Eastern Rivers and Mountains Network Stream Fish Community Monitoring

Sampling Reach Summaries and 2013-2014 to 2022-2023 Survey Comparisons: Delaware Water Gap National Recreation Area

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In collaboration with the U.S. Geological Survey (Pennsylvania Cooperative Fish and Wildlife Research Unit) and The Pennsylvania State University (PSU), the Eastern Rivers and Mountains Network surveyed fish communities in wadeable streams throughout six National Park Service units, once during 2013-2014 and once during 2022-2023.

This document contains (1) summaries of electrofishing surveys and in-stream habitat assessments throughout Delaware Water Gap National Recreation Area during 2022-2023 and (2) descriptions of observed reach-scale fish community differences between survey periods.

To account for imperfect detection of fishes, and to estimate species occupancy and detection probabilities, 100-meter-long reaches (n = 30) were sampled using pulsed-DC backpack electrofishing during summer 2022 and 2023, typically on three independent occasions with as few days as logistically possible between visits. All captured fish were counted and identified to species before releasing them throughout the sampled reach. At least one representative individual of each species, sex (when distinguishable), and age class (i.e., young-of-year, adult) were photographed as photo-vouchers. In-stream and riparian habitat metrics, characterized for use as occupancy modeling covariates, included: basic water quality (e.g., pH, specific conductance), discharge, substrate size and embeddedness, channel morphology, fish cover, riparian vegetation type and cover, and human disturbance. Stream water temperature statistics were calculated from continuous (1 hr interval) data logger measurements that were deployed from April 2022 – present, within 100 m of sampling reaches.

Morgan Zazworsky (Stum) contributed substantially and was invaluable to this research as a PSU graduate student. ERMN Fish Community Monitoring resources, including data packages, peer-reviewed publications, and Standard Operating Procedures are available here.

DEWA.3012 – Adams Creek 33



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	25.6
Avg. # Annual Days with Daily Mean Temp. > 20 °C	50
Avg. # Annual Days with Daily Max. Temp. > 20 °C	102
Avg. Julian Day of Annual Max. Temp.	202
Avg. DO (mg/L)	9.24
Avg. pH	7.03
Avg. Specific Conductance (µS/cm)	98.4
Avg. Discharge (m^3/s)	0.037



Reach Downstream End – 2022: Notable growth of understory and emergent vegetation, following increased light penetration from fallen hemlocks.

Reach Habitat	
Avg. Width (m)	6.02
Avg. Depth (cm)	24.96
Max. Depth (cm)	145
Avg. % Substrate Embeddedness	30.8%
Mode Substrate Class	GC*
Avg. Substrate Diameter (mm)	452
% Sand/Fines	0%
% Substrate > Fine Gravel	92%
% Canopy Cover	78.2%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	104.5%
LWD Density (m^3/m^2)	0.251
EPA RBP Score	89%

*GC = Coarse Gravel

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
12.5	2	272.5	0.065	3606.4	77.3%	14.8%	0.22%

Fish Counts (Total over 3 visits)		
Species (Nativity*)	**2013**	**2022**
Lepomis macrochirus (*I*)	3	1
Micropterus salmoides (*I*)	8	0
Rhinichthys atratulus (*N*)	162	284
Salvelinus fontinalis (*N*)	16	0
Semotilus atromaculatus (*N*)	3	153

*N = native; I = introduced



Significant LWD accumulation just before end of reach

Adams Creek 33 was the uppermost reach on Adams Creek, located next to Milford Road (PA Rt. 2001), downstream from a small neighborhood, which resulted in it having the highest proportion of developed area of all the Adams Creek reaches. The substrate was mostly coarse gravel over bedrock, although there were several areas with large cobble and small boulders present. Most of the reach was relatively shallow, except for a large, deep pool below a substantial waterfall at the reach upstream end. This pool, along with a significant large woody debris (LWD) accumulation, ended effective electrofishing at approximately 80 m. The summary metrics for water temperature at Adams Creek 33 had the warmest values for all Adams Creek reaches, despite having the smallest in drainage area. These warmer water temperatures were possibly due to a combination of increased light penetration due to recent loss (2018-2019) of Eastern Hemlock around the reach, increased water retention in the upstream pool, several pond outflows outside of the park boundary, and nearby upstream development.



Large adult bluegill captured on first visit

Although largemouth bass *Micropterus salmoides not* was captured within the reach in 2022, several adults were visually identified swimming in the large pool at the head of the reach below the waterfall. Additionally, only one bluegill *Lepomis macrochirus* was captured on the first visit, but more *Lepomis sp.* were visually observed in the pool above the reach. These individuals, as well as the one captured, were very large. It was unclear if natural reproduction was occurring, as no Young of Year (YOY) were observed. However, the pool and LWD may have provided spawning and rearing habitat for nest-tending centrarchids. The absence of brook trout *Salvelinus fontinalis* after three visits was somewhat concerning given the detection of at least four individual per visit in 2013. While brook trout could have been present and not captured, the water temperatures in the reach frequently exceeded their thermal stress threshold (~21.0 °C)[1] and reached potentially lethal temperatures (>25.3 °C)[2]. This warm thermal regime, coupled with large predators (e.g., largemouth bass) provide evidence for the current (2022) extirpation of brook trout at Adams Creek 33. Further monitoring for brook trout presence, increasing water temperatures, and centrarchid population dynamics at this reach are necessary to determine the viability of a brook trout population and appropriate conservation methods.

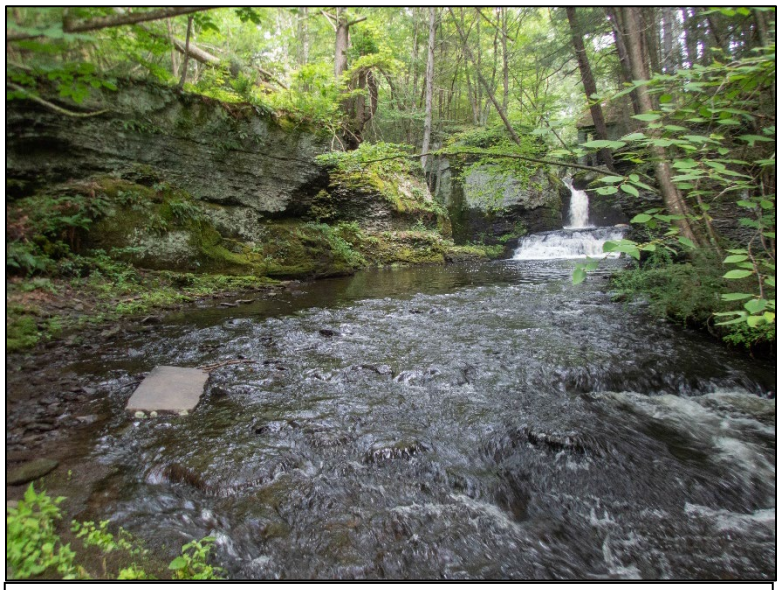
[1] Chadwick, et al. 2015 https://doi.org/10.1093/conphys/cov017
[2] Wehrly, et al. 2007 https://doi.org/10.1577/T06-163.1

DEWA.3039 – Adams Creek 21



Reach Downstream End – 2023: Deep pool difficult to

Water Quality	
Avg. Annual Max. Temp. (°C)	23.5
Avg. # Annual Days with Daily Mean Temp. > 20 °C	26
Avg. # Annual Days with Daily Max. Temp. > 20 °C	82
Avg. Julian Day of Annual Max. Temp.	220
Avg. DO (mg/L)	9.88
Avg. pH	6.92
Avg. Specific Conductance (µS/cm)	90.1
Avg. Discharge (m^3/s)	0.256



Reach Upstream End – 2023: Another deep pool below an old mill structure

Reach Habitat	
Avg. Width (m)	9.67
Avg. Depth (cm)	20.44
Max. Depth (cm)	112
Avg. % Substrate Embeddedness	36%
Mode Substrate Class	GC
Avg. Substrate Diameter (mm)	92
% Sand/Fines	12%
% Substrate > Fine Gravel	80%
% Canopy Cover	96%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	73.5%
LWD Density (m^3/m^2)	0.062
EPA RBP Score	97%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
15.98	2	205.57	0.065	2474.14	78.8%	13.98%	0.29%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Anguilla rostrata (*N*)	NA	1
Micropterus salmoides (*I*)	NA	1
Rhinichthys atratulus (*N*)	NA	417
Salvelinus fontinalis (*N*)	NA	78
Semotilus atromaculatus (*N*)	NA	3



LWD accumulations near midpoint looking upstream with some increased deciduous understory growth

Adams Creek 21 was the second-most upstream reach on Adams Creek, which was not sampled for fish during the pilot survey in 2013. Although the area is seasonally closed to recreation, one hiker was encountered, and there were many signs of human disturbance, including trash, clothes, and a pool floatie. The reach was located below a historic mill, between two bedrock-cascade waterfalls that flowed into pools that were too deep for effective backpack electrofishing. The substrate was mainly coarse gravel over smooth bedrock with a few areas of cobble and small boulders. There was a large bedrock pool near the midpoint with a large LWD jam that provided ample fish cover. Although the loss of Eastern Hemlock and subsequent deciduous understory growth was apparent in some sections of the reach, the mixed coniferous riparian area and canopy cover were slightly more intact than upstream at Adams Creek 33 (DEWA.3012). The water temperature summary metrics reflected this as the annual maximum stream temperature was cooler than upstream at DEWA.3012, and there were fewer days with temperatures exceeding 20 °C. A visible spring seep near the midpoint on the right bank may have also contributed to the cooler water temperatures.

The thermal regime was suitable for brook trout reproduction and growth, as individuals of all size classes including YOY were captured. Given that this was the only Adams Creek reach where brook trout were present without competition from brown trout *Salmo trutta*, it represents an important reach for continued monitoring and conservation. However, a small largemouth bass was captured on the second visit, which likely came from a source population upstream (e.g., impoundment). If established, largemouth bass could be a significant brook trout predation threat. Despite many substantial waterfall barriers downstream, a small American eel *Anguilla rostrata* was captured on the second visit.



Small largemouth bass captured on second



Floatie found with discarded clothes and trash

DEWA.3011 – Adams Creek 14



Reach Upstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	24.1
Avg. # Annual Days with Daily Mean Temp. > 20 °C	23
Avg. # Annual Days with Daily Max. Temp. > 20 °C	79
Avg. Julian Day of Annual Max. Temp.	220
Avg. DO (mg/L)	9.00
Avg. pH	6.96
Avg. Specific Conductance (µS/cm)	63.4
Avg. Discharge (m^3/s)	0.047



Reach Upstream End – 2022: Increased LWD accumulation and deciduous understory growth

Reach Habitat	
Avg. Width (m)	7.02
Avg. Depth (cm)	11
Max. Depth (cm)	30
Avg. % Substrate Embeddedness	46.85
Mode Substrate Class	GC
Avg. Substrate Diameter (mm)	15.7
% Sand/Fines	4%
% Substrate > Fine Gravel	72%
% Canopy Cover	78.6%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	116%
LWD Density (m^3/m^2)	0.315
EPA RBP Score	92%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
17.79	2	158.61	0.027	1798.87	80.4%	12.8%	0.26%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Anguilla rostrata (*N*)	73	45
Lepomis macrochirus (*I*)	4	0
Rhinichthys atratulus (*N*)	95	345
Salmo trutta (*I*)	44	115
Salvelinus fontinalis (*N*)	5	15



Reach Downstream End – 2022

Adams Creek 14 was the second most downstream reach* on Adams Creek (*middle reach in 2013) and had similar conditions to other Adams Creek reaches, featuring mixed riparian forest and a substrate of coarse gravel, cobble, and some small boulders over smooth bedrock. However, the reach consisted of mostly riffle/run habitat with few deep pools. Several extensive LWD accumulations were present. The thermal regime was comparable to Adams Creek 21 (DEWA.3039) and cold enough to support trout reproduction. Like other reaches on Adams Creek, despite being seasonally closed to the public, newly discarded trash was found between visits, and a group of hikers trying to locate the old trail was encountered in the stream.



YOY brown trout

Blacknose dace *Rhinichthys atratulus* were abundant and American eels were common. Brown trout were also prolific, and many YOY individuals were captured throughout the reach. Brook trout were present but rare, with all captures being YOYs, except one adult. The adult brook trout was likely the same individual (identified by size and markings) captured on all three visits near the downstream end of the reach. The bluegill observed in 2013 were most likely transient from the upstream pools and unable to persist or reproduce due to the lack of pools and slow-moving water. However, given they were previously found in low numbers and only on the second and third visit, some may have been present and not captured in 2022 due to LWD, which made electrofishing difficult.

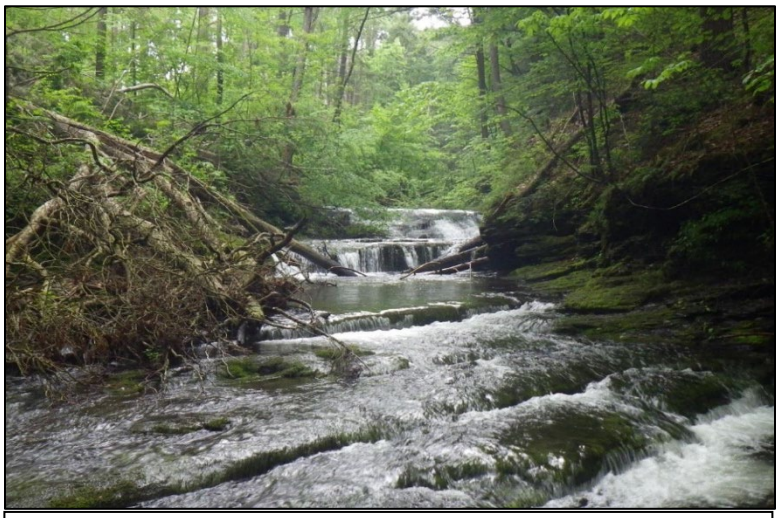


YOY brook trout



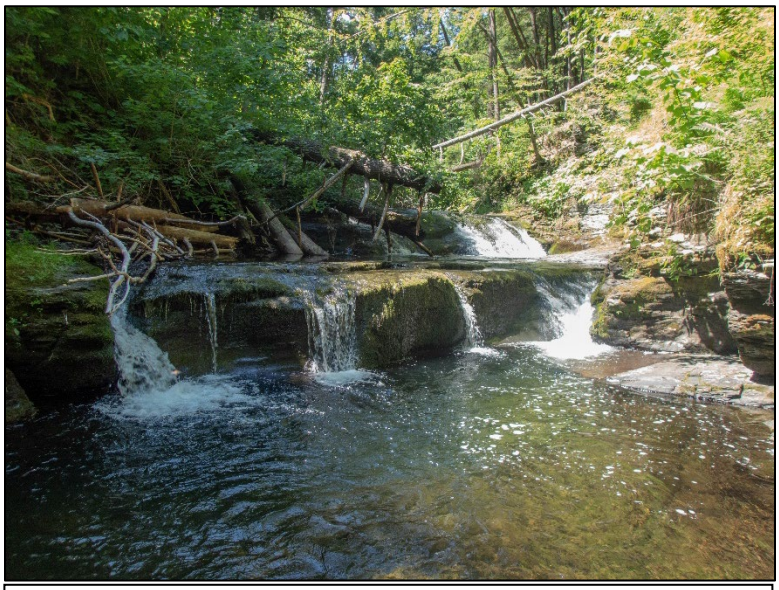
Single adult brook trout captured in reach

