



Water Quality Monitoring for Fort Laramie National Historic Site

2015 Data Report

Natural Resource Data Series NPS/FOLA/NRDS—2020/1270



ON THE COVER

Photograph of high waters on the Laramie River at Fort Laramie National Historic Site, WY
Photograph courtesy of the United States Geological Survey

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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.

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.

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Contents

	Page
Figures.....	iv
Tables.....	v
Abstract.....	vi
Introduction.....	1
Methods.....	5
Data Collection.....	5
Results.....	7
Further Analysis.....	17
Literature Cited	18
Appendix A. USGS Water Data Quality Report for Laramie River 06670500, 2015.....	19

Figures

	Page
Figure 1. Map of Fort Laramie National Historic Site and the Laramie River and North Platte River in Wyoming.	1
Figure 2. Photograph of the Laramie River on June 5, 2015 during a flooding event.....	2
Figure 3. Map of Fort Laramie National Historic Site and water quality monitoring location (blue triangle) and nearby weather station (red flag).	3
Figure 4. A sonde device is used to measure water quality in the Laramie River at Fort Laramie National Historic Site in 2015.	5
Figure 5. Daily mean gage height (black line) on the Laramie River at Fort Laramie National Historic Site from March 26, 2015, to November 2, 2015, at USGS Gaging Station 06670500.	7
Figure 6. Total monthly precipitation (light blue bars) and average monthly minimum (blue) and maximum (red) temperature for the 2015 water year in Fort Laramie National Historic Site (top panel).	8
Figure 7. Daily mean water temperature (black line) collected on the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015.....	12
Figure 8. Daily mean dissolved oxygen concentrations (black line; top graph) and daily discharge (bottom) of the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015.	14
Figure 9. Daily mean specific conductance (top) and daily discharge (bottom) of the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015.....	15
Figure 10. Daily mean pH (black line) of the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015.	16

Tables

	Page
Table 1. Water quality parameters measured as part of the Northern Great Plains Inventory & Monitoring Water Quality Program and associated state standards (WYDEQ 2018).	4
Table 2. Field journal for 2015 Water Quality Sampling at Fort Laramie 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 on the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015.....	9
Table 4. Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Fort Laramie National Historic Site on the Laramie River from March 27, 2015, to November 1, 2015.	10

Abstract

The Northern Great Plains Inventory and Monitoring Network (NGPN) began monitoring water quality in the Laramie River at Fort Laramie National Historic Site (FOLA) in 2015, with the assistance of the U.S. Geological Survey (USGS). This report summarizes the data collected during the 2015 ice-free season (March 27 through November 1) for streamflow, water temperature, dissolved oxygen, specific conductance, and pH.

2015 was a flood year and discharge on the Laramie River peaked at over 4570 cubic feet per second in late May. 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 temperatures were warm in the summer months and above the Wyoming state water quality standard for cold water fisheries for most of June, July, and August.

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

Fort Laramie National Historic Site (FOLA) was established in 1938 with a purpose to preserve the historic scenes and resources at the confluence of the Laramie and North Platte Rivers, and to interpret the roles and significance of the diverse and vibrant cultures that interacted at this crossroads of the West (National Park Service 2017). The Laramie River is approximately 450 km long. It begins in the Roosevelt National Forest in Colorado (2800 m elevation) and flows north into Wyoming on and then northeast where it joins the North Platte River at Fort Laramie, Wyoming (Figure 1). Approximately 6 km of the Laramie River flows through Fort Laramie National Historic Site.

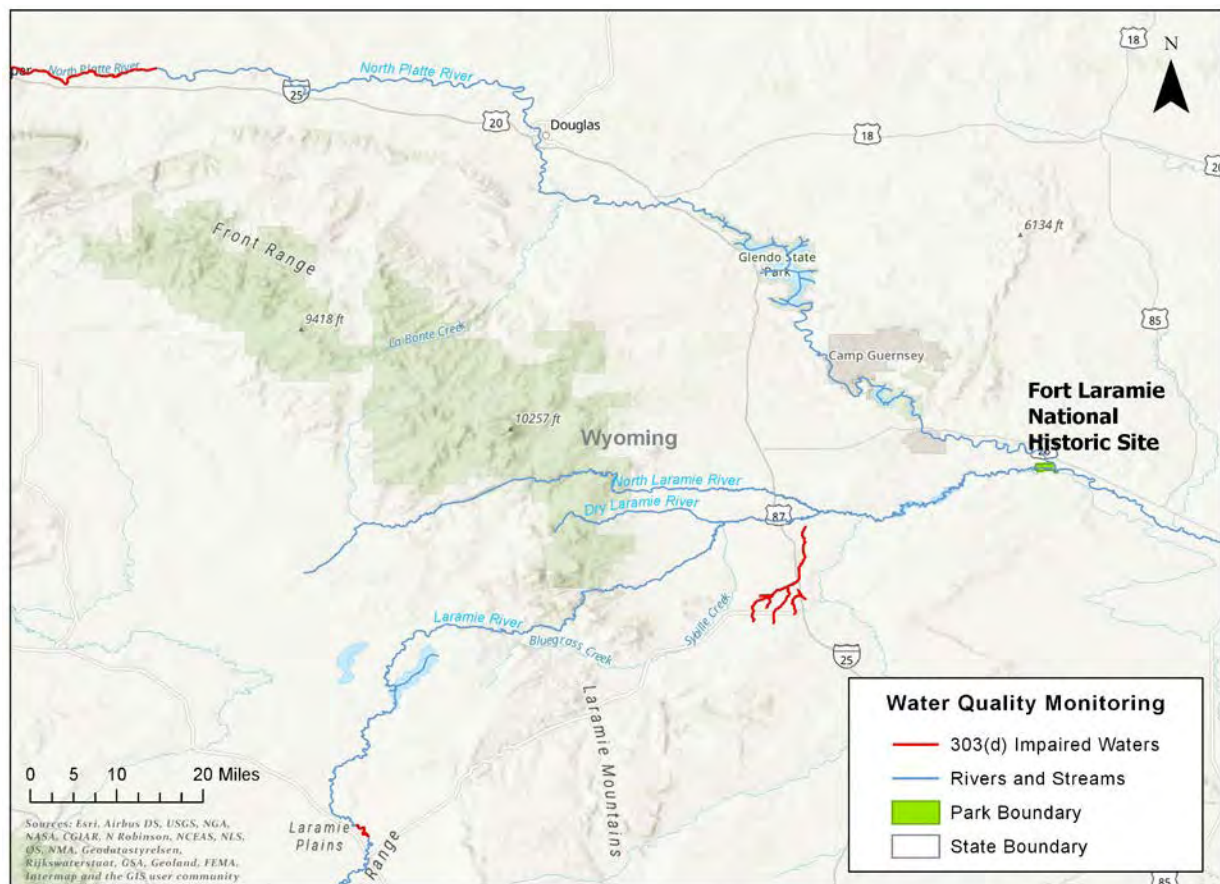


Figure 1. Map of Fort Laramie National Historic Site and the Laramie River and North Platte River in Wyoming. The stretches of the rivers highlighted in red are listed as impaired under 303(d) criteria for fecal coliform, *Escherichia coli*, or selenium.

