

Water Quality Monitoring for Missouri National Recreational River, Niobrara River

2020 Data Report

Anine T. Rosse¹

¹ National Park Service, Northern Great Plains Network Inventory & Monitoring Program, 820 Columbus St, Rapid City, SD 57701



Photograph of Niobrara River near Verdel, NE at Missouri National Recreational River, August 2020 looking downstream from the bridge.

[A wide brownish-green river has sandbars visible in the background with trees lining the shore.](#)

Photograph by USGS, station 06465500.



View upstream from gage near Verdel, NE, Niobrara River, September 2020.

Wide river with ripples and sand bars visible. Trees are on banks.

Photograph by USGS, station 06465500.

Abstract

The Northern Great Plains Inventory and Monitoring Network (NGPN) began monitoring water quality in the Niobrara River at Missouri National Recreational River in 2014, with the assistance of the U.S. Geological Survey (USGS). This report summarizes the data collected during the 2020 ice-free season (March 23 through October 22) for water temperature, dissolved oxygen, specific conductance, and pH. Streamflow is measured year-round. This was the third season of continuous monitoring.

2020 ended up being a very dry year with less than 50% of the yearly average precipitation. However, daily mean discharge peaked at 10,800 cubic feet per second (and maximum instantaneous discharge of 15,500 cfs) on June 9th, considerably lower than the record peak in 2019 of 123,000 cfs, which translated to above average streamflow. Water quality also was measured, including in 2014 which had a peak of 7,670 cfs and 2017 which had a peak of 4,910 cfs. There was considerable seasonal variation in all water quality measures. A summary of our results can be found in the Descriptive Statistics Summary tables for the ice-free season (Table 2) and for each month (Table 3). Water temperature exceeded states standards .23% of the time, while pH exceeded state standards 2.85% of the time.

Nebraska Department of Environment and Energy monitors *Escherichia coli* (*E. coli*) bacteria in the Niobrara River. *E. coli* can be a human health concern especially because the Niobrara's main draw is river recreation. Between 2014 and 2021, bacteria levels exceeded standards for moderately used recreational waters (298 cfu/100 mL) 24 % of the time in reach (NI2-10000) and the geomean

standard (126 cfu/100 mL) exceeded standards in 2020. The Niobrara River remains nonsupporting of its recreation use due to *E. coli*. There is an approved TMDL for *E. coli*, placing it in category 4a.

NGPN's collaboration with USGS supported real-time and archived access to this data through the USGS National Water Information System Website [Niobrara River Near Verdel, Nebr. - USGS Water Data for the Nation](#) where it remains available to the public.

List of Terms or Acronyms

>:	greater than
≥:	greater than or equal to
<:	less than
≤:	less than or equal to
#:	number
303(d) list:	List of Impaired Waters, under the CWA
cfs:	cubic feet per second
CWA:	Clean Water Act
°C:	degrees Celsius
DO:	dissolved oxygen
<i>E. coli</i> :	<i>Escherichia coli</i>
EPA:	Environmental Protection Agency
I&M:	Inventory & Monitoring
IRMA:	Integrated Resource Management Applications
km ² :	square kilometers
mi ² :	square miles
mL:	milliliters
MNRR:	Missouri National Recreational River
NAWQA:	National Water Quality Assessment (USGS)
NE:	Nebraska

NDEE:	Nebraska Department of Environment and Energy
NGPN:	Northern Great Plains Network
NPS:	National Park Service
NWIS:	National Water Information System (U.S. Geological Survey)
SC:	Specific conductance
SOP:	standard operating procedure
TNC:	The Nature Conservancy
WRSA:	Wild and Scenic Rivers Act
USEPA:	U.S. Environmental Protection Agency
USGS:	U.S. Geological Survey

Introduction

The Niobrara River flows for 535 miles from the high plains near Manville, Wyoming, eastward through northern Nebraska where it joins the Missouri River near the town of Niobrara, NE. The lower twenty miles of the Niobrara River were first designated as a national recreational river under the Wild and Scenic Rivers Act (WSRA) in 1978. The unit is now managed as part of MNRR (NPS 2017) in partnership with other agencies including the US Army Corps of Engineers, US Fish and Wildlife, Nebraska Game and Parks Commission, and the South Dakota Department of Game, Fish, and Parks. NPS land consists of 887 acres within a 48,456-acre area (NPS 2024). MNRR consists of two districts. The 39-mile district consists of the Missouri River upstream of Lewis and Clark Lake and runs from Fort Randall Dam, including the confluence with the Niobrara River to Running Water, SD. The 39-mile district includes 8 miles of lower Verdigris Creek and the lower 20 miles of Niobrara River. This district is dam-influenced. The 59-mile district begins just downstream of Gavins Point Dam to Ponca, NE. This district consists of a wide, meandering channel in free-flowing condition. Sandbar, forested floodplain, and floodplain wetland habitats are prevalent throughout the district (NPS 2017). The two districts, one of which includes the Niobrara River, are to be administered as recreational rivers.

MNRR has five significant park features. The first feature is the unique geology. In MNRR, two contrasting geologic landscapes: the Cretaceous bluffs and the glacial landscapes of the Pleistocene, are both visible. MNRR protects some of the last dynamic channel habitats in the Missouri River basin such as sandbars, islands, side channels, and riparian cottonwood forest. The park has a rich history of human use from prehistoric times to Fort Randall. The recreational opportunities are special, with river access points and land and water trails. The scenic views of the river valley and features are considered significant. Similarly, the fundamental resources and values and outstanding remarkable values (ORVs) have been identified: cultural values, ecological values, fish and wildlife

values, free-flowing condition and water quality values, geological values, recreational values, and scenic views. These values as the special characteristics a river possesses that warrant special protection under the WSRA. Each segment in MNRR can include some or all of the defined ORVs. The Niobrara River segment contains all the ORVs listed for MNRR (NPS 2012).

Cultural values include significance to local tribes, archeological sites, the Mormon monument, the Ponca Fort, and Fort Randall Historic Site. Ecological values include a dynamic channel and floodplain system, one that is rare due to dam infrastructure and impacts. Fish and wildlife values include 704 species of plants and 424 fish and wildlife species (NPS 2012). Ninety-three species of fish and 154 species of birds (NPS 2017) dwell in MNRR. 37 species of fish live on Segment 3, the Niobrara River (NPS 2017). Pallid sturgeon, shovelnose sturgeon, and blue suckers live in the lower Niobrara River. Federally listed least terns and piping plovers call MNRR's sandbars home. The lower Niobrara also sustains the false map turtle. The park is an important refuge for reptiles and amphibians. Invasive species such as purple loosestrife and zebra mussels threaten terrestrial and aquatic habitats. Dam activity threatens wildlife habitat. Geologic values in the Niobrara River segment include the physical features: Pierre shale outcrops, sandbars, islands, braided channels, and backwaters which are part of the Niobrara River channel. Paddling and wildlife watching are some of the recreational opportunities that the Niobrara segment offers. Scenic views of the isolated valley contribute to the scenic ORV. Free-flowing condition and water quality values include the unique dynamic channel habitat which enables recreational opportunities and freely migrates within the floodplain. Minimal bank stabilization exists on the Niobrara River, three bridges cross this segment, and irrigation withdrawals occur (NPS 2012).

MNRR has hot, humid summers and winters ranging from mild to very cold (Stark 2011). Knox County Nebraska's 1991-2020 mean July temperature is 74.4° F. The mean January temperature is 21.5° F, and the county receives on average 37.37 inches of precipitation (1991-2020, NCEI 2024). Year-to-year precipitation can be highly variable (Stark 2011). In 2020, Knox County received 19.56 inches of precipitation, slightly below the 30-year average, following record precipitation in 2019 (32.94 inches). Average temperature for the year in 2020 was 49.6°F, well above the 30-year mean of 48.5°F and 100-year mean of 48.0°F (1900-2000), making 2020 a drier and warmer year on average.

