



Water Quality Monitoring for Niobrara National Scenic River

2020 Data Report

Natural Resource Data Series NPS/NIOB/NRDS—2023/xxx





ON THIS PAGE

Downstream from USGS Gaging Station 06461500 on the Niobrara River near Sparks in July 2020 at Niobrara National Scenic River, Nebraska.

Photograph by USGS, station 06461500.

ON THE COVER

Upstream from USGS Gaging Station 06461500 on the Niobrara River near Sparks in July 2020 at Niobrara National Scenic River, Nebraska.

Photograph by USGS, station 06461500.

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Abstract

The Northern Great Plains Inventory and Monitoring Network (NGPN) began monitoring water quality in the Niobrara River at Niobrara National Scenic 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 (April 8 through October 26) 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 moderately wet year after a record wet year in 2019 with daily mean discharge peaking at 1,810 cubic feet per second (and maximum instantaneous discharge of 1,890 cfs) on March 31st, considerably lower than the record peak in 2019 of 6,970 cfs. Flow was comparable to the other years. Water quality was measured including in 2014 which had a peak of 2,930 cfs, and 2017 which had a peak of 1,870 cfs. Discharge in 2020 still remained above the median for the period of record, 795 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). Measured parameters are well within state standards with just one dissolved oxygen measurement falling below the state standard of 5.0 mg/L in 2020. In comparison, 2017 produced some minor high pH exceedances but there were no violations in 2014.

The state of Nebraska and the National Park Service (NPS) monitor *Escherichia coli* (*E. coli*) bacteria in the 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) 3-57 % of the time in the lower reach (NI3-10000) and the geomean standard (126 cfu/100 mL) exceeded standards in 2020. The upper reach (NI3-20000) does not violate state water quality standards though *E. coli* remains an important issue in NIOB.

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 Sparks, Nebr. - USGS Water Data for the Nation](#) where it remains available to the public.

Abbreviations and 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
KNRI:	Knife River Indian Villages NHS
mi ² :	square miles
mL:	milliliters
NAWQA:	National Water Quality Assessment (USGS)
NE:	Nebraska
NDEE:	Nebraska Department of Environment and Energy
NGPN:	Northern Great Plains Network
NIOB:	Niobrara National Scenic River
NPS:	National Park Service

NWIS:	National Water Information System (U.S. Geological Survey)
NSR:	National Scenic River
SC:	Specific conductance
SOP:	standard operating procedure
TNC:	The Nature Conservancy
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. Niobrara National Scenic River was designated part of the National Wild and Scenic River system by the United States Congress in 1991. Seventy-six miles of the free-flowing Niobrara River were included in the designation from Valentine, NE east to Highway 137. The unit is now managed by the National Park Service as the Niobrara National Scenic River (NIOB) (NPS 2016). NIOB merited special protection and recognition due to its free-flowing clean water, accessible and undeveloped shoreline, and outstanding remarkable values that highlight the unique Niobrara River Valley. These outstanding remarkable values include its geologic formations, fossils and paleontology, fish and wildlife, scenery, and recreation. Though NIOB consists of the Niobrara River, the land area around NIOB is held mainly by private landowners. Only 1,030 acres in an 29,089- acre area are federal lands (NPS 2023), owned mainly by the U.S. Fish and Wildlife Service (USFWS), with only 186 acres owned by NPS (NPS 2023). The Nature Conservancy owns a large section of land that includes 25 river miles of the park.

The Niobrara River is an outstanding example of a free-flowing Great Plains River; hundreds of springs feed water to the Niobrara River as it flows through the Nebraska Sand Hills (NPS 2020). The river is primarily groundwater-fed and so flow remains stable year-round. Groundwater can account for up to 95% of the river's flow (Nebraska Department of Natural Resources 2004). Several dams and irrigation withdrawals have reduced the flow in the Niobrara since 1965 (Narumalani 2010). The Niobrara cuts through geologic formations that were deposited over the past 98 million years. These layers are visible as one travels upstream along the river. The major formations include the Pierre Shale, the Rosebud Formation, the Valentine Formation, and the Ash Hollow Formation. On top of the Ash Hollow Formation lay the Sand Hills. The Sand Hills themselves were formed in the past 10,000 years. Numerous waterfalls cascade down the terraces surrounding the river revealing the variety of geologic layers. The unique geology gives rise to a mixture of habitats (NPS 2016).

NIOB is home to immense paleontological resources, which have been widely studied over the past 125 years. The river cuts through several rock formations to expose many important mid-Tertiary and Pleistocene fossils (NPS 2020) including good examples of mammal evolution (NPS 2016).

The wide variety of ecosystems within the Niobrara River system nurtures the fish and wildlife populations that inhabit it. The unique topography and multitude of water sources create six unique ecosystems within the park boundaries: ponderosa forest, eastern hardwood forest, northern boreal forest remnants from the Pleistocene age, short grass prairie, tallgrass prairie, and Sand Hills mixed grass prairie (NIOB 2003). Aquatic macroinvertebrate, river otter, cool-water fish, and spiny softshell turtle inhabit the river. Elk favor the ponderosa pine and upland forests. Paper birch, aspen, birds, and Bailey's eastern woodrat dwell in the spring branch canyons. Grassland birds and bison live in the grasslands, and the interior least tern and piping plover favor sandy habitats (Narumalani 2010). In addition to containing unique habitats, the Niobrara River valley is a biological mixing zone with eastern and western species, boreal forest, and three prairie habitats. At the Niobrara

Valley Preserve, owned by the Nature Conservancy, a wide range of biota have been documented including 583 plant, 213 bird, 44 mammal, 25 fish, 17 reptile, and 8 amphibian species (TNC 2023).

The spring branch canyons and prevalence of waterfalls are unique in the Great Plains. These features offer spectacular scenic views which deserve protection (NPS 2016). The river is a popular destination for tubing, canoeing, kayaking, and rafting (NPS 2016). Floating the river is a prime way to see the river. Privately owned enterprises provide camping and rental opportunities.

