National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Water Quality Monitoring for Knife River Indian Villages National Historic Site

2016 Data Report

Natural Resource Data Series NPS/KNRI/NRDS—2020/1262

ON THE COVER

Downstream from USGS Gaging Station 06340590 on the Knife River in July 2016 at Knife River Indian Villages National Historic Site, North Dakota.

Photograph courtesy of the United State Geological Survey

Water Quality Monitoring for Knife River Indian Villages National Historic Site

2016 Data Report

Natural Resource Data Series NPS/KNRI/NRDS—2020/1262

Isabel Ashton
Stephanie Rockwood

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

February 2020

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of those protocols

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from Northern Great Plains Network website, and the Natural Resource Publications Management website. If you have difficulty accessing information in this publication, particularly if using assistive technology, please email irma@nps.gov.

Please cite this publication as:

Ashton, I.W. and S.L. Rockwood. 2020. Water quality monitoring for Knife River Indian Villages National Historic Site: 2016 data report. Natural Resource Data Series NPS/KNRI/NRDS—2020/1262. National Park Service, Fort Collins, Colorado.

NPS 468/166928, February 2020

Contents

Figures iv

Tables v

Abstract vi

Introduction 1

Methods 5

Data Collection 5

Results 8

Further Analysis 18

Literature Cited 19

Appendix A. USGS Water Data Quality Report for Knife River 06340590, 2016 20

Figures

Page

Figure 1. Map of the Knife River Indian Villages National Historic Site and the Knife River in North Dakota 1

Figure 2. Map of Knife River Indian Villages National Historic Site and water quality monitoring location (blue triangle) and nearby weather station (red flag) 3

Figure 3. A sonde device is used to measure water quality on the Knife River in 2016 at Knife River Indian Villages National Historic Site (right panel) 5

Figure 4. Daily mean discharge (black line) in 2016 on the Knife River at Knife River Indian Villages National Historic Site, USGS Gaging Station 06340590. 8

Figure 5. Total monthly precipitation (red bars) and average monthly minimum (green line) and maximum (blue line) temperature for 2016 in Knife River Indian Villages National Historic Site (top panel) 9

Figure 6. Daily mean water temperature (black line) collected on the Knife River at Knife River Indian Villages National Historic Site in 2016 13

Figure 7. Daily mean dissolved oxygen concentrations (top) and daily discharge (bottom) of the Knife River in 2016 at Knife River Indian Villages National Historic Sit 15

Figure 8. Daily mean specific conductance (top) and daily discharge (bottom) of the Knife River in 2016 at Knife River Indian Villages National Historic Site 16

Figure 9. Daily mean pH (black line) of the Knife River at Knife River Indian Villages National Historic Site in 2016 17

Tables

Page

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 2019).....4

Table 2. Field journal for 2016 Water Quality Sampling at Knife River Indian Villages National Historic Site.....6

Table 3. Summary of descriptive statistics for water temperature, dissolved oxygen, specific conductance, and pH measured for the ice-free sampling period at Knife River Indian Villages National Historic Site in the Knife River from March 10 to November 3, 2016.....10

Table 4. Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Knife River Indian Villages National Historic Site in the Knife River from March 10 to November 3, 2016.....11

Abstract

The Northern Great Plains Inventory and Monitoring Network (NGPN) began monitoring water quality in the Knife River at Knife River Indian Villages National Historic Site (KNRI) in 2013, with the assistance of the U.S. Geological Survey (USGS). This report summarizes the data collected during the 2016 ice-free season (March 10 through November 3) for streamflow, water temperature, dissolved oxygen, specific conductance, and pH.

2016 was a moderately dry year and discharge on the Knife River peaked at only 800 cubic feet per second in April. 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 ice-free season (Table 2) and for each month (Table 3). Notably, water temperature exceeded state standards in summer months although these exceedances made up less than 2% of all records.

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.

Introduction

Knife River Indian Villages National Historic Site (KNRI) was established in 1974 with a mission to commemorate the culture and history of the Northern Great Plains Indian peoples and to preserve, study, and interpret the historic and archeological resources of the site. KNRI sits on 1,758 acres of upland mixed-grass prairie and riparian forests, at the confluence of the Knife and the Missouri River. The Knife River originates in the Badlands of west-central North Dakota and flows about 200 miles (193 km) until it reaches the Missouri River (Figure 1). KNRI is in a semi-arid region that averaged 19 inches of precipitation annually from 1995-2015, but extreme variation in temperature and precipitation is common in this region.