DEWA.3027 – Adams Creek 03



Reach Upstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	24.1
Avg. # Annual Days with Daily Mean Temp. > 20 °C	12
Avg. # Annual Days with Daily Max. Temp. > 20 °C	64
Avg. Julian Day of Annual Max. Temp.	186
Avg. DO (mg/L)	9.16
Avg. pH	7.09
Avg. Specific Conductance (µS/cm)	90.3
Avg. Discharge (m^3/s)	0.061



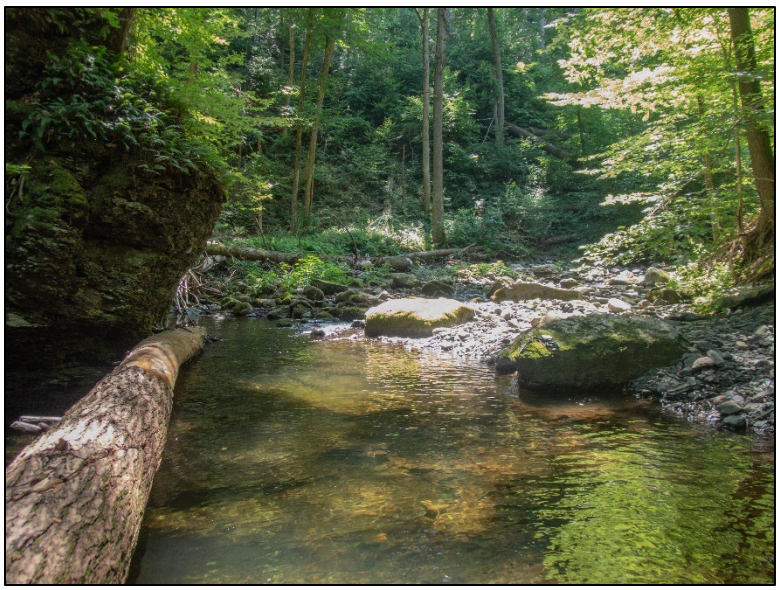
Reach Upstream End – 2022: Some LWD to left still present but out of view in photo

Reach Habitat	
Avg. Width (m)	5.72
Avg. Depth (cm)	14.16
Max. Depth (cm)	93
Avg. % Substrate Embeddedness	31.2%
Mode Substrate Class	RS*
Avg. Substrate Diameter (mm)	156.5
% Sand/Fines	0%
% Substrate > Fine Gravel	80%
% Canopy Cover	80.8%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	67%
LWD Density (m^3/m^2)	0.232
EPA RBP Score	92%

*RS = Smooth Bedrock

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
19.3	2	128.69	0.027	737.54	81.9%	11.8%	0.24%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Anguilla rostrata (*N*)	33	75
Lepomis gibbosus (*N*)	0	1
Lepomis macrochirus (*I*)	13	0
Micropterus salmoides (*I*)	3	0
Rhinichthys atratulus (*N*)	10	405
Salmo trutta (*I*)	74	41
Salvelinus fontinalis (*N*)	3	4
Semotilus atromaculatus (*N*)	0	2



Reach Downstream End – 2022: Deep bedrock pool; increased cobble bar and landslide debris at reach bend

Adams Creek 03 was the downstream-most reach on Adams Creek, located above a significant waterfall barrier and below a series of smaller waterfalls with a deep plunge pool (>3 m deep) that was inaccessible for backpack electrofishing. This reach was heavily forested with steep banks, but more recent Eastern Hemlock blowdowns caused landslides and heavy LWD accumulation in some areas. The substrate in the first and last 25 m was primarily smooth bedrock, while the middle section contained newly deposited cobble and gravel around a LWD jam that formed a pool. Despite increased light from new canopy openings, this reach had the fewest annual days with mean and maximum daily water temperatures exceeding 20 °C.

Regardless of the cold water, fewer brook trout were found here than the middle two Adams Creek reaches (although counts were similar to 2013), and only YOY were observed. Brown trout were also slightly reduced, but they remained common. Additional surveys would be necessary to determine if and why trout populations declined. Conversely, the number of blacknose dace increased notably, and one creek chub *Semotilus atromaculatus* was captured on the first and second visit, which was a new species observation for this reach. Similarly, one large adult pumpkinseed *Lepomis gibbosus* was captured near the edge of the deep plunge pool at the end of the reach. Although bluegill and largemouth bass were not detected in 2022, it is plausible that they were present in the pool with the pumpkinseed and were not captured. These centrarchids likely came from upstream pools or impoundments outside the park. Many American eels were present despite the height of several waterfalls between the reach and Delaware River.



Large adult pumpkinseed captured at the edge of the plunge pool on first visit

DEWA.3001 – Caledonia Creek 13



Reach Upstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	18.7
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	0
Avg. Julian Day of Annual Max. Temp.	250
Avg. DO (mg/L)	10.05
Avg. pH	6.84
Avg. Specific Conductance (µS/cm)	37.43
Avg. Discharge (m^3/s)	0.04



Reach Upstream End – 2022: One of two small trees had fallen into the pool and created a sand/gravel bar below it

Reach Habitat	
Avg. Width (m)	3.38
Avg. Depth (cm)	7.16
Max. Depth (cm)	32
Avg. % Substrate Embeddedness	44.8%
Mode Substrate Class	GC
Avg. Substrate Diameter (mm)	18.7
% Sand/Fines	20%
% Substrate > Fine Gravel	52%
% Canopy Cover	98.4%
% Mixed Veg. (non-deciduous)	40%
% Natural Fish Cover (all types)	125.5%
LWD Density (m^3/m^2)	0.150
EPA RBP Score	95.5%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
2.2	1	197	0.048	1267.7	98.64%	0.91%	0%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Salvelinus fontinalis (*N*)	173	175



Reach Downstream End – 2022

Caledonia Creek 13 was the only reach on Caledonia Creek. The Caledonia Creek watershed is entirely within the park and does not have upstream impoundments or urban development, which was reflected by the physical habitat and fish community. The reach was a small, heavily forested stream with dense rhododendrons in the immediate riparian area that provided almost complete canopy closure. Overall, it was relatively shallow with a few small pools formed by boulders or LWD, which was where most fish were captured. Substrate was a mixture of coarse gravel and cobble over bedrock. There were several deposits of clean sand and fine gravel in the tails of pools which provided good spawning habitat for trout. However, there were also some areas with silt and heavy leaf litter near new fallen LWD. The maximum annual water temperature was the lowest of all DEWA reaches, never exceeding 20 °C, which is ideal for trout and well below their thermal stress limit.

Brook trout was the only species observed at Caledonia Creek 13. Individuals of all size classes were captured in remarkably similar numbers to 2013. With a healthy brook trout population and a stable, cold thermal regime, this reach has potential to be a resilient brook trout stronghold. A small downstream impoundment for drinking water supply is fragmenting habitat (e.g., American eel migration) and drawing cold water from the stream; however, this barrier is also likely helping to prevent upstream invasion from introduced species.



Large adult brook trout with dark coloration



Brook trout YOY captured in reach

DEWA.3023 – UNT Dingmans Creek 07



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	26.1
Avg. # Annual Days with Daily Mean Temp. > 20 °C	9
Avg. # Annual Days with Daily Max. Temp. > 20 °C	72
Avg. Julian Day of Annual Max. Temp.	220
Avg. DO (mg/L)	9.39
Avg. pH	6.94
Avg. Specific Conductance (µS/cm)	137.1
Avg. Discharge (m^3/s)	0.093



Reach Downstream End – 2023: Large tree fallen into stream with root ball creating a scour pool in the middle

Reach Habitat	
Avg. Width (m)	4.84
Avg. Depth (cm)	9.96
Max. Depth (cm)	26
Avg. % Substrate Embeddedness	40%
Mode Substrate Class	CB*
Avg. Substrate Diameter (mm)	8.83
% Sand/Fines	20%
% Substrate > Fine Gravel	60%
% Canopy Cover	96.9%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	106.5%
LWD Density (m^3/m^2)	0.082
EPA RBP Score	91.5%

*CB = Cobble

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
2.26	1	218.7	0.066	3461.1	69.1%	26.1%	0.20%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Lepomis gibbosus (*N*)	9	34
Micropterus salmoides (*I*)	1	0
Rhinichthys atratulus (*N*)	156	86
Salvelinus fontinalis (*N*)	121	31



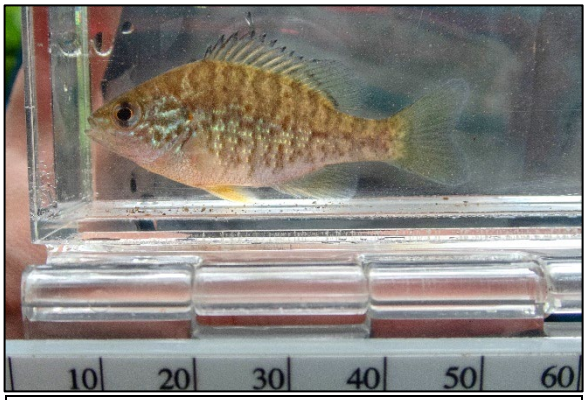
Reach Upstream End – 2023: Abundant invasive shrubs

UNT Dingmans Creek 07 was the only reach on a small tributary between the two downstream-most reaches on Dingmans Creek (DEWA.3004 and DEWA.3031). Located just above Silver Lake Road and adjacent to PA Route 739, this stream drains a mix of low intensity developed and suburban areas, which was evident from comparatively high specific conductance and litter around the stream. Increased light penetration from the reduced riparian buffer along the road has led to invasive shrubs dominating the understory. The stream was shallow with cobble and gravel substrate and a few small pools below LWD accumulations. There were areas along the right bank (facing downstream) with significant undercuts (at least 1 m). Most adult brook trout were captured from these undercut banks, including one very large individual.



Reach Upstream End – 2023 (Spring):

The ratio of pumpkinseed sunfish to brook trout increased considerably from 2013 to 2023. Most pumpkinseed captured were YOYs or small juveniles, which suggested the species may be reproducing in the reach, or individuals were recently flushed from an upstream impoundment. Largemouth bass was not detected in 2023 but could have been present and not captured as only one YOY was found on the third visit in 2013.



Juvenile pumpkinseed

The reduction of brook trout numbers from 2013 to 2023 was somewhat concerning, although the presence of a few YOY individuals indicates reproduction. With the average annual maximum water temperature at UNT Dingmans Creek exceeding a potentially lethal threshold (>25.3 °C), thermal stress may be a limiting factor for this brook trout population. Migratory individuals can also access Dingmans Creek, which may provide greater resources or thermal refugia, depending on time of year.



Large adult brook trout from under bank

DEWA.3008 – Dingmans Creek 57



Reach Upstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	28.2
Avg. # Annual Days with Daily Mean Temp. > 20 °C	85
Avg. # Annual Days with Daily Max. Temp. > 20 °C	126
Avg. Julian Day of Annual Max. Temp.	187
Avg. DO (mg/L)	8.39
Avg. pH	6.86
Avg. Specific Conductance (µS/cm)	82.9
Avg. Discharge (m^3/s)	0.159



Reach Upstream End – 2022: LWD present just above reach; some bank erosion

Reach Habitat	
Avg. Width (m)	8.64
Avg. Depth (cm)	14.7
Max. Depth (cm)	40
Avg. % Substrate Embeddedness	47.6%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	105
% Sand/Fines	4%
% Substrate > Fine Gravel	88%
% Canopy Cover	83.1%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	65%
LWD Density (m^3/m^2)	0.003
EPA RBP Score	90.5%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
32.5	3	280.66	0.048	6115.8	63.7%	20%	0.19%

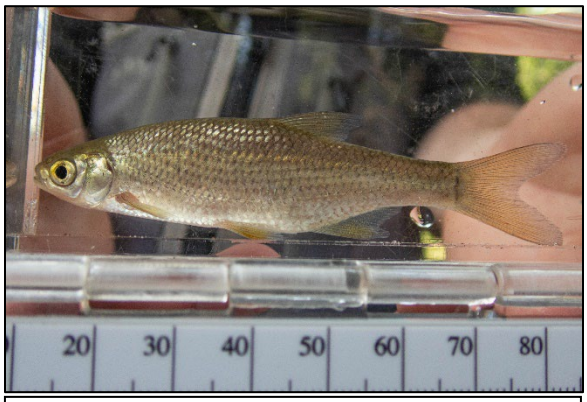
Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Ameiurus natalis (*N*)	1	9
Catostomus commersonii (*N*)	17	30
Lepomis gibbosus (*N*)	3	0
Lepomis macrochirus (*I*)	21	0
Micropterus salmoides (*I*)	10	1
Notemigonus crysoleucas (*N*)	0	1
Noturus insignis (*N*)	44	23
Oncorhynchus mykiss (*I*)	8	0
Perca flavescens (*N*)	12	0
Rhinichthys atratulus (*N*)	166	249
Salmo trutta (*I*)	10	0
Semotilus atromaculatus (*N*)	15	108



Reach Downstream End – 2022

Dingmans Creek 57 was the uppermost reach on Dingmans Creek, located below George W. Childs Park along PA Route 2004. This reach had the warmest annual maximum water temperature and the most days with temperatures exceeding 20°C of all DEWA reaches for both daily mean and maximum. It drains from several nearby lakes and residential communities, which are likely responsible for its relatively warm water temperatures.

The fish community was surprisingly sparse, despite the mix of riffle, run, and pool habitats, coarse substrate, and suitable fish cover. The reach was dominated by blacknose dace and creek chub, with white sucker *Catostomus commersonii* and margined madtom *Noturus insignis* being less common. Many of the warm water species captured in 2013 were caught in fewer numbers or not detected in 2022 (e.g., pumpkinseed, bluegill, yellow perch *Perca flavescens*, one YOY largemouth bass), whereas yellow bullhead *Ameiurus natalis* were found more often, and one golden shiner *Notemigonus crysoleucas* was a new species observation for the reach in 2022. These species likely came from upstream impoundments, given there are several large waterfalls downstream that prevent colonization, and the fluctuation in abundance or species presence reflects the periodic nature of lake flushing events rather than natural population dynamics within the reach. The lack of both brown trout and rainbow trout *Oncorhynchus mykiss* in 2022 was likely due to the cessation of trout stocking in Dingmans Creek after 2021, as well as warm water temperatures that prohibit trout reproduction.



Small golden shiner



YOY largemouth bass

DEWA.3015 – Dingmans Creek 39



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	26
Avg. # Annual Days with Daily Mean Temp. > 20 °C	67
Avg. # Annual Days with Daily Max. Temp. > 20 °C	110
Avg. Julian Day of Annual Max. Temp.	187
Avg. DO (mg/L)	8.67
Avg. pH	7
Avg. Specific Conductance (µS/cm)	108.1
Avg. Discharge (m^3/s)	0.082



Reach Downstream End – 2022: New LWD accumulations

Reach Habitat	
Avg. Width (m)	7.76
Avg. Depth (cm)	7.3
Max. Depth (cm)	30
Avg. % Substrate Embeddedness	60%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	38
% Sand/Fines	12%
% Substrate > Fine Gravel	64%
% Canopy Cover	98.2%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	51.5%
LWD Density (m^3/m^2)	0.046
EPA RBP Score	84.5%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
36.5	3	212.1	0.036	4387.5	64.1%	21.2%	0.23%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Anguilla rostrata (*N*)	0	1
Catostomus commersonii (*N*)	2	15
Lepomis macrochirus (*I*)	4	0
Micropterus salmoides (*I*)	0	2
Noturus insignis (*N*)	31	78
Oncorhynchus mykiss (*I*)	1	0
Rhinichthys atratulus (*N*)	87	258
Salmo trutta (*I*)	66	4
Semotilus atromaculatus (*N*)	1	46



Reach Upstream End – 2022: Shallow and flat

Dingmans Creek 39, the second most upstream reach on Dingmans Creek, shared similar habitat with Dingmans Creek 57 (DEWA.3008) but had less bedrock, fewer pools, and a lower stream gradient, which resulted in more fine sediment. It was more remote with a densely forested riparian area, which likely resulted in the cooler annual water temperatures than observed upstream at Dingmans Creek 57.

