



Eastern Rivers and Mountains Network River Monitoring

2014 Water Data Report – Delaware River at Lordville, NY

Natural Resource Data Series NPS/ERMN/NRDS—2015/795



ON THE COVER

View of Delaware River, downstream of the Lordville water quality monitoring equipment.
Photograph by: Jessica Newbern, Upper Delaware Scenic and Recreational River.

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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 formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

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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 of the Delaware River at Lordville, NY, near the upstream terminus of Upper Delaware Scenic and Recreational River during the 2014 water year (10/01/2013 – 9/30/2014). 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).

Acknowledgments

This work could not have been completed without Upper Delaware Scenic and Recreational River staff – D. Hamilton, J. Myers, and J. Newbern did an excellent job installing the monitoring equipment and provided support while transferring stewardship of the site to the ERMN. The Lordville, NY continuous monitoring site on the Delaware River is expected to provide consistently high quality data for many years to come, due in large part to their efforts.

List of Terms

μS/cm	Microsiemens per centimeter
°C	Degrees Celsius
cfs	Cubic feet per second
ERMN	Eastern Rivers and Mountains Network
mg/L	Milligrams per liter
NPS	National Park Service
FNU	Formazin Nephelometric units
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; consequently, two ERMN monitoring programs track the condition of surface water hydrology and water chemistry in wadeable streams (Tzilkowski et al., in preparation) and rivers (Tzilkowski et al., in preparation). Draft copies of both protocols are available upon request (contact; caleb_tzilkowski@nps.gov).

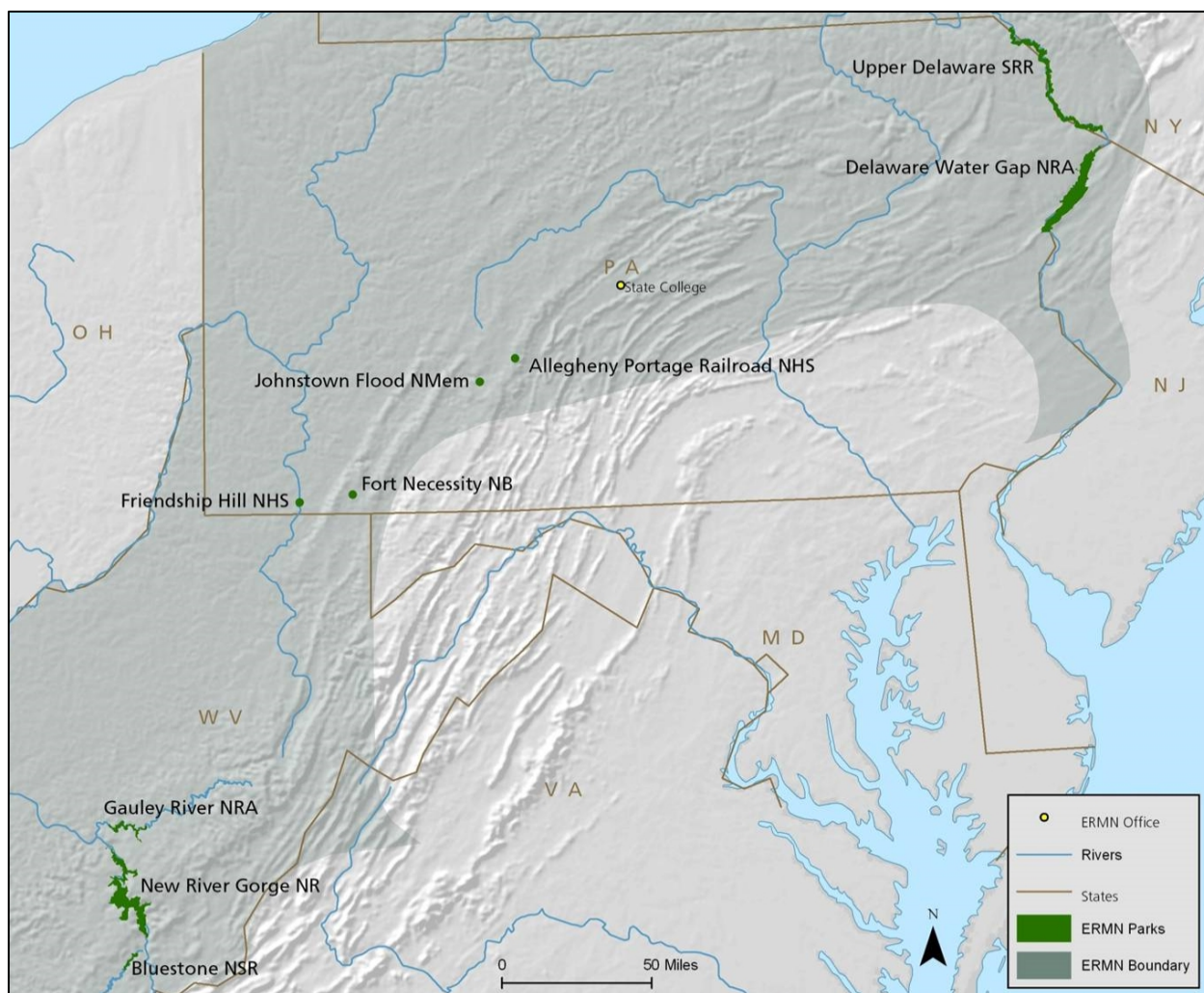


Figure 1. Location of parks in the Eastern Rivers and Mountains Network (ERMN).

