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Eastern Rivers and Mountains Network Wadeable Stream Monitoring

Water Quality and Benthic Macroinvertebrate Summary Report (2008–2013)

Natural Resource Data Series NPS/ERMN/NRDS—2015/769

ON THE COVER
Spackmans Creek in Delaware Water Gap NRA.
Photograph by: C. Tzilkowski

Eastern Rivers and Mountains Network Wadeable Stream Monitoring

Water Quality and Benthic Macroinvertebrate Summary Report (2008–2013)

NPS/ERMN/NRDS—2015/769

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Executive Summary

Freshwater water quality and benthic macroinvertebrate (BMI) communities are indicators of aquatic and terrestrial ecosystem health; consequently, they were chosen to be "Vital Signs" in the National Park Service's Eastern Rivers and Mountains Network (ERMN). The ERMN sampled core water quality parameters (temperature, pH, dissolved oxygen, and specific conductance) and BMI communities at 81 stream reaches throughout the network from 2008–2013 while the ERMN was developing a protocol to implement long-term ecological monitoring of wadeable streams.

Stream reaches (i.e., sites) were sampled using United States Geological Survey (USGS) methods (i.e.., Richest Targeted Habitat Sampling). Twenty eight reaches (35%) were chosen in consultation with park staff to fill important data gaps or support ongoing park initiatives. The remaining 52 reaches (65%) were selected by ERMN staff and were placed on wadeable streams defined as perennially flowing streams within the parks' authorized boundaries that had upstream drainage area <100 km^2.

In many cases, data in this report provided the only known assessment of BMI communities and/or water quality for the respective, and often remote, stream reaches. In other instances, these data augment ongoing water quality monitoring programs and/or provide current information for previously (state) assessed waters. Water quality and BMI data collected by the ERMN often supported state-assigned designated uses for the respective streams; however, there were cases when water quality samples exceeded impairment criteria. Moreover, BMI community assessments suggested potential (undocumented) poor ecological integrity of some stream reaches. This information should help resource managers, in cooperation with other stakeholders (e.g., states), to achieve the fundamental NPS mission of maintaining or improving ecological conditions of park resources. Not only do findings in this report provide information for contemporary management decisions (e.g., refinement of stream designated uses), they also provide a baseline for future condition comparisons to be made.

List of Acronyms

AMD	Acid Mine Drainage
BMI	Benthic macroinvertebrate
DO	Dissolved oxygen
ERMN	Eastern Rivers and Mountains Network
MIBI	Macroinvertebrate Index of Biotic Integrity
MTI	Macroinvertebrate Tolerance Index
NB	National Battlefield
NHS	National Historic Site
NMem	National Memorial
NPS	National Park Service
NR	National River
NRA	National Recreation Area
NSR	National Scenic River
PADEP	Pennsylvania Department of Environmental Protection
RTH	Richest targeted habitat
SFLCR	South Fork Little Conemaugh River
SRMP	Scenic Rivers Monitoring Program
SRR	Scenic and Recreational River
TMDL	Total Maximum Daily Load
UNT	Unnamed tributary
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WSA	Wadeable Streams Assessment
WVDEP	West Virginia Department of Environmental Protection

Introduction

The Eastern Rivers and Mountains Network (ERMN) is one of 32 networks in the National Park Service (NPS) Inventory and Monitoring Program and is responsible for monitoring ecological condition of nine parks in New York, New Jersey, Pennsylvania, and West Virginia (Figure 1). The ERMN sampled benthic macroinvertebrate (BMI) communities and core water quality parameters (temperature, pH, dissolved oxygen, and specific conductance) at 81 stream reaches throughout network parks from 2008 to 2013. These data were collected while the ERMN was developing a protocol (Tzilkowski et al., in preparation) to implement long-term ecological monitoring of wadeable streams. The field and lab methods summarized here are consistent with those that will be used by the ERMN for its long-term ecological monitoring program. Many of the sampling locations will not be included in the protocol (and will no longer be sampled) for reasons summarized in the Monitoring Reach Selection section. Despite the "pilot" nature of these data, substantial new information was generated and is summarized in this report.

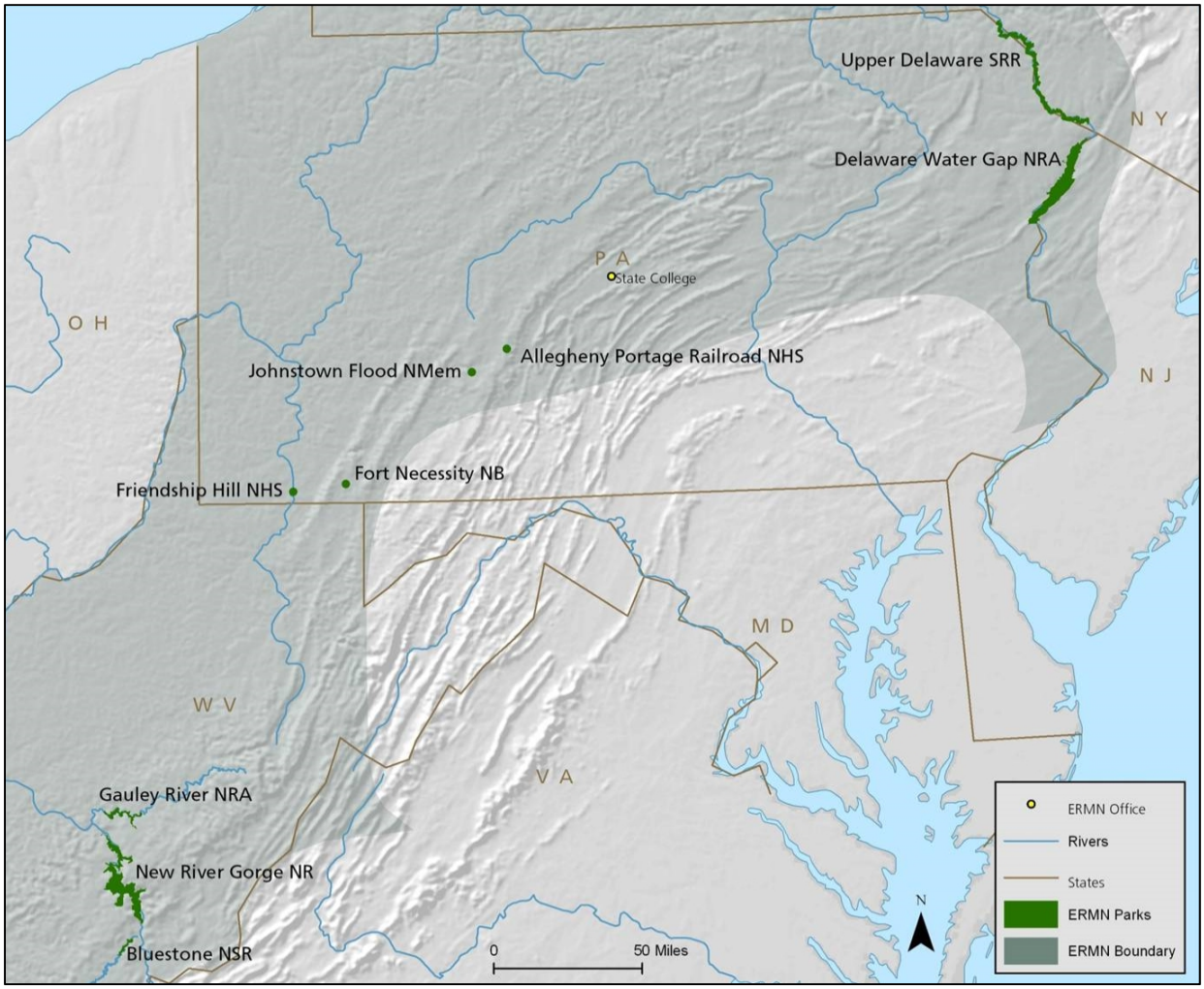

Figure 1. Location of parks in the Eastern Rivers and Mountains Network (ERMN).

Parks in the ERMN comprise 86,342 ha (213,356 ac) of land area and more than 966 stream and river km (600 mi) within authorized boundaries of the parks. The network includes four relatively small parks (Allegheny Portage Railroad NHS [National Historic Site], Johnstown Flood NMem [National Memorial], Fort Necessity NB [National Battlefield], and Friendship Hill NHS) in central and southwestern Pennsylvania that have primarily a cultural and historical focus. Five larger parks (Upper Delaware SRR [Scenic and Recreational River], Delaware Water Gap NRA [National Recreation Area], New River Gorge NR [National River], Gauley River NRA, and Bluestone NSR [National Scenic River]) preserve segments of large rivers and generally extend to adjacent ridge tops.

Rationale for Monitoring Benthic Macroinvertebrates

Benthic macroinvertebrates are aquatic invertebrate animals (larger than microscopic size) that live on or within the stream bottom, and because they are vital components of all functioning stream ecosystems, they are often used as indicators of ecosystem integrity. In addition to being instrumental to nutrient and carbon dynamics, BMI are an important link between basal resources (e.g., algae and detritus) and higher trophic levels (e.g., fish and birds) in food webs. Because BMI have been, by far, the most commonly used group for biological monitoring of aquatic ecosystems (Carter and Resh 2001), many metrics have been evaluated with respect to natural variation and responses to various sources of human-induced degradation. Given the proven ability to derive ecosystem integrity based on measures of BMI assemblage structure and composition, combined with the relatively low sampling cost, BMI are widely regarded as the single best biological group to assess and monitor the ecological integrity of wadeable streams.

Rationale for Monitoring Core Water Quality Parameters

Physical and chemical characteristics of water have strong effects on aquatic biota; consequently, direct and indirect human alteration of stream 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 monitoring program. The NPS Water Resources Division has identified four “core” water quality parameters (temperature, conductivity, pH, and dissolved oxygen) that are critical to understanding baseline conditions in aquatic habitats.

Monitoring Reach Selection

Monitoring reach selection occurred in an ad hoc manner, and reasons that particular reaches were selected differed among parks. Twenty-eight reaches (35%), referred to as “Index Reaches,” were chosen in consultation with park staff to either: 1) fill important data gaps (5 reaches); or 2) support ongoing park initiatives (23 reaches, Table 1, Appendix A).

The remaining reaches were located on wadeable streams defined as forested, perennially flowing streams within authorized boundaries of the parks—these reaches were termed “Wadeable Reaches.” A watershed or catchment area of ≥ 1.0 km^2 was used to define streams with perennial flow (Paybins 2003) and catchment area ≥ 100 km^2 was used to exclude streams and rivers that were not considered wadeable. An additional constraint at New River Gorge NR and Delaware Water Gap NRA was that

Table 1. Distribution of Wadeable and Index reaches throughout Eastern Rivers and Mountains Network parks.

Park	Wadeable	Index	Total
Allegheny Portage Railroad National Historic Site	3	0	3
Bluestone National Scenic River	2	2	4
Delaware Water Gap National Recreation Area	19	8	27
Fort Necessity National Battlefield	2	1	3
Friendship Hill National Historic Site	2	0	2
Gauley River National Recreation Area	3	1	4
Johnstown Flood National Memorial	0	2	1
New River Gorge National River	22	2	24
Upper Delaware Scenic and Recreational River	0	12	12
Total	53	28	81

the stream was required to have at least 1 km of length within the authorized boundary of the park to be included. This criterion was meant to focus sampling on streams that would have a greater "management significance" due to the stream length under NPS jurisdiction. Most streams that met these criteria (i.e., wadeable streams) had a single sample reach placed at either the downstream (either park boundary or confluence with larger water body) or upstream (park boundary) end of the stream. Because New River Gorge NR and Delaware Water Gap NRA had too many streams to sample (53 and 32 possible streams, respectively), a subset of streams was selected at random (22 and 19 selected streams, respectively). Once a stream was selected for sampling, the monitoring reach was randomly placed at either the downstream or upstream end of the stream. A full description of this reach selection methodology is available in Marshall et al. (2012).

It is important to note that the reach selection methodology did not allow valid inference to any area or stream segment beyond those that were actually sampled; consequently, this is the primary reason why most of the reaches included in this report are not included in the current ERMN Wadeable Streams Monitoring Protocol (Tzilkowski et al., in preparation).

Monitoring Reach Summary

Allegheny Portage Railroad National Historic Site

Allegheny Portage Railroad NHS encompasses approximately 520 ha (1,285 ac) in central Pennsylvania and was established in 1964 to preserve and commemorate the historic Allegheny Portage Railroad. The park's main unit (Figure 2) is located within the Blair Gap Run watershed which, in addition to intrinsic resource values, serves as a municipal water supply for the cities of Altoona and Hollidaysburg, Pennsylvania. Due to the linear, winding nature of the park and Blair Gap Run, there were only short segments of Blair Gap Run and its tributaries that flow through park property and met the "wadeable stream" criteria. An attempt was made to establish monitoring reaches along as many of these segments as possible—one reach on Millstone Run and two reaches on Blair Gap Run. The reach between the Plane Nine and Hollidaysburg reservoirs was referred to as "Blair Gap Run (Muleshoe)" whereas the reach near the downstream end of the park was known as "Blair Gap Run (Foot of Ten)".

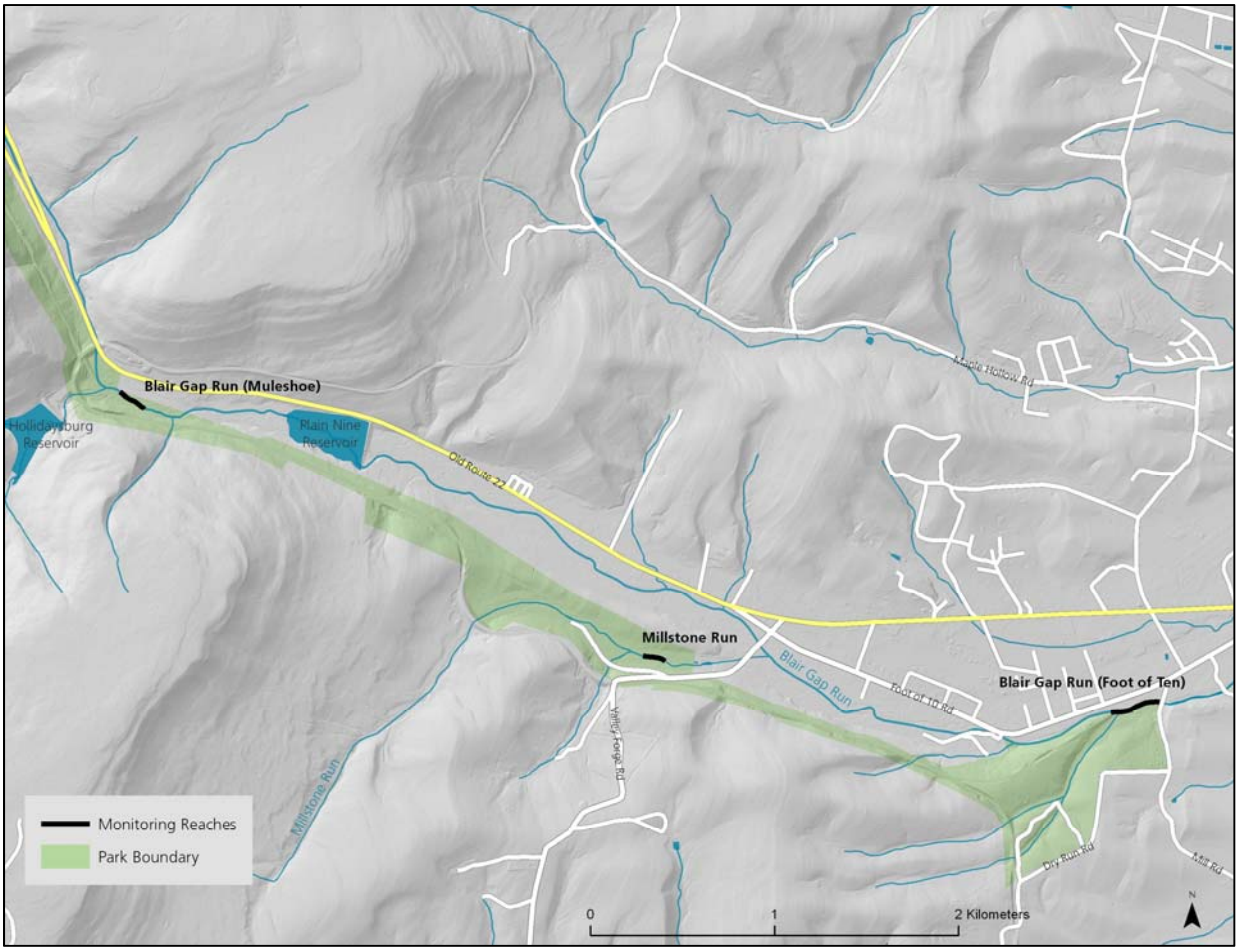

Figure 2. Monitoring reaches at Allegheny Portage Railroad NHS from 2008 to 2013.

Bluestone National Scenic River

Bluestone NSR is part of the national park system and the Wild and Scenic Rivers system. The headwaters of Bluestone River begin near Bluefield, Virginia, and flow for 124 km (77 mi) to Bluestone Lake near Hinton, WV. The lower 16.9 km (10.5 mi) of Bluestone River (Figure 3) cuts through a biologically diverse gorge that is designated as Bluestone NSR (1,744 ha; 4,310 ac). Two index reaches on Bluestone River were established to support the park-based water quality monitoring initiative and two wadeable stream reaches were sampled on Bluestone River tributaries (Mountain Creek and Little Bluestone River).

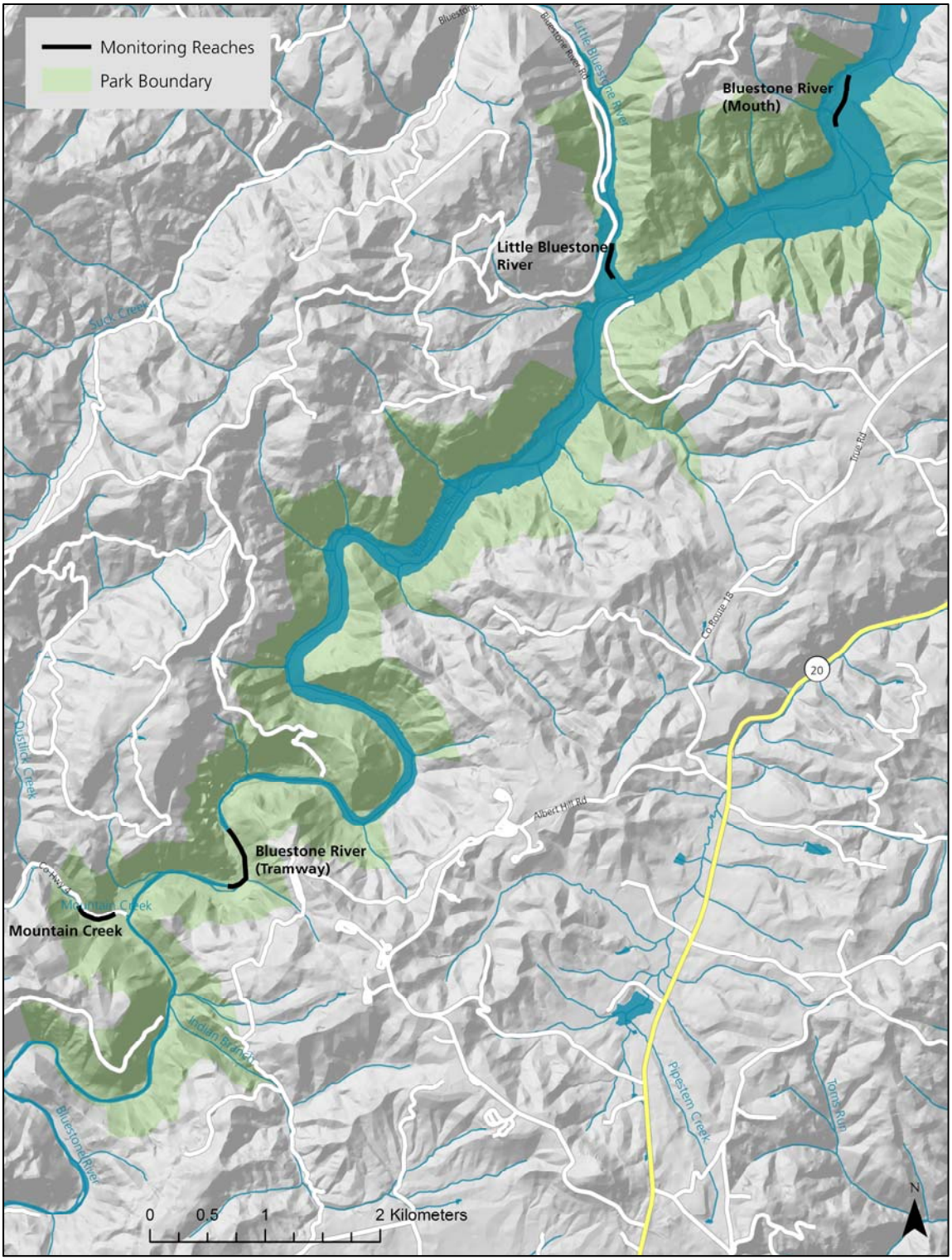

Figure 3. Monitoring reaches at Bluestone National Scenic River from 2008 to 2013.

Delaware Water Gap National Recreation Area

Delaware Water Gap NRA encompasses 27,009 ha (66,741 ac) along 64 km (40 mi) of the Middle Delaware National Scenic and Recreational River in Pennsylvania and New Jersey. At the southern end of the park, the river cuts an S-shaped pass through the mountains, forming the Delaware Water Gap. Congress established Delaware Water Gap NRA in 1965 to preserve this natural and historic area.

There were 18 wadeable stream reaches and eight index reaches selected throughout Delaware Water Gap NRA (Table 2, Figure 4). Two index reaches on Flat Brook were chosen to fill data gaps after discussion with Delaware Water Gap NRA resource managers, who conveyed the ecological and recreational significance of that watershed to the park. The other six index reaches were selected to support an ongoing park initiative termed the Scenic Rivers Monitoring Program (SRMP).

Table 2. Monitoring reaches at Delaware Water Gap National Recreation Area, 2008–2013, that were selected using the ERMN reach selection process (Wadeable) or to support ongoing park initiatives (Index).

Stream	Wadeable	Index
Adams Creek	X	
Big Flat Brook		X
Bushkill Creek		X
Caledonia Creek	X	
Dingmans Creek	X	
Dunnfield Creek	X	
Flat Brook (Flatbrookville)		X
Flat Brook (Walpack)		X
Fuller Brook	X	
Hornbecks Creek	X	
Little Bushkill Creek	X	
UNT to Dingmans Creek	X	
Little Flat Brook		X
Mill Creek	X	
Raymondskill Creek	X	
Sawkill Creek		X
Shimers Brook		X
Slateford Creek	X	
Spackmans Creek	X	
Toms Creek	X	
UNT to Delaware River (Sunfish Pond)	X	
UNT to Toms Creek	X	
Van Campen Creek	X	
Vancampens Brook	X	
Vandermark Creek		X
White Brook	X	

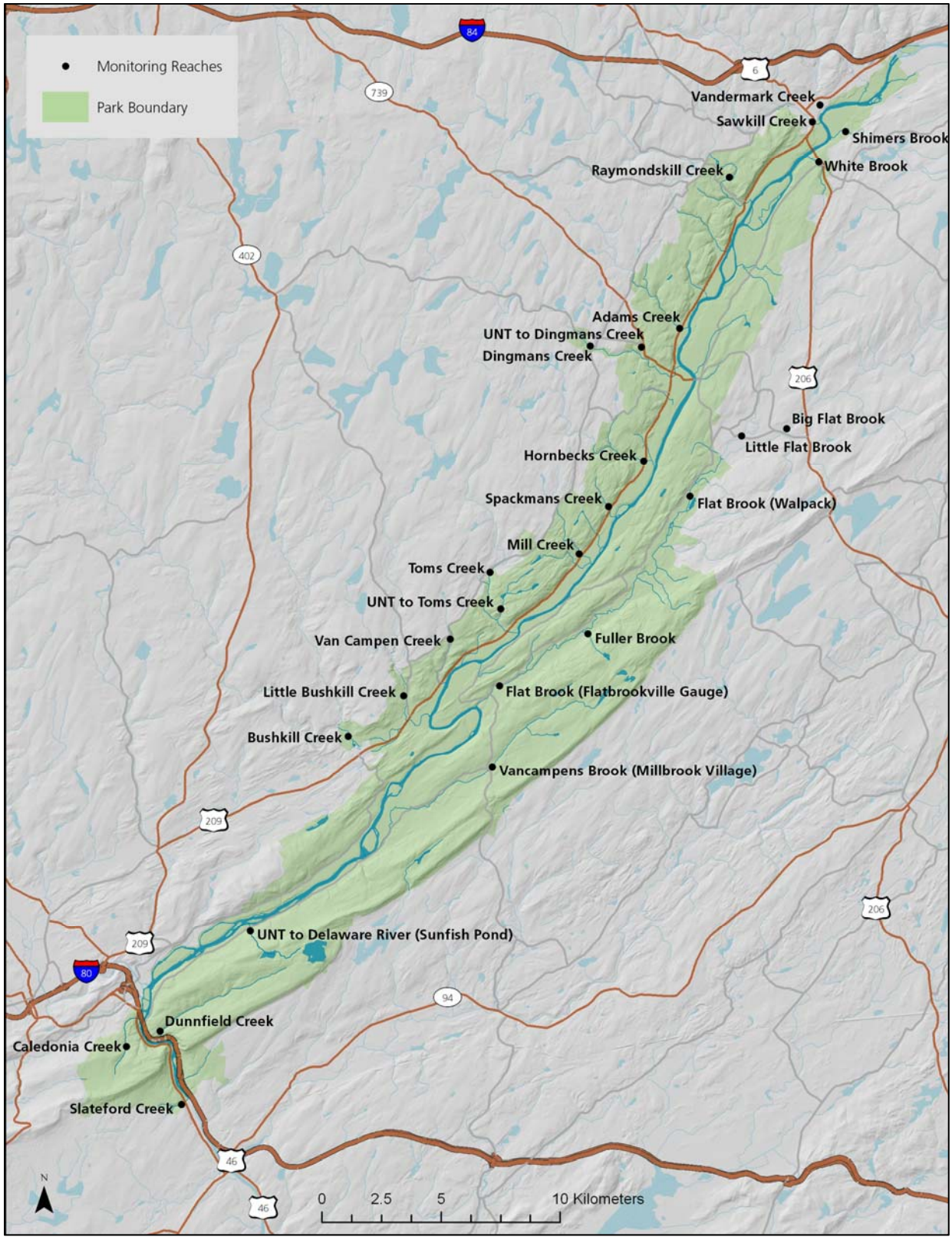

Figure 4. Monitoring reaches at Delaware Water Gap National Recreation Area from 2008 to 2013.

The SRMP is a joint NPS and Delaware River Basin Commission (DRBC) effort (http://www.nj.gov/drbc/library/documents/SRMP.pdf, accessed 9/14/2012) intended to establish water quality standards and assess attainment of standards. It is expected that the SRMP will continue as a long-term monitoring program so that DRBC can consistently perform its 305b assessment, evaluate trends, prioritize management activities, and assess effectiveness of strategy implementation. Seven of the selected "ERMN Wadeable" reaches also support the SRMP because they are collocated with SRMP sampling sites.

Fort Necessity National Battlefield

Fort Necessity NB encompasses 364 ha (900 ac) in southwestern Pennsylvania and was established in 1931 to preserve and commemorate the early career of George Washington and the battle of Fort Necessity. The park's main unit is located on a plateau with several small streams originating on (and flowing off) park property. Two stream reaches met the wadeable stream criteria (UNT to Great Meadows Run and UNT to Scotts Run; Figure 5). The section of Great Meadows Run within the park is maintained as an open area for cultural resource interpretation and was included as an index reach to fill a data gap because it (along with the UNT to Great Meadows Run) represents the primary aquatic resource for the park.