The Niobrara River has primary contact recreation, aquatic life, agricultural, and aesthetic beneficial uses. The Niobrara River within MNRR is designated as a Nebraska warmwater Class A stream for aquatic life. Warmwater class waters are those which provide, or could provide, a habitat consisting of sufficient water volume or flow, water quality, and other characteristics such as substrate composition which can maintain year-round populations of warmwater biota. Class A waters are those that provide, or could provide, a habitat suitable for maintaining one or more identified key species on a year-round basis. These waters also can maintain year-round populations of a variety of other warmwater fish and associated vertebrate and invertebrate organisms and plants. These differ from class B warmwater criteria where warmwater biota is limited by flow, water quality, substrate composition, or other habitat conditions (NDEE 2019). Warmwater biota are life forms in waters where temperatures frequently exceed 25°C (77°F). The Niobrara is also designated a state resource water. Designation as state resource waters (Class A) means that the Niobrara River through MNRR

(NI2-10000) is an outstanding state or national resource which includes wild and scenic rivers and should be protected from degradation. Under the Wild and Scenic Rivers Act, the state resource water designation applies from Western Knox County to the mouth at the Missouri. The existing quality of these surface waters must be protected (NDEE 2019).



Figure 1. Map of Missouri National Recreation River, western portion. The water quality impairments for streams in the vicinity are color-coded. Blue indicates the river is meeting state standards. The lower section of the Niobrara River (NI2-10000) is impaired for *E. coli*, but has an approved TMDL. The water quality monitoring station, 06465500, and the weather station at Yankton are also indicated.

Figure #1. Map of Missouri National Recreation River, including the lower portion of the Niobrara River, NI2-10000.

“Figure 1. Map of streams in MNRR vicinity including the Niobrara River. Impaired reaches are labeled by color including Niobrara River which is impaired for *E. coli* bacteria.”

While the Northern Great Plains Inventory & Monitoring Network (NGPN) does not collect *E. coli* data, it is important to summarize some of the data available, as *E. coli* is a pollutant of concern. *E. coli* bacteria impairments are present in the lower reaches of the Niobrara River in MNRR. Primary contact waters should not exceed a geometric mean of 126 cfu/ 100 mL or 298 cfu/100 mL for moderately used recreational waters. There are not a lot of geomean data because sampling has usually been performed monthly. A geomean requires that five samples be taken within a 30-day calendar period.

Four monthly geomeans were collected by NDEE in the lower Niobrara Reach, NI2-10000 at Verdel in 2020, three of which violated standards. Given that only one geomean violating would result in an impairment, this reach is clearly impaired. Twenty-three out of 95 samples at that location since 2014 exceeded the single sample maximum of 298 cfu/100 mL. Data are publicly available from water quality portal, [Water Quality Data Home](#). There is an approved TMDL in place to address the pollution. Summaries for the Niobrara River at MNRR are available [How's My Waterway - Waterbody Report \(epa.gov\)](#).

NGPN began monitoring water quality at MNRR in 2014 to better understand current conditions and changes over time in the Niobrara River. The monitoring has been conducted at the gaging station at near Verdel, NE (Monitoring Location 06465500; Figure 2) in collaboration with the USGS. The objective is to determine the status and long-term trends of core water quality parameters during the ice-free season. NGPN plans to repeat water quality monitoring at MNRR every three years, and an in-depth analysis of status and trends will be conducted after three to five cycles of sampling (Wilson, et al. 2014).

NGPN's core water quality parameters include: streamflow, dissolved oxygen (DO), pH, specific conductivity, and water temperature (Table 1; Wilson, et al. 2014). These parameters are measured every 15 minutes throughout the ice-free season (typically March to November), and results are made available in real-time on the USGS National Water Information System website.

Table 1. Water quality parameters measured as part of the Northern Great Plains Inventory & Monitoring Water Quality Program and associated state standards for Nebraska warmwater class A waters (NDEE 2019).

Table #1: Water quality parameters measured as part of the Northern Great Plains Inventory & Monitoring Water Quality Program and associated state standards for Nebraska warmwater class A waters (NDEE 2019).

Water Quality Parameter	Description	NE state standards applicable to warm water fisheries designations
Water temperature (°C)	Water temperature is affected by solar radiation, air temperature, rainfall, flow dynamics, stream shading, in-stream bed material, reflectance, and land use/cover in the watershed.	- For warm waters, the maximum limit is 32°C. - The maximum increase shall not be greater than five degrees Fahrenheit (3°C) above natural background conditions.
Dissolved Oxygen (mg/L)	Dissolved oxygen level is a measure of the amount of oxygen in the water column and an important indicator of a water body's ability to support aquatic life.	- One day minimum of not less than 5 mg/L for early life stages. Applies April 1 through September 30. - One day minimum of not less than 3 mg/L for all life stages other than early life stages. Applies October 1 through March 31. - Seven-day mean minimum of not less than 4.0 mg/L. Applies October 1 through March 31. - Seven-day mean of not less than 6.0 mg/L for early-life stages. Applies April 1 through September 30. - Thirty-day mean of not less than 5.5 mg/L. Applies October 1 through March 31.
Specific Conductance (µS/cm)	Specific conductivity is a measure of the water's ability to conduct electricity. Specific conductivity is typically proportional to the dissolved major ions in the water such as calcium, magnesium, sodium, and sulfate.	Agricultural use dictates conductivity cannot exceed 2000 umhos/cm (µS/cm) between April 1 and September 30.
pH	The pH of the stream is a measure of the hydrogen ion concentration in the water. Different organisms flourish within different ranges of pH.	PH is to be maintained between 6.5 – 9.0, unless due to natural conditions.

Methods

The NGPN Water Quality Monitoring Protocol (Wilson, et al. 2014) sets out the methods used for sampling water quality and streamflow. The general approach is briefly described below. For more detail, please see Wilson, et al. 2014 (available at <https://www.nps.gov/im/ngpn/water-quality.htm>).

Data Collection

Water quality data are collected at a real-time USGS stream gage (ID number 06465500) inside the park at Verdel, NE at approximately 1,312 ft elevation. Water quality is measured every fifteen minutes throughout the ice-free season. Water quality monitoring at MNRR was conducted in 2014, 2017, and 2020; and will continue to be repeated every three years. Program funding currently limits monitoring to a cycle of one year of monitoring, followed by two years without monitoring. Streamflow is monitored every 15 minutes, continuously every year, and has been monitored since 1945.

In 2020, NGPN continued to partner with the USGS Nebraska Water Science Center to have USGS staff collect water quality and streamflow data at MNRR. The USGS deployed a continuous, multi-parameter sonde off the Pischelville Bridge, station 06465500 on March 23, 2020 (Figure 2) and visited the gaging station (Figure 3) every three to four weeks for equipment maintenance (Table 2). This instrument recorded dissolved oxygen, pH, specific conductivity, and water temperature every fifteen minutes, while the gage simultaneously measured stream stage (or gage height) and discharge, a measure of streamflow.



Figure 2. A sonde device is used to measure water quality on the Niobrara River in 2020 at Missouri National Recreational River. This sonde is full of sediment.

Figure #2. Water quality sonde used to monitor the Niobrara River at MNRR during 2020 with sediment lodged inside prior to cleaning.

“Figure 2. Water quality sonde with sediment inside the casing.”