The Laramie River is designated as a Class 2AB cold water fishery, defined as a water known to support game fish populations or spawning and nursery areas at least seasonally and where a game fishery and drinking water use is attainable (WYDEQ 2018). Some stretches of the river are listed as impaired waterways under section 303(d) of the Clean Water Act for high fecal coliform and *Escherichia coli* concentrations, but no impairments are reported for the stretch of river running

through Fort Laramie National Historic Site (Figure 1). For more details and current impairment information visit the Wyoming Department of Environmental Quality website.

The riparian area along the banks of the Laramie River is well established through FOLA and is dominated by cottonwood, ash, and willow trees with an understory of grasses (Ashton and Davis 2016). Previous pH and dissolved oxygen data collected from the Laramie River met state criteria and the resource was described as in good condition (Dibner et al. 2018). Recent temperature sampling also met state criteria, and assessment of aquatic invertebrates indicated the Laramie River had good ecosystem quality (Tronstad 2013). The intact riparian vegetation is likely contributing to the maintenance of high ecosystem quality. However, a major flood in the spring of 2015 on the Laramie River (Figure 2) caused a loss of 5 acres of park lands and some archaeological resources (National Park Service 2017).



Figure 2. Photograph of the Laramie River on June 5, 2015 during a flooding event.

The Northern Great Plains Inventory & Monitoring Network (NGPN) began monitoring water quality at FOLA in 2015 to better understand current conditions and changes over time in the Laramie River. The monitoring is conducted at the gaging station at Fort Laramie National Historic Site, WY (Monitoring Location 06670500; Figure 3) 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 FOLA every three years, starting in 2015 (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 (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.

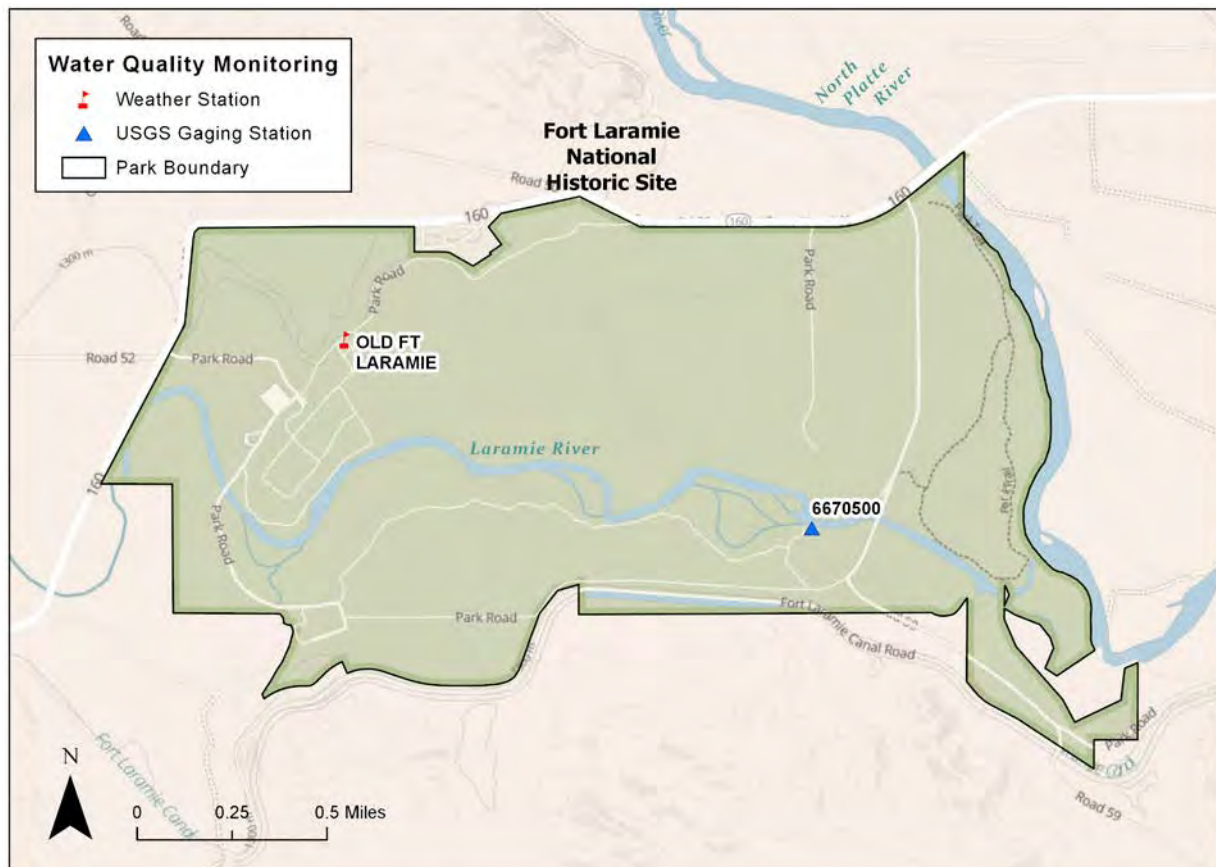


Figure 3. Map of Fort Laramie National Historic Site and water quality monitoring location (blue triangle) and nearby weather station (red flag). Climate data in this report is taken from the Old Fort Laramie weather station.

Table 1. Water quality parameters measured as part of the Northern Great Plains Inventory & Monitoring Water Quality Program and associated state standards (WYDEQ 2018). These standards are not enforceable in periods of low flow, as defined by the minimum seven consecutive day flow which has the probability of occurring once in ten years (WYDEQ 2018).