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. As the program progresses and is refined, findings should be used to help prioritize and guide activities within ERMN parks. Park managers have committed to improving the water quality of impaired waters by adopting the NPS Government Performance Results Act (GPRA) goal, stating that 99.3% of streams and rivers managed by NPS will meet state and federal water quality standards; furthermore, park managers should document and maintain high quality water where it exists. The NPS should be leading the way in achieving and maintaining high water quality regardless of beneficial uses to humans (i.e., consideration should be given to water resources for their intrinsic value).

The primary monitoring objectives of the ERMN river water quality and quantity 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 (i.e., 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 or violated for parameters listed in objective 1.

This report summarizes Delaware River water quality data from the 2014 water year (i.e., 10/01/2013 – 9/30/2014) at Lordville, NY, near the upstream terminus of Upper Delaware Scenic and Recreational River (SRR). The ERMN took responsibility for the Lordville, NY site on November 22, 2013; consequently, only data collected after that date are included in this report.

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 quantity and 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 of the parameters listed below; consequently, measuring discharge can be useful for interpreting observed patterns in water quality data.

Temperature

Water temperature strongly influences chemical processes (e.g., nutrient cycling); therefore, water temperature dictates the physiology, growth, behavior, and distribution of aquatic organisms.

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; therefore, it is useful as a 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 more easily made.

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); consequently, 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

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 mE, 4635126 mN) 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).

Methods

Instrumentation

A Manta2™ (Eureka Water Probes, Austin, TX) multiparameter data sonde (hereafter, sonde) was continuously deployed in-situ on the Lordville Road (CR 1023) bridge near the main flow of the Delaware River (Figure 2). Water quality measurements were recorded every 15 min and this report includes data from November 22, 2013 to September 30, 2014. The sonde was suspended from the top of the bridge (Figure 3), 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. The installation was 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.



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.



Figure 3. Photograph of Delaware River water quality monitoring equipment on the Lordville Road Bridge near Lordville, NY. A data collection platform that controls the datasonde is located within the aluminum shelter. All electronics are powered by a solar-charged battery and data are transmitted hourly via satellite and the pictured antenna.

Cross-section summary and sonde maintenance

A cross-section survey was conducted on August 27, 2014 during low flow conditions to verify that the sonde deployment location was laterally and vertically representative of Delaware River water quality at Lordville, NY. Core parameters were measured from the Lordville Road bridge 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. Immediately after taking core parameter measurements across the river's width, the sonde was lowered into the deployment pipe where 10 instantaneous measurements were taken to compare the in-situ deployment location to conditions across the river's width.

Maintenance visits were typically conducted once each month 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. Safety and logistical issues during winter (December, 2013 to March, 2014) prevented visits for relatively long periods

(approximately once every two months). 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.

Data Processing and Analysis

The ERMN River Monitoring Protocol (Tzilkowski et al., in preparation) provides detailed methods for data processing, management, and analysis. Most of the methods (including data grading criteria, Table 1) that the ERMN uses 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 1. 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	$\leq \pm 0.2$ °C	$>\pm 0.2-0.5$ °C	$>\pm 0.5-0.8$ °C	$>\pm 0.8$ °C
Specific Conductance	$\leq \pm 3\%$	$>\pm 3-10\%$	$>\pm 10-15\%$	$>\pm 15\%$
Dissolved Oxygen	$\leq \pm 0.3$ mg/L or $\leq \pm 5\%$, whichever is greater	$>\pm 0.3-0.5$ mg/L or $>\pm 5-10\%$, whichever is greater	$>\pm 0.5-0.8$ mg/L or $>\pm 10-15\%$, whichever is greater	$>\pm 0.8$ mg/L or $>\pm 15\%$, whichever is greater
pH	$\leq \pm 0.2$ units	$>\pm 0.2-0.5$ units	$>\pm 0.5-0.8$ units	$>\pm 0.8$ units
Turbidity	$\leq \pm 0.5$ NTU or $\leq \pm 5\%$, whichever is greater	$>\pm 0.5-1.0$ NTU or $>\pm 5-10\%$, whichever is greater	$>\pm 1.0-1.5$ NTU or $>\pm 10-15\%$, whichever is greater	$>\pm 1.5$ NTU or $>\pm 15\%$, whichever is greater

Results

Cross-section Survey

With the exception of specific conductance, core parameter data were different between the sonde deployment location and across the river width (Tables 2 – 4); 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 river was well mixed 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. Bearing in mind that there were 30 minutes between the first and last cross-section measurements, these measurements were generally very similar, particularly where the majority of the river flowed (i.e., intervals where river depth was > 1 m; Table 4). Note that measurements nearest the left bank were likely influenced by Humphries Brook which enters the river just upstream of the bridge – water conditions at the sonde deployment location are not affected by this very small tributary.

