 and 2005 studies may have resulted in fish moving away from the disturbance and out of the area of the selected reaches thus resulting in lower fish counts.

Summary

Physical-habitat, water-quality, and biological data were collected from 12 selected reaches at four locations on the Sheyenne River in east-central North Dakota during July and August 2010. This data collection is part of an on-going evaluation of the water-quality and ecological conditions of the Sheyenne River by the State. With releases of Devils Lake water from the Devils Lake State Outlet near Peterson Coulee and potential natural water spills through the Tolna Coulee into the Sheyenne River, concerns were raised about the water quality and biological integrity of the Sheyenne River because of the interbasin transfer of water.

The 12 reaches are distributed among four locations (Kleven, Sheyenne, Cooperstown, and West Fargo) on the Sheyenne River. The reaches sampled during the study are (1) upstream from the Devils Lake State Outlet on the Sheyenne River south of Flora, North Dakota, (2) downstream from the Devils Lake State Outlet on the Sheyenne River northwest of Bremen, North Dakota, (3) upstream from the headwaters of Lake Ashtabula near Cooperstown, North Dakota, and (4) near the confluence with the Red River at West Fargo, North Dakota.

The methods used for data collection were developed during previous Environmental Monitoring and Assessment Program (EMAP) studies. The data-collection efforts during this study required methods for non-wadeable streams and wadeable streams.

The water-quality field measurements and results of chemical analyses generally are comparable to summary statistics calculated for Sheyenne River from 1980 through 2006. Field measurements for dissolved oxygen in the Kleven Reach were lower than the 5-mg/L daily minimum standard for waters in North Dakota. However, too few samples were collected during this study to accurately define stream conditions. The mean sulfate concentrations satisfied the State of North Dakota water-quality requirements of less than 750 mg/L in the upper Sheyenne River and less than 450 mg/L in the lower Sheyenne River. Arsenic concentrations at most reaches exceeded the U.S. Environmental Protection Agency standard of 10 µg/L. Nutrient concentrations (nitrate, phosphorus) were higher in the upstream reaches than in the lower reaches of the Sheyenne River.

During 2010, 35 families and 44 genera of benthic macroinvertebrates were collected and identified. On the basis of preliminary IBI scores for macroinvertebrates, Cooperstown reaches are considered to be moderately disturbed, whereas Kleven, Sheyenne, and West Fargo reaches are considered to be most disturbed.

During 2010, 37 genera and 165 species of periphyton were collected and identified. Evaluation of the data indicates that similar taxa dominant species of periphyton were present in the Kleven, Sheyenne, and Cooperstown reaches, and a different set of dominant taxa species was present in the West Fargo reaches. For diatoms, the Kleven 3 reach had the lowest species richness value of 33.0, whereas the Cooperstown 8 reach had the highest species richness value of 57.0. For soft-bodied algae, the species richness values ranged from 8.0 at the Sheyenne 4 reach to 20.0 at the West Fargo 10 reach. On the basis of the Shannon-Weaver H' (log e) index, values for periphyton ranged from 2.08 for West Fargo 11 reach to 3.39 for Cooperstown 8 reach, compared to typical index values ranging from 1.50 for low species richness and evenness to 3.50 for high species evenness and richness.

During fish collection, 32 species, representing 10 families, were caught in the Sheyenne River. All but two species are native to the Sheyenne River system; the two introduced species are common carp and white crappie. Of the 32 species, 29 are tolerant to moderately tolerant to changes in water quality and habitat degradation, 16 species are tolerant to moderately tolerant to turbidity, and 16 are tolerant to moderately tolerant to sensitivity to total dissolved solids, sulfate, and chloride. All fish species were categorized into four trophic groups. The largest group, the insectivores (both benthic and general), consisted of 19 species. The predator group consisted of seven species, and the omnivores consisted of six species. The species with the highest count of specimens was the spotfin shiner (insectivore), 488 individuals. All of the spotfin shiners were found in the West Fargo reaches. More fish were found in the lower Sheyenne River below Baldhill Dam than in the upper Sheynne River above Baldhill Dam in North Dakota.

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Appendixes 1–5

Appendix 1. Reporting criteria for water-quality characteristics and constituents analyzed for in water samples collected from selected reaches on the Sheyenne River, North Dakota, 2010.

Appendix 2. Macroinvertebrates metrics data for selected reaches on the upper and lower Sheyenne River, North Dakota, August 2010.

Appendix 3. Physical-habitat transect data for Kleven, Sheyenne, Cooperstown and West Fargo reaches.

Appendix 4. Physical-habitat data for selected reaches on the Sheyenne River, North Dakota, August 2010.

Appendix 5. Streamflows and water-quality characteristics and constituents in samples collected from selected reaches on the Sheyenne River, North Dakota, August 2010.

Table 1–1. Reporting criteria for water-quality characteristics, properties and constituents analyzed in water samples collected from selected reaches on the Sheyenne River, North Dakota.

[Samples were analyzed by the North Dakota Department of Health Laboratory, Bismarck, North Dakota; --, no data; <, less than]

Property or constituent	Parameter code	Measurement type	Minimum detection limit	Units
Streamflow	00060	Field	--	Cubic foot per second
Specific conductance	00095	Field	--	Microsiemens per centimeter at 25 degrees Celsius
pH	00400	Field	--	Standard unit
Temperature, water	00010	Field	--	Degree Celsius
Dissolved oxygen	00300	Field	--	Milligram per liter
Transparency (Secchi disc)	00077	Field	--	Inch
Total dissloved solids	70301	Calculated	--	Milligram per liter
Hardness	00900	Laboratory	--	Milligram per liter as calcuim carbonate
Suspended solids, unfiltered	00530	Laboratory	<5	Milligram per liter
Calcium, unfiltered	00916	Laboratory	<2	Milligram per liter
Magnesium, unfiltered	00927	Laboratory	<1	Milligramsper liter
Potassium, unfiltered	00937	Laboratory	<1	Milligram per liter
Sodium adsorption ratio	00931	Calculated	--	Percent
Sodium, unfiltered	00929	Laboratory	<3	Milligram per liter
Acid neutralizing capacity	90410	Laboratory	<3.3	Milligram per liter
Bicarbonate, unfiltered	00451	Laboratory	<1	Milligram per liter
Carbonate, unfiltered	00448	Laboratory	<1	Milligram per liter
Chloride, filtered	00940	Laboratory	<.3	Milligram per liter
Sulfate, filtered	00945	Laboratory	<.3	Milligram per liter
Nitrogen, ammonia plus organic (Kjeldahl), unfiltered	00625	Calculated	<.08	Milligram per liter
Nitrogen, ammonia, unfiltered	00610	Laboratory	<.001	Milligram per liter
Nitrite plus nitrate, unfiltered	00630	Laboratory	<.03	Milligram per liter
Phosphorus, unfiltered	00665	Laboratory	<.004	Milligram per liter
Nitrogen, unfiltered	62855	Laboratory	<.015	Milligram per liter
Aluminum, unfiltered	01105	Laboratory	<50	Microgram per liter
Barium, unfiltered	01007	Laboratory	<5	Microgram per liter
Beryllium, unfiltered	01012	Laboratory	<5	Microgram per liter
Cadmium, unfiltered	01027	Laboratory	<5	Microgram per liter
Chromium, unfiltered	01034	Laboratory	<5	Microgram per liter
Copper, unfiltered	01042	Laboratory	<5	Microgram per liter
Iron, unfiltered	01045	Laboratory	<50	Microgram per liter
Lead, unfiltered	01051	Laboratory	<5	Microgram per liter
Manganese, unfiltered	01055	Laboratory	<10	Microgram per liter
Nickel, unfiltered	01067	Laboratory	<5	Microgram per liter
Silver, unfiltered	01077	Laboratory	<5	Microgram per liter
Thallium, unfiltered	01059	Laboratory	<5	Microgram per liter
Zinc, unfiltered	01092	Laboratory	<5	Microgram per liter
Antimony, unfiltered	01097	Laboratory	<5	Microgram per liter
Arsenic, unfiltered	01002	Laboratory	<5	Microgram per liter
Boron, unfiltered	01022	Laboratory	<50	Microgram per liter
Selenium, unfiltered	01147	Laboratory	<5	Microgram per liter

Table 2-1. Macroinvertebrates metrics data for selected reaches on the upper and lower Sheyenne River, North Dakota, August 2010.

[Not all the same metrics were used for the upper and lower Sheyenne River. Data values from metrics compiled by Aaron Larsen (North Dakota Department of Health, written commun., 2011. EPT, Ephemeroptera–Plecoptera–Trichoptera]

Reach number	Hilsenhoff's Biotic Index	Percent of EPT	Percent of non-insect	Percent of univoltine	Swimmer taxa	Tolerant taxa
Reaches in the Upper Sheyenne River above Baldhill Dam						
Kleven						
1	5.85	25.42	69.49	27.12	2.00	6.00
2	6.45	20.00	40.00	49.56	3.00	7.00
3	5.61	8.20	77.05	16.39	3.00	4.00
Sheyenne						
4	6.92	3.82	75.57	5.34	3.00	7.00
5	5.90	2.79	82.12	1.68	3.00	5.00
6	6.00	12.28	63.16	7.02	1.00	5.00
Cooperstown						
7	6.09	50.00	2.94	52.94	3.00	3.00
8	5.54	42.42	42.42	39.39	2.00	2.00
9	5.54	50.00	45.45	40.91	2.00	2.00

	Hilsenhoff's Biotic Index	Percent of EPT	Diptera taxa	Scraper taxa	Shannon Weiner-index	Sprawler taxa	Total taxa
Reaches in the Lower Sheyenne River below Baldhill Dam							
West Fargo							
10	5.36	3.85	2.00	2.00	0.89	1.00	8.00
11	5.12	9.09	0	3.00	.84	1.00	6.00
12	4.95	19.30	2.00	3.00	1.62	1.00	14.00