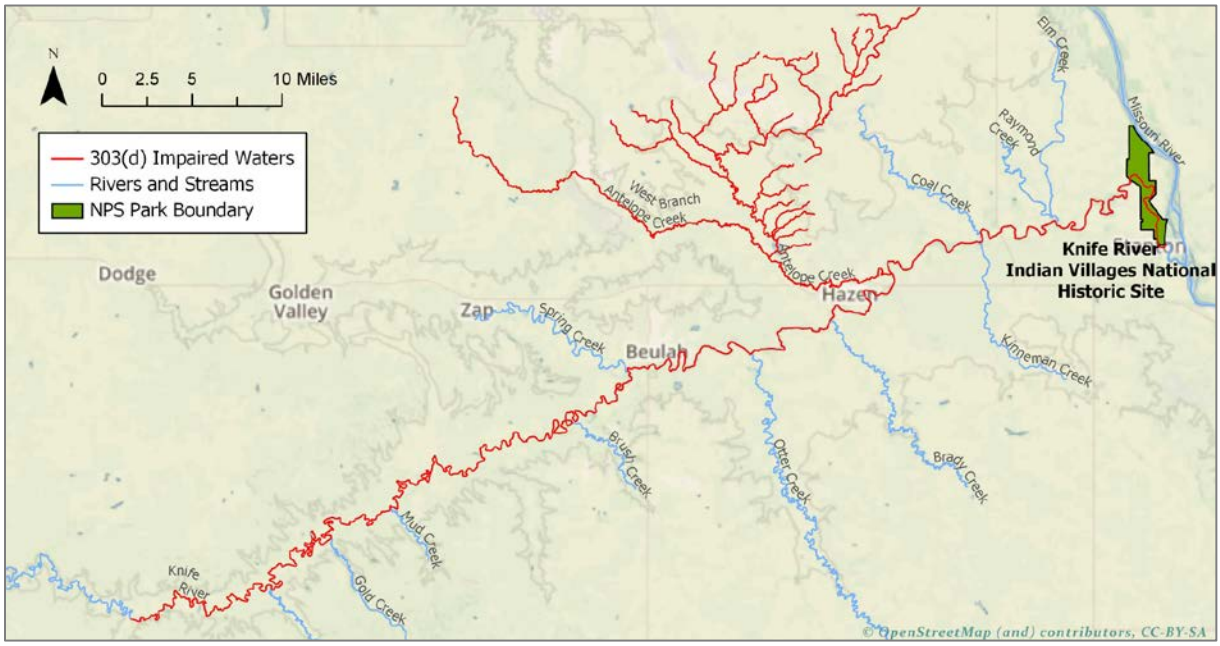

Figure 1. Map of the Knife River Indian Villages National Historic Site and the Knife River in North Dakota. The stretch of the river running through the monument, is listed as impaired under 303(d) criteria (indicated in red) for fecal coliform.

The Knife River flows through about 3 miles of the park and many of the archeological sites are on or close to the banks of the river (National Park Service 2013). In this area, river flow tends to peak between March and May, while annual low flows occur in November and December (NPS 1997).

The Knife River is designated as a Class II water in North Dakota. Class II waters are similar to Class I 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" but for Class II additional treatment may be required to meet drinking water requirements (NDDEQ 2019). The stretch of the Knife River that runs through KNRI is listed as an impaired waterway under section 303(d) of the Clean Water Act and is listed for *Escherichia coli* (ND Department of Health 2019). Fecal coliform concentrations were found to be as high as 2419 CFU / 100 ML in 2011, which is

almost ten times the maximum concentration for recreation (Tronstad 2013). The source of the *E. coli* and fecal coliform is not known, but livestock feeding operations, agriculture, and failing septic systems are likely contributors. For more details and current impairment information visit the North Dakota Department of Environmental Quality website.

The Knife River is characterized by a large amount of organic matter (Tronstad 2013) and a high sediment load. In one study, the Knife River was found to transport 1690 tons of sand per day and 270 tons of clay and silt (Berkas 1995). Riverbank erosion is a continued threat to archeological resources in the park (National Park Service 2013).

The Northern Great Plains Inventory & Monitoring Network (NGPN) began monitoring water quality at KNRI in 2013 to better understand current conditions and changes over time in the Knife River (Ashton and Rockwood 2020). The monitoring is conducted at the gaging station at Knife River Indian Villages National Historic Site, ND (Monitoring Location 06340590; 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 repeats water quality monitoring at KNRI every three years and 2016 was the second monitoring season (Wilson et al. 2014), conducting in-depth analysis of status and trends after 3 to 5 cycles of sampling.

NGPN's core water quality parameters include streamflow, dissolved oxygen, 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.

Figure 2. Map of Knife River Indian Villages National Historic Site and water quality monitoring location (blue triangle) and nearby weather station (red flag). Climate data in this report is taken from the Knife River 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 2019).

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 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 06340590) inside the park, at around 1640 ft. elevation. Water quality and streamflow are measured every 15 minutes throughout the ice-free season. Monitoring at KNRI began in 2013, was repeated in 2016, and will be repeated every three years thereafter. Program funding currently limits monitoring to a cycle of one year of monitoring, followed by two years without.

In 2016, NGPN partnered with the USGS North Dakota Water Science Center to have USGS staff collect water quality and streamflow data at KNRI. The USGS deployed a continuous, multi-parameter sonde along the left bank downstream of the bridge along the Knife River on March 10, 2016 (Figure 3) and visited the gaging station every 3–4 weeks for equipment maintenance (Table 2). This instrument recorded dissolved oxygen, pH, specific conductivity, and water temperature every 15 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 Knife River in 2016 at Knife River Indian Villages National Historic Site (right panel). The United States Geological Survey Knife River gaging station (06340590) is set up for real-time data transmission via satellite (left panel). Photographs courtesy of NPS.

Table 2. Field journal for 2016 Water Quality Sampling at Knife River Indian Villages National Historic Site.

Date	Notes
March 10, 2016	Installed gage and monitor, ~ 11 am. Cable was not long enough for bridge deployment, installed on left bank downstream from bridge. Problems with Satlink.
March 11, 2016	Replaced Satlink – recording but still not transmitting. Collected cross section data for water quality monitoring
March 24, 2016	Realigned antennae; Repaired H355
April 7, 2016	Routine service. 200' cable not in yet. Sensors had moderate levels of bugs and worms; wiper was clean. Tried adjusting antennae again, but still not transmitting.
April 26, 2016	Switched tx to east satellite. No high-water marks, no reset.
May 13, 2016	No high-water marks. Replaced antennae and cable, now transmitting. Meter remains deployed along left bank. Cleaned monitor – mud and critters moderate.
June 8, 2016	Routine service. Checked calibration on water quality meter – no resets or recalibrations needed.
June 9, 2016	Replaced batteries. Satlink did not read anything upon arrival – reset at 11:40am, all sensors reading at 12:30pm. YSI probe made Satlink bog down.
June 30, 2016	Routine service – gage good and no reset needed. Cleaned sensors – minor mud and algae
July 21, 2016	Made two sets of measurements – reset twice, with first reset not done right.
July 25, 2016	Routine service – some mud and bugs in guard and specific conductance sensor port. GZF (gage height of zero flow) found; no high-water mark seen.
August 25, 2016	Cleaned sensors – some silting. Checked multi-parameter sonde. No resets, no high-water marks.
September 15, 2016	Checked calibration on multi-parameter sonde; no recalibration. Reset at 12:35pm. No high-water mark seen.
September 28, 2016	Routine service - checked multi-parameter sonde, recalibrated DO sensor. No resets.
November 3, 2016	Routine inspection. Moderate algae, worms, and bugs on sensors. pH sensor not working but appears stable across. Shut down for season and removed equipment ~12:15pm.

