



Water Quality Monitoring for Theodore Roosevelt National Park

2022 Data Report

Natural Resource Data Series NPS/THRO/NRDS—2024/XXXX



**ON THIS PAGE**

Photograph of USGS Dakota Water Science Center water quality sonde location in the Little Missouri River near Medora, ND.
Photograph by USGS, station 06336000.

ON THE COVER

Photograph of Little Missouri River near Medora, ND, at Theodore Roosevelt National Park, July 2022.
Photograph by USGS, station 06336000.

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Natural Resource Data Series NPS/THRO/NRDS—2024/XXXX

Anine T. Rosse

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

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

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Abstract

The Northern Great Plains Inventory and Monitoring Network (NGPN) began monitoring water quality in the Theodore Roosevelt National Park (THRO) in 2013, with the assistance of the U.S. Geological Survey (USGS). This report summarizes the data collected during the 2022 ice-free season (April 5 through October 13) for streamflow, water temperature, dissolved oxygen, specific conductance, and pH. This was the fourth season of continuous water quality monitoring.

Compared to earlier sampling periods in 2013, 2016, and 2019, 2022 was a drier year. Discharge on the Little Missouri River peaked at 5,930 cubic feet per second (cfs) May 3rd. For context, the highest flow in 2013 was 8,400 cfs, 2016 was 1,650 cfs, and 2019 peaked at 27,600 cfs. There was considerable seasonal variation in all water quality measures. A summary of our results can be found in Descriptive Statistics Summary tables for the entire ice-free season (Table 3) and for each month (Table 4). Slight exceedances for temperature (2.09% exceedances), dissolved oxygen (.18%), and pH (3.57%) were recorded during the 2022 season. *E. coli* bacteria, which is not monitored by NGPN, continues to be an issue for the north unit of THRO, as well as a small portion of the south unit south of Andrews Creek near the I-94 bridge.

NGPN's collaboration with USGS supported real-time and archived access to this data through the USGS National Water Information System Website, where it remains available to the public, [LITTLE MISSOURI RIVER AT MEDORA, ND - USGS Water Data for the Nation](#).

Introduction

Located in southwestern North Dakota, Theodore Roosevelt National Park (THRO) encompasses 70,477 acres of the Little Missouri Badlands. THRO is composed of three discrete management units, each of which is a patchwork of mixed-grass prairie, clay buttes, bottomland forest, and open shrublands. The three park units (North, Elkhorn Ranch, and South) are connected by the Little Missouri River, an undammed tributary of the Missouri River with headwaters located in northeastern Wyoming, making it the major hydrologic feature for THRO. The Little Missouri flows for approximately 560 miles from south to north through parts of Wyoming, Montana, South Dakota, and the badlands of North Dakota and is the only designated state scenic river in North Dakota. The river is listed as a fundamental resource of THRO and is an integral part of the landscape that inspired Theodore Roosevelt (NPS 2014). Approximately 28 miles run through the park (Figure 1). The 269 miles of intermittent streams within the park provide substantial flow to the Little Missouri River during spring snowmelt and summer rainfall events (Gitzen et al. 2010).

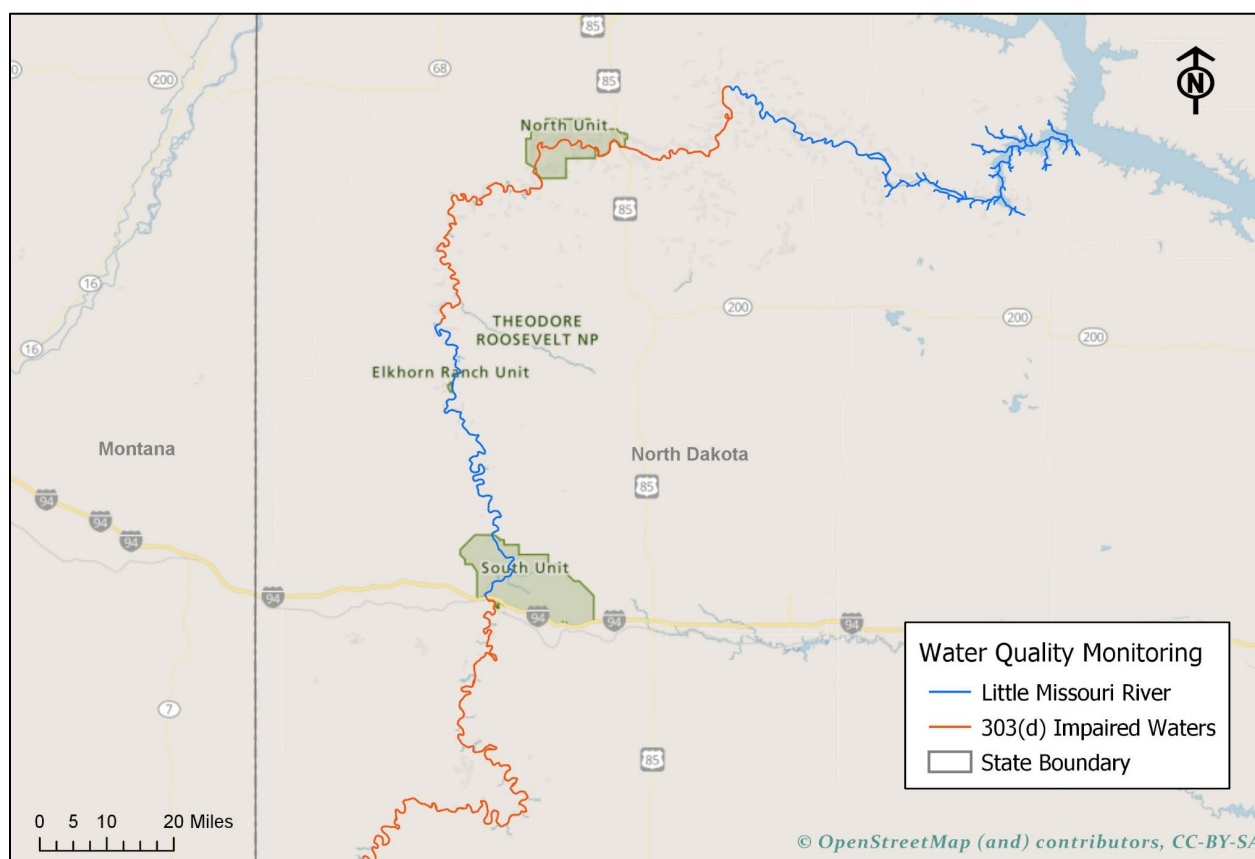


Figure 1. Map of Theodore Roosevelt National Park and the Little Missouri River in North Dakota. The stretch of the river running through the North Unit, is listed as impaired under 303(d) criteria (indicated in red) for *Escherichia coli*. [How's My Waterway - Community \(epa.gov\)](https://www.epa.gov/303d)

The Little Missouri River is designated as a Class II water in North Dakota. Class II waters are similar to Class I waters which are defined as “water suitable for propagation or protection, or both,

of resident fish species and other aquatic biota and for swimming, boating and other water recreation”. Class II waters may require additional treatment to meet drinking water requirements (NDDEQ 2021). The stretch of the Little Missouri that runs through the North Unit (ND-10110205-001-S_00) is listed as an impaired waterway under section 303(d) of the Clean Water Act for exceedances of *Escherichia coli* (ND Department of Health 2019). A small part of the Little Missouri River within the THRO South Unit boundary (Figure 1) is also listed as impaired for *E. coli* (ND-10110203-025-S_00 which is south of Andrews Creek near the I-94 bridge). No regular bacteria sampling occurs within the major south unit reach and it is likely the high *E. coli* counts found in ND-10110203-025-S_00 continue into the unassessed reach ND-10110203-057-S_00 which is the major reach in the South Unit of THRO.