Table 2. Descriptive statistics and two sample t-test of core parameter measurements recorded during a cross-section survey of the Delaware River at Lordville, NY on August 27, 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 (<i>n</i> = 10) Median; mean (SD)	Cross-section (<i>n</i> = 15) Median; mean (SD)	Estimated difference (<i>p</i> -value)
Temperature (°C)	19.9; 19.9 (0.0)	19.3; 19.4 (0.3)	0.5 (0.00)
Specific conductance (µS/cm)	88.5; 88.5 (0.1)	88.4; 88.5 (0.2)	-0.03 (0.64)
Dissolved oxygen (mg/L)	10.0; 10.0 (0.0)	9.9; 9.8 (0.1)	0.14 (0.00)
pH	7.74; 7.73 (0.02)	7.69; 7.67 (0.05)	0.06 (0.00)

Table 3. Core parameter measurements recorded at the sonde deployment location during a cross-section survey of the Delaware River at Lordville, NY on August 27, 2014. Measurements were taken in rapid succession. T = temperature (oC), SC = specific conductance ($\mu\text{S}/\text{cm}$), DO = dissolved oxygen (mg/L).

Measurement number	T	SC	DO	pH
1	19.9	88.4	9.9	7.70
2	19.9	88.5	9.9	7.71
3	19.9	88.5	9.9	7.72
4	19.9	88.4	9.9	7.73
5	19.9	88.5	9.9	7.73
6	19.9	88.4	10.0	7.74
7	19.9	88.5	10.0	7.75
8	19.9	88.5	10.0	7.75
9	19.9	88.5	10.0	7.75
10	20.0	88.4	10.0	7.75

Table 4. Core parameter measurements recorded across the Delaware River width recorded during a cross-section survey of the river at Lordville, NY on August 27, 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 ($\mu\text{S}/\text{cm}$), DO = dissolved oxygen (mg/L).

Distance (m)	River Depth (m)	Measurement Depth (m)	T	SC	DO	pH
1	0.5	0.3	19.4	88.5	9.7	7.60
5	1.0	0.5	19.3	88.3	9.8	7.62
9	1.5	0.8	19.3	88.4	9.8	7.64
14	2.2	1.1	19.1	88.4	9.8	7.64
18	3.0	1.5	19.2	88.4	9.8	7.69
22	3.0	1.5	19.1	88.4	9.9	7.70
26	3.2	1.6	19.1	88.4	9.9	7.71
30	3.1	1.6	19.1	88.4	9.9	7.71
35	3.5	1.8	19.1	88.4	9.9	7.69
39	3.0	1.5	19.1	88.5	9.9	7.71
43	3.6	1.8	19.5	88.5	9.9	7.70
47	2.2	1.1	19.7	88.5	9.9	7.69
51	2.3	1.2	20.2	88.6	9.9	7.76
56	1.1	0.6	19.8	89.1	9.8	7.62
60	0.5	0.3	19.8	94.6	9.7	7.57

Data Quality and Completeness

Data quality was typically “Excellent” or “Good” for all parameters throughout the year but there were a few exceptions (Figure 4). There were issues with pH and DO measurements in two different periods during winter which resulted in data from those periods receiving a “Poor” grade. These, and any other water quality data graded as “Poor”, are removed from ERMN data sets. pH was erratic because a loss of electrolyte in the reference electrode whereas DO was calibrated incorrectly on January 14, 2014 which resulted in erroneous readings for the subsequent deployment period.

Condensation on the internal electronics of the sonde resulted in erroneous DO measurements for approximately one week in late summer before the site could be revisited to replace the sonde. Other sensors were not affected and recorded accurately for that period; therefore, DO was the only parameter removed for that deployment period.

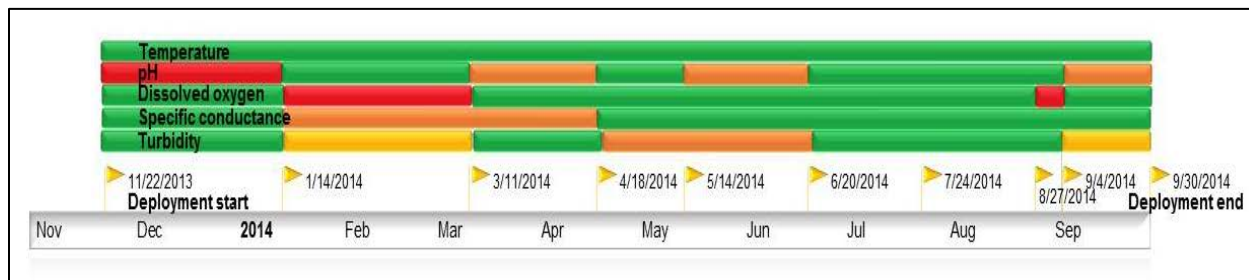


Figure 4. Summary of water quality grades for core water quality parameters (and turbidity) for the 2014 water year. Flags on the timeline denote maintenance visits whereas colored bars represent data quality grades. Green = Excellent, Orange = Good, Yellow = Fair, Red = Poor. See Table 1 for grade criteria.

Water Quantity

Published (i.e., approved) USGS discharge data 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 the co-located gaging station were used to aid interpretation of water quality data but are not summarized in detail.

Water Quality

The purpose of this report is to provide a succinct and basic summary of the effort and results at this monitoring location during the 2014 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 2014 water year. Complete electronic versions of the data are available upon request (contact; caleb_tzilkowski@nps.gov).