The fish community was similar to Dingmans Creek 57 but included fewer warmwater species, likely due to cooler water and the lack of pool habitat for their persistence, after being flushed from upstream impoundments. Two warmwater species—bluegill in 2013 and largemouth bass in 2022—may have been present in both sampling periods but not captured in one or the other due to their rarity and small size. One American eel, a new species record for this reach, was captured in 2022, suggesting that eels can navigate significant downstream barriers contrary to previous assumptions[3].

The absence of rainbow trout and relatively few brown trout was likely due to the cessation of stocking in Dingmans Creek after 2021. However, YOY individuals were captured on the first and third visits in 2022 which indicated that a wild brown trout population occurs in this reach. A few adult brown trout were encountered in pools just below the reach during the electrofishing test. Low water levels and warm temperatures in 2022 may have decreased the number of brown trout occupying the reach during late summer. The notable increase in blacknose dace, creek chub, and margined madtom may have been in part due to reduced trout predation.



YOY largemouth bass captured on the first visit

[3] Faulk 2015

DEWA.3031 – Dingmans Creek 30



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	25.4
Avg. # Annual Days with Daily Mean Temp. > 20 °C	69
Avg. # Annual Days with Daily Max. Temp. > 20 °C	106
Avg. Julian Day of Annual Max. Temp.	184
Avg. DO (mg/L)	9.86
Avg. pH	7.42
Avg. Specific Conductance (µS/cm)	103.5
Avg. Discharge (m^3/s)	0.377



Reach Downstream End – 2023: More LWD accumulation and deciduous understory growth

Reach Habitat	
Avg. Width (m)	10.24
Avg. Depth (cm)	16.8
Max. Depth (cm)	66
Avg. % Substrate Embeddedness	16.8%
Mode Substrate Class	RS
Avg. Substrate Diameter (mm)	803
% Sand/Fines	4%
% Substrate > Fine Gravel	84%
% Canopy Cover	89%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	113.5%
LWD Density (m^3/m^2)	0.132
EPA RBP Score	92%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
37	3	197.27	0.036	3525.9	64.5%	21%	0.22%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Ameiurus nebulosus (*N*)	1	0
Catostomus commersonii (*N*)	15	60
Lepomis gibbosus (*N*)	7	0
Lepomis macrochirus (*I*)	29	56
Micropterus salmoides (*I*)	5	7
Notemigonus crysoleucas (*N*)	1	0
Noturus insignis (*N*)	15	22
Oncorhynchus mykiss (*I*)	14	0
Perca flavescens (*N*)	5	8
Rhinichthys atratulus (*N*)	66	366
Salmo trutta (*I*)	48	10
Semotilus atromaculatus (*N*)	1	62



Large, deep pool and bedrock cliffs just below reach

Dingmans Creek 30 was the second downstream-most reach on Dingmans Creek, but it was closer and more similar in habitat features to Dingmans Creek 39 (DEWA.3015) than Dingmans Creek 05 (DEWA.3004). The reach was gorge-like, with steep banks and bedrock shelves, located above a small waterfall and very deep pool where people were cliff jumping and swimming. There were also several LWD accumulations throughout the reach and one deep pool at ~75 m that was difficult to backpack electrofish.

Like other Dingmans Creek reaches, the fish community was a mixture of cool and warmwater species, with YOY bluegill, largemouth bass, and yellow perch being captured in both sampling periods. These individuals likely originated from impoundments upstream. It is possible that warmwater species are reproducing in deeper pools in/near the reach, but their rarity suggests conditions are not ideal for their population growth. Likewise, although brown bullhead, pumpkinseed, and golden shiner may have been present in low numbers but not detected in 2023, their recent potential absence reflects the sporadic nature of lake flushing events rather than natural population dynamics within the reach.

The absence of rainbow trout and rarity of brown trout was likely due to the cessation of stocking in Dingmans Creek after 2021. Both YOY brown trout and an adult stocked brown trout were observed, indicating trout reproduction as well as likely stocked trout "holding over" (i.e., surviving for more than a year after stocking). However, temperatures exceeding brown trout thermal stress limits are likely limiting the wild population. The notable increase in blacknose dace, creek chub, white sucker, and margined madtom—all common prey items—may be the result of reduced predation by trout.



YOY yellow perch



Adult "holdover" stocked brown trout

DEWA.3004 – Dingmans Creek 05



Reach Upstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	24.75
Avg. # Annual Days with Daily Mean Temp. > 20 °C	54
Avg. # Annual Days with Daily Max. Temp. > 20 °C	83
Avg. Julian Day of Annual Max. Temp.	197
Avg. DO (mg/L)	9.86
Avg. pH	7.42
Avg. Specific Conductance (µS/cm)	103.5
Avg. Discharge (m^3/s)	0.124



Reach Upstream End – 2022: LWD swept away; bank erosion evident

Reach Habitat	
Avg. Width (m)	10.82
Avg. Depth (cm)	12.6
Max. Depth (cm)	36
Avg. % Substrate Embeddedness	68%
Mode Substrate Class	GF
Avg. Substrate Diameter (mm)	8.83
% Sand/Fines	28%
% Substrate > Fine Gravel	48%
% Canopy Cover	81.6%
% Mixed Veg. (non-deciduous)	80%
% Natural Fish Cover (all types)	79.5%
LWD Density (m^3/m^2)	0.069
EPA RBP Score	80.5%

*GF = Fine Gravel

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
43.6	3	126.53	0.013	1129.5	67.1%	20%	0.29%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Ambloplites rupestris (*I*)	0	2
Ameiurus natalis (*N*)	0	2
Ameiurus nebulosus (*N*)	3	1
Anguilla rostrata (*N*)	29	141
Catostomus commersonii (*N*)	33	52
Etheostoma olmstedi (*N*)	0	33
Exoglossum maxillingua (*N*)	17	44
Hypentelium nigricans (*N*)	2	8
Lepomis auritus (*N*)	2	0
Lepomis cyanellus (*I*)	1	1
Lepomis gibbosus (*N*)	10	3
Lepomis macrochirus (*I*)	11	3
Micropterus dolomieu (*I*)	0	6
Micropterus salmoides (*I*)	1	1
Noturus insignis (*N*)	47	38
Oncorhynchus mykiss (*I*)	14	0
Perca flavescens (*N*)	2	2
Percina peltata (*N*)	7	10
Petromyzon marinus (*N*)	0	6
Rhinichthys atratulus (*N*)	194	512
Rhinichthys cataractae (N)	92	231
Salmo trutta (*I*)	48	42
Semotilus atromaculatus (*N*)	0	72
Semotilus corporalis (*N*)	14	0



Reach Downstream End – 2022: New LWD on banks

Dingmans Creek 05 was the downstream-most reach on Dingmans Creek and had the third largest watershed area in DEWA, but interestingly, had the coolest water temperatures of all Dingmans Creek reaches. The reach was wide and flat with cobble substrate embedded in fine gravel. Under low flow conditions, the downstream-most ~50 m was exposed cobble that formed shallow riffles where many dace and darters were captured. The upstream half of the reach narrowed into a long, shallow pool that was more forested with undercut banks, which was where most centrarchids were captured.

This was the most speciose (21 species) reach at DEWA in 2022, partly due to its proximity and connectivity to the Delaware River, which was just over 1 km away with no significant barriers to fish movement. Several species observed in low numbers, in one or the other sampling period, may have "always" been present but not detected, such as yellow bullhead *Ameiurus natalis*, sea lamprey *Petromyzon marinus*, rock bass *Ambloplites rupestris*, redbreast sunfish *Lepomis auritus*, and smallmouth bass *Micropterus dolomieu*. It was surprising to find creek chub and tessellated darter *Etheostoma olmstedi* in large numbers in 2022, compared to zero captures a decade earlier. The lack of rainbow trout in 2022 was likely due to the cessation of trout stocking in Dingmans Creek after 2021; however, brown trout numbers remained similar, with many YOY and wild adult individuals observed. In 2013, fallfish *Semotilus corporalis* were only detected on the third visit (July 31), and it was hypothesized that they migrated during late summer as the water warmed to their preferred temperature. However, in 2022, the third visit occurred at a similar date (July 26), but fallfish were not captured. Due to the very low stream flow during summer 2022, fallfish (and other species) may not have been able to migrate as far up Dingmans Creek.

DEWA.3033 – Dunnfield Creek 26



Reach Upstream End – 2015 (no photo from 2013)

Water Quality	
Avg. Annual Max. Temp. (°C)	21.8
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	22
Avg. Julian Day of Annual Max. Temp.	221
Avg. DO (mg/L)	9.57
Avg. pH	6.48
Avg. Specific Conductance (µS/cm)	27.1
Avg. Discharge (m^3/s)	0.060

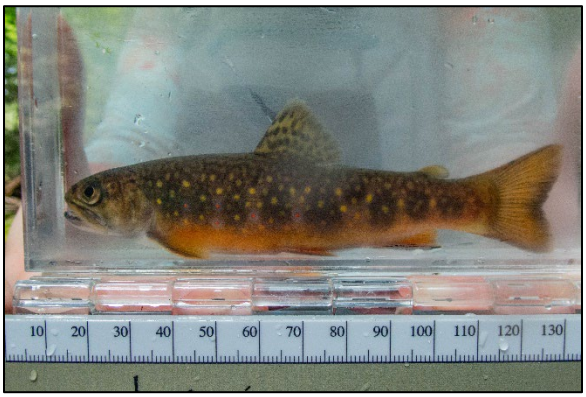


Reach Upstream End – 2023: Some increased erosion and undercutting of banks

Reach Habitat	
Avg. Width (m)	4.19
Avg. Depth (cm)	8.0
Max. Depth (cm)	29
Avg. % Substrate Embeddedness	55.2%
Mode Substrate Class	GF
Avg. Substrate Diameter (mm)	20.5
% Sand/Fines	0%
% Substrate > Fine Gravel	64%
% Canopy Cover	99.0%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	36%
LWD Density (m^3/m^2)	0.058
EPA RBP Score	89.5%

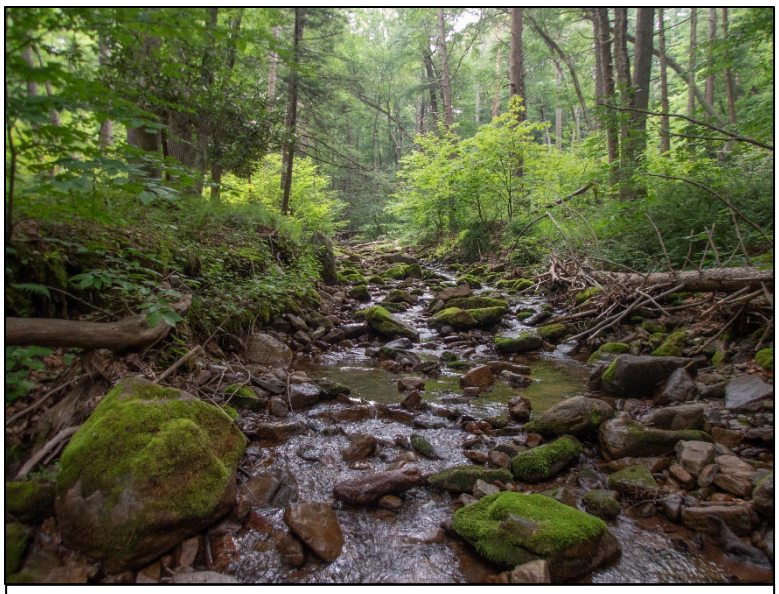
Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
6.8	2	222.12	0.041	2568.2	93.1	0.29	0.05

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Anguilla rostrata (*N*)	0	1
Salmo trutta (*I*)	133	29
Salvelinus fontinalis (*N*)	26	50





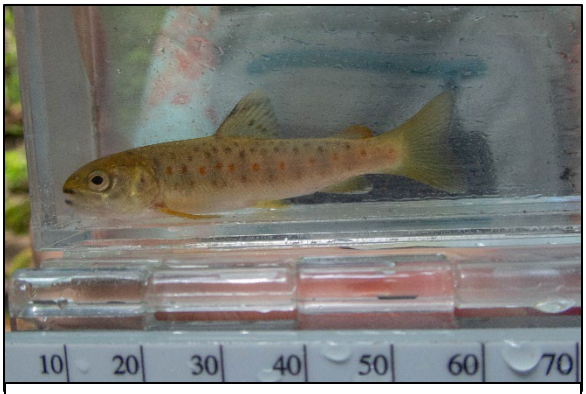
Adult (top) and YOY (bottom) brook trout



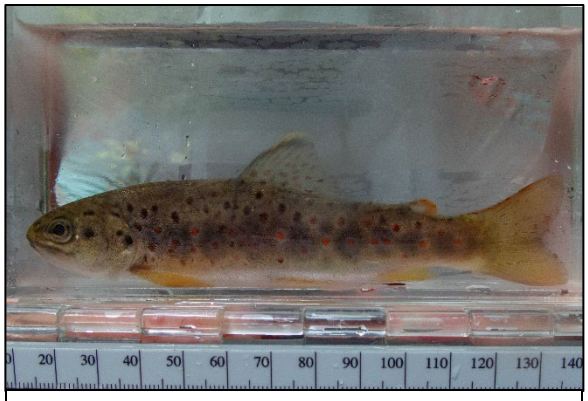
Reach Downstream End – 2022: Reach was straight and high gradient, causing erosional downcutting on banks

Dunnfield Creek 26 was the upper reach* on Dunnfield Creek (*middle reach in 2013; DEWA.30037 retired), located in Worthington State Forest. It was remote and heavily forested, flowing along Dunnfield Creek Hiking Trail, which joins the Appalachian Trail nearby. The reach was straight and steep with mostly cobble to small boulder substrate, surrounded by fine gravel, creating an almost continuous series of riffles and runs with few pools. The water temperature was cold and rarely exceeded 20 °C—ideal for trout.

One American eel was captured in the reach on the third visit, and other eels were observed just outside the reach. This was the first record of American eel at this reach, indicating they can navigate significant waterfalls above Dunnfield Creek 03 (DEWA.3005), contrary to prior hypotheses. Brook trout remained abundant in all size classes, although the proportion of YOYs to adults increased later in the summer, likely as adults sought deeper (cooler) pools elsewhere for thermal refuge. Compared to 2013, brown trout was less abundant and captured in fewer numbers than brook trout, contrary to the 2013 effort. Given that brown trout typically outcompete brook trout, this sympatric population with stable brook trout numbers may be important for brook trout conservation. Given the reach topography and relative lack of pools, LWD, or other habitat features, it may be vulnerable to flash floods/droughts which are expected to increase with increasing frequency of extreme weather patterns.