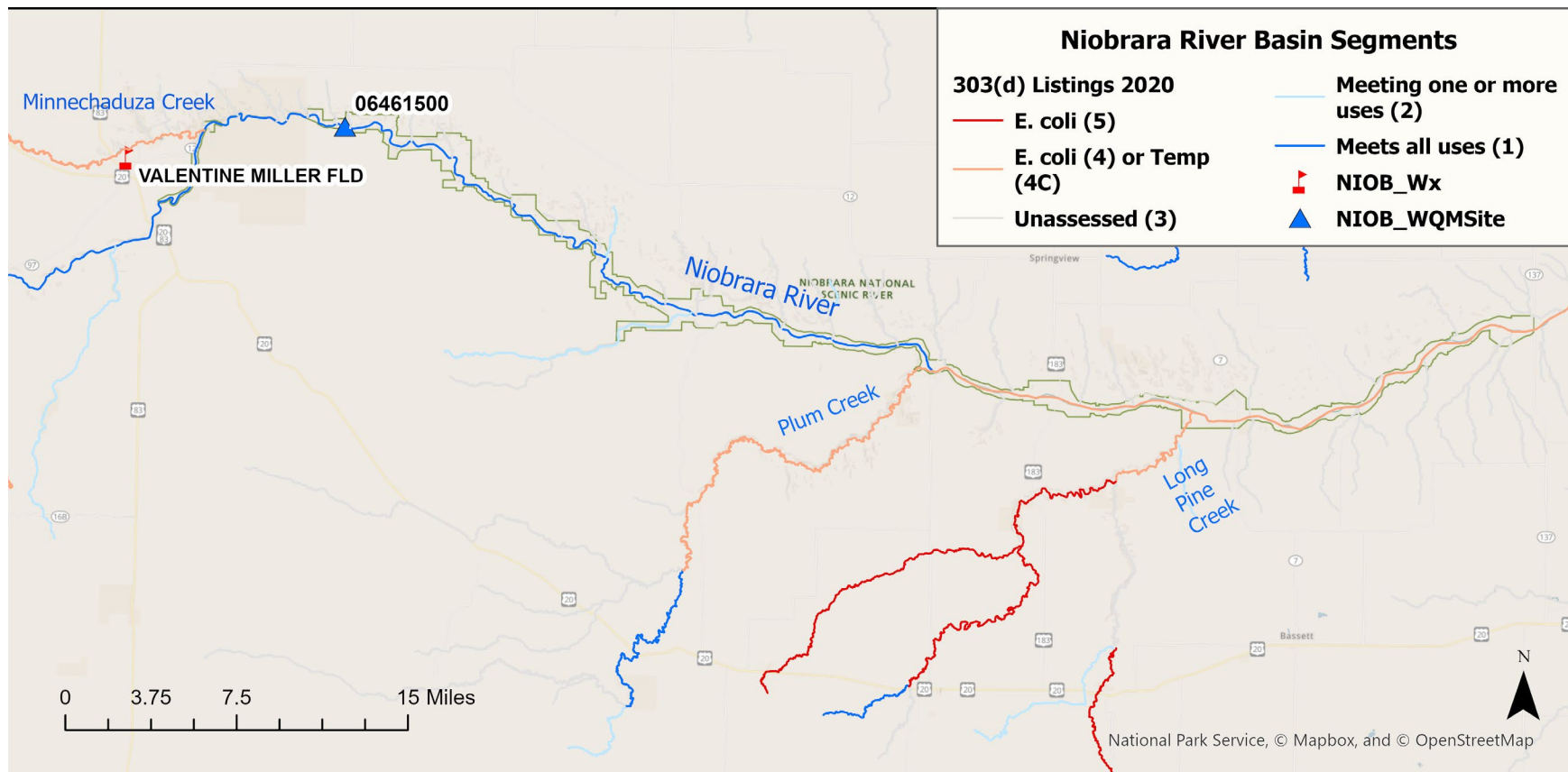


Figure 1. Map of the Niobrara Scenic River. The stretches of the rivers highlighted in red are listed as impaired under 303(d) criteria for *Escherichia coli* bacteria. Dark blue indicates the water is meeting state standards. Those orange segments indicate the waterbody is still impaired but that an approved TMDL is in place. The upper portion of NIOB at our gage is meeting standards but the lower portion of the Niobrara River is not meeting standards, due to *E. coli*.

The central Niobrara valley including NIOB has a continental climate. The Cherry County average July temperature is 73.2° F. The mean January temperature is 24.7° F, and the county receives on average 22 inches of precipitation (1991-2020, NCEI 2023). Year-to-year precipitation can be highly variable (Narumalani 2010). In 2020, Cherry County received 18.44 inches of precipitation, slightly below the 30-year average, following record precipitation in 2019 (32.24 inches). Average temperature for the year in 2020 was 49.5°F, well above the 30-year mean of 47.9°F and 100-year mean of 46.6°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 NIOB 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 NIOB is an outstanding state or national resource which includes wild and scenic rivers. The existing quality of these surface waters must be protected (NDEE 2019).

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 NIOB (from lower Plum Creek extending downstream from NIOB to Keya Paha River shown in orange in Figure 1). 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 geomeans were collected in the lower Niobrara Reach, NI3-10000 near the 137 bridge in 2020, all of which violated standards. Thirty-one out of 54 samples at that location exceeded the single sample maximum of 298 cfu/100 mL. Data are publicly available from water quality portal, [Water Quality Data Home](#). Recent data at the 183 bridge, also in the lower reach of the park only resulted in 1 sample out of 30 violating water quality standards for *E. coli*, available at [Water Quality Data Home](#). There is an approved TMDL in place to address the pollution. Both NDEE and NPS sampled at the bridge at Sparks, [USGS 06461500 Niobrara River near Sparks, Nebr](#) in the upper reach, NI3-20000. Since 2014, 16 out of 165 samples exceeded 298 cfu/100 mL. One of five geomeans violated in 2014, while no geomeans violated in 2020. “How’s My Waterway” is an EPA site displaying and summarizing state-wide assessment data. Summaries for the upper reach ([How's My Waterway -](#)

[Waterbody Report \(epa.gov\)](#)) and the lower reach of the Niobrara River at NIOB [How's My Waterway - Waterbody Report \(epa.gov\)](#) are available.

NGPN began monitoring water quality at NIOB 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 Niobrara National Scenic River, NE (Monitoring Location 06461500; 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 NIOB 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 were made available in real-time on the USGS National Water Information System website.