Satellite telemetry transmitted the water data to the Water Science Center in near real-time (https://waterdata.usgs.gov/monitoring-location/06340590/). 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 with 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 – data critical to correction and grading of the final data. On November 3, 2016, the USGS removed the multi-parameter sonde from the Knife River (Table 2).

Quality assurance and quality control was conducted by USGS staff following established USGS guidelines (Wagner et al. 2006). NGPN received the final corrected (approved) data in February of 2017 from the USGS, and used AQUARIUS Workstation by Aquatic Informatics (http://aquaticinformatics.com/) and R (R Core Team 2019) 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 there were missing data due to instrument error, means were generated by excluding the missing values and the maximum and minimum were left blank. Means were not calculated for days where all time steps were missing (i.e. the instrument didn't collect any data that day).

Climate data were downloaded from the RAWS Knife River Climate Station. The data were accessed and graphed using the web-based tool Climate Analyzer.

Results

The water quality monitoring season (ice-free) on the Knife River at KNRI lasted from March 10, 2016 to November 3, 2016. The discharge of the Knife River peaked in late April and increased in a few pulses throughout the season (Figure 4). The maximum recorded discharge in 2016 was in April at just over 800 cubic feet per second and the minimum was recorded in August 2016 at less than 40 cubic feet per second (Appendix A). This was much lower than the maximum discharge in 2013 of over 5000 cubic feet per second. In comparison to the past years, 2016 was very dry in August (Figure 5). In 2016, it rained and snowed 15.7 inches with total monthly precipitation peaking in July (Figure 5).

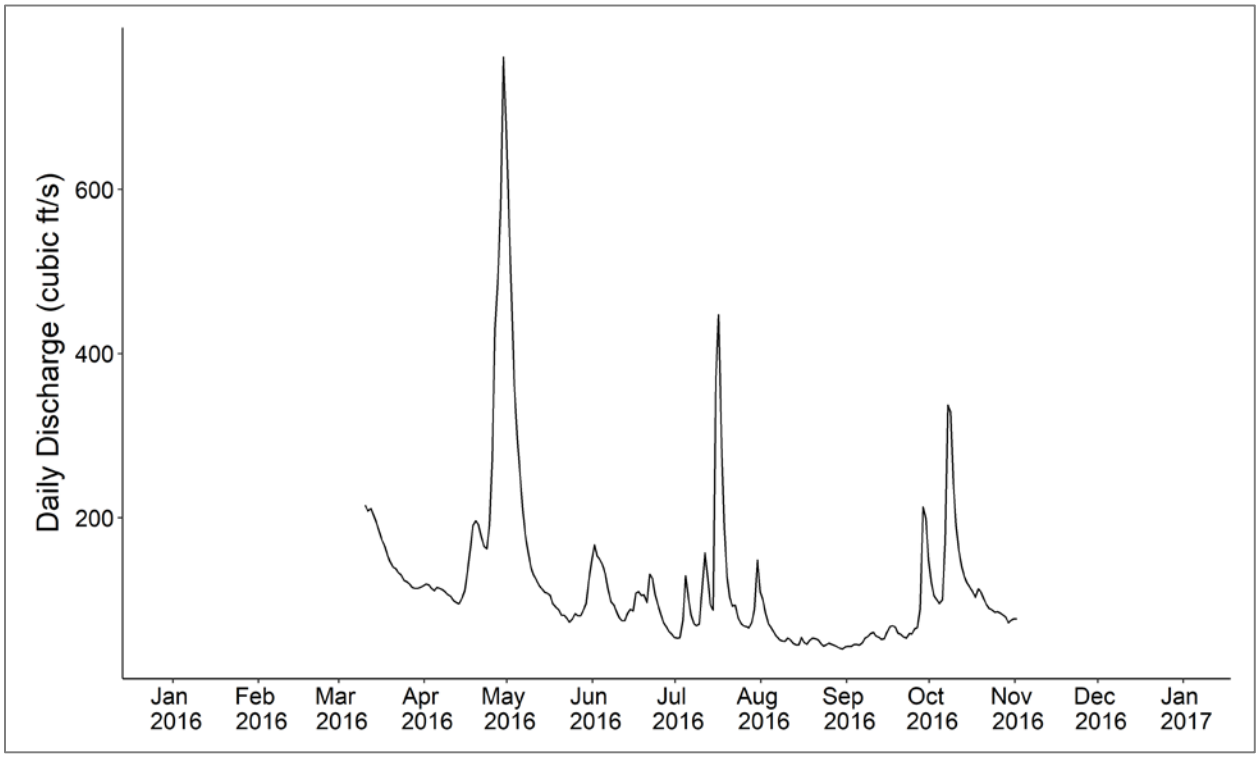

Figure 4. Daily mean discharge (black line) in 2016 on the Knife River at Knife River Indian Villages National Historic Site, USGS Gaging Station 06340590.