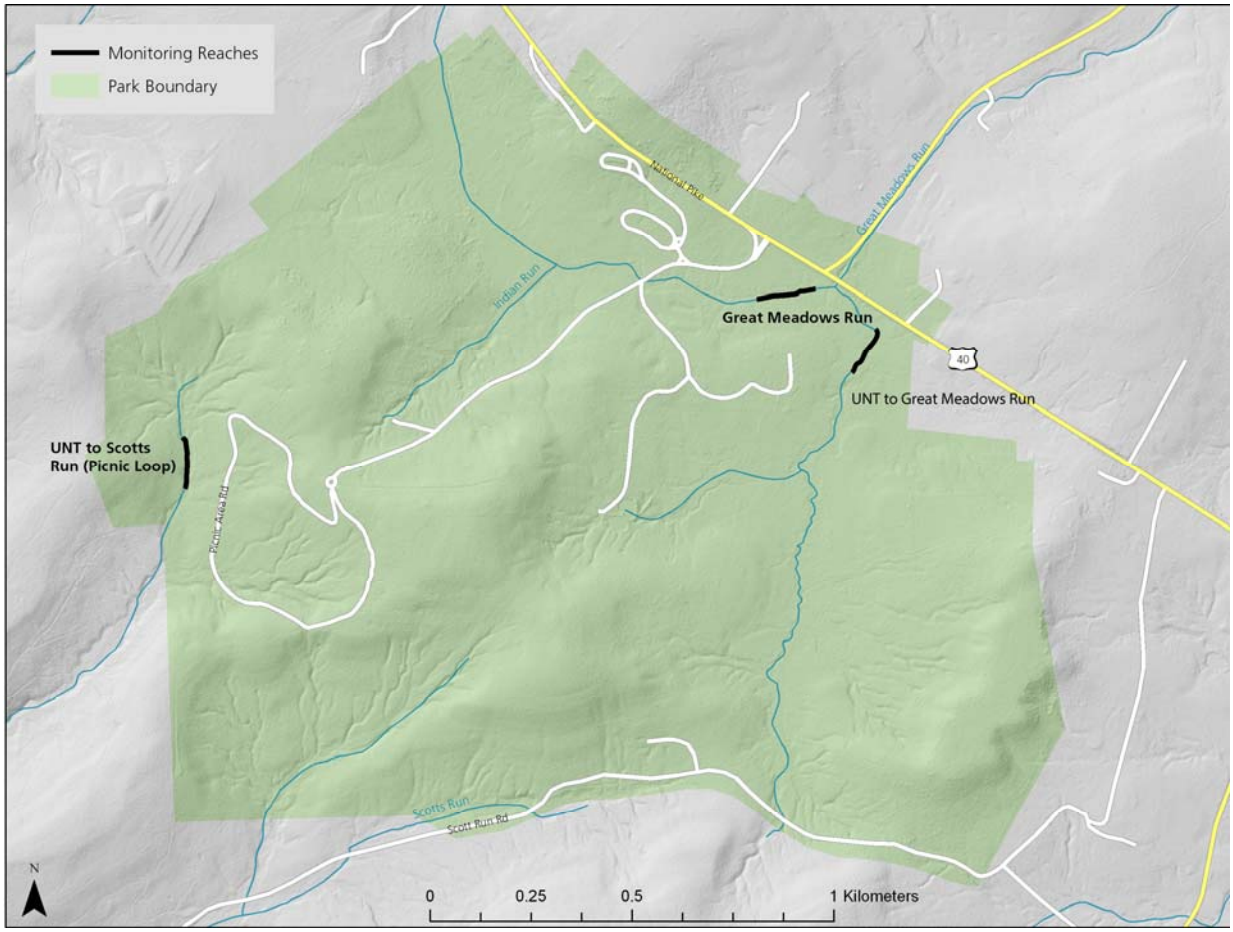

Figure 5. Monitoring reaches at Fort Necessity National Battlefield from 2008 to 2013.

Friendship Hill National Historic Site

Friendship Hill NHS encompasses 273 ha (675 ac) along the Monongahela River in southwestern Pennsylvania. The park was established in 1978 to commemorate and interpret Albert Gallatin, U.S. Secretary of Treasury for thirteen years under Presidents Jefferson and Madison. The park has two perennially flowing streams (Dublin Run and Ice Pond Run) which met the wadeable stream criteria and were sampled (Figure 6).

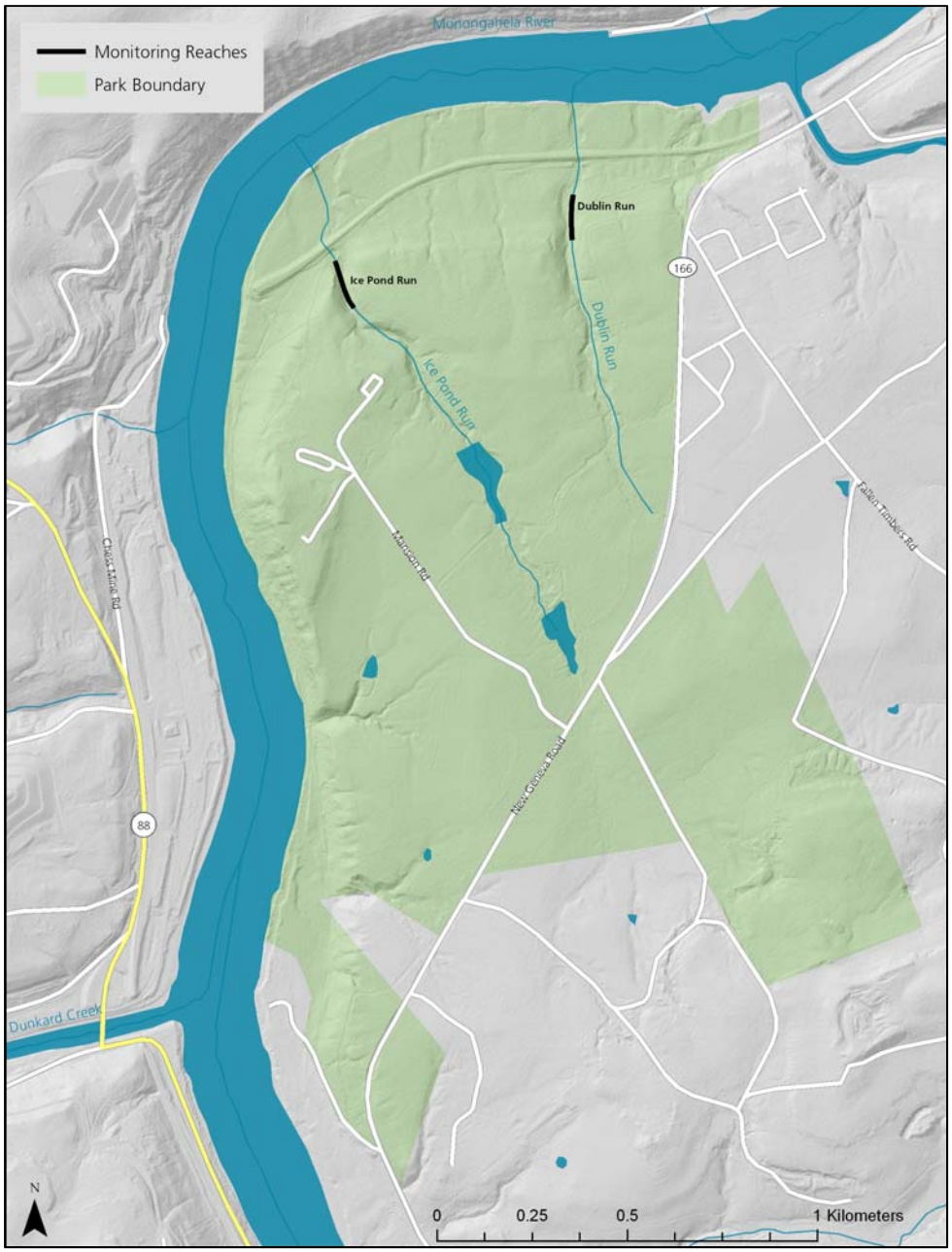

Figure 6. Monitoring reaches at Friendship Hill National Historic Site from 2008 to 2013.

Gauley River National Recreation Area

Gauley River NRA was established in 1988 and encompasses 4,452 ha (11,000 ac) of rugged, mountainous terrain along 40 km (25 mi) of the Gauley River and 8 km (5 mi) of the Meadow River in West Virginia. Three streams (Laurel Creek, Horseshoe Creek, and Meadow Creek) that met the wadeable stream criteria were sampled (Figure 7). Peters Creek and Meadow River were too large (>100 km^2) and excluded. It was decided later (2010) that an index reach should be located on Peters Creek to support data collected there as part of the water quality monitoring program operated by New River Gorge NR staff.

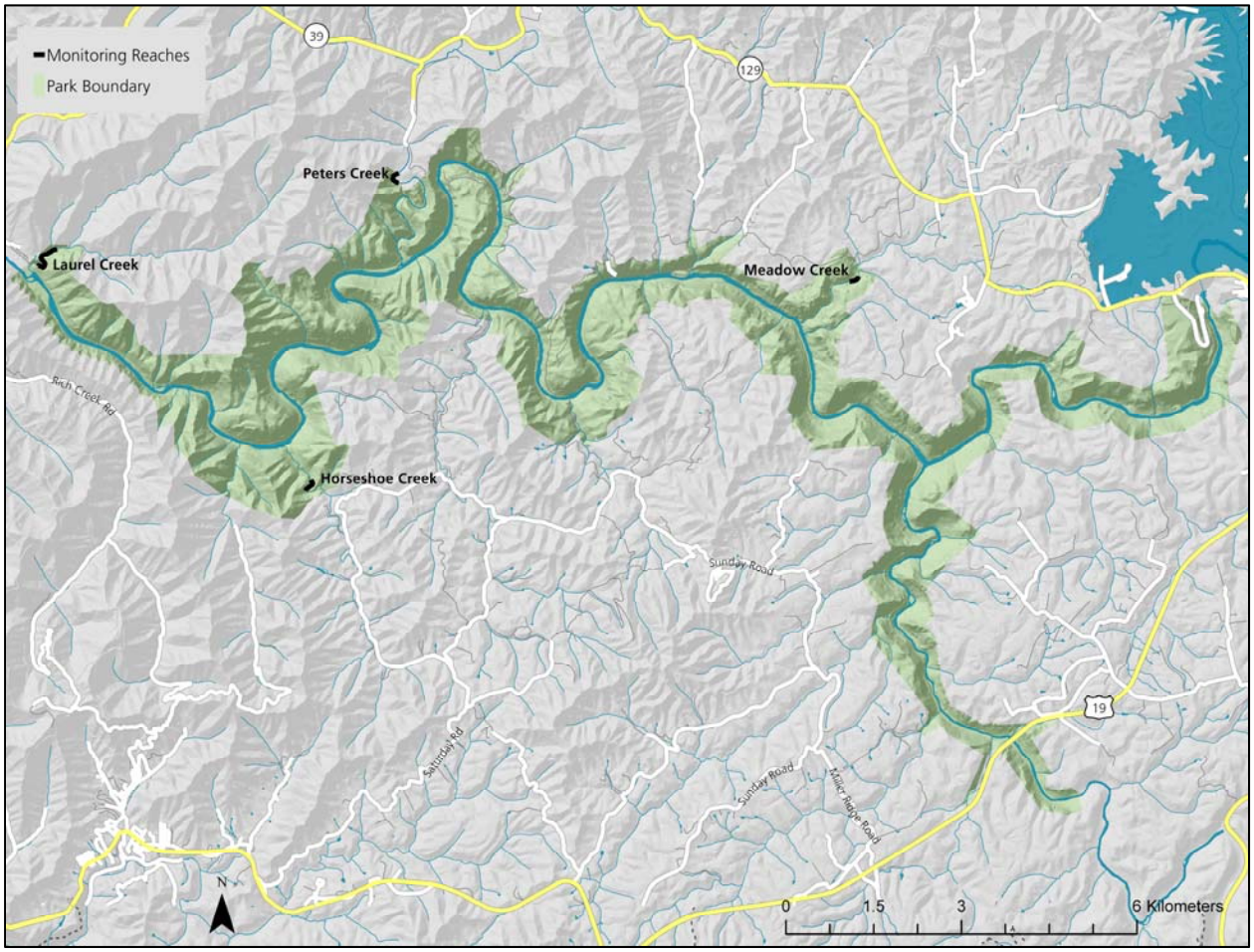

Figure 7. Monitoring reaches at Gauley River National Recreation Area from 2008 to 2013.

Johnstown Flood National Memorial

Johnstown Flood NMem was established in 1964 to commemorate the events that took place at (and nearby) the site in 1889. On May 31, 1889, the dam at Conemaugh Lake failed, which caused flooding that ultimately killed 2,209 people. The historic lakebed is managed as a "wet meadow" which allows visitors to stand on either side of the remaining dam abutments to view the empty lakebed and visualize the quantity of water that converged on Johnstown after the dam failed. There is less than 1 km (0.6 mi) of stream length at Johnstown Flood NMem due to the relatively small area (72 ha; 178 ac) of the park.

An index reach was established on South Fork Little Conemaugh River (SFLCR; Figure 8) to provide baseline information but was only sampled once. The southernmost tributary to the SFLCR

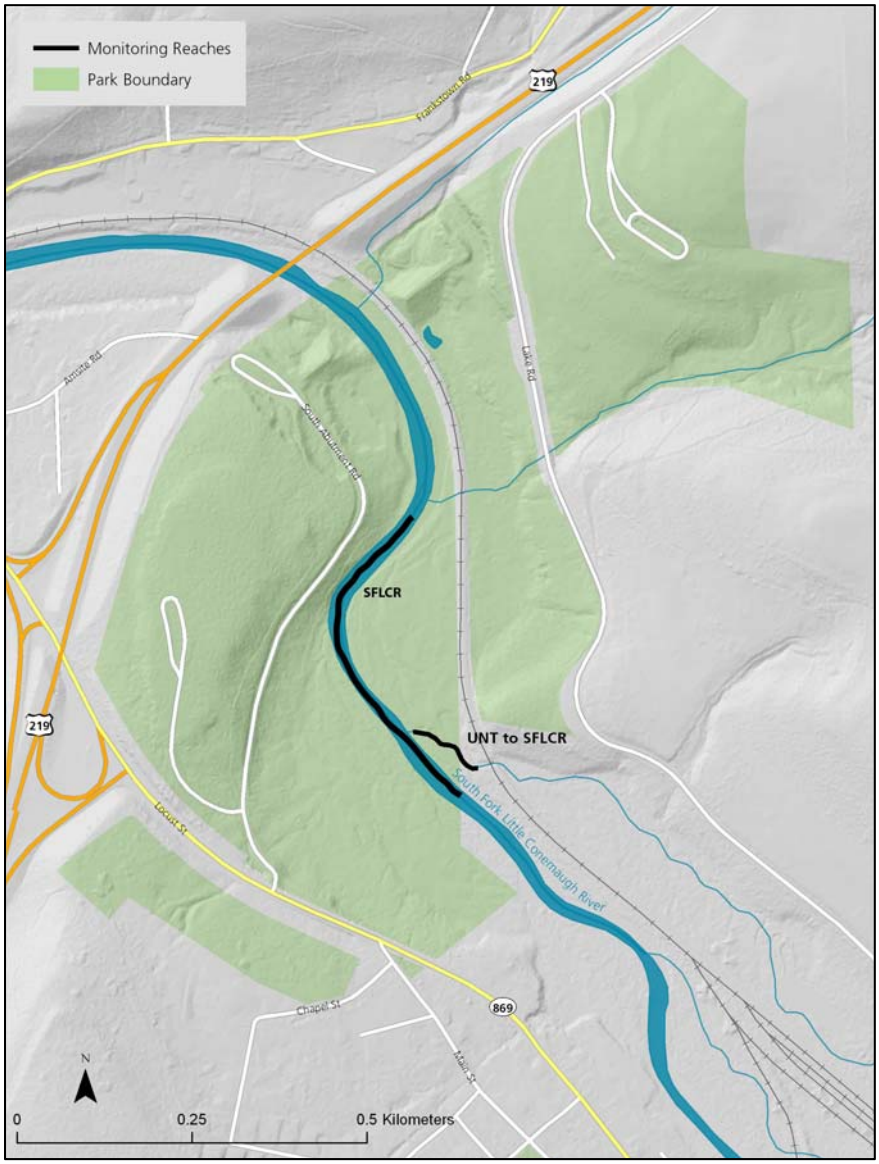

Figure 8. Monitoring reaches at Johnstown Flood National Memorial from 2008 to 2013.

within Johnstown Flood NMem is the only other perennial stream on NPS property; an index reach was established on that stream to fill data gaps as well. Two very small streams in the park were evaluated for inclusion in 2008 and 2009 but were determined to be ephemeral and consequently were not sampled.

New River Gorge National River

Established in 1978, New River Gorge NR encompasses more than 29,214 ha (72,189 ac) of rugged mountainous terrain along a 85 km (53 mi) segment of the New River in West Virginia. There were 22 wadeable stream reaches and two index reaches established at New River Gorge NR (Figure 9). One reach on Glade Creek and one reach on Piney Creek were chosen in consultation with Jesse Purvis (New River Gorge NR Fisheries Biologist) to support the New River Gorge NR water quality monitoring program.

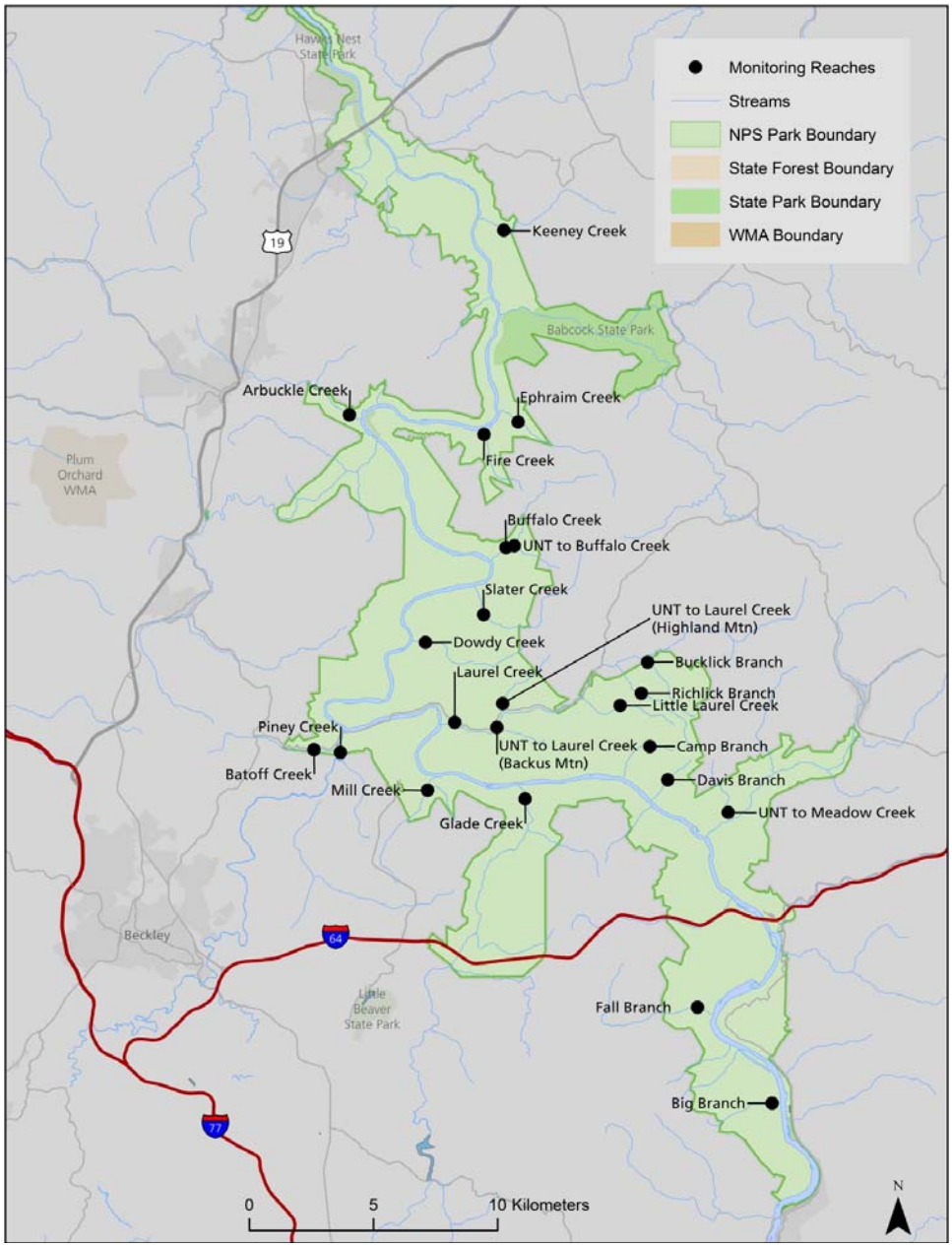

Figure 9. Monitoring reaches at New River Gorge National River from 2008 to 2013.

Upper Delaware Scenic and Recreational River

The authorized boundary of Upper Delaware SRR encompasses approximately 26,000 ha (64,247 ac); however, only about 12 ha (30 ac) are owned by the NPS. Furthermore, only five percent of the land within the authorized boundary is held by public entities (i.e., federal government, Commonwealth of Pennsylvania, New York State, or Sullivan County Parks).

Given that park jurisdiction at Upper Delaware SRR is essentially the mainstem river with little adjacent NPS ownership, it was determined in consultation with Don Hamilton (Upper Delaware SRR Resource Management Specialist) that index reaches would be established to support the park-based DRBC SRMP. Reaches were prioritized based upon: (1) their dilution ratio (relative contribution of water to the Delaware River), (2) whether historical water quality and BMI data were available, and (3) whether they were currently sampled for water quality. The 12 streams that best fit these criteria were chosen for sampling and were typically sampled within 1 km of their confluence with the Delaware River (Figure 10).

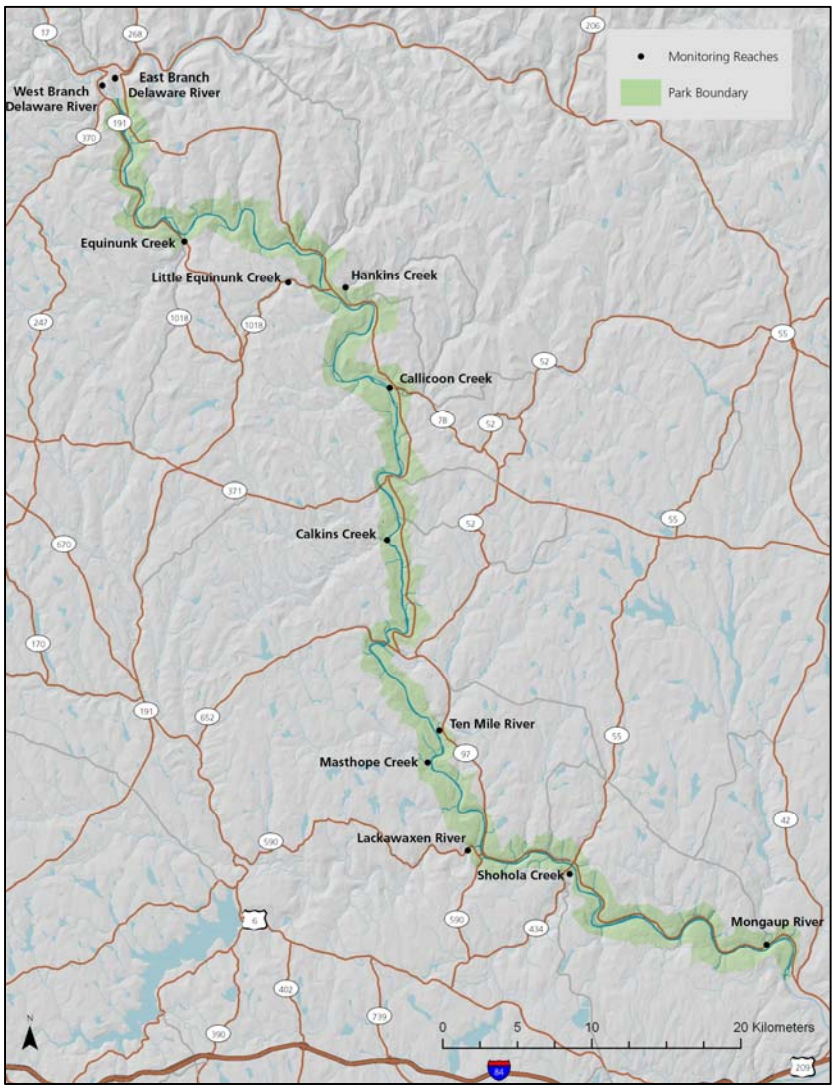

Figure 10. Monitoring reaches at Upper Delaware Scenic and Recreational River from 2008 to 2013.

Methods

Data Collection

Water Quality

Discrete water quality (i.e., core parameters) samples were collected concurrently with BMI samples at all monitoring reaches. Parameters (pH, temperature, specific conductance, and DO) were measured with a Eureka Sub2 multiparameter water quality multiprobe (Austin, TX) prior to collecting BMI samples or otherwise disturbing the reach. Water quality meters were typically checked and/or calibrated for accuracy daily, but always within 36 hours prior to use. Water quality data collection methods were based on USGS procedures and are detailed in Tzilkowski et al. (2010).

Benthic Macroinvertebrate Communities

Benthic macroinvertebrate samples were collected with the USGS "semi-quantitative richest-targeted habitat" (RTH) method (Moulton et al. 2002). An RTH is a targeted habitat, usually a riffle, where faunistically richest BMI communities typically occur. Riffles were available at all ERMN monitoring reaches and were considered the optimal RTH for sampling. The semi-quantitative riffle sample consists of five discrete collections that are processed and combined into a composited sample (see Tzilkowski et al. [2010] for detailed BMI sampling methods).

The RTH method requires disturbance-removal sampling – a general description of disturbance-removal sampling is to define a sampling area and then disturb substrate within that area so that BMI are dislodged and then drift into a net placed downstream of the sampling area. A Slack sampler and area template are used by ERMN for BMI sampling - the Slack sampler is constructed of a rectangular, tapered net (50×33-cm frame; 500 µm mesh) fitted with a wooden handle, whereas an area template delineates the 0.25 m^2 sampling area from which BMI are collected. BMI samples were processed in the field, which served the purpose of reducing sample volume and the quantity of inorganic material, thereby improving laboratory efficiency. A basic description of field processing BMI samples is to: 1) rinse and remove large debris (e.g., cobble and leaves) from each discrete sample; 2) remove, but retain, large BMI (e.g., crayfish) from each discrete collection so that they do not prey on or damage other BMI in the sample while the discrete collections are being processed; 3) sequentially add discrete collections (i.e., 5 Slack samples per reach) to composite sample (5 gal bucket) as they are collected; 4) elutriate and sieve the composite sample to separate BMI and organic debris from inorganic debris (e.g., mineral sediments); 5) if necessary, reduce the volume (<750 mL) for laboratory analysis; and 6) place the composite sample in labeled jars and preserve with 95% ethanol.

Laboratory Procedures

The ERMN uses a fixed-count (i.e., 300±60 individuals) method to identify and estimate the abundance of each BMI taxon sorted from samples. A subsample size of 300 individuals is greater than most state and federal protocols and yields data quality (i.e. precision and accuracy) that meets or exceeds most monitoring programs standards; however, processing and identifying additional individuals (>300) does not typically yield enough additional information to justify the added effort (Moulton et al. 2000). Most composite samples contain many more than 300 individuals; consequently, samples were subsampled by using subsampling frames that are partitioned into

5.1×5.1-cm grids. A generalized processing procedure is as follows: 1) uniformly distribute the sample in a subsampling frame; 2) estimate the average number of organisms per grid by using smaller "estimation trays"; 3) select an appropriate processing strategy based on estimated BMI density; 4) randomly select grids from the appropriate subsampling frame and sort organisms from each grid until target count (i.e., 300 BMI) is reached; and 5) sort large-rare organisms from any remaining unsorted portion(s) of the sample.

BMI were identified to the lowest practical taxonomic level (typically genus) using standard keys and up to 100× magnification. See Tzilkowski et al. (2012) for detailed description of all laboratory procedures.

Analytical Methods

Water Quality Criteria

Discrete water quality data (i.e., core parameters) collected by the ERMN wadeable streams program were compared to the most recently available state water quality standards to identify potential water quality degradation issues in a regulatory context. Comparisons made to state water quality criteria in this report are for illustrative purposes only, state agencies are responsible for implementing regulations and determining designated use(s) attainment or impairment.

Benthic Macroinvertebrate Communities

Parks in the ERMN are located in four states that use different approaches for collecting and analyzing BMI data; consequently, a regional index (Multimetric Index of Biological Integrity [MIBI]; Klemm et al. 2003, Herlihy et al. 2008) developed and used by the U.S. EPA was calculated so that a common index could be presented for all BMI data. The MIBI was developed using samples collected using the U.S. EPA sampling approach which differs from USGS methods; consequently, MIBI condition classes (e.g., good vs. poor) were not referenced in this report. Regardless, the MIBI and its constituent metrics were used because they are expected to respond similarly to increasing biological integrity consistently regardless of sampling methodology.

