



Eastern Rivers and Mountains Network River Water Quality Monitoring

2015 Water Year Summary Report

Natural Resource Data Series NPS/ERMN/NRDS—2016/1071



ON THE COVER

View of Delaware River, upstream of the Lordville, NY water quality monitoring equipment.

Photograph by: Caleb Tzilkowski

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Abstract

Due, in part, to the abundance of flowing freshwaters at Eastern Rivers and Mountains Network (ERMN) parks, surface water hydrology and water chemistry were chosen as vital signs of ecological condition. Because of the direct relationship between water chemistry and biota, water chemistry is typically a central component of any stream or river monitoring program; consequently, two ERMN monitoring programs track the condition of surface water hydrology and water chemistry in wadeable streams and rivers. This report provides a succinct summary of continuous water quality monitoring at three locations during the 2015 water year (10/01/2014 – 9/30/2015). Monitoring locations included: 1) Delaware River at Lordville, NY, near the upstream terminus of Upper Delaware Scenic and Recreational River; 2) Delaware River at Montague, NJ, near the upstream terminus of Delaware Water Gap National Recreation Area; and 3) New River at Thurmond, WV, within New River Gorge National River. More thorough analyses will be conducted periodically (e.g., every five years) as additional data are collected. Electronic versions of the data are available upon request (contact; caleb_tzilkowski@nps.gov).

List of Symbols and Acronyms

μS/cm	Microsiemens per centimeter
°C	Degrees Celsius
DO	Dissolved oxygen
cfs	Cubic feet per second
ERMN	Eastern Rivers and Mountains Network
FNU	Formazin Nephelometric units
mg/L	Milligrams per liter
NPS	National Park Service
NR	National River
NRA	National Recreation Area
PVC	Polyvinyl Chloride
SRR	Scenic and Recreational River
USGS	United States Geological Survey

Introduction

The Eastern Rivers and Mountains Network (ERMN) of the National Park Service (NPS) includes nine parks in New York, New Jersey, Pennsylvania, and West Virginia (Figure 1), which encompass nearly 91,000 ha and more than 600 stream and river miles within authorized boundaries of the parks. Due, in part, to the abundance of flowing freshwaters at ERMN parks, surface water hydrology and water chemistry were chosen as vital signs of the network. Physical and chemical characteristics of water have strong effects on aquatic biota; consequently, direct and indirect human alteration of water quality is associated with altered biotic communities and ecosystem processes. Because of the direct relationship between water chemistry and biota, water chemistry is typically a central component of any stream or river monitoring program; therefore, two ERMN monitoring programs track the condition of surface water hydrology and water chemistry in wadeable streams (Tzilkowski et al., 2016) and rivers (Tzilkowski et al., in preparation).

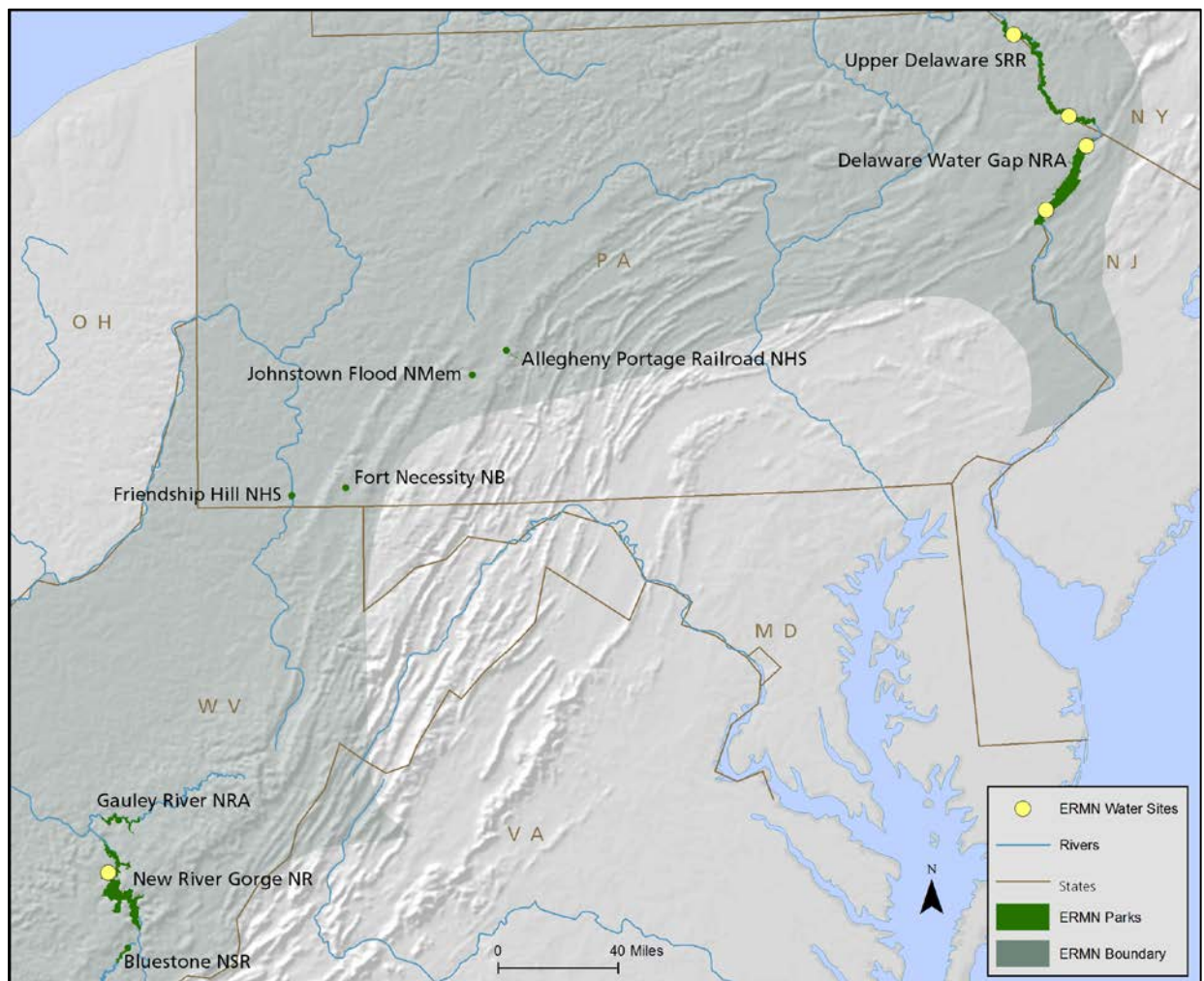


Figure 1. Location of parks and river water quality monitoring sites (Water Sites) in the Eastern Rivers and Mountains Network (ERMN).

A primary goal of the ERMN river water quality and quantity monitoring protocol is to help maintain or improve the condition of rivers that flow through ERMN parks. The primary monitoring objectives of the ERMN river water quality monitoring program are to:

1. Document the status and trends of river discharge, “core” water quality parameters (dissolved oxygen, pH, specific conductance, water temperature) and turbidity at five locations on two of the network’s largest rivers (Delaware River and New River).
2. Describe seasonal and annual patterns of parameters listed in objective 1.
3. Document, where appropriate, whether existing state, federal, and/or special protection water quality criteria are met for parameters listed in objective 1.

This report provides a succinct summary of continuous water quality monitoring at three locations during the 2015 water year (10/01/2014 – 9/30/2015). Monitoring locations included: 1) Delaware River at Lordville, NY, near the upstream terminus of Upper Delaware SRR; 2) Delaware River at Montague, NJ, near the upstream terminus of Delaware Water Gap NRA; and 3) New River at Thurmond, WV, within New River Gorge NR.

Water Quality and Quantity Parameters

As recommended by the NPS Water Resources Division, the “core” water quality parameters are measured at all monitoring stations throughout the I&M Program because they “...are primarily collected as basic data to characterize a waterbody or stream segment and typically are fundamental components of any monitoring and regulatory program”. An expanded discussion of these parameters (and turbidity) is available in the ERMN river water quality monitoring protocol (Tzilkowski et al., in preparation) but brief descriptions are provided below.

Discharge

River discharge is fundamentally important to resident flora and fauna because it defines the quantity, and often quality, of available habitat and affects most aspects of river ecosystems (e.g., chemical, physical, and biological process). Fluctuations of discharge can affect all parameters listed below; consequently, measuring discharge can be useful for interpreting observed patterns in water quality data. The ERMN uses provisional data collected by the USGS to help interpret and illustrate observed patterns in core water quality parameter time series.

Temperature

Water temperature strongly influences chemical processes (e.g., nutrient cycling) and therefore dictates the physiology, growth, behavior, and distribution of aquatic organisms. Water temperature measurement can provide information regarding existing habitat and serve as a proxy for potential changes in the physical environment.

Dissolved oxygen

Many aquatic organisms require oxygen to survive; therefore, dissolved oxygen (DO) concentration is a fundamental component of monitoring aquatic systems. Principal sources of DO include

mechanical aeration of the water and photosynthetic output. DO is consumed through respiration, mechanical degassing, and biochemical reactions that occur in the substrate.

pH

Water pH can range from 0–14 on a continuous scale and is the negative logarithm ($-\log_{10}$) of hydrogen-ion activity expressed in moles per liter. Low pH values are acidic whereas high values are basic. A pH of 7 is generally considered neutral though slight variability in the neutral value occurs with changing temperature. Unpolluted surface water usually has a pH range from 6.0–8.5, with values outside of this range occurring under certain circumstances (e.g., thermal spring waters can have very low pH; Hem 1985).

Specific conductance

Conductivity is the ability of a substance to conduct electrical current. Conductivity of water is related to the concentration of dissolved ionic species in solution and is therefore a useful general water quality indicator. Conductance of natural waters is widely variable depending on geology, soil type and other sources of solutes. Although conductance is not a direct indicator of water quality or aquatic system impairment, it can be used to identify changes in water chemistry. Specific conductance (as measured by the ERMN) is a standardized (water temperature = 25°C) measure of conductivity that allows spatial or temporal comparisons to be made more easily.

Turbidity

Turbidity is a measure of the optical properties of a sample that cause light to be scattered and absorbed rather than transmitted through a sample (ASTM International, 2003); accordingly, turbidity values reflect the presence and quantity of suspended and dissolved matter (e.g., clay, silt, finely divided organic matter, plankton and other microscopic organisms). Implicit in this definition is the fact that color, either of dissolved materials or of particles suspended in the water, also can affect turbidity (ASTM International, 2003).

Study Area

Lordville, NY (Upper Delaware SRR)

The Lordville, NY monitoring site on the Delaware River is 15.6 km (9.7 mi) southeast of Hancock, NY. The upstream terminus of Upper Delaware SRR is near Hancock, where the East Branch Delaware River and West Branch Delaware River flow together to form the Delaware River (river mile 331) – the monitoring site at Lordville, NY is located 14.5 km (9 mi) downstream (river mile 322; UTM: 18T, 482263 m E, 4635126 m N) and is co-located with the U.S. Geological Survey (USGS) gaging station (station #01427207) which has an upstream drainage area of 4,118 km² (1,590 mi²).

Montague, NJ (Delaware Water Gap NRA)

The Montague, NJ site on the Delaware River is approximately 6.4 km downstream of the upstream terminus of Delaware Water Gap NRA and is co-located with a USGS gage (station #01438500). The monitoring site is in Pike County, PA (UTM: 18T, 517121 m E, 4573129 m N) – although Montague, NJ is nearby, the name is primarily an artifact of the USGS naming system and the ERMN retained that name for consistency. The site is on right bank (descending) 457 m upstream

from U.S. Route 206 between Montague, NJ and Milford, PA, 1.3 km downstream from Sawkill Creek (river mile 246).

Thurmond, WV (New River Gorge NR)

The Thurmond, WV monitoring site on the New River is co-located with a USGS stream gage (station #03185400; UTM: 17 S, 493289.66 m E, 4200840.22 m N) near the middle of New River Gorge NR – 32 km upstream and 59 km downstream of the park bounds (downstream and upstream, respectively). The site is on the right bank at Chessie System pump house, 0.1 mi upstream from Dunloup Creek, 0.3 mi upstream from railroad/highway bridge at New River mile 25.8 and Kanawha River mile 122.4. Contributing drainage area to the site is 6,687 mi², excluding that of Dunloup Creek (directly across river and not contributing to discharge).

Methods

Instrumentation

Manta2™ (Eureka Water Probes, Austin, TX) multiparameter data sondes (hereafter, sondes) were deployed at all sites but deployment periods and measurement intervals differed depending on site infrastructure (Table 1). All sites were equipped with satellite telemetry capability so that ERMN staff and other interested stakeholders could remotely monitor the condition of the sensors and provisional water quality data.

Table 1. Deployment periods and measurement intervals of continuous river water quality monitoring sites in the Eastern Rivers and Mountains Network during the 2015 water year.

Site	Deployment Period	Measurement Interval (minutes)
Lordville, NY	10/01/2014 – 09/30/2015	15
Montague, NJ	10/09/2014 – 09/30/2015	60
Thurmond, WV	05/20/2015 – 09/30/2015	60

Lordville, NY (Upper Delaware SRR)

A sonde was continuously deployed *in-situ* on the Lordville Road (CR 1023) bridge near the main flow of the Delaware River (Figure 2). The sonde was suspended from near the bridge deck, approximately 0.5 m above the river bed, inside a 10 cm (4”) diameter deployment pipe by nylon cord and a communication cable. The deployment pipe was attached to the concrete bridge pier just below the 45 degree taper to the downstream point of the pier, ensuring a representative flow of water past the sonde while protecting it from debris flowing downstream. The bottom 1.5 m (5 ft.) of the pipe (i.e., from the riverbed up) was perforated schedule-80 PVC pipe whereas the remainder of the pipe was galvanized steel.



Figure 2. Aerial view of Lordville Road Bridge across Delaware River near Lordville, NY. The top circle, located near the primary river flow, outlines the Eastern Rivers and Mountains Network water quality monitoring equipment whereas the bottom circle outlines the United States Geological Survey river stage recorder.