Figure 3. A sonde device is used to measure water quality at 06405500 in a cross-section of the Niobrara River and the radar head for the gage is attached to the bridge.

Figure #3. A sonde device is used to measure water quality at 06465500 in a cross-section of the Niobrara River and the radar head for gage is attached to bridge.

“Figure 3. A sonde device is used to measure water quality at 06465500 and radar head for gage is shown attached to bridge.”

Table 2. Field journal for 2020 Water Quality Sampling at Missouri National Recreational River.

Table #2: Field journal for 2020 Water Quality Sampling at Missouri National Recreational River.

Date	Notes
23-Mar-20	Installed water quality (WQ) monitor. Completed cross-section.
8-Apr-20	Sonde was buried 4/3-4/4, data removed. Field inspection and fouling check.
30-Apr-20	Field inspection and fouling check. Cross-section.
9-Jun-20	Sonde was buried 6/6/- 6/9, data removed. Field inspection and fouling check. Cross-section.
10-Jun-23	Field inspection and fouling check.
15-Jun-20	Field inspection and fouling check. Cross-section.
23-Jun-20	Sonde was buried 6/19-6/23, data removed. Field inspection and fouling check.
30-Jun-20	Field inspection and fouling check.
2-Jul-20	Field inspection and fouling check.
18-Aug-20	Unexplained drop in data on 7/23, data removed. Field inspection and fouling check.
15-Sep-20	Unexplained drop in data 9/12-9/15, data removed. Field inspection and fouling check. Cross-section
14-Oct-20	Field inspection and fouling check.
22-Oct-20	Field inspection and fouling check. Cross-section. Sonde removed for season.

The field journal in Table 2 recounts 13 visits made to the site during the 2020 monitoring season. Monitoring was difficult due to the shifting sandbars and variable conditions. See further details in the station analysis in Appendix A. 92% of the temperature measurements were published and the record was rated ‘good’. Only 56% of the specific conductance measurements were published and that record was rated ‘poor’. 81% of pH measurements are published and the record is rated ‘good’. 74% of dissolved oxygen records were published and were rated ‘good’.

Satellite telemetry transmitted the water data to the Water Science Center in near real-time (<https://waterdata.usgs.gov/monitoring-location/06465500/>). The USGS staff reviewed the real-time data daily to verify the accurate transfer of provisional field data and to identify sensor malfunctions or erroneous data. Access to the real-time data allowed them to recognize problems due to recording equipment malfunction, sedimentation, electrical disruption, debris, or vandalism. If disruptions occurred, the USGS staff scheduled additional site visits to minimize the loss of data.

During each site visit, USGS staff conducted a site inspection and a side-by-side comparison with the in-the-water sonde and an independent field sonde. They serviced and calibrated the sensors as needed, if possible. Calibration included pre- and post-calibration checks to quantify fouling errors and equipment drift, which are data critical to the correction and grading of the final data.

Quality assurance and quality control were conducted by USGS staff following established USGS guidelines (Wagner, et al. 2006). NGPN received the final corrected (approved) data in December of 2021 from the USGS, and used AQUARIUS Workstation by Aquatic Informatics

(<http://aquaticinformatics.com/>) and R (R Core Team 2023) to store and analyze the water data. Water year reports are provided by USGS, and the text can be found in Appendix A. Figures were generated in R, and daily mean values were calculated from fifteen-minute interval data. In the case where data values were missing due to instrument error, the means were generated by excluding the missing values; the daily maximum and minimum were left blank for these days. Means were not calculated on days where all time steps were missing (i.e., the instrument did not collect any data that day). The proportion of records that exceeded Nebraska environmental regulatory thresholds were calculated and are shown in Table 1.

Climate data were downloaded from the RAWs Yankton Climate Station (#399502). The data were accessed and graphed using the web-based tool [Climate Analyzer](#).

Results

The water quality monitoring season (ice-free) on the Niobrara River lasted from March 23, 2020 to October 22, 2020. The discharge of the Niobrara River was higher in spring and lower through the rest of the year. Discharge peaked at 15,500 cfs on June 9, 2020 and slowly decreased throughout the growing season (Figure 4). Eventually in November, the discharge picked up slightly. Mean discharge was 3080 cfs and the minimum discharge occurred on September 14, 2020 with a recorded value of 1,150 cfs.

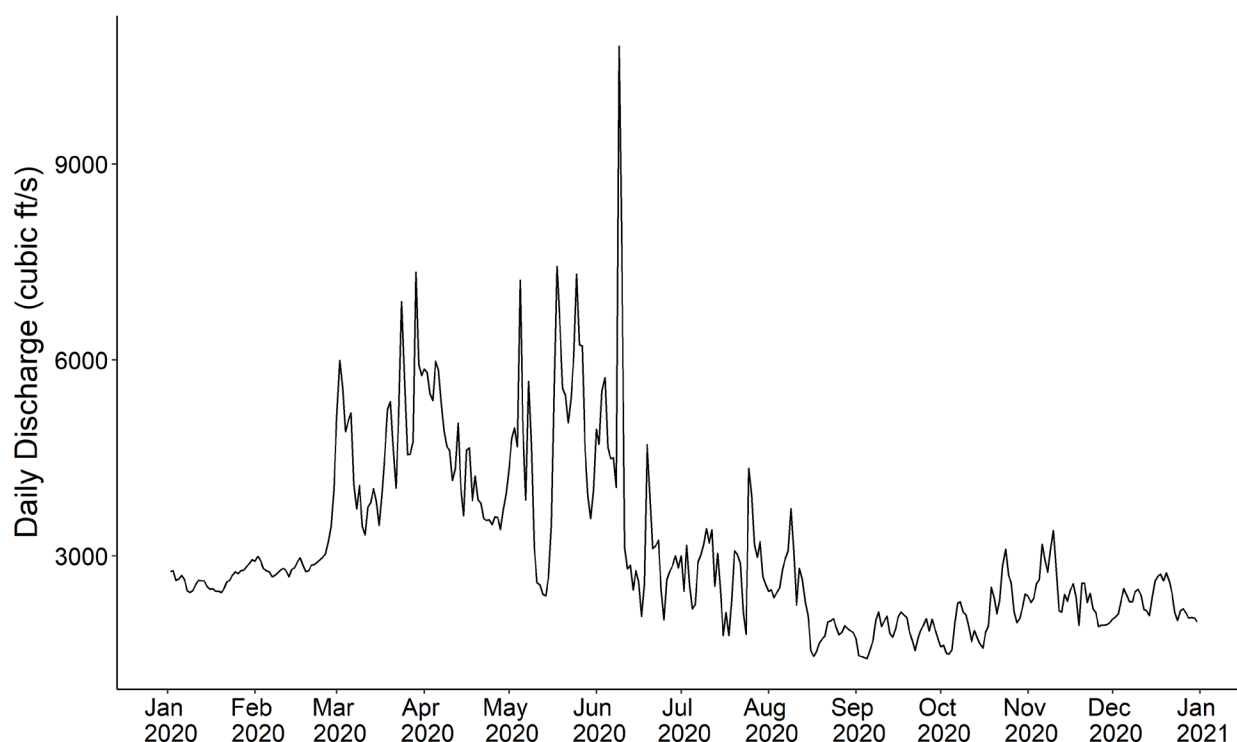


Figure 4. Daily mean discharge (black line) in 2020 on the Niobrara River at Missouri National Recreational River, USGS Gaging station 06465500.

Figure #4. Daily mean discharge (black line) in 2020 on the Niobrara River at Missouri National Recreational River, USGS Gaging station 06465500.