<u>Multimetric Index of Biotic Integrity (USEPA)</u>

The MIBI was developed and regionalized for streams across the contiguous United States. The MIBI that was designed for the Mid-Atlantic Highlands Region (Klemm et al. 2003) was intended for use in upland and lowland streams dominated by riffle habitat, which are the type of streams monitored by the ERMN. Moreover, the MIBI was developed and thoroughly tested using a large dataset of 574 wadeable stream reaches in the region (Klemm et al. 2003).

The MIBI consists of seven metrics selected from 100 metrics, based on genus level taxonomy, that are commonly used for bioassessment and biomonitoring. The metrics chosen were those that performed best in terms of range, precision, responsiveness to various human-induced disturbances, relationship to catchment area, and redundancy (Table 3; Klemm et al. 2003). Most MIBI metrics are counts or proportions of taxa in the community that are characterized as tolerant or intolerant to human perturbations. One of the metrics, the Macroinvertebrate Tolerance Index (MTI), is more complex because it incorporates values (0–10) for each taxon with respect to pollution tolerance (weighted by taxon abundance) and results in higher scores as the proportion of taxa tolerant to

Table 3. Benthic macroinvertebrate metrics that comprise the Multimetric Index of Biotic Integrity (MIBI). "Response" indicates metric response to decreasing biotic integrity.

Index	Metric	Description	Response
MIBI[1]	Ephemeroptera richness	Number of Ephemeroptera taxa	↓
	Plecoptera richness	Number of Plecoptera taxa	↓
	Trichoptera richness	Number of Trichoptera taxa	↓
	Collector-filterer richness	Number of taxa with a collecting or filtering-feeding strategy	↓
	% Non-insect individuals	Percentage of individuals that are not insects	↑
	Macroinvertebrate Tolerance Index	Abundance-weighted mean tolerance: $\sum_{i=1}^{N} TV_i \ A_i/N$ where TVi is the tolerance value of taxon "i," Ai is the abundance of taxon "i," and N is the number of taxa in the sample	↑
	% Five dominant taxa	Percentage of individuals in the five numerically dominant taxa	↑

[1]Macroinvertebrate Index of Biotic Integrity (U.S. EPA; Klemm et al. 2003, Herlihy et al. 2008)

general pollution increases (Klemm et al. 2003). Pollution tolerance values incorporated in the MTI were average tolerances to "various types of stressors" (Klemm et al. 2002).

Results

Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial

Water Quality

Four of five stream reaches sampled by the ERMN at Allegheny Portage Railroad NHS and Johnstown Flood NMem supported their designated use according to Pennsylvania Department of Environmental Protection (PADEP; Pa. Code § 93.9; Table 4). South Fork Little Conemaugh River (SFLCR), which flows through Johnstown Flood NMem, was listed as impaired due to abandoned mine drainage (i.e., metals and low pH); all other sampled reaches supported their designated use.

Core parameter data collected by the ERMN mostly supported PADEP listings with a few exceptions. SFLCR has known water quality issues and was listed as impaired. Core water quality parameters (and BMI) were sampled one time (10/16/2012) in SFLCR by the ERMN. Water temperature at that reach was above (11.1^{o}C [52°F]) its designated use criteria (10.0^{o}C [50°F]) for the time period; however, it should be noted that thermal water criteria only apply in Pennsylvania if there is a heated waste discharge to the water body and discrete measurements do not constitute a violation. Specific conductance was considerably greater (781.7 µS/cm) than what is typical of unimpaired Pennsylvania streams – a designated use criteria does not exist for specific conductance in Pennsylvania.

Although there is not a heated waste discharge to Blair Gap Run, water temperature was above designated use (Cold Water Fishes) criteria on two of five occasions at the "Muleshoe" monitoring reach on Blair Gap Run (Allegheny Portage Railroad NHS). Otherwise, water temperature was below designated use criteria on all other occasions at all other reaches throughout the two parks (Figure 11; Appendix B). pH at UNT to SFLCR was near (6.05) the minimum state threshold (6.00) on one occasion, whereas dissolved oxygen (DO) concentrations met criteria on all occasions at all reaches. Although water quality criteria do not exist for specific conductance in Pennsylvania, both reaches at Johnstown Flood NMem had specific conductance values greater than typical for wadeable streams in the ERMN (Figure 12; Appendix B). Specific conductance of monitoring reaches at Allegheny Portage Railroad NHS was greatest at the downstream-most reach (Blair Gap Run [Foot of Ten]) which is likely due, in part, to more human influence (e.g., roads, septic systems) situated in the lower portion of the watershed.

Table 4. Pennsylvania Department of Environmental Protection designated uses and status of wadeable stream monitoring reaches at Allegheny Portage Railroad NHS (ALPO) and Johnstown Flood NMem (JOFL).

Park	Reach Name	Designated Use[1]	Status[2]
ALPO	Blair Gap Run (Foot of Ten)	TSF	Supporting
ALPO	Blair Gap Run (Muleshoe)	CWF	Supporting
ALPO	Millstone Run	TSF	Supporting
JOFL	South Fork Little Conemaugh River	CWF	Impaired (Abandoned Mine Drainage; metals and pH)
JOFL	UNT[3] to South Fork Little Conemaugh River	CWF	Supporting

[1]Designated uses in these parks are determined by the Pennsylvania Department of Environmental Protection (Pa. Code § 93.9); TSF = Trout Stocking, CWF = Cold Water Fishes

[2]Assessment status determined from http://www.epa.gov/waters/ir/index.html; August 2013

[3]UNT = Unnamed tributary

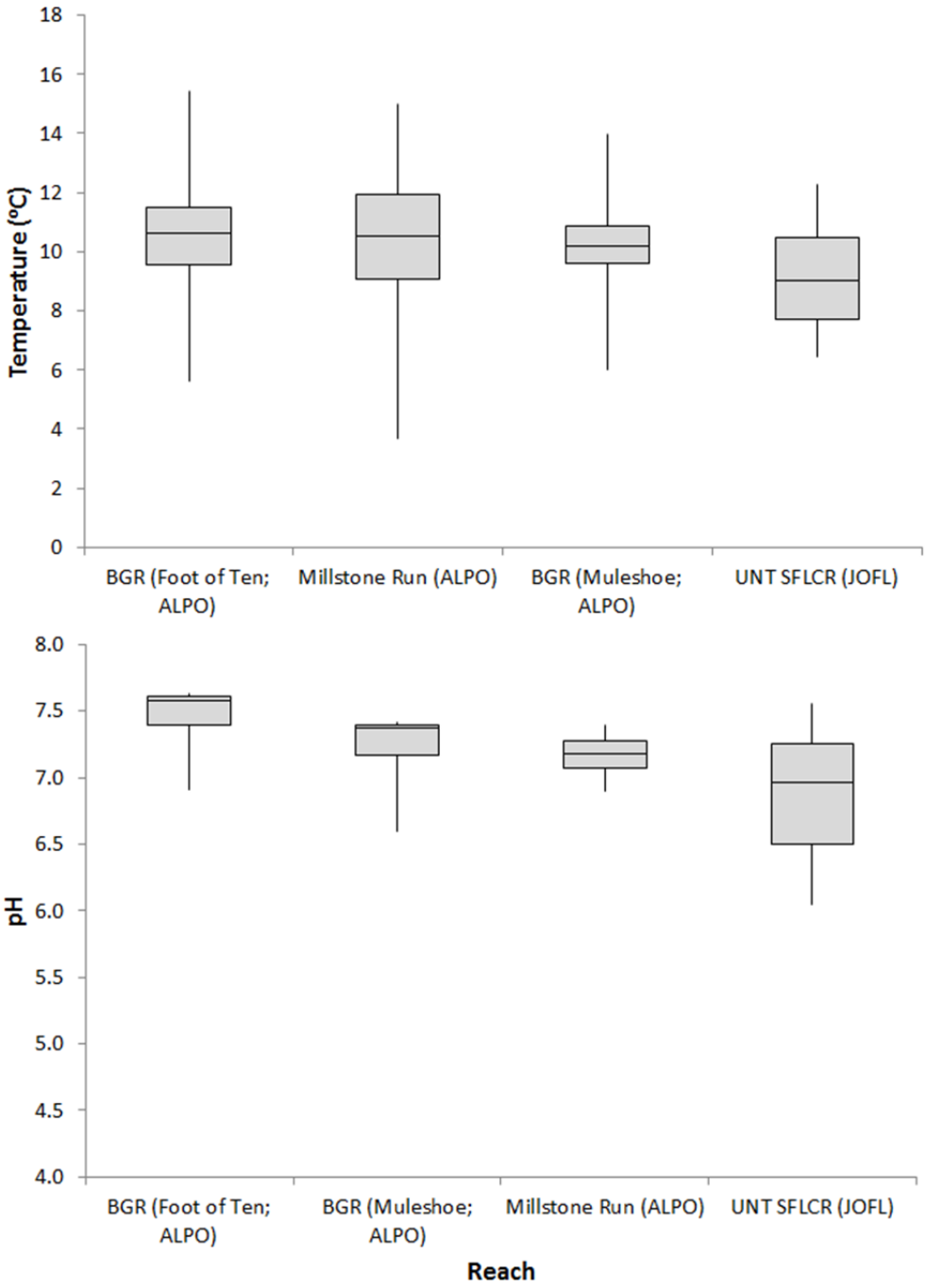

Figure 11. Boxplots of water temperature (top; *n* = 5) and pH (bottom; *n* = 4) at monitoring reaches in Allegheny Portage Railroad NHS (ALPO) and Johnstown Flood NMem (JOFL) from 2008 to 2012. Discrete measurements were taken concurrently with benthic macroinvertebrate sampling. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values. UNT SFLCR = Unnamed tributary to South Fork Little Conemaugh River.

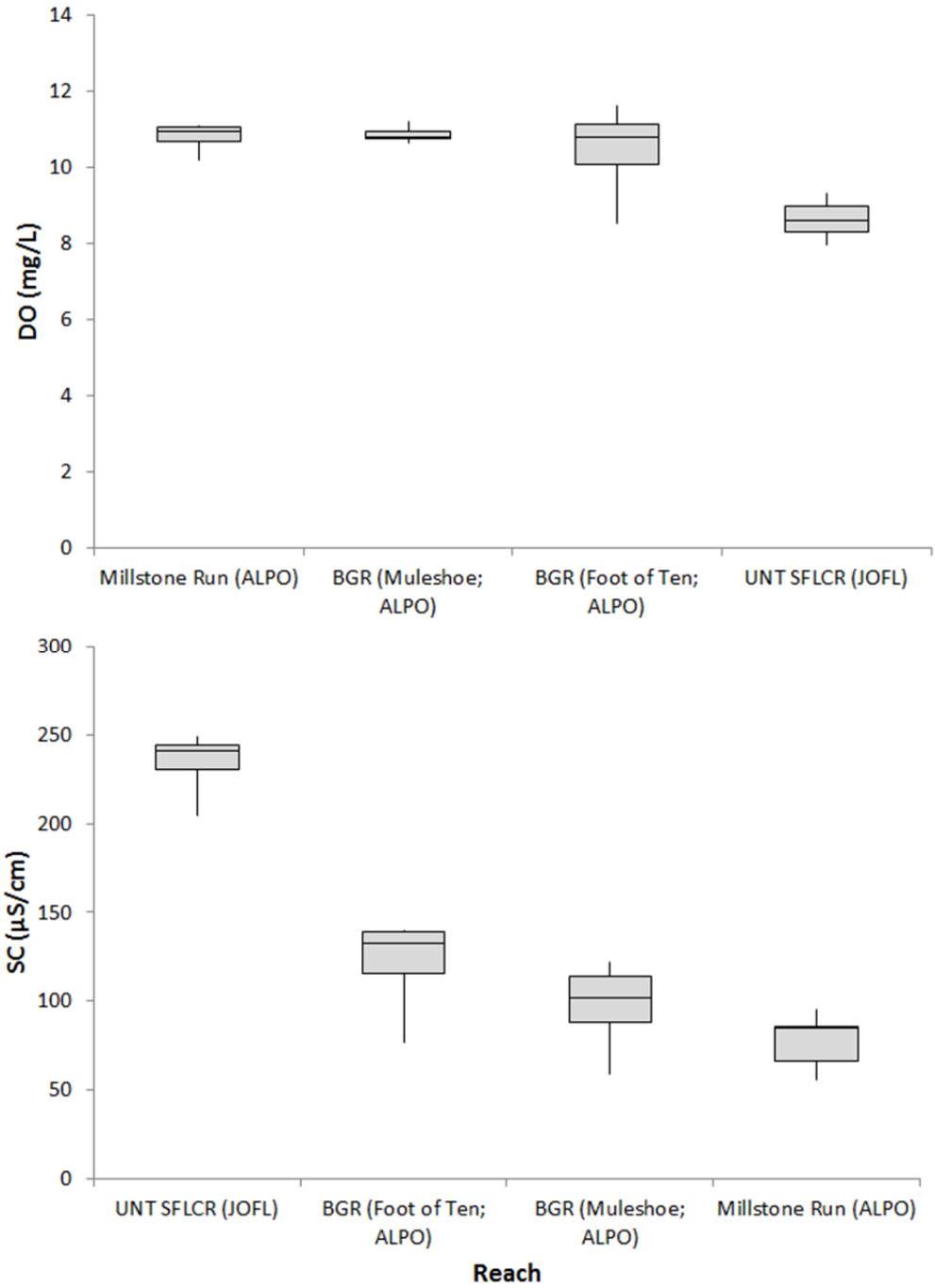

Figure 12. Boxplots of dissolved oxygen (DO; n = 4; top) and specific conductance (SC; n = 5; bottom) at monitoring reaches in Allegheny Portage Railroad NHS (ALPO) and Johnstown Flood NMem (JOFL) from 2008 to 2012. Discrete measurements were taken concurrently with benthic macroinvertebrate sampling. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values. UNT (SFLCR) = Unnamed tributary to South Fork Little Conemaugh River.

Benthic Macroinvertebrates

Multimetric Index of Biotic Integrity (MIBI) scores were variable among sites but were not statistically ($p \leq 0.05$) different among years at Allegheny Portage Railroad NHS and Johnstown Flood NMem (Table 5). Millstone Run was typically assessed as being in the best condition (MIBI=63.1±6.5 [SD]) among all reaches in both parks (Figure 13, Table 6). Conversely, the two reaches at Johnstown Flood NMem were in the poorest condition. Although the average MIBI score was slightly greater at the "Foot of Ten" reach (53.3±7.0) than the "Muleshoe" reach (49.0±10.7) on Blair Gap Run (Allegheny Portage Railroad NHS), MIBI scores were typically similar between those reaches. One BMI sample at the Muleshoe reach, which was collected during 2012 during dam repair on Blair Run, was considerably lower (32.6) than in other years. MIBI scores from the UNT to South Fork Little Conemaugh River (SFLCR) were consistently low (25.0±2.9), whereas the one BMI sample collected from the mainstem SFLCR had the lowest MIBI score (7.1) among sampled reaches throughout the ERMN – note that streams at Johnstown Flood NMem were not sampled in 2012.

Table 5. Interannual variability of Multimetric Index of Biotic Integrity [MIBI] scores for samples collected at Allegheny Portage Railroad NHS and Johnstown Flood NMem from 2008 to 2012. MIBI scores were not different among years based on Tukey-Kramer comparison with 95% confidence intervals. *n* = sample size; SD = standard deviation; Min = minimum; Max = maximum.

Year	*n*	Mean	SD	Min	Max
2008	4	42.2	12.1	25.3	53.7
2009	4	48.8	15.0	28.7	64.9
2010	4	48.3	17.3	24.1	65.2
2011	4	51.9	20.2	21.7	64.0
2012	3	54.1	19.7	32.6	71.3

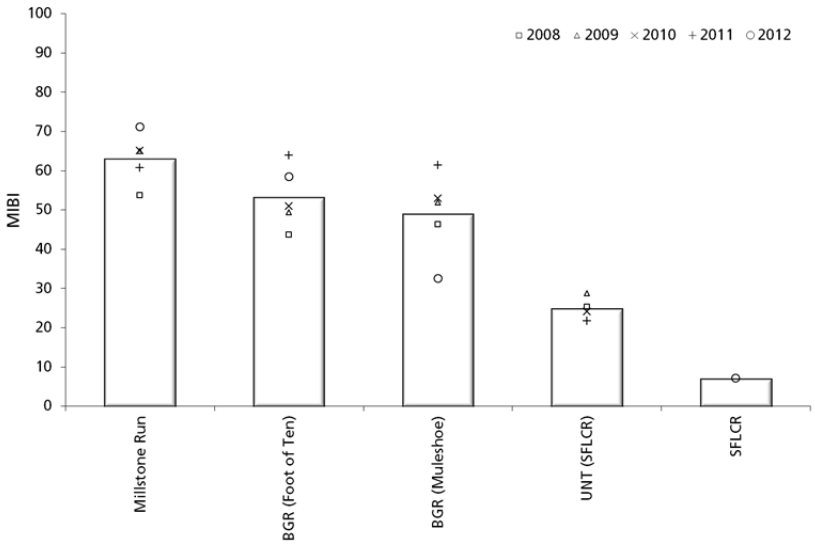

Figure 13. Multimetric Index of Biotic Integrity scores (MIBI) of benthic macroinvertebrate community samples collected at Allegheny Portage Railroad NHS and Johnstown Flood NMem from 2008 to 2012. Bars represent average MIBI scores. BGR = Blair Gap Run; SFLCR = South Fork Little Conemaugh River; UNT = Unnamed tributary.

Table 6. Multimetric Index of Biotic Integrity [MIBI] scores and constituent metrics for samples collected at Allegheny Portage Railroad NHS (ALPO) and Johnstown Flood NMem (JOFL) from 2008 to 2012. The MIBI consists of seven metrics (Ephemeroptera richness [E], Plecoptera richness [P], Trichoptera richness [T], Collector-filterer richness [CF], Percent non-insect individuals [%NI], Percent five dominant taxa [%D5], and Macroinvertebrate Tolerance Index [MTI]). Note that metrics must be scaled (i.e., from 0 to 100) based on "standardization" values (Klemm et al. 2003) to calculate the index.

Park	Reach	Date	Taxa	E	P	T	CF	% NI	% D5	MTI	MIBI
ALPO	BGR[1] (Foot of Ten)	10/31/2008	27	4	3	7	7	11	65	4.03	**43.7**
		10/21/2009	28	4	2	9	8	5	74	3.70	**49.4**
		10/11/2010	26	6	3	8	7	2	82	3.50	**50.9**
		10/25/2011	27	7	5	8	8	2	65	3.30	**64.0**
		10/09/2012	26	6	4	8	7	1	65	3.64	**58.5**
ALPO	BGR (Muleshoe)	10/31/2008	25	7	4	7	6	28	59	3.56	**46.3**
		10/21/2009	30	7	4	8	6	12	56	3.16	**51.9**
		10/11/2010	28	5	5	7	6	5	67	2.32	**53.0**
		10/25/2011	29	7	6	7	6	4	61	1.89	**61.4**
		10/09/2012	25	4	5	5	5	22	73	3.23	**32.6**
ALPO	Millstone Run	10/31/2008	28	6	6	5	4	2	58	1.91	**53.7**
		10/21/2009	41	7	7	8	4	1	54	1.84	**64.9**
		10/11/2010	36	9	5	8	5	1	53	2.34	**65.2**
		10/25/2011	32	7	6	7	5	2	63	1.33	**60.7**
		10/09/2012	37	9	6	8	7	1	55	1.90	**71.3**
JOFL	SFLCR[2]	10/16/2012	8	0	1	2	1	39	91	4.79	**7.1**
JOFL	UNT[3] (SFLCR)	11/04/2008	18	1	1	5	4	1	85	5.16	**25.3**
		10/21/2009	24	1	3	4	5	3	83	4.50	**28.7**
		10/11/2010	27	2	2	5	6	9	79	5.14	**24.1**
		10/25/2011	21	2	2	5	4	4	86	5.28	**21.7**

[1] BGR = Blair Gap Run

[2] SFLCR = South Fork Little Conemaugh River

[3] UNT = Unnamed tributary

Bluestone National Scenic River and Gauley River National Recreation Area

Water Quality

Bluestone National Scenic River

Little Bluestone River was the only reach sampled by the ERMN at Bluestone NSR that was not listed as impaired by the West Virginia Department of Environmental Protection (WVDEP; http://www.epa.gov/waters/ir/index.html, accessed August 2013; Table 7). The other three reaches were impaired due to PCBs (polychlorinated biphenyls) and/or fecal coliform.

Table 7. West Virginia Department of Environmental Protection designated use and status of wadeable stream monitoring reaches at Bluestone NSR.

Reach Name	Designated Use[1]	Status[2]
Bluestone River (Mouth)	A&W, B-1, Contact, Indust., PWS, Tier 3	Impaired (Fecal Coliform, Polychlorinated Biphenyls)
Bluestone River (Pipestem)	A&W, B-1, Contact, Indust., PWS, Tier 3	Impaired (Fecal Coliform, Polychlorinated Biphenyls)
Little Bluestone River	A&W, B-2, Contact, Indust., PWS, Tier 3	Supporting
Mountain Creek	A&W, B-2, Contact, Indust., PWS	Impaired (Fecal Coliform)

[1]All designated uses of streams in Bluestone NSR are determined by the WVDEP (W. Va. C.S.R.§47-2):

Tier 3 = Outstanding Natural Resource Water
B2 = Cold Water Fishes
Contact = Water Contact Recreation
PWS = Public Water Supply
B1 = Warm Water Fishery
A&W = Agriculture and Wildlife
Indust. = Industrial

[2]Assessment status determined from http://www.epa.gov/waters/ir/index.html; August 2013

The "Tier 3" waters designation by the WVDEP affords the greatest water quality protection of any designation in the state and is intended to "Maintain and protect water quality in outstanding national resource waters" (http://www.dep.wv.gov/WWE/Programs/wqs/Pages/default.aspx, accessed 8/2/13). Despite their impairment, both reaches on Bluestone River were listed as "Tier 3" waters because this section of the river was specifically designated under the Wild and Scenic Rivers Act and the National Parks and Recreation Act of 1978 (§47-2A-4.3a). The Little Bluestone River reach is listed as a Tier 3 water body for the same reason.

The only instance when any core parameter did not meet designated use criteria was at Mountain Creek, where pH (5.99) was just below West Virginia criteria (pH$\geq$6.0) on one occasion (3/29/2011; Appendix B). Water temperature at Bluestone River reaches was considerably greater than at tributary reaches, primarily because river and tributary reaches were sampled in late summer and early spring, respectively (Figure 14). Other core parameters reflected natural differences (e.g., underlying geology) between mainstem river reaches and tributary reaches; specifically, pH and specific conductance were similar between river reaches, which were substantially greater than at tributary reaches (i.e., Mountain Creek and Little Bluestone River). The consistently greater specific conductance at Mountain Creek relative to Little Bluestone River (Figure 15) may have reflected the issues (e.g., inadequate sewage treatment) associated with its impairment (i.e., fecal coliform).

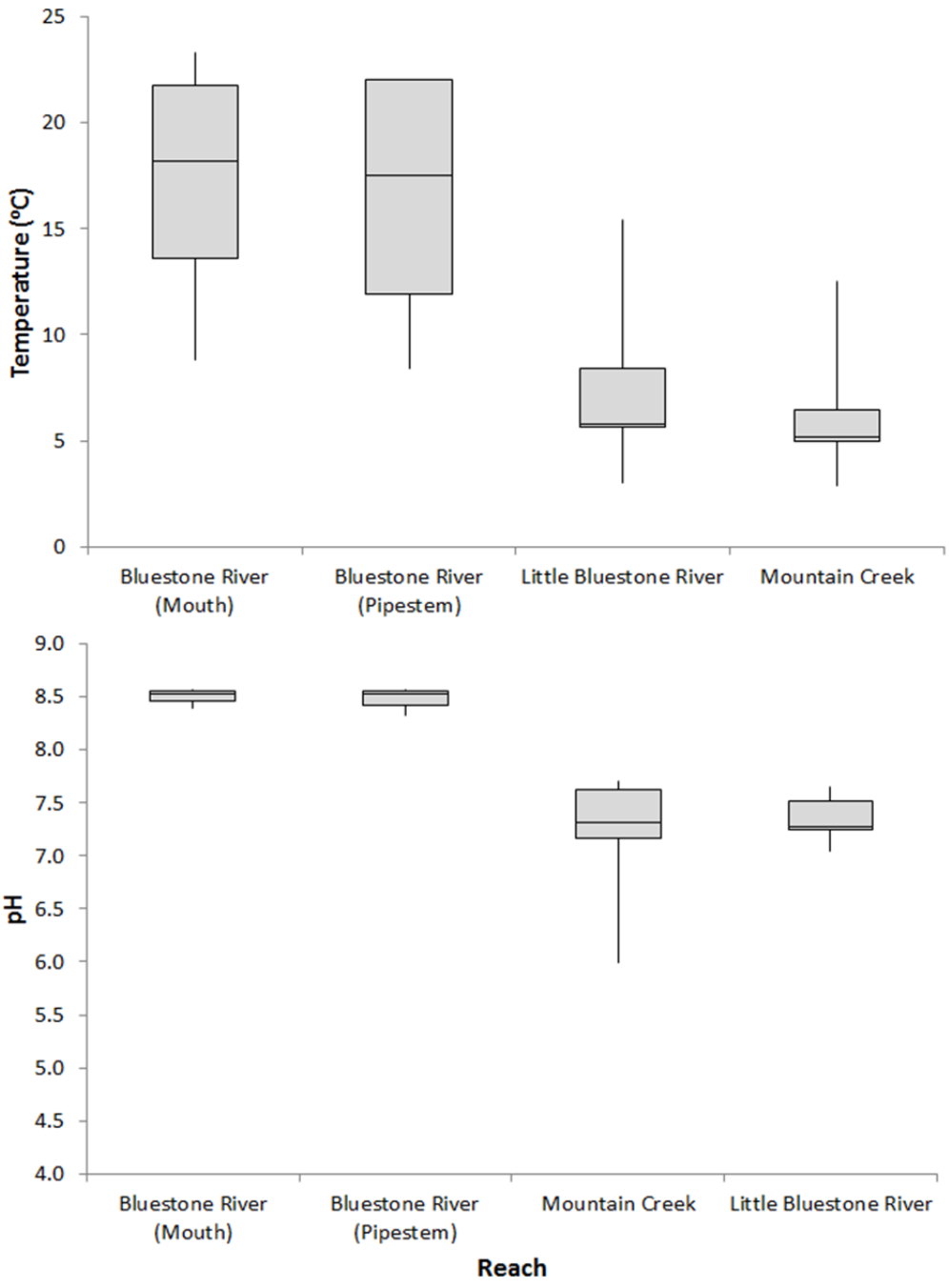

Figure 14. Boxplots of water temperature (top) and pH (bottom) at monitoring reaches in Bluestone NSR from 2008 to 2013. Bluestone River reaches were sampled four times whereas Mountain Creek and Little Bluestone River reaches were sampled five times. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values.