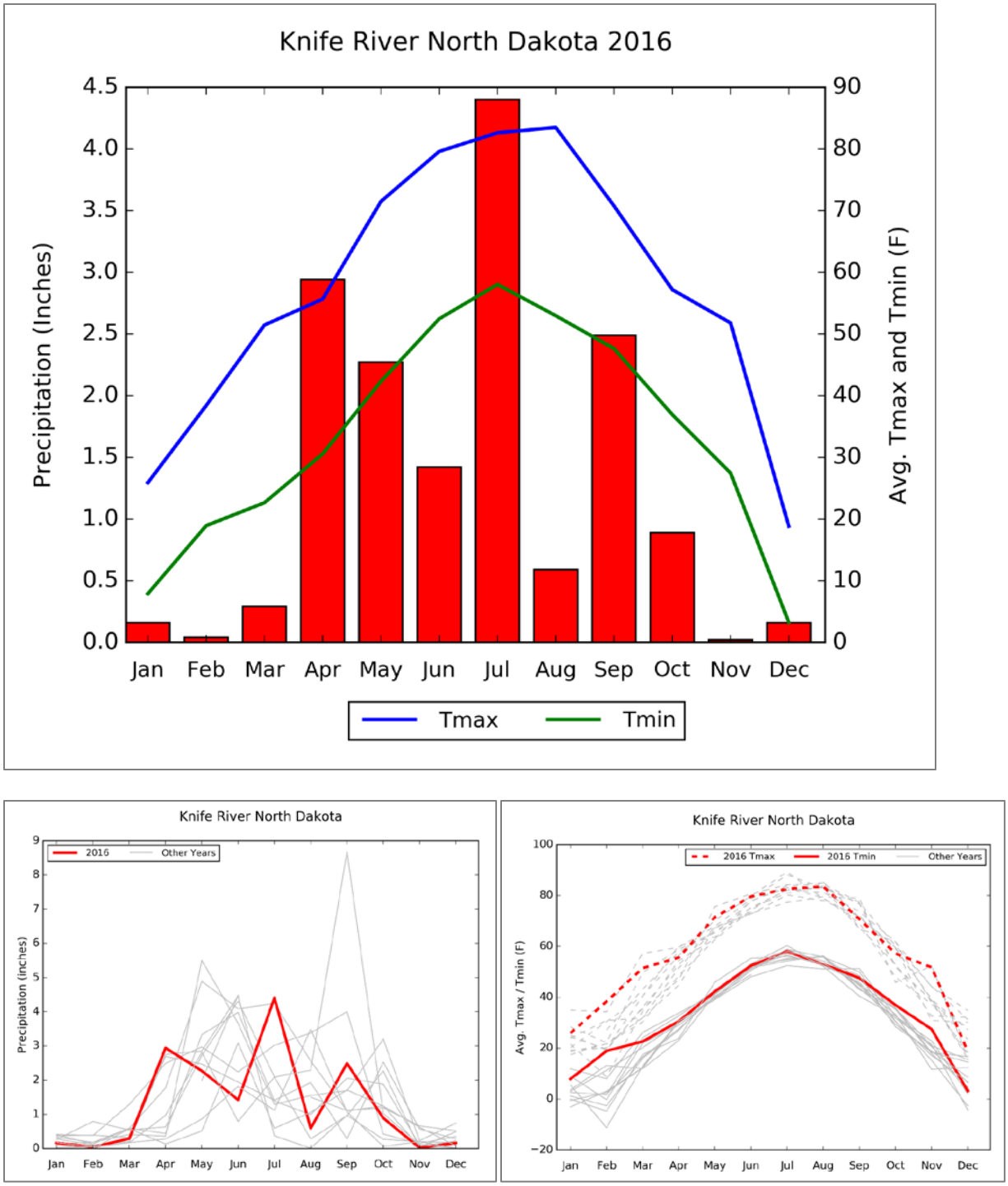

Figure 5. Total monthly precipitation (red bars) and average monthly minimum (green line) and maximum (blue line) temperature for 2016 in Knife River Indian Villages National Historic Site (top panel). A comparison of 2016 precipitation (bottom left) and temperature (bottom right) in Knife River Indian Villages National Historic Site compared to the period of record. Climate data are from Knife River RAWS climate station. The data were accessed and graphed using the web-based tool Climate Analyzer.

During the ice-free season at KNRI, we collected over 20,000water quality measurements in the Knife River (Table 3). We found mean water temperature of 15.6°C, dissolved oxygen concentrations of 9.6 mg/L, specific conductance of 2213, and pH of 8.4 (Table 3). There was, however, variation across months in all parameters (Table 4). Mean water temperature in March was 5°C and increased to a mean of close to 24°C in July before declining back to 8.2°C in November (Table 4, Figure 6). Maximum water temperature exceeded the North Dakota water quality standard of 29.4°C 324 times in June, July, and August (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 Knife River Indian Villages National Historic Site in the Knife River from March 10 to November 3, 2016. 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	15.64	9.59	2213.45	8.43
Standard Deviation	7.49	1.67	434.69	0.10
Median	15.80	9.40	2170.00	8.40
Minimum	-0.10	5.60	1200.00	8.10
Maximum	33.20	14.00	3780.00	8.70
Number of Points	20117	19998	19921	20115
Number of Points below or above standard	324 (above)	0	NA	0
% Exceedance	1.61%	0%	NA	0%

Table 4. Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Knife River Indian Villages National Historic Site in the Knife River from March 10 to November 3, 2016. 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).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	pH
March 10-31, 2013	Number of measurements	1912	1912	1909	1912
	Mean	5.35	12.25	2181.18	8.42
	Standard Deviation	2.81	0.91	22.01	0.06
	Median	5.40	12.20	2180.00	8.40
	Minimum	-0.10	10.40	2120.00	8.30
	Maximum	12.20	14.00	2250.00	8.50
	% Exceedance	0.00	0.00	–	0.00
April, 2013	Number of measurements	2875	2875	2687	2875
	Mean	8.64	11.13	2641.74	8.43
	Standard Deviation	3.12	0.89	403.78	0.07
	Median	8.00	11.10	2420.00	8.40
	Minimum	0.80	9.30	2170.00	8.20
	Maximum	16.40	13.40	3780.00	8.50
	% Exceedance	0.00	0.00	–	0.00
May, 2016	Number of measurements	2968	2967	2968	2968
	Mean	16.70	9.20	2623.46	8.38
	Standard Deviation	3.82	0.84	291.53	0.08
	Median	17.00	9.20	2570.00	8.40
	Minimum	7.50	7.60	2080.00	8.20
	Maximum	25.30	11.40	359.00	8.60
	% Exceedance	0.00	0.00	–	0.00
June, 2016	Number of measurements	2301	2301	2298	2301
	Mean	22.81	8.22	2646.98	8.41
	Standard Deviation	3.57	0.84	157.64	0.07
	Median	22.60	8.20	2630.00	8.40
	Minimum	13.40	6.60	2230.00	8.20
	Maximum	30.70	10.40	2930.00	8.50
	% Exceedance	3.22%	0.00	–	0.00