The source of the *E. coli* and fecal coliform is unknown in the North Unit reach, but livestock feeding operations, agriculture, and failing septic systems are likely contributors to bacteria impairments in North Dakota (ND Department of Health 2019). The South Unit reach ND-10110203-025-S_00 has a total maximum daily load report (TMDL) in place (NDDEQ 2022). Significant sources of *E. coli* in that reach include largely nonpoint sources: unpermitted animal feeding operations and riparian grazing. Smaller point sources of bacteria including City of Medora and The Burning Hills Amphitheater WWTPs. For more details and current impairment information visit the [North Dakota Department of Environmental Quality website](#). Best management practices (BMPs) to reduce *E. coli* in ND-10110203-025-S_00 include livestock exclusion from riparian areas, water well and tank development, and prescribed grazing. Bacteria counts collected by NDDEQ are available from [Water Quality Data Home](#) and the past ten years of data are listed in Appendix A.

The Northern Great Plains Inventory & Monitoring Network (NGPN) began monitoring water quality at THRO in 2013 to better understand current conditions and changes over time in the Little Missouri River (Rockwood and Ashton 2020a and 2020b, Rosse and Cramer 2022). The monitoring is conducted at the gaging station at Medora, ND (Monitoring Location 06336000, Figure 2) in collaboration with the United States Geological Survey (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 THRO every three years, with the first cycle having been completed in 2013 (Wilson et al. 2014). NGPN will conduct an in-depth analysis of the status and trends of the Little Missouri River after three to five cycles of sampling.

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 April to October), and results are made available in real-time on the USGS National Water Information System Website [LITTLE MISSOURI RIVER AT MEDORA, ND - USGS Water Data for the Nation](#).

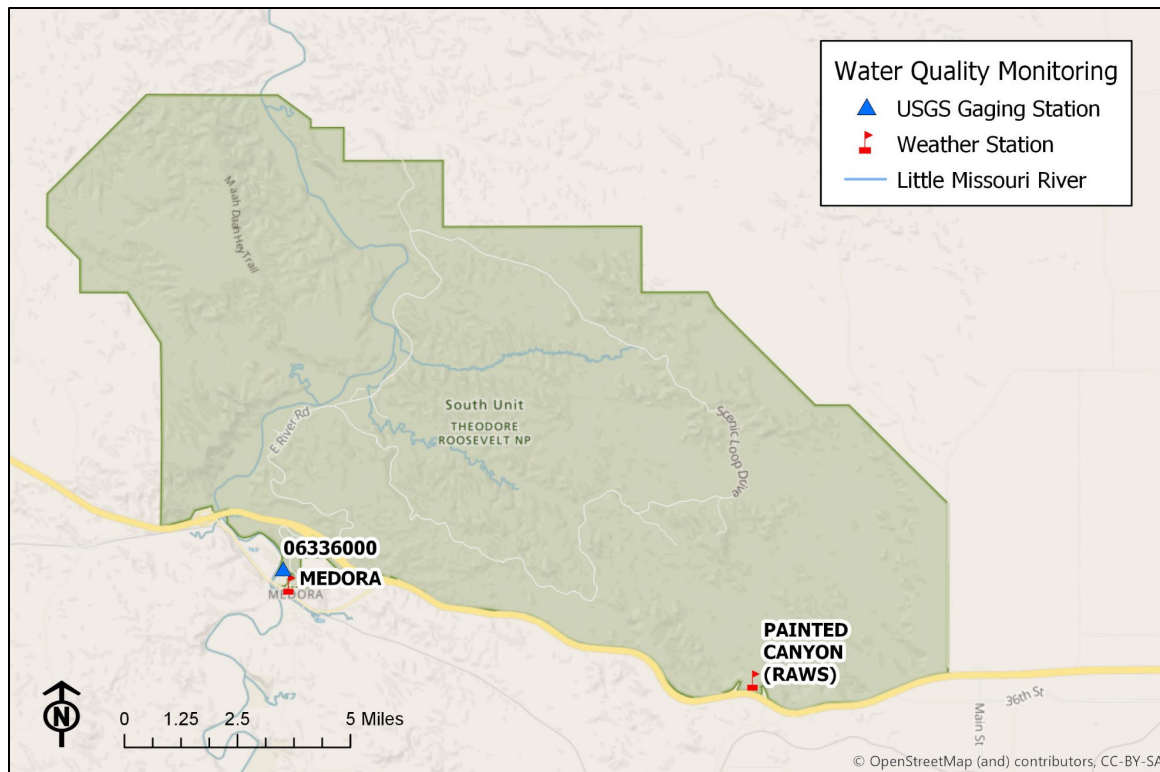


Figure 2. Map of Theodore Roosevelt National Park and water quality monitoring location (blue triangle) and nearby weather station (red flags). Climate data in this report is taken from the Painted Canyon RAWS weather station.

Table 1. Water quality parameters measured as part of the Northern Great Plains Inventory & Monitoring Water Quality Program and associated state standards for North Dakota Class II waters (NDDEQ 2021).

Water Quality Parameter	Description	ND 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 and reflectance and land use/cover in the watershed.	• 29.44°C • The maximum increase shall not be greater than five degrees Fahrenheit (2.78°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.	• 5 mg/l as a daily minimum • Up to 10% of representative samples collected during any 3-year period may be less than this value, provided that lethal conditions are avoided.
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.	No criteria
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.	• 6.0–9.0 • up to 10% of representative samples collected during any 3-year period may exceed this range, provided that lethal conditions are avoided.

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 06336000) in Medora, ND at around 2,248 ft elevation. Water quality and streamflow are measured every 15 minutes throughout the ice-free season. Monitoring at THRO was conducted in 2013, 2016, 2019 and 2022; this will continue to be repeated every three years. Program funding currently limits monitoring efforts to a cycle of one year of monitoring, followed by two years without monitoring.

In 2022, NGPN continued to partner with the USGS North Dakota Water Science Center to have USGS staff collect water quality and streamflow data at THRO. The USGS deployed a continuous, multi-parameter sonde at the Little Missouri River Gaging Station (06336000) near Medora, ND, on April 5, 2022, (Figure 3) and visited the gaging station five times through the sampling season for equipment maintenance (Table 2). The sonde instrument recorded dissolved oxygen (DO), pH, specific conductivity, and water temperature every 15 minutes, while the gage simultaneously measured stream stage (gage height; measured in feet) and discharge, a measure of streamflow.



Figure 3. A sonde device is used to measure water quality in the Little Missouri River at Theodore Roosevelt National Park and it is installed within a pipe for protection (left panel). The United States Geological Survey Little Missouri gaging station (06336000) is set up for real-time data transmission via satellite (right panel). Photographs courtesy of USGS, station 06336000.