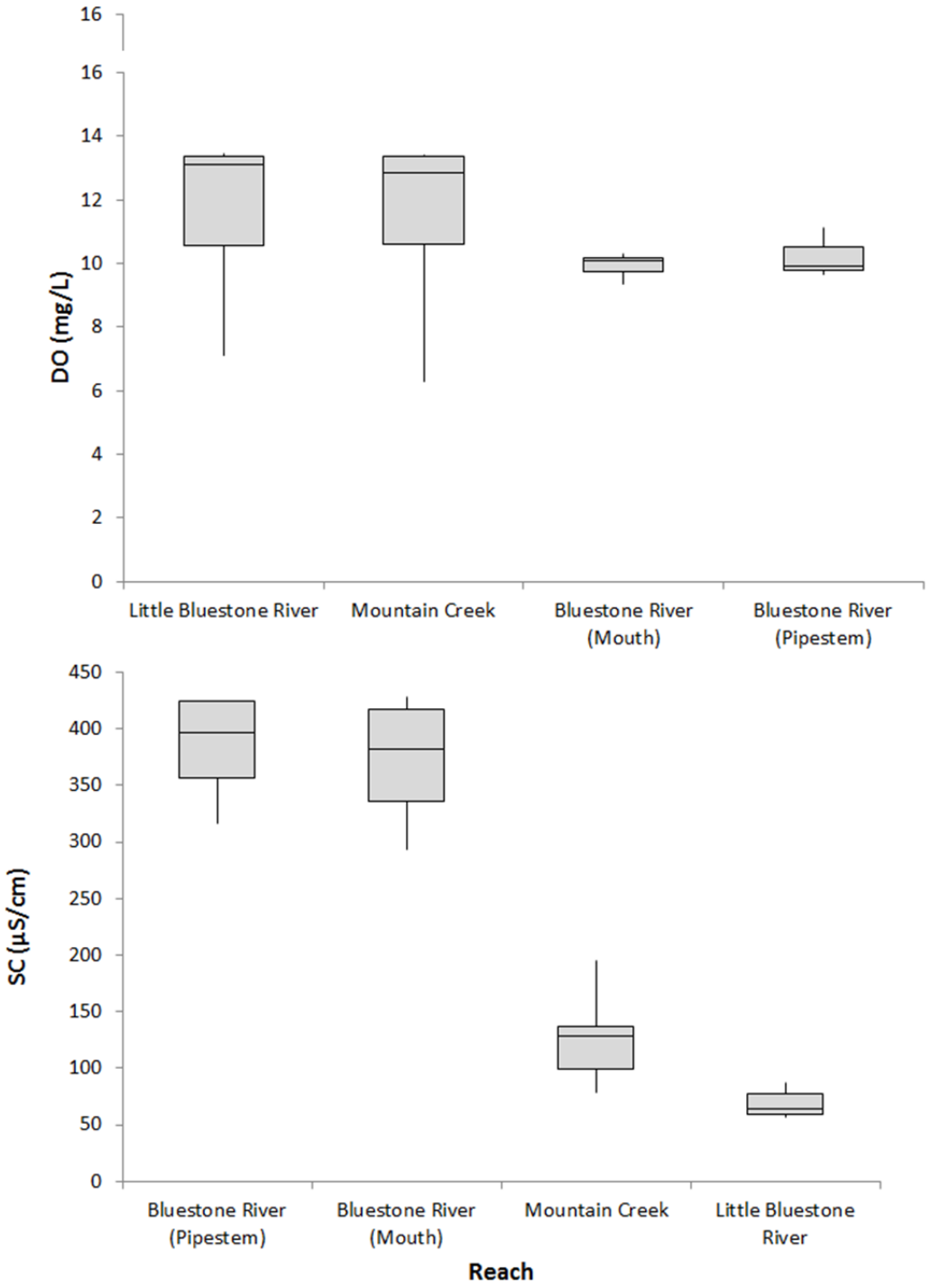

Figure 15. Boxplots of dissolved oxygen (DO; top) and specific conductance (SC; bottom) at monitoring reaches in Bluestone NSR from 2008 to 2013. Bluestone River reaches were sampled four times whereas Mountain Creek and Little Bluestone River reaches were sampled five times. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values.

Gauley River National Recreation Area

Four reaches were sampled in four streams at Gauley River NRA (Table 8). At the time that this report was written, two of those streams (Horseshoe Creek and Laurel Creek) were not assessed by WVDEP (W. Va. C.S.R. §47-2**)**. Meadow Creek was listed as supporting its designated uses, whereas Peters Creek was impaired due to iron and fecal coliform.

Table 8. Designated use and status of wadeable stream monitoring reaches at Gauley River NRA.

Reach Name	Designated Use[1]	Status[2]
Horseshoe Creek	A&W, B-1, Contact, Indust., PWS	Not Assessed
Laurel Creek	A&W, B-1, Contact, Indust., PWS, Tier 3	Not Assessed
Meadow Creek	A&W, B-1, Contact, Indust., PWS, Tier 3	Supporting
Peters Creek	A&W, B-2, Contact, Indust., PWS	Impaired (Metals [Iron],Fecal Coliform

[1]All designated uses of streams in Gauley NRA are determined by the West Virginia Department of Environmental Protection (W. Va. C.S.R.§47-2):

A&W = Agriculture and Wildlife
CWF = Cold Water Fishes
Indust. = Industrial
Tier 3 = Outstanding Natural Resource Water
B1 = Warm Water Fishery,
Contact = Water Contact Recreation
PWS = Public Water Supply

[2]Assessment status determined from http://www.epa.gov/waters/ir/index.html; August 2013

Water temperature, pH, and dissolved oxygen concentrations met designated use criteria at all reaches on all sampling occasions. Water temperature did not differ among reaches (Figure 16), nor did dissolved oxygen concentrations (Figure 17); conversely, Peters Creek had the greatest observed pH and specific conductance, which was likely due, in part, to human influences that caused its impairment listing. Meadow Creek, which was listed as supporting its designated uses, had greater pH and specific conductance than reaches in the two unassessed streams (Horseshoe Creek and Laurel Creek).

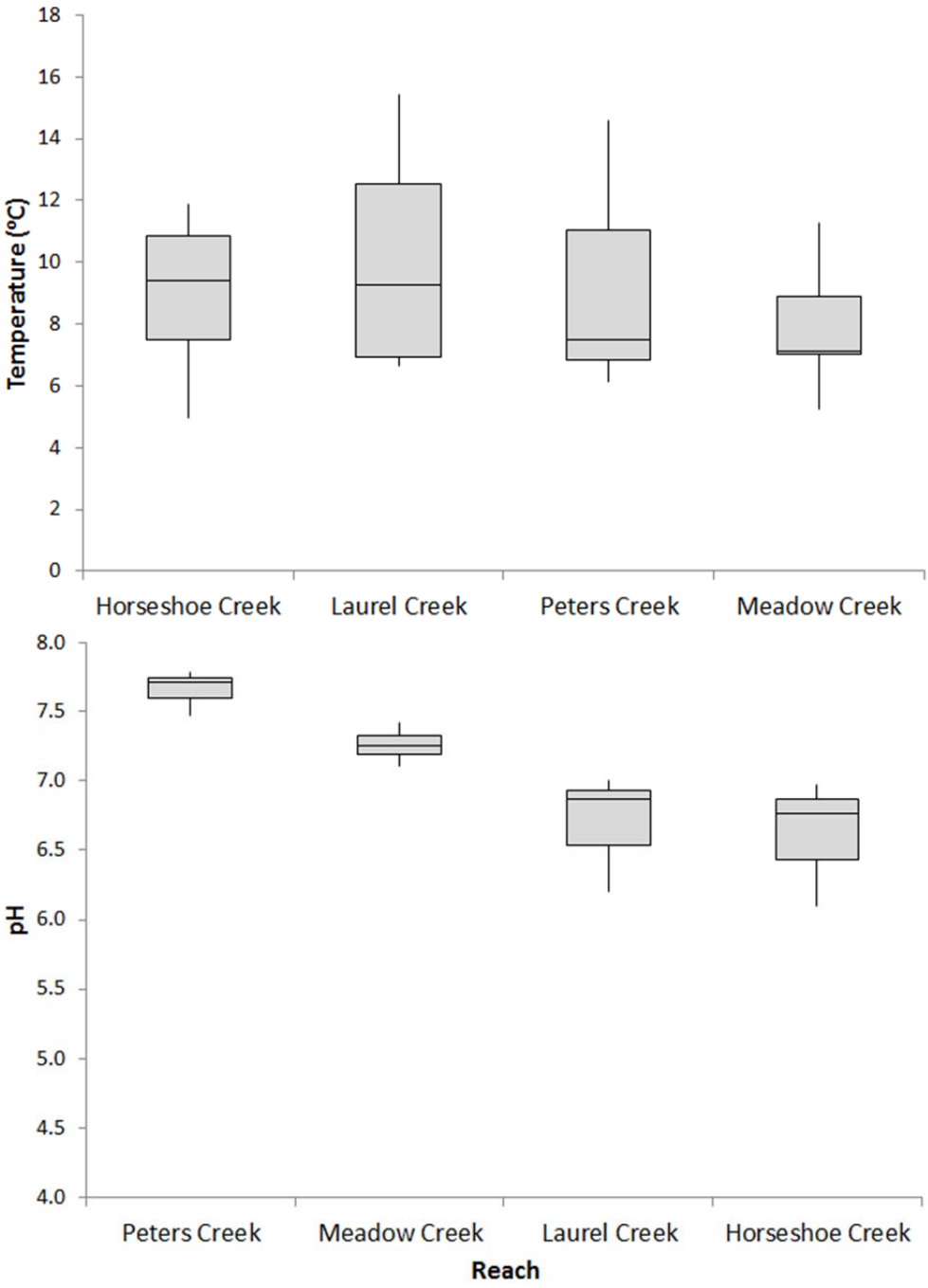

Figure 16. Boxplots of water temperature (top) and pH (bottom) at monitoring reaches in Gauley River NRA from 2008 to 2013. Sample size differed among reaches – see Appendix B. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values.

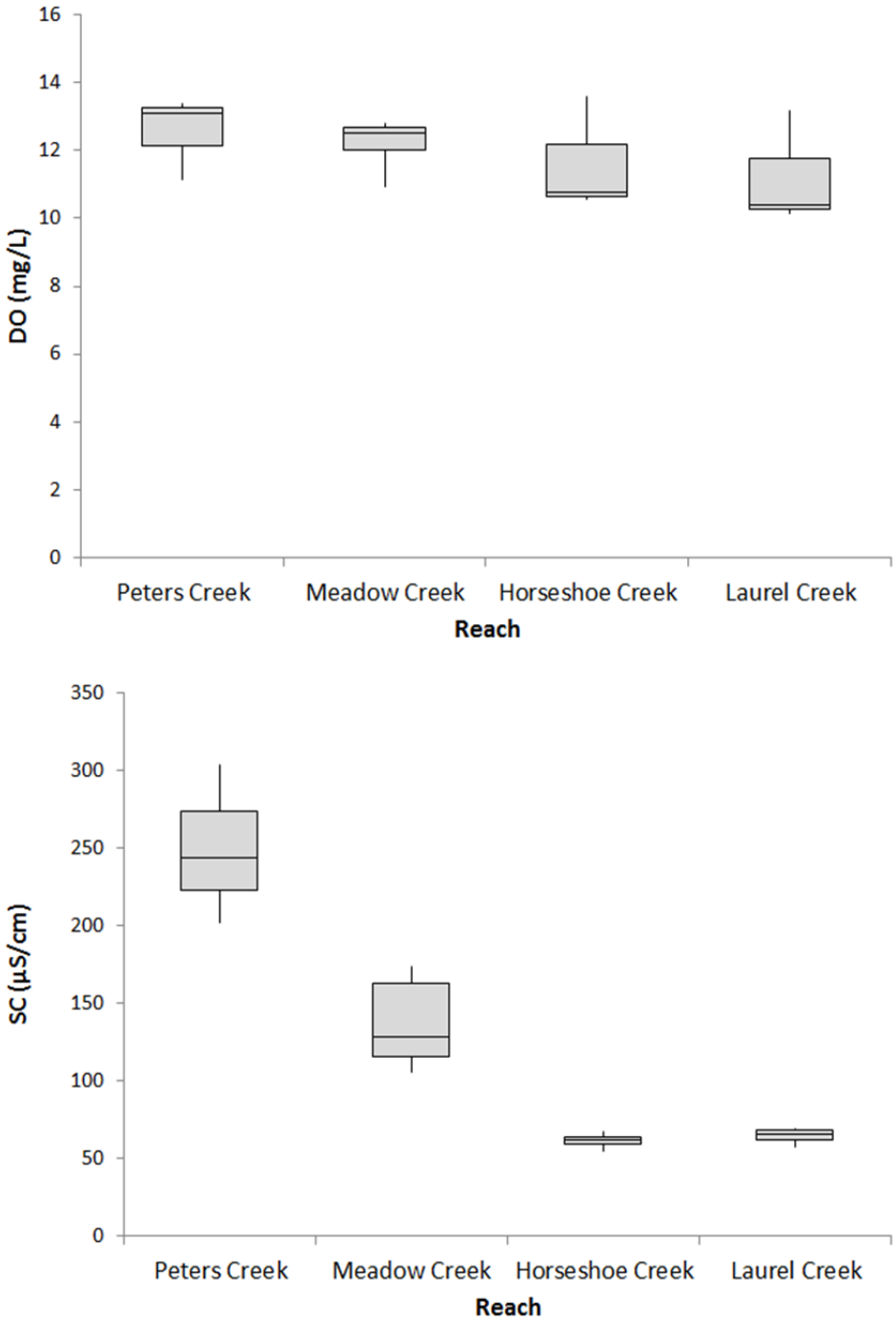

Figure 17. Boxplots of dissolved oxygen (DO; top) and specific conductance (SC; bottom) at monitoring reaches in reaches in Gauley River NRA from 2008 to 2013. Sample size differed among reaches – see Appendix B. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values.

Benthic Macroinvertebrates

Multimetric Index of Biotic Integrity (MIBI) scores varied considerably among sites but were not statistically ($p \leq 0.05$) different among years at Bluestone NSR and Gauley River NRA (Table 9). Horseshoe Creek at Gauley River NRA consistently ranked highest (MIBI=62.8±4.0 [SD]) among reaches according to the MIBI, whereas the two Bluestone River reaches and Peters Creek were typically lowest (Figure 18). Bluestone River (Pipestem) and Peters Creek were the only reaches that had MIBI scores that were less than 30.0 on any occasion and Bluestone River (Pipestem) had the lowest average MIBI (34.4±5.9; Table 10). It should be noted that, in addition to the recognized impairment sources to the Bluestone River, the reaches where samples were collected are considerably different (e.g., larger) than streams from which the MIBI was developed (i.e., wadeable streams). Furthermore, underlying geology (e.g., limestone) of the Bluestone River valley likely favors BMI communities for which the index was not calibrated. Although some states have developed indices intended for use in limestone-influenced streams (e.g., Pennsylvania) or rivers (e.g., New York), West Virginia currently has neither. More investigation is needed to determine the extent that these differences may have contributed to the relatively low scores for Bluestone River reaches.

Table 9. Interannual variability of Multimetric Index of Biotic Integrity [MIBI] scores for samples collected at Bluestone NSR and Gauley River NRA from 2009 to 2013. MIBI scores were not different among years based on Tukey-Kramer comparison with 95% confidence intervals (two samples collected in 2013 were not included in this analysis). *n* = sample size; SD = standard deviation; Min = minimum; Max = maximum.

Year	*n*	Mean	SD	Min	Max
2009	5	47.3	8.9	38.8	59.1
2010	7	47.2	7.4	40.4	60.0
2011	8	48.3	14.8	27.9	67.1
2012	8	52.6	8.8	34.2	62.2
2013	2	58.7	6.4	54.2	63.2

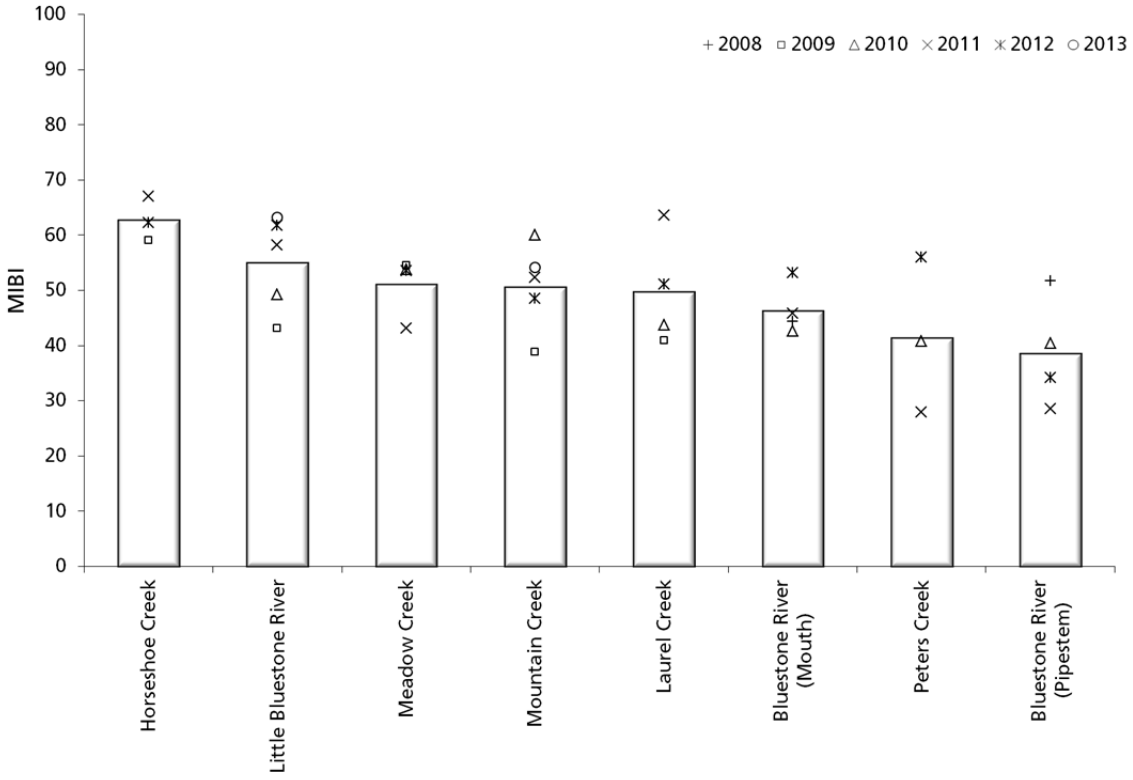

Figure 18. Multimetric Index of Biotic Integrity scores (MIBI) of benthic macroinvertebrate community samples collected at Bluestone NSR and Gauley River NRA from 2008 to 2013. Bars represent average MIBI scores.

Table 10. Multimetric Index of Biotic Integrity [MIBI] scores and constituent metrics for samples collected at Bluestone NSR and Gauley NRA from 2008 to 2013. The MIBI consists of seven metrics (Ephemeroptera richness [E], Plecoptera richness [P], Trichoptera richness [T], Collector-filterer richness [CF], Percent non-insect individuals [%NI], Percent five dominant taxa [%D5], and Macroinvertebrate Tolerance Index [MTI]). Note that metrics must be scaled (i.e., from 0 to 100) based on "standardization" values (Klemm et al. 2003) to calculate the index.

Park	Reach	Date	E	P	T	CF	% NI	% D5	MTI	MIBI
BLUE	Mountain Creek	03/31/2009	5	5	4	3	6.9	70	3.64	38.8
		04/07/2010	8	7	6	5	1.3	69	2.76	60.0
		03/29/2011	6	7	5	5	1.1	76	3.65	52.3
		03/08/2012	7	5	4	4	1.7	64	3.56	48.5
		03/11/2013	7	7	4	4	0.9	63	2.80	54.2
BLUE	Little Bluestone River	03/31/2009	10	7	4	3	1.2	78	4.77	43.2
		04/07/2010	8	5	4	4	1.5	66	2.54	49.2
		03/29/2011	11	8	4	5	1.2	66	4.26	58.2
		03/08/2012	10	8	3	5	0.6	61	3.02	61.7
		03/11/2013	10	7	4	5	2.5	53	2.96	63.2
BLUE	Bluestone River (Mouth)	10/24/2008	5	4	7	6	7.2	66	4.27	44.4
		09/14/2010	5	3	5	6	7.5	60	4.01	42.6
		09/14/2011	8	2	8	5	3.8	69	4.39	45.8
		09/25/2012	8	2	8	6	0.9	67	4.15	53.1
BLUE	Bluestone River (Pipestem)	10/24/2008	6	3	7	8	13.9	49	4.10	51.7
		09/14/2010	6	1	6	6	17.8	50	4.22	40.4
		09/14/2011	7	3	5	6	26.5	66	4.79	28.6
		09/25/2012	5	2	7	8	24.5	71	4.63	34.2
GARI	Laurel Creek	03/30/2009	7	6	5	3	5.0	83	4.03	41.0
		04/05/2010	7	6	3	2	0.7	78	2.50	43.7
		03/22/2011	9	7	7	5	2.9	66	2.97	63.6
		03/11/2012	7	7	4	3	4.2	63	3.27	51.1
GARI	Horseshoe Creek	03/30/2009	7	4	8	5	4.6	48	3.47	59.1
		03/22/2011	9	6	8	5	2.5	50	3.72	67.1
		03/11/2012	8	6	7	4	1.9	55	3.67	62.2
GARI	Meadow Creek	04/01/2009	7	3	6	7	4.6	62	3.61	54.5
		04/05/2010	5	6	7	4	0.7	69	3.59	53.8
		03/29/2011	5	2	6	6	1.3	76	4.11	43.2
		03/11/2012	6	4	7	6	0.3	69	3.84	53.5
GARI	Peters Creek	04/05/2010	9	3	5	5	2.4	76	4.44	40.8
		03/29/2011	6	2	3	5	1.0	82	4.81	27.9
		03/11/2012	8	6	5	6	2.4	61	4.07	56.1

Delaware Water Gap National Recreation Area

Water Quality

Based upon currently available data (http://www.epa.gov/waters/ir/index.html, accessed August 2013), most (94%) Pennsylvania stream reaches sampled at Delaware Water Gap NRA supported their designated aquatic life uses (Table 11); conversely, only 20% of New Jersey stream reaches in the park supported their aquatic life use. It should be noted that assessment methodologies used by the states were considerably different; consequently, the proportion of "impaired" streams listed by the respective states may not be directly comparable because of differing attainment criteria.

It must be noted that regulatory thermal criteria do not apply unless the water receives a thermal discharge; comparisons presented here are for illustrative purposes only. Based upon core parameter data collected by the ERMN from 2008 to 2013, there were many (27%) instances when water temperature of sampled reaches (Figure 19) exceeded designated use criteria (Appendix B). More than half (65%) of sampled reaches had water temperature that exceeded designated use criteria on at least one occasion; furthermore, water temperature was above designated use criteria on more than half of the sampling visits at five reaches (Dunnfield Creek, Slateford Creek, UNT to Dingmans Creek, Vancampens Brook, and White Brook). Water temperature did not exceed designated use criteria on any occasion at nine reaches.

The highest and lowest pH values observed at Delaware Water Gap NRA were at White Brook and UNT (Sunfish Pond), respectively. pH mostly reflected underlying geology of the respective reaches – reaches with less limestone in the contributing watershed generally had lower pH than those with limestone bedrock. Two reaches (UNT [Sunfish Pond] and Vandermark Creek) consistently had pH values less than the minimum pH criterion for many New Jersey streams (pH = 6.50) – note that the minimum pH criterion in Pennsylvania is 6.0. Because the UNT (Sunfish Pond) reach drains a natural bog/pond complex it would likely be considered its natural condition and, consequently, not impaired, given its designated use (i.e., FW1 narrative criteria were "Maintained as to quality in their natural state" [N.J.A.C. 7:9B]). It is possible that pH values in Vandermark Creek were unnaturally low, due, in part, to local human activities (e.g., impervious surfaces), because a considerable portion of the Vandermark Creek watershed is comprised of Milford, Pennsylvania. Dissolved oxygen concentrations were always greater than minimum criteria at all reaches and were typically between 10 and 12 mg/L (Figure 20). Many of the greatest observed DO concentrations were at reaches in relatively large open canopy (hence biologically productive) streams with apparent instream photosynthetic potential (e.g., periphyton and aquatic vegetation). Patterns in observed specific conductance among reaches were similar to pH. Reaches in valley "limestone streams" (e.g., White Brook and Little Flat Brook) had the greatest specific conductance, whereas the lowest specific conductance values were observed in "freestone stream" reaches with underlying geology associated with ridges. Specific conductance in White Brook was so high (>500 µS/cm) on several occasions that it could be considered unnatural (U.S. EPA 2011; Appendix B).

Table 11. New Jersey and Pennsylvania Department of Environmental Protection designated uses and status of wadeable stream monitoring reaches at Delaware Water Gap NRA.

Reach Name	Designated Use[1]	Status[2]
Adams Creek	PA(EV)	Supporting
Big Flat Brook	NJ(FW2-TPC1)	Impaired (pH, Aquatic Life – Trout)
Bushkill Creek	PA(HQ-TSF)	Impaired, Fish Consumption Advisory
Caledonia Creek	PA(CWF)	Supporting
Dingmans Creek	PA(HQ-CWF)	Supporting
Dunnfield Creek	NJ(FW1-TP)	Supporting
Flat Brook (Flatbrookville)	NJ(FW2-TMC1)	Impaired (Temperature, Aquatic Life – Trout)
Flat Brook (Walpack)	NJ(FW2-TMC1)	Impaired (Temperature, Aquatic Life – Trout; Escherichia coli, Primary Contact Recreation)
Fuller Brook	NJ(FW1-TM)	Impaired (Temperature, Aquatic Life – Trout)
Hornbecks Creek	PA(HQ-CWF)	Supporting
Little Bushkill Creek	PA(EV)	Supporting
Little Flat Brook	NJ(FW2-TPC1)	Impaired (Temperature, Aquatic Life – Trout)
Mill Creek	PA(HQ-CWF)	Supporting
Raymondskill Creek	PA(HQ-CWF)	Supporting
Sawkill Creek	PA(EV)	Supporting
Shimers Brook	NJ(FW2-TPC1)	Impaired (Temperature and dissolved oxygen, Aquatic Life – Trout; Escherichia coli, Primary Contact Recreation)
Slateford Creek	PA(CWF)	Supporting
Spackmans Creek	PA(HQ-CWF)	Supporting
Toms Creek	PA(EV)	Supporting
UNT to Delaware River (Sunfish Pond)	NJ(FW1)	Supporting
UNT to Dingmans Creek	PA(HQ-CWF)	Supporting
UNT to Toms Creek	PA(EV)	Supporting
Van Campen Creek	PA(HQ-CWF)	Supporting
Vancampens Brook (Millbrook Village)	NJ(FW2-TPC1)	Impaired (pH, Aquatic Life – Trout)
Vandermark Creek	PA(HQ-CWF)	Supporting
White Brook	NJ(FW2-TPC1)	Insufficient information

[1]Designated uses are determined by the Pennsylvania Department of Environmental Protection (Pa. Code § 93) or New Jersey Department of Environmental Protection (N.J.A.C. 7:9B).

C1 = Category One	C2 = Category 2	CWF = Cold Water Fishery
EV = Exceptional Value	FW1 = Warm Water Fishery	FW2 = Cold Water Fishery
HQ = High Quality	NJ = New Jersey	PA = Pennsylvania
TM = Trout Maintenance	TP = Trout Production	TSF o= Trout Stocking

[2]Assessment status determined from http://www.epa.gov/waters/ir/index.html; August 2013

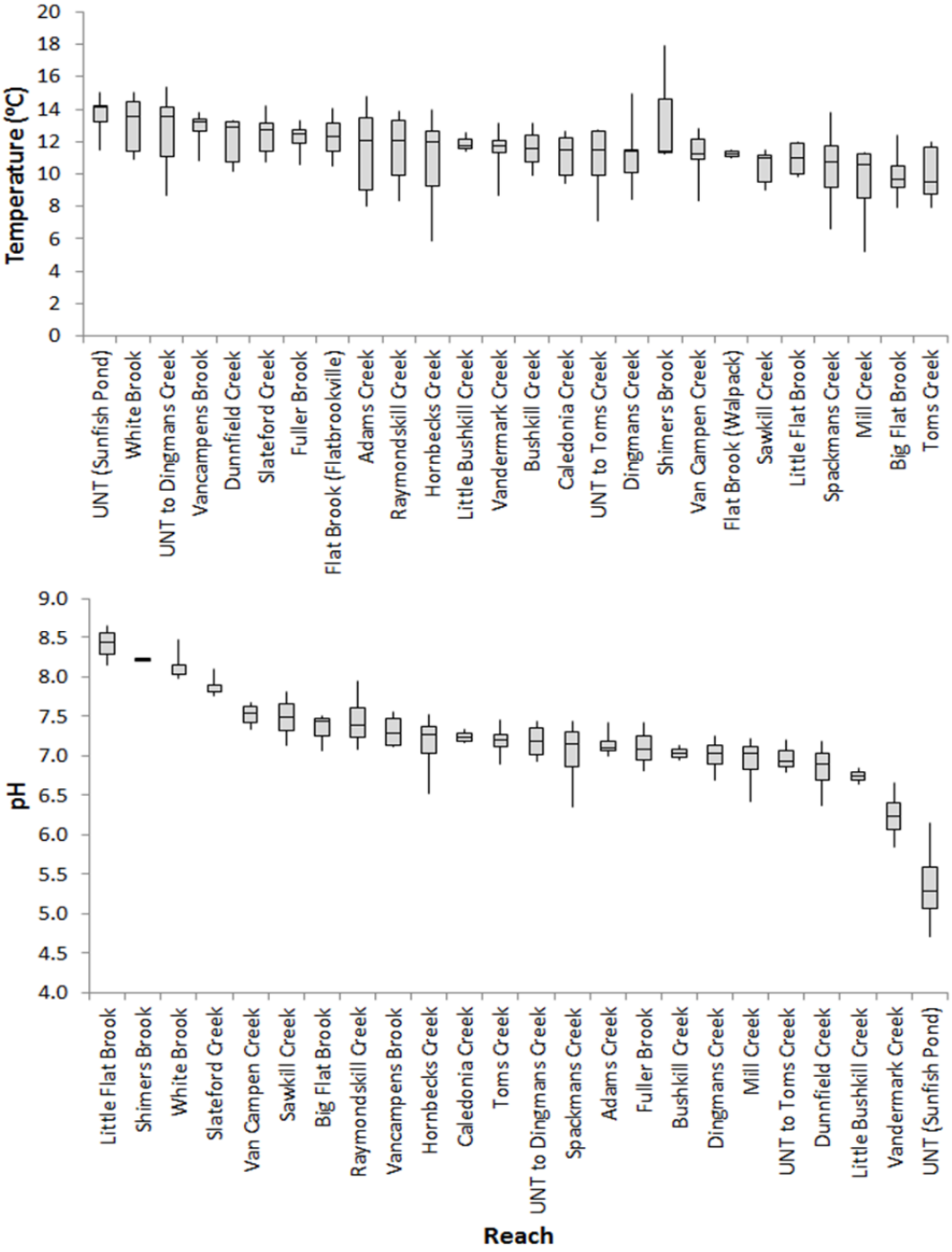

Figure 19. Boxplots of water temperature (top) and pH (bottom) at monitoring reaches in Delaware Water Gap NRA from 2008 to 2012. Sample size differed among reaches – see Appendix B. The bottom and top of the boxes represent the 1st and 3rd quartiles, respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values. UNT = unnamed tributary.