Montague, NJ (Delaware Water Gap NRA)

The monitoring site near Montague, NJ was a continuously operating flow-through system. A sonde and associated telemetry equipment were housed on, or were directly adjacent to, the USGS stilling well tower located just upstream of Milford Beach (Figure 3). Water was pumped through the system from an intake which was located 15 m from the river left bank (descending) approximately 0.5 m from the river bed. Water flowed from the intake through 3.8 cm (1.5”) copper pipe into a 25 cm (10”) diameter polyvinyl chloride (PVC) well which was located approximately 3 m from the concrete USGS stilling well footer. Water was pumped from the PVC well through a 19 L (5 gal) polyethylene tank that was housed in a galvanized steel shelter. The shelter was directly adjacent to the USGS tower whereas the data collection platform and satellite transmission equipment were located near the top of the USGS tower so that they were protected from flooding. A heat lamp and heat wires prevented water from freezing in the system during winter.

Water was pumped through the system for five minutes at the top of each hour (e.g., 10:00). Water quality measurements were taken by the sonde four minutes after each hour (e.g., 10:04) which ensured that measurements were not biased by air or ground temperature surrounding the system.

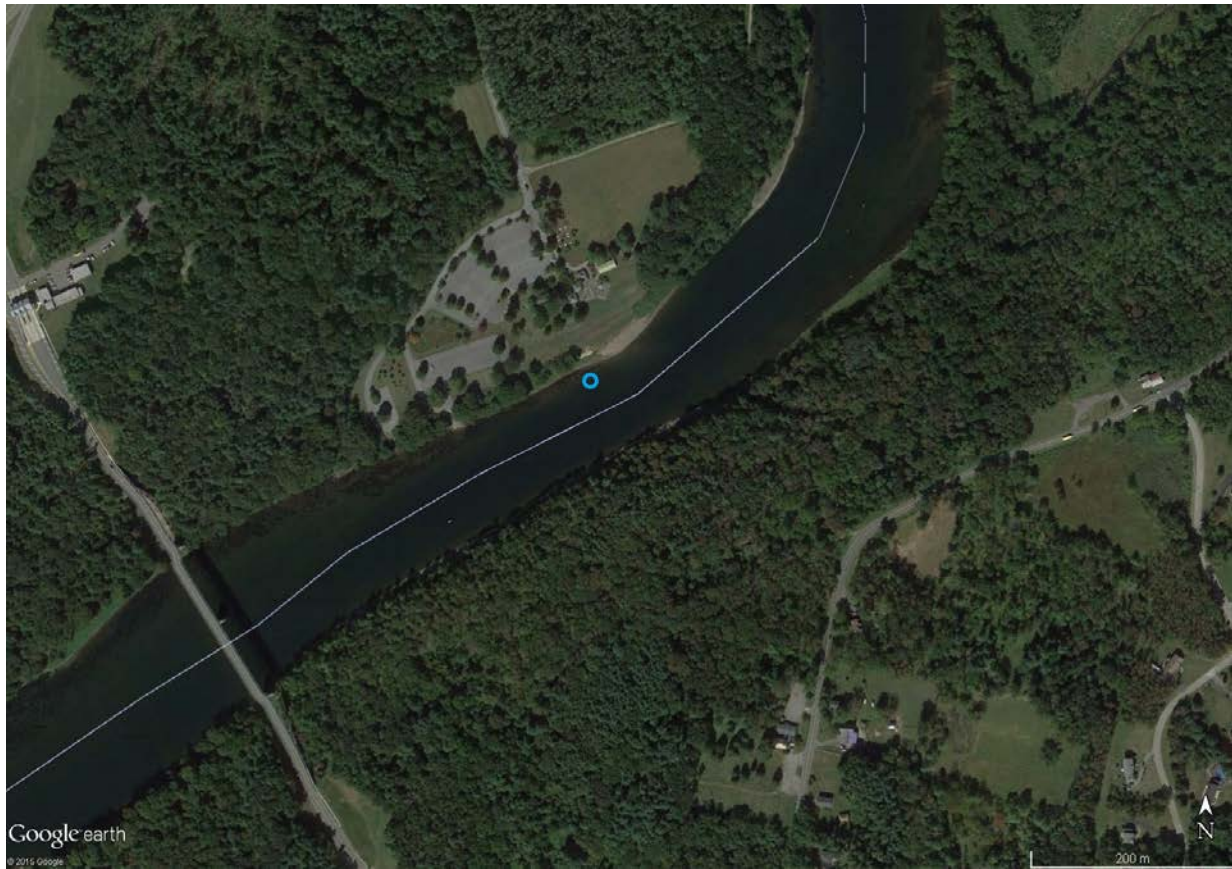


Figure 3. Aerial view of the water quality monitoring site on the Delaware River near Montague, NJ which is co-located with the United States Geological Survey river stage recorder. The blue circle outlines the intake location for Eastern Rivers and Mountains Network water quality monitoring equipment.

Thurmond, WV (New River Gorge NR)

The monitoring site near Thurmond, WV was a flow-through system that was operated only during the growing season. A sonde and associated telemetry equipment were located approximately 12 m uphill of the river near the railroad grade. Water was pumped through the system by a pump that was located on a steep boulder face in the river, which was approximately 5 m from the right bank (descending) during baseflow (Figure 4).

Water was pumped through the system for five minutes at the top of each hour (e.g., 10:00). Water quality measurements were taken by the sonde four minutes after each hour (e.g., 10:04) which ensured that measurements were not biased by air or ground temperature surrounding the system.



Figure 4. Aerial view of the water quality monitoring site on the New River near Thurmond, WV which is co-located with the United States Geological Survey river stage recorder. The blue circle outlines the intake location for Eastern Rivers and Mountains Network water quality monitoring equipment.

Sonde Maintenance

Maintenance visits were typically conducted once each month during deployments to: 1) download data collected during the previous month, 2) assess data quality during deployment intervals (i.e., quantifying fouling and drift error), and 3) clean and calibrate sensors to maximize data quality. Primary tasks associated with maintenance visits are described in detail in the ERMN River Monitoring Protocol (Tzilkowski et al., in preparation) and include: 1) downloading data, 2) recording “pre-cleaning” sonde measurements, 3) cleaning sonde sensors, 4) recording “post-cleaning” sonde measurements, 5) checking (and calibrating if necessary) sensor accuracy, 6) verifying sonde performance, and 7) redeploying the sonde.

Cross-section Surveys

Cross-section surveys were conducted at Lordville, NY and Montague, NJ during baseflow conditions to verify that the sonde deployment location was laterally and vertically representative of water quality conditions at monitoring sites. A cross-section could not be performed at Thurmond due to logistical constraints but will be conducted annually in the future.

At Lordville and Montague, core parameters were measured at 15 intervals (i.e., equally-spaced locations) across the river by first suspending a weighted cord to measure depth; subsequently, a

Sub2™ (Eureka Water Probes, Austin, TX) sonde was lowered to approximately half the water depth to measure core parameters. Measurements were taken from the Lordville Road Bridge at the Lordville site whereas a boat was used at Montague. Immediately after taking core parameter measurements across the river's width, the sonde was lowered into the deployment pipe (Lordville) or at the intake (Montague) where 10 instantaneous measurements were taken to compare monitoring site measurements to conditions across the river width.

Data Processing and Analysis

The ERMN River Monitoring Protocol (Tzilkowski et al., in preparation) provides detailed methods for data processing, management, and analysis. Most methods that the ERMN uses (including data grading criteria, Table 2) are based on those developed by the United States Geological Survey (USGS, Wagner et al. 2006). A brief summary of ERMN continuous water quality data processing and analysis is as follows:

1. During monthly maintenance visits, continuous water quality data are downloaded from deployed sondes and fouling and calibration data are recorded on electronic field forms.
2. Continuous data from each deployment period are imported into Aquarius® (release 3.0, Aquatic Informatics, Vancouver, BC).
 - a. Data for each parameter/deployment period are:
 - i. Graded and corrected based on fouling and calibration data collected during maintenance visits.
 - ii. Corrected data are joined into a continuous data set for the water year.
3. Approved water year data sets are summarized and analyzed with Aquarius® and are then archived on the ERMN server.

Table 2. United States Geological Survey data “grades” (i.e., accuracy ratings) of continuous water-quality records for core parameters and turbidity (from Wagner et al. 2006). These grades are used by the Eastern Rivers and Mountains Network and are based on combined fouling and calibration drift corrections that are applied to records. Corrections are applied to “Good” and “Fair” records whereas “Poor” data are removed from the data set – “Excellent” grades are typically not corrected.

Parameter	Data grade			
	Excellent	Good	Fair	Poor
Temperature	$\leq \pm 0.2\text{ }^{\circ}\text{C}$	$>\pm 0.2\text{-}0.5\text{ }^{\circ}\text{C}$	$>\pm 0.5\text{-}0.8\text{ }^{\circ}\text{C}$	$>\pm 0.8\text{ }^{\circ}\text{C}$
Specific Conductance	$\leq \pm 3\%$	$>\pm 3\text{-}10\%$	$>\pm 10\text{-}15\%$	$>\pm 15\%$
Dissolved Oxygen	$\leq \pm 0.3\text{ mg/L}$ or $\leq \pm 5\%$, whichever is greater	$>\pm 0.3\text{-}0.5\text{ mg/L}$ or $>\pm 5\text{-}10\%$, whichever is greater	$>\pm 0.5\text{-}0.8\text{ mg/L}$ or $>\pm 10\text{-}15\%$, whichever is greater	$>\pm 0.8\text{ mg/L}$ or $>\pm 15\%$, whichever is greater
pH	$\leq \pm 0.2\text{ units}$	$>\pm 0.2\text{-}0.5\text{ units}$	$>\pm 0.5\text{-}0.8\text{ units}$	$>\pm 0.8\text{ units}$
Turbidity	$\leq \pm 0.5\text{ NTU}$ or $\leq \pm 5\%$, whichever is greater	$>\pm 0.5\text{-}1.0\text{ NTU}$ or $>\pm 5\text{-}10\%$, whichever is greater	$>\pm 1.0\text{-}1.5\text{ NTU}$ or $>\pm 10\text{-}15\%$, whichever is greater	$>\pm 1.5\text{ NTU}$ or $>\pm 15\%$, whichever is greater

Results

Published (i.e., approved) USGS discharge data from gages co-located with the three ERMN sites were not available at the time this report was prepared but will be analyzed periodically for trend analysis and reporting. Provisional USGS discharge data from co-located gaging stations were used to aid interpretation of water quality data but are not summarized in detail.

The purpose of this report is to provide a succinct and basic summary of effort and results at these monitoring locations during the 2015 water year. More thorough analyses will be conducted periodically (e.g., every five years) as additional data are collected. The figures and tables below present summary statistics for core water quality parameters and turbidity in relation to (provisional) discharge for the 2015 water year. Complete electronic versions of the data are available upon request (contact; caleb_tzilkowski@nps.gov).

Lordville, NY (Upper Delaware SRR)

Cross-section Survey

With the exception of specific conductance, core parameter data were slightly different between the sonde deployment location and across the river width (Tables 3 – 5); however, most of this was likely attributable to temporal variability, not spatial variability. Specific conductance is typically more temporally stable compared to the other parameters and was not different across the river – this result suggested that the water was well mixed and that the sonde location was representative of the river at this location.

Measurements at the sonde deployment location were more similar to each other, in part, because they were taken in rapid succession; conversely, it took considerably longer to move between cross-section intervals, and then allow the instrument to stabilize and record measurements. It was infeasible to take measurements at all intervals across the river and at the sonde deployment site at the exact same time; therefore, considering the time difference among measurements, results of this cross-section survey demonstrated that the sonde deployment site was representative of the Delaware River at Lordville, NY.

Table 3. Descriptive statistics and results of two sample t-test of core parameter measurements recorded during a cross-section survey of the Delaware River at Lordville, NY on August 06, 2015. The estimated difference (of means) is the average of each parameter measured across the river width (Cross-section) subtracted from the average parameter value at the sonde deployment site (Deployment).

	Deployment (<i>n</i> = 10) Mean (SD)	Cross-section (<i>n</i> =14) Mean (SD)	Estimated difference (<i>p</i> -value)
Temperature (°C)	17.6 (0.1)	17.0 (0.2)	0.6 (< 0.01)
Specific conductance (µS/cm)	99.8 (0.1)	99.8 (0.2)	0.04 (0.40)
Dissolved oxygen (mg/L)	9.5 (0.1)	9.4 (0.1)	0.1 (< 0.01)
pH	7.3 (0.1)	7.4 (0.1)	- 0.1 (< 0.01)

Table 4. Core parameter measurements recorded at the sonde deployment location during a cross-section survey of the Delaware River at Lordville, NY on August 06, 2015. Measurements were taken in rapid succession. T = temperature (°C), SC = specific conductance (µS/cm), DO = dissolved oxygen (mg/L).

Measurement number	T	SC	DO	pH
1	17.61	99.8	9.49	7.27
2	17.61	99.7	9.50	7.27
3	17.60	99.8	9.50	7.27
4	17.59	99.8	9.49	7.28
5	17.58	99.7	9.49	7.28
6	17.58	99.8	9.49	7.28
7	17.58	99.8	9.49	7.28
8	17.58	99.7	9.49	7.29
9	17.60	99.8	9.48	7.29
10	17.60	99.8	9.48	7.29

Table 5. Core parameter measurements recorded across the Delaware River width recorded during a cross-section survey of the river at Lordville, NY on August 06, 2015. Distance is the perpendicular distance from the river right bank (descending) and the measurement depth is the depth to which the sonde was lowered to record parameters. T = temperature (°C), SC = specific conductance (µS/cm), DO = dissolved oxygen (mg/L).