Table 3–1. Physical-habitat transect data for Kleven site 1 (downstream, reach 1) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; GC, gravel, coarse; --, no data; GF, gravel, fine; CB, cobbles]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	35	0	0	17	0
Left center	3.2	80	GC	70	--	--	--	0	0
Center	6.3	85	GC	70	--	--	--	0	0
Right center	9.5	95	GC	70	--	--	--	0	0
Right	12.6	0	FN	100	25	0	0.2	14	0
Transect B									
Left	0	0	FN	100	60	0	0	11	0
Left center	2.7	70	GF	80	--	--	--	0	0
Center	5.5	95	FN	100	--	--	--	0	0
Right center	8.2	90	FN	100	--	--	--	0	0
Right	10.9	0	FN	100	25	0	0.2	0	0
Transect C									
Left	0	0	GC	70	40	0	0	17	0
Left center	3.6	70	GC	70	--	--	--	0	0
Center	7.3	70	GC	70	--	--	--	0	0
Right center	10.9	75	FN	100	--	--	--	0	0
Right	14.6	0	FN	100	35	0	0	16	0
Transect D									
Left	0	0	GC	70	90	0	0	15	0
Left center	2.7	60	GC	70	--	--	--	0	0
Center	5.5	70	GC	70	--	--	--	0	0
Right center	8.2	75	GC	70	--	--	--	0	0
Right	11.9	0	GC	70	65	0	0	15	0
Transect E									
Left	0	0	FN	100	75	0	0	17	0
Left center	1.9	40	CB	60	--	--	--	2	0
Center	3.8	35	CB	60	--	--	--	0	0
Right center	6.6	40	CB	60	--	--	--	0	0
Right	7.5	0	FN	100	55	0	0	17	0
Transect F									
Left	0	0	GC	70	85	0	0	16	0
Left center	1.4	50	GC	70	--	--	--	0	0
Center	2.8	50	GC	70	--	--	--	0	0
Right center	4.3	45	GC	70	--	--	--	0	0
Right	5.7	0	GC	70	22	0	0	17	0

Table 3–1. Physical-habitat transect data for Kleven site 1 (downstream, reach 1) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; GC, gravel, coarse; --, no data; GF, gravel, fine; CB, cobbles]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	GC	70	10	0	0	17	0
Left center	1.9	75	FN	100	--	--	--	0	0
Center	3.9	105	FN	100	--	--	--	0	1
Right center	5.9	55	FN	100	--	--	--	0	0
Right	7.9	0	FN	100	40	0	0.4	0	0
Transect H									
Left	0	0	FN	100	25	0	0	14	0
Left center	2.7	70	GC	70	--	--	--	0	0
Center	5.5	50	GC	70	--	--	--	0	1
Right center	8.3	45	FN	100	--	--	--	0	0
Right	11	0	FN	100	30	0	0	9	0
Transect I									
Left	0	0	FN	100	50	0	0.5	3	0
Left center	3	85	GC	70	--	--	--	0	0
Center	6	75	GC	70	--	--	--	0	0
Right center	9	50	FN	100	--	--	--	0	0
Right	12	0	FN	100	5	0	0	17	0
Transect J									
Left	0	0	FN	100	35	0	0	12	0
Left center	1.6	65	GC	70	--	--	--	0	0
Center	3.2	50	GC	70	--	--	--	0	0
Right center	4.8	50	FN	100	--	--	--	0	0
Right	6.5	0	FN	100	30	0	0	17	0
Transect K									
Left	0	0	FN	100	50	0	0	10	0
Left center	1.8	50	GC	70	--	--	--	0	0
Center	3.6	55	GC	70	--	--	--	0	0
Right center	5.4	50	GC	70	--	--	--	4	0
Right	7.2	0	FN	100	40	0	0	17	0

[1] Canadian thistle found near Transects G and H; mullosk shells found throughout reach.

Table 3–2. Physical-habitat transect data for Kleven site 2 (middle, reach 2) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; GC, gravel, coarse; --, no data; GF, gravel, fine]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	90	0	0	17	0
Left center	2.3	65	GC	70	--	--	--	0	0
Center	4.6	70	GC	70	--	--	--	0	0
Right center	6.9	60	GC	70	--	--	--	0	0
Right	9.2	0	FN	100	15	0	0	17	0
Transect B									
Left	0	0	FN	100	12	0	0	17	0
Left center	3.2	65	GC	70	--	--	--	0	0
Center	6.5	65	GC	70	--	--	--	0	0
Right center	9.8	65	GC	70	--	--	--	0	0
Right	13	0	FN	100	11	0	0	17	0
Transect C									
Left	0	0	FN	100	12	0	0	17	0
Left center	4	75	FN	100	--	--	--	0	0
Center	8	90	GC	70	--	--	--	0	0
Right center	12	70	GF	80	--	--	--	0	0
Right	16	0	FN	100	10	0	0	17	0
Transect D									
Left	0	0	FN	100	10	0	0	17	0
Left center	3.5	70	GC	70	--	--	--	0	0
Center	7	75	GC	70	--	--	--	0	0
Right center	10.5	65	GC	70	--	--	--	0	0
Right	14	0	FN	100	45	0	0	17	0
Transect E									
Left	0	0	FN	100	60	0	0	17	0
Left center	4	75	FN	100	--	--	--	0	0
Center	8	90	GC	70	--	--	--	0	0
Right center	12	80	GC	70	--	--	--	0	0
Right	16	0	FN	100	25	0	0	17	0
Transect F									
Left	0	0	FN	100	7	0	0	17	0
Left center	8.2	65	FN	100	--	--	--	0	0
Center	16.5	85	FN	100	--	--	--	0	0
Right center	24.8	75	FN	100	--	--	--	0	0
Right	33	0	FN	100	11	0	0	17	0

Table 3–2. Physical-habitat transect data for Kleven site 2 (middle, reach 2) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; GC, gravel, coarse; --, no data; GF, gravel, fine]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	9	0	0	17	0
Left center	8	60	FN	100	--	--	--	0	0
Center	16	75	FN	100	--	--	--	0	1
Right center	24	65	FN	100	--	--	--	0	0
Right	32	0	FN	100	10	0	0	17	0
Transect H									
Left	0	0	FN	100	15	0	0	17	0
Left center	4.8	65	FN	100	--	--	--	0	0
Center	9.5	75	FN	100	--	--	--	0	1
Right center	14.2	70	FN	100	--	--	--	0	0
Right	19	0	FN	100	12	0	0	17	0
Transect I									
Left	0	0	FN	100	10	0	0	17	0
Left center	3.8	60	FN	100	--	--	--	0	0
Center	7.6	90	FN	100	--	--	--	0	0
Right center	11.4	60	FN	100	--	--	--	0	0
Right	15.2	0	FN	100	10	0	0	17	0
Transect J									
Left	0	0	FN	100	10	0	0	17	0
Left center	3.6	60	FN	100	--	--	--	0	0
Center	7.1	100	FN	100	--	--	--	0	0
Right center	10.6	70	FN	100	--	--	--	0	0
Right	14.2	0	FN	100	10	0	0	17	0
Transect K									
Left	0	0	FN	100	5	0	0	17	0
Left center	2.5	60	FN	100	--	--	--	0	0
Center	5	70	GC	70	--	--	--	0	0
Right center	7.5	70	FN	100	--	--	--	0	0
Right	10	0	FN	100	5	0	0	17	0

[1] No flags found.

Table 3–3. Physical-habitat transect data for Kleven site 3 (upstream, reach 3) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GC, gravel, coarse]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	5	0	0	17	0
Left center	3.8	80	FN	100	--	--	--	0	0
Center	7.5	80	FN	100	--	--	--	0	0
Right center	11.3	65	FN	100	--	--	--	0	0
Right	15	0	FN	100	10	0	0	17	0
Transect B									
Left	0	0	FN	100	10	0	0	17	0
Left center	3.8	100	FN	100	--	--	--	0	0
Center	7.5	100	FN	100	--	--	--	0	0
Right center	11.3	90	FN	100	--	--	--	0	0
Right	15	0	FN	100	20	0	0	17	0
Transect C									
Left	0	0	FN	100	35	0	0	17	0
Left center	3.5	90	FN	100	--	--	--	0	0
Center	7	105	FN	100	--	--	--	0	0
Right center	10.5	100	FN	100	--	--	--	0	0
Right	14	0	FN	100	20	0	0	17	0
Transect D									
Left	0	0	FN	100	5	0	0	17	0
Left center	5.5	95	FN	100	--	--	--	0	0
Center	11	110	GC	70	--	--	--	0	0
Right center	16.5	100	FN	100	--	--	--	0	0
Right	22	0	FN	100	30	0	0	17	1
Transect E									
Left	0	0	FN	100	90	0	0	17	0
Left center	5.5	85	GC	70	--	--	--	0	0
Center	11	85	GC	70	--	--	--	0	0
Right center	16.5	85	GC	70	--	--	--	0	0
Right	22	0	FN	100	5	0	0	0	0
Transect F									
Left	0	0	FN	100	30	0	0	17	0
Left center	3.5	80	GC	70	--	--	--	0	0
Center	7	75	GC	70	--	--	--	0	0
Right center	10.5	75	GC	70	--	--	--	0	0
Right	14	0	FN	100	90	0.2	0	17	0

Table 3–3. Physical-habitat transect data for Kleven site 3 (upstream, reach 3) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GC, gravel, coarse]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	10	0	1.5	4	0
Left center	7	60	FN	100	--	--	--	0	0
Center	14	80	FN	100	--	--	--	0	0
Right center	21	65	FN	100	--	--	--	0	0
Right	28	0	FN	100	5	0	0	17	0
Transect H									
Left	0	0	FN	100	30	0	0	17	0
Left center	6.8	60	FN	100	--	--	--	0	0
Center	13.5	75	FN	100	--	--	--	0	0
Right center	20.3	30	FN	100	--	--	--	0	0
Right	27	0	FN	100	5	0	0	17	0
Transect I									
Left	0	0	FN	100	10	0	0.5	0	0
Left center	7.5	45	FN	100	--	--	--	0	0
Center	15	60	FN	100	--	--	--	0	0
Right center	22.5	20	FN	100	--	--	--	17	0
Right	30	0	FN	100	5	0	0	17	0
Transect J									
Left	0	0	FN	100	28	0	0.5	0	0
Left center	9.8	30	FN	100	--	--	--	17	0
Center	19.5	40	FN	100	--	--	--	17	0
Right center	29.2	15	FN	100	--	--	--	17	0
Right	39	0	FN	100	5	0	0	7	0
Transect K									
Left	0	0	FN	100	40	0	1.5	0	0
Left center	9.5	60	FN	100	--	--	--	0	0
Center	19	100	FN	100	--	--	--	0	0
Right center	28.5	75	FN	100	--	--	--	0	0
Right	38	0	GC	50	25	0	1.5	0	0

[1] Small creek between Transects I and J.