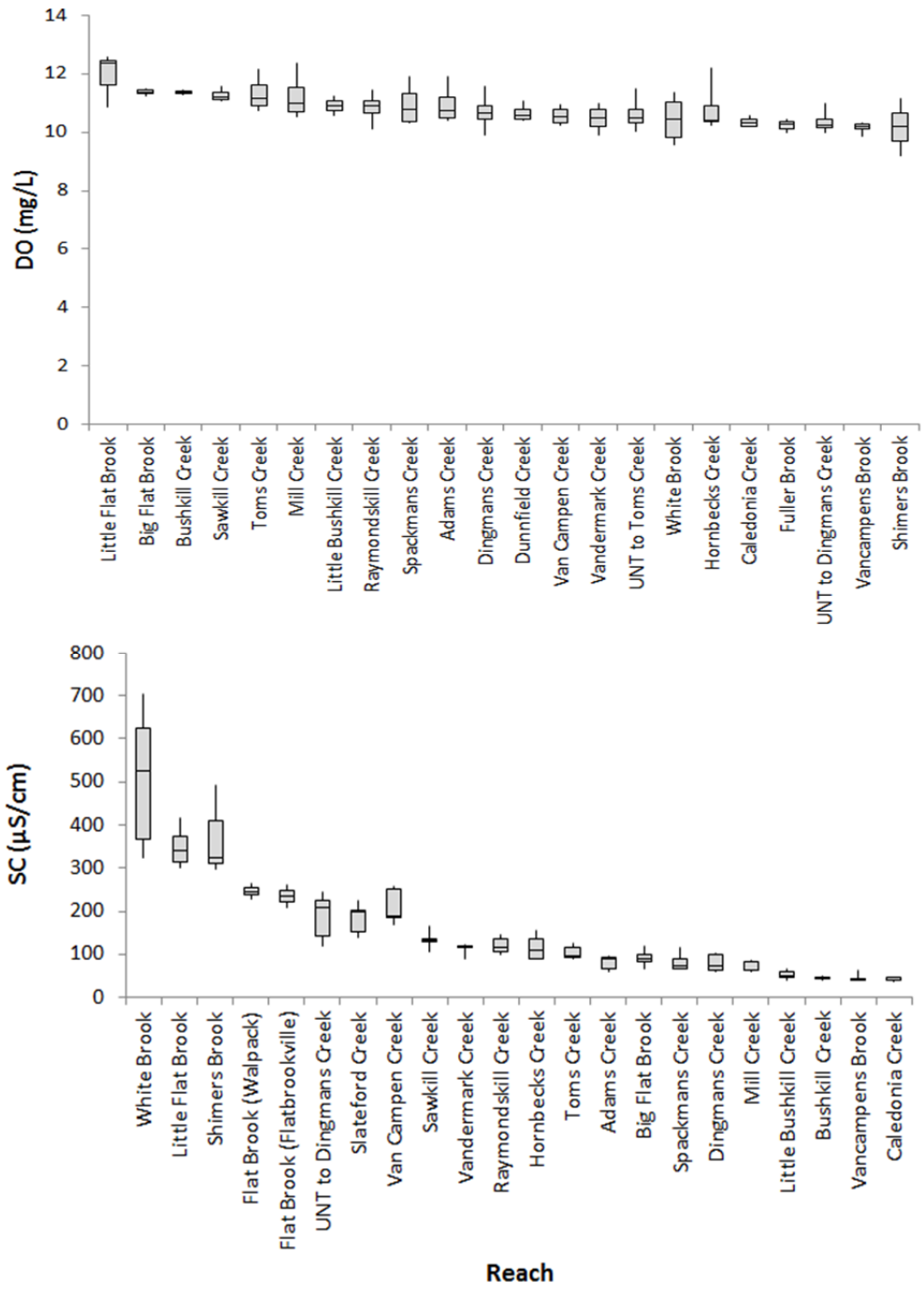

Figure 20. Boxplots of dissolved oxygen (DO; top) and specific conductance (SC; bottom) at monitoring reaches in Delaware Water Gap NRA from 2008 to 2012. Sample size differed among reaches – see Appendix B. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values. UNT = unnamed tributary.

Benthic Macroinvertebrates

Average MIBI scores at Delaware Water Gap NRA differed among years, ranging from least (49.3±9.8 [SD]) in 2008 to greatest in 2012 (56.3±8.9; Table 12). There are a variety of natural reasons (e.g., weather and hydrologic variability) that can affect BMI communities from year-to-year, but quantifying those effects was beyond the scope of this report. MIBI scores were quite variable in several stream reaches (e.g., Toms Creek, UNT [Dingmans], Dingmans Creek, Hornbecks Creek) due, in part, to relatively low MIBI scores in 2008 – fall of 2008 was particularly dry, which may have attributed to the low MIBI scores (Figure 21). Many other stream reaches (e.g., Caledonia Creek, Fuller Brook, Little Flat Brook) had remarkably consistent MIBI scores among years.

Although Raymondskill Creek and Adams Creek harbor rather different BMI communities as evidenced by the constituent MIBI metrics (Table 13), those reaches consistently had the greatest MIBI scores. That UNT(Sunfish Pond) reach consistently had the lowest MIBI score and was on the stream that drains Sunfish Pond - a bog with naturally acidic (pH<6.0) water. Most streams throughout the Mid-Atlantic region, thus the typical stream condition that the MIBI was based on and developed for, are not as acidic; consequently, a BMI community that inhabits naturally low pH waters is expected to be quite different (and appear impaired) relative to BMI communities that inhabit more typical (circum-neutral) streams.

A similar occurrence, on the opposite (basic) end of the pH spectrum, likely caused several New Jersey stream reaches (i.e., Shimers Brook, Little Flat Brook, and White Brook) that are underlain by limestone geology to be improperly assessed by the MIBI. In an analogous way to low pH affecting BMI community composition, a different, but also depauperate community can be expected in high pH communities. Some states (e.g., Pennsylvania) have acknowledged that limestone and limestone-influenced streams harbor naturally different BMI communities and have developed indices for their assessment – it was not possible to adjust the MIBI for streams that flow through limestone valleys. Other than these possible natural influences, a variety of unnatural factors (e.g., impoundments, impervious surfaces, current and historic land use) likely contributed to many of the low MIBI scores at Delaware Water Gap NRA.

Table 12. Interannual variability of Multimetric Index of Biotic Integrity [MIBI] scores for samples collected at Delaware Water Gap NRA from 2008 to 2012. MIBI scores differed among years based on Tukey-Kramer comparison with 95% confidence intervals; means that do not share a letter (Group) were significantly different.

Year	*n*	Mean	SD	Group	Min	Max
2008	24	49.3	9.8	B	27.7	65.0
2009	25	56.3	7.8	A	39.0	73.2
2010	26	52.9	12.0	AB	24.2	74.6
2011	21	54.3	10.0	AB	38.7	75.0
2012	19	56.3	8.9	A	37.6	69.0

n = sample size; SD = standard deviation; Min = minimum; Max = maximum.

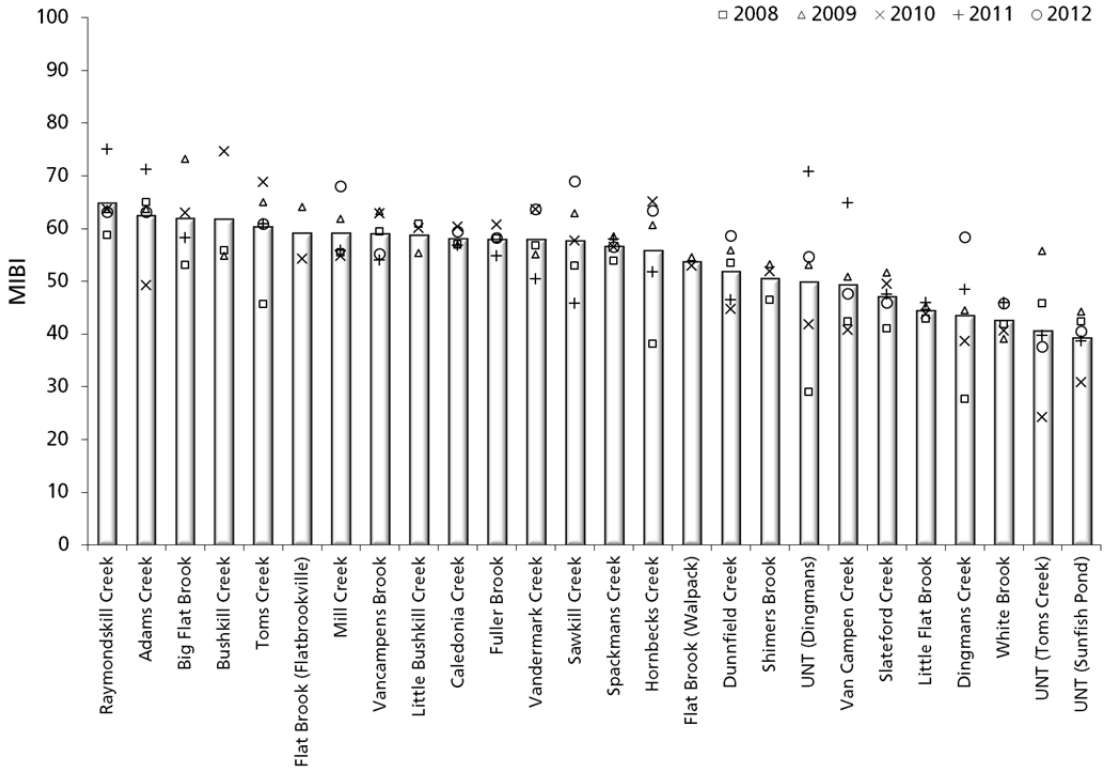

Figure 21. Multimetric Index of Biotic Integrity scores (MIBI) of benthic macroinvertebrate community samples collected from Delaware Water Gap NRA stream reaches from 2008 to 2012. Bars represent average MIBI scores. UNT = Unnamed tributary.

Table 13. Multimetric Index of Biotic Integrity [MIBI] scores and constituent metrics for samples collected at Delaware Water Gap NRA from 2008 to 2012. The MIBI consists of seven metrics (Ephemeroptera richness [E], Plecoptera richness [P], Trichoptera richness [T], Collector-filterer richness [CF], Percent non-insect individuals [%NI], Percent five dominant taxa [%D5], and Macroinvertebrate Tolerance Index [MTI]). Note that metrics must be scaled (i.e., from 0 to 100) based on "standardization" values (Klemm et al. 2003) to calculate the index.

Reach	Date	E	P	T	CF	%Non insect	% D5	MTI	MIBI
Adams Creek	10/08/2008	7	5	10	8	1	63	2.38	65.0
	10/05/2009	9	5	8	5	0	59	2.07	63.6
	10/21/2010	9	4	7	4	6	72	1.84	49.3
	10/11/2011	9	7	7	6	1	57	1.93	71.2
	10/02/2012	9	4	10	6	1	58	2.09	63.2
Big Flat Brook	10/04/2008	6	2	8	7	6	67	2.96	53.0
	10/06/2009	8	6	11	9	3	54	2.72	73.2
	10/18/2010	7	5	11	7	2	60	2.36	63.0
	11/09/2011	8	6	7	6	1	80	2.16	58.3
Bushkill Creek	10/07/2008	8	2	8	5	5	57	2.27	55.9
	10/08/2009	9	3	10	7	16	53	2.80	54.7
	10/25/2010	8	6	13	9	2	51	2.96	74.6
Caledonia Creek	10/03/2008	6	6	7	4	2	61	2.15	57.1
	10/02/2009	6	6	7	3	0	65	1.80	56.9
	10/19/2010	7	6	10	3	0	60	1.92	60.4
	10/12/2011	5	7	6	3	1	61	1.43	56.7
	10/01/2012	6	6	9	3	0	59	1.73	59.4
Dingmans Creek	10/07/2008	4	2	7	8	58	81	4.84	27.7
	10/06/2009	5	2	9	7	17	62	3.36	44.5
	10/21/2010	7	4	11	5	49	64	4.10	38.6
	11/08/2011	6	3	6	7	5	73	3.57	48.5
	10/02/2012	9	2	10	7	15	45	3.41	58.3
Dunnfield Creek	10/02/2008	5	5	8	3	4	57	2.45	53.5
	10/02/2009	7	5	8	3	3	60	1.65	55.8
	10/19/2010	6	4	8	3	8	69	1.58	44.7
	10/12/2011	5	5	5	2	2	67	1.19	46.5
	10/01/2012	8	4	9	3	0	56	1.86	58.6
Flat Brook (Walpack)	10/01/2009	4	0	10	6	2	49	3.07	54.6
	10/25/2010	5	2	11	6	5	60	3.40	52.9
Flat Brook (Flatbrookville)	10/07/2009	8	2	14	9	6	64	3.09	64.1
	10/25/2010	5	2	13	7	4	61	3.18	54.3
Fuller Brook	10/03/2008	4	6	8	3	0	55	2.07	58.1
	10/19/2010	6	6	8	3	1	54	1.83	60.7
	10/12/2011	4	6	6	2	0	58	1.80	54.8
	10/10/2012	8	5	7	3	0	63	1.68	58.3
Hornbecks Creek	10/06/2008	5	4	7	5	32	68	3.05	38.1
	10/05/2009	10	3	9	5	5	52	2.28	60.6
	10/20/2010	9	4	11	9	8	56	2.25	65.1
	11/07/2011	9	4	6	5	1	77	1.32	51.8
	10/02/2012	11	4	9	6	8	51	2.38	63.3
Little Bushkill Creek	10/05/2008	8	2	11	8	10	50	2.62	60.9
	10/08/2009	9	4	9	4	8	53	2.02	55.4
	10/25/2010	7	4	13	8	6	61	1.91	60.0

Reach	Date	E	P	T	CF	%Non insect	% D5	MTI	MIBI
Little Flat Brook	10/04/2008	5	2	7	4	5	73	3.18	42.9
	10/01/2009	4	3	9	5	2	67	4.02	45.3
	10/18/2010	3	2	11	6	5	80	3.08	43.8
	11/08/2011	3	2	8	5	1	77	3.11	45.9
Mill Creek	10/06/2008	7	3	7	5	3	59	2.13	55.5
	10/06/2009	7	6	8	6	2	65	1.57	61.8
	10/20/2010	8	3	7	4	4	56	2.42	54.7
	11/07/2011	7	6	6	5	2	69	1.67	55.8
	10/11/2012	10	6	11	7	6	58	1.87	68.0
Raymondskill Creek	10/08/2008	8	3	7	6	11	43	3.63	58.8
	10/05/2009	6	4	12	9	5	54	3.70	63.6
	10/25/2010	7	2	8	7	4	46	3.34	63.6
	11/09/2011	8	5	12	10	5	44	3.22	75.0
	10/02/2012	9	2	11	7	7	48	3.47	63.2
Sawkill Creek	10/04/2008	7	5	8	4	0	74	2.43	53.0
	10/09/2009	7	6	10	6	1	64	2.19	62.9
	10/21/2010	11	5	7	4	5	66	3.35	57.7
	11/09/2011	7	5	4	3	1	71	2.12	45.8
	10/11/2012	10	7	12	3	2	51	2.53	69.0
Shimers Brook	10/01/2008	2	2	8	6	1	83	3.35	46.5
	10/01/2009	3	2	9	6	1	63	2.72	53.2
	10/18/2010	2	1	12	7	1	72	2.31	51.8
Slateford Creek	10/03/2008	3	4	6	4	9	63	2.30	41.0
	10/02/2009	5	4	8	3	2	59	2.03	51.6
	10/19/2010	5	5	6	2	5	58	2.14	49.5
	10/12/2011	6	5	7	4	10	64	2.40	47.5
	10/01/2012	3	5	7	2	9	62	2.28	45.9
Spackmans Creek	10/06/2008	8	4	8	4	10	49	2.84	53.8
	10/06/2009	8	7	6	3	4	61	1.82	58.5
	10/20/2010	8	3	8	5	3	58	2.42	56.5
	11/07/2011	6	8	6	5	2	73	1.41	57.9
	10/02/2012	8	6	7	4	5	65	1.94	56.5
Toms Creek	10/07/2008	5	5	8	5	20	54	3.12	45.7
	10/08/2009	8	6	10	5	8	43	2.32	65.0
	10/20/2010	10	6	11	6	7	48	2.17	68.8
	11/08/2011	8	7	9	5	1	75	1.62	60.9
	10/11/2012	7	6	10	5	3	59	2.13	60.9
UNT (Dingmans Creek)	10/05/2008	1	2	6	6	34	65	4.57	29.0
	10/06/2009	6	5	8	8	15	61	3.08	53.1
	10/20/2010	5	4	12	6	18	58	3.89	41.8
	10/11/2011	7	5	8	8	4	43	2.37	70.8
	10/02/2012	7	4	8	5	1	66	2.91	54.7
UNT (Sunfish Pond)	10/02/2008	1	5	5	2	5	68	2.06	42.4
	10/07/2009	0	4	8	2	3	73	1.84	44.2
	10/19/2010	0	3	6	4	12	81	2.94	30.9
	10/12/2011	0	5	5	3	9	68	2.44	38.7
	10/01/2012	2	5	6	2	5	80	1.06	40.4
UNT (Toms Creek)	10/06/2008	7	3	8	5	6	72	3.90	45.8
	10/08/2009	4	4	10	6	5	52	3.13	55.7

Reach	Date	E	P	T	CF	%Non insect	% D5	MTI	MIBI
UNT (Toms Creek)	10/20/2010	3	3	5	4	18	82	3.64	24.2
	11/08/2011	3	4	6	6	1	90	4.33	39.8
	10/11/2012	3	3	8	6	16	70	3.81	37.6
Vancampens Brook	10/02/2008	6	5	11	4	14	53	2.19	59.4
	10/07/2009	8	6	8	4	6	54	2.02	63.2
	10/19/2010	9	5	11	5	22	60	1.39	62.9
	10/12/2011	7	3	7	3	4	60	1.88	54.0
	10/01/2012	7	4	9	4	4	61	1.83	55.2
Van Campen Creek	10/05/2008	5	3	9	5	0	62	3.10	42.3
	10/09/2009	6	4	10	5	2	64	2.40	50.8
	10/20/2010	5	3	10	7	1	69	3.48	40.8
	11/08/2011	7	6	7	6	1	52	2.81	64.8
	10/11/2012	4	3	9	6	0	71	3.32	47.7
Vandermark Creek	10/09/2008	5	6	9	5	9	49	1.99	56.8
	10/05/2009	6	6	7	3	8	54	1.68	55.1
	10/21/2010	7	6	10	5	3	53	1.71	63.7
	11/07/2011	6	6	8	3	1	80	1.18	50.4
	10/10/2012	6	8	8	3	1	60	1.74	63.6
White Brook	10/01/2008	2	3	5	3	1	68	2.71	41.8
	10/01/2009	2	4	5	3	1	79	2.61	39.0
	10/18/2010	2	4	6	3	1	84	2.14	40.6
	10/11/2011	3	3	6	5	1	71	3.34	45.9
	10/03/2012	2	5	7	3	1	84	2.29	45.9

Fort Necessity National Battlefield and Friendship Hill National Historic Site

Water Quality

One stream reach (Ice Pond Run) among the five sampled by the ERMN at Fort Necessity NB and Friendship Hill NHS was listed as impaired due to abandoned mine drainage by PADEP (Table 14; http://www.epa.gov/waters/ir/index.html; August 2013). Core parameter measurements collected by the ERMN from 2008 to 2013 supported the impaired status of Ice Pond Run and provided evidence of possible impairment of other sampled stream reaches.

Water temperature exceeded designated use maximum temperature criteria at least once at all reaches (Appendix B); however, it should be noted that thermal water criteria only apply in Pennsylvania if there is a heated waste discharge to the water body and discrete measurements do not constitute a violation. Water temperature was typically greatest at UNT to Great Meadows Run (Figure 22) and exceeded HQ-CWF criteria on three of four occasions. Although temperature was typically lowest at UNT to Scotts Run, it greatly exceeded maximum criteria on one occasion when stream flow was low. Acidification (i.e., low pH) is a known issue associated with Acid Mine Drainage (AMD) in Ice Pond Run; moreover, there was evidence of acidification being a potential problem in other sampled reaches. In addition to the consistently very low pH of Ice Pond Run, all other reaches except for Great Meadows Run had water pH below state criteria on one occasion.

Dissolved oxygen concentrations were similar among reaches and always well above minimum criteria for designated uses of the respective streams (Figure 23). Specific conductance at Ice Pond Run was higher than any monitored reach throughout the ERMN, which was not surprising due to the AMD issues within that watershed. Two reaches (UNT to Great Meadows Run and UNT to Scotts Run) at Fort Necessity NB had specific conductance values that were typical of forested, wadeable streams, whereas specific conductance in the other two reaches (Great Meadows Run and Dublin Run) was slightly greater than what is considered typical for unimpaired streams throughout the region.

Table 14. Designated uses and status of wadeable stream monitoring reaches at Fort Necessity NB and Friendship Hill NHS.

Park	Reach Name	Designated Use	Status
FONE	Great Meadows Run	HQ-CWF	Supporting
FONE	UNT to Great Meadows Run	HQ-CWF	Supporting
FONE	UNT to Scotts Run	HQ-CWF	Supporting
FRHI	Dublin Run	WWF	Supporting
FRHI	Ice Pond Run	WWF	Impaired (Abandoned Mine Drainage; metals and pH)

All designated uses in these parks are determined by the Pennsylvania Department of Environmental Protection (Pa. Code § 93.9); CWF = Cold Water Fishes, HQ = High Quality, WWF = Warm Water Fishes

Assessment status determined from http://www.epa.gov/waters/ir/index.html; August 2013

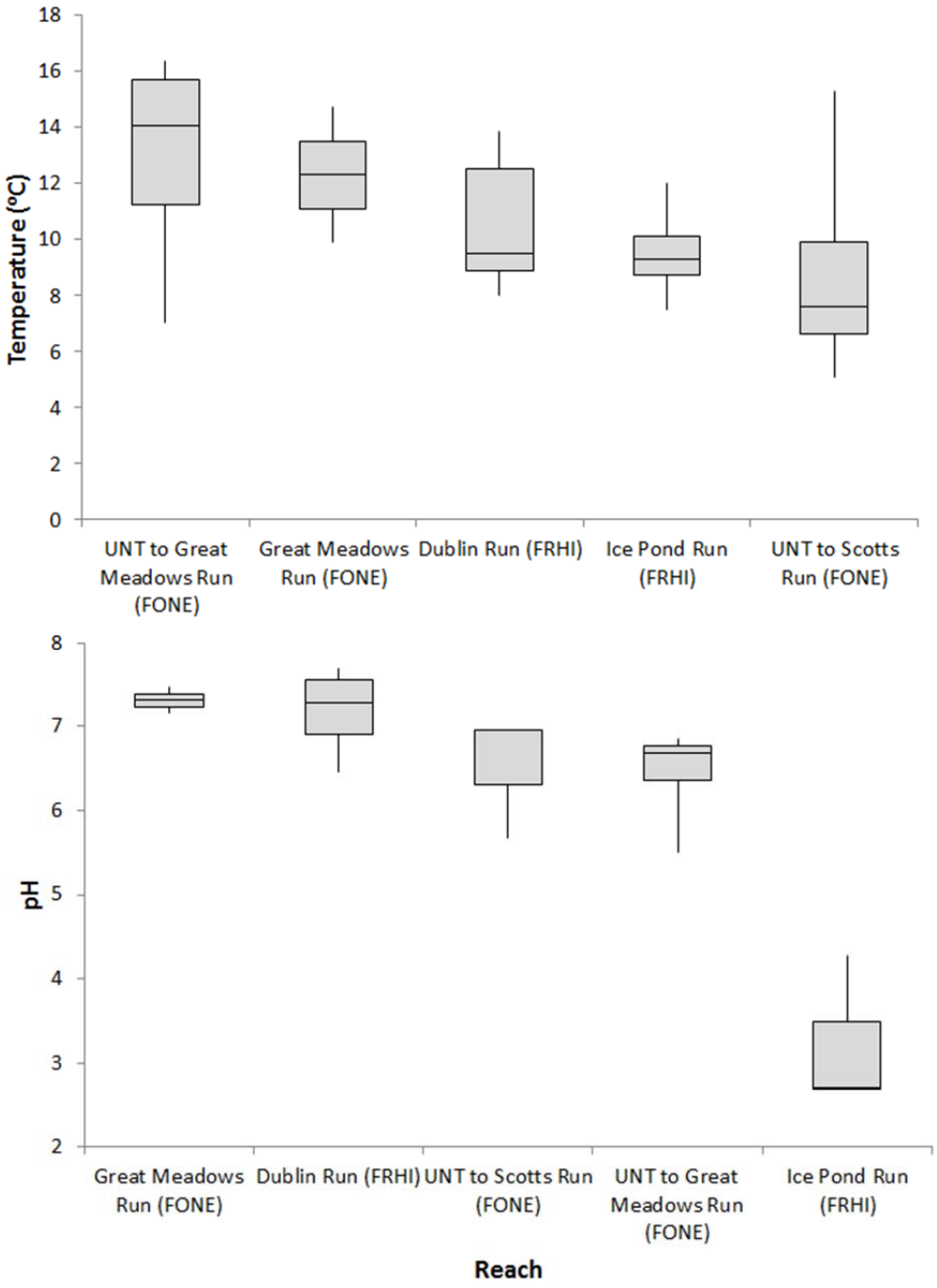

Figure 22. Boxplots of water temperature (top) and pH (bottom) at sampled reaches in Fort Necessity NB (FONE) and Friendship Hill NHS (FRHI) from 2009 to 2013. Sample size differed among reaches – see Appendix B. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values. UNT = unnamed tributary.