Distance (m)	River Depth (m)	Measurement Depth (m)	T	SC	DO	pH
1	0.5	0.3	16.74	100.2	9.22	7.55
4	0.5	0.3	16.78	99.6	9.26	7.40
8	1.0	0.5	16.74	99.6	9.30	7.40
11	1.4	0.7	16.77	99.6	9.36	7.41
15	2.5	1.3	16.85	99.7	9.46	7.43
19	3.0	1.5	16.85	99.7	9.47	7.43
23	3.1	1.6	16.90	99.7	9.43	7.42
27	3.2	1.6	16.98	99.8	9.49	7.42
30	3.5	1.8	17.02	99.8	9.50	7.37
34	3.5	1.8	17.04	99.8	9.50	7.43
38	2.9	1.5	17.19	99.8	9.44	7.30
42	2.1	1.1	17.42	99.6	9.39	7.32
46	2.2	1.1	17.25	99.7	9.39	7.27
50	1.9	1.0	17.32	99.6	9.40	7.15
57	0.0	0.0	*	*	*	*

Data Quality and Completeness

Data quality was “Excellent” or “Good” for all parameters throughout the year except for turbidity which was typically “Fair” or “Good” (Table 6). Condensation on the sonde motherboard resulted in erroneous measurements for approximately one week (May 21 – 28) before the site could be revisited to replace the sonde – those data were not useable and were deleted from the record.

Table 6. Summary data quality grades for core water quality parameters and turbidity recorded in the Delaware River at Lordville, NY during the 2015 water year. E = Excellent, G = Good, F = Fair, P = Poor. See Table 2 for grade criteria.

Period End Date	Dissolved Oxygen	pH	Specific Conductance	Temperature	Turbidity
10/17/2014	E	G	E	E	P
11/24/2014	E	E	E	E	F
04/13/2015	E	G	E	E	F
05/12/2015	E	E	G	E	G
05/20/2015	E	E	E	E	G
07/02/2015	E	G	E	E	F
08/06/2015	G	E	G	E	F
09/03/2015	E	G	E	E	F

Water Quality

Table 7. Minimum and maximum daily average core water quality parameters and turbidity of Delaware River water at Lordville, NY during the 2015 water year.

Parameter	Minimum	Maximum
Dissolved Oxygen (mg/L)	7.3 (May 12)	14.1 (January 09)
Dissolved Oxygen, Percent of Saturation	78.6 (March 05)	110.3 (July 29)
pH	6.49 (February 24)	7.98 (June 26)
Specific Conductance (µS/cm)	37.6 (April 11)	254.6 (March 14)
Water Temperature (°C)	≤ 0.2 (90 days) ¹	22.8 (June 13)
Turbidity (FNU)	≤ 0.5 (90 days) ²	150.9 (September 21)

¹ Average daily temperature was < 0.2° C for 90 days between January 01 and April 01.

² Average daily turbidity was equal to or below sensor precision specifications for 90 days throughout the year.

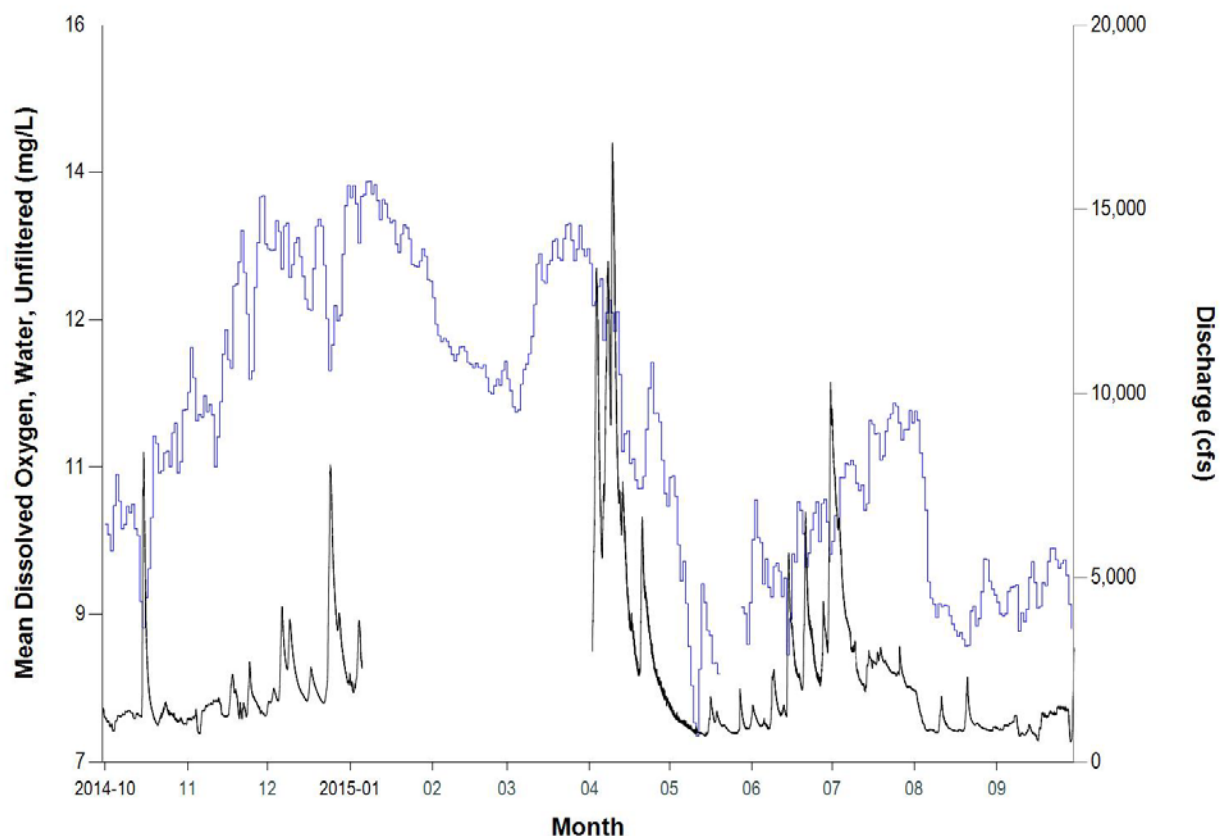


Figure 5. Mean daily dissolved oxygen concentration (blue line) in Delaware River water at Lordville, NY from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 8. Monthly descriptive statistics of dissolved oxygen concentration (mg/L) in Delaware River water at Lordville, NY from October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	2,917	2,871	2,974	2,973	2,683	2,971	2,864	2,202	2,872	2,964	2,954	2,879
Min	8.3	9.9	11.6	12.8	11.4	11.2	9.1	6.3	7.5	8.9	7.6	7.7
Max	12.5	14.6	14.3	14.5	13.1	14.0	13.7	11.8	11.5	12.5	12.3	10.9
$\bar{x}$	10.2	12.0	13.1	13.6	11.9	13.0	11.6	9.1	9.5	10.6	9.1	9.0
M	10.2	12.1	13.0	13.6	12.0	12.7	11.6	8.9	9.6	10.7	9.2	9.1
SD	0.9	1.0	0.6	0.4	0.3	0.8	1.0	1.1	0.9	0.9	1.1	0.8

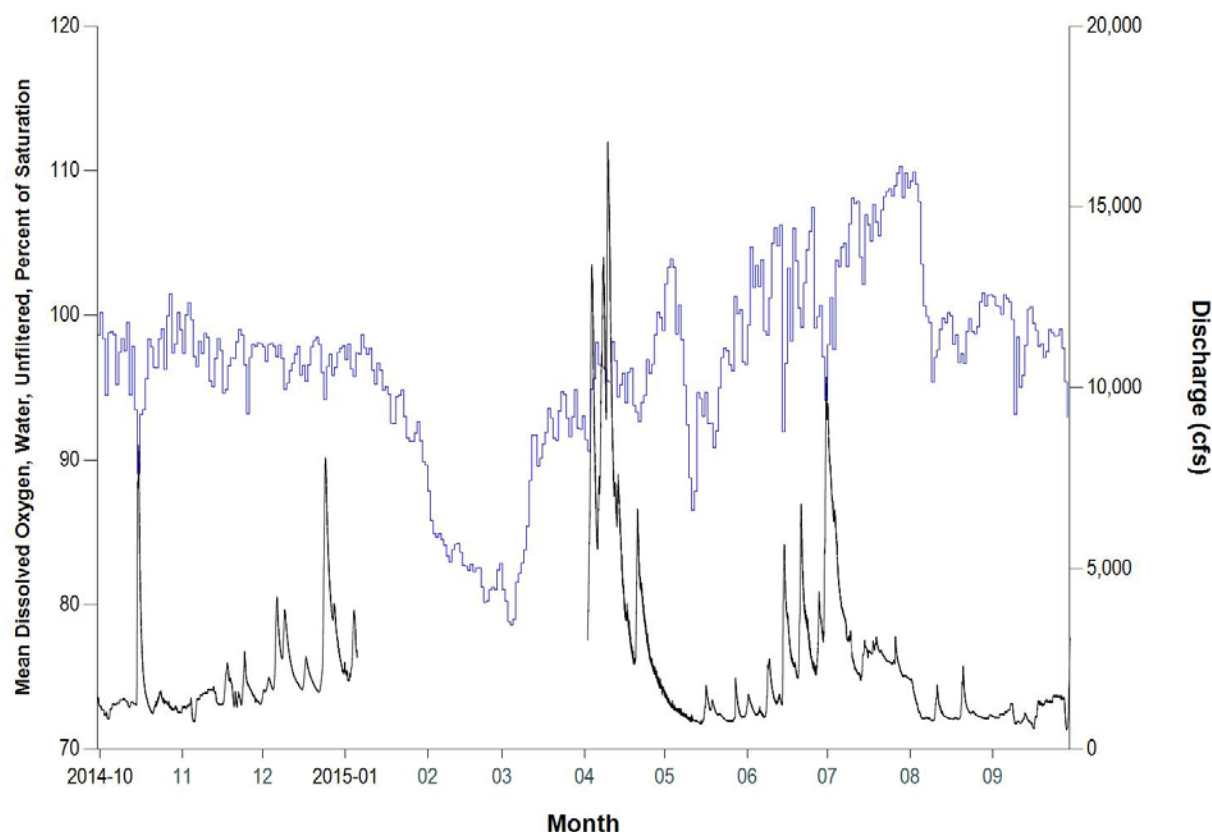


Figure 6. Mean daily dissolved oxygen percent of saturation (blue line) in Delaware River water at Lordville, NY from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 9. Monthly descriptive statistics of dissolved oxygen percent of saturation in Delaware River water at Lordville, NY from October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	2,826	2,847	2,950	2,941	2,683	2,822	2,848	2,955	2,868	2,952	2,922	2,871
Min	87.0	89.7	92.8	89.0	79.4	77.9	85.5	74.1	85.3	91.2	85.4	84.0
Max	116.4	112.7	103.8	100.9	91.3	98.1	115.3	124.2	128.5	125.6	122.5	118.9
$\bar{x}$	97.2	97.5	96.9	94.9	83.4	88.4	95.6	96.2	101.6	105.6	100.8	98.6
M	95.8	96.6	96.5	95.1	83.2	90.8	95.4	95.7	99.8	104.4	100.2	96.8
SD	6.8	4.8	2.4	2.6	2.2	5.6	4.5	9.5	9.8	9.0	9.5	9.7

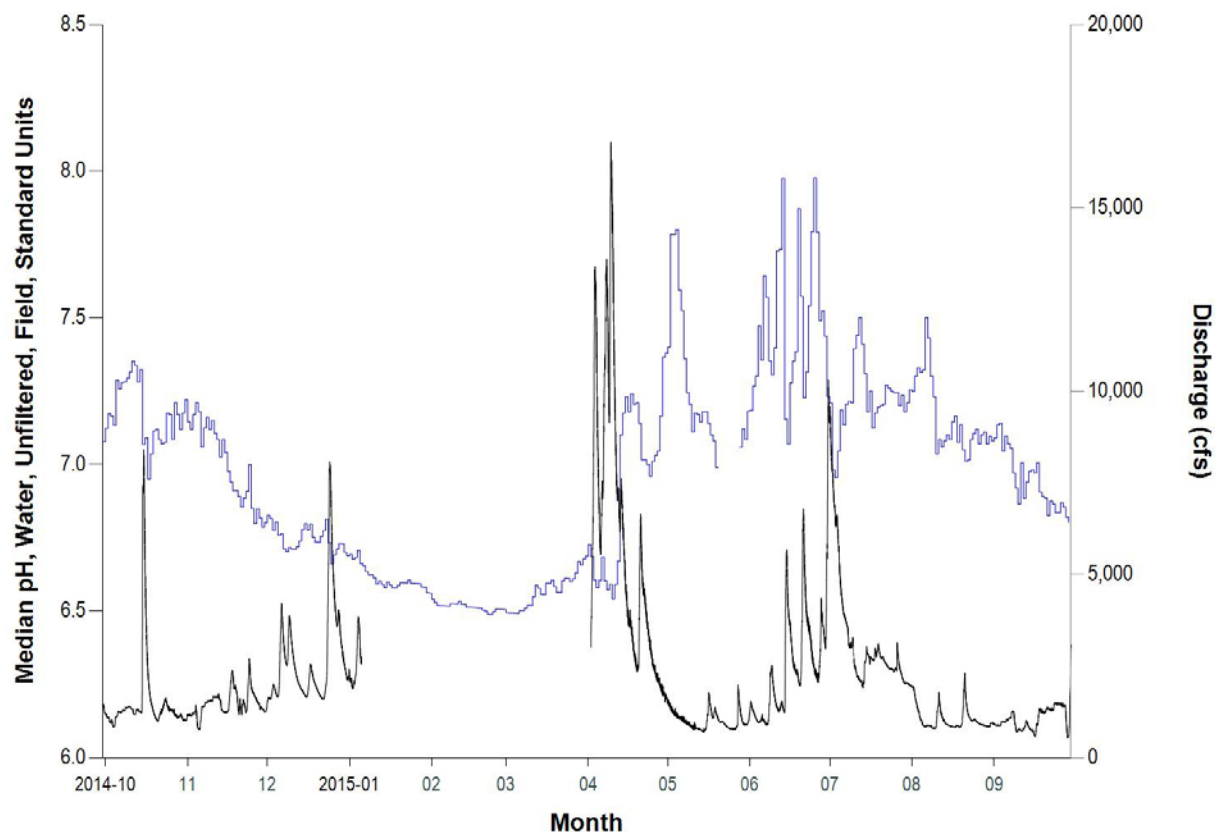


Figure 7. Median daily Delaware River water pH (blue line) at Lordville, NY from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 10. Monthly descriptive statistics of Delaware River water pH (standard units) at Lordville, NY October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	2,969	2,873	2,976	2,976	2,688	2,976	2,868	2,204	2,880	2,968	2,955	2,880
Min	6.8	6.7	6.6	6.6	6.5	6.5	6.5	6.8	6.9	6.7	6.8	6.6
Max	8.4	8.2	7.0	6.8	6.6	6.7	8.9	9.3	9.2	8.8	8.5	8.4
$\bar{x}$	7.2	7.1	6.8	6.6	6.5	6.6	6.9	7.3	7.6	7.3	7.3	7.1
M	7.2	7.0	6.8	6.6	6.5	6.6	6.9	7.2	7.4	7.2	7.2	6.9
SD	0.3	0.3	0.1	0.0	0.0	0.1	0.4	0.6	0.6	0.4	0.4	0.5