YOY brown trout



Adult brown trout

DEWA.3005 – Dunnfield Creek 03



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	20.8
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	6
Avg. Julian Day of Annual Max. Temp.	221
Avg. DO (mg/L)	9.13
Avg. pH	6.9
Avg. Specific Conductance (µS/cm)	34.3
Avg. Discharge (m^3/s)	0.023



Reach Downstream End – 2022: Large boulders shifted and embedded in large cobble deposit; bank near trail becoming undercut

Reach Habitat	
Avg. Width (m)	4.32
Avg. Depth (cm)	10.24
Max. Depth (cm)	40
Avg. % Substrate Embeddedness	48%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	84.3
% Sand/Fines	4%
% Substrate > Fine Gravel	84%
% Canopy Cover	95.1%
% Mixed Veg. (non-deciduous)	80%
% Natural Fish Cover (all types)	107.5%
LWD Density (m^3/m^2)	0.156
EPA RBP Score	89.0%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
9.75	2	108.63	0.061	349	95.1	0.21	0.07

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Anguilla rostrata (*N*)	44	107
Salmo trutta (*I*)	214	139
Salmo trutta × *Salvelinus fontinalis* (tiger trout; *I*)	1	0
Salvelinus fontinalis (*N*)	6	2



Reach Upstream End – 2013: Large deposit of small cobble separating two pools



Reach Upstream End – 2022: Cobble deposit washed downstream; bedrock shelf now exposed with large cobble and small boulders sitting on top surrounded by new LWD

Dunnfield Creek 03 was the downstream-most reach on Dunnfield Creek, located along a popular section of the Appalachian Trail. The reach was relatively steep with large boulder cascades separating cobble-filled runs. There was a ~25 m long, flat, bedrock pool, in which many large adult eels and brown trout were captured, that ended at a ~2 m high waterfall and LWD accumulation near the 75 m transect. More recent floods dramatically moved large deposits of cobble and small boulders throughout the reach, shifting the main channel closer to the trail and causing some bank erosion with new trees falling in. Surprisingly, given the large open pools, this reach had slightly colder annual water temperature metrics than the upstream Dunnfield Creek reach, possibly due to groundwater inflow between sites and/or the headwaters of Dunnfield Creek flowing out of a small, presumably warm, pond near Upper Yards Creek Reservoir.

American eel and brown trout still dominated the reach, with many individuals of all size classes captured. Only one adult brook trout, visually identified as the same individual, was found on the second and third visits. Maintaining habitat stability and availability amid volatile stream flows appeared to be the greatest conservation need at this reach.

DEWA.3035 – Hornbecks Creek 15



Reach Upstream End – 2015 (no photo from 2013)



Reach Upstream End – 2023: Majority of LWD still present and channel substrate appeared stable

Water Quality	
Avg. Annual Max. Temp. (°C)	24.4
Avg. # Annual Days with Daily Mean Temp. > 20 °C	46
Avg. # Annual Days with Daily Max. Temp. > 20 °C	87
Avg. Julian Day of Annual Max. Temp.	210
Avg. DO (mg/L)	9.63
Avg. pH	7.28
Avg. Specific Conductance (µS/cm)	142.1
Avg. Discharge (m^3/s)	0.219

Reach Habitat	
Avg. Width (m)	6.88
Avg. Depth (cm)	13.5
Max. Depth (cm)	38
Avg. % Substrate Embeddedness	36.4%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	41.5
% Sand/Fines	4%
% Substrate > Fine Gravel	84%
% Canopy Cover	96.9%
% Mixed Veg. (non-deciduous)	80%
% Natural Fish Cover (all types)	92%
LWD Density (m^3/m^2)	0.086
EPA RBP Score	94.0%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
20.1	3	143.75	0.021	2323.3	67.2	20.8	1.4

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Anguilla rostrata (*N*)	45	72
Catostomus commersonii (*N*)	7	3
Esox niger (*N*)	0	1
Exoglossum maxillingua (*N*)	16	65
Hypentelium nigricans (*N*)	7	1
Lepomis auritus (*N*)	1	0
Lepomis macrochirus (*I*)	2	2
Luxilus cornutus (*N*)	2	2
Micropterus salmoides (*I*)	0	5
Noturus insignis (*N*)	90	72
Percina peltata (*N*)	10	0
Rhinichthys atratulus (*N*)	22	27
Rhinichthys cataractae (*N*)	22	39
Salmo trutta (*I*)	106	39
Semotilus corporalis (*N*)	48	19



Reach Downstream End – 2023: Some erosion and bank undercutting along hiking trail, just upstream from foot bridge

Hornbecks Creek 15, the only reach* on Hornbecks Creek (*lowest reach in 2013; DEWA.3019 retired), flowed through a steep ravine with a hiking trail along most of its length. The reach was mostly flat with cobble substrate and a few pools below small boulders and LWD accumulations. The headwaters of Hornbecks Creek drain several impoundments and a relatively high percentage of developed area (i.e., residential areas) which likely led to higher specific conductance than most DEWA reaches. Additionally, Hornbecks Creek 15 had the second highest percentage of agricultural land use of all reaches, after White Brook 15.

Despite the upstream land uses, Hornbecks Creek 15 was notably speciose for a stream of its size, with mostly native cool water species; American eel, margined madtom, and several minnow species were abundant in both survey periods. The few centrarchids and chain pickerel *Esox niger* may have come from upstream impoundments, although fish are likely able to colonize this reach from the Delaware River as there are few significant downstream barriers.

Brown trout were found in several age classes, including YOYs, which indicated natural reproduction within and/or upstream of the reach. However, the markedly fewer captured brown trout (compared to 2013) may have reflected marginally suitable water temperatures limiting the species' population growth. Timing differences between sampling periods did not explain the reduction in captured brown trout. During 2013, the most individuals caught (47 individuals) during any visit occurred on the last visit (July 25, ~10:30 am) when water temperature was 17.7˚C. On nearly the same date in 2023 (i.e., July 25), only 12 brown trout were caught, but the water temperature was a degree warmer (18.7˚C) earlier in the day (9:00 am). It is possible that shield darter *Percina peltata* was present but not detected in 2023, given that it was rarely caught in 2013 and is difficult to capture with electrofishing gear. However, the potential absence of shield darter could be a concern given its sensitivity to siltation, pollution, and warm water temperatures.

DEWA.3003 – Deckers Creek 03



Reach Downstream End – 2014 (no comparable photo from 2013)



Reach Downstream End – 2022: channel substantially filled in with cobble and gravel (large boulder in lower left almost covered); very little flow

Water Quality	
Avg. Annual Max. Temp. (°C)	21.6
Avg. # Annual Days with Daily Mean Temp. > 20 °C	7
Avg. # Annual Days with Daily Max. Temp. > 20 °C	24
Avg. Julian Day of Annual Max. Temp.	197
Avg. DO (mg/L)	9.26
Avg. pH	6.83
Avg. Specific Conductance (µS/cm)	179.9
Avg. Discharge (m^3/s)	0.002

Reach Habitat	
Avg. Width (m)	2.48
Avg. Depth (cm)	2.12
Max. Depth (cm)	6
Avg. % Substrate Embeddedness	57.2%
Mode Substrate Class	GF
Avg. Substrate Diameter (mm)	15.7
% Sand/Fines	4%
% Substrate > Fine Gravel	52%
% Canopy Cover	93.9%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	45%
LWD Density (m^3/m^2)	0.42
EPA RBP Score	78%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
2.5	2	173.5	0.076	2896.7	82%	10.1%	1.3%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Ameiurus natalis (*N*)	1	0
Anguilla rostrata (*N*)	12	4
Lepomis gibbosus (*N*)	4	0
Lepomis macrochirus (*I*)	112	1
Notemigonus crysoleucas (*N*)	1	0
Oncorhynchus mykiss (*I*)	0	3
Perca flavescens (*N*)	2	0
Rhinichthys atratulus (*N*)	30	26



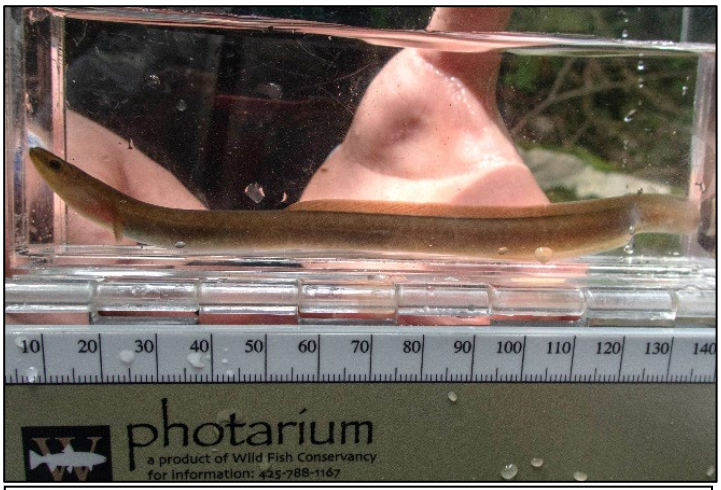
Mostly dry streambed with small pool under Japanese barberry where the rainbow trout was captured

Deckers Creek 03 was the only reach on Deckers Creek, which is a small, mostly forested tributary that drains two small impoundments in its headwaters that joins Hornbecks Creek just above DEWA.3035. It had extremely low water on the first visit (June 20) and was nearly dry with disjunct pools by the third visit (July 6). Despite this, the water temperature was relatively cold (12 – 17˚C) during that period. Based on reference photos and the relatively depauperate fish community, the reach is likely intermittent, in some, if not all years. In-reach habitat was lacking and the understory in the riparian area was dominated by invasive shrubs.



Stocked rainbow trout that was captured on all three visits

Blacknose dace was the most common species, with a few small American eels one small bluegill caught captured. One stocked rainbow trout was captured on all three visits in a small pool near the midpoint, which was the deepest location in the reach. It was surprising that this trout was able to survive in such low water conditions. It almost certainly came from one of the upstream impoundments (e.g., “Loch Lomond”) which is annually stocked with rainbow trout (PAFBC 2025). The other warm water/lentic species captured in low numbers in 2013 that were absent in 2022 (yellow bullhead, golden shiner, pumpkinseed, and yellow perch) also likely came from the upstream impoundments but are unlikely to persist in the intermittent reach. However, more juvenile bluegill and pumpkinseeds were observed in a small pool filled with LWD just below the reach during the electrofishing test.



Small American eel

DEWA.3013 – Little Bushkill Creek 01



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	25.2
Avg. # Annual Days with Daily Mean Temp. > 20 °C	64
Avg. # Annual Days with Daily Max. Temp. > 20 °C	99
Avg. Julian Day of Annual Max. Temp.	210
Avg. DO (mg/L)	9.54
Avg. pH	6.94
Avg. Specific Conductance (µS/cm)	70.3
Avg. Discharge (m^3/s)	0.337



Reach Downstream End – 2022: LWD no longer present

Reach Habitat	
Avg. Width (m)	8.82
Avg. Depth (cm)	20.4
Max. Depth (cm)	54
Avg. % Substrate Embeddedness	60.4%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	27.9
% Sand/Fines	24%
% Substrate > Fine Gravel	68%
% Canopy Cover	51.9%
% Mixed Veg. (non-deciduous)	0%
% Natural Fish Cover (all types)	38%
LWD Density (m^3/m^2)	0.012
EPA RBP Score	88.5%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
86.2	3	110.8	0.012	1721.1	71.3%	8.4%	0.15%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Ambloplites rupestris (*I*)	0	1
Ameiurus nebulosus (*N*)	0	1
Anguilla rostrata (*N*)	202	335
Catostomus commersonii (*N*)	14	22
Etheostoma olmstedi (*N*)	41	20
Exoglossum maxillingua (*N*)	22	59
Hypentelium nigricans (*N*)	6	7
Lepomis gibbosus (*N*)	35	0
Lepomis macrochirus (*I*)	5	0
Luxilus cornutus (*N*)	51	14
Micropterus dolomieu (*I*)	1	0
Micropterus salmoides (*I*)	4	0
Noturus insignis (*N*)	38	42
Oncorhynchus mykiss (*I*)	19	2
Perca flavescens (*N*)	2	0
Percina peltata (*N*)	42	60
Petromyzon marinus (*N*)	12	6
Rhinichthys atratulus (*N*)	352	346
Rhinichthys cataractae (*N*)	122	250
Salmo trutta (*I*)	24	6
Salvelinus fontinalis (*N*)	0	2
Semotilus corporalis (*N*)	78	23



Reach Upstream End – 2022. Most habitat was in this section

Little Bushkill Creek 01 was the largest DEWA reach by watershed area and the only reach on Little Bushkill Creek. The stream joins Bushkill Creek just downstream of the reach and is ~1.5 km from the Delaware River. The reach substrate was mostly cobble with a few small boulders and considerable fine sediment deposition in slower sections. One very large pool with significant LWD near the midpoint was too deep to electrofish effectively, but several stocked trout and many eels were captured from it.

Little Bushkill Creek 01 was the second most speciose reach after Dingmans Creek 05 (DEWA.3004), compared to being tied for the most speciose in 2013. The reach was open to fish colonization from the river, but several upstream impoundments may have contributed lentic species (e.g., brown bullhead *Ameiurus nebulosus*, yellow perch, pumpkinseed, bluegill, largemouth bass), which may have led to differences between sampling periods in their presence and abundance. Additionally, beavers were active in the area and constructed a dam just downstream of the reach between the second and third visits, which could periodically make the reach more habitable for lentic species. The remaining native species were present in similar or increased numbers as during 2013, except for common shiner and fallfish, which was potentially due to increased recruitment and immigration to the reach later in the summer of 2013. The prevalence of all size classes of eels and sea lamprey ammocoetes highlighted the importance of river connectivity for conservation of migratory species. The rainbow trout and brook trout were visually identified as stocked individuals that could have easily migrated from Bushkill Creek, which was stocked with both species. Brown trout are also stocked in Little Bushkill, but most of individuals captured were YOYs, indicating natural reproduction in or upstream of the reach, despite relatively warm annual water temperatures.

DEWA.3029 – Sand Hill Creek 08



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	26.9
Avg. # Annual Days with Daily Mean Temp. > 20 °C	64
Avg. # Annual Days with Daily Max. Temp. > 20 °C	122
Avg. Julian Day of Annual Max. Temp.	203
Avg. DO (mg/L)	8.41
Avg. pH	7.60
Avg. Specific Conductance (µS/cm)	288.6
Avg. Discharge (m^3/s)	0.086



Reach Downstream End – 2022: New LWD

Reach Habitat	
Avg. Width (m)	4.79
Avg. Depth (cm)	11.4
Max. Depth (cm)	37
Avg. % Substrate Embeddedness	67.6%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	9.7
% Sand/Fines	20%
% Substrate > Fine Gravel	60%
% Canopy Cover	96.3%
% Mixed Veg. (non-deciduous)	0%
% Natural Fish Cover (all types)	91.5%
LWD Density (m^3/m^2)	0.034
EPA RBP Score	78%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
8.4	2	126.3	0.012	2795.2	56.9%	28.6%	1.1%

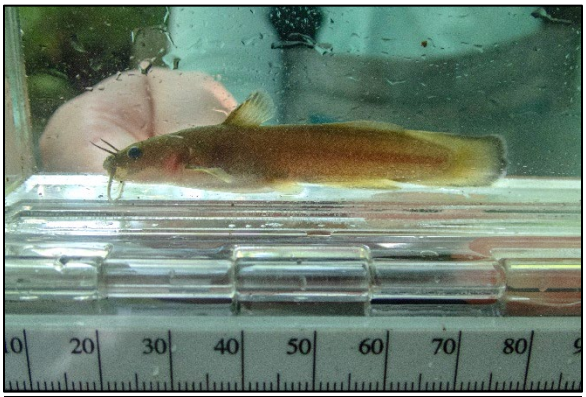
Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Anguilla rostrata (*N*)	66	35
Catostomus commersonii (*N*)	4	0
Exoglossum maxillingua (*N*)	2	0
Lepomis macrochirus (*I*)	0	1
Micropterus salmoides (*I*)	1	1
Notemigonus crysoleucas	1	0
Noturus insignis (*N*)	13	1
Rhinichthys atratulus (*N*)	227	290
Salmo trutta (*I*)	23	0
Salvelinus fontinalis (*N*)	1	0
Semotilus corporalis (*N*)	6	0



Reach Upstream End 2022 – Slightly more open with increased light penetration and invasive shrubs

Sand Hill Creek 08 was the only reach on Sand Hill Creek, which runs along PA Route 209 and drains a golf course, residential areas and commercially development; the reach had one of the highest relative percentages of developed land use of all DEWA reaches. As likely consequences, specific conductance was greater, and water temperature was warmer at this reach than any other DEWA reach. The reach was low gradient and very shallow, with cobble substrate and high sediment deposition. The understory was dominated by invasive shrubs, such that areas along the bank were difficult to electrofish due to the amount of overhanging vegetation.