Table 4 (continued). Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Knife River Indian Villages National Historic Site in the Knife River from March 10 to November 3, 2016. 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).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	pH
July, 2016	Number of measurements	2973	2973	2973	2973
	Mean	23.99	8.08	1845.17	8.42
	Standard Deviation	3.30	1.14	246.49	0.13
	Median	23.70	7.90	1820.00	8.50
	Minimum	17.70	5.60	1200.00	8.10
	Maximum	33.20	11.20	2590.00	8.60
	% Exceedance	7.16%	0.00	–	0.00
August, 2016	Number of measurements	1814	1814	1814	1814
	Mean	23.42	8.07	1814.17	8.38
	Standard Deviation	3.20	0.95	90.35	0.10
	Median	23.40	7.90	1820.00	8.40
	Minimum	14.90	6.40	1400.00	8.10
	Maximum	30.50	10.50	2020.00	8.60
	% Exceedance	2.04%	0.00	–	0.00
September, 2016	Number of measurements	2202	2202	2202	2200
	Mean	16.36	9.16	1924.08	8.43
	Standard Deviation	3.04	0.80	188.91	0.09
	Median	15.80	9.20	1860.00	8.40
	Minimum	9.20	7.20	1710.00	8.10
	Maximum	25.90	11.20	2790.00	8.60
	% Exceedance	0.00	0.00	–	0.00
October, 2016	Number of measurements	2880	2768	2878	2880
	Mean	9.09	10.55	1938.46	8.55
	Standard Deviation	2.92	0.81	267.74	0.07
	Median	8.40	10.60	1880.00	8.60
	Minimum	4.30	8.40	1660.00	8.40
	Maximum	18.40	12.20	3670.00	8.70
	% Exceedance	0.00	0.00	–	0.00

Table 4 (continued). Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Knife River Indian Villages National Historic Site in the Knife River from March 10 to November 3, 2016. 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).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	pH
November 1 - 3, 2016	Number of measurements	192	186	192	192
	Mean	8.22	11.11	1929.11	8.60
	Standard Deviation	1.24	0.41	12.81	0.01
	Median	7.90	11.00	1930.00	8.60
	Minimum	5.90	10.50	1900.00	8.60
	Maximum	10.80	11.80	1950.00	8.70
	% Exceedance	0.00	0.00	–	0.00

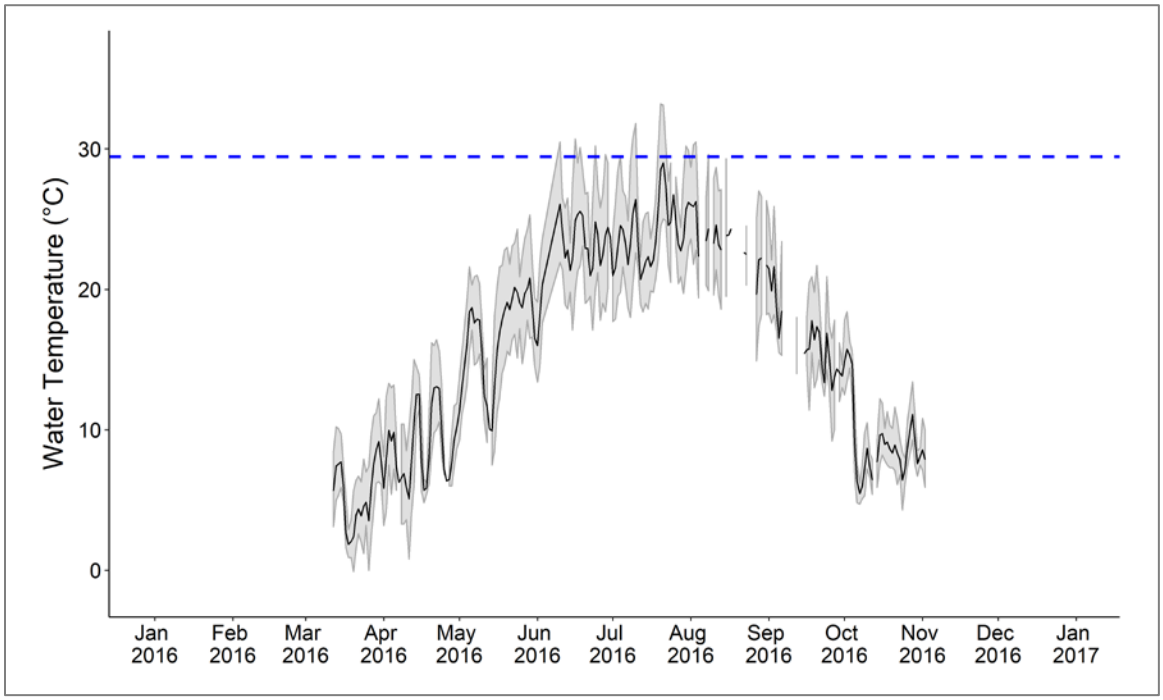

Figure 6. Daily mean water temperature (black line) collected on the Knife River at Knife River Indian Villages National Historic Site in 2016. The sonde was in the water from March 10 through November 3, 2016. The gray ribbon shows the daily maximum and minimum water temperature for the same period. 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 3, Figure 7). The highest mean dissolved oxygen concentrations were in the spring and fall, averaging greater than 10 mg/ L in March, April, October, and November. Dissolved oxygen was never found below North Dakota state water quality criteria (Table 1).