Table 3–4. Physical-habitat transect data for Sheyenne site 1 (downstream, reach 4) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GF, gravel, fine; GC, gravel, coarse]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	11	0	0	17	0
Left center	10	100	FN	100	--	--	--	17	0
Center	20	190	GF	50	--	--	--	0	0
Right center	30	90	FN	100	--	--	--	10	0
Right	40	0	FN	100	6	0	0	17	0
Transect B									
Left	0	0	FN	100	6	0	0	17	0
Left center	10.1	110	FN	100	--	--	--	17	0
Center	20.1	180	FN	100	--	--	--	0	0
Right center	30	100	FN	100	--	--	--	17	0
Right	40.2	0	FN	100	7	0	0	17	0
Transect C									
Left	0	0	FN	100	5	0	0	17	0
Left center	9.7	210	FN	100	--	--	--	17	0
Center	19.5	170	FN	100	--	--	--	0	0
Right center	29.2	100	FN	100	--	--	--	17	0
Right	39	0	FN	100	4	0	0	15	0
Transect D									
Left	0	0	FN	100	7	0	0	17	0
Left center	11	100	FN	100	--	--	--	17	0
Center	22.1	180	FN	100	--	--	--	0	0
Right center	33	140	FN	100	--	--	--	15	0
Right	44.2	0	FN	100	10	0	0	17	0
Transect E									
Left	0	0	FN	100	70	0	0	17	0
Left center	12.7	130	FN	100	--	--	--	17	0
Center	25.4	200	FN	100	--	--	--	0	0
Right center	38.1	140	FN	100	--	--	--	15	0
Right	50.8	0	FN	100	7	0	0	17	0
Transect F									
Left	0	0	FN	100	78	0	0	17	0
Left center	14	170	FN	100	--	--	--	0	0
Center	28.1	150	FN	100	--	--	--	0	0
Right center	42.1	120	FN	100	--	--	--	6	0
Right	56.2	0	FN	100	7	0	0	17	0

Table 3–4. Physical-habitat transect data for Sheyenne site 1 (downstream, reach 4) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GF, gravel, fine; GC, gravel, coarse]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	70	0	0	12	0
Left center	11.7	160	FN	100	--	--	--	0	0
Center	23.5	170	FN	100	--	--	--	0	1
Right center	35.2	150	FN	100	--	--	--	7	0
Right	47	0	FN	100	7	0	0	7	0
Transect H									
Left	0	0	FN	100	90	0	0	12	0
Left center	9.5	150	FN	100	--	--	--	0	0
Center	19	180	FN	100	--	--	--	0	0
Right center	28.5	90	FN	100	--	--	--	5	0
Right	38	0	FN	100	9	0	0	17	0
Transect I									
Left	0	0	FN	100	65	0	0	7	0
Left center	10.5	130	FN	100	--	--	--	0	0
Center	21	180	FN	100	--	--	--	0	0
Right center	31.5	140	FN	100	--	--	--	6	0
Right	42	0	FN	100	5	0	0	12	0
Transect J									
Left	0	0	FN	100	35	0	0	15	0
Left center	8.4	140	GC	50	--	--	--	0	0
Center	16.7	150	GC	50	--	--	--	0	0
Right center	25	130	FN	100	--	--	--	5	0
Right	33.4	0	FN	100	8	0	0	10	0
Transect K									
Left	0	0	FN	100	8	0	0	17	0
Left center	11.1	140	GC	100	--	--	--	10	0
Center	22.2	160	GC	100	--	--	--	0	0
Right center	33.3	160	GC	100	--	--	--	12	0
Right	44.4	0	FN	100	5	0	0	17	0

[1] Drainage ditch at Transect G.

Table 3–5. Physical-habitat transect data for Sheyenne site 2 (middle, reach 5) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GF, gravel, fine; GC, gravel, coarse]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	25	0	0	15	0
Left center	15	50	FN	100	-	-	-	0	0
Center	30	130	FN	100	-	-	-	0	0
Right center	45	130	FN	100	-	-	-	17	0
Right	60	0	FN	100	15	0	0	17	0
Transect B									
Left	0	0	FN	100	8	0	0	0	0
Left center	13.5	120	FN	100	-	-	-	0	0
Center	26.9	160	GF	50	-	-	-	0	0
Right center	40.4	100	FN	100	-	-	-	17	0
Right	53.8	0	FN	100	5	0	0	15	0
Transect C									
Left	0	0	FN	100	20	0	0	17	0
Left center	12.1	120	FN	100	-	-	-	10	0
Center	24.1	160	GC	50	-	-	-	0	0
Right center	36.2	150	FN	100	-	-	-	10	0
Right	48.2	0	FN	100	2	0	0	17	0
Transect D									
Left	0	0	FN	100	6	0	0	17	0
Left center	12.1	80	FN	100	-	-	-	0	0
Center	24.2	170	GC	50	-	-	-	0	0
Right center	36.3	110	FN	100	-	-	-	17	0
Right	48.5	0	FN	100	3	0	0	12	0
Transect E									
Left	0	0	FN	100	10	0	0	17	0
Left center	13.5	120	FN	100	-	-	-	17	0
Center	27	180	GC	50	-	-	-	0	0
Right center	40.5	110	FN	100	-	-	-	17	0
Right	54	0	FN	100	5	0	0	5	0
Transect F									
Left	0	0	FN	100	8	0	0	0	0
Left center	18.1	150	FN	100	-	-	-	17	0
Center	36.1	160	FN	100	-	-	-	0	0
Right center	54.2	90	FN	100	-	-	-	10	0
Right	72.2	0	FN	100	10	0	0	17	0

Table 3–5. Physical-habitat transect data for Sheyenne site 2 (middle, reach 5) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GF, gravel, fine; GC, gravel, coarse]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	6	0	0	17	0
Left center	15	100	FN	100	-	-	-	17	0
Center	30	180	GC	50	-	-	-	0	0
Right center	45	110	FN	100	-	-	-	17	0
Right	60	0	FN	100	7	0	0	9	0
Transect H									
Left	0	0	FN	100	10	0	0	3	0
Left center	12.7	90	FN	100	-	-	-	17	0
Center	25.5	180	GC	50	-	-	-	0	0
Right center	38.2	120	FN	100	-	-	-	0	0
Right	51	0	FN	100	11	0	0	15	0
Transect I									
Left	0	0	FN	100	8	0	0	17	0
Left center	11.5	40	FN	100	-	-	-	17	0
Center	23	160	GF	50	-	-	-	0	0
Right center	34.5	110	FN	100	-	-	-	17	0
Right	46	0	FN	100	10	0	0	17	0
Transect J									
Left	0	0	FN	100	8	0	0	17	0
Left center	11	110	FN	100	-	-	-	0	0
Center	22	120	FN	100	-	-	-	0	0
Right center	33	140	FN	100	-	-	-	10	0
Right	44	0	FN	100	7	0	0	15	0
Transect K									
Left	0	0	FN	100	11	0	0	10	0
Left center	10.5	90	FN	100	-	-	-	17	0
Center	21	160	GF	50	-	-	-	0	0
Right center	31.5	90	FN	100	-	-	-	0	0
Right	42	0	FN	100	10	0	0	14	0

[1] No flags found.