The depauperate fish community reflected the relatively poor water quality and habitat condition throughout the reach. Blacknose dace were the most frequently caught species, with American eel being the only other common species; both species are generally tolerant to degraded conditions. Only one individual of three species (margined madtom, largemouth bass, bluegill) were captured. The comparatively few margined madtom individuals caught in 2022 was somewhat concerning, given the species' moderate tolerance to poor conditions compared to other madtom species. Although Sandhill Creek is open to colonization from Bushkill Creek and Delaware River, upstream impoundments may have provided source populations of largemouth bass and bluegill to the reach, as well as the single golden shiner captured in 2013. The trout observed in 2013 may have been stocked individuals that migrated upstream from Bushkill Creek. Also, the lack of trout and other cool water species (e.g., white sucker, cutlip minnow, and fallfish) caught during 2022 may have been due to sampling later in the summer with lower flows and warmer temperatures than in 2013. However, these species, as well as brown trout, were captured on the last visit in 2013 (July 15), which is within the sampling date range in 2022 (July 12 – July 31). Therefore, their potential absence may indicate habitat degradation and stressful (i.e., warm) water temperatures for cool water species. This reach could benefit from stream corridor restoration to help mitigate negative effects, likely attributable to upstream land uses.

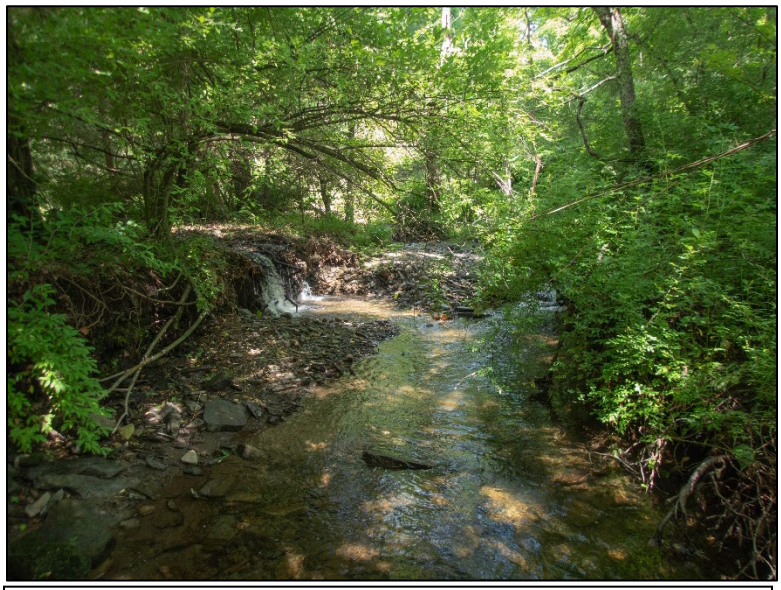


Single margined madtom that was captured on the first visit

DEWA.3020 – Mill Creek 25



Reach Upstream End – 2013



Reach Upstream End – 2022

Water Quality	
Avg. Annual Max. Temp. (°C)	24.1
Avg. # Annual Days with Daily Mean Temp. > 20 °C	30
Avg. # Annual Days with Daily Max. Temp. > 20 °C	91
Avg. Julian Day of Annual Max. Temp.	221
Avg. DO (mg/L)	9.17
Avg. pH	7.08
Avg. Specific Conductance (µS/cm)	94.1
Avg. Discharge (m^3/s)	0.041

Reach Habitat	
Avg. Width (m)	3.94
Avg. Depth (cm)	13.8
Max. Depth (cm)	64
Avg. % Substrate Embeddedness	49.6%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	70.6
% Sand/Fines	8%
% Substrate > Fine Gravel	88%
% Canopy Cover	91.8%
% Mixed Veg. (non-deciduous)	80%
% Natural Fish Cover (all types)	35%
LWD Density (m^3/m^2)	0.032
EPA RBP Score	76.5%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
7.6	2	241.1	0.029	3183.5	77.4%	13.5%	0.5%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Ameiurus nebulosus (*N*)	40	3
Esox niger (*N*)	3	8
Lepomis cyanellus (*I*)	20	0
Lepomis gibbosus (*N*)	17	11
Lepomis macrochirus (*I*)	1	4
Micropterus salmoides (*I*)	1	0
Notemigonus crysoleucas	1	0
Perca flavescens (*N*)	4	0
Rhinichthys atratulus (*N*)	188	119
Semotilus atromaculatus (*N*)	153	97



Reach Downstream End 2022 – Deep pool above boulder,

Mill Creek 25 was the only reach* on Mill Creek (*Mill Creek 12 was scheduled for fish sampling in 2022 but was not, due to unsafe access caused by storm damage during 2018/2019. The reach was located along Brisco Mountain Road and above a small, old, cement barrier. The road was visible from the reach and interrupted the riparian buffer, which caused increased light penetration, and an understory dominated by invasive shrubs. Despite the proximity to the road and some residential development upstream, the water quality and thermal regime was comparable to other DEWA reaches with more intact habitat (e.g., DEWA.3035, 3011, 3031). The reach was mostly shallow with cobble, although the first and last 25 m sections contained deeper pools filled with fine sediment. The reach split into two channels at multiple points: once near the midpoint, and once at the upstream end where water flows over a large mass of tree roots, acting as a small natural barrier.

Blacknose dace and creek chub were the two most abundant species, and are both cool water, native minnows, relatively tolerant to degraded habitats. However, several warmwater/lentic species were also present (e.g., brown bullhead, chain pickerel, pumpkinseed, and bluegill); other pond species captured in low numbers in 2013 may have been present but not detected in 2022 (e.g., golden shiner, yellow perch, largemouth bass). Several nearby, upstream impoundments likely contributed these species and may be responsible for the fluctuation in abundance/presence between sampling periods (e.g., the reduction in brown bullhead numbers and potential absence of green sunfish). Additionally, beaver ponds upstream were potential source populations for the lentic species. During the second sampling visit, the water suddenly became very turbid, and discharge increased significantly. After personal communication with park Natural Resources staff, it was determined that a beaver dam had intentionally been removed, causing a pulse in flow and sediment that reduced visibility in the upstream-most ~25 m.



Largest chain pickerel, captured on first visit



Brown bullhead captured on second visit

DEWA.3032 – Raymondskill Creek 13



Reach Upstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	27.8
Avg. # Annual Days with Daily Mean Temp. > 20 °C	75
Avg. # Annual Days with Daily Max. Temp. > 20 °C	120
Avg. Julian Day of Annual Max. Temp.	188
Avg. DO (mg/L)	9.34
Avg. pH	6.99
Avg. Specific Conductance (µS/cm)	114.4
Avg. Discharge (m^3/s)	0.735

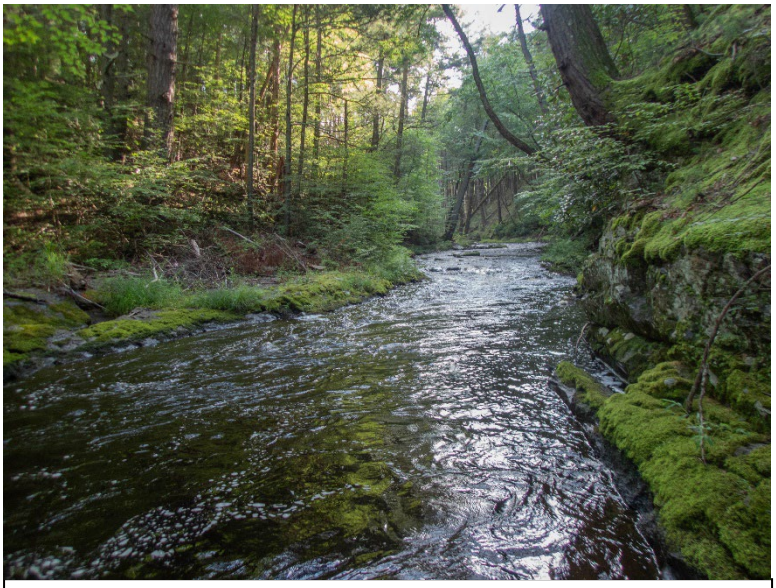


Reach Downstream End – 2023 (reach was shifted upstream)

Reach Habitat	
Avg. Width (m)	14.5
Avg. Depth (cm)	26.0
Max. Depth (cm)	94
Avg. % Substrate Embeddedness	39.6%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	73.8
% Sand/Fines	20%
% Substrate > Fine Gravel	76%
% Canopy Cover	69.2%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	69%
LWD Density (m^3/m^2)	0.032
EPA RBP Score	90%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
59.1	3	214.9	0.058	2162.8	65.8%	18.0%	0.86%

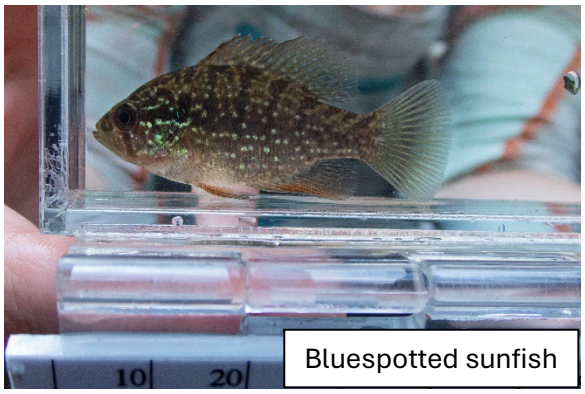
Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Ameiurus nebulosus (*N*)	2	0
Catostomus commersonii (*N*)	13	34
Enneacanthus gloriosus (*N*)	1	1
Esox americanus (*N*)	2	18
Esox niger (*N*)	2	1
Etheostoma olmstedi (*N*)	20	36
Lepomis auritus (*N*)	0	6
Lepomis gibbosus (*N*)	1	1
Lepomis macrochirus (*I*)	0	3
Luxilus cornutus (*N*)	4	7
Micropterus salmoides (*I*)	0	1
Notropis amoenus (*N*)	2	0
Noturus insignis (*N*)	45	44
Percina peltata (*N*)	5	0
Rhinichthys atratulus (*N*)	101	148
Rhinichthys cataractae (*N*)	274	235
Semotilus corporalis (*N*)	2	4



Reach Upstream End – 2023: Bedrock pool

Raymondskill Creek 13 was the only reach on Raymondskill Creek, located above a bridge crossing on PA Route 2009 and a series of cascading waterfalls. The reach was moved upstream since the 2013 survey to include riffle habitat for ERMN benthic macroinvertebrate monitoring. This was the second largest DEWA reach by watershed area and had the second warmest water temperature. The riparian area was heavily forested with a large proportion of coniferous trees, which likely contributed to the very tannic stream water. The downstream half of the reach was mostly cobble with a ~25 m riffle section that split into two channels around a small island, while the upstream half was a long, deep bedrock pool with some sand/fine sediment near a LWD pile.

Longnose dace *Rhinichthys cataractae* and blacknose dace were the most abundant species, while margined madtom, tessellated darter, and white sucker were also common. Other species were much less abundant and therefore may have been present in both survey periods but not always detected (i.e., caught). The magnitude of many downstream barriers likely prevents colonization; consequently, the lentic species were likely from nearby, upstream impoundments. However, all species except bluegill and largemouth bass were native, and are also known to inhabit larger streams. One large, male redbreast sunfish was seen guarding a nest, and two YOY were captured, indicating reproduction within the reach. This was the only reach where redfin pickerel *Esox americanus* and bluespotted sunfish *Enneacanthus gloriosus* were captured.



Bluespotted sunfish



Redfin pickerel

DEWA.3022 – Toms Creek 25



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	23.8
Avg. # Annual Days with Daily Mean Temp. > 20 °C	9
Avg. # Annual Days with Daily Max. Temp. > 20 °C	43
Avg. Julian Day of Annual Max. Temp.	210
Avg. DO (mg/L)	9.74
Avg. pH	7.39
Avg. Specific Conductance (µS/cm)	115.1
Avg. Discharge (m^3/s)	0.267



Reach Downstream End – 2023: LWD accumulation stable; bank scour/erosion less obvious

Reach Habitat	
Avg. Width (m)	12.6
Avg. Depth (cm)	10.84
Max. Depth (cm)	56
Avg. % Substrate Embeddedness	48$
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	11.5
% Sand/Fines	16%
% Substrate > Fine Gravel	64%
% Canopy Cover	96.3%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	98.5%
LWD Density (m^3/m^2)	0.081
EPA RBP Score	91%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
18.9	3	166.21	0.023	4325.7	75.7%	21.5%	0.11%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Anguilla rostrata (*N*)	66	88
Lepomis gibbosus (*N*)	1	1
Rhinichthys atratulus (*N*)	19	182
Salmo trutta (*I*)	154	178
Salvelinus fontinalis (*N*)	1	1
Semotilus atromaculatus (*N*)	0	5



Reach Upstream End 2023 – Root ball with undercut bank

Toms Creek 25 was the upstream-most reach on Toms Creek, which had a relatively high proportion of low-intensity developed land due to the adjacent and upstream residential community. Despite having the smallest watershed of all Toms Creek reaches, it had the warmest water temperature summary metrics for Toms Creek, likely due to (1) warm outflow from several upstream impoundments and (2) a large area upstream of the reach, within park boundaries, with mostly open canopy and a large pool. Both the open canopy and large pool were a result of Eastern hemlock blowdowns and subsequent LWD; the increased sunlight shining on the relatively stagnant pool is very likely warming the stream. Substrate was mostly cobble and coarse gravel with some sand/fines in slower sections near several large LWD accumulations in the first ~50 m. The second half of the reach was a long, straight run with less fish cover, except for some root balls and LWD along the banks towards the end.



Large open area upstream of reach with slow pools and increased light penetration from hemlock blowdowns



Single adult brook trout captured on the first visit

Blacknose dace was the most frequently caught species, and it was seemingly much more abundant than in 2013. Similarly to 2013, brown trout and American eel were also abundant. Creek chub was a new species observation for this reach, but it may have been present in 2013, given its recent rarity. Like the 2013 survey, only one YOY pumpkinseed was observed, which likely came from an upstream impoundment. Additionally, one adult brook trout was captured, also only on the first visit, indicating that a brook trout population is persisting in low numbers in the Toms Creek headwaters. With warm water temperatures and high brown trout density, this reach and upstream areas may be important areas to focus brook trout conservation efforts.