“Figure 4. Daily mean discharge (black line) in 2020 on the Niobrara River at Missouri National Recreational River, USGS Gaging station 06465500.”

Figures 5 and 6 show some of the 2020 weather data from the Yankton weather station available here: [Yankton \(climateanalyzer.us\)](https://climateanalyzer.us). Figure 5 focuses on monthly precipitation, minimum and maximum temperatures. Figure 6 depicts departures from the 1991-2020 averages. Overall 2020 was a warmer-than average year except for May and September. It was also a drier than average year, receiving only about 50% of average precipitation.

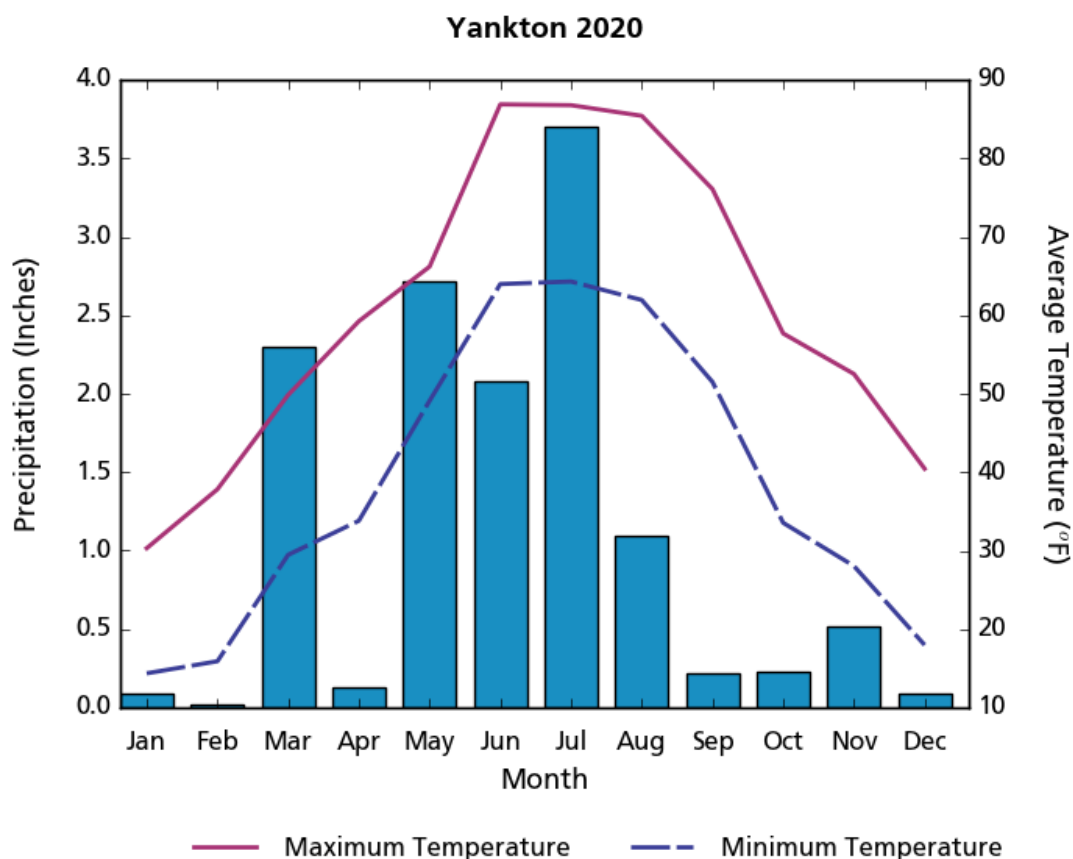


Figure 5. The above graph shows the total monthly precipitation (blue bars), average monthly minimum temperature (dashed blue line) and average monthly maximum temperature (solid red line) for the 2020 calendar year at Missouri National Recreational River. Climate data are from Yankton RAWS climate station (climateanalyzer.us). The data were accessed and graphed using the web-based tool Climate Analyzer.

Figure 5. Total monthly precipitation, average monthly minimum temperature, and average monthly maximum temperature for the 2020 calendar year at Missouri National Recreational River.

“Figure 5. Bar graph showing total monthly precipitation. Line graphs show average monthly minimum temperature, and average monthly maximum temperature for the 2020 calendar year at Missouri National Recreational River. “

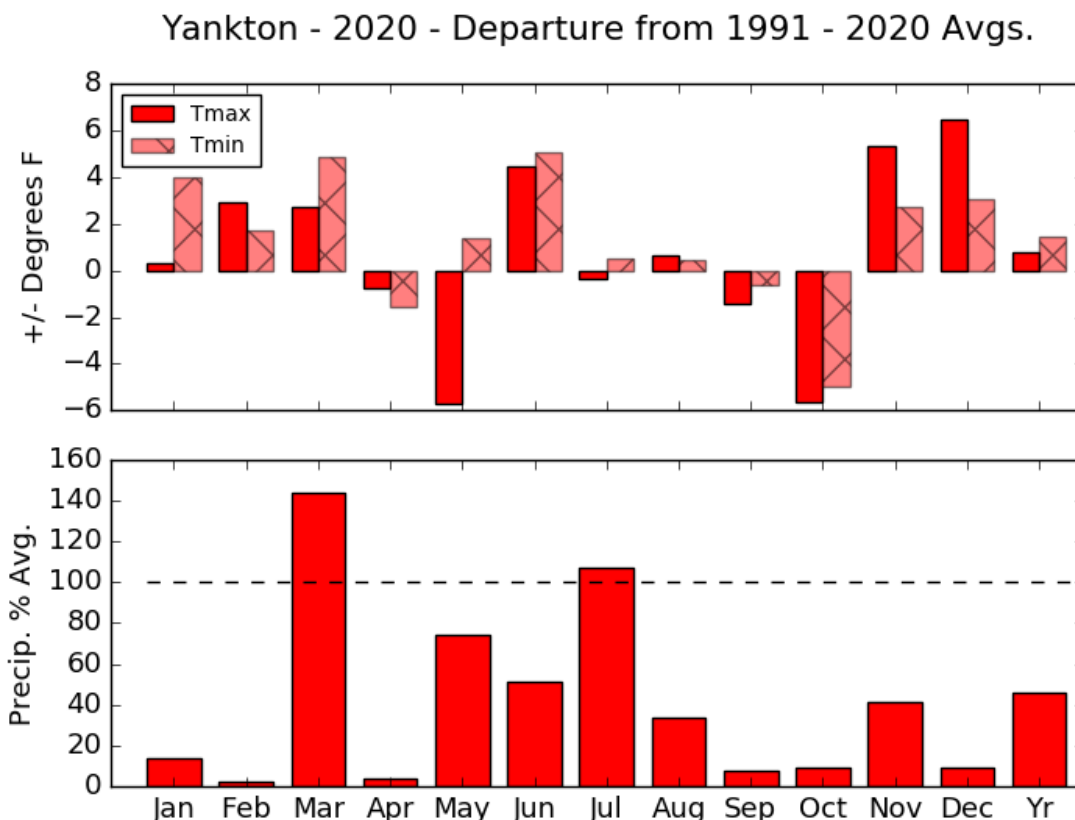


Figure 6. A comparison of 2020 temperature (top) and precipitation (bottom) at Missouri National Recreational River compared to 1991-2020 averages. Climate data are from Yankton RAWS climate station. The data were accessed and graphed using the web-based tool [Yankton \(climateanalyzer.us\)](https://yankton.climateanalyzer.us).

Figure #6. Total monthly precipitation, average monthly minimum temperature, and average monthly maximum temperature departures for the 2020 calendar year as compared to 1991-2020 averages at Missouri National Recreational River.