Table 3–6. Physical-habitat transect data for Sheyenne site 3 (upstream, reach 6) on Sheyenne River in North Dakota., August 2010

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GF, gravel, fine]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	10	0	0	7	0
Left center	17.7	110	FN	100	--	--	--	0	0
Center	35.5	130	FN	100	--	--	--	0	0
Right center	54.2	100	FN	100	--	--	--	17	0
Right	75	0	FN	100	5	0	0	0	0
Transect B									
Left	0	0	FN	100	15	0	0	0	0
Left center	17.6	80	FN	100	--	--	--	0	0
Center	35.2	140	FN	100	--	--	--	0	1
Right center	52.8	120	FN	100	--	--	--	17	0
Right	70.4	0	FN	100	5	0	0	0	0
Transect C									
Left	0	0	FN	100	10	0	0	6	0
Left center	14	110	FN	100	--	--	--	0	0
Center	27.9	140	FN	100	--	--	--	0	0
Right center	41.9	100	FN	100	--	--	--	17	0
Right	55.8	0	FN	100	5	0	0	0	0
Transect D									
Left	0	0	FN	100	20	0	0	0	0
Left center	12.7	120	FN	100	--	--	--	0	0
Center	25.3	140	FN	100	--	--	--	0	0
Right center	38	130	FN	100	--	--	--	17	0
Right	50.6	0	FN	100	7	0	0	10	0
Transect E									
Left	0	0	FN	100	8	0	0	0	0
Left center	12.8	110	FN	100	--	--	--	0	0
Center	25.5	140	FN	100	--	--	--	0	0
Right center	38.3	130	FN	100	--	--	--	17	0
Right	51	0	FN	100	3	0	0	11	0
Transect F									
Left	0	0	FN	100	20	0	0	0	0
Left center	12.8	90	FN	100	--	--	--	0	0
Center	25.6	160	FN	100	--	--	--	0	0
Right center	37.4	120	FN	100	--	--	--	17	0
Right	51.2	0	FN	100	7	0	0	17	0

Table 3–6. Physical-habitat transect data for Sheyenne site 3 (upstream, reach 6) on Sheyenne River in North Dakota., August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GF, gravel, fine]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	5	0	0	0	0
Left center	12.5	110	FN	100	--	--	--	17	0
Center	25	140	FN	100	--	--	--	0	0
Right center	37.5	130	FN	100	--	--	--	17	0
Right	50	0	FN	100	10	0	0	17	0
Transect H									
Left	0	0	FN	100	5	0	0	0	0
Left center	15.3	90	FN	100	--	--	--	0	0
Center	30.6	140	FN	100	--	--	--	0	0
Right center	45.9	130	FN	100	--	--	--	17	0
Right	61.2	0	FN	100	7	0	0	17	0
Transect I									
Left	0	0	FN	100	12	0	0	17	0
Left center	15	120	FN	100	--	--	--	17	0
Center	30	160	FN	100	--	--	--	0	0
Right center	45	120	FN	100	--	--	--	17	0
Right	60	0	FN	100	12	0	0	0	0
Transect J									
Left	0	0	FN	100	10	0	0	17	0
Left center	15.7	120	FN	100	--	--	--	17	0
Center	31.5	160	GF	50	--	--	--	0	0
Right center	47.2	110	FN	100	--	--	--	17	0
Right	63	0	FN	100	20	0	0	10	0
Transect K									
Left	0	0	FN	100	10	0	0	0	0
Left center	13	140	FN	100	--	--	--	17	0
Center	26	160	GF	50	--	--	--	0	0
Right center	39	120	FN	100	--	--	--	17	0
Right	52	0	FN	100	15	0	0	17	0

[1] Drainage ditch at Transect B.

Table 3–7. Physical-habitat transect data for Cooperstown site 1 (downstream, reach 7) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GC, gravel, coarse; SA, sand]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	15	0	0	17	0
Left center	5.7	130	FN	100	--	--	--	0	0
Center	11.5	140	FN	100	--	--	--	0	0
Right center	17.2	170	FN	100	--	--	--	0	0
Right	23	0	FN	100	90	0	0	8	0
Transect B									
Left	0	0	FN	100	50	0	0	6	0
Left center	4.3	220	FN	100	--	--	--	0	0
Center	8.6	190	FN	100	--	--	--	0	0
Right center	12.9	160	FN	100	--	--	--	0	0
Right	16.8	0	FN	100	10	0	0	8	0
Transect C									
Left	0	0	FN	100	30	0	0	6	0
Left center	4.5	190	FN	100	--	--	--	0	0
Center	8.9	210	GC	50	--	--	--	0	0
Right center	13.4	120	FN	100	--	--	--	0	0
Right	17.9	0	FN	100	30	0	0	9	0
Transect D									
Left	0	0	FN	100	35	0	0	17	0
Left center	5.6	150	GC	50	--	--	--	5	0
Center	11.1	140	GC	50	--	--	--	0	0
Right center	16.7	120	FN	100	--	--	--	0	0
Right	22.2	0	FN	100	25	0	0	17	0
Transect E									
Left	0	0	FN	100	20	0	0	16	0
Left center	4.7	110	FN	100	--	--	--	9	0
Center	9.4	130	SA	50	--	--	--	0	0
Right center	14.1	130	GC	50	--	--	--	0	0
Right	18.7	0	FN	100	50	0	0	10	0
Transect F									
Left	0	0	FN	100	20	0	0	15	0
Left center	5.8	160	GC	50	--	--	--	0	0
Center	11.6	160	GC	50	--	--	--	0	0
Right center	17.4	140	FN	100	--	--	--	0	0
Right	23.2	0	FN	100	40	0	0	17	0

Table 3–7. Physical-habitat transect data for Cooperstown site 1 (downstream, reach 7) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GC, gravel, coarse; SA, sand]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	50	0	0	10	0
Left center	3.8	220	FN	100	--	--	--	0	0
Center	7.6	250	GC	50	--	--	--	0	0
Right center	11.4	180	GC	50	--	--	--	0	0
Right	15.3	0	FN	100	15	0	0	1	0
Transect H									
Left	0	0	FN	100	40	0	0	12	0
Left center	6.1	150	FN	100	--	--	--	0	0
Center	12.1	140	FN	100	--	--	--	0	0
Right center	18.1	140	FN	100	--	--	--	0	0
Right	24.3	0	FN	100	20	0	0	6	0
Transect I									
Left	0	0	FN	100	70	0	0	17	0
Left center	6.5	160	GC	50	--	--	--	0	0
Center	12.8	110	FN	100	--	--	--	0	0
Right center	19.3	90	FN	100	--	--	--	0	0
Right	25.7	0	FN	100	25	0	0	17	0
Transect J									
Left	0	0	FN	100	20	0	0	17	0
Left center	5	140	FN	100	--	--	--	0	0
Center	10	210	GC	50	--	--	--	0	0
Right center	15	190	FN	100	--	--	--	0	0
Right	20	0	FN	100	25	0	0	17	0
Transect K									
Left	0	0	FN	100	25	0	0	9	0
Left center	4.7	100	GC	50	--	--	--	0	0
Center	9.3	140	GC	50	--	--	--	0	0
Right center	14	150	GC	50	--	--	--	0	0
Right	18.6	0	FN	100	50	0	0	17	0

[1] No flags found.

Table 3–8. Physical-habitat transect data for Cooperstown site 2 (middle, reach 8) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; GC, gravel, coarse; --, no data; GF, gravel, fine]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	20	0	0	17	0
Left center	7.1	120	GC	50	--	--	--	0	0
Center	14.2	120	GC	50	--	--	--	0	0
Right center	21.3	120	FN	100	--	--	--	0	0
Right	29.5	0	FN	100	5	0	0	17	0
Transect B									
Left	0	0	FN	100	30	0	0	10	0
Left center	6	140	GC	50	--	--	--	0	0
Center	12	140	GF	50	--	--	--	0	0
Right center	18	120	FN	100	--	--	--	0	0
Right	24	0	FN	100	20	0	0	17	0
Transect C									
Left	0	0	FN	100	55	0	0	12	0
Left center	4.5	180	GF	50	--	--	--	0	0
Center	9	180	GC	50	--	--	--	0	0
Right center	13.5	130	FN	100	--	--	--	0	0
Right	18	0	FN	100	20	0	0	17	0
Transect D									
Left	0	0	SA	50	20	0	0	17	0
Left center	5	90	FN	100	--	--	--	0	0
Center	10	150	GC	50	--	--	--	0	0
Right center	15.1	170	GC	50	--	--	--	0	0
Right	20.2	0	FN	100	40	0	0	17	0
Transect E									
Left	0	0	FN	100	35	0	0	14	0
Left center	4.5	140	GC	50	--	--	--	0	0
Center	9	140	GC	50	--	--	--	0	0
Right center	13.5	130	GC	50	--	--	--	0	0
Right	18	0	GF	50	90	0	0	17	0
Transect F									
Left	0	0	FN	100	35	0	0	17	0
Left center	5.3	130	GF	50	--	--	--	0	0
Center	10.6	160	GC	50	--	--	--	0	0
Right center	15.9	150	GF	50	--	--	--	0	0
Right	21.2	0	FN	100	90	0	0	17	0

Table 3–8. Physical-habitat transect data for Cooperstown site 2 (middle, reach 8) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; GC, gravel, coarse; --, no data; GF, gravel, fine]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	60	0	0	9	0
Left center	5	150	GC	50	--	--	--	0	0
Center	10	150	GC	50	--	--	--	0	0
Right center	15	180	GC	50	--	--	--	0	0
Right	20	0	FN	100	25	0	0	17	0
Transect H									
Left	0	0	GF	50	65	0	0	10	0
Left center	6.3	140	GC	50	--	--	--	0	0
Center	12.6	130	GF	50	--	--	--	0	0
Right center	18.9	70	FN	100	--	--	--	0	0
Right	25.3	0	FN	100	30	0	0	12	0
Transect I									
Left	0	0	FN	100	50	0	0	17	0
Left center	8.4	120	GC	50	--	--	--	0	0
Center	16.8	120	GC	50	--	--	--	0	0
Right center	25.2	100	GC	50	--	--	--	0	0
Right	33.5	0	FN	100	65	0	0	12	0
Transect J									
Left	0	0	FN	100	20	0	0	12	0
Left center	6.6	90	FN	100	--	--	--	0	0
Center	13.2	190	FN	100	--	--	--	0	0
Right center	19.8	130	GF	50	--	--	--	0	0
Right	26.5	0	FN	100	30	0	0	11	0
Transect K									
Left	0	0	FN	100	40	0	0	12	0
Left center	5.5	90	FN	100	--	--	--	0	0
Center	11	120	FN	100	--	--	--	0	0
Right center	16.5	140	FN	100	--	--	--	0	0
Right	22	0	FN	100	20	0	0	17	0

[1] No flags found.