Table 5. Minimum and maximum daily average core water quality parameters and turbidity of Delaware River water at Lordville, NY during the 2014 water year.

Parameter	Minimum	Maximum
Dissolved Oxygen (mg/L)	8.5 (August 23)	14.6 (March 14)
Dissolved Oxygen, Percent of Saturation	88.4 (December 22)	112.4 (July 1)
pH	6.62 (January 17)	8.13 (September 3)
Specific Conductance (µS/cm)	49.3 (May 17)	154.6 (February 23)
Water Temperature (°C)	0.0 (36 days ¹)	21.0 (July 1)
Turbidity (FNU)	0.9 (August 31 – September 2)	346 (June 26)

¹. Average daily temperature was 0.0° C for 36 days between 12/14/2013 and 2/21/2014.

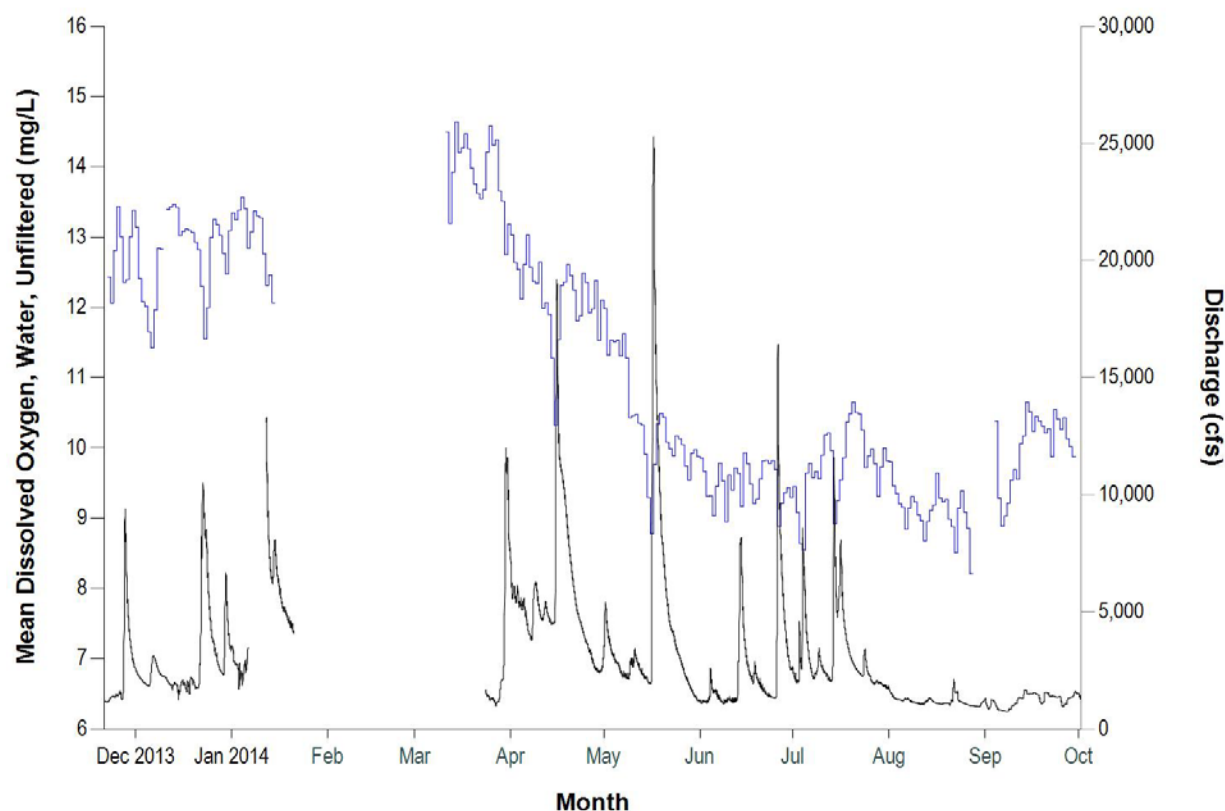


Figure 5. Mean daily dissolved oxygen concentration (blue line) in Delaware River water at Lordville, NY from November 22, 2013 to October 1, 2014. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 6. Monthly descriptive statistics of dissolved oxygen concentration (mg/L) in Delaware River water at Lordville, NY from November 22, 2013 to October 1, 2014. Mean, median, and standard deviation (SD) were not calculated for months with less than 80% data coverage.

Year	2013		2014								
Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Samples	812	2,750	1,305	0	1,934	2,862	2,959	2,868	2,962	2,550	2,519
Minimum	11.4	11.2	12.0	---	12.4	9.9	8.0	8.1	7.9	7.6	7.7
Maximum	14.0	13.9	13.7	---	15.4	13.8	13.1	11.2	11.8	11.1	11.7
Median	---	12.9	---	---	---	12.2	10.3	9.4	9.6	9.1	10.0
Mean	---	12.7	---	---	---	12.2	10.4	9.5	9.8	9.1	10.0
SD	---	0.6	---	---	---	0.8	1.0	0.7	0.9	0.7	0.8