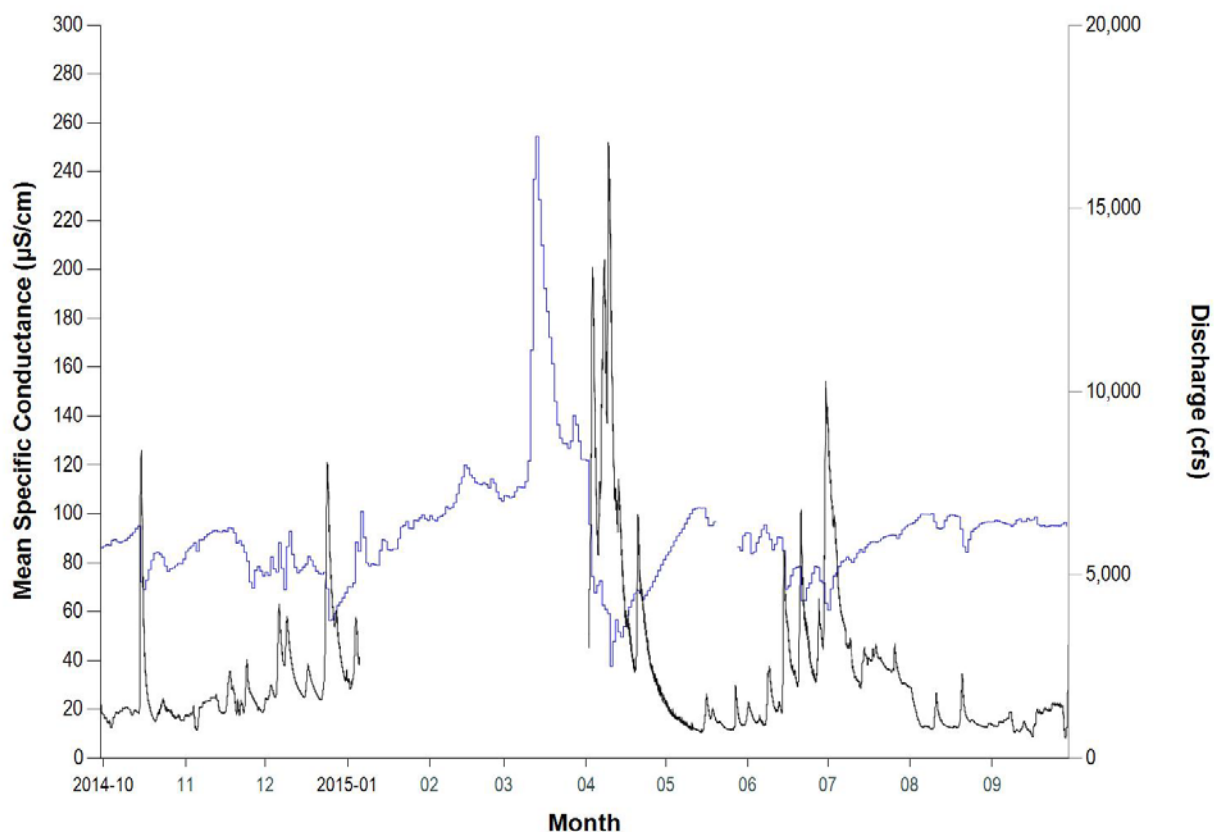


Figure 8. Mean daily Delaware River water specific conductance (blue line) at Lordville, NY from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 11. Monthly descriptive statistics of Delaware River water specific conductance ($\mu\text{S}/\text{cm}$) at Lordville, NY October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	2,969	2,873	2,976	2,976	2,688	2,976	2,868	2,204	2,880	2,968	2,955	2,880
Min	61	69	55	65	97	105	32	80	59	57	83	92
Max	96	97	98	106	121	260	125	103	97	96	102	101
$\bar{x}$	84	87	75	87	108	144	69	95	81	84	96	96
M	85	89	76	88	110	129	67	95	80	87	97	96
SD	7	7	9	10	7	42	18	7	9	8	4	1

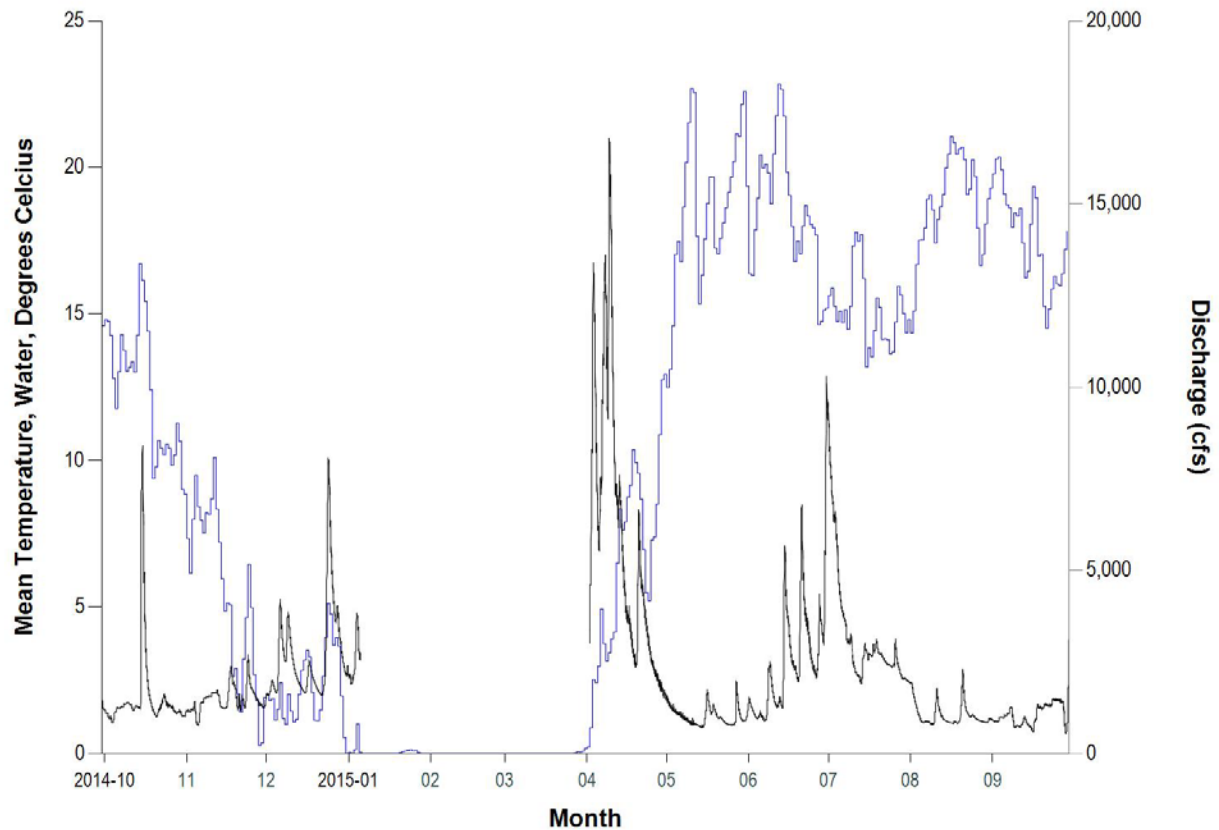


Figure 9. Mean daily Delaware River water temperature (blue line) at Lordville, NY from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 12. Monthly descriptive statistics of Delaware River water temperature at Lordville, NY from October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	2,969	2,873	2,976	2,976	2,688	2,976	2,868	2,204	2,880	2,968	2,955	2,880
Min	8.1	-0.1	0.1	-0.1	0.0	0.0	0.0	11.0	14.0	11.6	13.0	13.9
Max	17.2	10.4	5.5	1.3	0.0	0.2	14.5	24.4	24.4	19.2	22.4	21.9
$\bar{x}$	12.5	5.6	2.3	0.1	0.0	0.0	6.1	18.4	18.6	15.1	18.6	17.7
M	12.8	6.1	2.0	0.0	0.0	0.0	6.6	18.4	18.5	14.8	18.7	17.7
SD	2.2	2.9	1.2	0.2	-	0.0	3.4	3.3	2.3	1.5	2.0	1.8

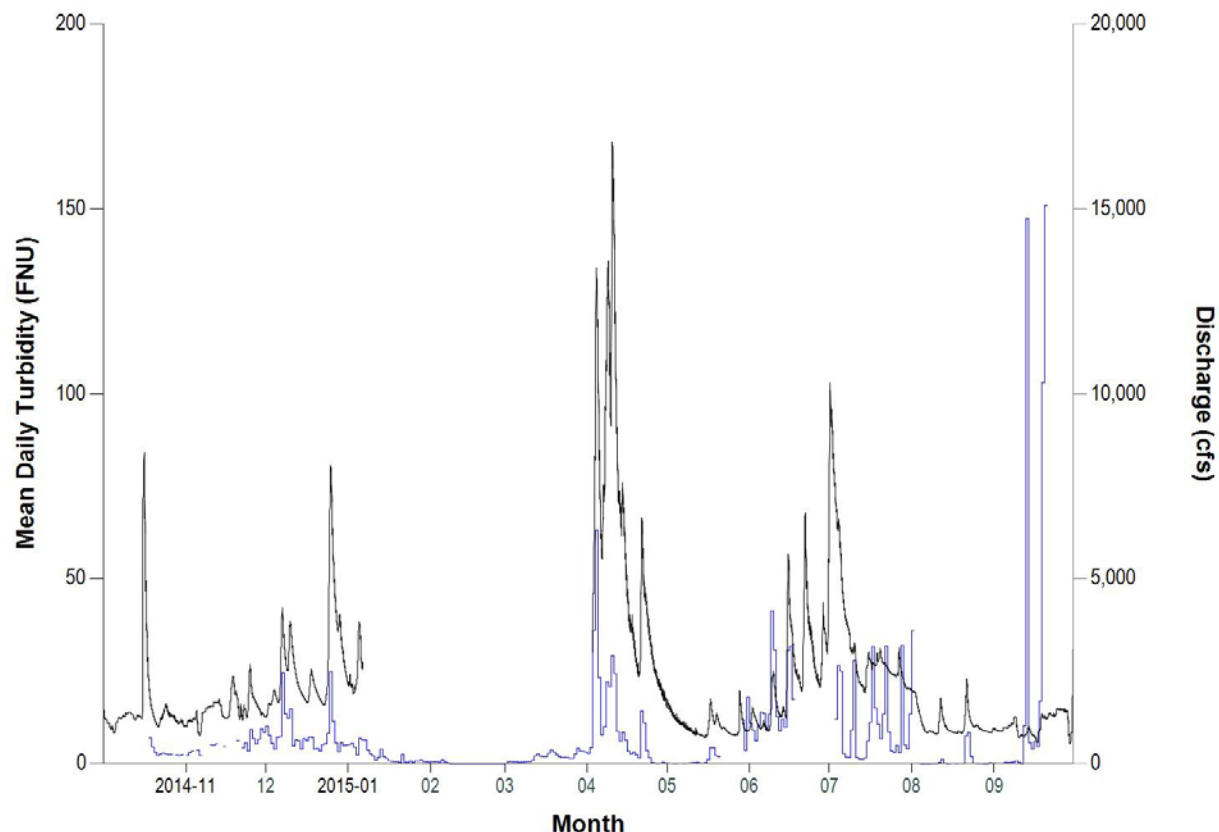


Figure 10. Mean daily Delaware River water turbidity (FNU = Formazin Nephelometric Units, blue line) at Lordville, NY from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 13. Monthly descriptive statistics of Delaware River water turbidity (Formazin Nephelometric Units) at Lordville, NY from October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	1,228	2,279	2,975	2,975	2,687	2,976	2,864	2,204	1,624	2,807	2,821	1,975
Min	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	< 0.5	0.9	< 0.5	< 0.5	< 0.5
Max	14.0	40.4	136.7	37.5	4.2	11.6	103.4	101.0	176.3	163.5	247.1	1,053.0
$\bar{x}$	3.2	5.4	8	2.2	0.1	1.8	10.6	3.3	21.9	13.4	3.7	24
M	12.7	4.6	6.1	0.7	0	1.6	4.8	1	6.5	1.8	0	5.8
SD	2.1	4.4	8.4	3.1	0.4	1.3	15.1	7.5	21.2	23.4	12.9	68.5

Montague, NJ (Delaware Water Gap NRA)

Cross-section Survey

Specific conductance and dissolved oxygen did not differ between the sonde intake and the river cross-section but temperature and pH did (Tables 14 – 16). Observed differences were likely attributable to temporal variability, not spatial variability, because 70 min elapsed between the first cross-section measurement and the last sonde intake measurement. These results suggested that the river was well mixed, and that the sonde location is representative of the river at this location.