Satellite telemetry transmitted the water data to the Water Science Center in near real-time (<https://waterdata.usgs.gov/monitoring-location/06336000/>). 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 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 between the in-the-water sonde and an independent field sonde. They serviced and calibrated the sensors as needed. Calibration included pre- and post-calibration checks to quantify fouling errors and equipment drift; this data is critical to the correction and grading of the final data. On October 13, the USGS removed the multi-parameter sonde from the Little Missouri River.

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 January 2023 from the USGS and used AQUARIUS Workstation by Aquatic Informatics (<http://aquaticinformatics.com/>) and R (R Core Team 2022) to store and analyze 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 15-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 for days where all time steps were missing (i.e. the instrument didn't collect any data that day). We calculated the proportion of records that exceeded North Dakota environmental regulatory thresholds (Table 1).

Climate data were downloaded from the Painted Canyon RAWS climate station. The data were accessed and graphed using the web-based tool, [Climate Analyzer](#).

Table 2. Field journal for 2022 Water Quality Sampling at Theodore Roosevelt National Park.

Date	Notes
April 5, 2022	Installed YSI 6920 WQ monitor 14J1000034 for season.
June 1, 2022	Serviced monitor with NPS. Previous monitor was not working, could not retrieve due to depth and cable buried. Installed new Ysi 03F109AC. Cross Section collected. Calibrated monitor in office prior to visit.
July 14, 2022	Retrieved old monitor. Did not service deployed monitor- too deep. Reinstalled orifice.
August 2, 2022	Serviced WQ Monitor, was on channel bottom and partially buried. Cleaned and calibrated. Reinstalled fence post to hold WQ Monitor.
October 13, 2022	Serviced WQ monitor and removed for year.

Results

The water quality monitoring season (ice-free) on the Little Missouri River at THRO lasted from April 5 to October 13, 2022. River discharge peaked for the year at 5,930 cubic feet per second (cfs) on May 3rd. Subsequent smaller peaks occurred in mid-May and early July. There were issues during the season reaching and serving the water quality monitor as well as burial of the monitor in the sediments which is a common occurrence at this gage (Table 2). Table 3 shows the amount of annual precipitation recorded at the nearby Painted Canyon RAWS station (#322503) along with the average and peak annual flows recorded at the [Little Missouri River at Medora, ND - USGS Water Data for the Nation](#).

Table 3. Total precipitation (recorded at RAWs station #322503) with peak and mean annual flows from the 06336000 gage at Medora for recent water quality monitoring years.

Year	Annual Precip (in)	Peak Annual Flows (cfs)	Mean Annual Discharge (cfs)
2013	16.89	8400	394.7
2016	16.74	1650	104.8
2019	18.59	27700	1003
2022	14.54	5930	407.7

According to precipitation measurements at the Painted Canyon weather station, 2022 was the driest year yet for precipitation (14.54 inches) out of the years we monitored water quality at THRO. Figure 4 shows a graph of discharge recorded during the ice-free season while Figure 5 shows some of the climate data collected at the nearby RAWS station during 2022.

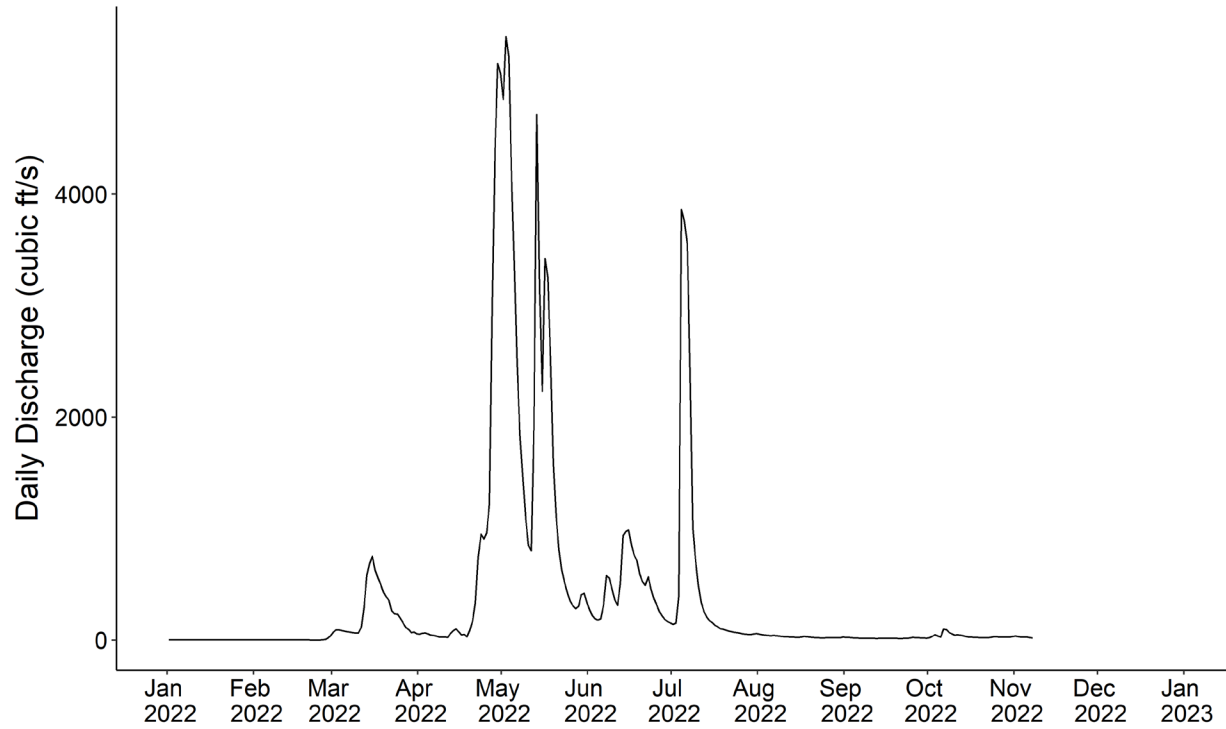


Figure 4. Daily mean discharge on the Little Missouri River at Theodore Roosevelt National Park at USGS Gaging Station 06336000 in 2022.