Water Quality Parameter	Description	WY state standards applicable to cold 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.	Pollution attributable to the activities of man shall not change ambient water temperatures to levels which result in harmful acute or chronic effects to aquatic life, or which would not fully support existing and designated uses. When ambient temperatures are above 15.6°C, pollution attributable to the activities of man shall not result in an increase of more than 1.1°C The maximum allowable stream temperature will be the maximum natural daily stream temperature plus the allowable change, provided that this temperature is not lethal to existing fish life and under no circumstance shall pollution attributable to the activities of man result in a temperature that exceeds 20°C
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.	Minimum criteria include: • 30-day mean of 6.5 mg/L • 7-day mean of 9.5 / 6.5 mg/L • 7-day mean minimum of 5.0 mg/L • 1-day minimum of 8.0 / 5.0 mg/L
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.	Pollution attributable to the activities of man shall not be present in amounts which will cause the pH to be less than 6.5 or greater than 9.0 standard units. Pollution attributable to the activities of man shall not change the pH to levels which result in harmful acute or chronic effects to aquatic life, directly or in conjunction with other chemical constituents, or which would not fully support existing and designated uses.

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 06670500) inside the park, at around 4220 ft. elevation. Water quality and streamflow are measured every 15 minutes throughout the ice-free season. Monitoring at FOLA began in 2015 and will be repeated in 2018, 2021, and every three years thereafter. Program funding currently limits monitoring to a cycle of one year of monitoring, followed by two years without.

In 2015, NGPN partnered with the USGS Wyoming–Montana Water Science Center to have USGS staff collect water quality and streamflow data at FOLA. The USGS deployed a continuous, multi-parameter sonde at the gage on March 26, 2015 (Figure 4) and visited the gaging station every 3–4 weeks for equipment maintenance. This instrument recorded dissolved oxygen, pH, specific conductivity, and water temperature every 15 minutes, while the gage simultaneously measured stream stage (or gage height, measured in feet) and discharge, a measure of streamflow. During each site visit, the USGS takes photographs of upstream, downstream, and the sonde location.



Figure 4. A sonde device is used to measure water quality in the Laramie River at Fort Laramie National Historic Site in 2015. The United States Geological Survey Laramie River gaging station (06670500) is set up for real-time data transmission via satellite. Photographs courtesy of NPS.

Satellite telemetry was used to transmit the water data to the Water Science Center in near real-time (<https://waterdata.usgs.gov/monitoring-location/06670500/>). 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 such as 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 2, 2015, the USGS removed the multi-parameter sonde from the Laramie River.

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 2016 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). We calculated the proportion of records that exceeded Wyoming environmental regulatory thresholds (Table 1).

Climate data were downloaded from the Old Fort Laramie (486852) National Weather Service Cooperator Observer Program station. The data were accessed and graphed using the web-based tool [Climate Analyzer](#).

Table 2. Field journal for 2015 Water Quality Sampling at Fort Laramie National Historic Site.

Date	Notes
March 26, 2015	Installed gage and field monitor, ~ 10 am. Collected discharge data with Flowtracker.
April 14, 2015	Routine service, cleaned sonde.
May 5, 2015	Routine service, cleaned sonde.
May 12, 2015	Cleaned sonde. Discharge measurement/ cross-section measurement.
May 19, 2015	Flow/ river discharge data collected with ADCP
May 26, 2015	Waded 3 overflow channels when collecting discharge data.
June 2, 2015	Maintenance on sonde pipe.
June 5, 2015	Service visit for sonde maintenance
June 23, 2015	Fixed cantilever gage – was mangled by high flow
July 14, 2015	–
July 24, 2015	–
August 6, 2015	–
August 25, 2015	–
September 14, 2015	–
October 6, 2015	–
November 2, 2015	Final visit for 2015. Removed equipment.

Results

The water quality monitoring season (ice-free) on the Laramie River at FOLA lasted from March 26, 2015, to November 2, 2015. In late May, the river flooded and discharge remained high for most of June (Figure 5). The maximum recorded discharge was on May 27th at 4750 cubic feet per second. The gage height was over 8.5 feet at that time. Compared to the 30-year period from 1981–2010, April and May were much wetter than average (~200% of average; Figure 6). In 2015, it rained and snowed 17.17 inches with total monthly precipitation peaking in May (Figure 6).