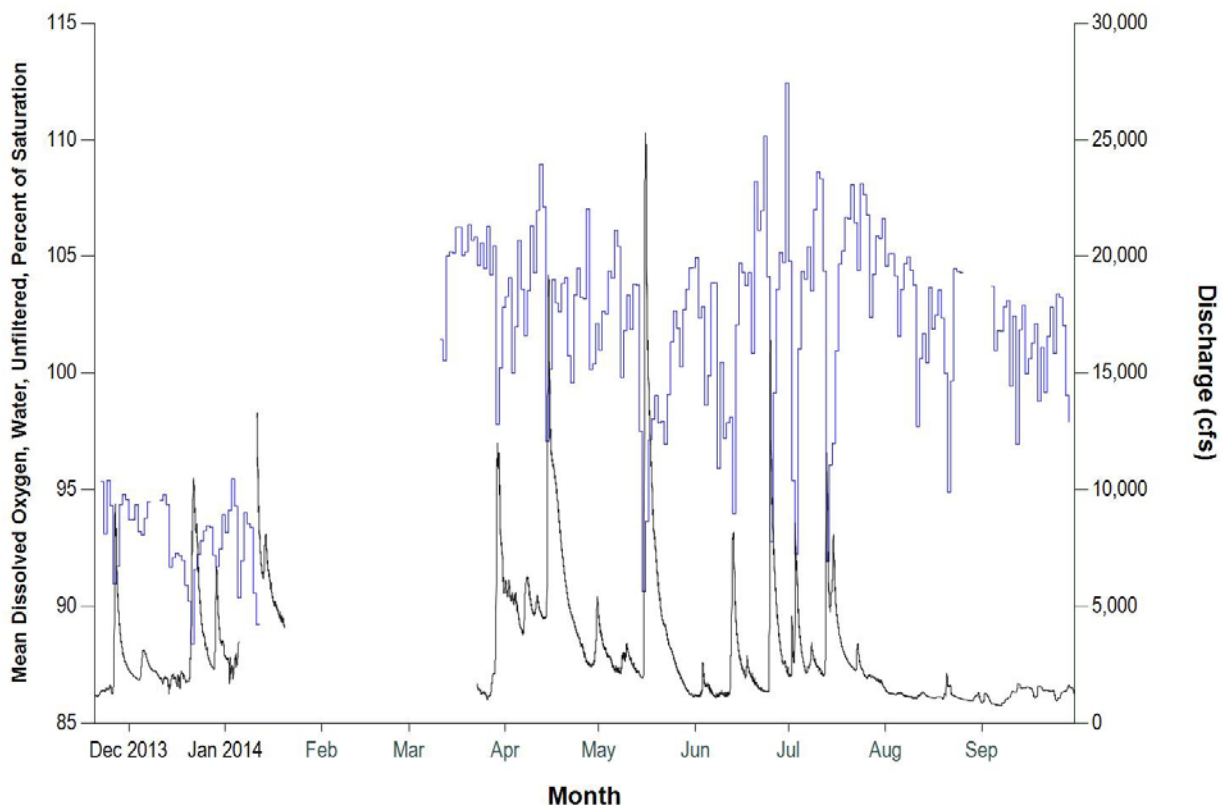


Figure 6. Mean daily dissolved oxygen percent of saturation (blue line) in Delaware River water at Lordville, NY from November 22, 2013 to October 1, 2014. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 7. Monthly descriptive statistics of dissolved oxygen percent of saturation in Delaware River water at Lordville, NY from November 22, 2013 to October 1, 2014. Mean, median, and standard deviation (SD) were not calculated for months with less than 80% data coverage.

Year	2013		2014								
Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Samples	812	2,749	1,206	0	1,946	2,856	2,831	1,024	2,703	2,509	2,487
Minimum	88	87	87	---	94	92	84	87	89	88	86
Maximum	104	100	96	---	122	124	123	124	127	123	121
Median	---	93	---	---	---	102	99	---	101	101	100
Mean	---	93	---	---	---	103	101	---	104	103	101
SD	---	2	---	---	---	7	9	---	10	10	8