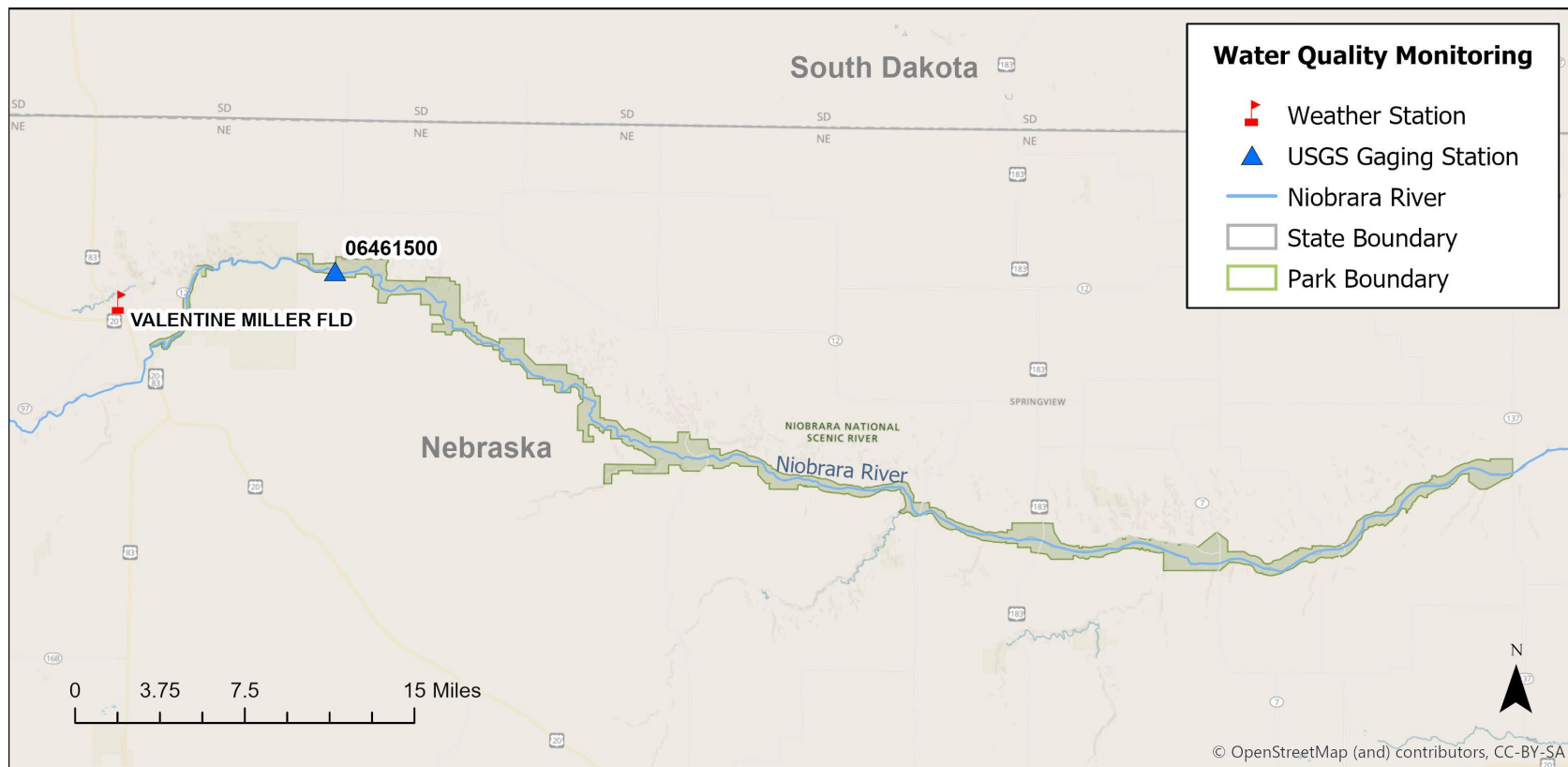


Figure 2. Map of Niobrara National Scenic River, the water quality monitoring location (06461500, blue triangle) and the nearby weather station (red flag). Climate data in this report are taken from the Valentine Miller Field weather station, 250402.

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 06461500) inside the park at Sparks, NE at approximately 2,288 ft elevation. Water quality is measured every fifteen minutes throughout the ice-free season. Water quality monitoring at NIOB 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 NIOB. The USGS deployed a continuous, multi-parameter sonde along the left bank downstream of Berry Bridge along the Niobrara River, station 06461500 on April 8, 2020 (Figure 3) and visited the gaging station every three to four weeks for equipment maintenance (Table 2). Due to COVID-19, only seven field visits were made. 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 3. A sonde device is used to measure water quality on the Niobrara River in 2020 at Niobrara National Scenic River (left panel). This sonde is coated in sediment. The United States Geological Survey Niobrara River gaging station (06461500) is set up for real-time data transmission via satellite (right panel). Photographs courtesy of USGS.

Table 2. Field journal for 2020 Water Quality Sampling at Niobrara National Scenic River.

Date	Notes
April 8, 2020	Installed water quality (WQ) monitor, ~ 12 pm. Completed cross-section.
June 23, 2020	Cleaned and calibrated probe. Cross-section completed.
July 22, 2020	Cleaned and calibrated probe. DO data poor from July 15-22.
August 18, 2020	Cleaned and calibrated probe. Cross-section completed.
September 15, 2020	Cleaned and calibrated probe. Cross-section completed.
October 15, 2020	Cleaned and calibrated probe. Handheld died during cleaning, only some temperature and oxygen available after this point till October 26. Significant fouling on probe due to dead fish. DO values impacted by sand after October 26 th .
November 5, 2020	Retrieved WQ probe at end of season.

Satellite telemetry transmitted the water data to the Water Science Center in near real-time (<https://waterdata.usgs.gov/monitoring-location/06461500/>). 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 Valentine Miller Field Climate Station (#258760). 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 April 8, 2020 to October 26, 2020. The discharge of the Niobrara River was higher in spring and lower through the summer and early fall. Discharge peaked at 1,890 cfs on March 31, 2020 and slowly decreased throughout the growing season (Figure 4). Eventually in November, the discharge picked up, coinciding with higher than average fall rains. Mean discharge was 1085.78 cfs and the minimum discharge occurred on August 26, 2020 with a recorded value of 538 cfs.