“Figure 6. Bar graph showing the departure from normal of Tmin (minimum temperature) and Tmax (maximum temperature) for each month in 2020. May and September were much below average while July, October, and November were much above average. Overall the year was slightly above average for temperature. Bottom graph shows the total monthly precipitation. March had above average rainfall, while Jan, Feb, Apr, August, September, October, and December were much below average. Overall the year showed about half the average rainfall.”

During the ice-free season at MNRR, over 20,000 water quality measurements in the Niobrara River were collected, although some sensors on the multi-parameter sonde experienced errors and data were not recorded (Table 3). This monitoring period had a mean water temperature of 17.93°C, a

mean dissolved oxygen concentration of 9.33 mg/L, a mean specific conductance of 325 $\mu\text{S}/\text{cm}$, and a mean pH of 8.55 (Table 3). There was, however, variation across months in all parameters (Table 4). Mean water temperature in April was 11°C and increased to a mean of 26.95 °C in July before declining down to 12.71°C in October (Table 4, Figure 7). Dissolved oxygen fell below the Nebraska water quality standard of 5 mg/L .23% of the time with 48 observations in the summer months (Table 4). PH exceeded state standards 2.85% of the time, with exceedances falling between July and October.

Table 3. Summary of descriptive statistics for water temperature, dissolved oxygen, specific conductance, and pH measured for the ice-free sampling period at Missouri National Recreational River in the Niobrara River from March 23 to October 22, 2020. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 32°C; dissolved oxygen ≥ 5.0 mg/L; conductivity is <2000 $\mu\text{S}/\text{cm}$ and pH range is >6.5 or <9.0).

Table #3. Summary of descriptive statistics for water temperature, dissolved oxygen, specific conductance, and pH measured for the ice-free sampling period at Missouri National Recreational River in the Niobrara River from March 23 to October 22, 2020.

Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance ($\mu\text{S}/\text{cm}$)	pH
Mean	17.93	9.33	325.05	8.55
Standard Deviation	8.49	1.26	53.28	0.25
Median	18.6	9.4	313	8.4
Minimum	0	6.6	211	7.9
Maximum	33.1	13.2	473	9.2
Number of Points	20615	16775	14439	17572
Number of Points below or Above Standard	48	0	0	501
Percent Exceedance	0.23%	0%	0%	2.85%

Table 4. Summary of monthly descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Missouri National Recreational River in the Niobrara River from March 23 to October 22, 2020. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 32°C; dissolved oxygen ≥ 5.0 mg/L; conductivity is <2000 $\mu\text{S}/\text{cm}$ and pH range is >6.5 or <9.0).

Table #4. Summary of monthly descriptive statistics for water temperature, dissolved oxygen, specific conductance, and pH measured for the ice-free sampling period at Missouri National Recreational River in the Niobrara River from March 23 to October 22, 2020.

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	pH
March 22- March 31, 2020	Number of measurements	809	809	805	420
	Mean	9.27	10.9	380.47	8.3
	Standard Deviation	2.15	0.51	13.88	0.13
	Median	8.9	11	375	8.2
	Minimum	4.8	9.5	356	8.2
	Maximum	15.5	12	415	8.7
	% Exceedance	0.00%	0.00%	0.00%	0.00%
April, 2020	Number of measurements	2,791	2,686	1,495	2,265
	Mean	11.33	10.47	375.22	8.4
	Standard Deviation	4.42	1.07	10.59	0.04
	Median	11.6	10.3	375	8.4
	Minimum	1.7	8.6	346	8.2
	Maximum	21.4	13.2	390	8.5
	% Exceedance	0.00%	0.00%	0.00%	0.00%
May, 2020	Number of measurements	2,976	2,973	2,835	2,976
	Mean	15.74	9.39	248.99	8.4
	Standard Deviation	3.65	0.81	4.15	0.1
	Median	16.1	9.4	248	8.4
	Minimum	8.4	7.4	237	8.2
	Maximum	24.5	11.2	259	8.7
	% Exceedance	0.00%	0.00%	0.00%	0.00%
June, 2020	Number of measurements	2,265	1,606	1,385	2,371
	Mean	24.56	8.34	364.6	8.59
	Standard Deviation	3.45	0.59	22.8	0.26
	Median	24.8	8.3	370	8.6
	Minimum	14.6	6.8	278	8.1
	Maximum	32.1	10	466	9.2
	% Exceedance	0.13%	0.00%	0.00%	4.34%
July, 2020	Number of measurements	2,945	1,788	1,819	2,388
	Mean	26.95	8.27	307.97	8.72
	Standard Deviation	2.72	1.01	16.18	0.23

	Median	26.9	8	311	8.7
	Minimum	21.1	6.6	211	7.9
	Maximum	33.1	10.5	332	9.1
	% Exceedance	1.02%	0.00%	0.00%	4.56%
August, 2020	Number of measurements	2,974	2,904	2,644	2,912
	Mean	25.91	8.5	277	8.87
	Standard Deviation	2.9	1.1	28.81	0.13
	Median	25.8	8.3	280	8.9
	Minimum	18.4	6.7	226	8.6
	Maximum	32.6	10.6	335	9.2
	% Exceedance	0.50%	0.00%	0.00%	9.20%
September, 2020	Number of measurements	2,565	2,535	2,272	2,565
	Mean	18.32	9.27	271.56	8.49
	Standard Deviation	4.05	0.79	11.53	0.22
	Median	18.4	9.3	274	8.4
	Minimum	9.8	7.6	238	8.2
	Maximum	27.8	11.1	295	9.1
	% Exceedance	0.00%	0.00%	0.00%	0.43%
October 1-22, 2020	Number of measurements	1,816	1,812	1474	1,818
	Mean	12.71	10.17	283.28	8.37
	Standard Deviation	3.77	0.88	2.27	0.16
	Median	12.8	10	283	8.4
	Minimum	5.2	8.5	279	8.1
	Maximum	21.2	12.2	291	9.1
	% Exceedance	0.00%	0.00%	0.00%	0.55%