Specific conductance of the Knife River was highly variable throughout the year (Table 3, Figure 8), but showed a less predictable seasonal pattern than temperature or dissolved oxygen concentrations. The pH of the Knife River stayed in a narrow range between 8.1 and 8.7 (Figure 9) and was never outside the range of the North Dakota state standards of 6.0 - 9.0

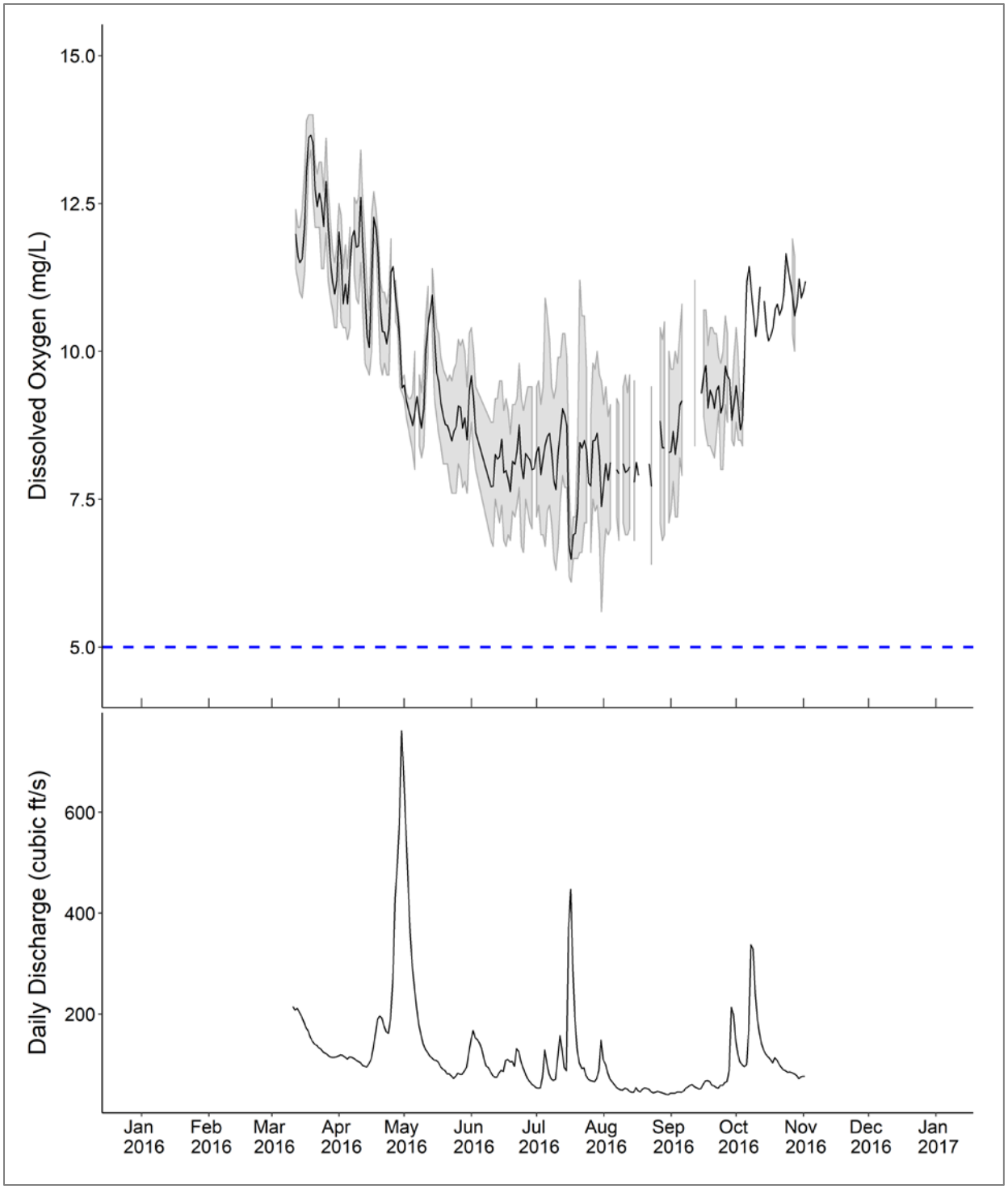

Figure 7. Daily mean dissolved oxygen concentrations (top) and daily discharge (bottom) of the Knife River in 2016 at Knife River Indian Villages National Historic Site. Measurements were taken from March 10 to November 3, 2016. The gray ribbon shows the daily maximum and minimum dissolved oxygen for 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.