Table 14. Descriptive statistics and results of two sample t-test of core parameter measurements recorded during a cross-section survey of the Delaware River at Montague, NJ on September 26, 2014. The estimated difference (of means) is the average of each parameter measured across the river width (Cross-section) subtracted from the average parameter value at the sonde deployment site (Deployment).

	Deployment (n = 10) Mean (SD)	Cross-section (n = 15) Mean (SD)	Estimated difference (p-value)
Temperature (°C)	16.9 (0.1)	16.5 (0.2)	0.4 (< 0.01)
Specific conductance (µS/cm)	99.6 (0.1)	99.8 (1.5)	- 0.2 (0.6)
Dissolved oxygen (mg/L)	9.8 (0.1)	9.9 (0.1)	- 0.1 (0.1)
pH	7.5 (0.1)	7.6 (0.1)	-0.1 (< 0.05)

Table 15. Core parameter measurements recorded at the sonde deployment location during a cross-section survey of the Delaware River at Montague, NJ on September 26, 2014. Measurements were taken in rapid succession. T = temperature (°C), SC = specific conductance (µS/cm), DO = dissolved oxygen (mg/L).

Measurement number	T	SC	DO	pH
1	16.85	99.6	9.79	7.51
2	16.85	99.6	9.79	7.51
3	16.85	99.6	9.79	7.51
4	16.85	99.6	9.79	7.51
5	16.85	99.6	9.79	7.51
6	16.85	99.6	9.79	7.51
7	16.85	99.6	9.79	7.51
8	16.87	99.6	9.79	7.51
9	16.88	99.6	9.79	7.51
10	16.88	99.6	9.79	7.50

Table 16. Core parameter measurements recorded across the Delaware River width recorded during a cross-section survey of the Delaware River at Montague, NJ on September 26, 2014. Distance is the perpendicular distance from the river right bank (descending) and the measurement depth is the depth to which the sonde was lowered to record parameters. T = temperature (oC), SC = specific conductance (μS/cm), DO = dissolved oxygen (mg/L).

Distance (m)	River Depth (m)	Measurement Depth (m)	T	SC	DO	pH
0	0.0	---	---	---	---	---
5	0.3	0.2	16.74	99.8	9.59	7.44
9	1.0	0.5	17.16	100.0	9.57	7.45
14	1.5	0.8	16.44	99.5	9.74	7.47
19	2.0	1.0	16.44	99.5	9.68	7.49
23	2.2	1.1	16.52	99.6	9.72	7.48
28	2.9	1.5	16.42	99.3	9.78	7.52
33	3.4	1.7	16.40	99.1	9.93	7.56
37	4.0	2.0	16.48	99.2	9.96	7.59
42	4.2	2.1	16.39	98.9	9.96	7.60
47	5.2	2.6	16.38	98.7	9.99	7.63
51	4.9	2.5	16.41	98.9	10.05	7.64
56	4.4	2.2	16.42	100.6	10.04	7.63
60	2.7	1.4	16.43	99.0	10.00	7.64
65	1.9	1.0	16.42	100.2	10.00	7.67

Data Quality and Completeness

Data quality was typically “Excellent” or “Good” for all parameters throughout the year but there were a few exceptions (Table 17). Turbidity was generally of lower quality than core parameters. pH data from the first deployment period (ending 10/16/14) were erroneous and deleted because the electrolyte solution had not been changed prior to deployment. Data from May 7 through May 11 were removed from the dataset because of damage that occurred to the system during winter. The PVC well shifted during winter, likely due to ice flow during the spring thaw; consequently, the secondary pump conduit was dislodged from the well. When the river water stage dropped to a level (approximately 2,600 cfs; May 7) at which the secondary pump was required, data were erroneous until May 11 when the system was repaired.

Table 17. Data quality grades for core water quality parameters and turbidity recorded in the Delaware River at Montague, NJ during the 2015 water year. E = Excellent, G = Good, F = Fair, P = Poor. See Table 2 for grade criteria.

Period End Date	Dissolved Oxygen	pH	Specific Conductance	Temperature	Turbidity
10/16/2014	E	-	E	E	G
11/25/2014	E	F	E	E	F
02/11/2015	E	G	E	E	G
04/14/2015	E	G	E	E	G
05/11/2015	E	G	G	E	P
07/03/2015	E	E	E	E	G
08/19/2015	E	E	E	E	F
09/30//2015	E	G	E	E	F

Water Quality

Table 18. Minimum and maximum daily average core water quality parameters and turbidity of Delaware River water at Montague, NJ during the 2015 water year.

Parameter	Minimum	Maximum
Dissolved Oxygen (mg/L)	6.0 (July 06)	14.6 (January 24)
Dissolved Oxygen, Percent of Saturation	69.6 (July 07)	112.8 (September 07)
pH	6.08 (February 12)	8.38 (September 08)
Specific Conductance ($\mu\text{S}/\text{cm}$)	75.8 (April 12)	198.2 (March 16)
Water Temperature ($^{\circ}\text{C}$)	≤ 0.2 (68 days) ¹	26.7 (August 19)
Turbidity (FNU)	≤ 0.5 (108 days) ²	75.1 (April 06)

¹ Average daily temperature was $< 0.2^{\circ}\text{C}$ for 68 days between January 04 and March 14, 2015.

² Average daily turbidity was equal to or below sensor precision specifications for 108 days throughout the year.

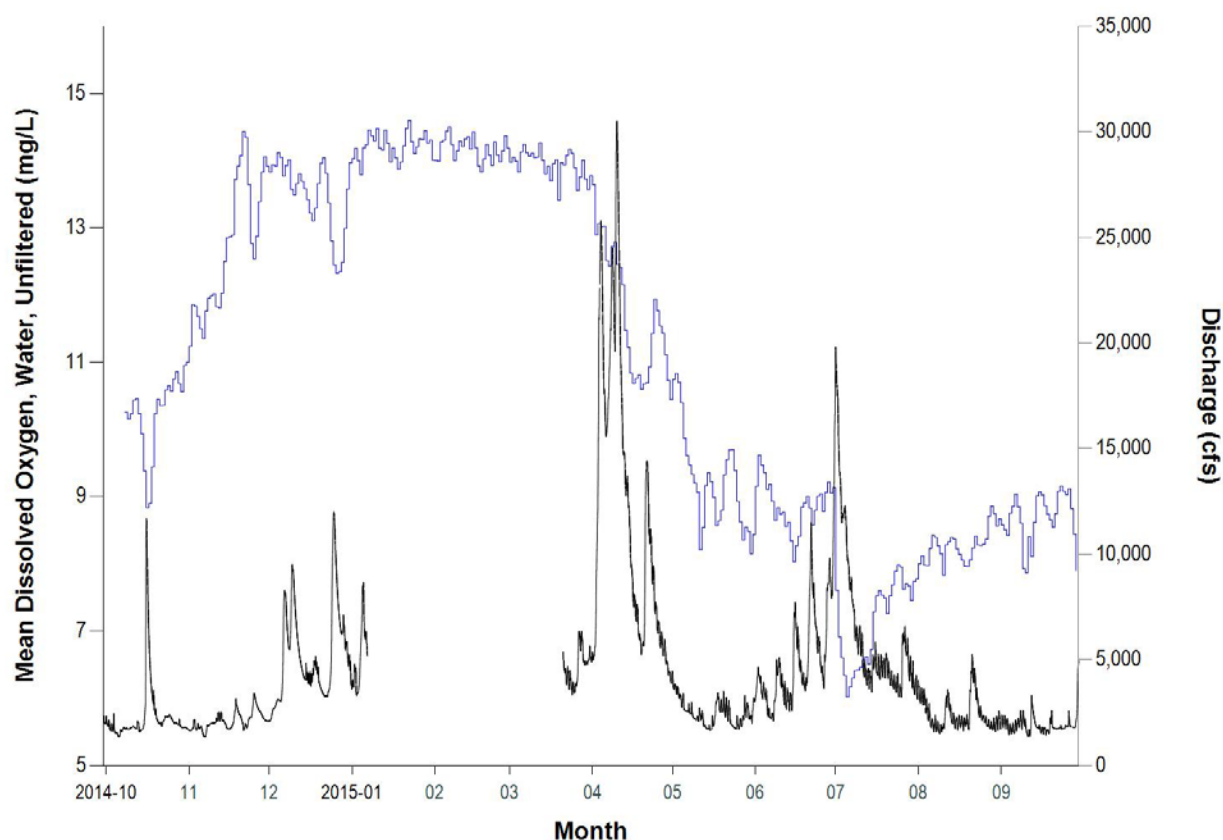


Figure 11. Mean daily dissolved oxygen concentration (blue line) in Delaware River water at Montague, NJ from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 19. Monthly descriptive statistics of dissolved oxygen concentration (mg/L) in Delaware River water at Montague, NJ from October 1, 2014 to September 30, 2015. *n* = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<i>n</i>	531	706	742	740	671	742	713	606	718	742	742	720
Min	8.6	10.6	12.1	13.6	13.4	12.1	10.0	7.3	7.3	5.7	6.7	6.2
Max	11.5	14.8	14.6	14.9	14.8	14.8	14.2	11.5	10.0	9.3	10.1	10.7
$\bar{x}$	10.2	12.6	13.5	14.2	14.2	14.0	11.9	9.3	8.9	7.2	8.2	8.7
M	10.2	12.4	13.6	14.2	14.2	13.9	11.8	9.2	8.9	7.1	8.2	8.6
SD	0.6	1.0	0.6	0.3	0.3	0.3	1.0	0.9	0.5	0.8	0.7	1.0

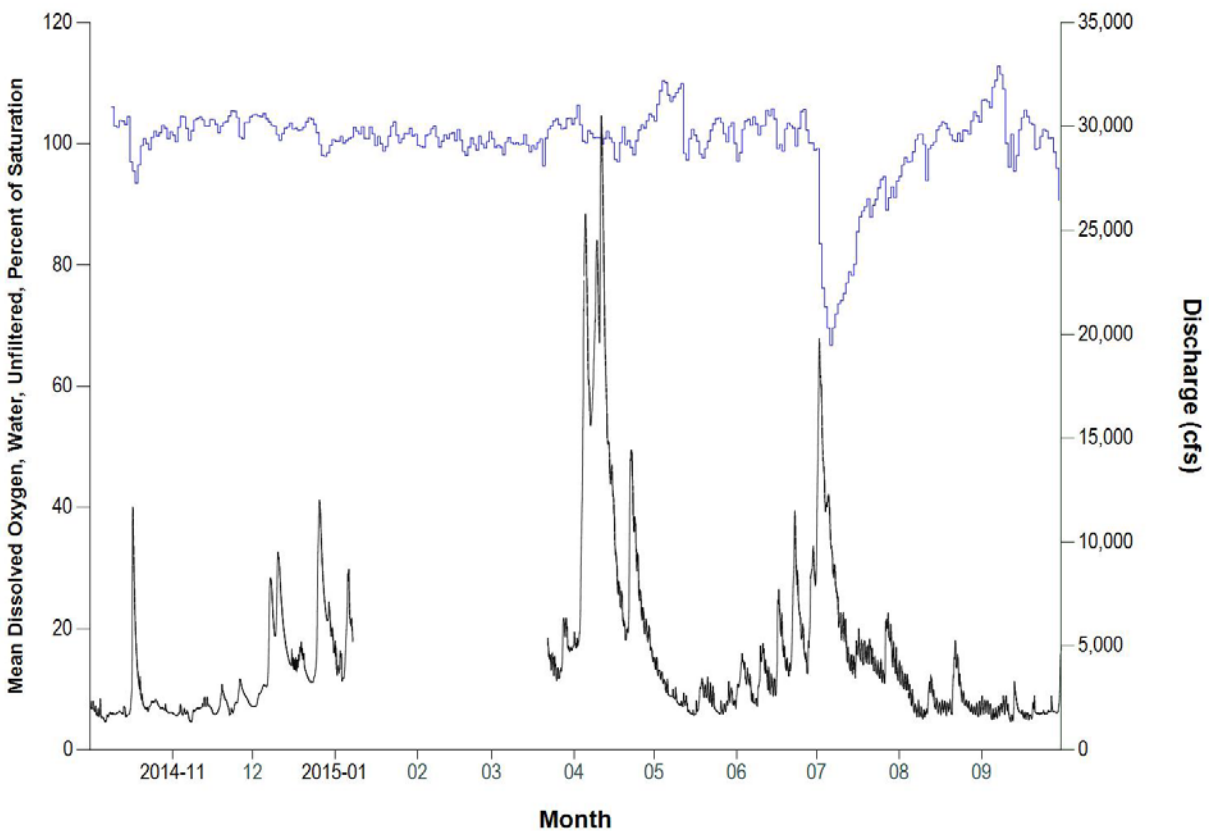


Figure 12. Mean daily dissolved oxygen percent of saturation (blue line) in Delaware River water at Montague, NJ from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 20. Monthly descriptive statistics of dissolved oxygen percent of saturation in Delaware River water at Montague, NJ from October 1, 2014 to September 30, 2015. *n* = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<i>n</i>	531	706	742	740	671	742	717	606	718	742	742	720
Min	0.0	96.4	95.7	96.9	95.1	87.2	90.6	86.0	89.4	62.7	79.9	75.1
Max	110.1	109.5	109.9	105.6	105.2	110.8	115.6	120.4	119.0	107.5	122.9	135.8
$\bar{x}$	100.8	103.2	102.4	101.2	100.6	100.9	101.4	103.6	102.3	83.8	100.7	102.9
M	103.5	103.0	102.4	101.2	100.5	100.5	100.8	104.8	100.9	83.1	100.3	101.5
SD	6.0	3.0	2.6	1.7	2.1	2.8	4.1	6.9	6.3	10.9	9.0	13.2