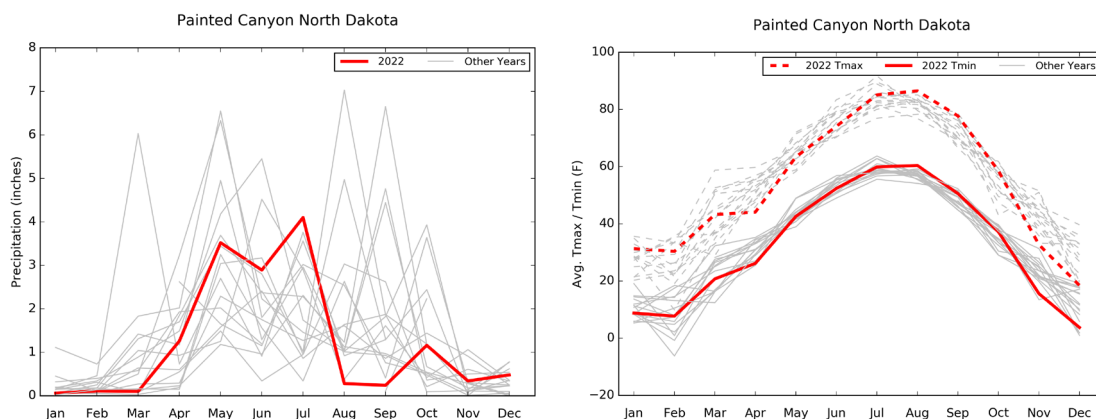
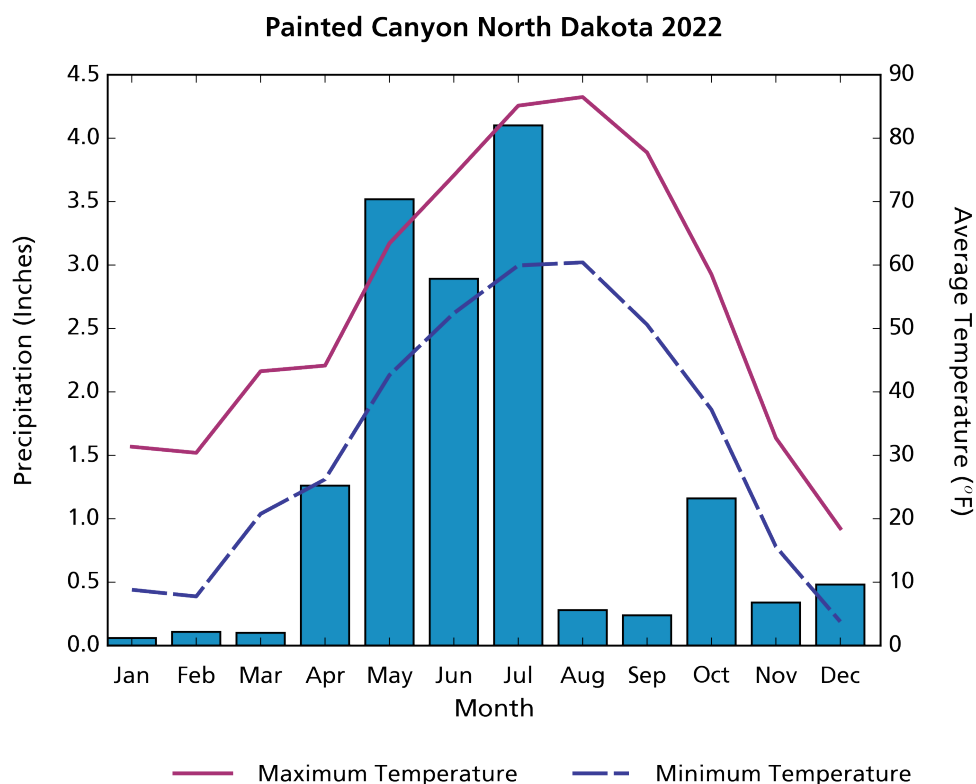


Figure 5. The top panel shows the total monthly precipitation (blue bars), average monthly minimum air temperature (dashed blue line) and average monthly maximum air temperature (solid red line) for the 2022 calendar year in Theodore Roosevelt National Park. The bottom left panel shows a comparison of 2022 precipitation data to the period of record, and the bottom right panel shows a comparison of 2022 temperature data to the period of record. Climate data are from Painted Canyon RAWS climate station. The data were accessed and graphed using the web-based tool Climate Analyzer.

During the ice-free season at THRO, 14,629 water quality measurements were collected in the Little Missouri River (Table 4). Water monitor errors resulted in data loss from May 5- June 1. The

remaining analysis will exclude November from the monitoring season since core water quality data were not recorded during that time.

This period had a mean water temperature of 18.62°C, a mean dissolved oxygen concentration of 8.75 mg/L, a mean specific conductance of 1,978 µS/cm, and a mean pH of 8.54 (Table 4). There was, however, variation across months in all parameters (Table 5). Monthly mean water temperature in April was 4.3 °C and peaked to a mean of close to 24.65 °C in July before declining back to 12.4 °C in October (Table 5, Figure 6). Slight exceedances for temperature (2.09% exceedances), dissolved oxygen (.18%), and pH (3.57%) were recorded during the 2022 season.

Table 4. Summary of descriptive statistics for water temperature, dissolved oxygen, specific conductance, and pH measured for the ice-free sampling period on the Little Missouri River at Theodore Roosevelt National Park from April 5 to October 13, 2022, at USGS Gaging Station 06336000. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 29.4°C; dissolved oxygen ≥ 5.0 mg/L and pH range is <6.0 or >9.0).

Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm)	pH
Mean	18.62	8.75	1978.89	8.54
Standard Deviation	7.13	1.57	599.51	0.24
Median	20	8.5	2150	8.6
Minimum	-0.4	3.4	421	7.8
Maximum	32.3	13.7	2770	9.2
Number of Points	14629	14543	14572	14,576
Number of Points below or above standard	306 (above)	26 (below)	–	521 (above) 0 (below)
% Exceedance	2.09%	0.18%	–	3.57%

Table 5. Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Little Missouri River at Theodore Roosevelt National Park from April 5 to October 13, 2022, at USGS Gaging Station 06336000. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 29.4°C; dissolved oxygen $\geq$ 5.0 mg/L and pH range is <6.0 or >9.0).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (μ S/cm)	pH
April 5–30, 2022	Number of measurements	1,695	1,618	1,677	1,706
	Mean	4.3	11.97	1,515.21	8.93
	Standard Deviation	3.31	0.83	446.65	0.2
	Median	4.5	12	1,710	9
	Minimum	-0.4	8.8	576	8.4
	Maximum	12.4	13.7	2,020	9.2
	% Exceedance	0%	0%	–	31%
May, 2022	Number of measurements	71	81	46	81
	Mean	11.84	9.65	437.46	8.21
	Standard Deviation	0.24	0.06	8.66	0.03
	Median	11.8	9.6	439	8.2
	Minimum	11.5	9.6	421	8.2
	Maximum	12.2	9.8	456	8.3
	% Exceedance	0%	0%	–	0%
June, 2022	Number of measurements	2836	2835	2836	2842
	Mean	19.67	8.37	1343.53	8.4
	Standard Deviation	3.51	0.58	204.73	0.15
	Median	19.6	8.3	1330	8.4
	Minimum	12.5	7.2	971	8.2
	Maximum	28.6	9.6	2020	8.8
	% Exceedance	0%	0%	–	0%
July, 2022	Number of measurements	2,976	2,960	2,976	2,896
	Mean	24.65	7.51	1,686.32	8.32
	Standard Deviation	2.91	0.94	525.03	0.24
	Median	24.6	7.5	2,040	8.3
	Minimum	18	3.4	543	7.8
	Maximum	32.3	9.7	2,250	8.8
	% Exceedance	6%	1%	–	0%