Table 3–9. Physical-habitat transect data for Cooperstown site 3 (upstream, reach 9) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GC, gravel, coarse; GF, gravel, fine]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	90	0	0	11	0
Left center	7.2	130	FN	100	--	--	--	0	0
Center	14.4	120	FN	100	--	--	--	0	0
Right center	21.6	100	FN	100	--	--	--	0	0
Right	28.8	0	FN	100	15	0	2	0	0
Transect B									
Left	0	0	FN	100	25	0	0	17	0
Left center	5.4	140	FN	100	--	--	--	0	0
Center	10.8	110	FN	100	--	--	--	0	0
Right center	16.2	90	FN	100	--	--	--	0	0
Right	21.6	0	FN	100	25	0	0	17	0
Transect C									
Left	0	0	FN	100	20	0	0	15	0
Left center	5	150	FN	100	--	--	--	0	0
Center	10	120	FN	100	--	--	--	0	0
Right center	15	110	FN	100	--	--	--	0	0
Right	20	0	FN	100	30	0	0	17	0
Transect D									
Left	0	0	FN	100	30	0	0	15	0
Left center	5	160	FN	100	--	--	--	0	0
Center	10	140	FN	100	--	--	--	0	0
Right center	15	110	GC	50	--	--	--	0	0
Right	20	0	FN	100	20	0	0	17	0
Transect E									
Left	0	0	FN	100	30	0	0	8	0
Left center	5.4	130	FN	100	--	--	--	0	0
Center	10.8	120	FN	100	--	--	--	0	0
Right center	16.2	110	FN	100	--	--	--	0	0
Right	21.5	0	FN	100	30	0	0	17	0
Transect F									
Left	0	0	FN	100	35	0	0	12	0
Left center	5.6	120	FN	100	--	--	--	0	0
Center	11.2	120	FN	100	--	--	--	0	0
Right center	16.8	120	GF	50	--	--	--	0	0
Right	22.4	0	FN	100	25	0	0	17	0

Table 3–9. Physical-habitat transect data for Cooperstown site 3 (upstream, reach 9) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data; GC, gravel, coarse; GF, gravel, fine]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	40	0	0	11	0
Left center	5.9	130	GF	50	--	--	--	0	0
Center	11.8	120	GF	50	--	--	--	0	0
Right center	17.7	110	GF	50	--	--	--	0	0
Right	23.7	0	FN	100	25	0	0	17	0
Transect H									
Left	0	0	FN	100	20	0	0	17	0
Left center	15.4	110	FN	100	--	--	--	0	0
Center	30.7	130	FN	100	--	--	--	0	0
Right center	46.1	130	GC	50	--	--	--	0	0
Right	61.5	0	FN	100	25	0	0	17	0
Transect I									
Left	0	0	FN	100	20	0	0	17	0
Left center	6.2	70	FN	100	--	--	--	0	0
Center	12.5	100	GF	50	--	--	--	0	0
Right center	18.7	130	GC	50	--	--	--	0	0
Right	25	0	FN	100	75	0	0	17	0
Transect J									
Left	0	0	FN	100	45	0	0	13	0
Left center	6.1	90	GF	50	--	--	--	0	0
Center	12.2	120	FN	100	--	--	--	0	0
Right center	18.4	90	FN	100	--	--	--	0	0
Right	24.5	0	FN	100	30	0	0	15	0
Transect K									
Left	0	0	FN	100	40	0	0	14	0
Left center	5.4	130	GC	50	--	--	--	0	0
Center	10.8	120	GC	50	--	--	--	0	0
Right center	16.4	120	GF	50	--	--	--	0	0
Right	21.6	0	FN	100	45	0	0	16	0

[1] No flags found.

Table 3–10. Physical-habitat transect data for West Fargo site 1 (downstream, reach 10) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type)	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	22	0	0	17	0
Left center	4.5	280	FN	100	--	--	--	17	0
Center	9	300	FN	100	--	--	--	10	1
Right center	13.5	130	FN	100	--	--	--	3	0
Right	18	0	FN	100	65	0	.5	6	0
Transect B									
Left	0	0	FN	100	25	0	0	15	0
Left center	4.8	260	FN	100	--	--	--	5	0
Center	9.6	250	FN	100	--	--	--	0	0
Right center	14.4	230	FN	100	--	--	--	7	0
Right	19.2	0	FN	100	5	0	2	17	0
Transect C									
Left	0	0	FN	100	25	0	0	6	0
Left center	4.6	150	FN	100	--	--	--	2	0
Center	9.3	270	FN	100	--	--	--	0	0
Right center	13.9	270	FN	100	--	--	--	3	0
Right	18.5	0	FN	100	30	0	.3	17	0
Transect D									
Left	0	0	FN	100	40	0	0.1	17	0
Left center	4.5	230	FN	100	--	--	--	6	0
Center	8.9	250	FN	100	--	--	--	0	0
Right center	13.4	80	FN	100	--	--	--	7	0
Right	17.8	0	FN	100	35	0	0	16	0
Transect E									
Left	0	0	FN	100	40	0	0.2	17	0
Left center	4.6	250	FN	100	--	--	--	6	0
Center	9.3	220	FN	100	--	--	--	0	0
Right center	13.9	190	FN	100	--	--	--	0	0
Right	18.5	0	FN	100	25	0	0	3	0
Transect F									
Left	0	0	FN	100	90	0	0	11	0
Left center	4.5	200	FN	100	--	--	--	0	0
Center	9.1	250	FN	100	--	--	--	0	1
Right center	13.7	160	FN	100	--	--	--	3	0
Right	18.2	0	FN	100	30	0	0	17	0

Table 3–10. Physical-habitat transect data for West Fargo site 1 (downstream, reach 10) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type)	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	90	0	0	17	0
Left center	4	240	FN	100	--	--	--	12	0
Center	8	270	FN	100	--	--	--	3	0
Right center	12	170	FN	100	--	--	--	5	0
Right	16	0	FN	100	15	0	0	2	0
Transect H									
Left	0	0	FN	100	20	0	0	4	0
Left center	5.1	120	FN	100	--	--	--	2	0
Center	10.1	190	FN	100	--	--	--	4	0
Right center	15.2	260	FN	100	--	--	--	15	0
Right	20.3	0	FN	100	40	0	0	17	0
Transect I									
Left	0	0	FN	100	90	0	0	17	0
Left center	4.7	260	FN	100	--	--	--	11	0
Center	9.5	230	FN	100	--	--	--	2	0
Right center	4.3	150	FN	100	--	--	--	1	0
Right	19	0	FN	100	10	0	0	15	0
Transect J									
Left	0	0	FN	100	60	0	0	10	0
Left center	4.3	250	FN	100	--	--	--	1	0
Center	8.5	310	FN	100	--	--	--	1	0
Right center	12.8	200	FN	100	--	--	--	4	0
Right	17	0	FN	100	25	0	0	13	0
Transect K									
Left	0	0	FN	100	65	0	0	4	0
Left center	4.3	270	FN	100	--	--	--	0	0
Center	7.5	250	FN	100	--	--	--	0	0
Right center	10.8	140	FN	100	--	--	--	3	0
Right	15	0	FN	100	30	0	0	3	0

[1] Garbage found at Transects A and F and at various locations throughout reach.

Table 3–11. Physical-habitat transect data for West Fargo site 2 (middle, reach 11) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	20	0	0	15	0
Left center	6.1	250	FN	100	--	--	--	2	0
Center	12.2	250	FN	100	--	--	--	4	0
Right center	18.3	210	FN	100	--	--	--	8	0
Right	24.3	0	FN	100	55	0	.5	17	0
Transect B									
Left	0	0	FN	100	30	0	0	14	0
Left center	6	200	FN	100	--	--	--	14	0
Center	12	340	FN	100	--	--	--	3	0
Right center	18	270	FN	100	--	--	--	6	0
Right	24.1	0	FN	100	90	0	0	17	0
Transect C									
Left	0	0	FN	100	30	0	0	17	0
Left center	6.1	150	FN	100	--	--	--	17	0
Center	12.2	280	FN	100	--	--	--	9	0
Right center	18.3	280	FN	100	--	--	--	6	0
Right	24.5	0	FN	100	40	0	0	17	0
Transect D									
Left	0	0	FN	100	25	0	0	16	0
Left center	5.2	240	FN	100	--	--	--	13	0
Center	10.3	360	FN	100	--	--	--	5	0
Right center	15.6	280	FN	100	--	--	--	1	0
Right	20.7	0	FN	100	30	0	0	14	0
Transect E									
Left	0	0	FN	100	30	0	0	17	0
Left center	6.1	260	FN	100	--	--	--	17	0
Center	12.3	360	FN	100	--	--	--	15	0
Right center	18.4	250	FN	100	--	--	--	6	0
Right	24.5	0	FN	100	35	0	0.1	17	0
Transect F									
Left	0	0	FN	100	30	0.5	0	17	0
Left center	5.3	260	FN	100	--	--	--	17	0
Center	10.6	270	FN	100	--	--	--	17	0
Right center	15.9	250	FN	100	--	--	--	2	0
Right	21.3	0	FN	100	85	0	0	17	0

Table 3–11. Physical-habitat transect data for West Fargo site 2 (middle, reach 11) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	90	0.2	0.5	17	0
Left center	6.6	380	FN	100	--	--	--	17	0
Center	13.1	380	FN	100	--	--	--	1	1
Right center	19.8	60	FN	100	--	--	--	0	0
Right	26.2	0	FN	100	20	0	.5	17	0
Transect H									
Left	0	0	FN	100	25	0	1	17	0
Left center	5.6	250	FN	100	--	--	--	5	0
Center	11.3	450	FN	100	--	--	--	3	0
Right center	16.9	170	FN	100	--	--	--	12	0
Right	23.5	0	FN	100	20	0	1	14	0
Transect I									
Left	0	0	FN	100	40	0	0.3	7	0
Left center	5.8	330	FN	100	--	--	--	2	0
Center	11.6	250	FN	100	--	--	--	4	1
Right center	17.4	230	FN	100	--	--	--	4	0
Right	23.1	0	FN	100	25	0	0	17	0
Transect J									
Left	0	0	FN	100	35	0	1	17	0
Left center	5.2	270	FN	100	--	--	--	16	0
Center	10.4	370	FN	100	--	--	--	11	1
Right center	15.6	310	FN	100	--	--	--	7	0
Right	20.8	0	FN	100	30	0	.5	17	0
Transect K									
Left	0	0	FN	100	40	0	0.5	17	0
Left center	6.1	200	FN	100	--	--	--	1	0
Center	12.2	250	FN	100	--	--	--	1	1
Right center	18.3	260	FN	100	--	--	--	11	0
Right	24.4	0	FN	100	40	0	1	17	0

[1] Garbage found at Transects G, I, and J; pump in the water at Transect K.