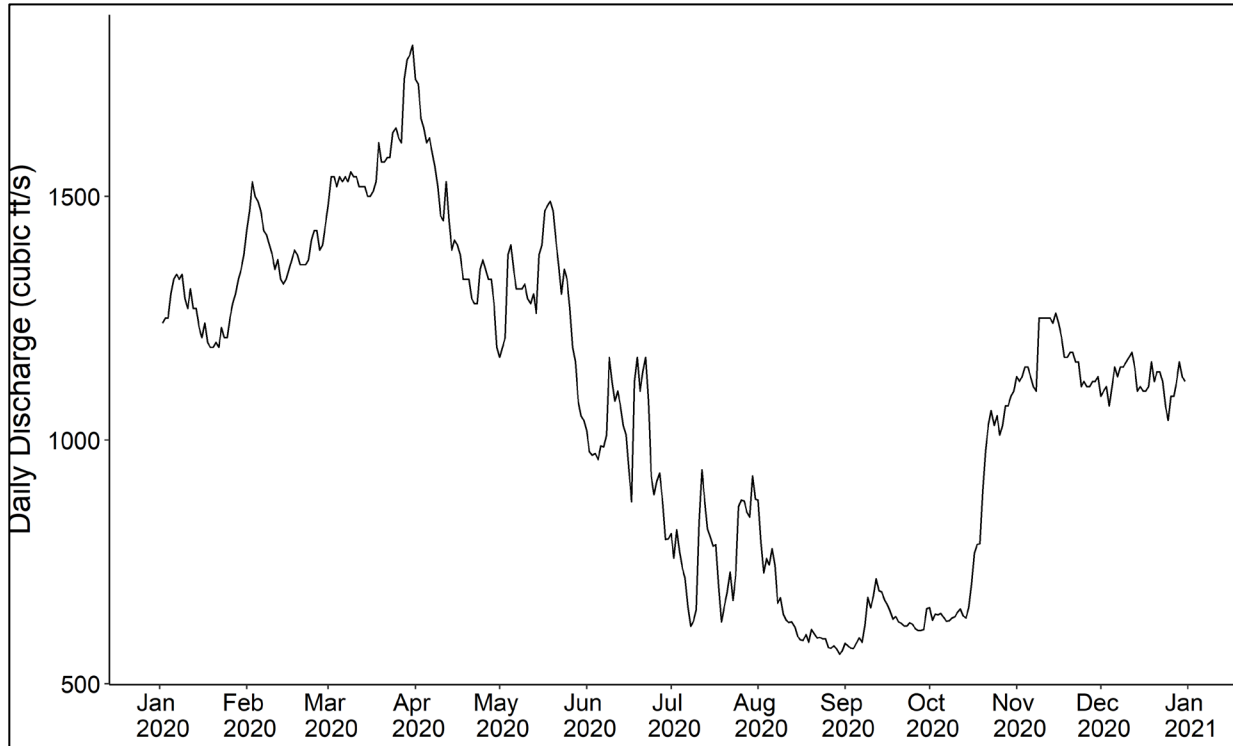


Figure 4. Daily mean discharge (black line) in 2020 on the Niobrara River at Niobrara National Scenic River, USGS Gaging Station 06461500.

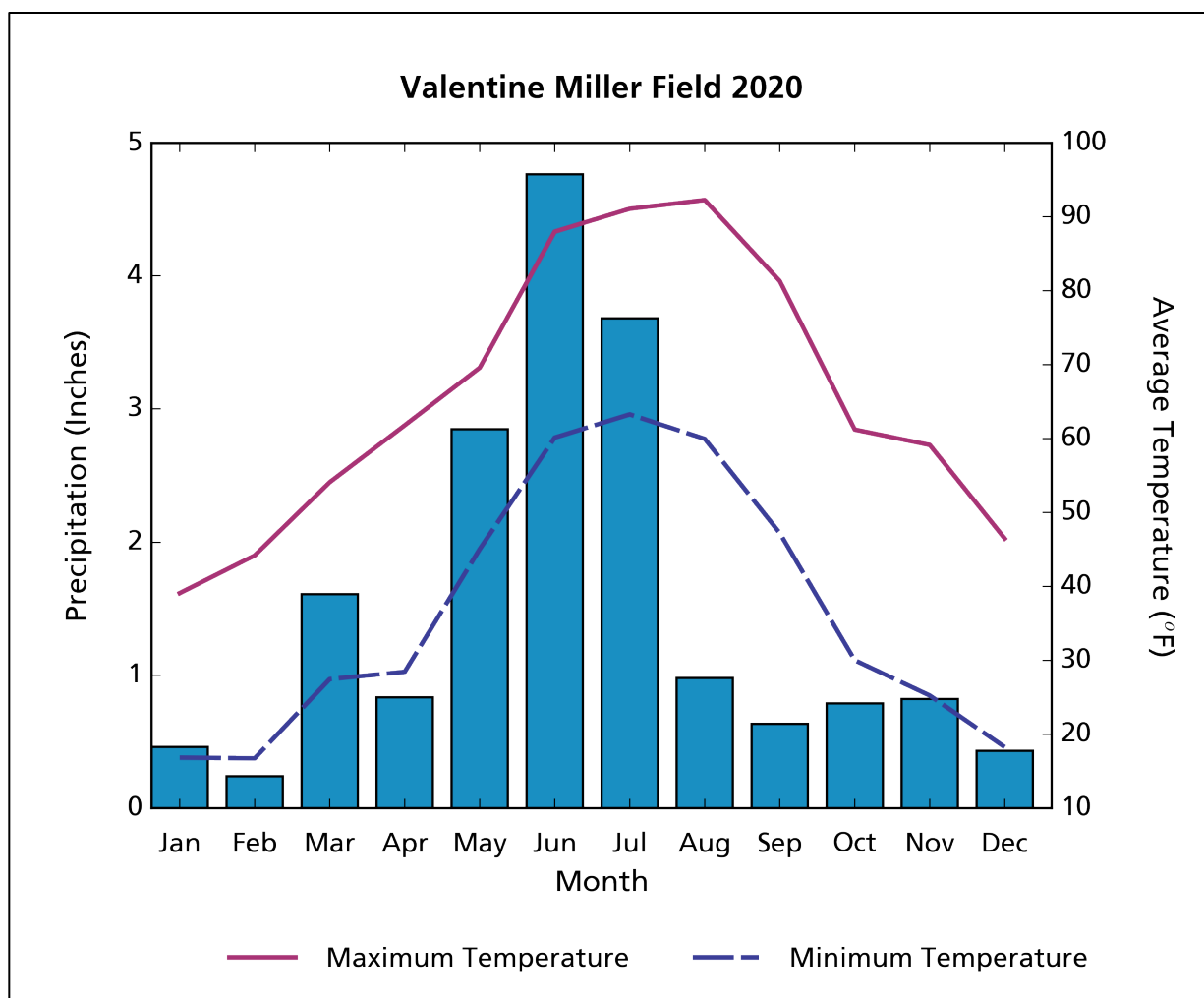


Figure 5. The above graph shows the total monthly precipitation (blue bars), average monthly minimum temperature (dashed blue line) and average monthly maximum temperature (solid red line) for the 2020 calendar year at Niobrara National Scenic River. Climate data are from Valentine Miller Field RAWS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