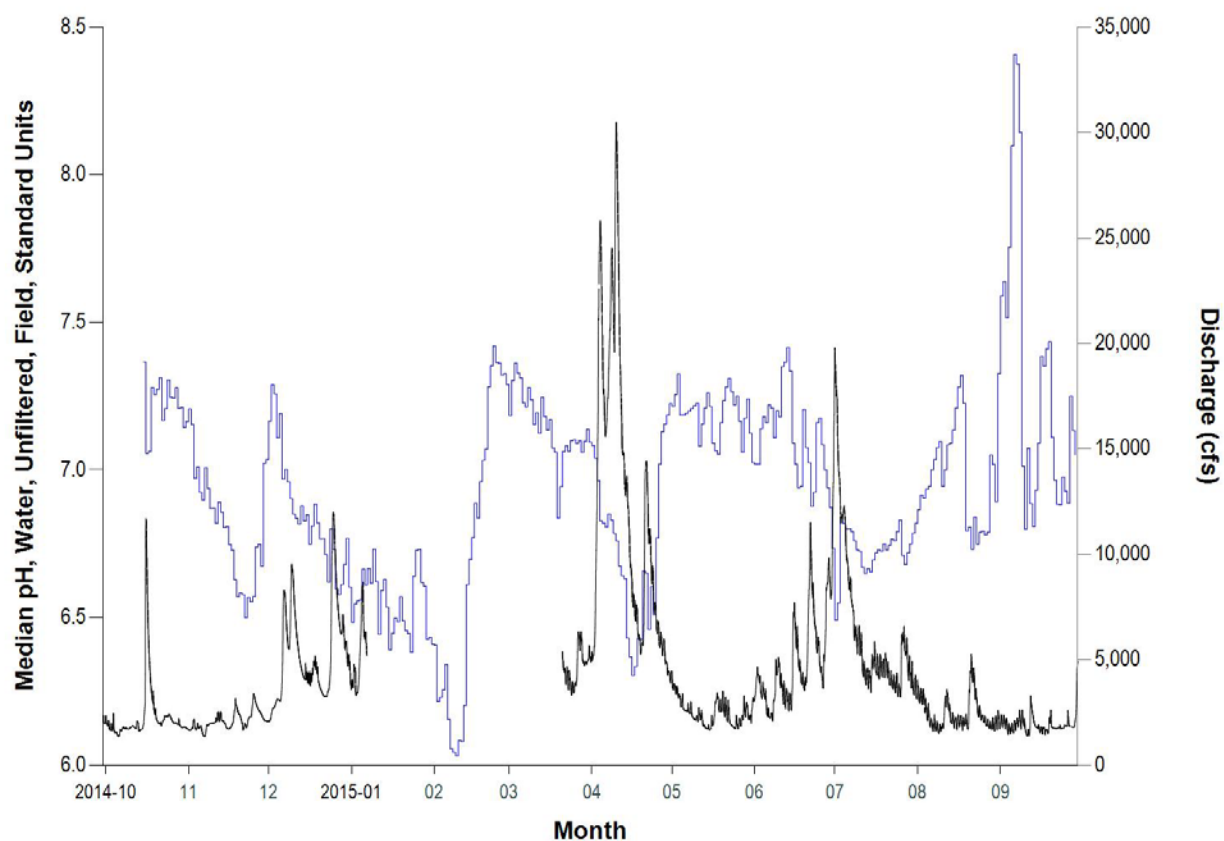


Figure 13. Median daily Delaware River water pH (blue line) at Montague, NJ from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 21. Monthly descriptive statistics of Delaware River water pH (standard units) at Montague, NJ from October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	364	706	744	741	672	744	717	607	718	743	742	720
Min	6.9	6.1	6.4	6.2	5.7	6.7	6.0	6.9	6.8	6.5	6.4	6.5
Max	7.5	7.3	7.5	6.8	7.5	7.5	7.8	8.2	8.5	7.0	8.2	9.1
$\bar{x}$	7.2	6.8	6.9	6.6	6.7	7.2	6.7	7.2	7.2	6.7	7.0	7.4
M	7.4	6.8	6.8	6.6	6.7	7.1	6.7	7.2	7.1	6.7	7.0	7.1
SD	0.1	0.2	0.2	0.1	0.5	0.1	0.3	0.2	0.4	0.1	0.3	0.6

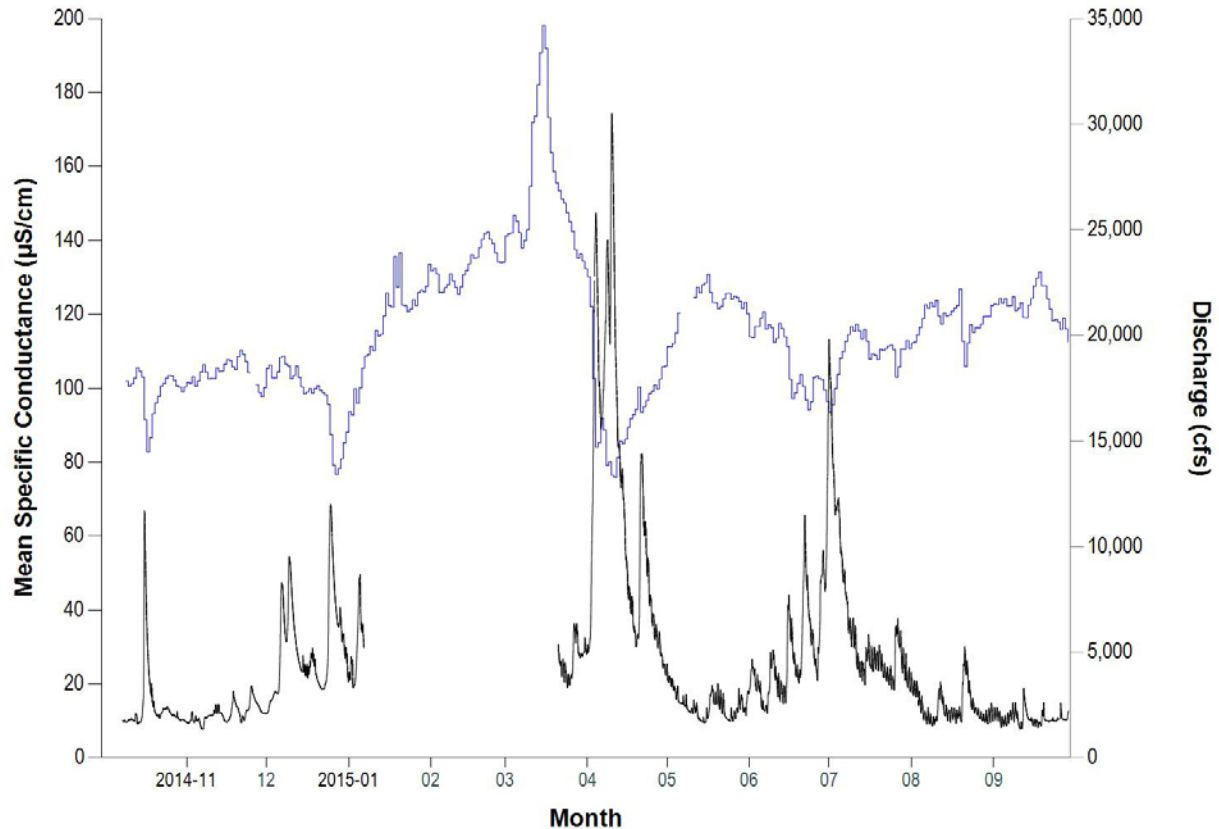


Figure 14. Mean daily Delaware River water specific conductance (blue line) at Delaware River water at Montague, NJ from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 22. Monthly descriptive statistics of Delaware River water specific conductance ($\mu\text{S}/\text{cm}$) at Montague, NJ from October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	531	706	744	741	672	744	715	626	718	743	742	720
Min	82.1	96.8	76.1	85.9	122.6	129.3	74.7	100.9	92.1	91.3	103.0	106.6
Max	108.2	112.6	113.5	145.3	151.8	202.3	135.2	137.5	125.1	123.6	131.6	135.5
$\bar{x}$	99.1	103.9	98.2	115.8	133.1	153.6	94.9	122.7	108.6	109.1	118.0	122.3
M	101.5	104.0	99.9	120.7	132.6	147.5	93.0	123.4	110.7	110.1	118.5	122.4
SD	5.9	3.3	9.2	12.7	5.4	18.3	14.1	6.6	8.7	6.3	5.1	4.7

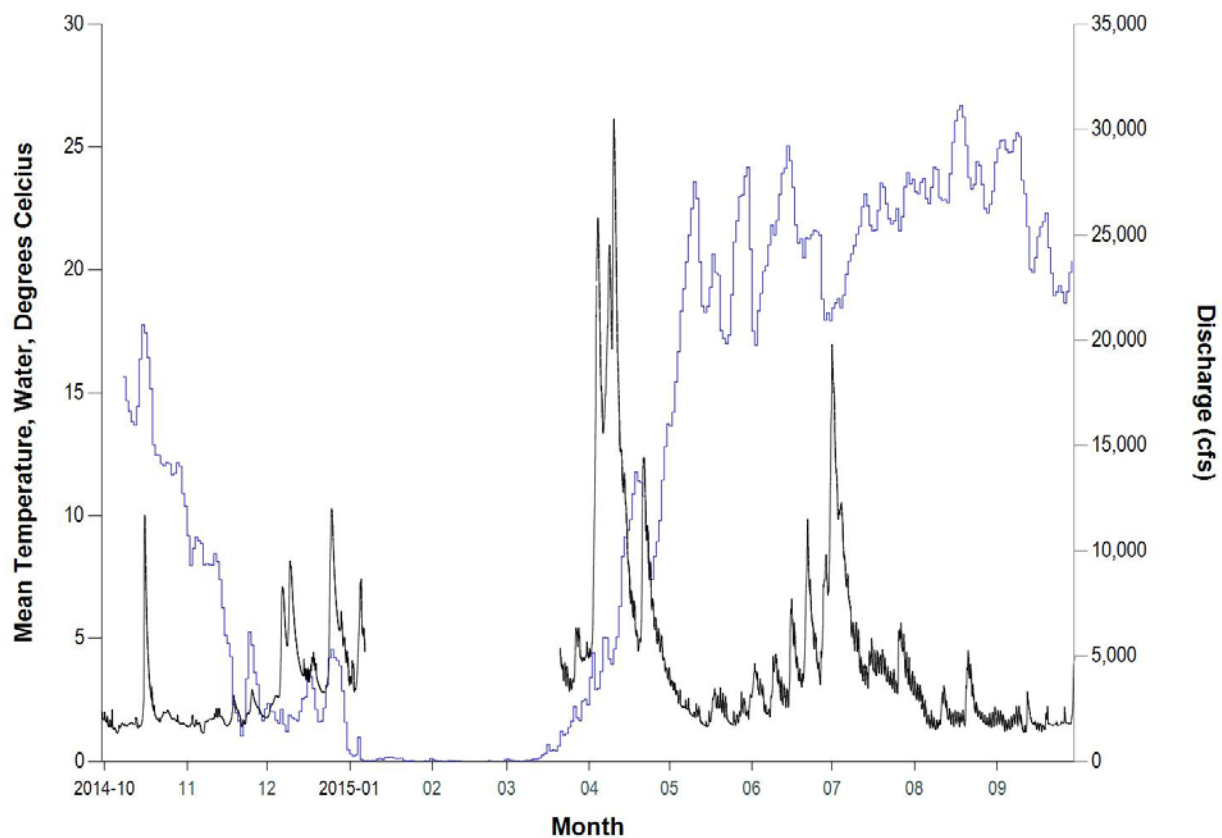


Figure 15. Mean daily Delaware River water temperature (blue line) at Montague, NJ from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 23. Monthly descriptive statistics of Delaware River water temperature at Montague, NJ from October 1, 2014 to September 30, 2015. n = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
n	529	706	744	741	672	744	715	607	718	743	742	720
Min	10.4	0.5	1.1	0.0	-0.1	0.0	1.3	12.3	15.8	17.4	21.3	17.7
Max	18.4	10.9	4.9	1.2	0.3	3.1	14.6	25.2	25.9	25.1	27.6	26.6
$\bar{x}$	13.6	5.7	2.5	0.1	0.0	0.7	7.4	19.4	21.0	21.4	23.8	22.1
M	14.4	5.8	2.1	0.1	0.0	0.2	7.9	19.0	21.1	21.7	23.6	21.8
SD	2.0	2.9	1.0	0.2	0.0	0.9	3.2	3.1	2.2	1.8	1.4	2.5

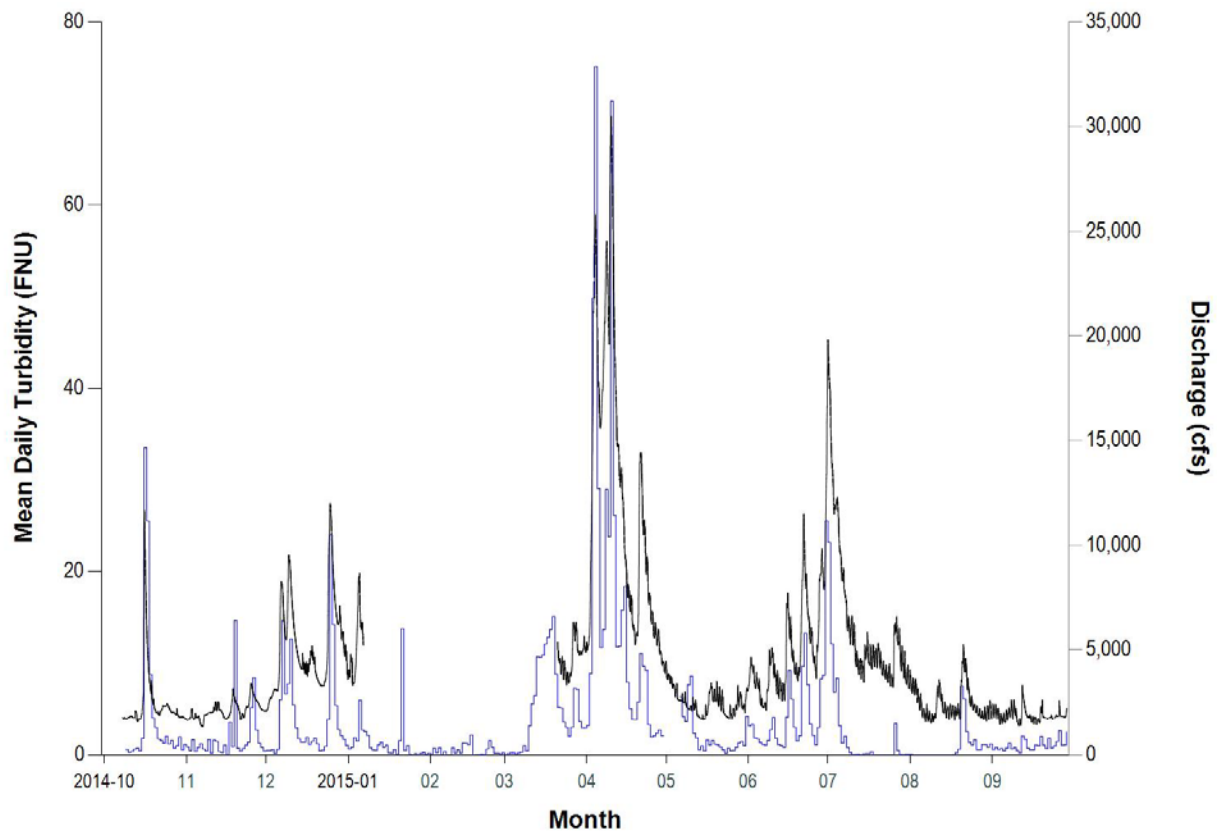


Figure 16. Mean daily Delaware River water turbidity (FNU = Formazin Nephelometric Units, blue line) at Montague, NJ from October 1, 2014 to September 30, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 24. Monthly descriptive statistics of Delaware River water turbidity (Formazin Nephelometric Units) at Montague, NJ from October 1, 2014 to September 30, 2015. *n* = number of measurements, Min = minimum, Max = maximum, $\bar{x}$ = mean, M = median, SD = standard deviation.