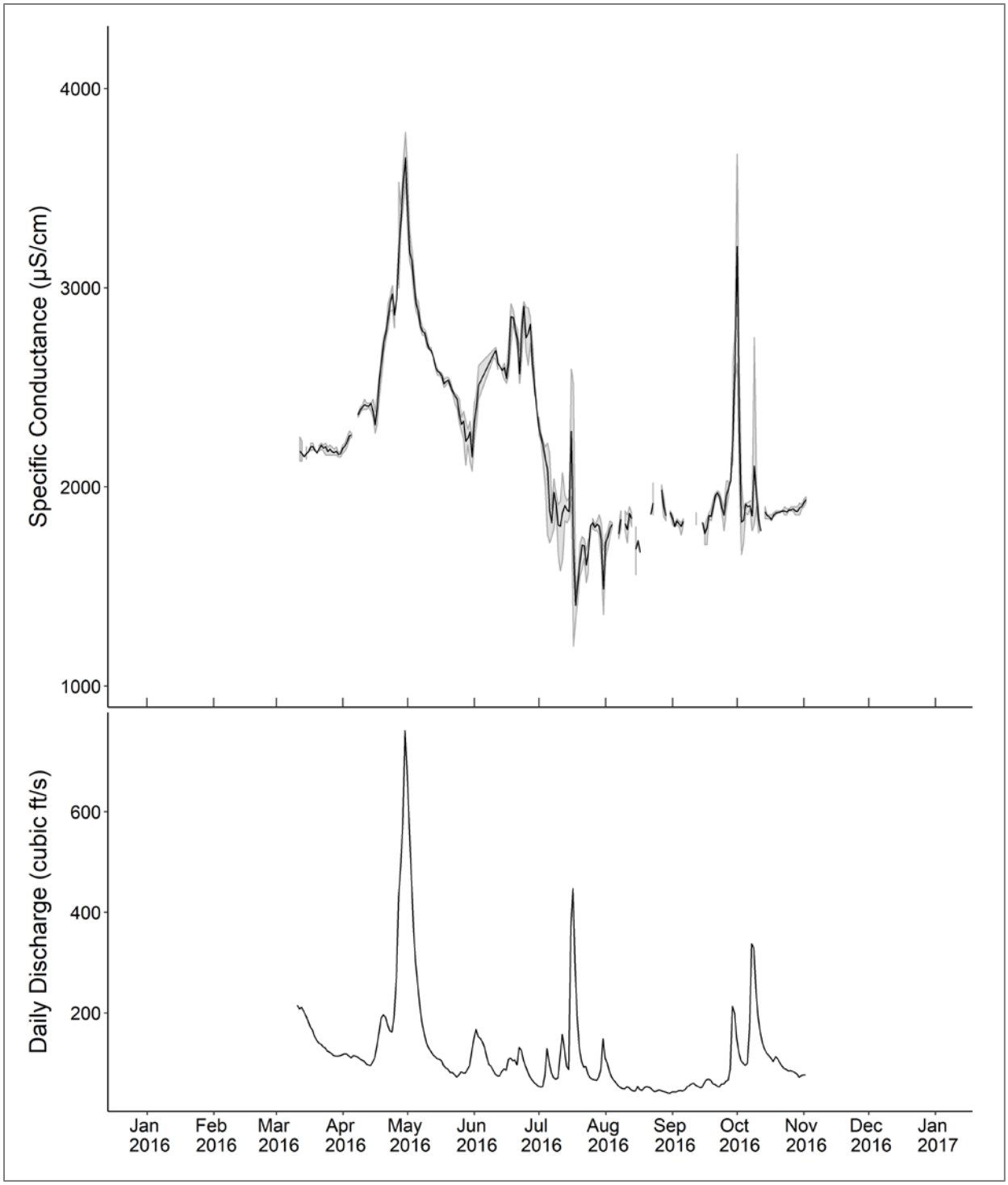

Figure 8. Daily mean specific conductance (top) and daily discharge (bottom) of the Knife River in 2016 at Knife River Indian Villages National Historic Site. Measurements were taken from March 10 to November 3, 2016. The gray ribbon shows the daily maximum and minimum specific conductivity for the same period. The periods where the instrument did not collect data are indicated by gaps in the record.

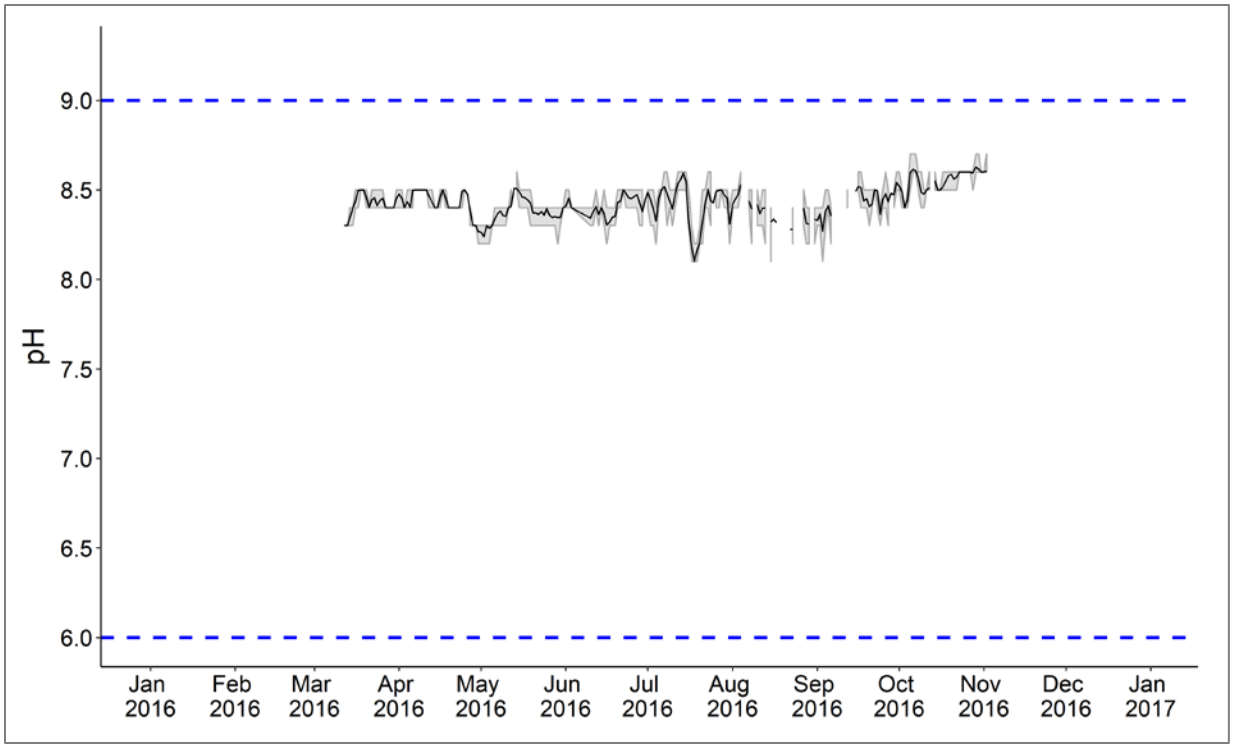

Figure 9. Daily mean pH (black line) of the Knife River at Knife River Indian Villages National Historic Site in 2016. Measurements were taken from March 10 to November 3, 2016. The gray ribbon shows the daily maximum and minimum pH for the same period. The dashed blue lines indicate the North Dakota 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 report is intended to provide a basic review of the data collected during the 2016 water quality monitoring season at Knife River Indian Villages National Historic Site. 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 06340590.

Literature Cited

Ashton, I.W. and S.L. Rockwood. 2020. Water quality monitoring for Knife River Indian Villages National Historic Site: 2013 data report. Natural Resource Data Series NPS/KNRI/NRDS—2020/1257. National Park Service, Fort Collins, Colorado.

Berkas, W. R. 1995. Transpot and sources of sediment in the Missouri River between Garrison Dam and the headwaters of Lake Oahe, North Dakota, May 1998 through April 1991. U.S. Geological Survey. Water-Resources Investigations Report 95-4087.

National Park Service. 2013. Foundation document: Knife River Indian Villages National Historic Site, North Dakota. https://www.nps.gov/knri/learn/management/upload/Foundation.pdf. National Park Service.

ND Department of Health. 2019. North Dakota 2018 integrated Section 305 (b) water quality assessment report and Section 303 (d) list of waters needing total maximum daily loads. North Dakota Department of Health, Division of Water Quality, Bismarck, ND.