DEWA.3006 – Toms Creek 20



Reach Upstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	20.9
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	5
Avg. Julian Day of Annual Max. Temp.	210
Avg. DO (mg/L)	9.38
Avg. pH	6.77
Avg. Specific Conductance (µS/cm)	140.2
Avg. Discharge (m^3/s)	0.098



Reach Upstream End – 2022: New LWD accumulation and increase in cobble bar; majority of flow shifted to

Reach Habitat	
Avg. Width (m)	7.42
Avg. Depth (cm)	9.36
Max. Depth (cm)	55
Avg. % Substrate Embeddedness	58.4%
Mode Substrate Class	GF
Avg. Substrate Diameter (mm)	16.4
% Sand/Fines	12%
% Substrate > Fine Gravel	52%
% Canopy Cover	96.7%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	65%
LWD Density (m^3/m^2)	0.067
EPA RBP Score	91.5%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
19.2	3	155.8	0.023	3846	76%	21.1%	0.10%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Ameiurus nebulosus (*N*)	2	0
Anguilla rostrata (*N*)	38	50
Rhinichthys atratulus (*N*)	12	108
Salmo trutta (*I*)	230	254



Reach Downstream End 2022 – Overhanging root ball with bank erosion; substantial LWD for the first ~25m

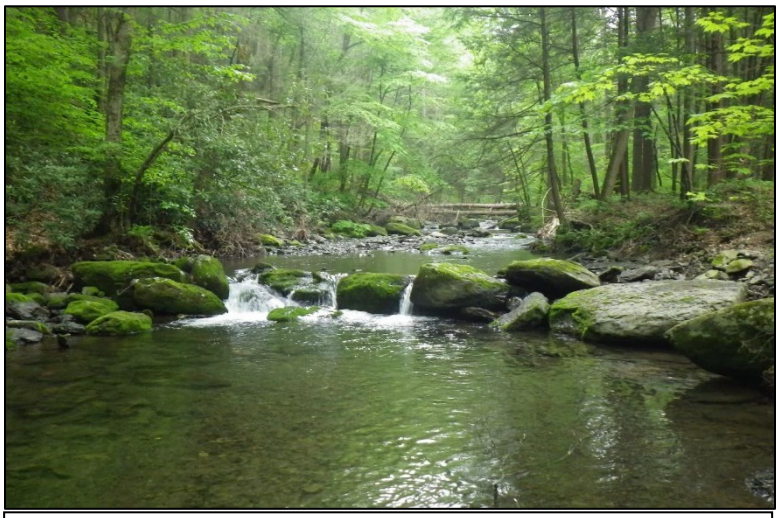
Toms Creek 20 was the second most upstream reach on Toms Creek, with similar habitat to Toms Creek 25 (DEWA.3022), but fewer pools and less LWD. The reach was mostly wide, flat riffles and runs with cobble substrate embedded in fine gravel. Some areas of the bank had significant erosion, and more recent increases in cobble bars/gravel deposition were apparent. The water temperature summary metrics for this reach were much colder than upstream, suggesting the water continues to cool down from the upstream development and ponds as it flows through the forested riparian area with possible groundwater influence.

The fish community was more typical of a low-productivity, cold water stream. Brown trout was the dominant species at this reach, and individuals of all size classes were observed, including several very large adults (>40 cm) that were captured in small pools below root balls. Blacknose dace was also abundant, with a notable increase in counts compared to 2013. American eels of various sizes were common. Although brown bullhead may have been present but not detected in 2022, the individual captured in 2013 likely originated from an upstream impoundment; therefore, the potential absence of this species almost certainly reflected transient individuals rather than natural population dynamics, given the cold-water temperature metrics.



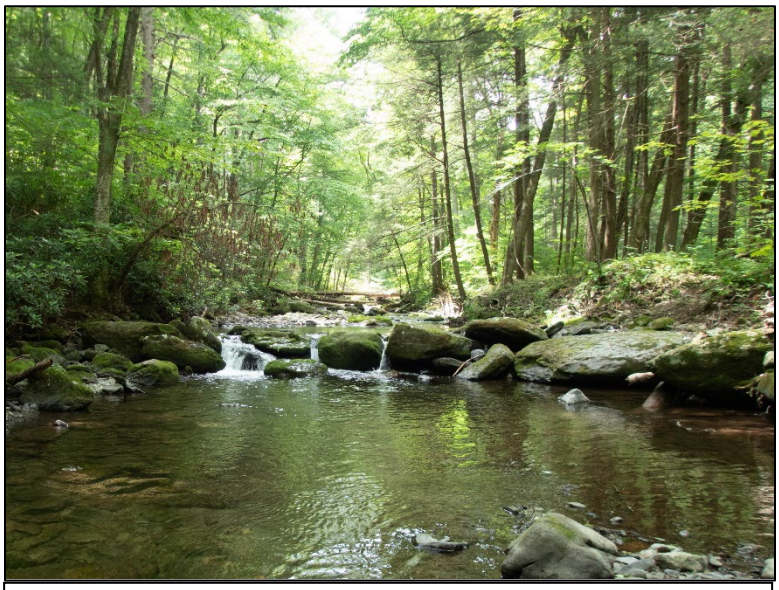
One of several very large brown trout captured in at “Toms Creek 20”

DEWA.3018 – Toms Creek 07



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	20.6
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	11
Avg. Julian Day of Annual Max. Temp.	210
Avg. DO (mg/L)	10.1
Avg. pH	7.18
Avg. Specific Conductance (µS/cm)	138.5
Avg. Discharge (m^3/s)	0.147



Reach Downstream End – 2022: No notable differences; small bent tree on left bank (facing upstream) appeared to be dead/dying (brown leaves)

Reach Habitat	
Avg. Width (m)	5.96
Avg. Depth (cm)	14.08
Max. Depth (cm)	41
Avg. % Substrate Embeddedness	63.2%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	59.2
% Sand/Fines	16%
% Substrate > Fine Gravel	76%
% Canopy Cover	97.5%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	62%
LWD Density (m^3/m^2)	0.113
EPA RBP Score	92%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
21.4	3	123.2	0.027	2602.4	76.6%	20.6%	0.13%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Anguilla rostrata (*N*)	59	54
Exoglossum maxillingua (*N*)	6	13
Lepomis cyanellus (*I*)	1	0
Lepomis gibbosus (*N*)	2	0
Noturus insignis (*N*)	10	2
Rhinichthys atratulus (*N*)	21	29
Rhinichthys cataractae (*N*)	5	2
Salmo trutta (*I*)	248	209
Salvelinus fontinalis (*N*)	6	0
Semotilus atromaculatus (*N*)	1	0



Reach Upstream End, 2022 – Runs with cobble below small waterfalls, created by large boulders, was the typical habitat throughout the reach.

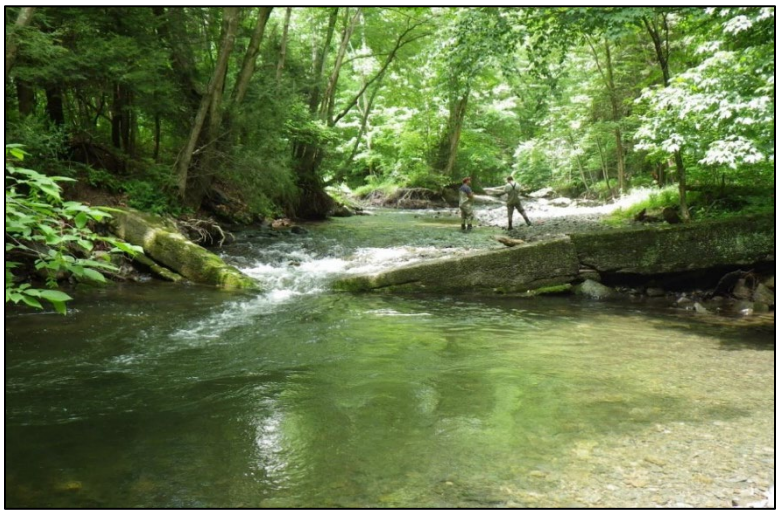
Toms Creek 07 was the second downstream-most reach on Toms Creek, located along a popular hiking trail with some bank erosion evident at the beginning of the reach. It had similar habitat to the other Toms Creek reaches, but with more large boulders and deeper pools. There were two pools near the reach's downstream end and midpoint that contained many large trout and eels. The thermal regime was relatively cold and most like Toms Creek 20 (DEWA.3006).

The fish community was slightly more speciose than at reaches farther upstream, but similarly indicative of a cold to cool water thermal regime. As with reaches farther upstream, brown trout and American eel were the most abundant species and were caught in similar numbers to 2013. The number of large adult brown trout decreased later in the summer with diminishing stream flows. With only a few moderately sized downstream barriers, other minnow species (e.g., longnose dace and cutlip minnow) and margined madtom were able to colonize this portion of Toms Creek. Creek chub may have been present but not detected during 2022, as only one individual was captured in 2013, and creek chub were present at the upstream-most Toms Creek reach (DEWA.3022). Similarly, green sunfish and pumpkinseed may have been present but not detected in 2022, although the 2013 individuals may have been transient from an upstream impoundment, especially because the outflow of Landis Lake and several other smaller impoundments join Toms Creek just downstream of the reach. The lack of brook trout may have been due to sampling timing, as the 2013 individuals were captured only on the first visit (May 22), which occurred much earlier in the year than sampling during 2022 (June 21 – July 12). However, water temperatures throughout the summer of 2022 were suitable for brook trout, indicating competition with brown trout may be affecting brook trout abundance. More surveys would be required to determine if brook trout are extirpated from this reach or if the species continues to occupy it seasonally.



Large brown trout captured in pool near midpoint

DEWA.3034 – Toms Creek 03



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	21.1
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	23
Avg. Julian Day of Annual Max. Temp.	220
Avg. DO (mg/L)	9.98
Avg. pH	7.36
Avg. Specific Conductance (µS/cm)	118.1
Avg. Discharge (m^3/s)	0.281



Reach Downstream End – 2023: chunk of concrete barrier washed away; channel shifted to opposite side; increased bank erosion

Reach Habitat	
Avg. Width (m)	5.18
Avg. Depth (cm)	20.36
Max. Depth (cm)	61
Avg. % Substrate Embeddedness	25.6%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	39.7
% Sand/Fines	0%
% Substrate > Fine Gravel	84%
% Canopy Cover	96.5%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	85.5%
LWD Density (m^3/m^2)	0.045
EPA RBP Score	90%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
24.0	3	114.8	0.016	949.9	78.1%	18.8%	0.14%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Ameiurus nebulosus (*N*)	6	0
Anguilla rostrata (*N*)	56	58
Etheostoma olmstedi (*N*)	0	1
Exoglossum maxillingua (*N*)	6	15
Lepomis cyanellus (*I*)	0	1
Lepomis gibbosus (*N*)	6	0
Lepomis macrochirus (*I*)	1	0
Micropterus dolomieu (*I*)	0	11
Notropis amoenus (*N*)	1	0
Noturus insignis (*N*)	14	5
Percina peltata (*N*)	2	4
Rhinichthys atratulus (*N*)	0	20
Rhinichthys cataractae (*N*)	27	29
Salmo trutta (*I*)	286	130
Salvelinus fontinalis (*N*)	1	0
Semotilus corporalis (*N*)	2	3

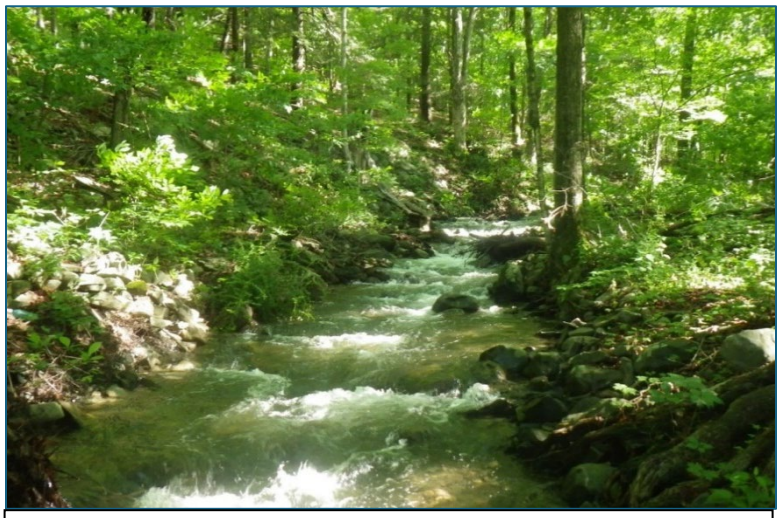


Old Reach Upstream End – 2023: Dry channel at head of island that used to contain most stream flow and was the upstream reach end through 2019.

Toms Creek 03 was the downstream-most reach on Toms Creek, less than 1 km upstream from the Delaware River with no significant barriers hindering migration or colonization. The reach was next to a popular picnicking and hiking area, with many obvious signs of human activity, including bank erosion near the trail and stacked rocks/small rock dams creating slow pools later in the summer. At the downstream end of the reach, a piece of an old cement impoundment was washed farther downstream, while the remaining blocks were being undercut, creating a shallow pool. Since the 2013 survey, the upper 50 m of the stream channel changed from two split channels to flowing entirely on the right side of the island (facing downstream), with the other channel being completely dry. Most of the reach was riffle-run-pool habitat with large cobble substrate and little to no sand/fines. A deep pool near the midpoint and a long deep run next to the island for ~25 m were difficult to electrofish. There was a large area of substantial erosion and LWD accumulation from a landslide between the midpoint and upstream end. The water temperature was slightly warmer than the two middle Toms Creek reaches (DEWA.3006 & 3018), but colder than the most upstream reach (DEWA.3022), and suitable for trout.

Brown trout remained the dominant species (i.e., as during 2013) but considerably fewer were caught during 2023. This did not appear to be due to timing differences between surveys; in 2013, most trout were captured on the third visit (161 trout; Aug. 6) whereas in 2023, the most trout (60 individuals) were captured during the second visit on August 1. American eel was the next most abundant species, followed by longnose dace, which were both captured in similar numbers to 2013. The increase in blacknose dace was interesting, given their non-detection in 2013. Fallfish, cutlip minnow, margined madtom, and shield darter were present in similarly low numbers in both years. The remaining warm water/lentic species that were observed in low numbers in only one sampling period (e.g., comely shiner, brown bullhead, all *Lepomis* spp.) may have either migrated in from the river or come from an upstream impoundment. The reach may be important nursey habitat for smallmouth bass as only YOYs were captured. Tessellated darter and brook trout may have been present in both years but not detected, as only one individual each was captured; however, competition and predation from brown trout remain as threats.