Table 5 (continued). Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Little Missouri River at Theodore Roosevelt National Park from April 5th to October 13, 2022, at USGS Gaging Station 06336000. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 29.4°C; dissolved oxygen $\geq$ 5.0 mg/L and pH range is <6.0 or >9.0).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (μ S/cm)	pH
August, 2022	Number of measurements	2,975	2,973	2,975	2,975
	Mean	23.45	7.95	2,323.76	8.53
	Standard Deviation	3.28	0.85	118.29	0.06
	Median	23.4	7.9	2,350	8.5
	Minimum	16.1	5.3	2150	8.3
	Maximum	31	10	2,540	8.6
	% Exceedance	4%	0%	–	0%
September, 2022	Number of measurements	2,880	2,880	2,880	2,880
	Mean	17.54	9.02	2,686.00	8.61
	Standard Deviation	3.59	0.97	40.42	0.04
	Median	17.3	9	2,690	8.6
	Minimum	10.5	6.8	2540	8.5
	Maximum	26.6	10.9	2,770	8.7
	% Exceedance	0%	0%	–	0%
October 1–13, 2022	Number of measurements	1,196	1,196	1,182	1,196
	Mean	12.4	9.65	2,366.94	8.68
	Standard Deviation	3.41	1.03	253.9	0.08
	Median	12.9	9.8	2,380	8.7
	Minimum	3.6	7	1750	8.5
	Maximum	18.9	11.8	2,730	8.8
	% Exceedance	0%	0%	–	0%

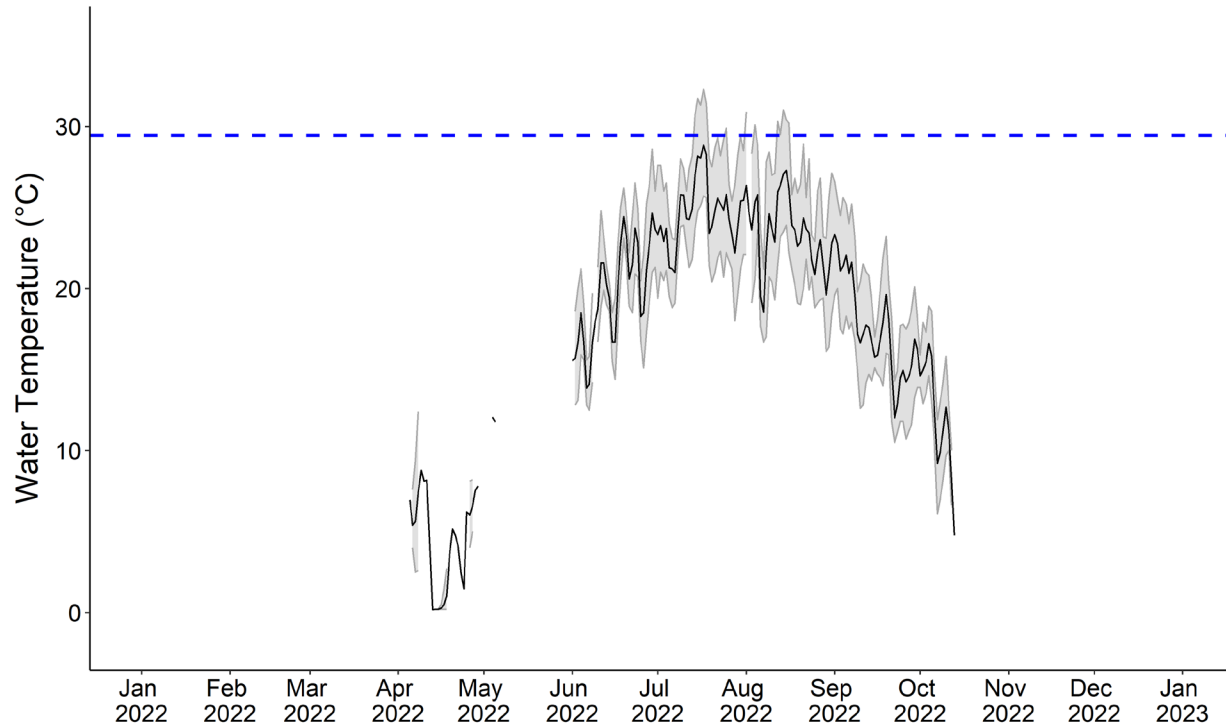


Figure 6. Daily mean water temperature (black line) collected on the Little Missouri River at Theodore Roosevelt National Park from April 5 to October 13, 2022, at USGS Gaging Station 06336000. The gray ribbon shows the daily maximum and minimum water temperature for the same period. The dashed blue line indicates one of the North Dakota 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.

Dissolved oxygen also displayed seasonal variation (Table 5, Figure 7). Higher mean dissolved oxygen concentrations occurred in the spring and fall, with a maximum monthly average of 9.65 mg/L in October 2022. Dissolved oxygen was lowest in July 2022 where the minimum dissolved oxygen level dipped down to 3.4 mg/L with .88% exceedance for the month.

Specific conductance of the Little Missouri River was highly variable throughout the year (Table 5, Figure 8), and showed a less predictable seasonal pattern than temperature or dissolved oxygen concentrations. The pH of the Little Missouri River ranged between 7.9 and 8.9 (Figure 9) and exceeded North Dakota water quality standards in April 2022.