Year	2014			2015								
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<i>n</i>	532	718	744	742	672	744	718	628	720	743	744	720
Min	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	0.6	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
Max	43.5	83.8	32.9	112.2	8.2	118.6	130.3	33.0	24.8	43.2	25.4	41.0
$\bar{x}$	4.2	1.8	4.1	1.4	0.5	5.0	15.8	4.6	3.8	2.8	0.8	1.0
M	2.0	≤ 0.5	1.6	0.4	≤ 0.5	3.4	8.3	1.2	2.4	≤ 0.5	≤ 0.5	0.7
SD	8.8	5.7	5.7	5.3	1.0	6.8	21.1	3.2	3.8	6.7	2.4	2.2

Thurmond, WV (New River Gorge NR)

Cross-section Survey

A cross-section survey was not conducted at Thurmond, WV during the first year it was deployed (2015) due to logistical reasons. The surveys will require boat access and will be conducted annually beginning in 2016 by coordinating with New River Gorge NR staff.

Data Quality and Completeness

Data quality was typically “Excellent” for core parameters throughout the growing season but turbidity grades were generally “Fair” (Table 25).

Table 25. Summary of water quality grades for core water quality parameters and turbidity of New River water at Thurmond, WV from May 20, 2015 to October 1, 2015. E = Excellent, G = Good, F = Fair, P = Poor. See Table 2 for grade criteria.

Period End Date	Dissolved Oxygen	pH	Specific Conductance	Temperature	Turbidity
06/24/2015	E	F	E	E	E
07/30/2015	E	E	E	E	F
09/02/2015	E	E	E	E	F
09/30/2015	E	G	E	E	F

Water Quality

Table 26. Minimum and maximum daily average core water quality parameters and turbidity of New River water at Thurmond, WV from May 20, 2015 to October 1, 2015.

Parameter	Minimum	Maximum
Dissolved Oxygen (mg/L)	5.7 (June 23)	9.6 (September 15)
Dissolved Oxygen, Percent of Saturation	77.0 (June 23)	112.9 (May 21)
pH	7.3 (June 24)	9.2 (September 13)
Specific Conductance ($\mu\text{S}/\text{cm}$)	110.7 (June 29)	231.2 (September 18)
Water Temperature ($^{\circ}\text{C}$)	19.7 (May 22)	27.9 (June 23)
Turbidity (FNU)	< 0.5 (8 days) ¹	164.9 (June 29)

¹ Average daily turbidity was equal to or below sensor precision specifications for eight days during the growing season.

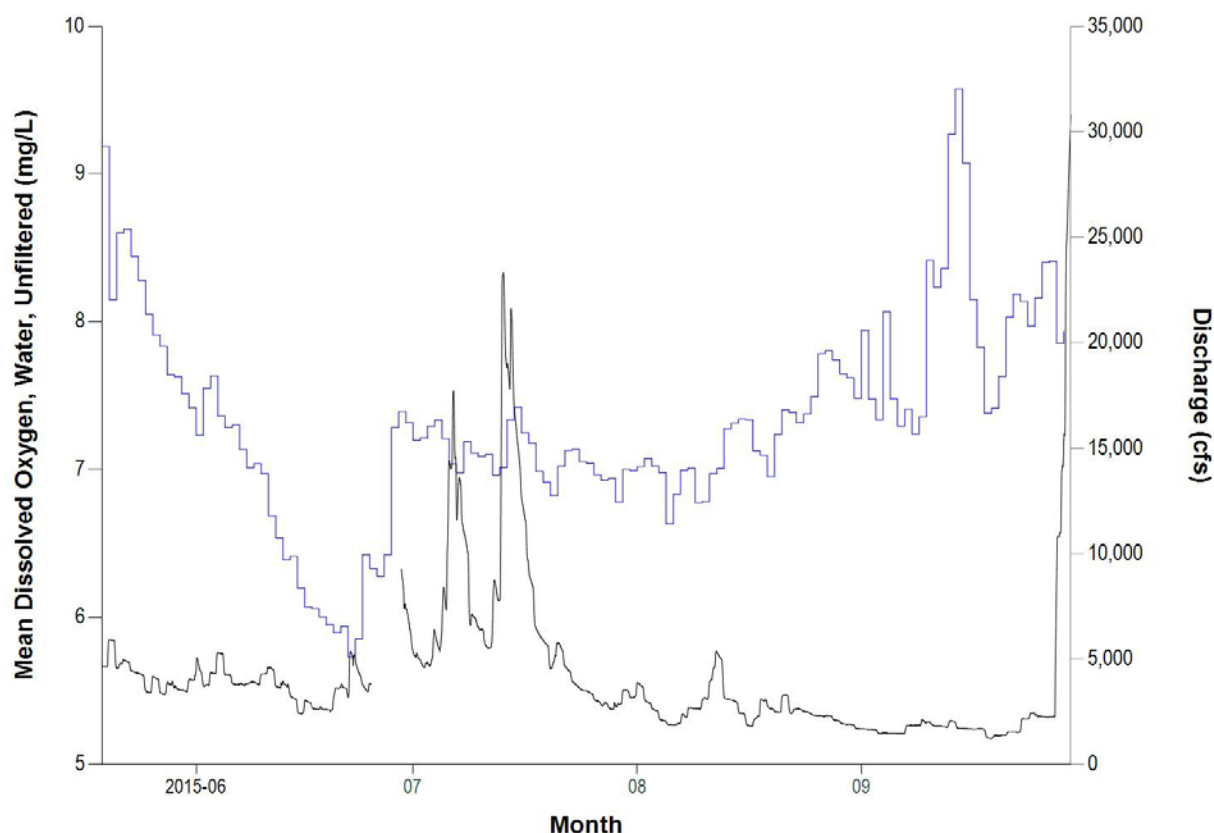


Figure 17. Mean daily dissolved oxygen concentration (blue line) in New River water at Thurmond, WV from May 20, 2015 to October 1, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 27. Monthly descriptive statistics of dissolved oxygen concentration (mg/L) in New River water at Thurmond, WV from May 20, 2015 to September 30, 2015.

Month	May	Jun	Jul	Aug	Sep
Samples	267	718	742	744	610
Minimum	7.0	5.4	6.3	6.1	6.7
Maximum	9.3	8.2	7.8	8.7	11.9
Mean	8.1	6.7	7.1	7.2	8.0
Median	9.3	6.6	7.1	7.1	7.9
SD	0.5	0.7	0.3	0.6	0.9

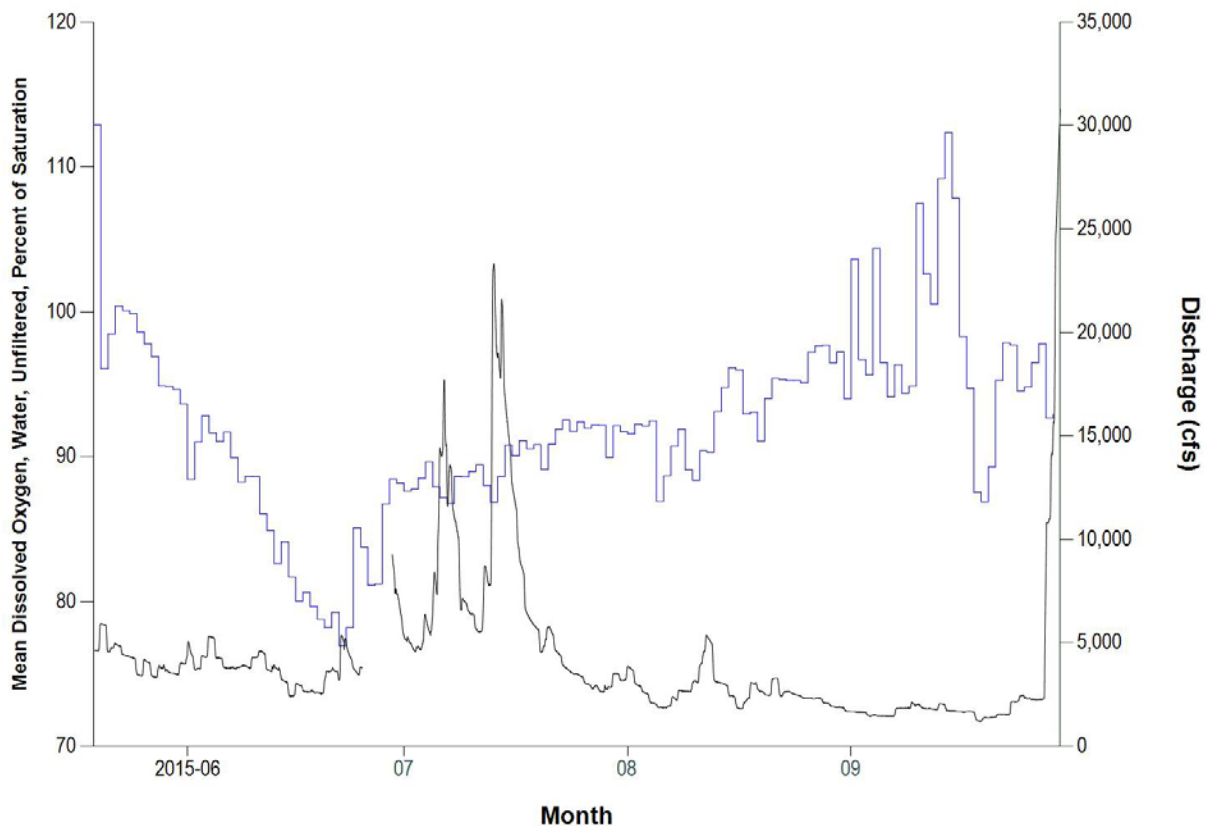


Figure 18. Mean daily dissolved oxygen percent of saturation (blue line) in New River water at Thurmond, WV from May 20, 2015 to October 1, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 28. Monthly descriptive statistics of dissolved oxygen percent of saturation in New River water at Thurmond, WV from May 20, 2015 to October 1, 2015.

Month	May	Jun	Jul	Aug	Sep
Samples	267	718	742	744	612
Minimum	86.5	71.6	81.5	79.8	83.3
Maximum	114.8	102.9	106.0	113.4	151.6
Mean	97.7	85.1	89.8	93.2	97.6
Median	114.4	85.0	88.4	91.3	94.0
SD	6.7	7.4	4.8	8.1	11.4

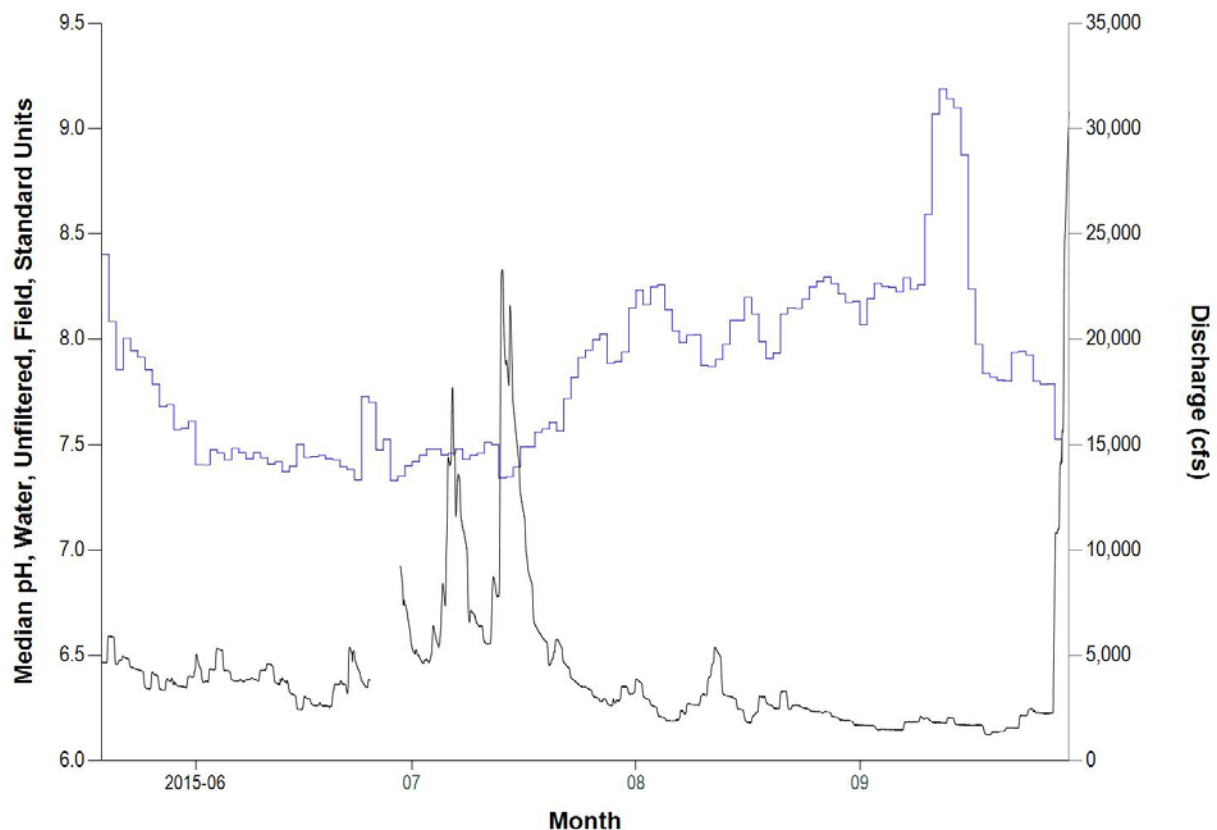


Figure 19. Median daily Delaware River water pH (blue line) at Thurmond, WV from May 20, 2015 to October 1, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 29. Monthly descriptive statistics of New River water pH (standard units) at Thurmond, WV from May 20, 2015 to October 1, 2015.