Table 3–12. Physical-habitat transect data for West Fargo site 3 (upstream, reach 12) on Sheyenne River in North Dakota, August 2010.

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect A									
Left	0	0	FN	100	40	0	0	17	1
Left center	6.4	220	FN	100	--	--	--	0	0
Center	12.8	400	FN	100	--	--	--	0	0
Right center	19.2	250	FN	100	--	--	--	5	0
Right	25.7	0	FN	100	50	0	0	17	1
Transect B									
Left	0	0	FN	100	40	0	0.1	17	0
Left center	4.9	250	FN	100	--	--	--	7	0
Center	9.8	220	FN	100	--	--	--	9	0
Right center	14.7	260	FN	100	--	--	--	17	0
Right	19.7	0	FN	100	90	0	0	17	0
Transect C									
Left	0	0	FN	100	40	0	0	17	1
Left center	5.4	380	FN	100	--	--	--	17	0
Center	10.8	350	FN	100	--	--	--	5	0
Right center	16.2	250	FN	100	--	--	--	14	0
Right	21.9	0	FN	100	50	0	0	17	0
Transect D									
Left	0	0	FN	100	30	0	0.1	17	0
Left center	5	360	FN	100	--	--	--	14	0
Center	10	360	FN	100	--	--	--	2	0
Right center	15	170	FN	100	--	--	--	16	0
Right	20	0	FN	100	30	0	0.2	17	0
Transect E									
Left	0	0	FN	100	25	0	0	17	0
Left center	5.2	370	FN	100	--	--	--	5	0
Center	10.4	410	FN	100	--	--	--	0	0
Right center	15.6	130	FN	100	--	--	--	10	0
Right	20.7	0	FN	100	40	0	0	17	0
Transect F									
Left	0	0	FN	100	50	0	0	17	0
Left center	5.8	290	FN	100	--	--	--	17	0
Center	11.6	370	FN	100	--	--	--	8	0
Right center	17.4	300	FN	100	--	--	--	4	0
Right	23.2	0	FN	100	35	0	0	13	0

Table 3–12. Physical habitat transect data for West Fargo site 3 (upstream, reach 12) on Sheyenne River in North Dakota, August 2010.—Continued

[Undercut, 0 equals no undercut; riparian vegetation is distance that vegetation is growing from the water's edge; canopy, 0 is minimum density and 17 is maximum density; Flag, notable field comments; FN, fines; --, no data]

Location facing downstream	Distance from left bank (meters)	Channel of depth (centimeters)	Substrate type	Embeddedness (percent)	Bank angle (degrees)	Undercut (meters)	Riparian vegetation (meters)	Canopy	Flag[1]
Transect G									
Left	0	0	FN	100	35	0	0	17	1
Left center	6.2	280	FN	100	--	--	--	6	0
Center	12.4	250	FN	100	--	--	--	11	0
Right center	18.6	250	FN	100	--	--	--	17	0
Right	24.7	0	FN	100	40	0	0.5	17	0
Transect H									
Left	0	0	FN	100	85	0	0	17	1
Left center	5.6	240	FN	100	--	--	--	3	0
Center	11.1	180	FN	100	--	--	--	5	0
Right center	16.6	130	FN	100	--	--	--	14	0
Right	22.3	0	FN	100	40	0	0	17	1
Transect I									
Left	0	0	FN	100	50	0	0	17	1
Left center	6.3	190	FN	100	--	--	--	7	0
Center	12.6	220	FN	100	--	--	--	12	0
Right center	18.9	270	FN	100	--	--	--	17	0
Right	24.8	0	FN	100	30	0	0	17	0
Transect J									
Left	0	0	FN	100	80	0	0	17	0
Left center	5.6	170	FN	100	--	--	--	2	0
Center	11.1	280	FN	100	--	--	--	6	0
Right center	16.7	180	FN	100	--	--	--	17	0
Right	22.2	0	FN	100	60	0	0	17	0
Transect K									
Left	0	0	FN	100	20	0	0	0	0
Left center	4.9	380	FN	100	--	--	--	0	0
Center	9.9	420	FN	100	--	--	--	0	0
Right center	14.8	250	FN	100	--	--	--	2	0
Right	19.8	0	FN	100	70	0	0	16	0

[1] Garbage found near Transects A, B, C, G, H, and I; irrigation line in water at Transect D.

Table 4–1. Physical-habitat data for selected reaches on Sheyenne River, North Dakota, August 2010.

[Bar width, 0 equals no bar found]

Transect	Wetted width, (meters)	Bar width, (meters)	Bankfull width, (meters)	Bankfull height, (meters)	Incised height, (meters)	Channel code
Kleven reach 1—downstream						
A	12.6	0	15	1.2	2.6	Glide
B	10.9	0	20	1.3	2.8	Glide
C	14.6	0	17	1.2	2.4	Glide
D	11.9	0	20	1	2.8	Glide
E	7.5	0	9	1	2.8	Glide
F	5.7	0	7.5	1	2.8	Glide
G	7.9	0	9	1	2.5	Glide
H	11	0	12.5	1	2.7	Glide
I	12	0	27	1.2	3	Glide
J	6.5	0	9	1.3	2.8	Glide
K	7.2	1	9	1.5	2.8	Glide
Kleven reach 2—middle						
A	9.2	0	14.5	1.7	2.7	Glide
B	13	0	26	1.2	2.5	Glide
C	16	0	21	1.6	2.7	Glide
D	14	0	21	1.7	3	Glide
E	16	0	25	1.8	3.1	Glide
F	33	0	45	1.7	2.8	Glide
G	32	0	40	1.5	2.5	Glide
H	19	0	35	1.8	3	Glide
I	15.2	0	33	1.8	3	Glide
J	14.2	0	30	1.6	2.8	Glide
K	10	0	25	1.5	2.8	Glide
Kleven reach 3—upstream						
A	15	0	30	1.7	3	Glide
B	15	0	30	1.8	3	Glide
C	14	0	40	1.8	2.8	Glide
D	22	0	40	1.5	3	Glide
E	22	0	26	1	3	Glide
F	14	0	17	1	2	Pool, backwater
G	28	0	30	1.5	3	Pool, backwater
H	27	.2	28	1.5	3	Pool, backwater
I	30	0	34	1.5	3	Pool, backwater
J	39	3	41.5	1.5	3	Pool, backwater
K	38	0	42	1.5	3	Pool, backwater

Table 4–2. Physical-habitat data for selected reaches on Sheyenne River, North Dakota, August 2010.

[Bar width, 0 equals no bar found]

Transect	Wetted width, (meters)	Bar width, (meters)	Bankfull width, (meters)	Bankfull height, (meters)	Incised height, (meters)	Channel code
Sheyenne reach 4—downstream						
A	40	0	45	0.9	1.8	Glide
B	40.2	0	45	1	2	Glide
C	39	0	43	1	2	Glide
D	44.2	0	47	1	2	Glide
E	50.8	0	53	2	3	Glide
F	56.2	0	58	1	2	Glide
G	47	0	53	2	3	Glide
H	38	0	40	1.5	2.5	Glide
I	42	0	44	1.5	2.5	Glide
J	33.4	0	37	1.5	2	Glide
K	44.4	0	46	2	3	Glide
Sheyenne reach 5—middle						
A	60	0	64	0.5	1	Glide
B	53.8	0	55	.5	1	Glide
C	48.2	0	50	2	3	Glide
D	48.5	0	50	2	3	Glide
E	54	0	56	2	4	Glide
F	72.2	0	77	.3	1	Glide
G	60	0	68	.2	0.8	Glide
H	51	0	56	.2	0.8	Glide
I	46	0	50	.4	1	Glide
J	44	0	50	1	2	Glide
K	42	0	45	1	2	Glide
Sheyenne reach 6—upstream						
A	75	0	78	1	3	Glide
B	70.4	0	72	1	3	Glide
C	55	0	57	1	2	Glide
D	50.6	0	52	1	2	Glide
E	51	0	54	1	2	Glide
F	51.2	0	53	1	2	Glide
G	50	0	52	1	2	Glide
H	61.2	0	63	1	2	Glide
I	60	0	62	1	2	Glide
J	63	0	64	.7	1.4	Glide
K	52	0	54	.5	1	Glide

Table 4–3. Physical-habitat data for selected reaches on Sheyenne River, North Dakota, August 2010.