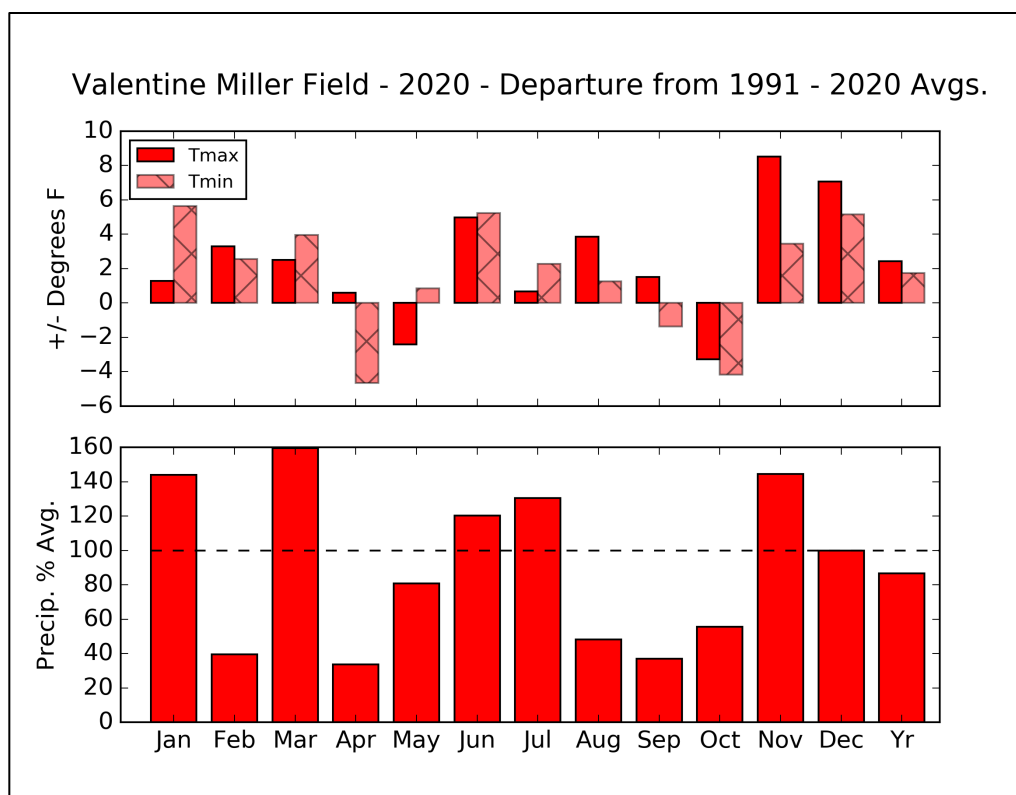


Figure 6. A comparison of 2020 temperature (top) and precipitation (bottom) at Niobrara National Scenic River compared to 1991-2020 averages. Climate data are from Valentine Miller Field RAWS climate station. The data were accessed and graphed using the web-based tool [Valentine Miller Field \(climateanalyzer.us\)](https://climateanalyzer.us/).

During the ice-free season at NIOB, over 20,200 water quality measurements in the Niobrara River were collected, although some sensors on the multi-parameter sonde experienced intermittent errors and data were not recorded (Table 3). This monitoring period had a mean water temperature of 17.94°C, a mean dissolved oxygen concentration of 9.15 mg/L, a mean specific conductance of 234 µS/cm, and a mean pH of 8.43 (Table 3). There was, however, variation across months in all parameters (Table 4). Mean water temperature in late April was nearly 11°C and increased to a mean of 25.15°C in July before declining down to 9.17°C in October (Table 4, Figure 7). Dissolved oxygen fell below the Nebraska water quality standard of 5 mg/L with one observation in July (Table 4).

Table 3. Summary of descriptive statistics for water temperature, dissolved oxygen, specific conductance, and pH measured for the ice-free sampling period at Niobrara National Scenic River in the Niobrara River from April 8 to October 26, 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).

Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance ($\mu\text{S}/\text{cm}$)	pH
Mean	17.94	9.15	234.49	8.43
Standard Deviation	6.92	1.6	13.2	0.19
Median	18.8	9.2	229	8.4
Minimum	0	4.9	168	8
Maximum	31.2	14.3	264	9
Number of Points	20,214	19,145	18,351	18,686
Number of Points below or above standard	0	1 (below)	0	0
% Exceedance	0.00%	0.01%	0.00%	0%

Table 4. Summary of monthly descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Niobrara National Scenic River in the Niobrara River from April 8 to October 26, 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 $\geq$ 5.0 mg/L; conductivity is <2000 μ S/cm and pH range is >6.5 or <9.0).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (μ S/cm)	pH
April 8-30, 2020	Number of measurements	2,173	2,160	2,142	2,176
	Mean	10.8	10.59	255.21	8.49
	Standard Deviation	3.53	0.95	5.93	0.1
	Median	11.1	10.6	256	8.5
	Minimum	3.1	8.4	244	8.4
	Maximum	19	12.9	264	8.7
	% Exceedance	0.0%	0.0%	0.0%	0.0%
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	0.0%	0.0%	0.0%	0.0%
June, 2020	Number of measurements	2,877	2,828	2,839	2,875
	Mean	22.95	8.28	237.70	8.42
	Standard Deviation	3.18	1.06	8.73	0.19
	Median	23	8.2	238	8.4
	Minimum	13.2	5.9	188	8.1
	Maximum	30.6	11.4	258	9
	% Exceedance	0.0%	0.0%	0.0%	0.0%
July, 2020	Number of measurements	2,976	2,951	2,957	2,976
	Mean	25.15	8.18	228.88	8.52
	Standard Deviation	2.72	1.52	9.46	0.22
	Median	25	7.9	228	8.5
	Minimum	19.2	4.9	168	8.1
	Maximum	31.2	11.8	247	9