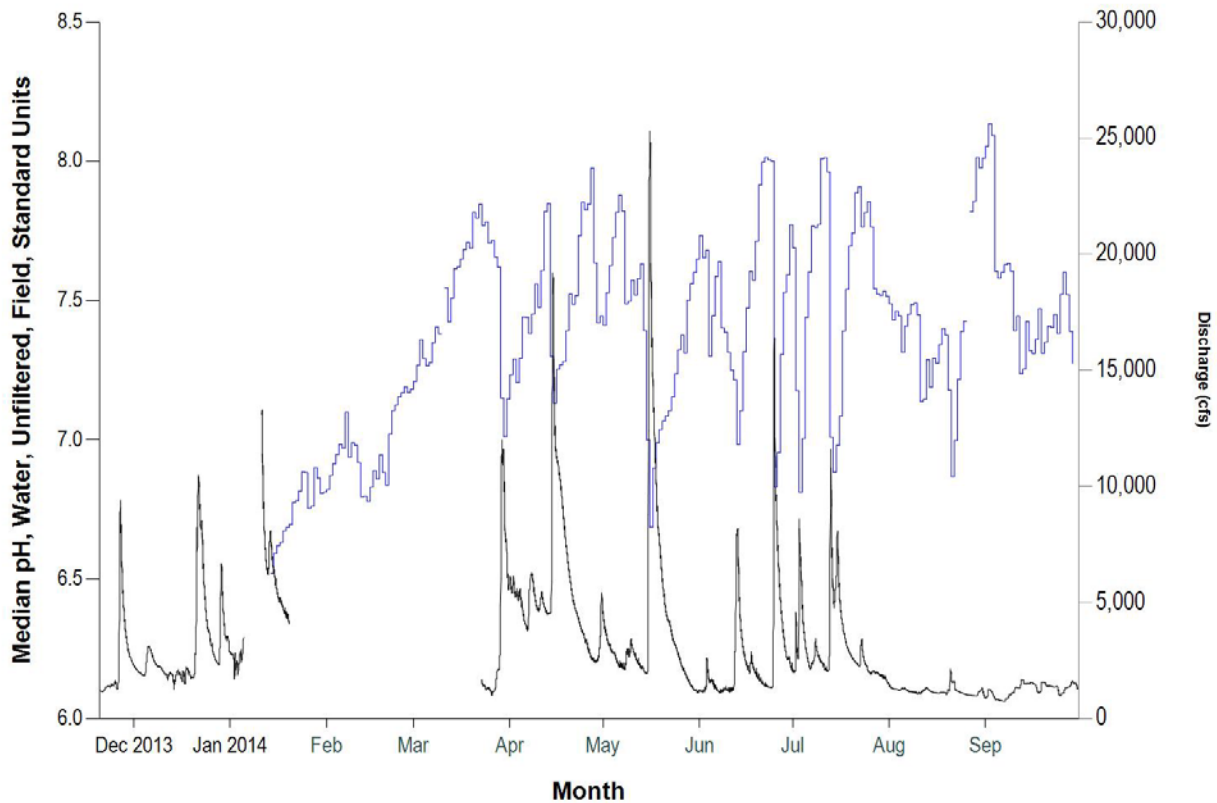


Figure 7. Mean daily Delaware River water pH (blue line) at Lordville, NY from November 22, 2013 to October 1, 2014. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 8. Monthly descriptive statistics of Delaware River water pH (standard units) at Lordville, NY November 22, 2013 to October 1, 2014. Mean, median, and standard deviation (SD) were not calculated for months with less than 80% data coverage.

Year	2013		2014								
Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Samples	0	0	1,646	2,668	2,946	2,868	2,962	2,866	2,973	2,955	2,872
Minimum	---	---	6.5	6.7	6.9	7.0	6.6	6.6	6.7	6.7	7.0
Maximum	---	---	---	7.5	8.9	9.1	9.1	9.1	9.1	8.6	8.6
Median	---	---	---	6.9	7.4	7.3	7.2	7.3	7.3	7.2	7.4
Mean	---	---	---	7.0	7.5	7.5	7.4	7.5	7.6	7.4	7.5
SD	---	---	---	0.2	0.4	0.4	0.5	0.6	0.7	0.5	0.4