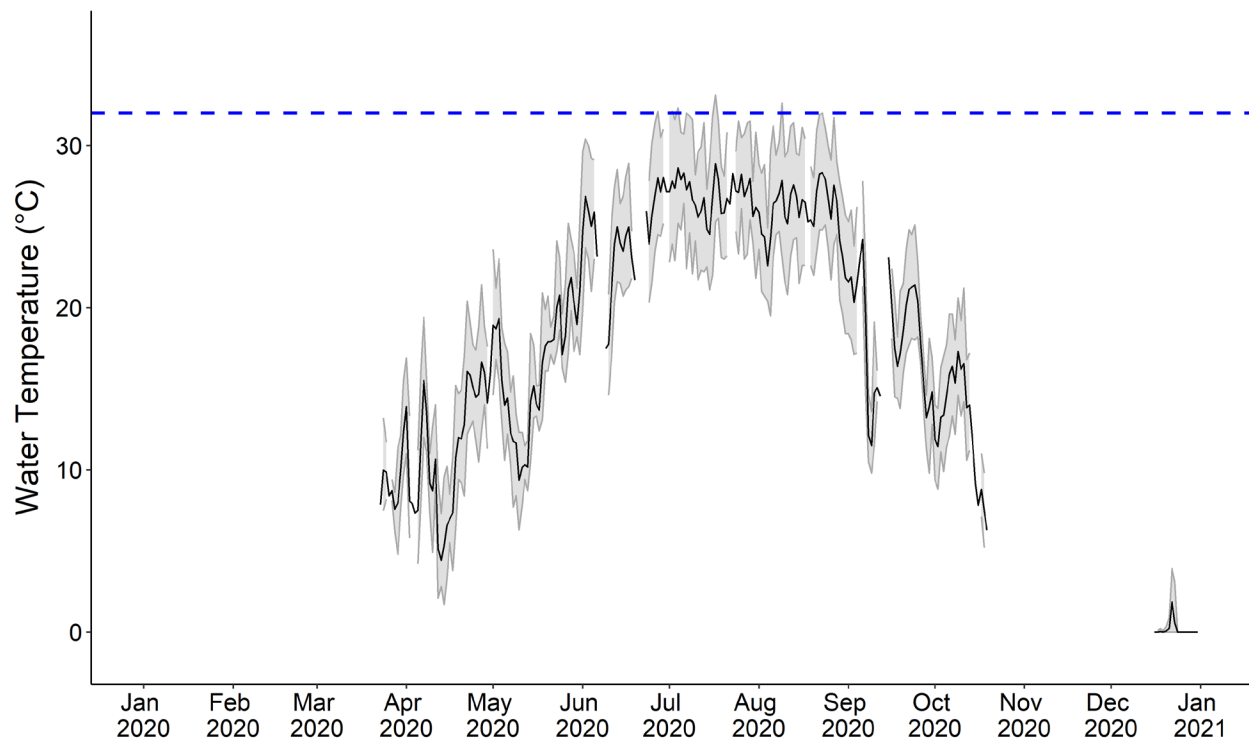


Figure 7. Daily mean water temperature (black line) collected on the Niobrara River at Missouri National Recreational River in 2020. The sonde was in the water and recording data from March 22 through October 22, 2020. The gray ribbon shows the daily maximum and minimum water temperature for the same period. The dashed blue line indicates one of the Nebraska state water quality standards (see Table 1 for more details). The periods where the instrument did not collect data are indicated by gaps in the record.

Figure #7. Daily mean water temperature (black line) in 2020 on the Niobrara River at Missouri National Recreational River, USGS Gaging station 06465500.

“Figure 7. Daily mean water temperature (black line) in 2020 on the Niobrara River at Missouri National Recreational River, USGS Gaging station 06465500.”

Temperature displayed seasonal variation (Table 3, Figure 7). The highest mean temperatures were in the summer, averaging greater than 20°C in June, July, and August. Temperature strayed above state standards as the maximum temperature, 33.1°C, was above the state standard of 32°C and the total exceedance rate for the year was .23%.

Dissolved oxygen also displayed seasonal variation (Table 3, Figure 8). The highest mean dissolved oxygen concentrations were in the spring and fall, averaging greater than 9 mg/L in March, April, May, September, and October. Dissolved oxygen stayed below the state water quality criterion of 5 mg/L during 2020 (Table 1). 16,775 dissolved oxygen measurements were taken in 2020.

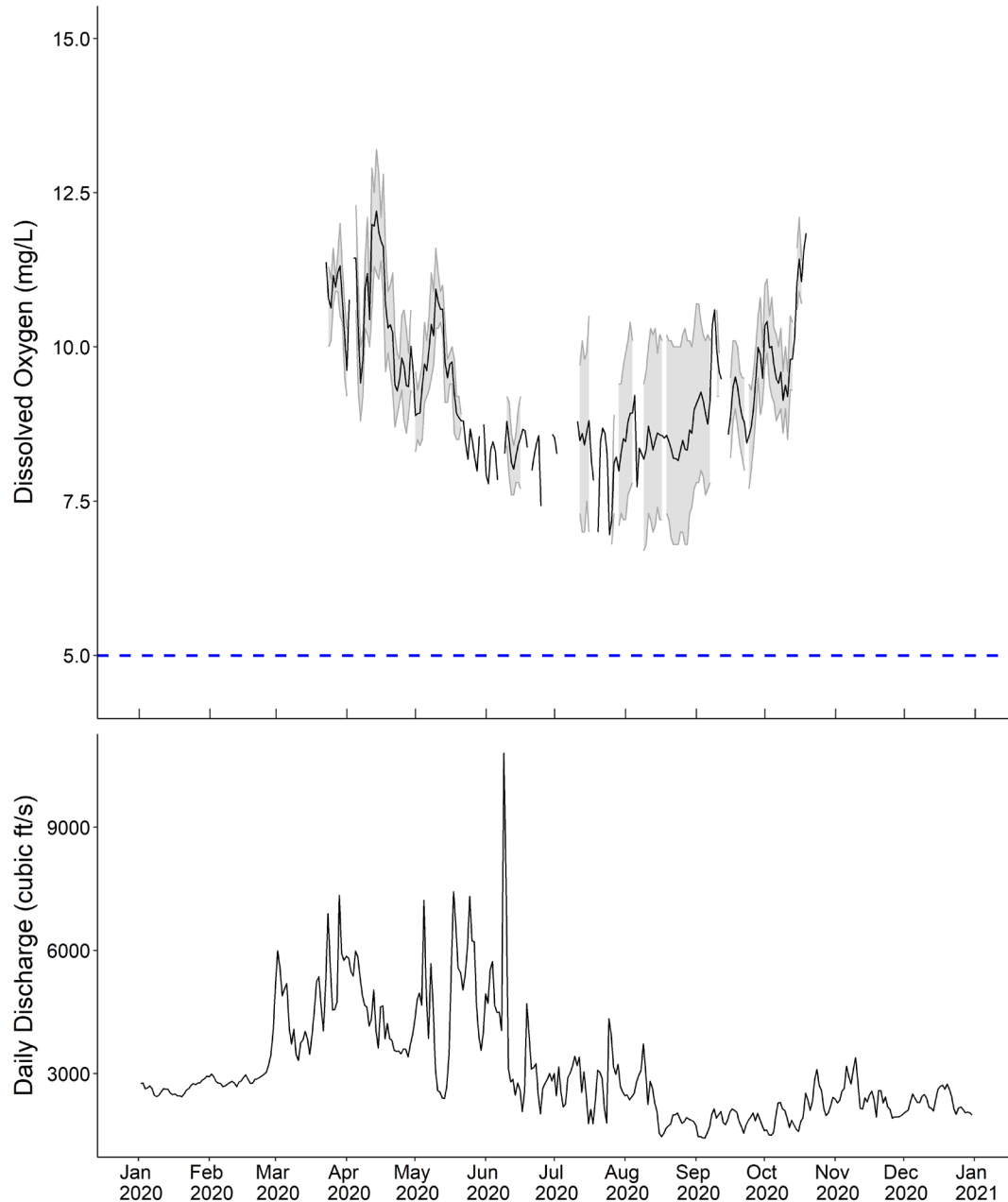


Figure 8. Daily mean dissolved oxygen concentrations (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River. Measurements were taken from March 22 through October 22, 2020. The gray ribbon shows the daily maximum and minimum dissolved oxygen for the same period. The dashed blue line indicates one of the Nebraska state water quality standards (see Table 1 for more details). The periods where the instrument did not collect data are indicated by gaps in the record.

Figure #8. Daily mean dissolved oxygen concentrations (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River.

“Figure 8. Daily mean dissolved oxygen concentrations (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River.”

Specific conductance of the Niobrara River (Table 3, Figure 9) showed a less predictable seasonal pattern than temperature or dissolved oxygen concentrations. Values were fairly low for the Northern Great Plains. Values above 2,000 $\mu\text{S}/\text{cm}$ are generally considered high though conductivity is very dependent on local geology and soil properties (Wilson, et al. 2014). The 2020 median specific conductance was 313 $\mu\text{S}/\text{cm}$, and ranged from 211–473 $\mu\text{S}/\text{cm}$. The pH of the Niobrara River ranged between 7.9 and 9.2 (Figure 10) rose above the Nebraska state standard of 6.5 – 9.0, 2.85% of the time.