NDDEQ. 2019. NDAC Chapter 33.1-16-02.1 Standards of quality for waters of the state. https://deq.nd.gov/WQ/3_Watershed_Mgmt/10_WQStand/WQStand.aspx. North Dakota Department of Environmental Quality.

NPS. 1997. Baseline water quality data inventory and analyis: Knife River Indian Villages National Historic Site. National Park Service. Water Resources Division. Fort Collins, CO. Technical Report NPS/NRWRD/NRTR-97/127.

R Core Team. 2019. R: A language and environment for statistical computing. version 3.6.1. http://www.R-project.org. Vienna, Austria.

Tronstad, L. 2013. Aquatic invertebrate monitoring for Knife River Indian Villages National Historic Site. Natural Resource Technical Report NPS/NGPN/NRTR—2013/778. National Park Service, Fort Collins, Colorado.

Wagner, R. J., R. W. Boulger, C. J. Oblinger, and B. A. Smith. 2006. Guidelines and standard procedures for continuous water-quality monitors: station operation, record computation, and data reporting. . United States Geological Survey Techniques and methods 1-D3. https://pubs.usgs.gov/tm/2006/tm1D3/.

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 Report for Knife River 06340590, 2016

06340590 KNIFE RIVER NR STANTON, ND

LOCATION: Lat 47°21'29", long 101°23'50" referenced to North American Datum of 1927, in SW 1/4 SW 1/4 sec.21, T.145 N., R.84 W., Mercer County, ND, Hydrologic Unit 10130201, on left bank, 10 ft downstream from county bridge, and 2.4 mi north of Stanton.

DRAINAGE AREA: Not determined.

SURFACE-WATER RECORDS

PERIOD OF RECORD: DAILY DISCHARGE--April to October 201 3, March to November 2016 (discontinued).

PERIOD OF RECORD, DAILY GAGE HEIGHT: April to October 201 3, March to November 2016 (discontinued).

GAGE: Water stage recorder. Datum of gage is 1,640 ft above North American Vertical Datum of 1988, from topographic map.

REMARK: 10/ 01/ 15-09/ 30/ 16: Records good except for estimated daily discharges, which are poor.

EXTREMES FOR WATER YEAR 2016: Maximum flow, 806 ft 3 / s, April 3, peak stage, 11.13 ft; minimum daily flow, 40 ft'/ s, August 30 and 31.

REGULATION: Slight regulation by Lake !lo 81 mi upstream, capacity, 7,130 acre-ft.

WATER-QUALITY RECORDS

PERIOD OF DAILY RECORD

WATER TEMPERATURE: April to October 2013, March to November 2016 (Discont inued).

SPECIFIC CONDUCTANCE: April to October 201 3, March to November 2016 (Discontinued).

PH: April to October 2013, March to November 2016 (Discontinued).

DISSOLVED OXYGEN: April to October 2013, March to November 2016 (Discontinued).

INSTRUMENTATION: Multiparameter water-quality monitor.

REMARKS

RECORD RATED WATER TEMPERATURE:

- Period April 4-October 16, 2013: Rated good: April 4-October 16.
- Period March 11-November 3, 2016: Rated good: March 11-November 3.

RECORD RATED SPECIFIC CONDUCTANCE:

- Period April 4-October 16, 2013 : Rated good : April 4-May 20, June 10-October 16. Rated fair: May 21-June 9.
- Period March 11-November 3, 2016: Rated good: March 11-April 28, May 14-July 15, July 26-November 3. Rated fair: April 29-May 9,
- July 16-23. Rated poor: May 10-13, July 24-25.

RECORD RATED PH:

- Period April 4-October 16, 2013: Rated good : April 4-October 16.
- Period March 11-November 3, 2016: Rated good : March 11-November 3.

RECORD RATED DISSOLVED OXYGEN:

- Period April 4-October 16, 2013 : Rated good : April 29-October 16. Rated poor: April 4-28.
- Period March 11-November 3, 2016: Rated good : March 11-November 3.

EXTREMES FOR PERIOD - APRI L 4-OCTOBER 16, 2013:

WATER TEMPERATURE: Maximum recorded, 29 .5°C, July 18; minimum recorded, 0.0°C, April 4, 15.

- SPECIFIC CONDUCTANCE: Maximum recorded, 2,340 microsiemens, July 15; minimum recorded, 761 microsiemens, April 6.
- PH: Maximum recorded, 8.7 units, July 14; minimum recorded, 7.6 units, May 29.
- DISSOLVED OXYGEN: Maximum recorded, 12.4 mill igrams per liter, April 9; minimum recorded, 4.8 milligrams per liter, September 11.

EXTREMES FOR PERIOD - MARCH 11-NOVEMBER 3, 2016:

- WATER TEMPERATURE: Maximum recorded, 33.2°C, July 20; minimum recorded, -0.1 °c, March 20.
- SPECIFIC CONDUCTANCE: Maximum recorded, 3,770 microsiemens, April 30; minimum recorded, 1,200 microsiemens, July 17.
- PH: Maximum recorded, 8.7 units, October 5-7, 29-30, November 2-3; minimum recorded, 8.1 units, July 17-18, August 14-15.
- DISSOLVED OXYGEN: Maximum recorded, 14.0 mill igrams per liter, March 18-20; minimum reco rded, 5.6 mil ligrams per liter, July 31.

EXTREMES FOR PERIOD OF DAI LY RECORD -

- WATER TEMPERATURE: Maximum recorded, 33.2°C, July 20, 2016; minimum recorded, -0 .1 °c, March 20, 2016.
- SPECIFIC CONDUCTANCE: Maximum recorded, 3,770 microsiemens, April 30, 2016; minimum recorded, 761 microsiemens, April 6, 201 3.

- PH : Maximum recorded, 8.7 units, many days; minimum recorded, 7.6 units, May 29, 2013.
- DISSOLVED OXYGEN: Maximum recorded, 14.0 mill igrams per lite r, March 18-20, 2016; minimum recorded, 4.8 milligrams per liter, September 11, 201 3.

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 468/166928, February 2020

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525