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	pH
	% Exceedance	0.0%	0.0%	0.0%	0.0%
August, 2020	Number of measurements	2,973	2,971	2,926	2,970
	Mean	24.12	8.03	221.32	8.45
	Standard Deviation	2.75	1.48	5.16	0.22
	Median	24.1	7.7	222	8.4
	Minimum	16.1	5.1	193	8
	Maximum	30.2	12.1	234	9
	% Exceedance	0.0%	0.0%	0.0%	0.0%
September, 2020	Number of measurements	2,875	2,874	2,830	2,869
	Mean	17.23	9.36	225.01	8.36
	Standard Deviation	3.49	1.14	2.45	0.18
	Median	17.3	9.3	225	8.3
	Minimum	9.3	7	219	8.1
	Maximum	25	11.6	231	8.8
	% Exceedance	0.0%	0.0%	0.0%	0.0%
October 1-26, 2020	Number of measurements	2,950	2,388	1822	1,844
	Mean	9.17	10.94	227.6	8.31
	Standard Deviation	4.33	1.29	2.37	0.19
	Median	9.3	10.9	228	8.2
	Minimum	0	8.5	222	8.1
	Maximum	17.4	14.3	235	8.7
	% Exceedance	0.0%	0.0%	—	0.0%

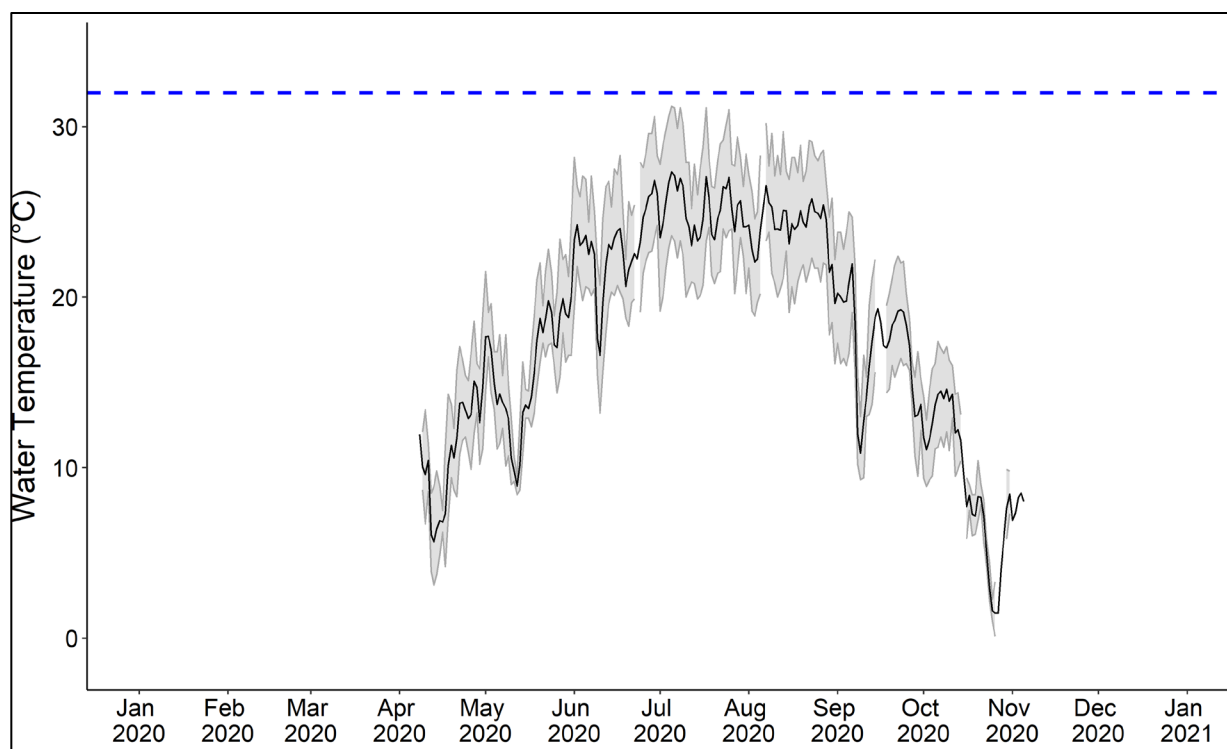


Figure 7. Daily mean water temperature (black line) collected on the Niobrara River at Niobrara National Scenic River in 2020. The sonde was in the water and recording data from April 8 through November 5, 2020. The gray ribbon shows the daily maximum and minimum water temperature for the same period. 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.

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 stayed within state standards as the maximum temperature, 31.2 °C, was below the state standard of 32°C.

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 April, May, September, and October. Dissolved oxygen fell below the state water quality criterion of 5 mg/L once on July 28, 2020 (Table 1). The observation was 4.9 mg/L, and no additional observations were below 5 mg/L for the remainder of the season. 19,145 dissolved oxygen measurements were taken, so this deficient observation was well below the 10% exception specified in the Nebraska water quality standards (Table 1). Thus the data that were recorded do not suggest that Niobrara River was in violation of the dissolved oxygen standards.