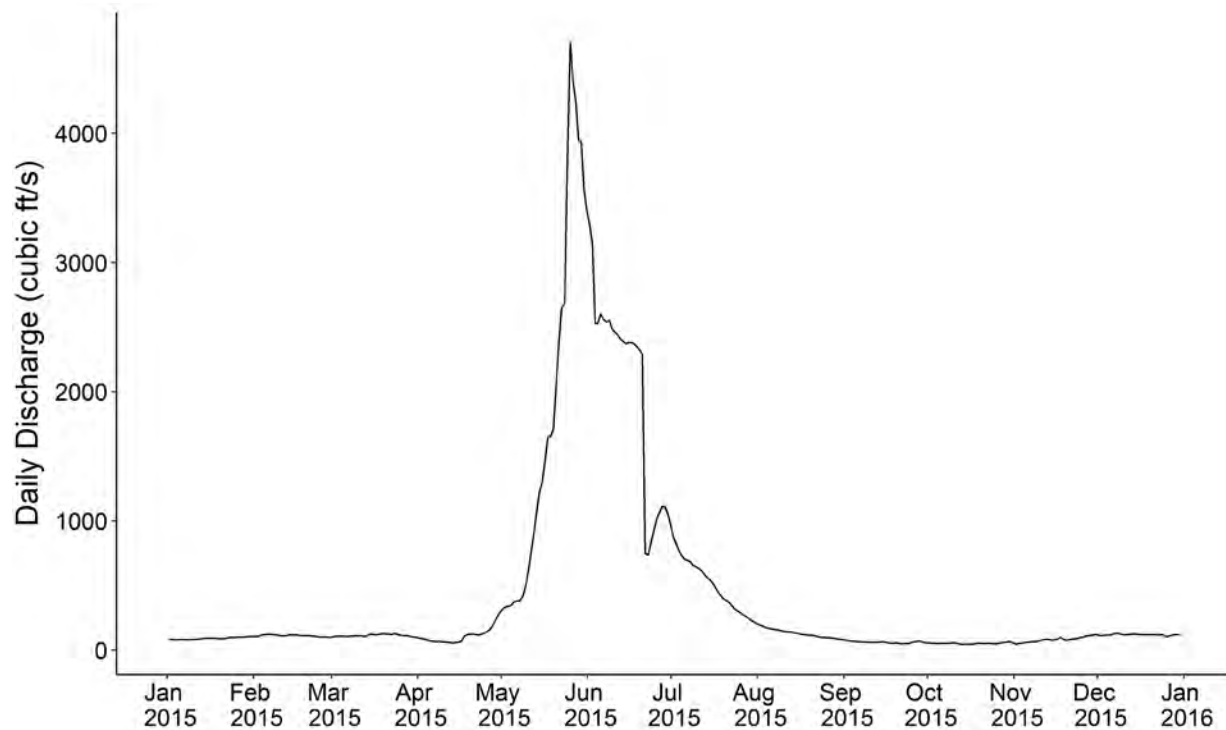
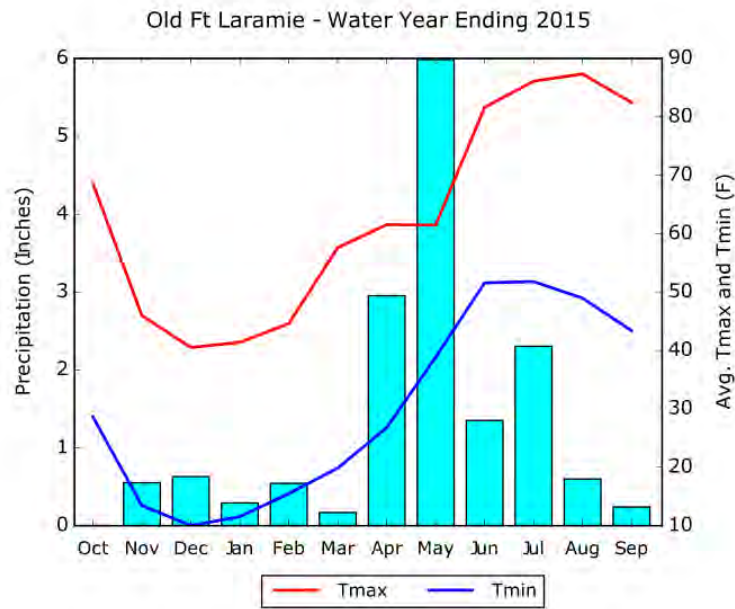


Figure 5. Daily mean gage height (black line) on the Laramie River at Fort Laramie National Historic Site from March 26, 2015, to November 2, 2015, at USGS Gaging Station 06670500. The gray ribbon shows the daily maximum and minimum stage height for the same period.



Old Ft Laramie - Water Year 2015 - Departure from 1981 - 2010 Avgs.

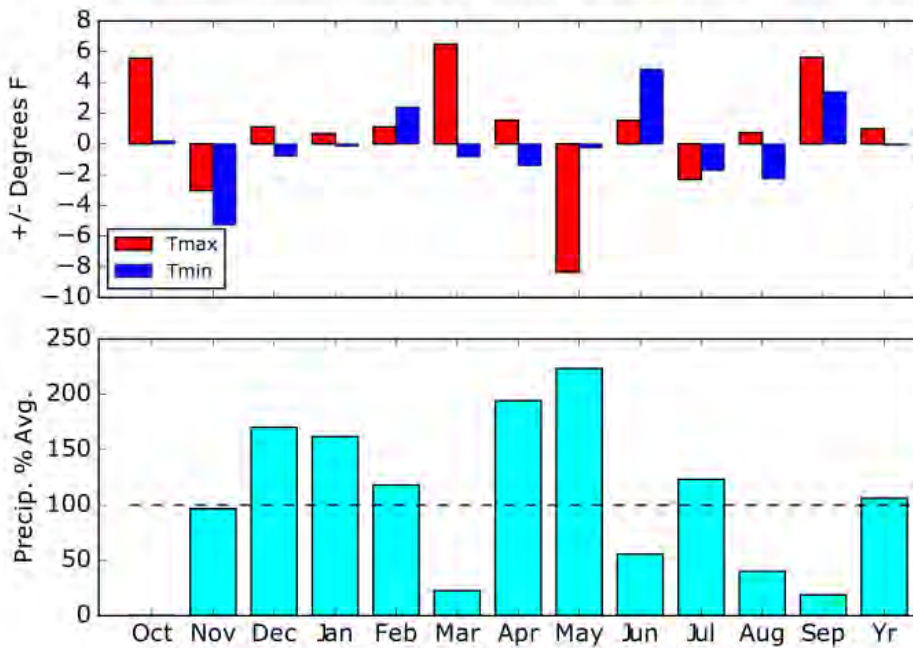


Figure 6. Total monthly precipitation (light blue bars) and average monthly minimum (blue) and maximum (red) temperature for the 2015 water year in Fort Laramie National Historic Site (top panel). Monthly departures from 1981–2010 average temperature and precipitation for the 2015 water year in Fort Laramie National Historic Site (bottom panel). Climate data are from Old Fort Laramie Station (486852). The data were accessed and graphed using the web-based tool [Climate Analyzer](#).

During the ice-free season at FOLA, we collected over 20,000 water quality measurements in the Laramie River (Table 2). We found mean water temperature of 16.7°C, dissolved oxygen concentrations of 8 mg/L, specific conductance of 653, and pH of 8.3 (Table 2). There was, however, variation across months in all parameters (Table 3). Mean water temperature in March was 10°C and increased to a mean of close to 22.4°C in July before declining back to 10°C in November (Table 3, Figure 7). Maximum temperature exceeded the Wyoming water quality standard of 20°C (Table 1), for much of June, July, and August (Table 3). Overall, 31% of the recorded temperatures were above the state threshold for cold water fisheries (Table 3).

Table 3. Summary of descriptive statistics for water temperature, dissolved oxygen, specific conductance, and pH measured for the ice-free sampling period on the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 20.0°C; dissolved oxygen $\geq$ 5.0 mg/L and pH range is 6.5–9.0).

Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (μ S/cm)	pH
Mean	16.66	8.05	653.47	8.31
Standard Deviation	4.9	1.53	60.13	0.14
Median	16.7	8	677	8.3
Minimum	5.7	5.2	369	8
Maximum	27.5	13	716	8.7
Number of Points	21059	19298	20493	19333
Number of Points below or above standard	6699 (above)	0 (below)	0 (above)	0 (above) 0 (below)
% Exceedance	31.8%	0%	0%	0%

Table 4. Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Fort Laramie National Historic Site on the Laramie River from March 27, 2015, to November 1, 2015. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 20.0°C; dissolved oxygen $\geq$ 5.0 mg/L and pH range is 6.5–9.0).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (μ S/cm)	pH
March 27–31, 2015	Number of measurements	480	479	476	480
	Mean	10.39	9.32	680.98	8.42
	Standard Deviation	1.83	0.62	5.65	0.06
	Median	10.6	9.4	682	8.4
	Minimum	6.9	8.1	669	8.3
	Maximum	13.7	10.5	692	8.5
	% Exceedance	0	0	–	0
April, 2015	Number of measurements	2878	2877	2864	2877
	Mean	10.92	9.36	676.16	8.28
	Standard Deviation	2.39	0.98	10.09	0.1
	Median	10.85	9.4	677	8.3
	Minimum	5.7	7.2	637	8
	Maximum	16.2	11.3	698	8.5
	% Exceedance	0	0	–	0
May, 2015	Number of measurements	2871	1536	2776	2583
	Mean	12.62	8.59	621.32	8.3
	Standard Deviation	2.01	0.68	73.62	0.12
	Median	12.3	8.6	655	8.3
	Minimum	7.4	7.2	369	8
	Maximum	18	10	683	8.6
	% Exceedance	0	0	–	0
June, 2015	Number of measurements	2875	2489	2255	2878
	Mean	20.57	7.05	538.76	8.22
	Standard Deviation	2.78	0.72	75.18	0.13
	Median	20.7	6.9	537	8.2
	Minimum	13.9	5.6	433	8
	Maximum	26.8	9.3	664	8.5
	% Exceedance	59.03%	0	–	0

Table 4 (continued). Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Fort Laramie National Historic Site on the Laramie River from March 27, 2015, to November 1, 2015. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 20.0°C; dissolved oxygen $\geq$ 5.0 mg/L and pH range is 6.5–9.0).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (μ S/cm)	pH
July, 2015	Number of measurements	2975	2956	2950	1919
	Mean	22.42	6.9	643.15	8.29
	Standard Deviation	1.74	0.81	10.29	0.11
	Median	22.3	6.7	643	8.3
	Minimum	18.6	5.4	615	8
	Maximum	27.5	8.9	682	8.6
	% Exceedance	91.23	0	–	0
August, 2015	Number of measurements	2971	2773	2971	2396
	Mean	20.82	7.42	676.84	8.38
	Standard Deviation	2.08	1.59	11.88	0.15
	Median	20.9	7.1	677	8.4
	Minimum	14.7	5.2	652	8.1
	Maximum	25.5	12.2	716	8.7
	% Exceedance	66.37	0	–	0
September, 2015	Number of measurements	2688	2874	2880	2879
	Mean	17.83	7.53	695.04	8.28
	Standard Deviation	1.85	1.32	8.61	0.12
	Median	17.7	7.2	696	8.3
	Minimum	13.4	5.3	678	8
	Maximum	23	10.4	713	8.6
	% Exceedance	11.76	0	–	0
October, 2015	Number of measurements	2973	2967	2973	2973
	Mean	13.06	9.27	687.36	8.38
	Standard Deviation	2.12	1.49	3.76	0.13
	Median	12.9	8.9	688	8.4
	Minimum	7.9	6.6	674	8.2
	Maximum	18.2	13	695	8.7
	% Exceedance	0	0	– ^c	0

Table 4 (continued). Monthly summary of descriptive statistics and percent exceedances for core water quality parameters for the ice-free sampling period at Fort Laramie National Historic Site on the Laramie River from March 27, 2015, to November 1, 2015. Percent exceedance is the proportion of samples that exceed the respective state regulatory threshold described in Table 1 (water temperature max. limit is 20.0°C; dissolved oxygen ≥ 5.0 mg/L and pH range is 6.5–9.0).

Dates	Descriptive Statistic	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity ($\mu\text{S}/\text{cm}$)	pH
November 1, 2015	Number of measurements	348	347	348	348
	Mean	10.62	9.14	683.31	8.49
	Standard Deviation	0.32	0.86	3.07	0.06
	Median	10.6	8.8	682	8.5
	Minimum	9.9	8.5	681	8.3
	Maximum	11.7	12.5	693	8.7
	% Exceedance	0	0	–	0