[Bar width, 0 equals no bar found]

Transect	Wetted width, (meters)	Bar width, (meters)	Bankfull width, (meters)	Bankfull height, (meters)	Incised height, (meters)	Channel code
Cooperstown reach 7—downstream						
A	23	0	24	1	2	Glide
B	16.8	0	17.5	1	2	Glide
C	17.9	0	18.4	2	3	Glide
D	22.2	0	25	3	4	Glide
E	18.7	0	24	1	2	Glide
F	23.2	0	25	1.5	2.5	Glide
G	15.3	0	17	1	2	Glide
H	24.3	0	26	1	2	Glide
I	25.7	0	27	.7	1.2	Glide
J	20	0	22	1	2	Glide
K	18.6	0	20	2	3	Glide
Cooperstown reach 8—middle						
A	29.5	0	31	1	2	Glide
B	24	0	26	1	2	Glide
C	18	0	20	1	2	Glide
D	20.2	0	23	1	2	Glide
E	18	0	20	1	2	Glide
F	21.2	0	24	2	3	Glide
G	20	0	22	2	3	Glide
H	25.3	0	27	1	2	Glide
I	33.5	12	37	1	2	Glide
J	26.5	0	30	1	2	Glide
K	22	0	24	1	2	Glide
Cooperstown reach 9—upstream						
A	25.8	0	30	0.5	1	Glide
B	21.6	0	22	.5	1	Glide
C	20	0	21	.5	1	Glide
D	20	0	21	.5	1	Glide
E	21.5	0	23	.5	1	Glide
F	22.4	0	23	2	3	Glide
G	23.7	0	25	2	3	Glide
H	61.5	30	65	2	3	Glide
I	25	0	26	1	2	Glide
J	24.5	0	25	1	2	Glide
K	21.6	0	23	2	3	Glide

Table 4–4. Physical-habitat data for selected reaches on Sheyenne River, North Dakota, August 2010.

[Bar width, 0 equals no bar found]

Transect	Wetted width, (meters)	Bar width, (meters)	Bankfull width, (meters)	Bankfull height, (meters)	Incised height, (meters)	Channel code
West Fargo reach 10—downstream						
A	18	0	27	2	3	Glide
B	19.2	0	36	3.5	4.5	Glide
C	18.5	0	38.5	3.5	4.5	Glide
D	17.8	0	30	3.8	4.7	Glide
E	18.5	0	27	3.5	4.5	Glide
F	18.2	0	23.2	4	4.7	Glide
G	16	0	26	3	4	Glide
H	20.3	0	27	3	4	Glide
I	19	0	25	3	4	Glide
J	17	0	22	2	3	Glide
K	15	0	16	2.5	3	Glide
West Fargo reach 11—middle						
A	24.3	0	27	3	4	Glide
B	24.1	0	26	5	6	Glide
C	24.5	0	25.8	3	4	Glide
D	20.7	0	22	2	3	Glide
E	24.5	0	30	4	5	Glide
F	21.3	0	26	3	4	Glide
G	26.2	5	29	3	4	Glide
H	23.5	0	29	3	4	Glide
I	23.1	0	27	6	7	Glide
J	20.8	0	22	6	7	Glide
K	24.4	0	28	4	5	Glide
West Fargo reach 12—upstream						
A	25.7	4	27	2	3	Glide
B	19.7	0	21	3	4	Glide
C	21.9	0	23	3	4	Glide
D	20	0	24	2	3	Glide
E	20.7	0	23	2	3	Glide
F	23.2	0	28	2.5	3.5	Glide
G	24.7	0	28	5	6	Glide
H	22.3	0	26	2	3	Glide
I	24.8	0	27	2	3	Glide
J	22.2	0	23	2	3	Glide
K	19.8	0	25	2	3	Glide

Table 5–1. Streamflow and water-quality characteristics and constituents in samples collected from selected reaches on the Sheyenne River, North Dakota, August 2010.

[ft^3/s, cubic foot per second; mg/L, milligram per liter; N, nitrogen; P, phosphorus; µS/cm, microsiemen per centimeter; SE., southeast; W., west; <, less than; µg/L, microgram per liter]

Reach number (table 1)	Reach name	Date	Time	Streamflow (ft^3/s)	Dissolved oxygen, unfiltered (mg/L)	pH, water, field, (standard units)	Specific conductance, field, (µS/cm) at 25 degrees Celsius	Temperature, water (degrees Celsius)	Transparency, Secchi disc (inches)	Dissolved solids, sum of constituents (mg/L)
1	Sheyenne River Kleven Site 1 SE. of Maddock, N. Dak.	08-13-10	0940	31	3.9	8.1	1,500	24.1	0.15	984
2	Sheyenne River Kleven Site 2 SE. of Maddock, N. Dak.	08-13-10	1130	31	3.9	8.2	1,490	24.8	.20	956
3	Sheyenne River Kleven Site 3 SE. of Maddock, N. Dak.	08-13-10	1155	31	4.3	8.2	1,490	25.1	.20	960
4	Sheyenne River Sheyenne Site 1 W. of Sheyenne, N. Dak.	08-12-10	1010	279	5.9	8.5	1,840	25.6	.25	1,230
5	Sheyenne River Sheyenne Site 2 W. of Sheyenne, N. Dak.	08-12-10	1105	279	5.8	8.4	1,840	25.3	.25	1,240
6	Sheyenne River Sheyenne Site 3 W. of Sheyenne, N. Dak.	08-12-10	1200	279	5.6	8.3	1,840	25.1	.22	1,230
7	Sheyenne River Cooperstown Site 1 Cooperstown, N. Dak.	08-11-10	1245	315	5.9	8.2	1,740	26.3	.25	1,140
8	Sheyenne River Cooperstown Site 2 Cooperstown, N. Dak.	08-11-10	1445	315	6.3	8.3	1,740	27.1	.20	1,150
9	Sheyenne River Cooperstown Site 3 Cooperstown, N. Dak.	08-11-10	1630	315	6.3	8.2	1,740	27.4	.25	1,140
10	Sheyenne River West Fargo Site 1 West Fargo, N. Dak.	08-10-10	1055	485	6.9	8.2	1,120	25.6	.15	746
11	Sheyenne River West Fargo Site 2 West Fargo, N. Dak.	08-10-10	1110	485	7	8.2	1,120	25.5	.20	746
12	Sheyenne River West Fargo Site 3 West Fargo, N. Dak.	08-11-10	0800	483	6.3	8.3	1,120	25.1	.20	738

Table 5–1. Streamflow and water-quality characteristics and constituents in samples collected from selected reaches on the Sheyenne River, North Dakota, August 2010.—Continued

[ft^3/s, cubic foot per second; mg/L, milligram per liter; N, nitrogen; P, phosphorus; µS/cm, microsiemen per centimeter; SE., southeast; W., west; <, less than; µg/L, microgram per liter]

Reach number (table 1)	Reach name	Date	Time	Hardness, (mg/L) as calcium carbonate	Suspended solids, unfiltered (mg/L)	Calcium, water, unfiltered, recoverable (mg/L)	Magnesium, water, unfiltered, recoverable (mg/L)	Potassium, water, unfiltered, recoverable (mg/L)	Sodium adsorption ratio, water (percent)	Sodium, water, unfiltered, recoverable (mg/L)
1	Sheyenne River Kleven Site 1 SE. of Maddock, N. Dak.	08-13-10	0940	390	75	60.7	57.5	13.7	5.30	239
2	Sheyenne River Kleven Site 2 SE. of Maddock, N. Dak.	08-13-10	1130	360	40	55.7	54.2	12.9	5.30	231
3	Sheyenne River Kleven Site 3 SE. of Maddock, N. Dak.	08-13-10	1155	360	34	55.1	53.6	12.7	5.20	228
4	Sheyenne River Sheyenne Site 1 W. of Sheyenne, N. Dak.	08-12-10	1010	490	24	70.7	76.3	33.1	4.70	240
5	Sheyenne River Sheyenne Site 2 W. of Sheyenne, N. Dak.	08-12-10	1105	500	47	72.2	78.3	33.5	4.70	244
6	Sheyenne River Sheyenne Site 3 W. of Sheyenne, N. Dak.	08-12-10	1200	490	43	70.5	76.2	32.9	4.70	240
7	Sheyenne River Cooperstown Site 1 Cooperstown, N. Dak.	08-11-10	1245	480	89	75.1	70.8	27.4	4.20	210
8	Sheyenne River Cooperstown Site 2 Cooperstown, N. Dak.	08-11-10	1445	490	73	77.3	72.9	28.1	4.20	217
9	Sheyenne River Cooperstown Site 3 Cooperstown, N. Dak.	08-11-10	1630	480	88	74.7	70.9	27.6	4.20	212
10	Sheyenne River West Fargo Site 1 West Fargo, N. Dak.	08-10-10	1055	470	151	98.9	54.5	11.2	1.90	93.6
11	Sheyenne River West Fargo Site 2 West Fargo, N. Dak.	08-10-10	1110	470	156	99.5	54.1	11.3	1.90	93.0
12	Sheyenne River West Fargo Site 3 West Fargo, N. Dak.	08-11-10	0800	470	151	98.9	53.3	11.2	1.90	92.5

Table 5–1. Streamflow and water-quality characteristics and constituents in samples collected from selected reaches on the Sheyenne River, North Dakota, August 2010.—Continued

[ft^3/s, cubic foot per second; mg/L, milligram per liter; N, nitrogen; P, phosphorus; µS/cm, microsiemen per centimeter; SE., southeast; W., west; <, less than; µg/L, microgram per liter]