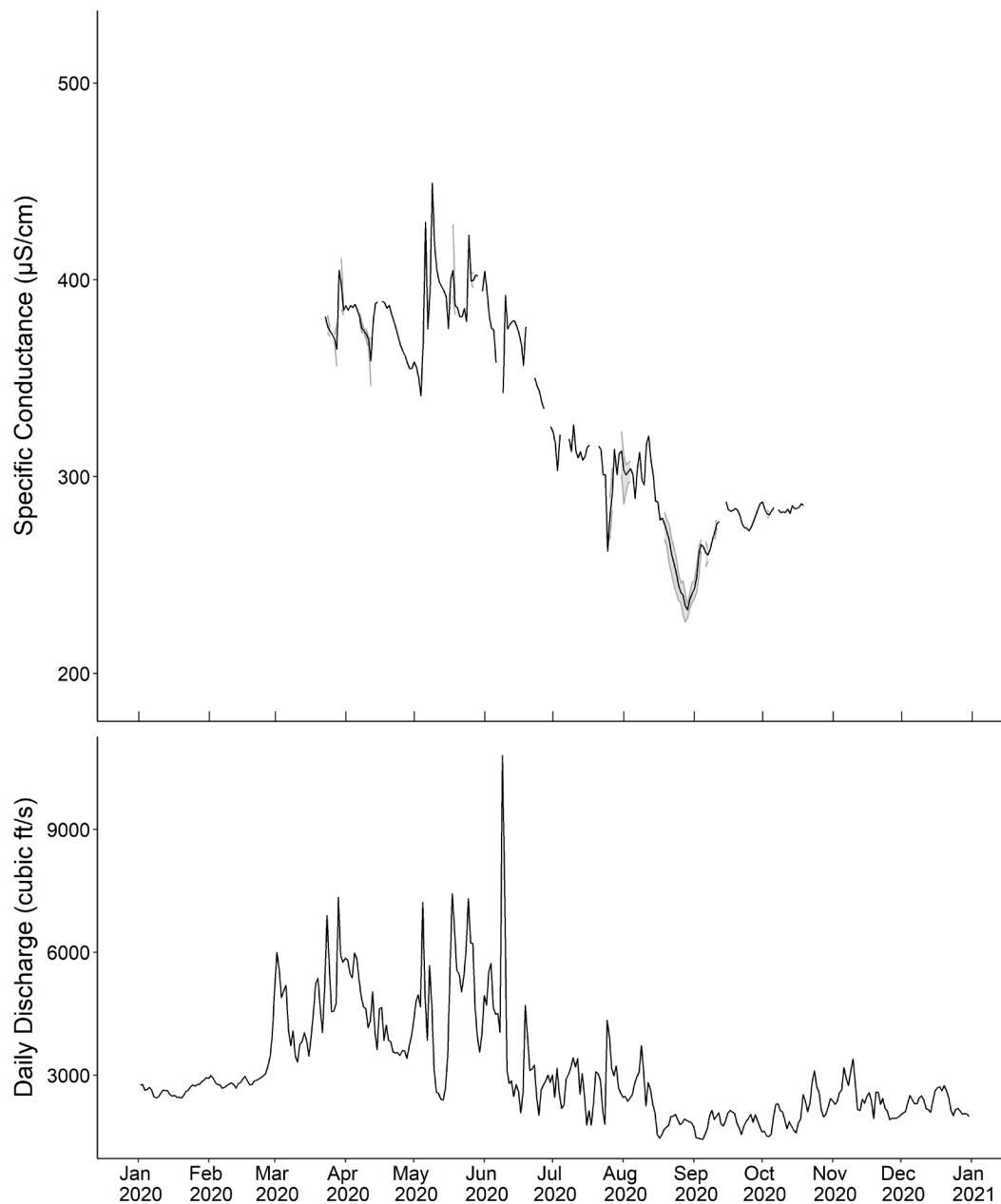


Figure 9. Daily mean specific conductance concentrations (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River. Measurements were taken from March 22 through October 22, 2020. The gray ribbon shows the daily maximum and minimum specific conductance

for the same period. The dashed blue line indicates one of the Nebraska state water quality standards (see Table 1 for more details). The periods where the instrument did not collect data are indicated by gaps in the record.

Figure #9. Daily mean specific conductance concentrations (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River.

“Figure 9. Daily mean specific conductance concentrations (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River.”

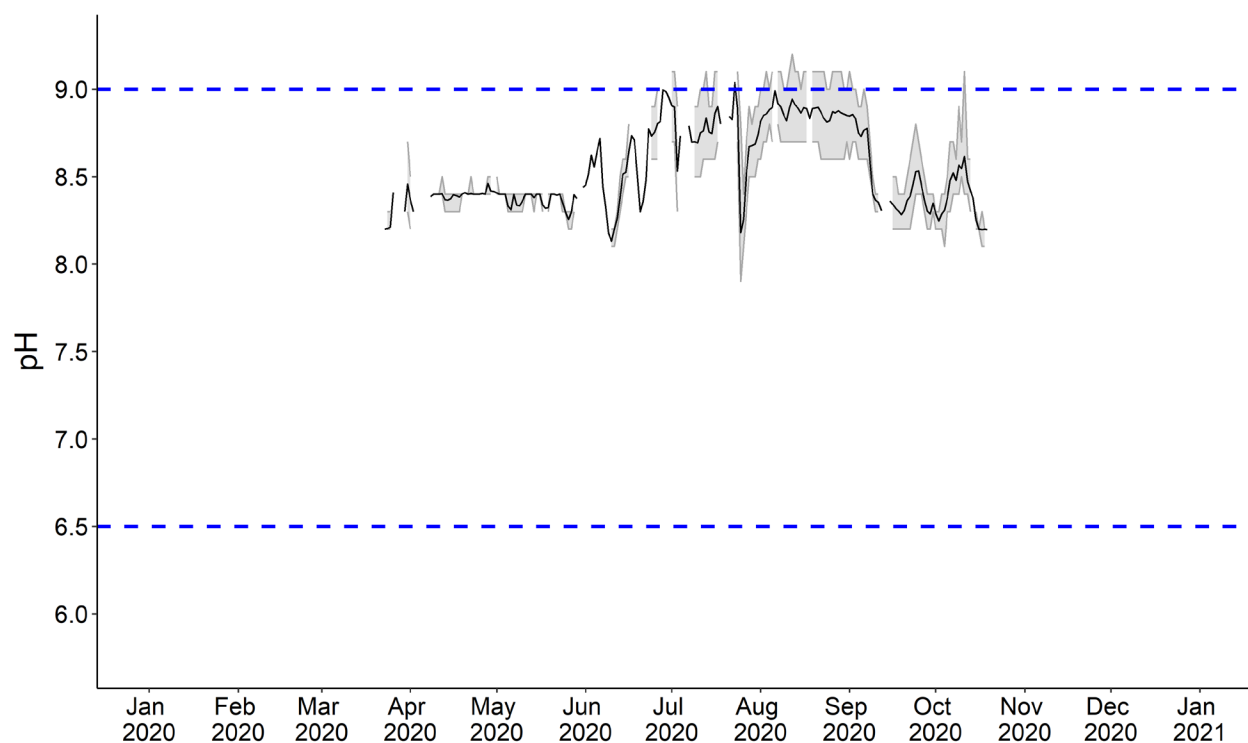


Figure 10. Daily mean pH levels (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River. Measurements were taken from March 22 through October 22, 2020. The gray ribbon shows the daily maximum and minimum pH for the same period. The dashed blue line indicates one of the Nebraska state water quality standards (see Table 1 for more details). The periods where the instrument did not collect data are indicated by gaps in the record.