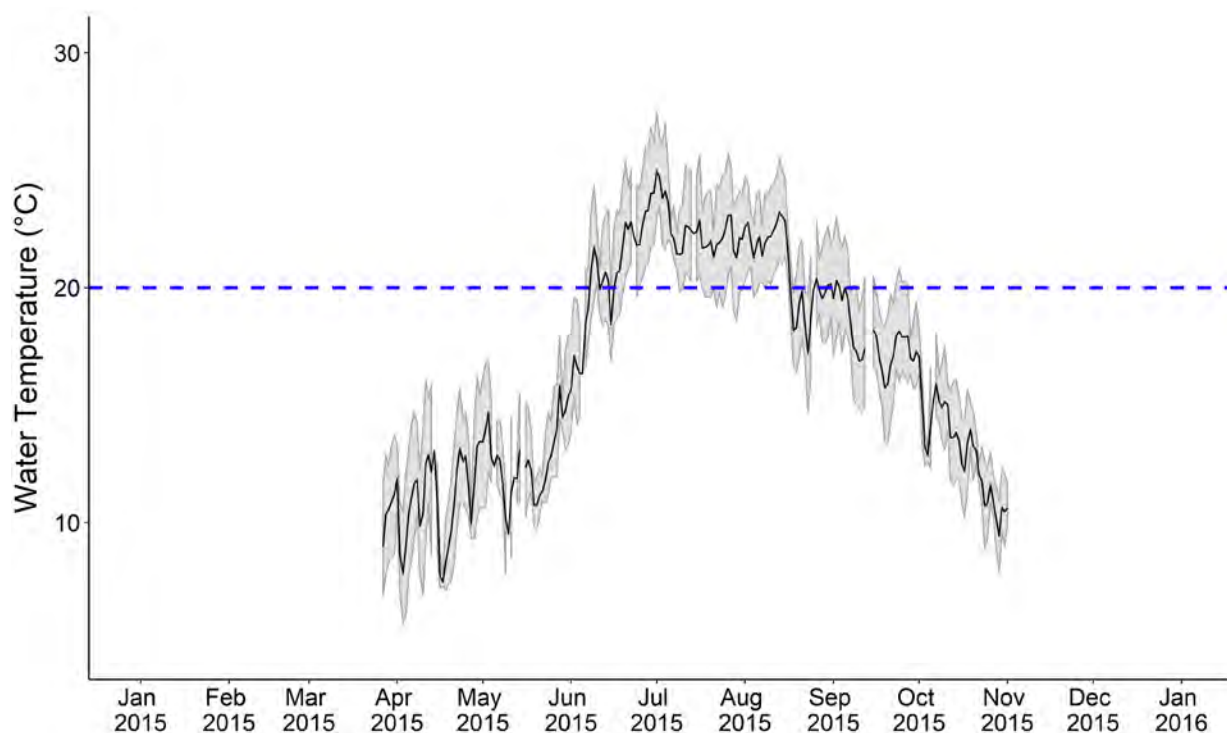


Figure 7. Daily mean water temperature (black line) collected on the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015. The gray ribbon shows the daily maximum and minimum water temperature for the same period. The dashed blue line indicates one of the Wyoming 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 displayed seasonal variation (Table 3, Figure 8). The highest mean dissolved oxygen concentrations were in the spring and fall, averaging greater than 9 mg/ L in March, April, October, and November. Dissolved oxygen measures were all above the Wyoming state water quality criteria (Table 1).

Specific conductance of the Laramie River was highly variable throughout the flood period in May and June (Table 3, Figure 9), but otherwise stayed roughly between 600 and 700 $\mu\text{S}/\text{cm}$. The pH of the Laramie River ranged between 8.0 and 8.7 (Figure 10) and was never outside the range of the Wyoming state standards of 6.5–9.

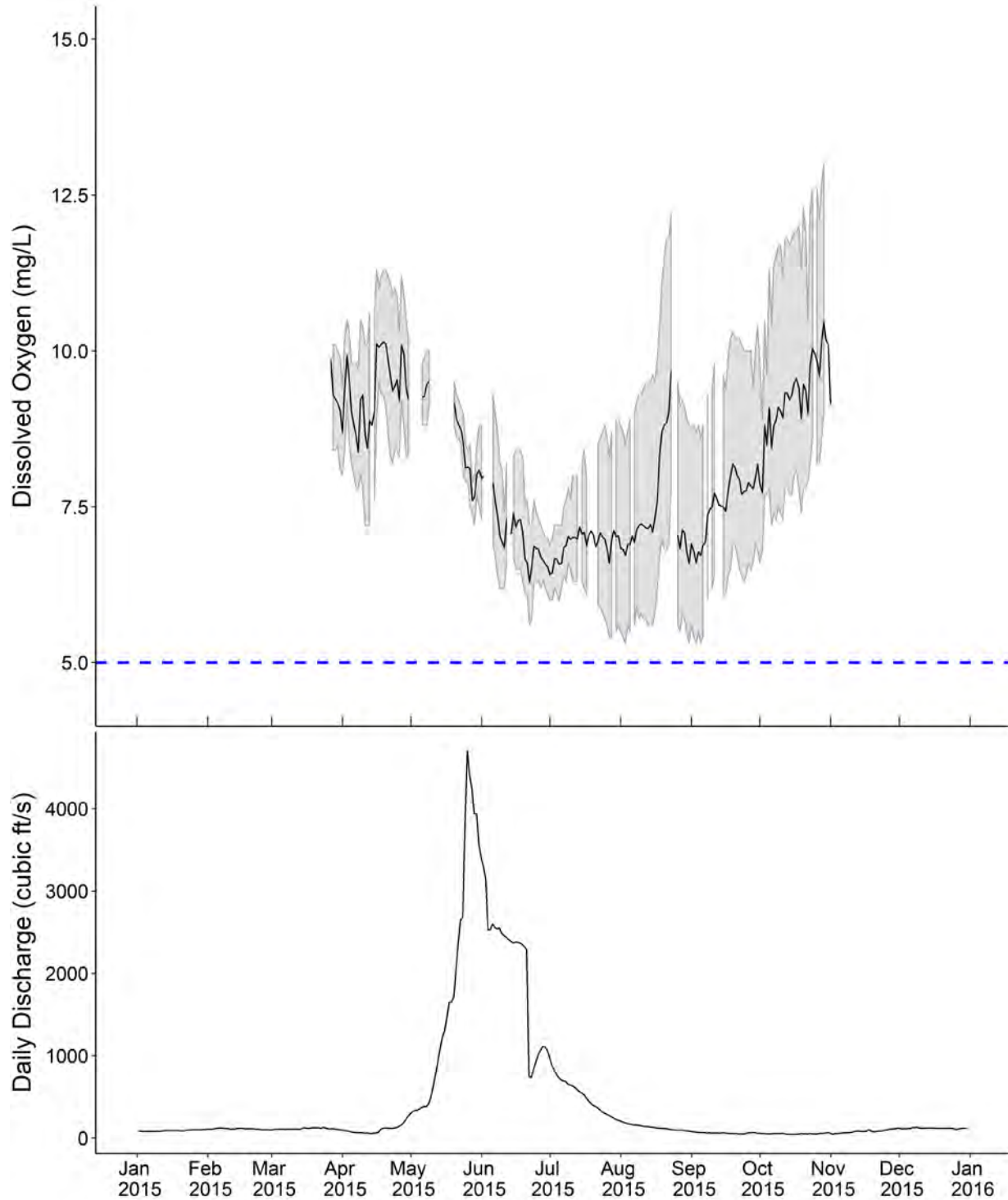


Figure 8. Daily mean dissolved oxygen concentrations (black line; top graph) and daily discharge (bottom) of the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015. The gray ribbon shows the daily maximum and minimum dissolved oxygen for the same period. The dashed blue line indicates one of the Wyoming state water quality standards (see Table 1 for more details). The periods where the instrument did not collect data are indicated by gaps in the record.