Month	May	Jun	Jul	Aug	Sep
Samples	267	718	742	744	645
Minimum	7.5	7.3	7.2	7.7	7.3
Maximum	8.5	7.9	8.2	8.5	9.3
Mean	7.8	7.5	7.6	8.1	8.2
Median	8.4	7.4	7.5	8.1	8.1
SD	0.2	0.1	0.2	0.2	0.5

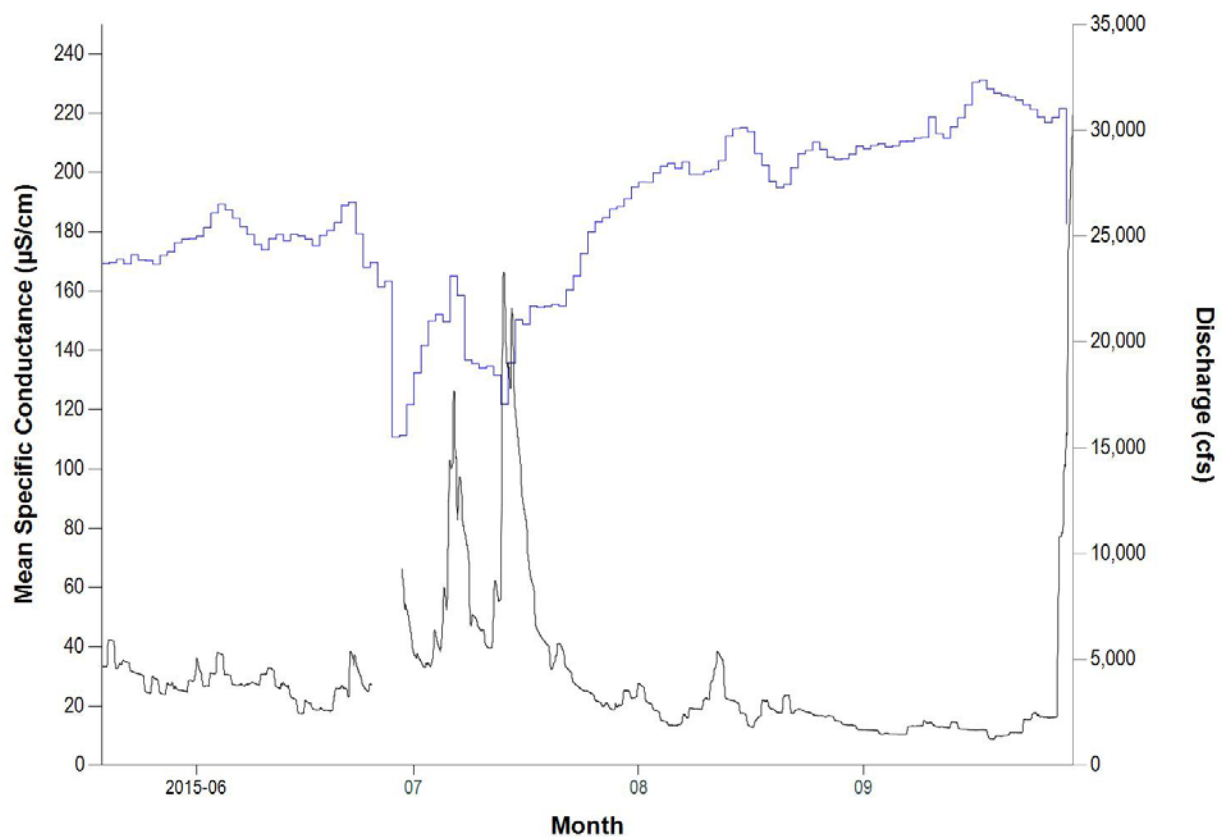


Figure 20. Mean daily Delaware River water specific conductance (blue line) at Thurmond, WV from May 20, 2015 to October 1, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 30. Monthly descriptive statistics of New River water specific conductance ($\mu\text{S}/\text{cm}$) at Thurmond, WV from May 20, 2015 to October 1, 2015.

Month	May	Jun	Jul	Aug	Sep
Samples	267	718	742	744	641
Minimum	167.9	103.8	117.1	191.9	144.4
Maximum	180.3	191.0	192.9	216.7	233.6
Mean	171.9	174.2	154.5	203.6	216.5
Median	169.3	178.6	153.4	202.9	216.6
SD	3.0	18.4	19.8	5.8	10.6

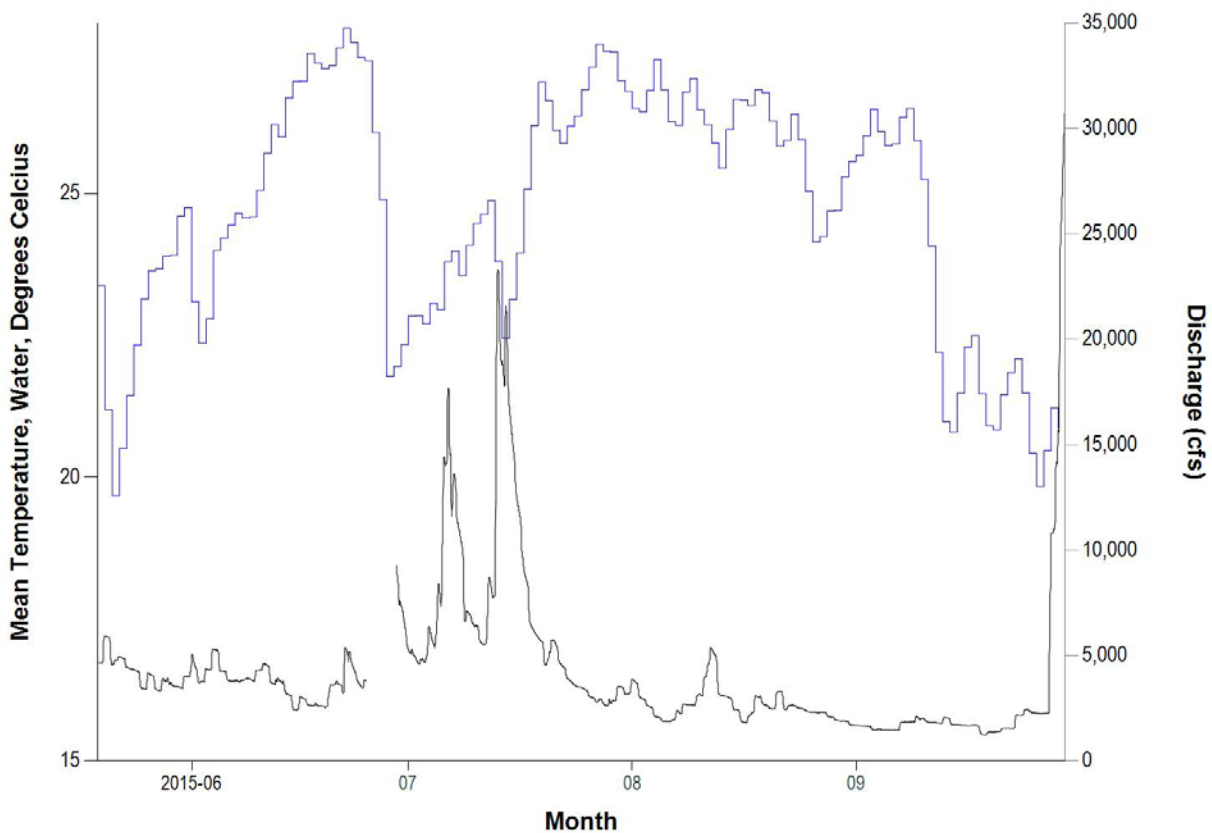


Figure 21. Mean daily New River water temperature (blue line) at Thurmond, WV from May 20, 2015 to October 1, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 31. Monthly descriptive statistics of New River water temperature at Thurmond, WV from May 20, 2015 to October 1, 2015.

Month	May	Jun	Jul	Aug	Sep
Samples	267	718	742	744	645
Minimum	18.1	20.6	21.4	22.7	19.1
Maximum	26.2	29.4	29.4	29.2	29.0
Mean	22.6	25.5	24.9	26.1	23.1
Median	23.5	25.7	24.6	26.0	22.3
SD	1.8	2.0	1.9	1.3	2.5

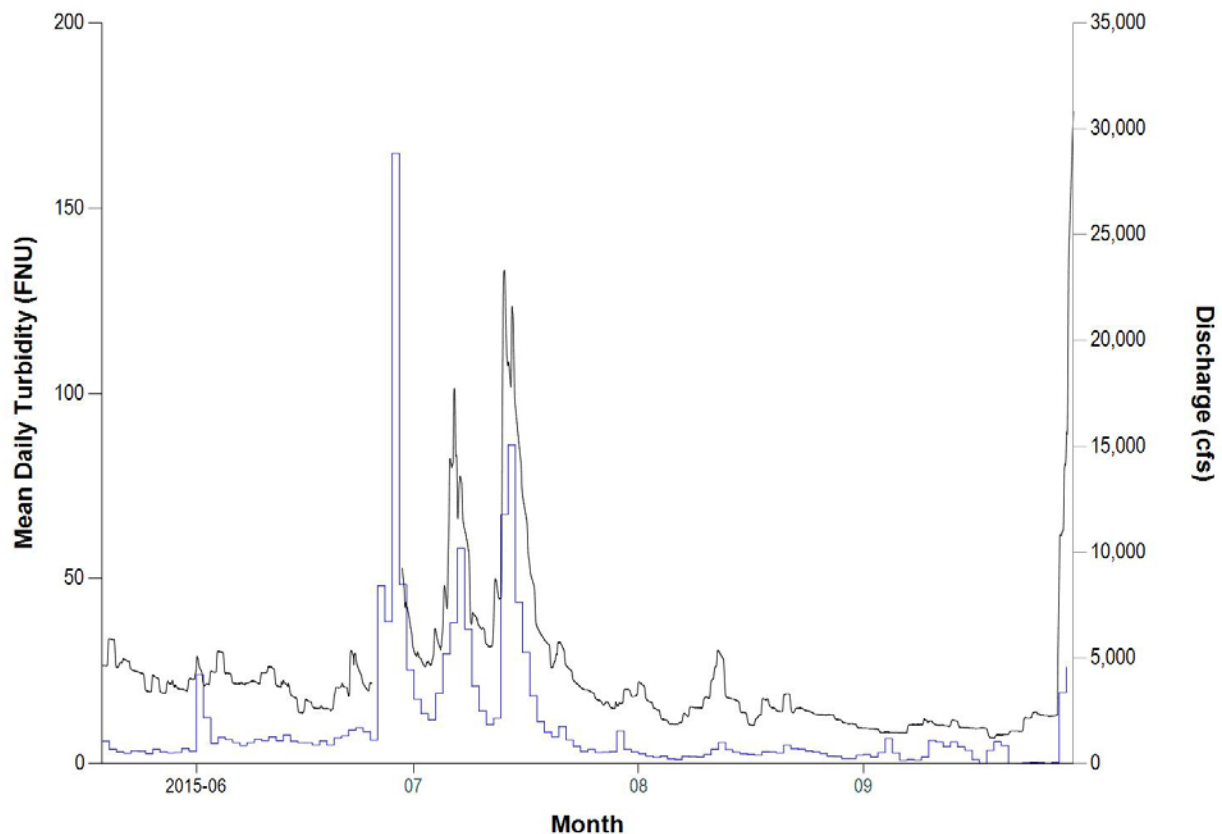


Figure 22. Mean daily New River water turbidity (FNU = Formazin Nephelometric Units, blue line) at Thurmond, WV from May 20, 2015 to October 1, 2015. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 32. Monthly descriptive statistics of New River water turbidity (Formazin Nephelometric Units) at Thurmond, WV from May 20, 2015 to October 1, 2015.

Month	May	Jun	Jul	Aug	Sep
Samples	267	715	742	744	691
Minimum	1.5	2.5	2.3	0.9	< 0.5
Maximum	18.0	414.3	194.3	11.7	40.3
Mean	3.4	16.4	20.4	2.8	3.9
Median	9.7	6.5	12.8	2.6	1.6
SD	1.5	35.9	23.7	1.3	6.4

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