Figure #10. Daily mean pH (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River.

“Figure 10. Daily mean pH (top) and daily discharge (bottom) of the Niobrara River in 2020 at Missouri National Recreational River.”

Further Analysis

This report is intended to provide a basic review of the data collected during the 2020 water quality monitoring season at Niobrara National Scenic River. All data included in this report is available upon request from the [Northern Great Plains Inventory and Monitoring Network](#), as well as in the archives found on the USGS National Water Information System, [USGS 06465500 Niobrara River near Verdel, Nebr.](#)

References

- Nebraska Department of Environmental Quality. 2020. 2020 Nebraska Surface Water Quality Integrated Report. NDEQ. <http://deq.ne.gov/NDEQProg.nsf/OnWeb/TMDL>
- Nebraska Department of Environmental Quality. 2022. 2022 Nebraska Surface Water Quality Integrated Report. NDEQ. [NDEE Publications \(ne.gov\)](#)
- National Park Service. 2012. Outstanding Remarkable Values: Missouri National Recreational River, Nebraska and South Dakota. [values.pdf \(npshistory.com\)](#)
- National Park Service. 2017. Foundation document: Missouri National Recreational River, Nebraska and South Dakota. [MNRR_FD_PRINT.indd \(npshistory.com\)](#)
- National Park Service. 2024. [National Park Service Land Acreage Reports. AcreageReports - Land and Water Conservation Fund \(U.S. National Park Service\) \(nps.gov\)](#)
- National Centers for Environmental Information. 2023. [County Time Series | Climate at a Glance | National Centers for Environmental Information \(NCEI\) \(noaa.gov\)](#)
- R Core Team. 2023. R: A language and environment for statistical computing. version 4.3.0. <http://www.R-project.org>. Vienna, Austria.
- Rust JD. 2006. Establishing baseline data for aquatic resources in national parks of the Northern Great Plains Network.
- Stark, K.J., L.J. Danzinger, M.R. Komp, A.J. Nadeau, S. Amberg, E. Iverson, D. Kadlec, and B. Drazkowski. 2011. Missouri National Recreational River: Natural Resource Condition Assessment. Natural Resource Report NPS/XXXX/NRR—20XX/XXX. National Park Service, Fort Collins, Color
- US EPA, How's My Waterway. 2024. [How's My Waterway - Waterbody Report \(epa.gov\)](#) Accessed January 17, 2024.
- US EPA. Water Quality Portal. 2024. [Water Quality Data Home](#). Accessed January 17, 2024.
- US Geological Survey. National Water Information System (NWIS). 2024. [USGS 06465500 Niobrara River near Verdel, Nebr.](#) Accessed January 25, 2024. .

Wilson, M. H., B. L. Rowe, R. A. Gitzen, S. K. Wilson, and K. J. Paintner-Green. 2014. Water quality monitoring protocol for Wadeable streams and rivers in the Northern Great Network: Narrative version 1.0. Natural Resources Report NPS/NGPN/NRR—2014/868 National Park Service, Fort Collins, Colorado.

Appendix A. USGS Water Data Quality Findings and Station Analysis for Niobrara River, Verdel NE 06465500, 2020.

Continuous water quality monitoring on the Niobrara River at Verdel, NE. The Niobrara River at the Pischelville Bridge near Verdel, NE had its water quality monitored during 2020. Water quality parameters were monitored on a continuous basis in a study performed at the USGS Niobrara River Verdel gage (06465500) on the Missouri National Recreation River. This monitoring was done in cooperation with the National Park Service I&M office out of Rapid City, SD. This was done to assess the current status and long-term trends of water quality on the Niobrara River near the Missouri River. This monitoring effort is identical to work performed in 2014, 2017, and planned work for 2023.

The site was operated out of the USGS Nebraska office and visits were coordinated with the National Park Service's Missouri National Recreation River office. All water quality collected data for 2020, as well as prior year's water quality and stream data are available online. This includes any metadata and daily values, including stage and discharge data that dates back to 1990. All data for this site can be retrieved at: https://waterdata.usgs.gov/nwis/uv?site_no=06465500 The water quality monitor used for this site was an YSI-Exo multi-parameter sonde with four parameter capability of Specific Conductance, Dissolved Oxygen, pH and water temperature. Data were collected every 15 minutes and reported hourly online. Data were collected during the deployed period of March 23rd, 2020 to October 22nd, 2020.

13 field inspections were made during the nine-month deployment. At each of the 13 inspections fouling-checks were made, and as needed instrument-drift checks were made. Fouling and calibration checks were made by cleaning the sonde and checking it to a reference field meter or standards. If a fouling or calibration correction was needed, the correction was prorated from last inspection. Corrections were compiled using Aquarius.

After the March 2019 flood, the river was especially challenging to monitor. An old dam was breached during the flood and left without repair, resulting in much higher sand movement in the channel. As a result, frequent sandbar shifts were present in the river. On several visits when the monitor was found to be buried in a sandbar on one visit, it would be moved to an open channel. The monitor could be in flowing water with plenty of depth, only to have a sandbar move into it within a couple of days. An area that had high velocity and four foot of depth could be a sandbar area within 24 hours.

Water temperature data for the Niobrara River are rated as good. Some sand fouling on the temperature probe was present during the nine month deployment at the site and sandbar activity frequently impacted the sensors ability to collect data. River flows past the instrument were able to keep the thermistor representative of the water flowing past. No corrections were needed to adjust the data because of this. The maximum water temperature observed was 33.1 degC on July 17 and

minimum temperature observed was 5.2 degC on October 19, 2020. These extremes may have been exceeded during nonmonitoring periods.

Specific conductance data for the Niobrara River are rated as poor. Specific conductance is normally a good indicator of the number of ions in the water and the amount of potential runoff present. The probe was frequently susceptible to sand fouling during the deployment. Sand would settle out on the probe causing the instrument to read slightly off, but still within reportable USGS standards (Wagner et al. 2005 TM1D3). Sandbar activity frequently impacted the sensors ability to collect data and resulted in data gaps throughout the year. Fouling corrections were applied to correct the data for this instrument failure. Minimal calibration corrections were needed throughout the period. The maximum specific conductance data point observed was 473 uS/cm on May 6, 2020 and minimum conductance data point observed was 211 uS/cm on July 25, 2020.

Dissolved oxygen data for the Niobrara River are rated as good. DO was susceptible to light sand fouling, algae fouling, and occasional debris, resulting in some small fouling corrections. The optical wipers were able to keep all forms of fouling off of the membrane a majority of the time and keep the record relatively free of any large corrections. Sandbar activity frequently impacted the sensors ability to collect data. There were minimal fouling and calibration corrections needed during the period of record. The maximum dissolved oxygen data point observed was 13.2 mg/L on April 14, 2020 and minimum dissolved oxygen data point observed was 6.6 mg/L on July 25, 2020.

pH data for the Niobrara River are rated as good for the period of record. There was minimal fouling on the pH probe throughout the deployment, resulting in minimal corrections. A few calibration corrections were needed on the probe throughout the year. Diurnal variations existed throughout the period and were most prevalent during non-run-off periods. The diurnal variations were likely due to temperature fluctuations and biological activity. Sandbar activity frequently impacted the sensors ability to collect data. The maximum pH data point observed was 9.2 std units on June 28, 2020 and minimum pH data point observed was 7.9 std units on July 25, 2020.