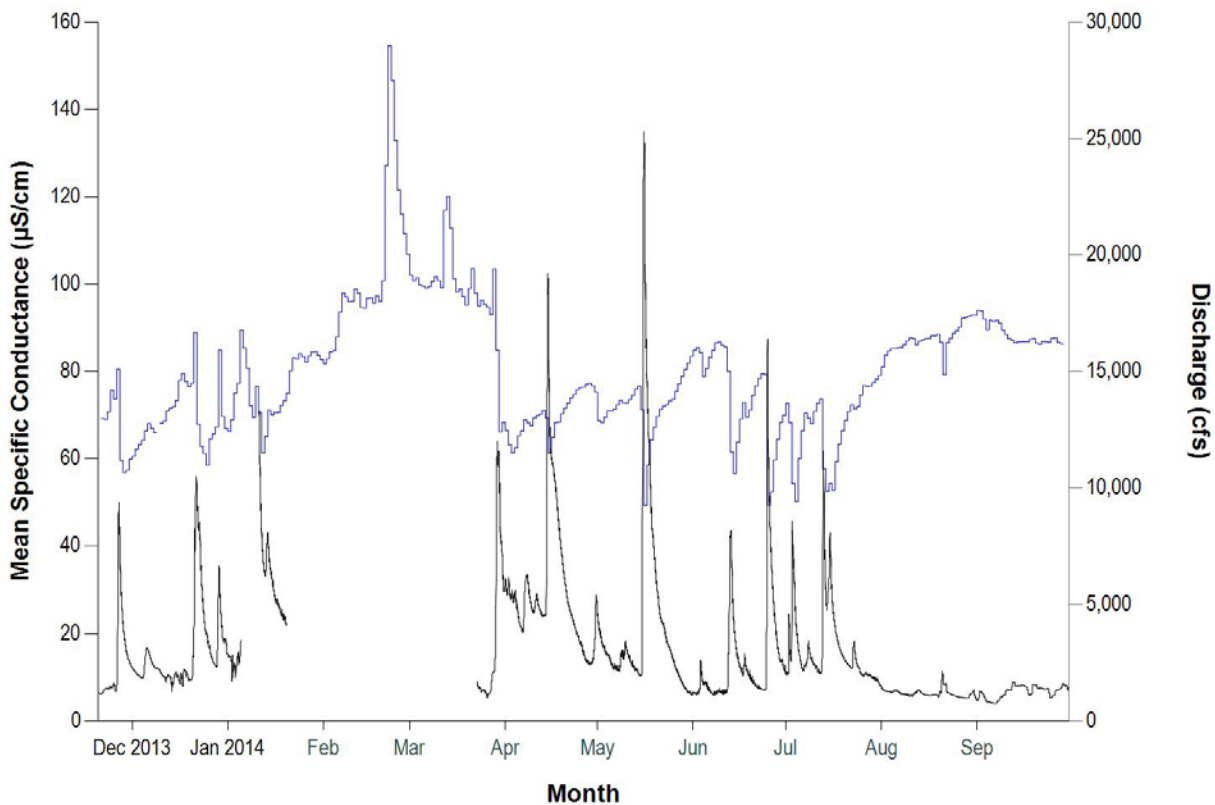


Figure 8. Mean daily Delaware River water specific conductance (blue line) at Lordville, NY from November 22, 2013 to October 1, 2014. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 9. Monthly descriptive statistics of Delaware River water specific conductance ($\mu\text{S}/\text{cm}$) at Lordville, NY November 22, 2013 to October 1, 2014. Mean, median, and standard deviation (SD) were not calculated for months with less than 80% data coverage.

Year	2013		2014								
Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Samples	813	2,753	2,958	2,668	2,946	2,868	2,962	2,870	2,969	2,955	2,870
Minimum	44	55	59	81	64	59	47	41	46	66	86
Maximum	98	98	123	158	127	78	82	89	79	94	95
Median	---	68	75	97	100	70	73	78	70	87	87
Mean	---	70	76	102	99	70	72	75	67	87	89
SD	---	8	9	19	9	5	6	11	9	4	3

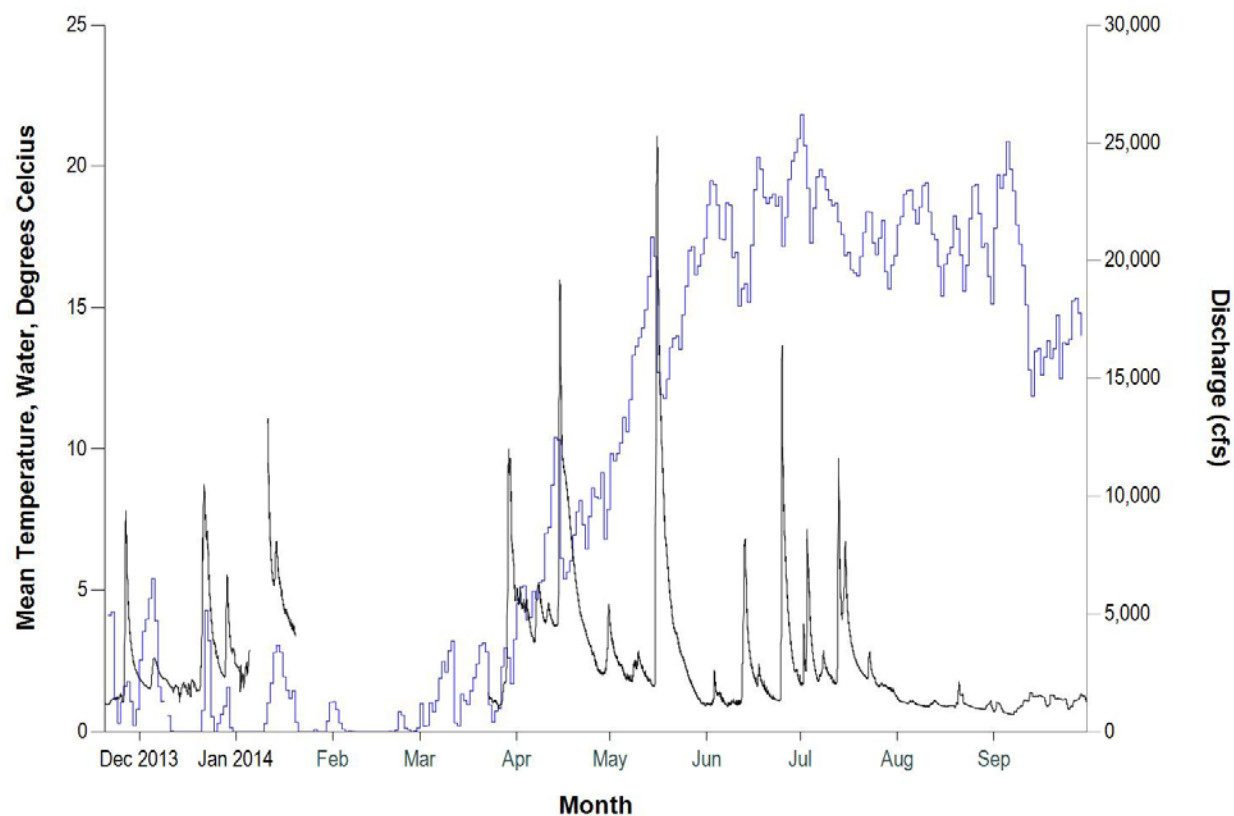


Figure 9. Mean daily Delaware River water temperature (blue line) at Lordville, NY from November 22, 2013 to October 1, 2014. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 10. Monthly descriptive statistics of Delaware River water temperature at Lordville, NY from November 22, 2013 to October 1, 2014. Mean, median, and standard deviation (SD) were not calculated for months with less than 80% data coverage.