Reach number (table 1)	Reach name	Date	Time	Acid neutralizing capacity, water, unfiltered, fixed endpoint (pH 4.5) titration, laboratory (mg/L) as calcium carbonate	Bicarbonate, water, unfiltered, fixed endpoint (pH 4.5) titration, laboratory (mg/L)	Carbonate, water, unfiltered, fixed endpoint (pH 8.3) titration, laboratory (mg/L)	Chloride, water, filtered (mg/L)	Sulfate, water, filtered (mg/L)	Ammonia plus organic nitrogen, water, unfiltered (mg/L) as N	Ammonia, water, unfiltered (mg/L) as N
1	Sheyenne River Kleven Site 1 SE. of Maddock, N. Dak.	08-13-10	0940	527	634	4	20.2	275	1.60	<0.17
2	Sheyenne River Kleven Site 2 SE. of Maddock, N. Dak.	08-13-10	1130	538	652	2	19.5	258	1.50	.18
3	Sheyenne River Kleven Site 3 SE. of Maddock, N. Dak.	08-13-10	1155	555	666	5	19.6	256	1.70	.18
4	Sheyenne River Sheyenne Site 1 W. of Sheyenne, N. Dak.	08-12-10	1010	351	390	19	89.3	509	1.20	<.17
5	Sheyenne River Sheyenne Site 2 W. of Sheyenne, N. Dak.	08-12-10	1105	352	401	14	89.3	508	1.20	<.17
6	Sheyenne River Sheyenne Site 3 W. of Sheyenne, N. Dak.	08-12-10	1200	354	406	13	89.2	507	1.30	<.17
7	Sheyenne River Cooperstown Site 1 Cooperstown, N. Dak.	08-11-10	1245	353	413	9	78.9	467	1.10	<.17
8	Sheyenne River Cooperstown Site 2 Cooperstown, N. Dak.	08-11-10	1445	352	409	10	78.4	464	1.00	<.17
9	Sheyenne River Cooperstown Site 3 Cooperstown, N. Dak.	08-11-10	1630	347	404	9	78.8	465	1.00	<.17
10	Sheyenne River West Fargo Site 1 West Fargo, N. Dak.	08-10-10	1055	301	348	10	23.7	282	.73	<.17
11	Sheyenne River West Fargo Site 2 West Fargo, N. Dak.	08-10-10	1110	301	348	9	23.8	283	.71	<.17
12	Sheyenne River West Fargo Site 3 West Fargo, N. Dak.	08-11-10	0800	306	355	9	22.9	274	.69	<.17

Table 5–1. Streamflow and water-quality characteristics and constituents in samples collected from selected reaches on the Sheyenne River, North Dakota, August 2010.—Continued

[ft^3/s, cubic foot per second; mg/L, milligram per liter; N, nitrogen; P, phosphorus; µS/cm, microsiemen per centimeter; SE., southeast; W., west; <, less than; µg/L, microgram per liter]

Reach number (table 1)	Reach name	Date	Time	Nitrate plus nitrite, water, unfiltered (mg/L) as N	Phosphorus, water, unfiltered (mg/L) as P	Total nitrogen, water, unfiltered (mg/L)	Aluminum, water, unfiltered (µg/L)	Barium, water, unfiltered (µg/L)	Beryllium, water, unfiltered (µg/L)	Cadmium, water, unfiltered (µg/L)	Chromium, water, unfiltered, recoverable (µg/L)
1	Sheyenne River Kleven Site 1 SE. of Maddock, N. Dak.	08-13-10	0940	0.21	0.306	1.79	2,110	108	<5.00	<5.00	<5.00
2	Sheyenne River Kleven Site 2 SE. of Maddock, N. Dak.	08-13-10	1130	.15	.288	1.67	1,290	94	<5.00	<5.00	<5.00
3	Sheyenne River Kleven Site 3 SE. of Maddock, N. Dak.	08-13-10	1155	.15	.280	1.83	1,330	91	<5.00	<5.00	<5.00
4	Sheyenne River Sheyenne Site 1 W. of Sheyenne, N. Dak.	08-12-10	1010	.06	.280	1.29	800	85	<5.00	<5.00	<5.00
5	Sheyenne River Sheyenne Site 2 W. of Sheyenne, N. Dak.	08-12-10	1105	.07	.284	1.31	810	89	<5.00	<5.00	<5.00
6	Sheyenne River Sheyenne Site 3 W. of Sheyenne, N. Dak.	08-12-10	1200	.06	.284	1.33	960	89	<5.00	<5.00	<5.00
7	Sheyenne River Cooperstown Site 1 Cooperstown, N. Dak.	08-11-10	1245	.18	.260	1.30	1,830	116	<5.00	<5.00	<5.00
8	Sheyenne River Cooperstown Site 2 Cooperstown, N. Dak.	08-11-10	1445	.18	.248	1.21	1,600	113	<5.00	<5.00	<5.00
9	Sheyenne River Cooperstown Site 3 Cooperstown, N. Dak.	08-11-10	1630	.18	.248	1.21	1,910	113	<5.00	<5.00	<5.00
10	Sheyenne River West Fargo Site 1 West Fargo, N. Dak.	08-10-10	1055	<.03	.172	.76	2,580	109	<5.00	<5.00	<5.00
11	Sheyenne River West Fargo Site 2 West Fargo, N. Dak.	08-10-10	1110	<.03	.186	.74	3,270	111	<5.00	<5.00	<5.00
12	Sheyenne River West Fargo Site 3 West Fargo, N. Dak.	08-11-10	0800	.08	.190	.77	2,190	106	<5.00	<5.00	<5.00

Table 5–1. Streamflow and water-quality characteristics and constituents in samples collected from selected reaches on the Sheyenne River, North Dakota, August 2010.—Continued

[ft^3/s, cubic foot per second; mg/L, milligram per liter; N, nitrogen; P, phosphorus; µS/cm, microsiemen per centimeter; SE., southeast; W., west; <, less than; µg/L, microgram per liter]

Reach number (table 1)	Reach name	Date	Time	Copper, water, unfiltered (µg/L)	Iron, water, unfiltered (µg/L)	Lead, water, unfiltered (µg/L)	Manganese, water, unfiltered (µg/L)	Nickel, water, unfiltered (µg/L)	Silver, water, unfiltered (µg/L)	Thallium, water, unfiltered (µg/L)	Zinc, water, unfiltered (µg/L)
1	Sheyenne River Kleven Site 1 SE. of Maddock, N. Dak.	08-13-10	0940	5.50	3.00	<5.00	0.4	7.10	<5.00	<5.00	14.60
2	Sheyenne River Kleven Site 2 SE. of Maddock, N. Dak.	08-13-10	1130	5.30	2.00	<5.00	.3	5.70	<5.00	<5.00	7.20
3	Sheyenne River Kleven Site 3 SE. of Maddock, N. Dak.	08-13-10	1155	5.10	2.00	<5.00	.3	5.90	<5.00	<5.00	47.70
4	Sheyenne River Sheyenne Site 1 W. of Sheyenne, N. Dak.	08-12-10	1010	<5.00	1.00	<5.00	.1	5.40	<5.00	<5.00	5.80
5	Sheyenne River Sheyenne Site 2 W. of Sheyenne, N. Dak.	08-12-10	1105	<5.00	1.00	<5.00	.1	5.80	<5.00	<5.00	6.30
6	Sheyenne River Sheyenne Site 3 W. of Sheyenne, N. Dak.	08-12-10	1200	<5.00	1.00	<5.00	.1	5.50	<5.00	<5.00	6.10
7	Sheyenne River Cooperstown Site 1 Cooperstown, N. Dak.	08-11-10	1245	5.00	2.00	<5.00	.5	9.20	<5.00	<5.00	22.30
8	Sheyenne River Cooperstown Site 2 Cooperstown, N. Dak.	08-11-10	1445	<5.00	2.00	<5.00	.4	8.10	<5.00	<5.00	28.10
9	Sheyenne River Cooperstown Site 3 Cooperstown, N. Dak.	08-11-10	1630	5.00	2.00	<5.00	.5	8.60	<5.00	<5.00	9.80
10	Sheyenne River West Fargo Site 1 West Fargo, N. Dak.	08-10-10	1055	6.60	3.00	<5.00	.6	12.30	<5.00	<5.00	20.20
11	Sheyenne River West Fargo Site 2 West Fargo, N. Dak.	08-10-10	1110	7.10	4.00	<5.00	.6	13.80	<5.00	<5.00	15.00
12	Sheyenne River West Fargo Site 3 West Fargo, N. Dak.	08-11-10	0800	6.30	3.00	<5.00	.5	12.10	<5.00	<5.00	11.20

Table 5–1. Streamflow and water-quality characteristics and constituents in samples collected from selected reaches on the Sheyenne River, North Dakota, August 2010.—Continued

[ft^3/s, cubic foot per second; mg/L, milligram per liter; N, nitrogen; P, phosphorus; µS/cm, microsiemen per centimeter; SE., southeast; W., west; <, less than; µg/L, microgram per liter]

Reach number	Reach name	Date	Time	Antimony, water, unfiltered (µg/L)	Arsenic, water, unfiltered (µg/L)	Boron, water, unfiltered (µg/L)	Selenium, water, unfiltered (µg/L)
1	Sheyenne River Kleven Site 1 SE. of Maddock, N. Dak.	08-13-10	0940	<5.00	10.30	516	<5.00
2	Sheyenne River Kleven Site 2 SE. of Maddock, N. Dak.	08-13-10	1130	<5.00	9.90	503	<5.00
3	Sheyenne River Kleven Site 3 SE. of Maddock, N. Dak.	08-13-10	1155	<5.00	9.70	494	<5.00
4	Sheyenne River Sheyenne Site 1 W. of Sheyenne, N. Dak.	08-12-10	1010	<5.00	12.60	305	<5.00
5	Sheyenne River Sheyenne Site 2 W. of Sheyenne, N. Dak.	08-12-10	1105	<5.00	13.40	313	<5.00
6	Sheyenne River Sheyenne Site 3 W. of Sheyenne, N. Dak.	08-12-10	1200	<5.00	13.00	297	<5.00
7	Sheyenne River Cooperstown Site 1 Cooperstown, N. Dak.	08-11-10	1245	<5.00	10.60	282	<5.00
8	Sheyenne River Cooperstown Site 2 Cooperstown, N. Dak.	08-11-10	1445	<5.00	11.10	288	<5.00
9	Sheyenne River Cooperstown Site 3 Cooperstown, N. Dak.	08-11-10	1630	<5.00	10.90	288	<5.00
10	Sheyenne River West Fargo Site 1 West Fargo, N. Dak.	08-10-10	1055	<5.00	10.10	256	<5.00
11	Sheyenne River West Fargo Site 2 West Fargo, N. Dak.	08-10-10	1110	<5.00	10.20	257	<5.00
12	Sheyenne River West Fargo Site 3 West Fargo, N. Dak.	08-11-10	0800	<5.00	10.80	234	<5.00

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