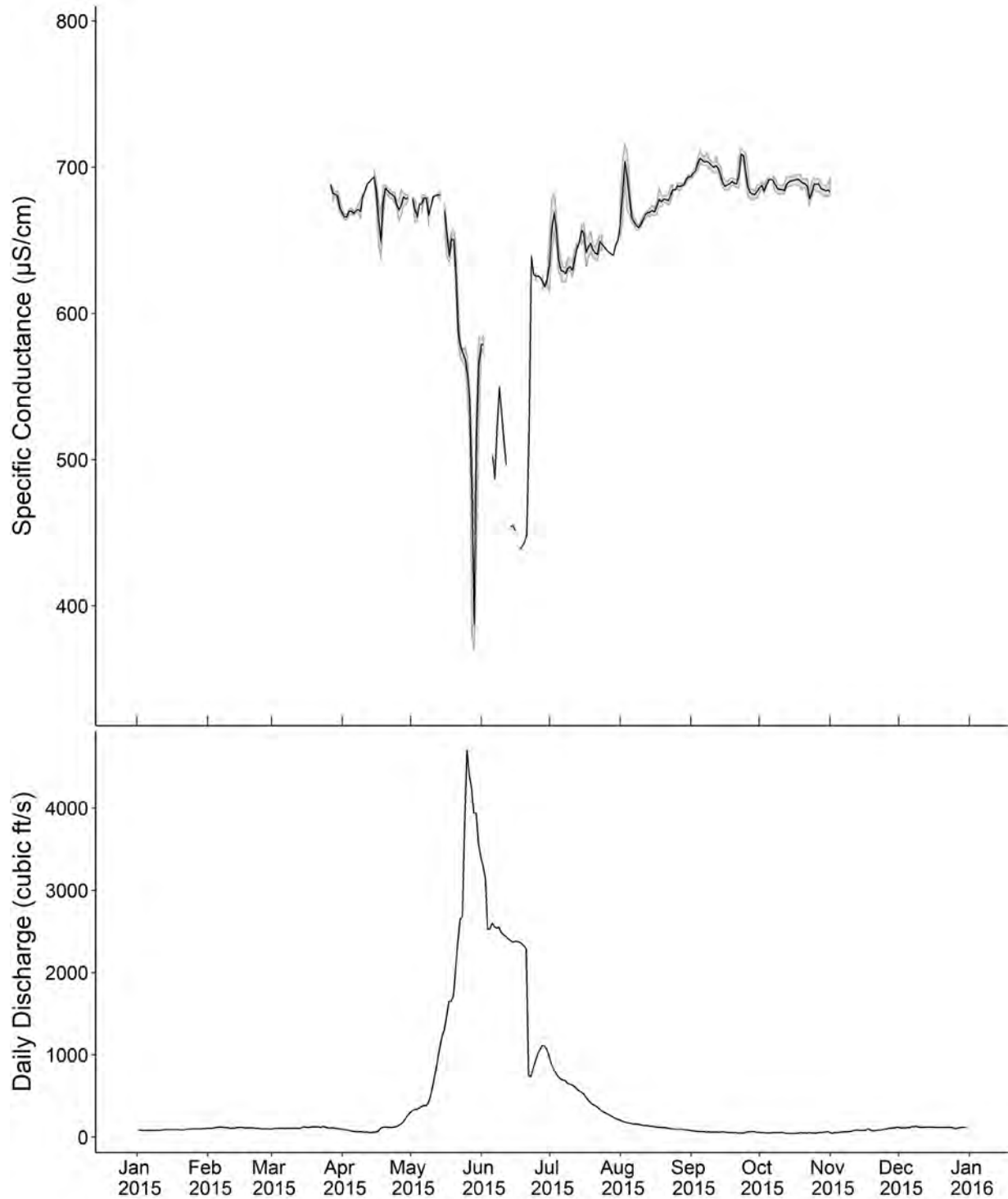


Figure 9. Daily mean specific conductance (top) and daily discharge (bottom) of the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015. The gray ribbon shows the daily maximum and minimum specific conductivity for the same period. The periods where the instrument did not collect data are indicated by gaps in the record.

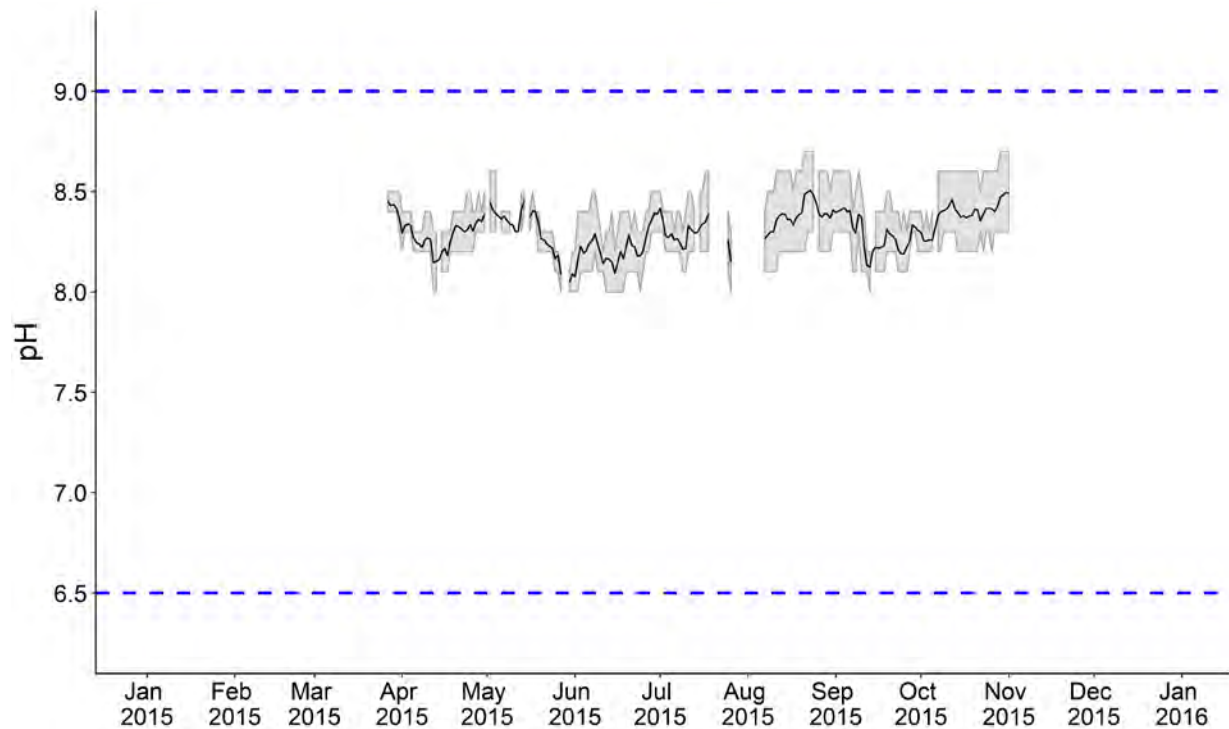


Figure 10. Daily mean pH (black line) of the Laramie River at Fort Laramie National Historic Site from March 27, 2015, to November 1, 2015. The gray ribbon shows the daily maximum and minimum pH for the same period. The dashed blue lines indicate the Wyoming state water quality standards (see Table 1 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 2015 water quality monitoring season at Fort Laramie 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 06670500](#).