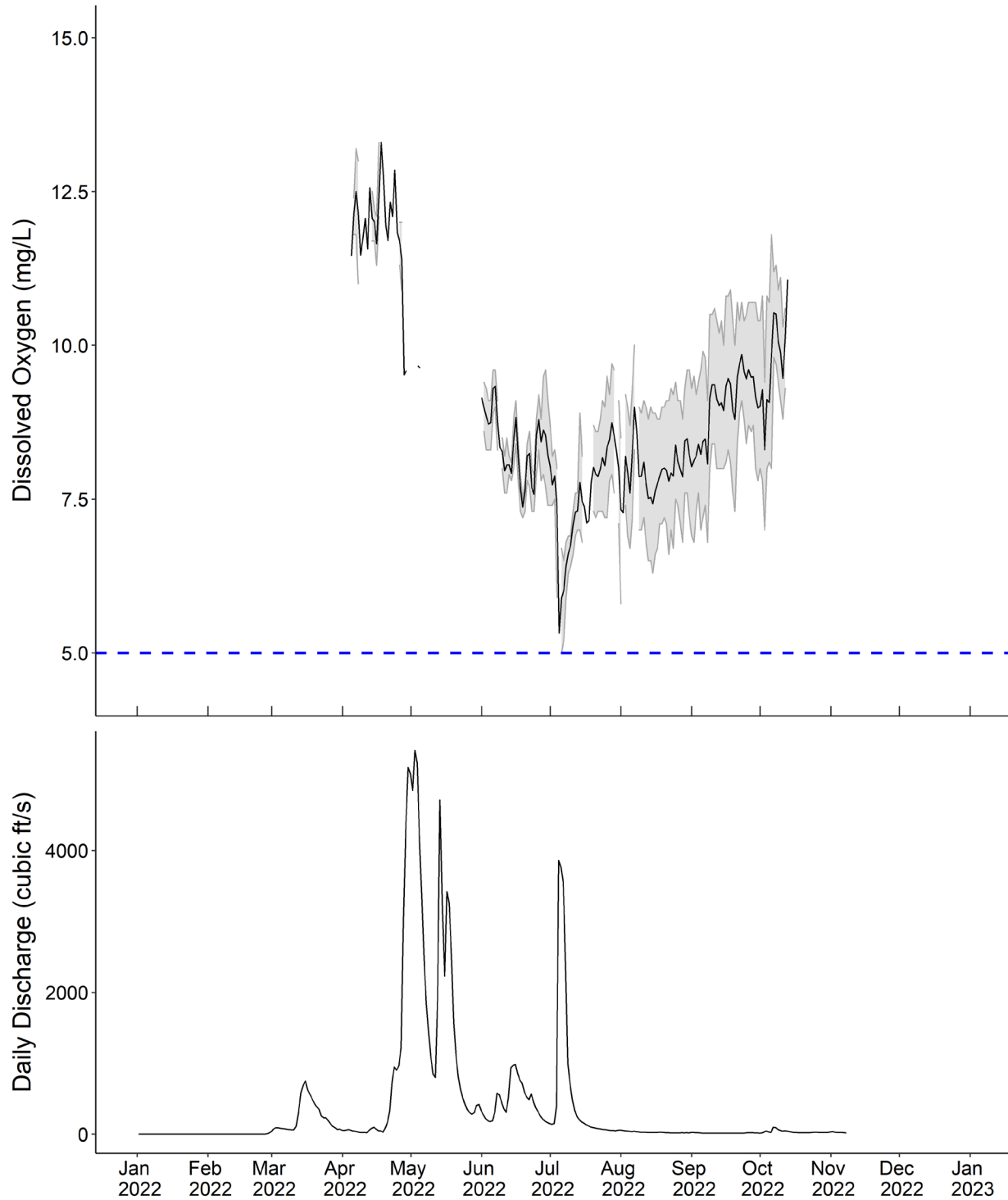


Figure 7. Daily mean dissolved oxygen concentrations (top) and daily discharge (bottom) of the Little Missouri River at Theodore Roosevelt National Park from April 5 to October 13, 2022, at USGS Gaging Station 06336000. The gray ribbon shows the daily maximum and minimum dissolved oxygen for the same period. The dashed blue line indicates one of the North Dakota 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.

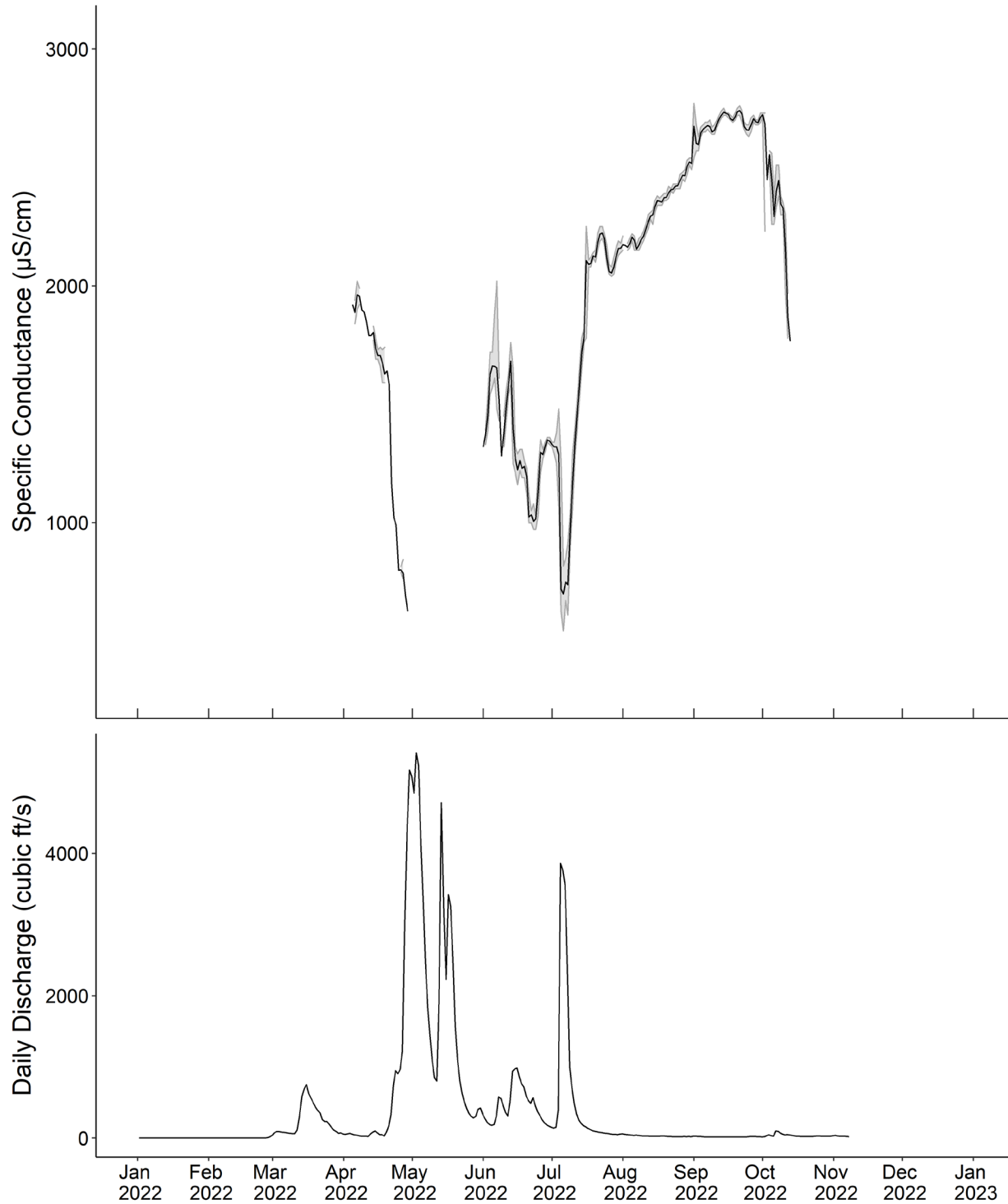


Figure 8. Daily mean specific conductance (top) and daily discharge (bottom) of the Little Missouri River at Theodore Roosevelt National Park from April 5 to October 13, 2022, at USGS Gaging Station 06336000. The gray ribbon shows the daily maximum and minimum specific conductivity for the same period. The periods where the instrument did not collect data are indicated by gaps in the record.