DEWA.3002 – Van Campen Creek 12



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	24.75
Avg. # Annual Days with Daily Mean Temp. > 20 °C	54
Avg. # Annual Days with Daily Max. Temp. > 20 °C	83
Avg. Julian Day of Annual Max. Temp.	197
Avg. DO (mg/L)	9.56
Avg. pH	7.26
Avg. Specific Conductance (µS/cm)	234.5
Avg. Discharge (m^3/s)	0.031

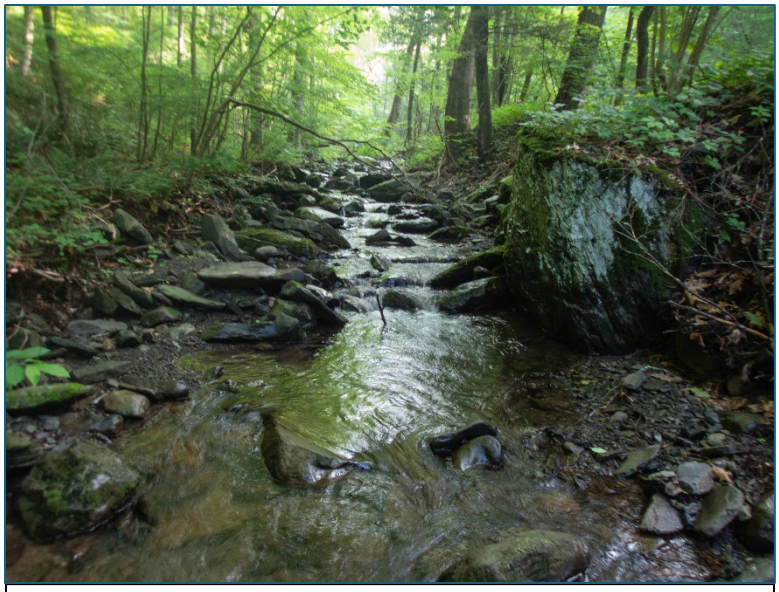


Reach Downstream End – 2022: No notable differences; some new LWD and changes in understory

Reach Habitat	
Avg. Width (m)	2.72
Avg. Depth (cm)	7.52
Max. Depth (cm)	24
Avg. % Substrate Embeddedness	51.6%
Mode Substrate Class	GC
Avg. Substrate Diameter (mm)	59.2
% Sand/Fines	4%
% Substrate > Fine Gravel	88%
% Canopy Cover	99.8%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	24%
LWD Density (m^3/m^2)	0.016
EPA RBP Score	90%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
3.85	1	161.44	0.049	1435.7	59.7%	36.9%	0.02%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Anguilla rostrata (*N*)	2	4
Rhinichthys atratulus (*N*)	33	27
Salmo trutta (*I*)	83	57



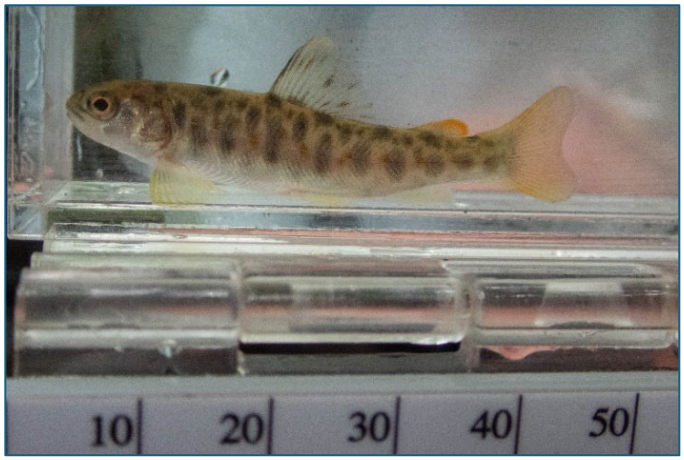
Reach Upstream End – 2022: Straight channel near road

Van Campen Creek 12 was the only reach on Van Campen Creek. Upstream of the park boundary, the stream flows from a pond (Maple Lake) and drains a residential community and municipal buildings, which resulted in this reach having the highest percentage of "developed" land use of all DEWA reaches. Upstream development, combined with the fact that the stream flows directly adjacent to Broadhead Road, likely resulted in the relatively high stream conductivity and warm water.



Small American eel.

Fish habitat was relatively poor; the stream was steep, straight, and shallow with very few pools. Substrate was mostly cobble, surrounded by coarse gravel with a few small boulders and sparse LWD. The fish community reflected the poor habitat quality, with only three relatively tolerant species present. It was surprising that brown trout persisted here, given the annual maximum water temperature was above the species' thermal stress threshold and daily temperatures frequently exceeded 20°C. Later in the summer, most captured individuals were YOYs, indicating suitable conditions for natural reproduction. Blacknose dace, which can tolerate a wide variety of habitat conditions, were uncommon (7 – 11 individuals per visit) and American eels were able to colonize the reach but were not abundant.

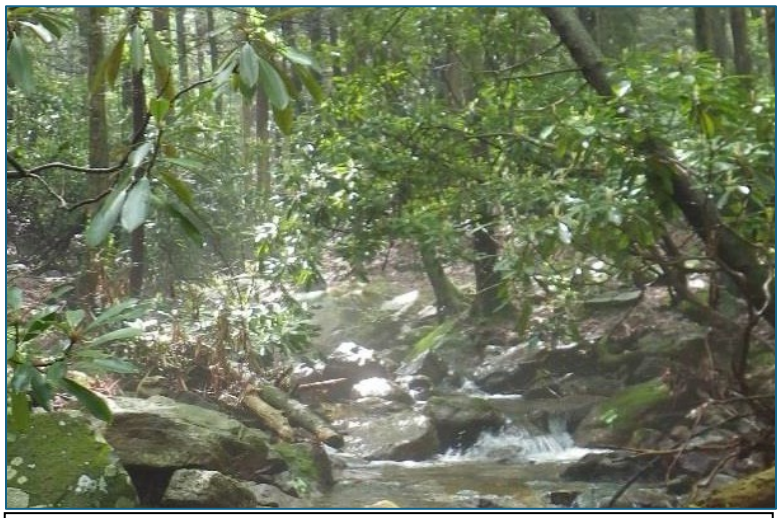


YOY brown trout



Largest adult brown trout captured (~15 cm)

DEWA.3026 – UNT to Vancampens Brook 05



Reach Downstream End – 2013



Reach Downstream End – 2023

Water Quality	
Avg. Annual Max. Temp. (°C)	20.3
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	1
Avg. Julian Day of Annual Max. Temp.	199
Avg. DO (mg/L)	9.63
Avg. pH	7.03
Avg. Specific Conductance (µS/cm)	31
Avg. Discharge (m^3/s)	0.019

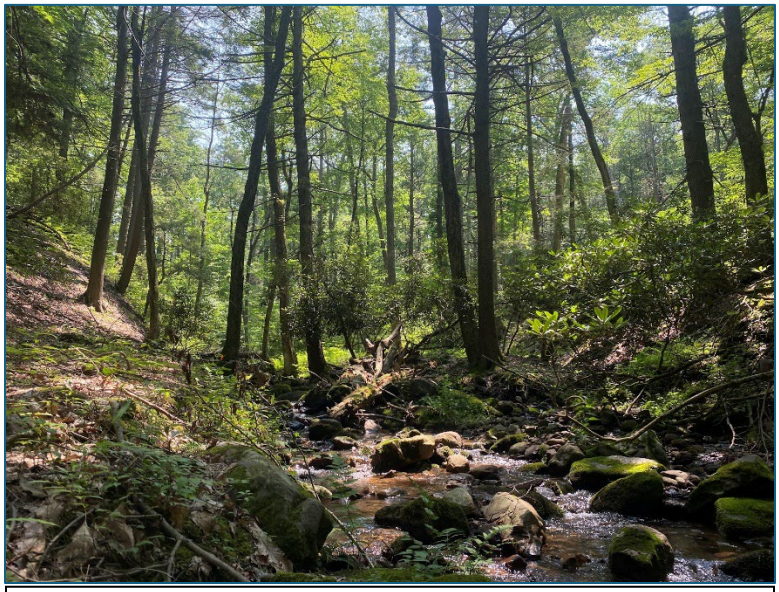
Reach Habitat	
Avg. Width (m)	3.76
Avg. Depth (cm)	5.4
Max. Depth (cm)	18
Avg. % Substrate Embeddedness	50.4%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	30.5
% Sand/Fines	12%
% Substrate > Fine Gravel	72%
% Canopy Cover	99.4%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	73%
LWD Density (m^3/m^2)	0.049
EPA RBP Score	92%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
2	1	286.8	0.058	11169.1	97.8%	0%	0.07%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Lepomis gibbosus (*N*)	8	0
Oncorhynchus mykiss (*I*)	1	0
Salvelinus fontinalis (*N*)	164	155



Reach Upstream End 2023 – LWD and boulder jam created small pool at head of reach.



Boulder-riffle-plunge pool habitat that was typical throughout the reach with a mixed riparian canopy

UNT Vancampens Brook 05 was on a headwater tributary that flows into Vancampens Brook downstream of Vancampens Brook 76 (DEWA.3038). The reach was high gradient with mostly cobble and small boulder substrate. It was very shallow during late summer, although a few small plunge pools existed below boulders and LWD, where most fish were captured. The downstream part of the reach had some rhododendron coverage, but this opened into a young deciduous understory near the reach's upstream end, where several Eastern hemlock trees had died and fallen. There appeared to be a spring seep with very cold water and sandy bottom flowing into the stream just before the reach's upstream end, where a few YOY trout were caught. The thermal regime was cold and ideal for trout, only exceeding 20˚C once, and that occurred on the date of annual maximum water temperature. The watershed is almost entirely forested with no upstream development, which was reflected in the low specific conductance and cool water temperatures.

Only brook trout were caught at this reach, in similar numbers to as in 2013. There was a mix of all size classes, which was somewhat surprising given the extremely low stream flows. The upstream impoundment (Mountain Ridge Lake) that likely contributed the 2013 pumpkinseed appears (based on aerial imagery) to fluctuate hydrologically, possibly due to beaver activity, which may be why no pumpkinseeds were captured in 2023. Pumpkinseeds caught in 2013 were almost certainly transient from the pond upstream, because it is unlikely that they would persist in this reach given the cold water. Similarly, rainbow trout were not captured in 2023, but there are no barriers downstream to prohibit trout in Vancampens Brook from migrating into the reach; the rainbow trout captured during 2013 likely migrated from Vancampens Brook. This reach is important for brook trout conservation because it: (1) was one of only three DEWA reaches where brook trout was the only trout species found (DEWA.3001 and 3010 were the others), (2) had excellent habitat and water quality, and (3) had consistently cold water.

DEWA.3010 – Vancampens Brook 95



Reach Downstream End – 2014 (no photo from 2013)

Water Quality	
Avg. Annual Max. Temp. (°C)	24.6
Avg. # Annual Days with Daily Mean Temp. > 20 °C	6
Avg. # Annual Days with Daily Max. Temp. > 20 °C	53
Avg. Julian Day of Annual Max. Temp.	210
Avg. DO (mg/L)	8.15
Avg. pH	5.24
Avg. Specific Conductance (µS/cm)	19.9
Avg. Discharge (m^3/s)	0.003



Reach Downstream End – 2022

Reach Habitat	
Avg. Width (m)	5.2
Avg. Depth (cm)	2.08
Max. Depth (cm)	8
Avg. % Substrate Embeddedness	76%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	5.43
% Sand/Fines	24%
% Substrate > Fine Gravel	48%
% Canopy Cover	99.6%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	128.5%
LWD Density (m^3/m^2)	0.022
EPA RBP Score	77%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
2.4	1	328.9	0.040	12890.6	88.3%	0.38%	0.12%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Salvelinus fontinalis (*N*)	22	30



Reach Upstream End 2022 – Heavy fine sediment layered on bedrock and cobble substrate with dense rhododendron cover

Vancampens Brook 95 was the fifth-smallest DEWA reach by watershed area and the most upstream reach on Vancampens Brook, located near the outflow of Long Pine Pond. It was very shallow and nearly dry by midsummer. The channel was poorly defined with many braided sections flowing over bedrock that had been broken into irregular, rectangular pieces of cobble. Deep pools were absent and thick layers of sand/fines accumulated in the few shallow pools downstream from root balls and small boulders. Dense rhododendron lined the banks, providing almost complete canopy closure. The water was low pH, likely due to low acid neutralizing capacity of the underlying geology and natural tannins, which very likely helped explain why only brook trout were present, given their tolerance to relatively acidic conditions. The water also had very low conductivity, which is indicative of clean, freestone streams.

Although the average water temperature throughout the 2022 survey period was slightly cooler (19.6˚C) than the 20˚C thermal threshold for trout, the water temperature summary metrics were quite warm, with daily maximum temperatures frequently exceeding 20˚C, and the annual maximum (24.6˚C) approaching the potentially lethal threshold for brook trout. Altered hydrology from the upstream impoundment (Long Pine Pond) is very likely responsible for the elevated water temperatures and sediment deposition, among other unnatural downstream effects.

It was surprising to find brook trout in the warm, turbid, and low water conditions, especially in slightly greater numbers than during 2013. All size classes were captured, which indicated that this reach serves as both nursery waters for YOY and summer habitat for adults. This was one of three DEWA reaches where only brook trout were present (DEWA.3001 and 3026) and is an important location for brook trout to persist without competition from other salmonids in the Vancampens Brook watershed, although warming water temperatures are likely to threaten the population. Many large adult brook trout were observed downstream of the reach in a large pool below a perched culvert where Vancampens Brook crosses Flatbrookville Stillwater Road. In low water conditions, this barrier likely prevents trout from accessing upstream habitat.

DEWA.3038 – Vancampens Brook 76



Reach Downstream End – 2015 (no photo from 2013)

Water Quality	
Avg. Annual Max. Temp. (°C)	21.3
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	15
Avg. Julian Day of Annual Max. Temp.	198
Avg. DO (mg/L)	9.60
Avg. pH	6.79
Avg. Specific Conductance (µS/cm)	30.5
Avg. Discharge (m^3/s)	0.113



Reach Downstream End – 2023: Increased LWD bridging above channel in first ~25m

Reach Habitat	
Avg. Width (m)	5.7
Avg. Depth (cm)	11.8
Max. Depth (cm)	36
Avg. % Substrate Embeddedness	48.4%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	15.7
% Sand/Fines	28%
% Substrate > Fine Gravel	60%
% Canopy Cover	98.6%
% Mixed Veg. (non-deciduous)	100%
% Natural Fish Cover (all types)	47.5%
LWD Density (m^3/m^2)	0.030
EPA RBP Score	94%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
5.8	2	267.1	0.027	11034.6	91.6%	1.4%	0.05%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Ameiurus natalis (*N*)	14	0
Ameiurus nebulosus (*N*)	1	0
Anguilla rostrata (*N*)	0	1
Catostomus commersonii (*N*)	1	2
Esox niger (*N*)	1	0
Lepomis auritus (*N*)	5	8
Lepomis cyanellus (*I*)	1	0
Lepomis gibbosus (*N*)	9	1
Lepomis macrochirus (*I*)	1	0
Oncorhynchus mykiss (*I*)	3	1
Rhinichthys atratulus (*N*)	45	82
Salvelinus fontinalis (*N*)	234	87
Semotilus atromaculatus (*N*)	5	4



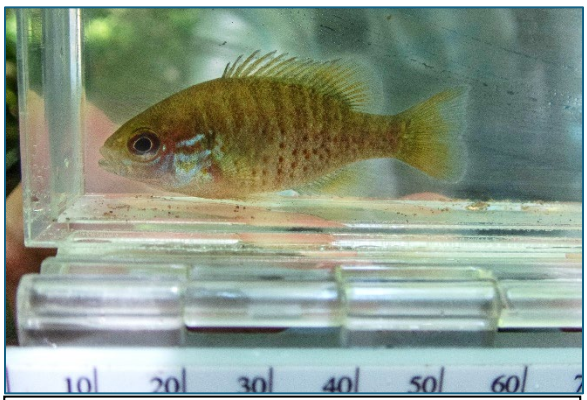
Large pool (facing downstream) near midpoint where pond species were captured – 2023

Vancampens Brook 76 was the second most upstream reach on Vancampens Brook in a very remote and heavily forested area, ~300 m upstream from the UNT confluence. The reach primarily consisted of shallow, riffle-run habitat over cobble, except for one long, deep pool with hardpan and fine sediment near the midpoint. Low water in mid-summer caused significant mats of moss to grow on the substrate in some areas. The thermal regime was the coldest of all Vancampens Brook reaches (not including the UNT).