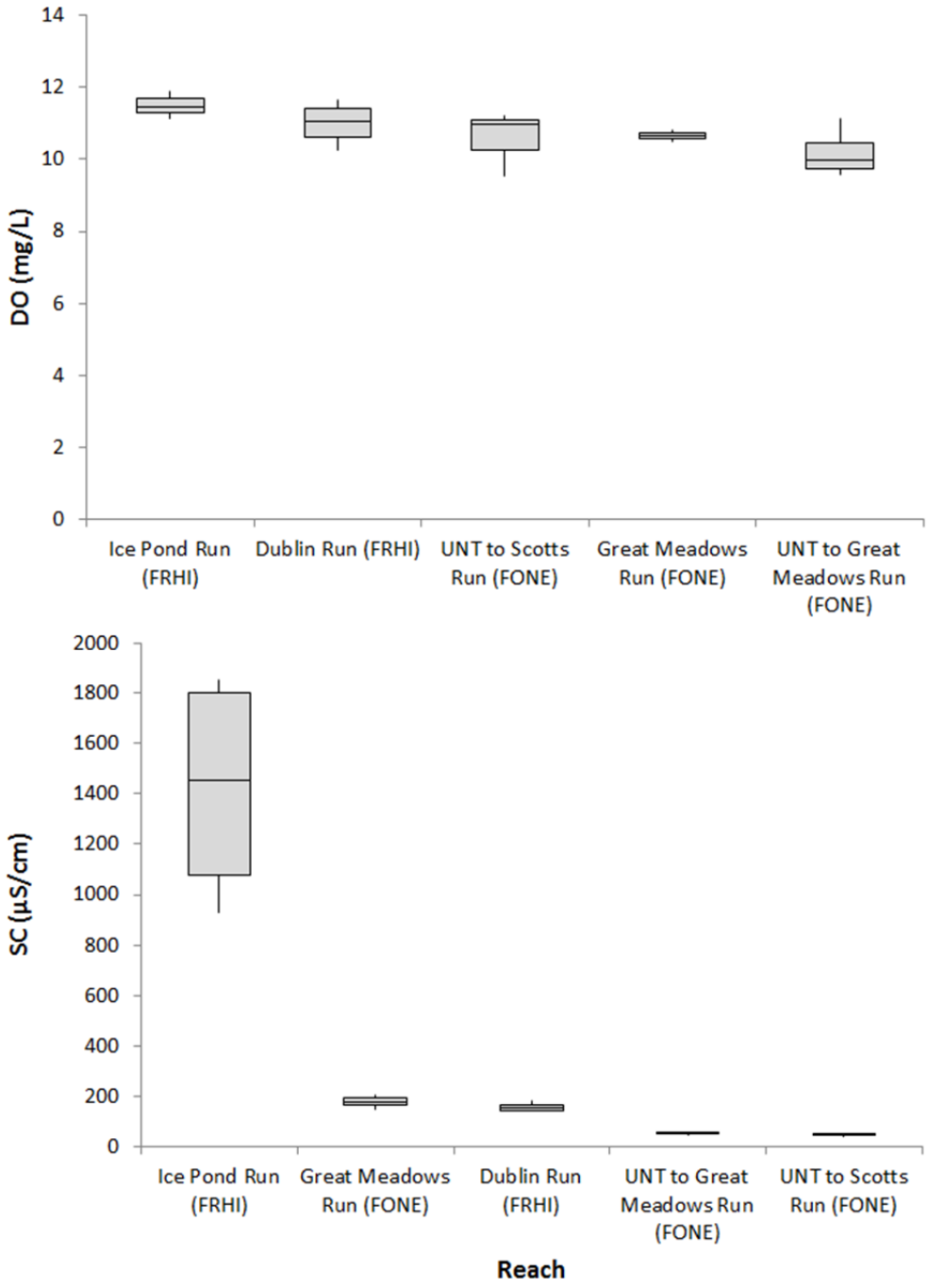

Figure 23. Boxplots of dissolved oxygen (DO; top) and specific conductance (SC; bottom) at sampled reaches in Fort Necessity NB (FONE) and Friendship Hill NHS (FRHI) from 2009 to 2013. Sample size differed among reaches – see Appendix B. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values. UNT = unnamed tributary.

Benthic Macroinvertebrates

MIBI scores were variable among sites but were not statistically ($p \leq 0.05$) different among years at Fort Necessity NB and Friendship Hill NHS (Table 15). Great Meadows Run (GMR) was sampled in three years (2009, 2010, and 2013) but results were discarded from 2009 due to sampling difficulties. Great Meadows Run poses a challenge to applying the ERMN sampling method which targets riffle habitat with cobble substrate – most of GMR lacks these habitats. Two small areas with a mix of cobble and small boulders within the reach were sampled but provided very different MIBI scores (Table 16) in 2010 (MIBI=41.2) and 2013 (MIBI=19.8). UNT to Scotts Run was consistently in the best condition between the parks, whereas Ice Pond Run was significantly impaired and always ranked the most poorly (Figure 24). The remaining reaches were similar in condition based on the MIBI (Table 16).

Table 15. Interannual variability of Multimetric Index of Biotic Integrity [MIBI] scores of benthic macroinvertebrate community samples collected in Fort Necessity NB and Friendship Hill NHS from 2009 to 2013. MIBI scores were not different among years based on Tukey-Kramer comparison with 95% confidence intervals.

Year	*n*	Mean	SD	Min	Max
2009	3	36.3	21.2	14.3	56.6
2010	5	40.0	15.5	14.3	56.3
2011	4	32.8	16.1	13.8	52.0
2012	3	43.9	16.0	34.2	62.3
2013	4	24.8	9.8	14.3	36.5

n = sample size; SD = standard deviation; Min = minimum; Max = maximum

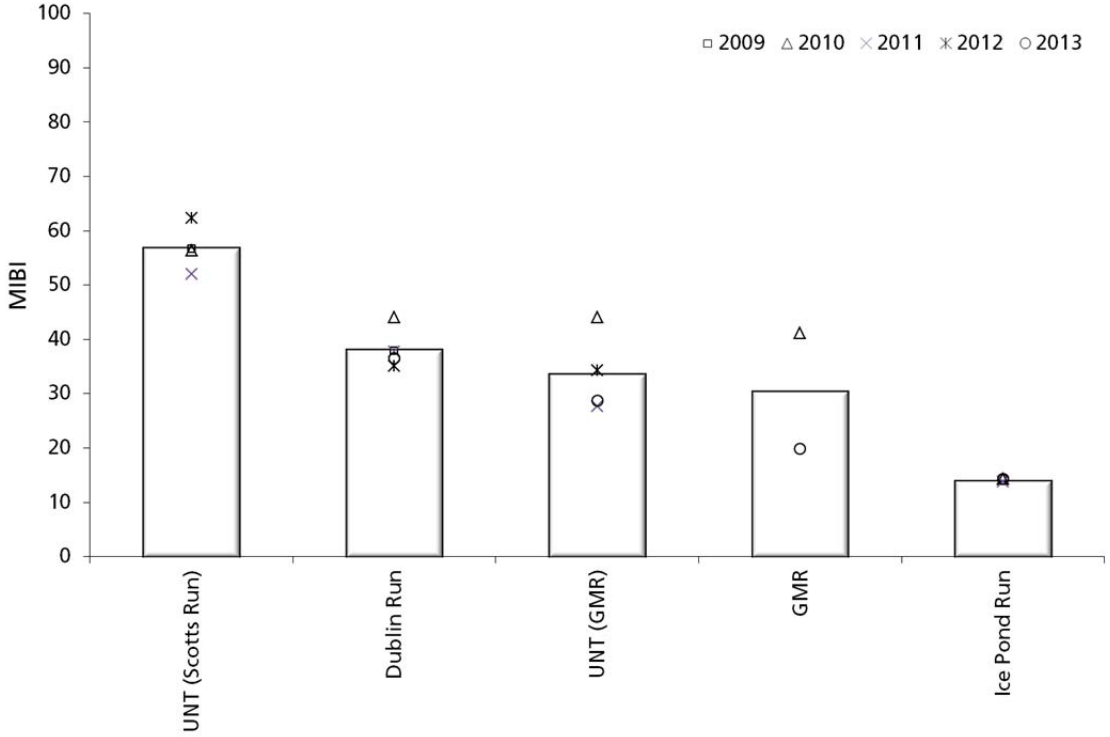

Figure 24. Multimetric Index of Biotic Integrity scores (MIBI) of benthic macroinvertebrate community samples collected in Fort Necessity NB and Friendship Hill NHS wadeable stream reaches from 2009 to 2013. Bars represent average MIBI scores. GMR = Great Meadows Run; UNT = Unnamed tributary.

Table 16. Multimetric Index of Biotic Integrity [MIBI] scores and constituent metrics for samples collected at at Fort Necessity NB (FONE) and Friendship Hill NHS (FRHI) from 2009 to 2013. The MIBI consists of seven metrics (Ephemeroptera richness [E], Plecoptera richness [P], Trichoptera richness [T], Collector-filterer richness [CF], Percent non-insect individuals [%NI], Percent five dominant taxa [%D5], and Macroinvertebrate Tolerance Index [MTI]). Note that metrics must be scaled (i.e., from 0 to 100) based on "standardization" values (Klemm et al. 2003) to calculate the index.

Park	Reach	Date	Taxa	E	P	T	CF	%Non-insect	%D5	MTI	MIBI
FONE	UNT[1] (Picnic Loop)	04/16/2009	39	9	6	6	4	5	61	3.38	56.6
		04/01/2010	37	8	6	5	4	4	55	3.04	56.3
		04/06/2011	34	7	5	6	4	5	61	3.28	52.0
		03/23/2012	33	6	7	6	5	1	56	2.79	62.3
FONE	UNT (GMR[2])	04/01/2010	34	7	5	6	4	23	49	3.85	44.0
		04/06/2011	24	3	5	2	3	9	82	3.54	27.6
		03/23/2012	20	3	5	4	3	5	82	3.73	34.2
		04/09/2013	30	4	4	4	3	17	61	3.84	28.7
FONE	GMR	04/01/2010	40	4	3	6	4	3	69	3.78	41.2
		04/09/2013	30	2	5	4	3	7	79	5.51	19.8
FRHI	Ice Pond Run	04/15/2009	7	0	0	0	1	0	100	6.17	14.3
		04/02/2010	6	0	0	0	0	0	99	5.88	14.3
		04/06/2011	9	0	1	0	1	1	97	6.00	13.8
		04/09/2013	5	0	0	0	0	0	100	5.98	14.3
FRHI	Dublin Run	04/15/2009	27	4	4	6	3	5	79	3.35	37.9
		04/02/2010	27	4	5	5	1	4	65	2.48	44.0
		04/06/2011	29	5	4	5	3	9	69	2.50	37.7
		03/23/2012	25	3	4	4	3	2	81	3.10	35.1
		04/09/2013	24	5	4	4	2	6	73	2.04	36.5

[1]UNT = Unnamed tributary

[2]GMR = Great Meadows Run

New River Gorge National River

Water Quality

Among the 25 reaches sampled by the ERMN in New River Gorge NR, nearly half (40%) of the streams in which they were located were listed as unassessed by the WVDEP (from http://www.epa.gov/waters/ir/index.html, August 2013; Table 17). Most unassessed streams were small and remote compared to assessed streams. Of the 15 streams in the park that had been assessed by WVDEP, eight were listed as supporting their designated uses and seven were considered impaired. All impaired streams had "fecal coliform" listed as a cause of impairment; additionally, Arbuckle Creek, Batoff Creek, and Wolf Creek had "metals other than mercury" or "Iron" listed as impairment sources.

Water temperature was inconsistent among years, likely as a result of sample collection timing both in regard to time of day and season (e.g., mid-March through April). Very few (3%) temperature observations throughout New River Gorge NR exceeded maximum temperature criteria – two relatively large streams that were listed as impaired (Arbuckle Creek and Piney Creek) and another large, unimpaired stream (Laurel Creek), each had one temperature exceedance (Appendix B).

The greatest observed pH was recorded at two streams (i.e., Arbuckle Creek and Piney Creek) with known sewage treatment issues, whereas the lowest pH was at streams with possible historic AMD issues and likely reduced ANC from acid deposition (Figure 25). Among all reaches, low pH values (i.e., below designated use criterion) were recorded on 14% of the sampling visits but most (10 of 13) were recorded at three reaches (Dowdy Creek, Little Laurel Creek, and Richlick Branch; Appendix B). Of the three reaches where pH was consistently below the state criterion (pH $\geq$ 6.0), two streams (Little Laurel Creek and Richlick Branch) were unassessed by WVDEP, whereas the third (Dowdy Creek) was listed as supporting its designated use (B-1, Warm Water Fishery).

Generally, low dissolved oxygen concentrations in ERMN streams are expected to occur in late summer when stream flows are low and air temperature is high; consequently, it was expected that all DO concentrations recorded while sampling in March or April would be above state criteria (e.g., 7.0 mg/L). Dissolved oxygen concentrations were well above designated use criteria at all reaches on all occasions (Figure 26) and were typically greater than 11.0 mg/L. Most reaches had specific conductance values that were typical of wadeable streams in the ERMN (i.e., $\leq$100 µS/cm; Figure 26). The streams with significantly greater SC were in streams (e.g., Arbuckle Creek and Piney Creek) with known water quality issues (e.g., fecal coliform from poor sewage treatment) and associated TMDLs in place.

Table 17. Designated uses and status of wadeable stream monitoring reaches at New River Gorge NR.

Reach Name	Designated Use[1]	Status[2]
Arbuckle Creek	A&W, B-2, C, I, PWS	Impaired (Benthic Macroinvertebrates, Fecal Coliform, Iron)
Batoff Creek	A&W, B-2, C, I, PWS	Impaired (Metals [other than Mercury], pH/Acidity/Caustic Conditions)
Big Branch	A&W, B-1, C, I, PWS	Not Assessed
Bucklick Branch	A&W, B-1, C, I, PWS	Not Assessed
Buffalo Creek	A&W, B-2, C, I, PWS, Tier 3,	Supporting
Camp Branch	A&W, B-1, C, I, PWS	Not Assessed
Davis Branch	A&W, B-1, C, I, PWS, Tier 3	Supporting
Dowdy Creek	A&W, B-1, C, I, PWS	Supporting
Ephraim Creek	A&W, B-1, C, I, PWS, Tier 3	Supporting
Fall Branch	A&W, B-2, C, I, PWS, Tier 3,	Supporting
Fire Creek	A&W, B-1, C, I, PWS	Not Assessed
Glade Creek	A&W, B-2, C, I, PWS	Impaired (Fecal Coliform)
Keeney Creek	A&W, B-2, C, I, PWS	Impaired (Fecal Coliform)
Laurel Creek	A&W, B-2, C, I, PWS, Tier 3	Supporting
Little Laurel Creek	A&W, B-1, C, I, PWS	Not Assessed
Meadow Creek	A&W, B-2, C, I, PWS Tier 3,	Impaired (Fecal Coliform)
Mill Creek	A&W, B-2, C, I, PWS	Supporting
Piney Creek	A&W, B-2, C, I, PWS	Impaired (Fecal Coliform, Iron)
Richlick Branch	A&W, B-1, C, I, PWS	Not Assessed
Slater Creek	A&W, B-1, C, I, PWS, Tier 3	Supporting
UNT to Buffalo Creek	Not designated	Not Assessed
UNT to Laurel Creek (Backus Mtn)	Not designated	Not Assessed
UNT to Laurel Creek (Highland Mtn)	Not designated	Not Assessed
UNT to Meadow Creek	Not designated	Not Assessed
Wolf Creek	B-2, PWS	Impaired (Benthic Macroinvertebrates, Fecal Coliform, Iron)

[1]All designated uses of streams in New River Gorge NR are determined by the West Virginia Department of Environmental Protection (W. Va. C.S.R.§47-2):

Tier 3 = Outstanding Natural Resource Water
B-2 = Trout Waters
C = Water Contact Recreation
PWS = Public Water Supply
B-1 = Warm Water Fishery
A&W = Agriculture and Wildlife,
I. = Industrial

[2]Assessment status determined from http://www.epa.gov/waters/ir/index.html; August 2013

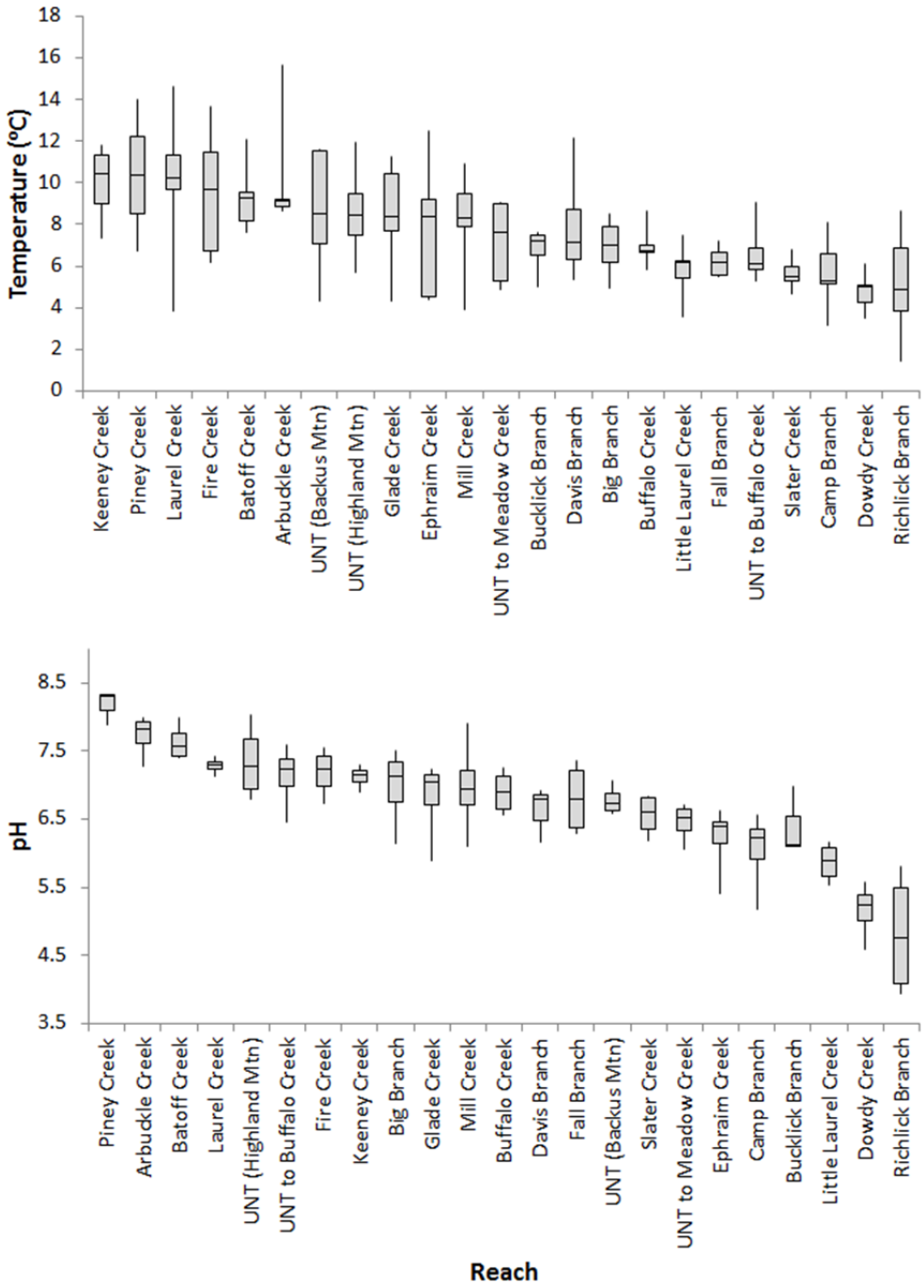

Figure 25. Boxplots of water temperature (top) and pH (bottom) at monitoring reaches in New River Gorge NR from 2009 to 2013. Sample size differed among reaches – see Appendix B. The bottom and top of boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values. UNT = unnamed tributary.

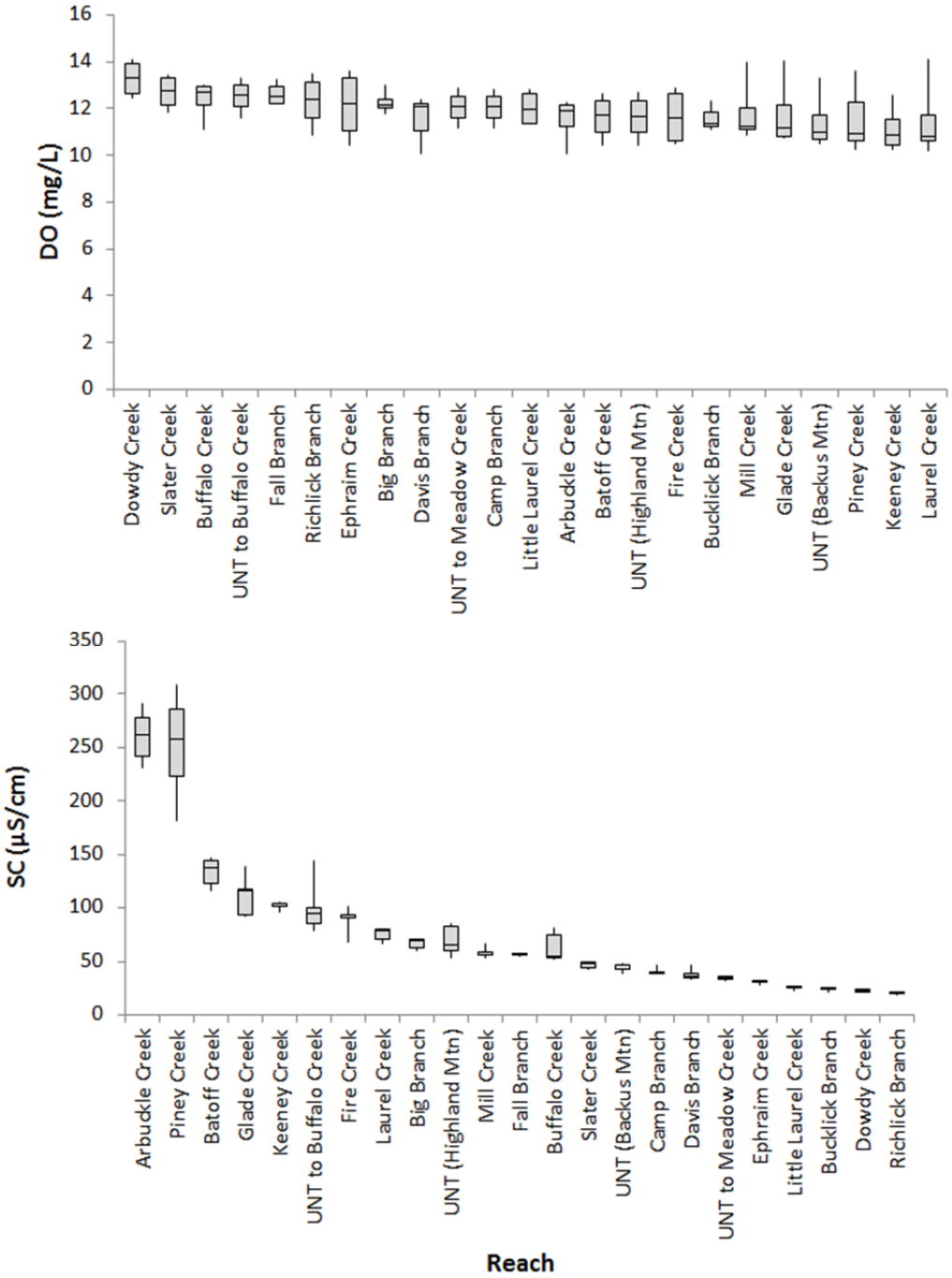

Figure 26. Boxplots of dissolved oxygen (DO; top) and specific conductance (SC; bottom) at monitoring reaches in reaches in in New River Gorge NR from 2009 to 2013. Sample size differed among reaches – see Appendix B. The bottom and top of the boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values. UNT = unnamed tributary.

Benthic Macroinvertebrates

Average MIBI scores at New River Gorge NR differed among years, ranging from least (48.0±12.7 [SD]) in 2013 to greatest in 2012 (54±13.5; Table 18). There are a variety of natural reasons (e.g., weather and hydrologic variability) that can affect BMI communities from year-to-year but quantifying those effects were beyond the scope of this report. In relation to most other parks in the ERMN, MIBI scores were very similar when comparing reaches to themselves among years at New River Gorge NR (Figure 21) – MIBI scores were most and least variable at Glade Creek (66.5±11.0) and Ephraim Creek (56.0±3.2) reaches, respectively. According to MIBI scores, reaches on two relatively large streams (Laurel Creek and Glade Creek) frequently (and on average) ranked as being in the best condition among sampled reaches (Figure 27, Table 19). Reaches on three streams (Arbuckle Creek, Piney Creek, and Wolf Creek) that have established TMDLs for various impairment sources were consistently assessed as being in comparatively very poor condition.

Table 18. Interannual variability of Multimetric Index of Biotic Integrity [MIBI] scores of benthic macroinvertebrate community samples collected in New River Gorge NR from 2009 to 2013. MIBI scores differed among years based on Tukey-Kramer comparison with 95% confidence intervals; means that do not share a letter (Group) were significantly different. *n* = sample size; SD = standard deviation; Min = minimum; Max = maximum.

Year	*n*	Mean	SD	Group	Min	Max
2009	24	48.1	12.2	B	22.8	76.1
2010	23	54.0	13.5	A	18.5	73.7
2011	23	51.6	13.0	AB	20.7	80.5
2012	22	51.2	12.2	AB	18.4	75.0
2013	21	48.0	12.7	B	15.9	72.9

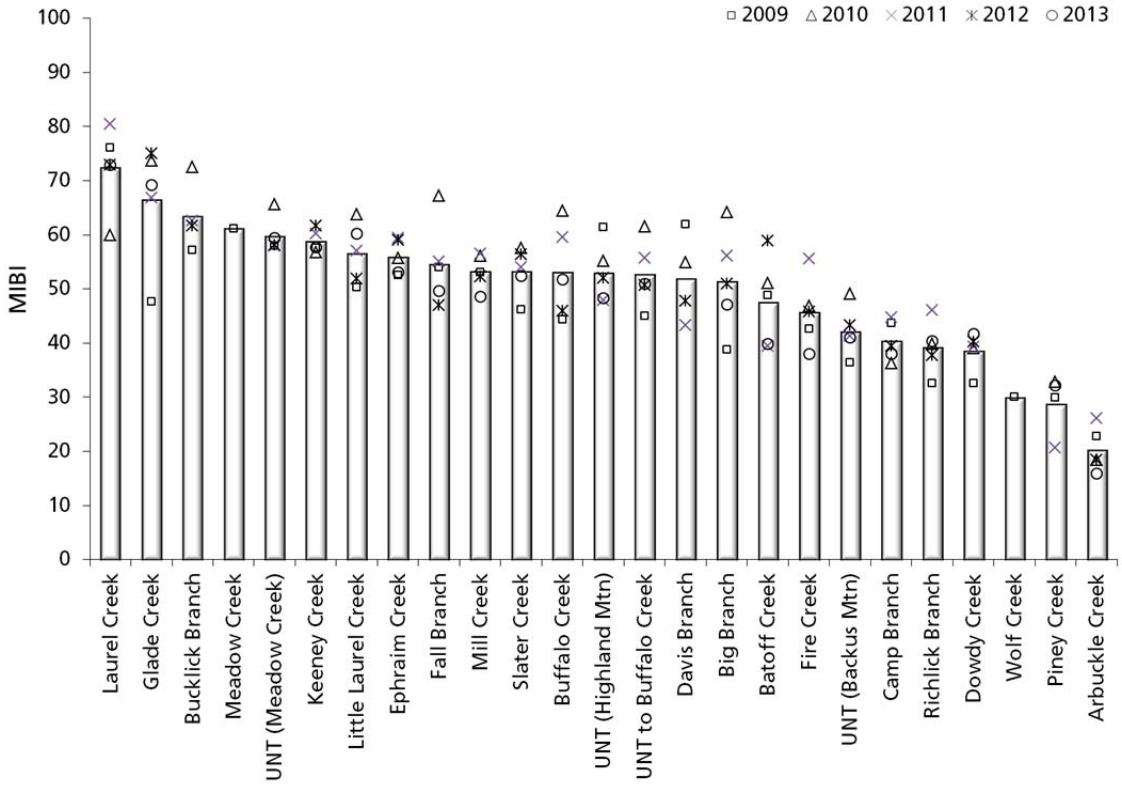

Figure 27. Multimetric Index of Biotic Integrity scores (MIBI) of benthic macroinvertebrate community samples collected at New River Gorge NR from 2009 to 2013. Bars represent average MIBI scores. UNT = Unnamed tributary.

Table 19. Multimetric Index of Biotic Integrity [MIBI] scores and constituent metrics for samples collected at New River Gorge NR from 2009 to 2013. The MIBI consists of seven metrics (Ephemeroptera richness [E], Plecoptera richness [P], Trichoptera richness [T], Collector-filterer richness [CF], Percent non-insect individuals [%NI], Percent five dominant taxa [%D5], and Macroinvertebrate Tolerance Index [MTI]). Note that metrics must be scaled (i.e., from 0 to 100) based on "standardization" values (Klemm et al. 2003) to calculate the index.