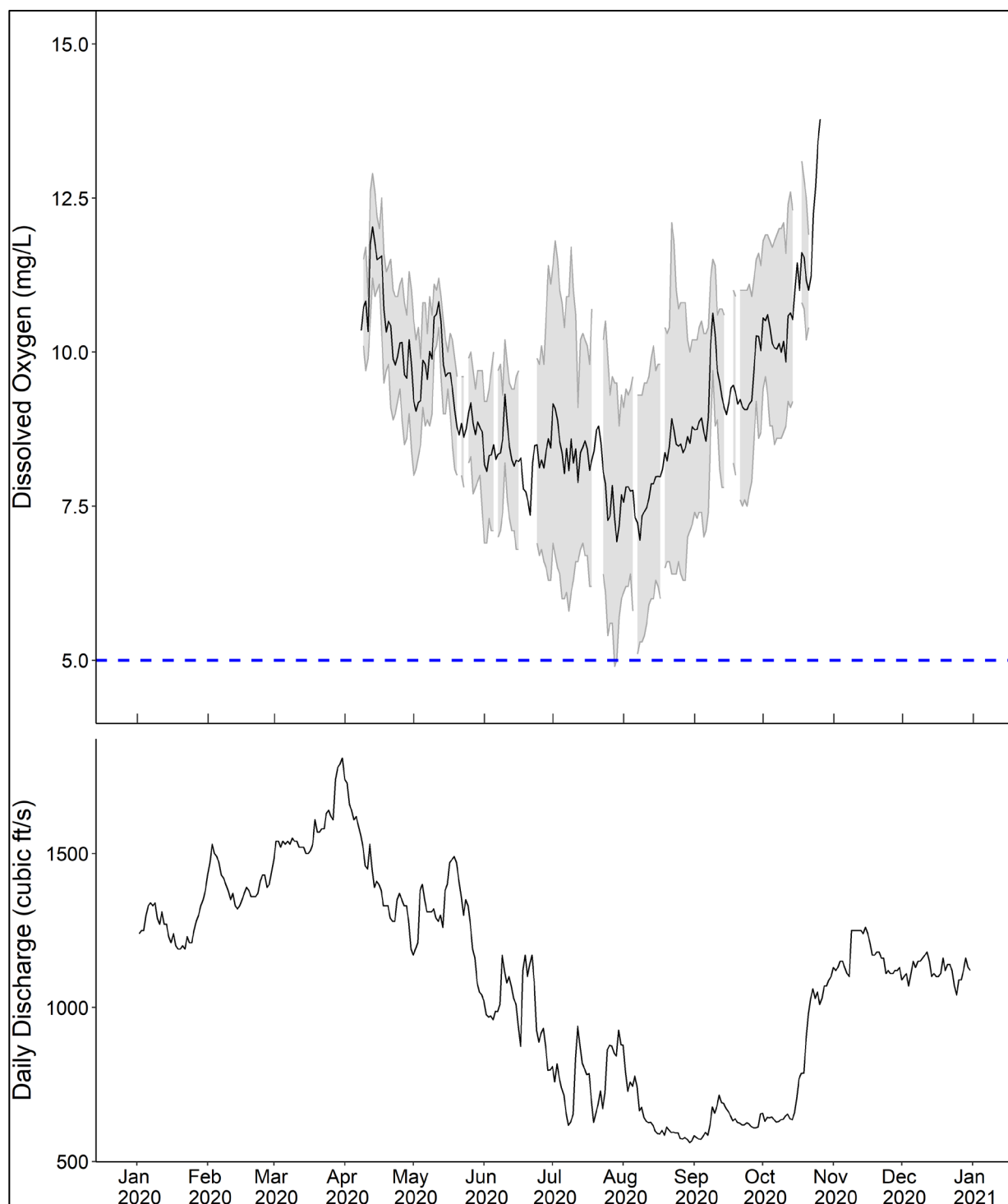


Figure 8. Daily mean dissolved oxygen concentrations (top) and daily discharge (bottom) of the Niobrara River in 2020 at Niobrara National Scenic River. Measurements were taken from April 8 to October 26, 2020. The gray ribbon shows the daily maximum and minimum dissolved oxygen for the same period. 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.

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 229 $\mu\text{S}/\text{cm}$, and ranged from 168-264 $\mu\text{S}/\text{cm}$. The pH of the Niobrara River ranged between 8 and 9 (Figure 10) and was never outside the range of the Nebraska state standard of 6.5 – 9.0.

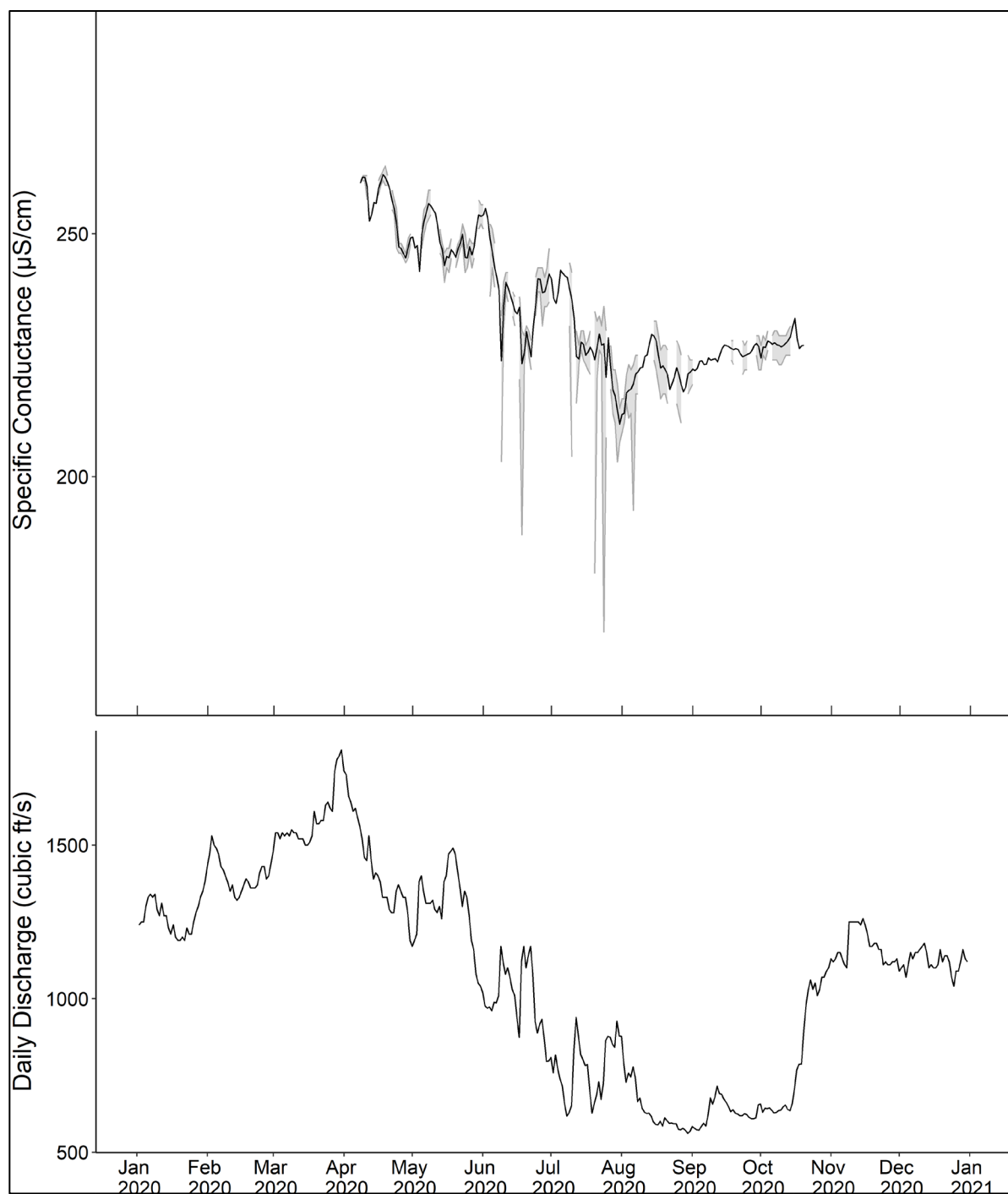


Figure 9. Daily mean specific conductance (top) and daily discharge (bottom) of the Niobrara River in 2020 at Niobrara National Scenic River. Measurements were taken from April 8 to October 20, 2020. The gray ribbon shows the daily maximum and minimum specific conductivity for the same period. The periods where the instrument did not collect data are indicated by gaps in the record.