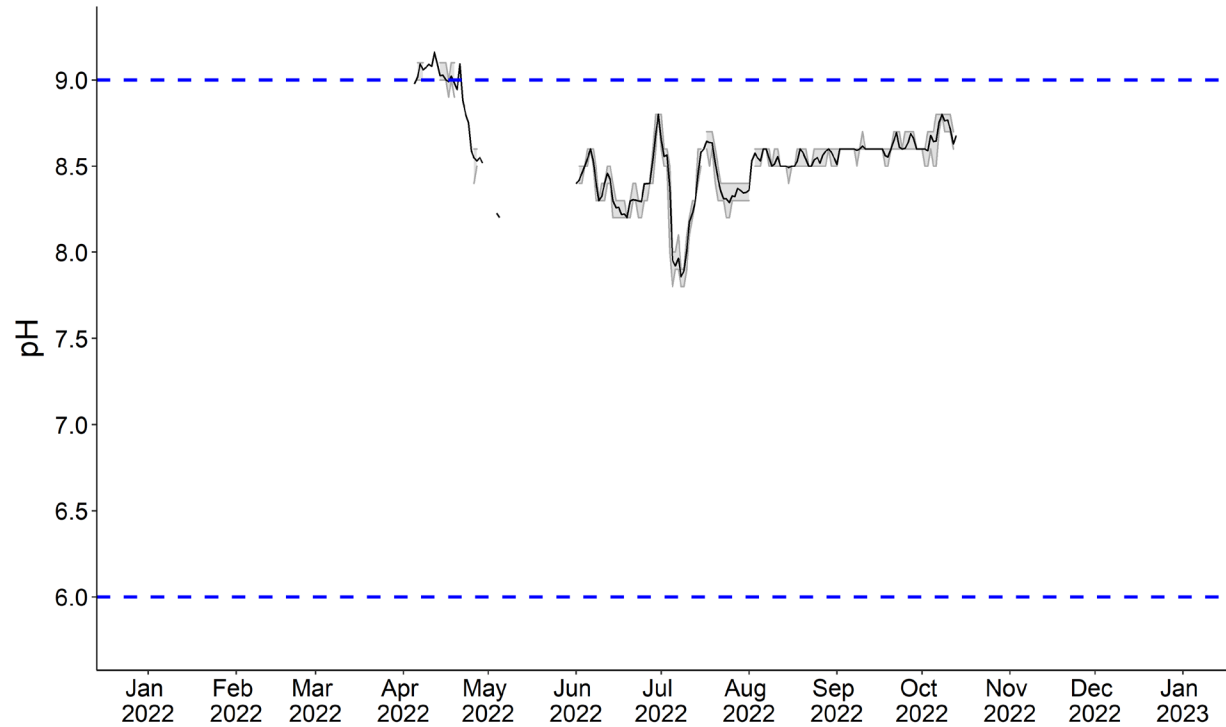


Figure 9. Daily mean pH (black line) of the Little Missouri River at Theodore Roosevelt National Park from April 5 to October 13, 2022, at USGS Gaging Station 06336000. The gray ribbon shows the daily maximum and minimum pH for the same period. The dashed blue lines indicate the North Dakota state water 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 Data Report is intended to provide a basic review of the data collected during the 2022 water quality monitoring season at Theodore Roosevelt National Park. 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 for site 06336000](#).

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Appendix A.

Table A-1. Recent ND Department of Environmental Quality (NDDEQ) *E. coli* counts from Water Quality Portal.

Date	Result (#/100ml)	
	South Unit 21NDHDWQ_WQX-380022 Little Missouri River Medora	North Unit 21NDHDWQ_WQX-380059 Little Missouri River Highway 85
5/13/2014	70	100
7/7/2014	920*	940*
8/12/2014	>24000*	>24000*
5/12/2015	40	10
6/9/2015	100	>24000*
7/21/2015	10	100
8/25/2015	8000*	200*
5/17/2016	130*	10
6/8/2016	700*	2700*
7/25/2016	80	1300*
8/22/2016	50	70
5/15/2017	360*	140*
6/14/2017	110	80
7/19/2017	720*	260*
8/14/2017	>24000*	16000*
5/1/2018	52	41
5/22/2018	180*	590*
6/5/2018	430*	3400*
7/17/2018	41	31
8/21/2018	150	41
5/6/2019	20	20
5/20/2019	1600*	2500*
6/10/2019	52	200*
7/22/2019	41	110
9/3/2019	74	0
5/19/2020	330*	830*
6/4/2020	52	200*
7/6/2020	1700*	>24000*
8/18/2020	2900*	960*
5/4/2021	75	63
6/28/2021	350*	360*
7/27/2021	540*	1100*
8/10/2021	110	1000*

5/19/2022	400*	1600*
6/8/2022	6100*	5200*
7/13/2022	1600*	9200*
8/17/2022	20	84
9/6/2022	NA	0
9/12/2022	NA	31
9/21/2022	NA	63
9/22/2022	NA	41
9/27/2022	NA	63
5/18/2023	1300*	2400*
6/20/2023	590*	370*
7/18/2023	86	430*
8/9/2023	NA	16000*

* E. coli count > 126/100ml, which exceed the ND water quality standard, also shown in bold. Counts marked >24000 were coded as 'too numerous to count.'

Appendix B.

USGS Water Data Quality Report for Little Missouri River 06336000, 2022 and Station Analysis.

06336000 LITTLE MISSOURI RIVER AT MEDORA, ND

LOCATION—Lat 46°55'05.06", long 103°31'49.24" referenced to North American Datum of 1983, in T.140 N., R. 102 W., Billings County, ND, Hydrologic Unit 10110203, on left bank 50 ft above bridge on U.S. Highway 10, one quarter of a mi west of Medora, and 1 1/4 mi upstream from Andrews Creek.

DRAINAGE AREA—6,190 mi². approximately.

REVISIONS HISTORY—WSP 546: Drainage area, WSP 1279: 1903–7, 1923–24, 1930–31, 1934(M), When the gage was re-established in March 2001, the base gage was incorrectly set 0.84 ft too low. All gage heights since October 1, 2002, and the 2001 peak stage have been corrected, Unit values and daily values data for water years 2001-02 have not been adjusted, Discharge data for those years are unaffected by this correction.

SURFACE-WATER RECORDS

PERIOD OF RECORD—DAILY DISCHARGE—May 1903 to October 1908, October to November 1921, April, May, and December 1922, May 1923 to September 1924, October 1928 to September 1934, October 1945 to September 1975, March 2001 to current year, Monthly discharge only for some periods, published in WSP 1309.

PERIOD OF RECORD.·DAILY GAGE HEIGHT—August 2001 to current year.

GAGE—Water-stage recorder on upstream side of highway bridge, Datum of gage is 2248.44 ft above North American Vertical Datum of 1988 (NAVD88). National Geodetic Vertical Datum of 1929 (NGVD29) datum was converted to NAVD88 datum using the National Geodetic Surveys VDATUM transformation tool in November, 2017. Prior to October 1, 2017, datum was published as 2,246.75 ft above the NGVD29. September 1951 to September 1975, recording gage 600 feet downstream at current datum. October 9, 1945, to August 22, 1951, non-recording gage at current location at current datum. Prior to October 9, 1945, non- recording gages at several sites within 0.2 miles upstream from present site at various datums.

REMARKS—Accuracy of records for water years prior to 2014 are noted in the individual Annual Data Reports for those water years. For water years 2014 onward, records good except for estimated discharges, which are poor, unless otherwise noted.

U.S. Department of the Interior

U.S. Geological Survey

Suggested citation: U.S. Geological Survey, 2022, National Water Information System data available on the World Wide Web (USGS Water Data for the Nation), accessed [November 14, 2022], https://mvis.waterdata.usgs.gov/nwis/wysJpt?dv_ts_ids=&91565&adr_begin_date=2019-10-01&adr_end_date=2020-09-30&site_no=06336000&agency_cd=USGS

Record: The monitor was ran at the station from 4/5/22 until 10/13/22 when the monitor was removed. This was part of NPS project that every three years we run a monitor for the open water period. The monitor recorded water temperature, specific conductance, pH, and dissolved oxygen. The monitor provided a good record for the period with only loss of data occurring in April due to monitor becoming buried over time due to high flows. Complete loss of data from 5/5 to 6/1 due to monitor buried. After monitor was retrieved and new one was installed on 6/1 the monitor provided a good record for the rest of the period.