Reach	Date	Taxa	E	P	T	CF	%Non insect	% D5	MTI	MIBI
Arbuckle Creek	03/25/2009	11	1	0	4	6	10.3	92	4.77	22.8
	04/06/2010	9	1	0	2	2	4.0	98	4.77	18.5
	03/26/2011	9	1	0	3	6	3.4	97	4.75	26.1
	03/10/2012	9	1	0	2	3	4.1	98	4.76	18.4
	03/10/2013	11	1	0	1	2	4.9	98	4.70	15.9
Batoff Creek	03/23/2009	18	4	6	6	5	0.0	84	2.56	48.8
	03/21/2010	19	5	8	4	4	0.7	71	2.95	51.1
	03/23/2011	16	4	6	3	4	0.0	84	2.75	39.5
	03/07/2012	20	6	7	6	4	0.9	60	1.93	58.8
	03/10/2013	21	4	4	5	3	0.6	77	2.68	39.9
Big Branch	03/24/2009	22	7	6	2	2	2.8	80	1.52	38.8
	03/21/2010	24	6	8	7	5	0.6	64	3.01	64.2
	03/27/2011	27	6	7	6	3	2.7	62	1.75	56.2
	03/08/2012	26	6	6	7	4	4.3	73	2.56	51.0
	03/11/2013	24	7	5	3	2	6.4	50	2.34	47.2
Bucklick Branch	03/29/2009	35	6	6	11	4	3.1	59	2.75	57.2
	04/09/2010	27	6	11	7	5	2.8	47	2.60	72.5
	03/30/2011	31	7	7	9	5	1.9	63	2.59	62.6
	03/14/2012	29	6	7	8	5	2.5	61	1.74	61.7
Buffalo Creek	03/25/2009	20	6	6	4	2	1.5	77	2.15	44.4
	03/20/2010	26	8	8	6	4	1.3	58	1.91	64.4
	03/26/2011	25	6	7	8	4	1.9	62	2.15	59.5
	03/10/2012	21	6	7	2	3	2.7	64	2.11	46.0
	03/30/2013	18	10	7	3	3	0.3	75	1.34	51.7
Camp Branch	03/28/2009	21	3	4	5	3	0.7	67	1.95	43.7
	03/19/2010	15	3	5	3	2	5.0	71	3.32	36.3
	03/25/2011	22	4	3	7	4	5.0	66	2.55	44.7
	03/07/2012	22	4	5	5	2	2.6	86	2.24	39.5
	03/09/2013	22	4	3	5	1	0.7	79	2.27	38.0
Davis Branch	03/26/2009	28	7	7	9	4	1.5	60	2.05	62.0
	04/08/2010	24	5	8	6	4	0.8	73	2.46	54.9
	03/25/2011	26	5	4	6	4	4.4	70	3.55	43.3
	03/09/2012	30	4	6	6	3	6.3	63	2.56	47.7
Dowdy Creek	03/25/2009	18	1	4	5	3	10.8	75	2.43	32.6
	03/20/2010	21	1	4	6	5	5.6	81	3.70	39.1
Dowdy Creek	03/26/2011	20	2	3	6	5	7.4	74	3.55	39.3
	03/10/2012	20	1	5	6	4	5.0	84	3.55	40.2
	03/30/2013	18	1	5	6	3	5.7	74	2.81	41.7
Ephraim Creek	03/29/2009	23	6	7	6	4	3.0	72	2.10	52.6
	04/06/2010	25	7	7	6	3	0.1	73	1.46	55.7
	03/28/2011	27	7	6	7	6	2.7	70	2.31	59.4
	03/13/2012	25	7	7	6	4	1.2	62	1.99	59.0
	03/29/2013	23	8	6	5	4	1.0	70	1.39	53.1

Reach	Date	Taxa	E	P	T	CF	%Non insect	% D5	MTI	MIBI
Fall Branch	03/24/2009	27	8	6	4	3	1.7	59	2.09	54.0
	03/21/2010	26	8	7	7	6	0.9	63	2.23	67.3
	03/27/2011	24	9	7	3	3	2.4	58	2.41	55.0
	03/12/2012	20	9	6	3	2	1.9	74	1.88	47.0
	03/11/2013	21	8	8	2	2	5.1	63	2.18	49.7
Fire Creek	03/29/2009	18	4	6	5	3	1.8	83	1.99	42.6
	04/06/2010	21	6	7	4	3	0.4	79	1.63	46.8
	03/28/2011	25	8	6	7	3	0.6	76	2.04	55.6
	03/13/2012	24	6	6	5	3	1.2	84	2.20	45.7
	03/29/2013	19	6	5	3	1	1.9	89	2.20	37.9
Glade Creek	04/01/2009	23	8	5	6	4	9.9	65	3.25	47.7
	04/08/2010	27	11	7	7	6	1.6	56	2.51	73.7
	03/23/2011	24	11	6	9	6	0.8	68	3.72	66.8
	03/12/2012	28	11	6	7	6	3.3	42	2.24	75.0
	03/10/2013	21	10	7	7	6	1.4	64	2.09	69.3
Keeney Creek	03/27/2009	25	6	8	6	4	4.9	61	2.55	57.5
	04/07/2010	24	7	6	7	4	2.2	66	2.39	56.8
	03/22/2011	26	7	6	8	5	2.3	62	2.99	60.2
	03/13/2012	26	7	7	6	5	1.2	61	2.68	61.6
	03/11/2013	24	7	7	6	5	1.7	70	2.73	57.7
Laurel Creek	03/24/2009	30	9	8	8	7	5.2	46	3.25	76.1
	04/07/2010	21	11	5	5	5	0.7	63	2.30	60.0
	03/23/2011	28	9	10	10	8	3.4	54	2.96	80.5
	03/14/2012	30	10	7	11	7	3.4	56	3.17	72.9
	03/10/2013	24	10	9	7	6	1.4	67	2.43	72.9
Little Laurel Creek	03/26/2009	29	8	7	4	4	3.9	71	2.72	50.3
	03/19/2010	32	7	7	7	5	4.0	56	2.61	63.8
	03/25/2011	30	6	7	6	3	3.3	59	2.98	57.0
	03/07/2012	28	7	6	4	5	1.3	68	2.84	51.9
	03/09/2013	29	8	8	5	3	1.8	61	2.85	60.2
Meadow Creek	03/24/2009	24	9	7	5	4	3.3	53	3.41	61.2
Mill Creek	03/23/2009	24	8	5	5	3	1.1	62	2.45	53.0
Mill Creek	04/09/2010	24	6	8	4	5	2.3	63	2.21	56.1
	03/23/2011	25	7	6	7	5	0.4	77	1.82	56.4
	03/12/2012	22	7	6	5	3	1.0	67	2.24	52.3
	03/10/2013	21	8	5	4	4	2.4	66	2.47	48.6
Piney Creek	03/31/2009	17	2	3	7	7	6.9	93	5.45	29.9
	04/08/2010	10	1	1	5	5	0.3	95	4.55	32.8
	03/23/2011	11	2	1	3	4	3.6	94	4.86	20.7
	03/10/2013	10	2	1	4	6	0.8	94	4.56	32.1
Richlick Branch	03/27/2009	19	4	4	3	4	2.7	84	2.92	32.5
	03/19/2010	24	4	6	4	3	4.0	77	2.85	39.8
	03/25/2011	28	4	7	5	4	4.2	73	2.49	46.0
	03/07/2012	22	2	6	3	4	2.3	86	3.20	37.7
	03/09/2013	21	2	7	3	3	3.9	75	3.66	40.4
Slater Creek	03/25/2009	21	5	7	5	3	1.8	81	1.75	46.2
	03/20/2010	21	7	8	5	4	1.3	66	1.64	57.6
	03/26/2011	25	6	6	7	4	1.2	72	1.84	54.0
	03/10/2012	25	7	7	6	5	1.9	74	2.28	56.3
	03/30/2013	21	7	6	5	4	0.3	69	2.71	52.4

Reach	Date	Taxa	E	P	T	CF	%Non insect	% D5	MTI	MIBI
UNT (Backus Mtn)	03/26/2009	18	3	5	4	2	5.2	77	2.73	36.4
	04/08/2010	23	4	7	5	2	4.6	63	1.71	49.1
	03/23/2011	17	3	5	5	4	0.7	85	2.14	41.3
	03/14/2012	21	4	6	5	2	0.9	81	2.54	43.2
	03/09/2013	20	3	4	6	4	5.1	72	2.01	41.1
UNT (Highland Mtn)	03/26/2009	27	8	7	8	3	3.3	61	2.25	61.4
	03/19/2010	25	7	6	7	3	3.1	68	2.02	55.2
	03/23/2011	24	8	5	4	3	2.6	66	1.78	48.0
	03/07/2012	24	7	6	5	3	8.1	53	2.63	52.1
	03/09/2013	25	6	6	6	4	6.4	69	2.31	48.3
UNT to Buffalo Creek	03/25/2009	22	6	6	3	3	2.1	68	2.46	45.0
	03/20/2010	24	6	8	7	4	1.9	63	1.82	61.5
	03/26/2011	27	5	7	8	4	2.7	67	2.02	55.7
	03/10/2012	24	5	6	6	3	2.0	68	2.71	50.7
	03/30/2013	20	6	5	6	4	0.0	69	2.15	51.0
UNT to Meadow Creek	03/24/2009	28	8	6	5	2	2.4	53	2.10	58.0
	03/21/2010	27	7	7	7	3	2.9	47	2.12	65.7
	03/28/2011	28	8	5	6	4	2.1	54	2.49	58.0
	03/08/2012	28	8	5	7	5	2.7	65	1.98	58.1
	03/08/2013	31	10	5	6	3	6.8	47	2.61	59.4
Wolf Creek	03/27/2009	11	1	1	2	1	1.1	100	3.53	30.0

Upper Delaware Scenic and Recreational River

Water Quality

Reaches at Upper Delaware SRR were sampled less frequently than other reaches throughout ERMN parks, primarily because the reaches selected were on 12 of the largest tributaries to the Delaware River throughout the SRR. Tropical storms and/or hurricanes, particularly during 2010 and 2011, made stream flows unsafe and/or sampling ineffective (unavailable riffle habitat). Smaller streams at other parks (e.g., Delaware Water Gap NRA) could be sampled during those years, but because the 12 reaches were the largest (by volume) in the Upper Delaware SRR, their flow did not recede to typical (sampleable) levels until winter.

All reaches were located on streams listed as supporting their designated uses by PADEP and NY Department of Environmental Conservation (Table 20). Four of 12 reaches had water temperatures that exceeded designated use criteria, all on one occasion during 2008 (Figure 28; Appendix B). The only pH exceedance occurred at the Ten Mile River reach which was below (6.04) state criteria (i.e., $6.5 \leq pH \leq 8.5$). Dissolved oxygen concentrations were similar among reaches but were always well above minimum criteria (Figure 29). Callicoon Creek was the only reach where specific conductance was greater than 110 µS/cm; otherwise, most sampled stream reaches had specific conductance values less than 80 µS/cm, which was expected for unimpaired waters.

Table 20. Designated use and status of wadeable stream monitoring reaches at Upper Delaware SRR.

Reach Name	Designated Use[1]	Status[2]
Calkins Creek	PA(HQ-CWF)	Supporting
Callicoon Creek	NY(C[T])	Supporting
East Branch Delaware River	NY(C[T])	Supporting
Equinunk Creek	PA(HQ-CWF)	Supporting
Hankins Creek	NY(C[T])	Supporting
Lackawaxen River	PA(HQ-TSF)	Supporting
Little Equinunk Creek	PA(HQ-CWF)	Supporting
Masthope Creek	PA(HQ-CWF)	Supporting
Mongaup River	NY(B[T])	Supporting
Shohola Creek	PA(HQ-CWF)	Supporting
Ten Mile River	NY(B[T])	Supporting
West Branch Delaware River	PA (CWF)	Supporting

[1]Designated uses are determined by the Pennsylvania Department of Environmental Protection (Pa. Code § 93.9) or New York Department of Environmental Conservation (N.Y.U.C.C. Law § 701):

B[T] = Primary and secondary contact recreation and fishing (Trout)
C[T] = Fishing (Trout)
CWF = Cold Water Fishery
HQ = High Quality
NY = New York
PA = Pennsylvania
TSF = Trout Stocking.

[2]Assessment status determined from http://www.epa.gov/waters/ir/index.html; August 2013.

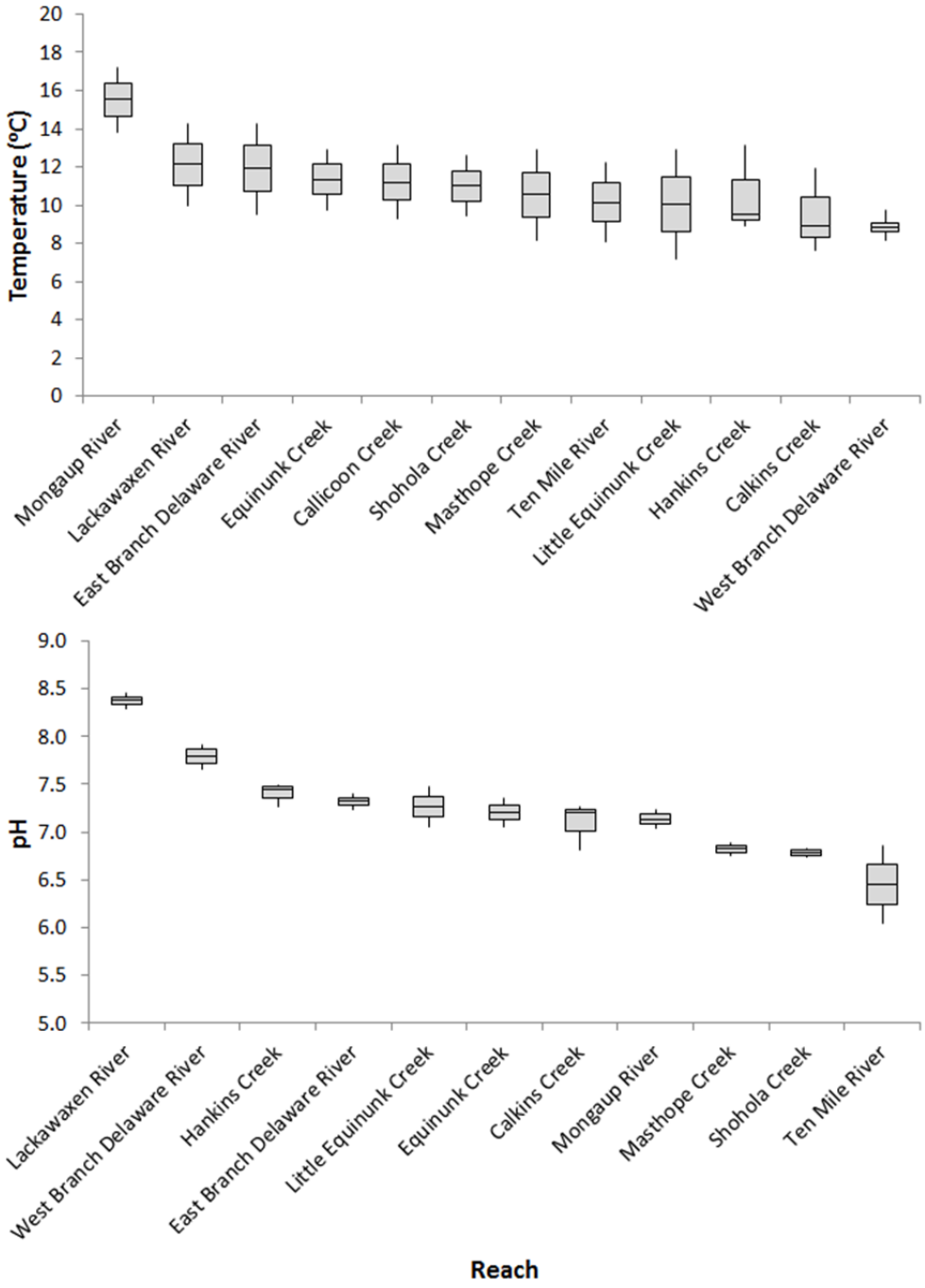

Figure 28. Boxplots of water temperature (top) and pH (bottom) at monitoring reaches near Upper Delaware SRR from 2008 to 2012. Sample size differed among reaches – see Appendix B. The bottom and top of boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values.

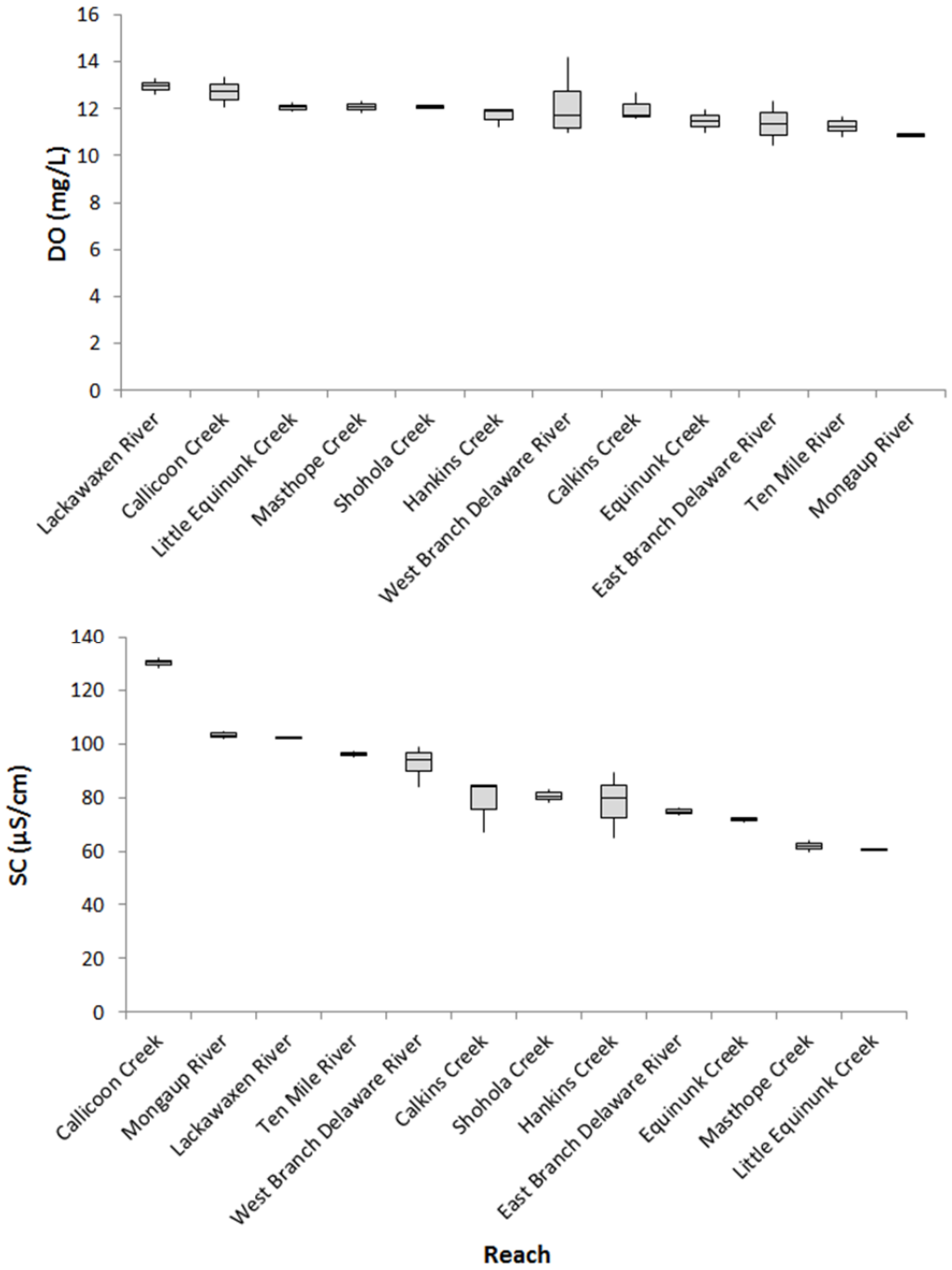

Figure 29. Boxplots of dissolved oxygen (DO; top) and specific conductance (SC; bottom) at monitoring reaches near Upper Delaware SRR from 2008 to 2012. Sample size differed among reaches – see Appendix B. The bottom and top of boxes represent the 1st and 3rd quartiles respectively, whereas the band in each box is the median. "Whisker" ends represent minimum and maximum values.

Benthic Macroinvertebrates

It should be noted again that the MIBI was developed for wadeable streams, not rivers, which are expected to have a naturally different community composition. Many reaches selected for sampling at Upper Delaware SRR were larger (i.e., rivers) than streams that the MIBI was specifically calibrated for; consequently, these results should be considered with that in mind. Nonetheless, most reaches at Upper Delaware SRR had rather high MIBI scores relative to many other ERMN reaches.

Multimetric Index of Biotic Integrity (MIBI) scores were not statistically ($p \leq 0.05$) different between 2008 and 2009 at Upper Delaware SRR (Table 21). All reaches sampled in Upper Delaware SRR were assessed, on average, as having relatively high biotic integrity according to MIBI scores (Figure 30, Table 22). Although there was variability between and among years, three reaches (Ten Mile River, Masthope Creek, and Equinunk Creek) consistently ranked highest, whereas West Branch Delaware River was typically lowest (Table 22).

Table 21. Interannual variability of Multimetric Index of Biotic Integrity [MIBI] scores for samples collected at Upper Delaware SRR during 2008 and 2009. MIBI scores were not different between years based on Tukey-Kramer comparison with 95% confidence intervals. *n* = sample size; SD = standard deviation; Min = minimum; Max = maximum.

Year	n	Mean	SD	Min	Max
2008	12	58.9	5.1	51.0	66.9
2009	12	59.4	5.9	49.9	69.2

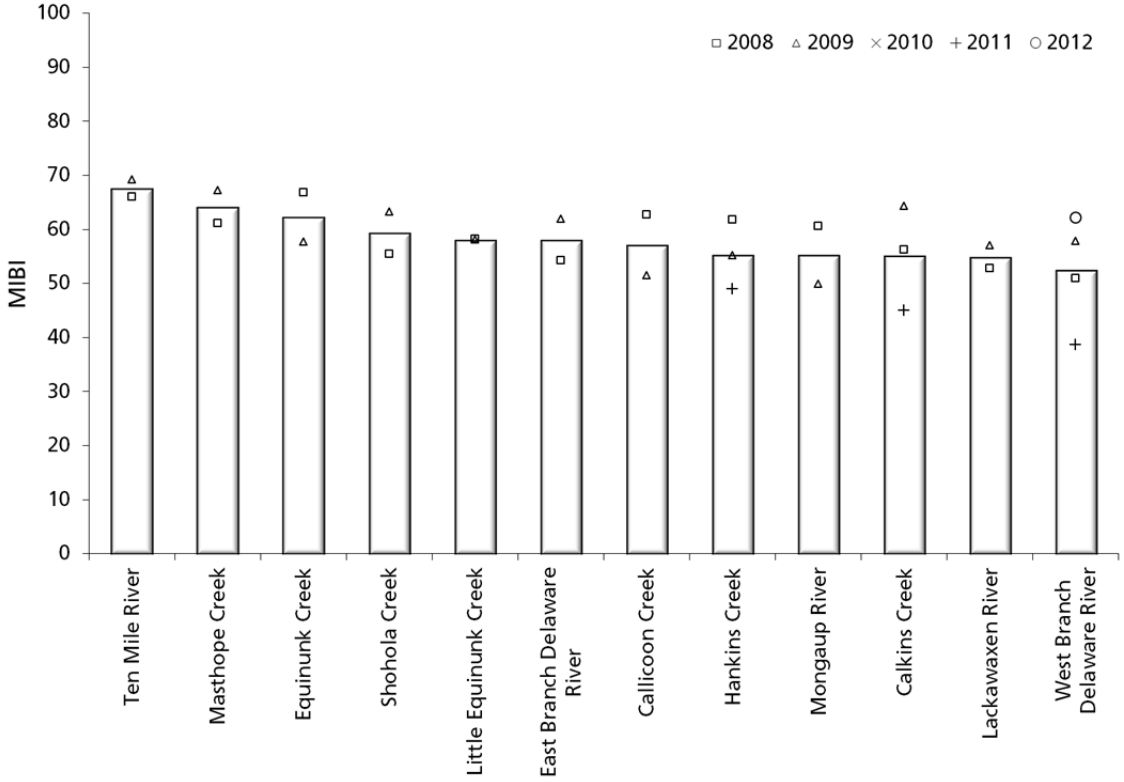

Figure 30. Multimetric Index of Biotic Integrity scores (MIBI) of benthic macroinvertebrate community samples collected at Upper Delaware SRR from 2008 to 2012. Bars represent average MIBI scores.

Table 22. Multimetric Index of Biotic Integrity [MIBI] scores and constituent metrics for samples collected at Upper Delaware SRR from 2008 to 2011. The MIBI consists of seven metrics (Ephemeroptera richness [E], Plecoptera richness [P], Trichoptera richness [T], Collector-filterer richness [CF], Percent non-insect individuals [%NI], Percent five dominant taxa [%D5], and Macroinvertebrate Tolerance Index [MTI]). Note that metrics must be scaled (i.e., from 0 to 100) based on "standardization" values (Klemm et al. 2003) to calculate the index.

Reach	Date	Taxa	E	P	T	CF	%Non insect	% D5	MTI	MIBI
Mongaup River	10/14/2008	38	7	3	18	11	9	64	2.94	60.59
	10/12/2009	37	6	1	14	9	22	57	3.81	49.90
Ten Mile River	10/15/2008	34	6	4	14	10	2	61	2.78	65.97
	10/12/2009	34	8	3	15	9	3	49	2.66	69.18
Callicoon Creek	10/15/2008	32	9	4	10	6	0	61	2.89	62.78
	10/13/2009	22	9	4	7	5	0	80	3.84	51.45
Hankins Creek	10/15/2008	30	9	7	7	4	0	71	2.17	61.80
	10/13/2009	28	9	5	7	3	0	75	1.77	55.17
	11/10/2011	20	8	6	3	4	0	70	2.27	48.96
East Branch Delaware River	10/16/2008	24	7	2	9	7	1	77	1.98	54.25
	10/13/2009	34	8	4	12	9	3	70	2.29	61.90
West Branch Delaware River	10/27/2008	23	7	2	6	6	4	68	3.05	50.98
	11/19/2009	27	7	1	7	8	3	70	2.89	57.86
Calkins Creek	10/15/2008	30	8	3	9	5	3	59	2.53	56.24
	10/13/2009	33	10	4	10	5	1	53	2.88	64.34
	11/10/2011	22	7	4	6	3	1	88	1.37	44.98
Equinunk Creek	10/16/2008	35	8	6	9	6	1	57	2.55	66.85
	10/14/2009	28	9	4	8	4	0	63	2.28	57.70
Lackawaxen River	10/14/2008	34	6	4	11	8	9	68	2.83	52.77
	10/12/2009	32	8	2	8	7	5	66	3.24	56.98
Little Equinunk Creek	10/15/2008	32	7	5	9	6	1	69	2.00	58.18
	10/14/2009	33	7	5	12	6	1	70	2.03	58.04
Masthope Creek	10/14/2008	31	8	3	12	7	2	60	2.09	61.08
	10/12/2009	37	9	4	12	8	3	56	2.21	67.21
Shohola Creek	10/14/2008	33	5	3	13	9	3	74	3.00	55.42
	10/12/2009	39	7	4	13	9	3	63	2.79	63.29

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Appendix A. Universal Transverse Mercator (UTM) coordinates of wadeable stream sampling locations throughout the Eastern Rivers and Mountains Network.