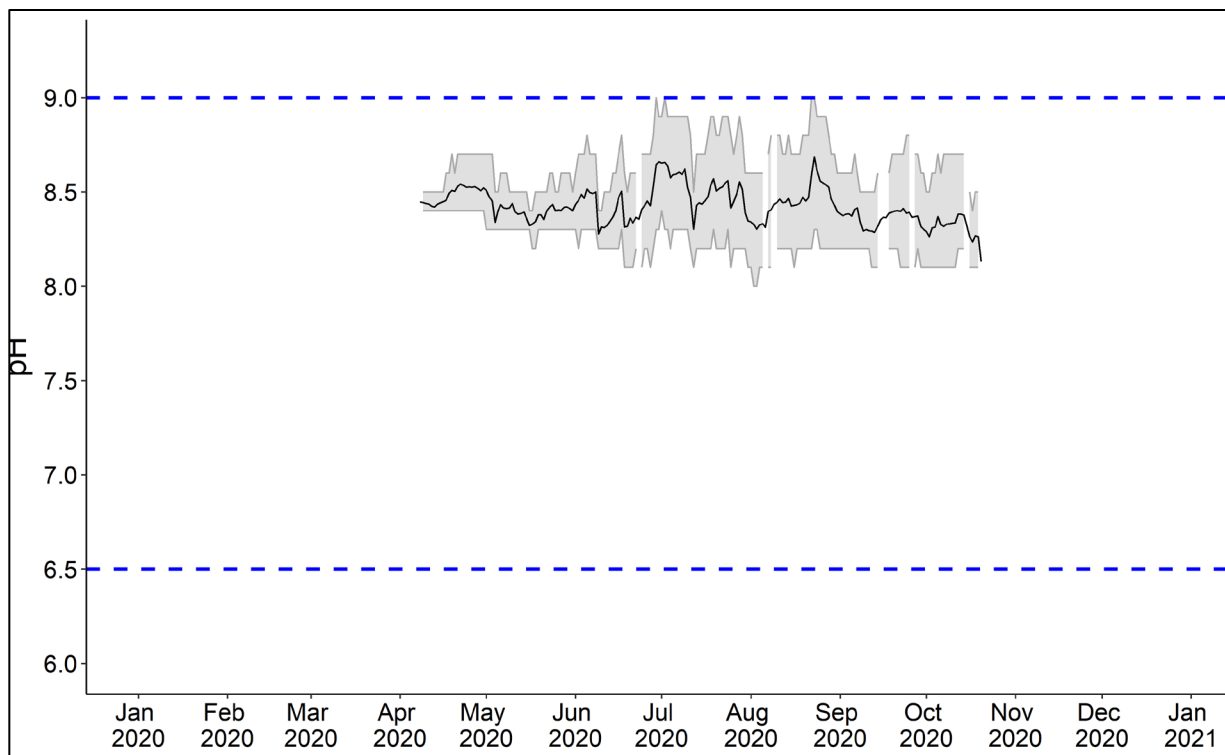


Figure 10. Daily mean pH (black line) of the Niobrara River at Niobrara National Scenic River. Measurements were taken from April 8 to October 20, 2020. The gray ribbon shows the daily maximum and minimum pH for the same period. The dashed blue lines indicate the Nebraska state water quality standards (see Table 1 for more details). The periods where the instrument did not collect data are indicated by gaps in the record.

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 06461500 Niobrara River near Sparks, Nebr.](#)

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Appendix A. USGS Water Data Quality Report and Station Analysis for Niobrara River Sparks, NE 06461500, 2020.

The Niobrara River at the Berry Bridge near Valentine, 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 Sparks gage (06461500), located on the Niobrara National Scenic Stretch. This monitoring was done in cooperation with the National Park Service I&M office out of Rapid City, SD. The monitoring was to assess the current status and long-term trends of water quality on the Niobrara River. This monitoring effort is identical to work performed in 2014 and 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 Niobrara National Scenic River. 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, as well as stage and discharge data going back to 1991. All data collected at this site can be retrieved at: https://waterdata.usgs.gov/nwis/uv?site_no=06461500.

The water quality monitor used for this site was a 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 April 8th, 2020 to November 5, 2020. With Covid-19 Pandemic restrictions in 2020, only 7 field inspections were made during the eight month deployment. At each of the 7 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. Water temperature data for the Niobrara River are rated as excellent. Minimal fouling on the temperature probe was present during the eight month deployment at the site. 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 31.2 deg C on July 5 and minimum temperature observed was 3.1 deg C on April 13. These extremes could have been exceeded during non-monitoring periods of the year. Specific conductance data for the Niobrara River are rated as excellent.

Specific conductance is normally a good indicator of the number of ions in the water and the amount of potential runoff present. The probe's ports were susceptible to sand fouling during the deployment. Sand would quickly settle out in the conductance ports causing the instrument to read slightly high, but still well within reportable USGS standards (Wagner, et al. 2005 TM1D3). 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 264 uS/cm on April 19, 2020 and minimum specific conductance data point observed was 168 uS/cm on July 24, 2020. Dissolved oxygen data for the Niobrara River are rated as excellent. 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. There were minimal fouling and calibration corrections needed during the period of record. The maximum dissolved oxygen data point observed was 12.9 mg/L on

April 13, 2020 and minimum dissolved oxygen data point observed was 4.9 mg/L on July 28, 2020. pH data for the Niobrara River are rated as excellent for the period of record. There was minimal fouling on the pH probe throughout the deployment, resulting in minimal or no fouling 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. The maximum pH data point observed was 9.0 standard units on August 22, 2020 and minimum pH data point observed was 8.0 standard units on August 6, 2020.

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NPS XXX/XXXX, October 2023



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