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Appendix A. USGS Water Data Quality Report for Laramie River 06670500, 2015

06670500 LARAMIE RIVER NEAR FORT LARAMIE, WY

LOCATION - Lat 42°12'02", long 104°32'16" referenced to North American Datum of 1927, in NE 1/4 SE 1/4 NE 1/4 sec.28, T.26 N., R.64 W., Goshen County, WY, Hydrologic Unit 10180011, on right bank 600 ft upstream from bridge on county road, 0.6 mi upstream from mouth, and 1.1 mi southwest of Fort Laramie.

DRAINAGE AREA - 4,564 mi² of which 631 mi² probably is noncontributing.

[REVISIONS HISTORY](#) - WSP 1918: Drainage area.

SURFACE-WATER RECORDS

PERIOD OF RECORD - April 1915 to current year (no winter records prior to 1927). Monthly discharge only for some periods, published in WSP 1310. Records for water years 1926-39, previously published including diversions to Gering-Fort Laramie Canal, were adjusted to exclude flow in the canal in WSP 1310. Prior to October 1931, published as "at Fort Laramie". No diversion to Gering-Fort Laramie Canal since 1956.

GAGE - Water-stage recorder. Elevation of gage is 4,220 ft above NGVD of 1929, from topographic map. April 4, 1915 to March 31, 1925, nonrecording gage at site 0.1 mi downstream from station at different datum. April 1, 1925 to September 30, 1932, nonrecording gage and October 1, 1932 to August 20, 1935, water-stage recorder at site 4.3 mi upstream from station at different datum. August 21, 1935, to November 2, 1970, water-stage recorder at site 0.3 mi upstream from station at different datum. November 3, 1970 to May 9, 1973, water-stage recorder 0.1 mi downstream from station at different datum. May 10, 1973 to April 5, 1977, water-stage recorder 4.3 mi upstream from station at different datum. U.S. Army Corps of Engineers data collection platform with satellite telemetry at station.

COOPERATION -

11-03-2017 to 10-15-2018: Thirteen discharge measurements provided by the Wyoming State Engineer's Office.

10-01-2016 to 11-02-2017: Eleven discharge measurements provided by the Wyoming State Engineer's Office.

Fourteen discharge measurements provided by the Wyoming State Engineer's Office.

REMARKS -

11-03-2017 to 10-14-2018: records are good, except estimated records are poor.

10-06-2016 to 11-02-2017: records are good, except estimated records are poor.

12-08-2015 to 10-05-2016: records are good, except estimated records are poor.

10-01-2014 to 12-07-2015: records are good, except estimated records are poor.

10-01-2013 to 09-30-2014: records are good, except estimated records are poor.

Major regulation began after completion of Grayrocks Reservoir in 1980. Diversion, at times, to Gering-Fort Laramie Canal, 5.4 mi upstream. Natural flow of stream affected by transbasin diversions, storage reservoirs, ground-water withdrawals and diversions for irrigation upstream from station, and return flow from irrigated areas.

EXTREMES FOR PERIOD OF RECORD - Minimum daily discharge, 2.0 ft³/s, Jan. 23, 1981, no flow Jan. 31 to Mar. 20, Oct. 24 to Dec. 17, 1926, Mar. 1-26, Apr. 14, 1938, all flows diverted to Gering-Fort Laramie Canal.

WATER-QUALITY RECORDS

PERIOD OF RECORD -

October 1965 to June 1988, October 2003 to May 2014, October 2018.

PERIOD OF DAILY RECORD -

SPECIFIC CONDUCTANCE: March to November 2015, March to November 2018.

pH: March to November 2015, March to November 2018.

WATER TEMPERATURE: March to November 2015, March to November 2018.

DISSOLVED OXYGEN: March to November 2015, March to November 2018.

INSTRUMENTATION - Water-quality monitors for specific conductance, pH, water temperature, and dissolved oxygen.

REMARKS -

SPECIFIC CONDUCTANCE

03-26-2015 to 11-02-2015: records are excellent, except records from Apr. 6-14, May 18, and Aug. 19-25 are good; records from May 19 and July 15-24 are fair; and records from June 3-5, and July 1-14 are poor.

pH

03-26-2015 to 11-02-2015: records are excellent, except records from July 19, Aug. 30 to Sept. 14, and Oct. 6 are good.

WATER TEMPERATURE

03-26-2015 to 11-02-2015: records are excellent.

DISSOLVED OXYGEN

03-26-2015 to 11-02-2015: records are excellent, except records from Apr. 10-14, Apr. 29 to May 1, and May 28 to June 2 are good.

Maximum and minimum recorded values in the EXTREMES paragraph may have occurred during days of partial record and may not appear in the daily values tables.

EXTREMES FOR PERIOD OF RECORD -

SPECIFIC CONDUCTANCE: Maximum recorded, 770 uS/cm, Jun. 8, 2018; minimum recorded, 369 uS/cm, May 29, 2015.

pH: Maximum recorded, 8.7 units, Aug. 21-24 and Oct. 29 to Nov. 1, 2015; minimum recorded, 7.6 units, July 8 to 13, 2018.

WATER TEMPERATURE: Maximum recorded, 27.5°C, July 1, 2015; minimum recorded, 2.2°C, Apr. 1, 2018.

DISSOLVED OXYGEN: Maximum recorded, 13.5 mg/L, May 30, 2018; minimum recorded, 4.6 mg/L, July 8 and 10, 2018.

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 375/167221, March 2020

National Park Service
U.S. Department of the Interior



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