Park	Reach Name	UTM Zone	UTM E	UTM N
ALPO	Millstone Run	17	713450	4477269
	Blair Gap Run (Muleshoe)	17	710619	4478639
	Blair Gap Run (Foot of Ten)	17	716143	4477044
BLUE	Mountain Creek	17	498184	4154206
	Little Bluestone River	17	502506	4159734
	Bluestone River (Mouth)	17	504544	4161507
	Bluestone River (Tramway)	17	499151	4154931
DEWA	White Brook	18	517003	4572359
	Dunnfield Creek	18	489349	4535863
	UNT to Delaware River (Sunfish Pond)	18	493131	4540045
	Vancampens Brook (Millbrook Village)	18	503300	4546948
	Slateford Creek	18	490243	4532769
	Caledonia Creek	18	487933	4535223
	Fuller Brook	18	507316	4552548
	Van Campen Creek	18	501529	4552321
	Little Bushkill Creek	18	499572	4549936
	UNT to Dingmans Creek	18	509549	4564567
	Toms Creek	18	503199	4555119
	UNT to Toms Creek	18	503653	4553598
	Mill Creek (DEWA)	18	506946	4555900
	Hornbecks Creek	18	509659	4559783
	Dingmans Creek	18	507400	4564621
	Adams Creek	18	511162	4565359
	Raymondskill Creek	18	513253	4571704
	Spackmans Creek	18	508179	4557869
	Big Flat Brook	18	515664	4561148
	Shimers Brook	18	518123	4573634
	Stony Brook	18	491780	4533326
	Little Flat Brook	18	513763	4560845
	Sawkill Creek	18	516740	4574045
	Bushkill Creek	18	497249	4548245
	Vandermark Creek	18	517046	4574752
	Flat Brook (Walpack)	18	511594	4558302
	Flat Brook (Flatbrookville Gauge)	18	504016	4550558
FONE	UNT to Scotts Run (Picnic Loop)	17	619861	4407623
	UNT to Great Meadows Run	17	621535	4407931
	Great Meadows Run	17	621413	4408131
FRHI	Ice Pond Run	17	591604	4404163
	Dublin Run	17	592181	4404331
GARI	Laurel Creek (GARI)	17	489737	4230696
	Horseshoe Creek	17	443798	4227203
	Meadow Creek (GARI)	17	503602	4230413
	Peters Creek	17	495912	4232100
JOFL	UNT to South Fork Little Conemaugh River	17	689010	4468236
	South Fork Little Conemaugh River	17	688876	4468874

Park	Reach Name	UTM Zone	UTM E	UTM N
NERI	Batoff Creek	17	490735	4188377
	Mill Creek (NERI)	17	495309	4186828
	Meadow Creek (NERI)	17	507074	4185333
	UNT to Meadow Creek (NERI)	17	507385	4185743
	Fall Branch	17	506265	4177887
	Big Branch	17	509199	4174121
	Laurel Creek (NERI)	17	496261	4189449
	Dowdy Creek	17	495086	4192678
	Slater Creek	17	497477	4193822
	Buffalo Creek	17	498337	4196445
	UNT to Buffalo Creek	17	498721	4196617
	Arbuckle Creek	17	422971	4202014
	UNT to Laurel Creek (Highland Mtn)	17	498286	4190116
	UNT to Laurel Creek (Backus Mtn)	17	497989	4189279
	Davis Branch	17	504907	4187081
	Little Laurel Creek	17	502953	4190099
	Richlick Branch	17	503776	4190647
	Wolf Creek	17	492209	4211624
	Keeney Creek	17	498222	4209397
	Camp Branch	17	504156	4188463
	Ephraim Creek	17	498829	4201617
	Fire Creek	17	497506	4201106
	Bucklick Branch	17	504047	4191913
	Piney Creek	17	491637	4188357
	Glade Creek	17	499128	4186544
UPDE	Shohola Creek	18	507171	4590951
	Lackawaxen River	18	500350	4592554
	Masthope Creek	18	497651	4598476
	Mongaup River	18	520377	4586212
	Ten Mile River	18	498433	4600580
	Calkins Creek	18	494929	4613425
	Callicoon Creek	18	495117	4623677
	Hankins Creek	18	492155	4630373
	Little Equinunk Creek	18	488298	4630717
	East Branch Delaware River	18	476689	4644452
	Equinunk Creek	18	481344	4633473
	West Branch Delaware River	18	475824	4644592

Appendix B. Core parameter water quality data collected at Wadeable Stream monitoring reaches throughout the Eastern Rivers and Mountains Network from 2008 to 2013. Values that are bold and outlined were those that exceeded applicable state water quality criteria.

Park	Stream Reach	Date	T (^oC)[1]	pH	DO[2] (mg/L)	DO (%)	SC[3]
ALPO	Blair Gap Run (Foot of Ten)	10/31/08	5.6	6.91	8.5	68.0	132.6
		10/21/09	9.6	7.56	11.6	102.2	140.0
		10/11/10	15.4	*	*	*	139.0
		10/25/11	10.6	7.60	10.6	100.0	76.4
		10/09/12	11.5	7.63	11.0	101.0	115.3
ALPO	Blair Gap Run (Muleshoe)	10/31/08	6.0	6.60	10.8	87.2	113.8
		10/21/09	**10.9**	7.39	11.2	101.6	122.0
		10/11/10	**14.0**	*	*	*	102.0
		10/25/11	9.6	7.36	10.6	97.9	59.1
		10/09/12	10.2	7.42	10.8	96.3	88.4
ALPO	Millstone Run	10/31/08	3.7	6.90	10.9	82.9	85.1
		10/21/09	10.5	7.40	11.0	99.2	95.0
		10/11/10	15.0	*	*	*	86.0
		10/25/11	11.9	7.13	10.2	98.9	56.0
		10/09/12	9.1	7.24	11.1	96.6	66.5
BLUE	Bluestone River (Mouth)	10/24/08	8.8	8.39	10.1	86.9	428.4
		9/14/10	21.3	*	*	*	413.0
		9/14/11	23.3	8.57	9.4	115.9	350.1
		9/25/12	15.2	8.53	10.3	106.1	293.7
BLUE	Bluestone River (Pipestem)	10/24/08	8.4	8.53	11.1	94.8	423.9
		9/14/10	22.0	*	*	*	425.0
		9/14/11	22.0	8.57	9.9	119.3	369.2
		9/25/12	13.1	8.32	9.6	94.9	316.1
BLUE	Little Bluestone River	3/31/09	8.4	7.65	7.1	69.8	56.9
		4/7/10	15.4	7.24	10.6	106.0	87.0
		3/29/11	3.0	7.04	13.5	100.0	78.0
		3/8/12	5.8	7.27	13.1	104.7	59.4
BLUE		3/11/13	5.6	7.51	13.4	106.1	63.9
BLUE	Mountain Creek	3/31/09	5.0	7.63	6.3	49.6	78.4
		4/7/10	12.5	7.71	10.6	99.5	128.0
		3/29/11	2.9	**5.99**	13.4	99.3	137.0
		3/8/12	6.4	7.16	12.8	104.3	99.6
		3/11/13	5.2	7.31	13.4	105.1	195.6
DEWA	Adams Creek	10/8/08	8.0	7.42	11.9	101.2	89.6
		10/5/09	12.1	7.00	10.9	101.5	91.0
		10/21/10	9.0	*	*	*	95.0
		10/11/11	**14.8**	7.11	10.4	102.5	60.0
		10/2/12	**13.5**	7.08	10.5	101.1	67.4
DEWA	Big Flat Brook	10/4/08	9.6	7.50	11.3	99.5	87.5
		10/6/09	**12.4**	7.44	11.5	107.6	119.0
		10/18/10	9.8	*	*	*	91.0
		11/9/11	8.0	7.07	11.4	96.0	67.0
DEWA	Bushkill Creek	10/7/08	9.9	7.14	11.5	101.3	39.5
		10/8/09	13.1	6.94	11.3	107.4	44.0

Park	Stream Reach	Date	T (°C)[1]	pH	DO[2] (mg/L)	DO (%)	SC[3]
		10/25/10	11.6	*	*	*	51.0
DEWA	Caledonia Creek	10/3/08	11.5	7.28	10.2	93.5	40.3
		10/2/09	9.5	7.17	10.4	91.0	46.0
		10/19/10	9.9	*	*	*	40.0
		10/12/11	**12.7**	7.34	10.6	99.7	37.0
		10/1/12	12.2	7.18	10.2	95.4	47.7
DEWA	Dingmans Creek	10/7/08	11.5	7.26	10.7	98.0	73.0
		10/6/09	11.4	7.09	10.6	97.4	100.0
		10/21/10	10.1	*	*	*	103.0
		11/8/11	8.5	6.69	11.6	99.0	64.0
		10/2/12	**15.0**	6.97	9.9	98.3	59.2
DEWA	Dunnfield Creek	10/2/08	**13.2**	6.98	10.4	99.0	26.5
		10/2/09	10.7	**6.37**	11.1	99.9	35.0
		10/19/10	10.2	*	*	*	30.0
		10/12/11	**13.3**	7.18	10.7	102.1	29.0
		10/1/12	**12.9**	6.81	10.5	99.5	32.6
DEWA	Flat Brook (Flatbrookville)	10/7/09	14.1	8.22	11.0	106.8	260.0
		10/25/10	10.5	*	*	*	209.0
DEWA	Flat Brook (Walpack)	10/1/09	11.5	8.05	12.1	110.9	263.0
		10/25/10	11.0	*	*	*	229.0
DEWA	Fuller Brook	10/3/08	12.4	7.43	10.0	94.5	*
		10/19/10	10.5	*	*	*	27.0
		10/12/11	13.3	7.09	10.3	98.0	26.0
		10/10/12	12.5	6.81	10.5	98.6	26.7
DEWA	Hornbecks Creek	10/6/08	12.0	7.53	10.4	96.5	107.7
		10/5/09	**12.6**	7.33	10.5	98.3	157.0
		10/20/10	9.3	*	*	*	135.0
		11/7/11	5.9	6.52	12.2	97.9	88.0
		10/2/12	**14.0**	7.20	10.2	99.7	88.8
DEWA	Little Bushkill Creek	10/5/08	**12.6**	6.85	10.6	99.7	39.4
		10/8/09	11.7	6.65	11.2	103.9	51.0
		10/25/10	11.4	*	*	*	66.0
DEWA	Little Flat Brook	10/4/08	12.0	8.66	12.6	116.7	302.5
		10/1/09	11.9	8.44	12.4	114.4	416.0
		10/18/10	10.1	*	*	*	361.0
		11/8/11	9.9	8.15	10.9	96.0	320.0
DEWA	Mill Creek (DEWA)	10/6/08	11.2	7.22	10.7	97.3	60.8
		10/6/09	11.3	6.97	10.5	96.4	87.0
		10/20/10	8.5	*	*	*	82.0
		11/7/11	5.2	6.42	12.4	97.4	62.0
		10/11/12	10.6	7.09	11.2	101.4	63.2
DEWA	Raymondskill Creek	10/8/08	9.9	7.50	11.0	97.2	116.3
		10/5/09	**13.3**	7.28	10.8	103.5	146.0
		10/25/10	12.1	*	*	*	135.0
		11/9/11	8.4	7.94	11.4	97.4	100.0
		10/2/12	**13.9**	7.09	10.1	98.6	106.2

Park	Stream Reach	Date	T (^oC)[1]	pH	DO[2] (mg/L)	DO (%)	SC[3]
DEWA	Sawkill Creek	10/4/08	11.0	7.60	11.1	98.9	131.5
		10/9/09	11.5	7.14	11.3	103.4	167.0
		10/21/10	9.5	*	*	*	136.0
		11/9/11	9.0	7.82	11.6	100.4	106.0
		10/11/12	11.2	7.39	11.1	101.7	130.3
DEWA	Shimers Brook	10/1/08	**17.9**	8.24	9.2	*	297.3
		10/1/09	11.2	8.20	11.2	101.7	494.0
		10/18/10	11.4	*	*	*	325.0
DEWA	Slateford Creek	10/3/08	**12.7**	7.82	9.7	93.0	153.4
		10/2/09	11.4	7.76	10.5	96.5	224.0
		10/19/10	10.8	*	*	*	197.0
		10/12/11	**14.2**	8.10	10.1	98.6	140.0
		10/1/12	**13.1**	7.82	10.1	96.7	196.9
DEWA	Spackmans Creek	10/6/08	11.7	7.44	10.3	94.7	74.4
		10/6/09	10.7	7.26	11.1	100.3	116.0
		10/20/10	9.2	*	*	*	88.0
		11/7/11	6.6	6.35	11.9	97.2	66.0
		10/2/12	**13.8**	7.03	10.4	100.8	65.6
DEWA	Toms Creek	10/7/08	9.5	7.45	11.4	100.0	88.5
		10/8/09	11.7	7.21	10.9	100.7	127.0
		10/20/10	8.8	*	*	*	117.0
		11/8/11	7.9	6.89	12.2	102.4	96.0
		10/11/12	12.0	7.19	10.8	100.2	94.0
DEWA	UNT to Delaware River (Sunfish Pond)	10/2/08	14.2	**5.19**	9.8	96.5	24.0
		10/7/09	13.2	**4.71**	10.3	97.8	29.0
		10/19/10	11.5	*	*	*	27.0
		10/12/11	15.1	**6.15**	10.1	100.5	24.0
		10/1/12	14.1	**5.40**	10.3	100.1	26.1
DEWA	UNT to Dingmans Creek	10/5/08	**14.1**	7.32	10.3	99.3	225.6
		10/6/09	8.7	6.93	11.0	94.2	246.0
		10/20/10	11.1	*	*	*	208.0
		10/11/11	**15.4**	7.44	10.2	102.1	120.0
		10/2/12	**13.5**	7.04	10.0	96.2	142.4
DEWA	UNT to Toms Creek	10/6/08	**12.7**	7.21	10.0	94.6	36.2
		10/8/09	11.5	6.80	10.4	95.8	42.0
		10/20/10	9.9	*	*	*	48.0
		11/8/11	7.1	*	11.5	94.8	34.0
		10/11/12	**12.7**	6.93	10.5	99.6	35.4
DEWA	Van Campen Creek	10/5/08	**12.8**	7.67	10.3	97.0	184.6
		10/9/09	12.2	7.33	10.3	96.3	252.0
		10/20/10	8.4	*	*	*	258.0
		11/8/11	10.9	7.46	10.7	97.1	187.0
		10/11/12	11.3	7.61	11.0	100.3	170.3

Park	Stream Reach	Date	T (°C)[1]	pH	DO[2] (mg/L)	DO (%)	SC[3]
DEWA	Vancampens Brook (Millbrook Village)	10/2/08	**13.2**	7.55	9.9	94.3	43.4
		10/7/09	12.7	7.11	10.2	96.0	63.0
		10/19/10	10.9	*	*	*	41.0
		10/12/11	**13.8**	7.44	10.3	100.0	39.0
		10/1/12	**13.4**	7.15	10.3	98.5	39.6
DEWA	Vandermark Creek	10/9/08	12.1	6.15	10.7	99.2	116.1
		10/5/09	11.7	6.33	10.3	95.2	121.0
		10/21/10	11.3	*	*	*	120.0
		11/7/11	8.7	**5.84**	11.0	94.4	91.0
		10/10/12	**13.1**	6.66	9.9	94.7	117.1
DEWA	White Brook	10/1/08	**15.0**	8.04	9.6	*	366.8
		10/1/09	10.9	8.04	11.0	99.4	704.0
		10/18/10	11.4	*	*	*	625.0
		10/11/11	**13.6**	8.48	11.4	109.3	525.0
		10/3/12	**14.5**	7.99	9.9	97.6	325.0
FONE	Great Meadows Run	4/1/10	9.9	7.16	10.8	95.7	150.0
		4/9/13	**14.7**	7.47	10.5	103.0	207.4
FONE	UNT to Great Meadows Run	4/1/10	**12.7**	6.65	10.2	96.2	55.0
		4/6/11	**7.0**	**5.50**	11.1	91.7	50.0
		3/23/12	**16.4**	6.73	9.6	97.9	50.8
		4/9/13	**15.5**	6.86	9.8	97.2	52.0
FONE	UNT to Scotts Run (Picnic Loop)	4/16/09	5.1	*	*	*	46.1
		4/1/10	8.1	6.96	11.2	94.6	47.0
		4/6/11	7.1	**5.67**	11.0	90.8	41.0
		3/23/12	**15.3**	6.96	9.6	95.3	51.4
FRHI	Dublin Run	4/15/09	9.5	*	*	*	144.3
		4/2/10	8.9	7.05	11.4	98.0	169.0
		4/6/11	8.0	6.46	11.6	98.4	143.0
		3/23/12	**12.5**	7.69	10.7	100.9	157.4
		4/9/13	**13.8**	7.51	10.3	98.6	185.1
FRHI	Ice Pond Run	4/15/09	9.5	*	*	*	928.0
		4/2/10	9.1	**2.68**	11.5	99.9	1785.0
		4/6/11	7.5	**4.28**	11.9	99.4	1127.0
		4/9/13	**12.0**	**2.71**	11.1	103.2	1851.0
GARI	Horseshoe Creek	3/30/09	8.3	*	*	*	54.9
		4/6/10	11.9	6.76	10.8	99.7	63.0
		3/22/11	10.5	6.10	10.5	94.4	68.0
		3/11/12	5.0	6.97	13.6	106.3	60.6
GARI	Laurel Creek (GARI)	3/30/09	7.0	*	*	*	57.3
		4/5/10	15.4	6.87	10.2	101.6	69.0
		3/22/11	11.6	6.20	10.4	95.4	68.0
		3/11/12	6.6	7.00	13.2	107.4	64.2
GARI	Meadow Creek (GARI)	4/1/09	8.9	*	*	*	105.9
		4/5/10	11.3	7.11	10.9	100.0	174.0
		3/29/11	5.3	7.42	12.8	100.9	163.0
		3/11/12	7.0	7.21	12.6	104.2	128.5
		3/29/13	7.1	7.29	12.4	102.1	115.8

Park	Stream Reach	Date	T (^oC)[1]	pH	DO[2] (mg/L)	DO (%)	SC[3]
GARI	Peters Creek	4/5/10	14.6	7.78	11.2	109.7	304.0
		3/29/11	6.2	7.71	13.4	108.0	244.0
		3/11/12	7.5	7.47	13.1	109.2	201.8
JOFL	South Fork Little Conemaugh River	10/16/12	11.1	6.63	10.6	96.9	781.7
JOFL	UNT to South Fork Little Conemaugh River	11/4/08	9.9	6.96	8.0	70.7	239.4
		10/21/09	6.5	*	*	*	243.0
		10/11/10	12.3	6.05	8.6	80.4	249.0
		10/25/11	8.1	7.56	9.3	82.7	204.2
NERI	Arbuckle Creek	3/25/09	9.2	*	*	*	277.8
		4/6/10	**15.7**	7.91	10.1	101.5	262.0
		3/26/11	8.6	7.27	11.6	99.6	242.0
		3/10/12	8.9	7.74	12.3	105.9	230.8
		3/10/13	9.1	8.00	12.2	104.7	291.2
NERI	Batoff Creek	3/23/09	9.3	*	*	*	116.6
		3/21/10	9.6	7.41	11.2	98.0	147.0
		3/23/11	12.1	8.00	10.4	97.1	137.0
		3/7/12	8.2	7.44	12.3	104.0	122.8
		3/10/13	7.7	7.69	12.6	104.7	144.0
NERI	Big Branch	3/24/09	7.9	*	*	*	69.2
		3/21/10	7.0	6.97	11.8	97.1	70.0
		3/27/11	5.0	6.14	12.2	95.8	70.0
		3/8/12	8.5	7.30	12.1	103.3	60.4
		3/11/13	6.2	7.50	13.0	104.7	63.3
NERI	Bucklick Branch	3/29/09	7.6	*	*	*	21.7
		4/9/10	7.4	6.10	11.4	94.7	24.0
		3/30/11	5.0	6.98	12.3	96.5	24.0
		3/14/12	7.0	6.12	11.1	91.6	24.7
NERI	Buffalo Creek	3/25/09	7.0	*	*	*	74.9
		3/20/10	8.6	6.69	11.1	100.1	82.0
		3/26/11	5.9	6.56	12.5	100.0	53.0
		3/10/12	6.7	7.09	13.0	106.2	52.4
		3/30/13	6.6	7.25	12.9	105.6	54.1
NERI	Camp Branch	3/28/09	8.1	*	*	*	39.2
		3/19/10	5.3	**5.18**	11.7	92.3	39.0
		3/25/11	6.6	6.17	11.2	91.1	38.0
		3/7/12	5.1	6.28	12.4	97.6	40.0
		3/9/13	3.2	6.56	12.8	94.5	47.2
NERI	Davis Branch	3/26/09	7.6	*	*	*	47.3
		4/8/10	12.2	6.91	10.1	93.9	36.0
		3/25/11	5.4	6.16	12.1	95.3	35.0
		3/9/12	6.6	6.80	12.4	101.1	32.7
NERI	Dowdy Creek	3/25/09	6.1	*	*	*	23.2
		3/20/10	5.0	**5.16**	12.5	97.4	23.0
		3/26/11	5.0	**4.59**	12.7	100.0	22.0
		3/10/12	4.3	**5.33**	13.8	106.2	21.8
		3/30/13	3.5	**5.57**	14.1	106.1	21.6

Park	Stream Reach	Date	T (^oC)[1]	pH	DO[2] (mg/L)	DO (%)	SC[3]
NERI	Ephraim Creek	3/29/09	9.2	*	*	*	28.0
		4/6/10	12.5	6.40	10.5	98.0	31.0
		3/28/11	4.4	**5.40**	13.2	101.4	31.0
		3/13/12	8.4	6.40	11.3	99.0	30.0
		3/29/13	4.5	6.62	13.6	105.3	31.3
NERI	Fall Branch	3/24/09	7.2	*	*	*	56.5
		3/21/10	6.2	6.40	12.2	98.5	58.0
		3/27/11	5.5	6.29	12.2	96.8	57.0
		3/12/12	5.5	7.17	13.2	*	56.6
		3/11/13	6.7	7.37	12.8	104.8	54.7
NERI	Fire Creek	3/29/09	9.7	*	*	*	68.2
		4/6/10	13.6	7.08	10.7	102.7	101.0
		3/28/11	6.2	6.73	12.6	101.8	94.0
		3/13/12	11.5	7.37	10.5	99.6	90.6
		3/29/13	6.7	7.56	12.9	105.4	90.5
NERI	Glade Creek	4/1/09	8.4	*	*	*	91.8
		4/8/10	11.3	7.23	10.8	98.9	116.0
		3/23/11	10.4	**5.90**	10.8	96.1	117.0
		3/12/12	7.7	6.97	11.5	99.6	93.9
		3/10/13	4.3	7.13	14.1	107.3	139.5
NERI	Keeney Creek	3/27/09	9.0	*	*	*	104.3
		4/7/10	10.5	7.11	11.2	105.0	102.0
		3/22/11	11.8	6.89	10.2	94.5	101.0
		3/13/12	11.3	7.19	10.5	98.6	96.5
		3/11/13	7.3	7.29	12.6	104.5	105.4
NERI	Laurel Creek (NERI)	3/24/09	9.7	*	*	*	79.5
		4/7/10	**14.7**	7.26	10.2	100.4	67.0
		3/23/11	11.3	7.32	10.8	98.2	80.0
		3/14/12	10.2	7.42	10.9	97.1	78.7
		3/10/13	3.8	7.14	14.1	106.4	70.7
NERI	Little Laurel Creek	3/26/09	7.5	*	*	*	25.8
		3/19/10	6.3	**5.54**	11.4	91.8	26.0
		3/25/11	6.2	5.71	11.3	91.5	23.0
		3/7/12	5.4	6.06	12.6	99.3	25.5
		3/9/13	3.6	6.17	12.8	95.5	26.1
NERI	Meadow Creek (NERI)	3/24/09	5.2	*	*	*	81.2
NERI	Mill Creek (NERI)	3/23/09	8.3	*	*	*	56.5
		4/9/10	10.9	6.90	10.9	98.6	59.0
		3/23/11	9.5	6.10	11.2	97.6	59.0
		3/12/12	7.9	7.91	11.4	98.7	53.0
		3/10/13	3.9	6.99	14.0	105.9	66.2
NERI	Piney Creek	3/31/09	9.1	*	*	*	181.2
		4/8/10	**14.0**	8.33	10.3	100.0	279.0
		3/23/11	11.6	7.89	10.9	100.7	237.0
		3/10/13	6.7	8.30	13.6	110.7	308.5

Park	Stream Reach	Date	T (^oC)[1]	pH	DO[2] (mg/L)	DO (%)	SC[3]
NERI	Richlick Branch	3/27/09	6.9	*	*	*	19.9
		3/19/10	8.6	**3.94**	10.9	93.0	21.0
		3/25/11	4.9	**4.14**	11.8	92.3	19.0
		3/7/12	3.8	**5.38**	13.0	98.6	20.0
		3/9/13	1.4	**5.80**	13.5	95.0	20.6
NERI	Slater Creek	3/25/09	6.0	*	*	*	47.6
		3/20/10	6.8	6.18	11.8	97.1	48.0
		3/26/11	5.5	6.40	12.3	97.6	44.0
		3/10/12	5.3	6.83	13.3	104.5	42.5
		3/30/13	4.7	6.80	13.4	104.4	48.3
NERI	UNT to Buffalo Creek	3/25/09	6.9	*	*	*	99.5
		3/20/10	9.1	7.17	11.6	103.0	144.0
		3/26/11	5.8	6.45	12.3	98.2	85.0
		3/10/12	5.3	7.30	13.3	105.1	78.9
		3/30/13	6.1	7.59	12.9	104.0	95.2
NERI	UNT to Laurel Creek (Backus Mtn)	3/26/09	7.1	*	*	*	42.9
		4/8/10	11.6	6.83	10.7	98.7	48.0
		3/23/11	11.6	7.06	10.5	96.2	43.0
		3/14/12	8.5	6.59	11.2	95.6	46.8
		3/9/13	4.3	6.63	13.3	100.7	38.4
NERI	UNT to Laurel Creek (Highland Mtn)	3/26/09	7.5	*	*	*	65.5
		3/19/10	9.5	7.55	11.2	97.7	86.0
		3/23/11	12.0	8.03	10.4	96.7	83.0
		3/7/12	8.5	6.99	12.2	104.2	53.1
		3/9/13	5.7	6.80	12.7	99.9	60.0
NERI	UNT to Meadow Creek (NERI)	3/24/09	7.6	*	*	*	36.2
		3/21/10	9.0	6.42	11.2	96.7	34.0
		3/28/11	5.3	6.07	12.4	97.8	36.0
		3/8/12	9.0	6.70	11.7	101.4	33.6
		3/8/13	4.9	6.64	12.9	99.3	32.5
NERI	Wolf Creek	3/27/09	9.0	*	*	*	175.5
UPDE	Calkins Creek	10/15/08	11.9	7.26	12.7	117.1	83.8
		10/13/09	8.9	6.81	11.7	101.1	84.0
		11/10/11	7.7	7.20	11.6	97.2	67.0
UPDE	Callicoon Creek	10/15/08	13.1	*	13.4	127.0	128.5
		10/13/09	9.3	7.32	12.1	105.4	132.0
UPDE	East Branch Delaware River	10/16/08	14.3	7.40	10.4	102.2	73.5
		10/13/09	9.5	7.24	12.3	107.9	76.0
UPDE	Equinunk Creek	10/16/08	**12.9**	7.36	11.0	104.3	72.5
		10/14/09	9.8	7.06	11.9	105.2	71.0
UPDE	Hankins Creek	10/15/08	13.1	7.49	11.9	113.4	89.1
		10/13/09	9.5	7.27	12.0	105.0	80.0
		11/10/11	8.9	7.45	11.2	96.9	65.0
UPDE	Lackawaxen River	10/14/08	14.3	8.46	12.6	123.6	102.1
		10/12/09	10.0	8.29	13.3	117.6	102.0
UPDE	Little Equinunk Creek	10/15/08	**12.9**	7.48	11.9	112.7	60.0
		10/14/09	7.2	7.05	12.2	101.3	61.0
UPDE	Masthope Creek	10/14/08	**12.9**	6.89	11.8	112.5	63.7
		10/12/09	8.2	6.75	12.3	104.5	60.0

Park	Stream Reach	Date	T (^oC)[1]	pH	DO[2] (mg/L)	DO (%)	SC[3]
UPDE	Mongaup River	10/14/08	17.2	7.04	10.9	112.8	104.5
		10/12/09	13.8	7.23	10.8	104.4	102.0
UPDE	Shohola Creek	10/14/08	**12.6**	6.73	12.0	113.3	78.1
		10/12/09	9.4	6.83	12.1	105.7	83.0
UPDE	Ten Mile River	10/15/08	12.2	6.86	10.8	101.5	97.1
		10/12/09	8.1	**6.04**	11.7	98.6	95.0
UPDE	West Branch Delaware River	10/27/08	8.8	7.65	11.2	96.0	99.0
		11/19/09	8.2	7.91	14.2	120.4	92.0
		11/10/11	9.7	7.85	11.0	96.6	84.0
		10/12/12	8.8	7.73	12.2	105.8	96.0

[1]T = Water temperature

[2]DO = Dissolved oxygen

[3]SC = Specific conductance

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.

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