Site characteristics: The river is a muddy sand bottom channel that has numerous sand bars throughout the reach. The monitor is located upstream side of bridge where the river is around 200 ft wide. River is subject to very high flows that cause shifting sand across the channel redefining the channel bed.

Instrumentation: A YSI 6920 V2 with optical DO, SN: 14J100034 started the period and then was replaced with SN: 03F1096AC on 6/1/22 for rest of period. The monitor was strung through conduit and attached to a fence post near the right bank by the bridge. Water temperature, specific conductance, and dissolved oxygen collected at station.

Field Visits: Five field visits were made to the monitor during this period. All visits cleaned the monitor and calibration checks were done usually every other visit other than 7/14 where river too deep to retrieve the monitor. DO and SC were stable during its calibration checks.

Deletions:

WT: Numerous trims and deletions were used from start of period until 6/1 when the monitor was becoming buried during high flows.

SC: Data was deleted during the same periods that the WT was deleted early in period when monitor was becoming buried. After 6/1, only couple deletions used for fouling spikes in the period.

pH: Data was deleted during the same periods that the WT was deleted early in period when monitor was becoming buried. After 6/1, only few deletions used for fouling spikes in the period and on 7/16 when monitor became partially buried and removed some data before data trace stabilized.

DO: Data was deleted during the same periods that the WT was deleted early in period when monitor was becoming buried. After 6/1, only few deletions used for fouling spikes in the period.

Fouling Corrections:

WT: None, all field meter readings within 0.2 deg of monitor.

SC: Prior to the 6/1 visit no corrections needed as assume monitor was good until became buried. From the 6/1 visit, assume monitor stays clear until high flows occur causing the fouling seen at 8/2 visit. The total correction is slightly over 25% during 7/16 to 8/2, but the cause is well documented, and the data trace looks good and compares well with trace after cleaning. A visit on 7/14 for field meter readings also help verify the SC during this time. Max allowable correction is 30% per USGS methods.

Table B-1. Specific Conductance Fouling Corrections.

Start Time	End Time	Correction Amount(s)	Comments
7/4/2022 19:45	7/14/2022 11:30	Start Shift Points: 0, 0; End Shift Points: 0, 0; 10000, 2500;	monitor FP gets swept from high flows and monitor becomes partially buried. Based on discharge assume the fouling prorated over this time to field meter check visit.
7/14/2022 11:45	8/2/2022 11:00	Start Shift Points: 0, 0; 10000, 2500;	fouling correction due to partially buried, carried back to field meter check. After the 8/2 visit showed very minor drift and fouling correction and just applied them as zero correction to end the period on 10/13.

pH:

Table B-2. pH Fouling Corrections.

Start Time	End Time	Correction Amount(s)	Comments
7/17/2022 0:00	8/2/2022 11:00	Start Shift Points: 0, 0.88;	fouling correction from being partially buried carried back to start of fouling. Advanced: Point

DO:

Table B-3. Dissolved Oxygen Fouling Corrections.

Start Time	End Time	Correction Amount(s)	Comments
7/14/2022 11:15	8/2/2022 11:00	Start Shift Points: 0, 0; End Shift Points: 0, 1.1;	fouling correction from when check showed was still good. Based on the field meter check on 7/14, assumed that any fouling prior to this date was minor.
8/2/2022 11:45	10/13/2022 10:45	Start Shift Points: 0, 0; End Shift Points: 0, - 0.02;	minor fouling Advanced: Point

Calibration Drift Corrections:

WT: 5 point check of first monitor 14J100034 showed a 0.42 average correction and this was applied to all WT readings for this monitor until it was replaced on 6/1. The new monitor did not need any corrections for the remainder of the period.

SC: No correction needed prior to the 6/1 visit as old monitor was damaged and could not get calibration results.

Table B-4. Specific Conductance Calibration Corrections.

Start Time	End Time	Correction Amount(s)	Comments
6/1/2022 9:30	8/2/2022 11:15	Start Shift Points: 0, 0; End Shift Points: 0, 0; 10000, -300;	drift correction, did not recalibrate Advanced: Point
8/2/2022 11:45	10/13/2022 10:45	Start Shift Points: 0, 0; 10000, -300; End Shift Points: 0, 0;	Minor drift between visits Advanced: Point

pH:

Table B-5. pH Calibration Drift Corrections.

Start Time	End Time	Correction Amount(s)	Comments
6/1/2022 9:30	8/2/2022 11:45	Start Shift Points: 0, 0.0; End Shift Points: 0, - 0.09;	minor drift, no recalibration Advanced: Point
8/2/2022 12:00	10/13/2022 10:45	Start Shift Points: 0, - 0.09; End Shift Points: 0, 0;	minor drift calibration. 10/13 visit showed no drift or fouling correction. Did not add separate correction for fouling during this time.

DO: A few drift corrections were used during the period based on calibration checks done during field visits.

Table B-6. DO Calibration Drift Corrections.

Start Time	End Time	Correction Amount(s)	Comments
6/1/2022 9:30	8/2/2022 11:45	Start Shift Points: 0, 0.0; End Shift Points: 0, -0.09;	minor drift, no recalibration Advanced: Point
8/2/2022 12:00	10/13/2022 10:45	Start Shift Points: 0, -0.09; End Shift Points: 0, 0;	minor drift calibration. 10/13 visit showed no drift or fouling correction. Did not add separate correction for fouling during this time.

Other Corrections: 5-point checks on water temp were done on 3/25 and 6/1/22 before monitors were installed for the open water season for instrument # 91292794. No correction needed for the period after 6/1/22.

Table B-7. Other Corrections: 3/25/22.

NIST	Instrument	Correction
26.46	26.12	0.37
21.04	20.63	0.41
40.27	39.77	0.5
8.52	7.86	0.66
14.72	14.57	0.15
	Average	0.42 BAD

Table B-8. Other Corrections: 06/01/22.

NIST	Instrument	Correction
20.2	20.1	0.1
4.12	4.06	0.06
36.46	36.34	0.12
28.15	28.11	0.04
13.97	13.97	0
	Average	0.06 OK

Cross-section surveys: One cross section was collected during the period on 6/1. The cross section was collected at the bridge near the monitor location and showed well mixed conditions. The cross section results compared well with the installed monitor and no correction is needed. Historically this station shows well mixed conditions during all flow regimes.

Comparisons:

WT: The water temperature compares well with the other nearby stations at 06340590 and 06342500. Similar temperature trends are seen. The diurnal temperature pattern is seen throughout the period.

SC: The SC compares well with the discharge at the station. An inverse relationship is seen with the SC to the discharge with all runoff events seeing the corresponding decrease in SC concentrations. The SC graph compares well with other nearby station 06340590.

pH: The pH compared well with the one other nearby station that had pH 06340590. The pH was fairly steady for most of the period.

DO: Do compares well with the other nearby station 06340590. Similar trends are seen between the two. The common diurnal pattern with seen throughout the period and compares well with air temperature from NDAWN station at Hazen 06340500.

Remarks: SIMS station description was reviewed, and updated water quality section. Overall, the record for all the parameters is fair to good through the period other than from 4/5 to 6/1 when all parameters are in poor condition.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS XXX/XXXX, January 2024

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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

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