Year	2013		2014								
Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Samples	813	2,753	2,958	2,668	2,946	2,868	2,962	2,870	2,969	2,955	2,872
Minimum	0.0	-0.1	0.0	0.0	-0.1	2.3	6.7	13.9	14.6	14.1	10.8
Maximum	4.9	5.7	3.4	1.5	5.1	11.7	18.7	21.7	22.8	21.3	21.8
Median	---	0.4	0.0	0.0	1.5	6.5	13.6	18.4	17.9	17.8	14.7
Mean	---	1.4	0.6	0.2	1.5	6.6	13.5	18.2	18.1	17.7	15.5
SD	---	1.8	1.0	0.4	1.2	2.0	2.7	1.7	1.7	1.4	2.7

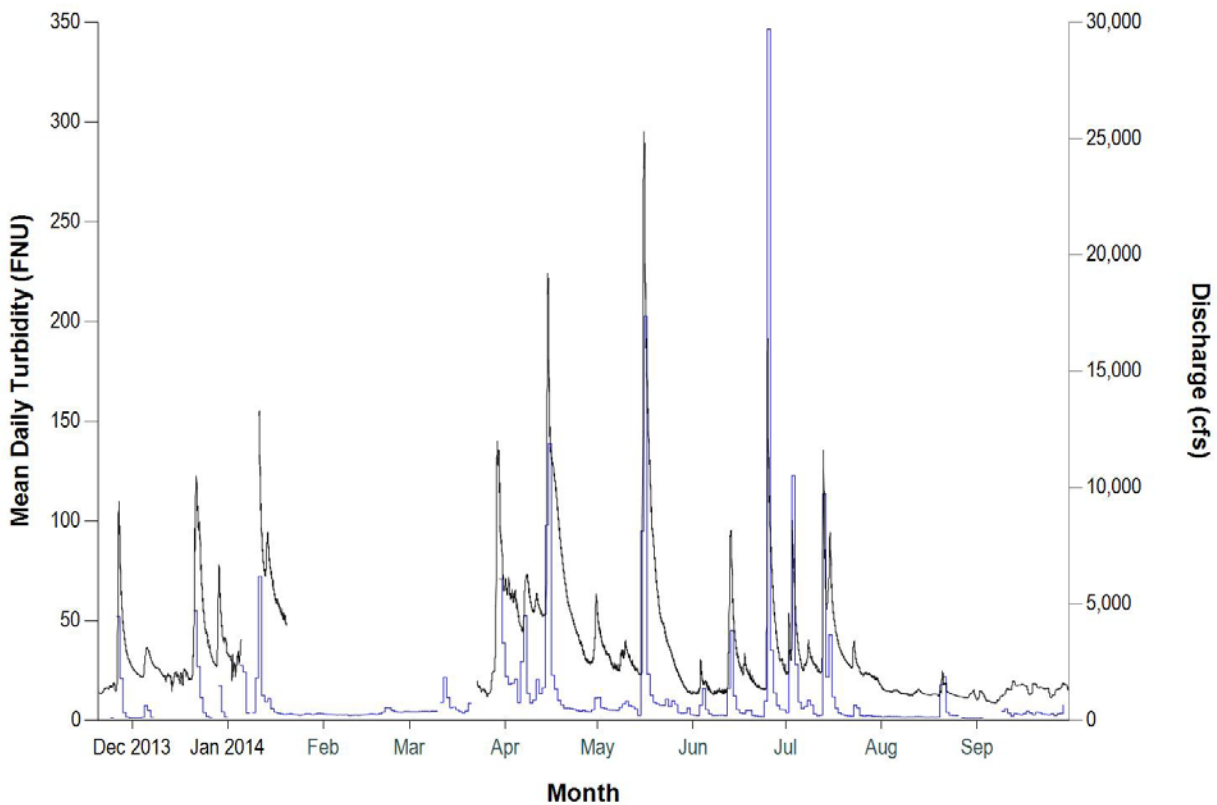


Figure 10. Mean daily Delaware River water turbidity (FNU = Formazin Nephelometric Units, blue line) at Lordville, NY from November 22, 2013 to October 1, 2014. Co-located hourly discharge data (cfs = cubic feet per second; black line) collected by the United States Geological Survey is provisional and shown for illustrative purposes only.

Table 11. Monthly descriptive statistics of Delaware River water turbidity (Formazin Nephelometric Units) at Lordville, NY from November 22, 2013 to October 1, 2014. Mean, median, and standard deviation (SD) were not calculated for months with less than 80% data coverage.

Year	2013		2014								
Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Samples	811	2742	2957	2668	2187	2866	2940	2870	2965	2955	2872
Minimum	0.5	0.5	0.5	2	2.3	4	2	1	1	1	0.5
Maximum	91	209	159	11	248	720	478	1000	441	267	66
Median	---	5	8	3	---	21	17	19	15	3	3
Mean	---	1	3	3	---	11	7	3	4	2	2
SD	---	12	17	1	---	43	53	80	41	10	4

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