Brook trout remained the most abundant species but less than half were caught than during 2013. Blacknose dace were caught nearly as frequently as brook trout, almost doubling the 2013 counts. Creek chub and white sucker were rare but consistent with 2013 observations. Among the warm water species caught during 2013, only redbreast sunfish and pumpkinseed were found in 2023, suggesting that they may have been transient from upstream impoundments. However, YOY and adult redbreast sunfish were captured in the mid-reach pool, which had suitable centrarchid breeding habitat. A small American eel, which was a new species record for the reach, may have been present due to improved aquatic passage after the removal of downstream barriers at Watergate Recreation Area. Only one rainbow trout was captured, on the third visit, which appeared to be wild. It may have been migrating upstream seeking thermal refuge, given that temperatures measured downstream were warmer.



Wild rainbow trout



YOY/Juvenile redbreast sunfish

DEWA.3014 – Vancampens Brook 73



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	22.3
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	39
Avg. Julian Day of Annual Max. Temp.	220
Avg. DO (mg/L)	9.46
Avg. pH	6.83
Avg. Specific Conductance (µS/cm)	65.8
Avg. Discharge (m^3/s)	0.057

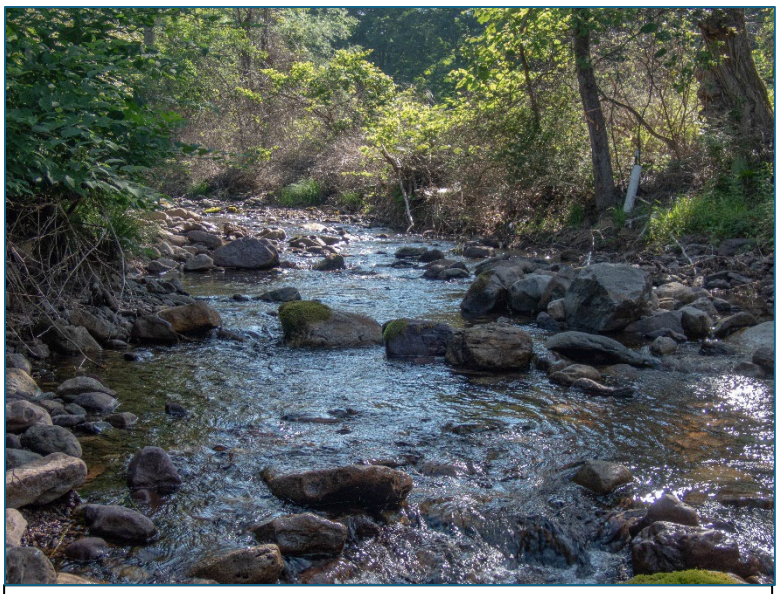


Reach Downstream End – 2023: Reach was adjusted after 2018, when stream "jumped" banks and formed new channel

Reach Habitat	
Avg. Width (m)	3.52
Avg. Depth (cm)	8.16
Max. Depth (cm)	24
Avg. % Substrate Embeddedness	53.2%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	33.3
% Sand/Fines	4%
% Substrate > Fine Gravel	88%
% Canopy Cover	72.0%
% Mixed Veg. (non-deciduous)	40%
% Natural Fish Cover (all types)	81.5%
LWD Density (m^3/m^2)	0.006
EPA RBP Score	80.5%

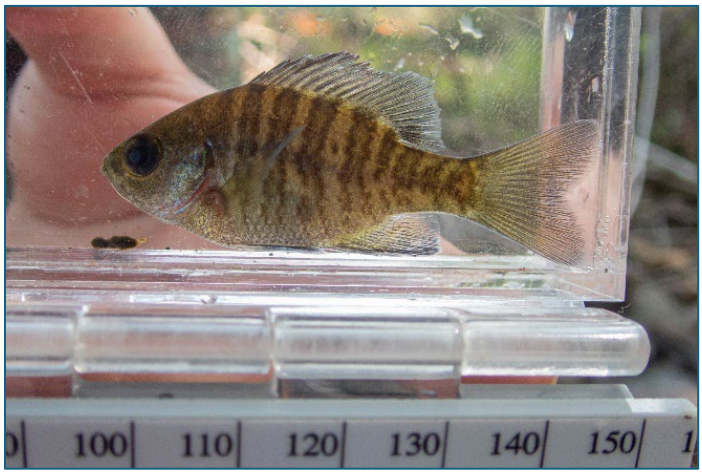
Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
13.7	3	192.7	0.020	7759.8	95.2%	1.2%	0.17%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Lepomis gibbosus (*N*)	0	3
Lepomis macrochirus (*I*)	1	40
Oncorhynchus mykiss (*I*)	104	141
Rhinichthys atratulus (*N*)	262	342
Salmo trutta (*I*)	0	3
Salvelinus fontinalis (*N*)	260	52
Semotilus atromaculatus (*N*)	24	16

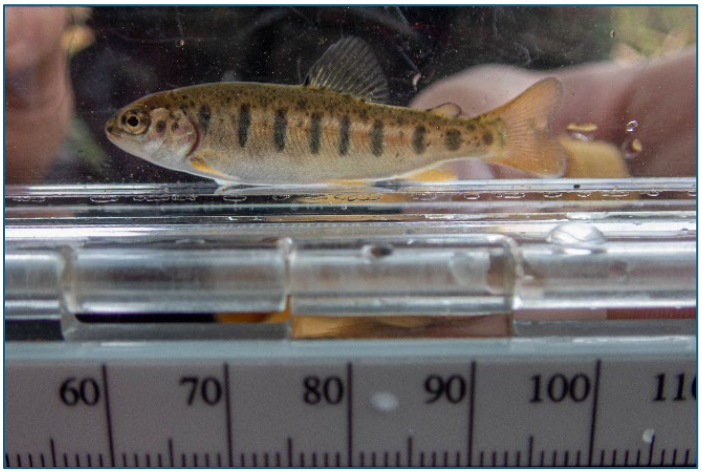


Reach Upstream End – 2022

Vancampens Brook 43 was the second most downstream reach* on Vancampens Brook, located near Millbrook Village (*middle reach in 2013; DEWA.3009 retired). More recently, the main channel shifted closer to the Millbrook Village tree line during a period of high flow. Subsequently, the riparian buffer on the left bank (facing downstream) was reduced, which lead to increased erosion and light penetration. The thermal regime was slightly warmer than upstream (DEWA.3038), which was unsurprising given the sun exposure. Also, invasive shrubs dominated the understory with very few coniferous trees. The reach was mostly cobble substrate with small boulders and some sand/fines in slower sections near the midpoint. The downstream half of the reach was a straight, continuous riffle/run, while the upstream half of the reach had undercut banks below root balls and a few deeper pools. Blacknose dace was still the most common species, and creek chub were captured in similar numbers as during 2013. Many YOY/juvenile bluegill were captured, along with one juvenile pumpkinseed each visit. While rainbow trout numbers were slightly higher, brook trout numbers were greatly reduced, reversing the ratio of brook trout to rainbow trout. In addition to possibly stressful water temperatures, competition with sunfish and other trout species may be threatening the brook trout population. The removal of the Watergate barrier(s) likely allowed brown trout to move into the reach, as one adult was observed on each visit—the most upstream record for brown trout in Vancampens Brook.

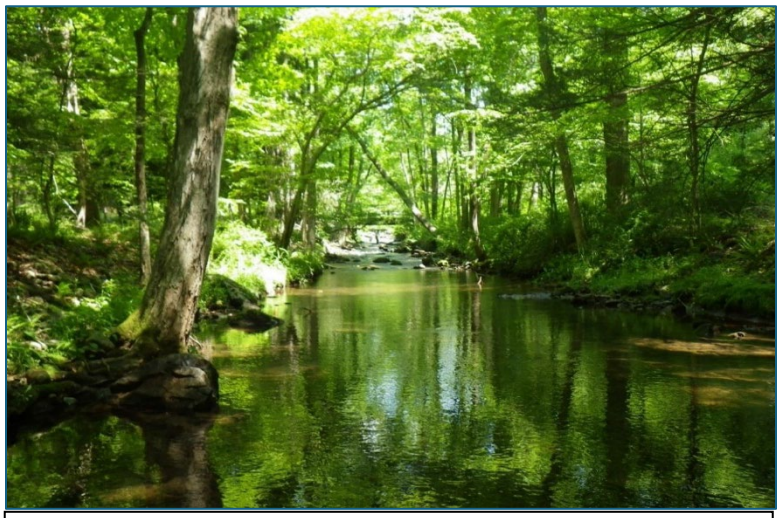


YOY bluegill



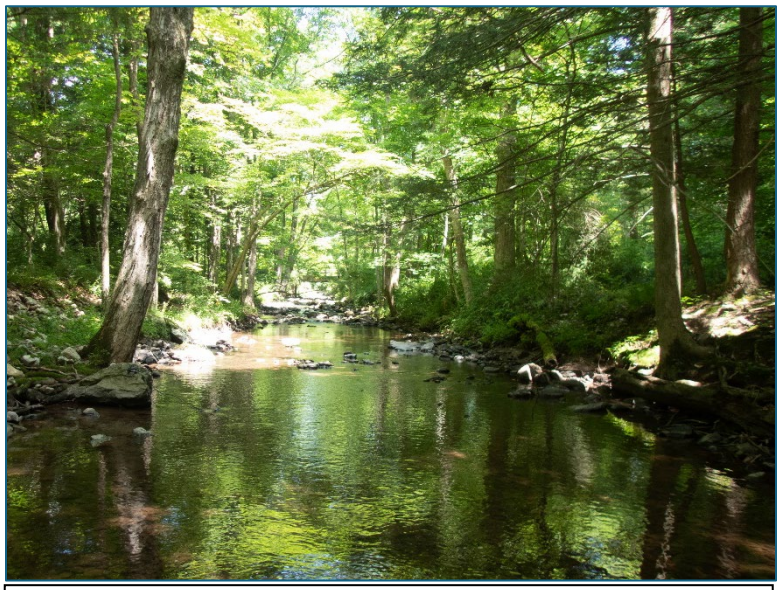
YOY wild rainbow trout

DEWA.3025 – Vancampens Brook 22



Reach Downstream End – 2013

Water Quality	
Avg. Annual Max. Temp. (°C)	26.5
Avg. # Annual Days with Daily Mean Temp. > 20 °C	45
Avg. # Annual Days with Daily Max. Temp. > 20 °C	94
Avg. Julian Day of Annual Max. Temp.	221
Avg. DO (mg/L)	8.95
Avg. pH	7.01
Avg. Specific Conductance (µS/cm)	86.4
Avg. Discharge (m^3/s)	0.051



Reach Downstream End – 2022: Little change; some increased light penetration; more rocks visible due to low

Reach Habitat	
Avg. Width (m)	6.16
Avg. Depth (cm)	9.12
Max. Depth (cm)	32
Avg. % Substrate Embeddedness	65.2%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	19.6
% Sand/Fines	28%
% Substrate > Fine Gravel	60%
% Canopy Cover	87.5%
% Mixed Veg. (non-deciduous)	80%
% Natural Fish Cover (all types)	41.5%
LWD Density (m^3/m^2)	0.004
EPA RBP Score	85.5%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
16.6	3	157.9	0.026	5618.3	94.3%	1.7%	0.34%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2022**
Ameiurus natalis (*N*)	0	7
Anguilla rostrata (*N*)	0	1
Catostomus commersonii (*N*)	26	18
Lepomis auritus (*N*)	4	3
Lepomis gibbosus (*N*)	9	0
Lepomis macrochirus (*I*)	3	3
Micropterus salmoides (*I*)	2	0
Oncorhynchus mykiss (*I*)	27	31
Perca flavescens (*N*)	1	0
Pomoxis nigromaculatus (*I*)	1	0
Rhinichthys atratulus (*N*)	372	383
Salmo trutta	12	11
Salvelinus fontinalis (*N*)	16	6
Semotilus atromaculatus (*N*)	29	15



Reach Upstream End – 2022: Small bedrock pool just above foot bridge; very open with little canopy cover

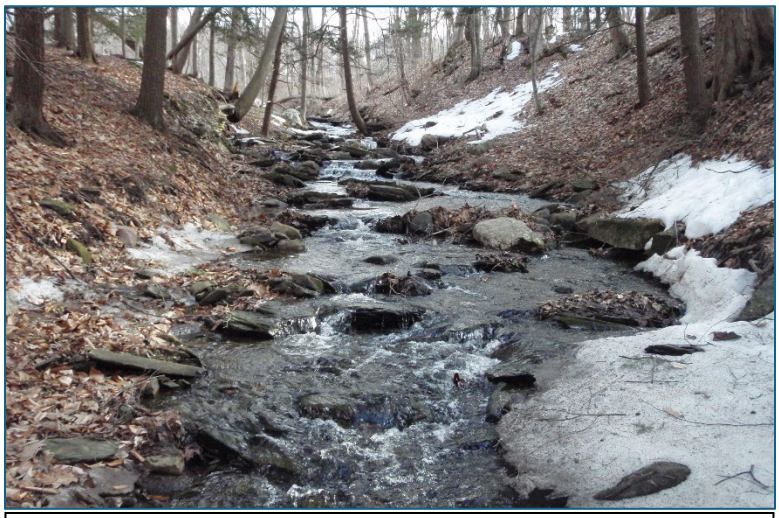
Vancampens Brook 22, the downstream-most reach on Vancampens Brook, near the popular Van Campen Glen trail, was mostly linear with only a slight bend at the upstream end. It featured a long run for the first ~50 m, one short riffle section, and a moderately deep pool under the bridge. Most pond species and white suckers were captured from undercuts in the pool, near the bridge abutments. The substrate was mainly cobble and gravel with considerable fine sediment, likely due to the recent wetland resotration, combined with low gradient and realtively slow flow. This reach had the warmest thermal regime of all Vancampens Brook reaches, with the daily mean and maximum water temperatures frequently exceeding 20°C, and the average annual maximum reaching potentially lethal levels for trout.

Blacknose dace was the most abundant species, with similar counts as in 2013. Likewise, counts of creek chub, white sucker, redbreast sunfish, and bluegill were comparable between years. The remaining warm water/lentic species (e.g., yellow bullhead, pumpkinseed, largemouth bass, yellow perch, and black crappie *Pomoxis nigromaculatus*) were captured in low numbers and only in one year, likely due to individuals flushing from the nearby upstream impoundment, which were removed in 2021. One large American eel, a new species record for this reach, was captured under the bridge on the first visit. This was one of two reaches (DEWA.3014) where all three trout species were captured in 2022, which was surprising given the warm water temperatures and few riffles. Rainbow trout remained the most abundant salmonid, followed by brown trout, both of which were observed in numbers like 2013, although only adult browns were captured in 2022. Brook trout was the least common trout species, with only four and two YOY individuals being captured on the second and third visits, respectively. Thermal stress, lack of instream habitat, and resource competition from other trout and pond species are likely the limiting factors for brook trout population growth and persistence at this point in the watershed.



Yellow bullhead captured under the bridge

DEWA.3028 – White Brook 15



Reach Downstream End – 2015 (no photo from 2013;

Water Quality	
Avg. Annual Max. Temp. (°C)	24.8
Avg. # Annual Days with Daily Mean Temp. > 20 °C	0
Avg. # Annual Days with Daily Max. Temp. > 20 °C	64
Avg. Julian Day of Annual Max. Temp.	178
Avg. DO (mg/L)	8.65
Avg. pH	7.75
Avg. Specific Conductance (µS/cm)	404.8
Avg. Discharge (m^3/s)	0.058



Reach Downstream End – 2023: low flow

Reach Habitat	
Avg. Width (m)	2.23
Avg. Depth (cm)	7.16
Max. Depth (cm)	20
Avg. % Substrate Embeddedness	36.4%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	49.6
% Sand/Fines	28%
% Substrate > Fine Gravel	60%
% Canopy Cover	98.0%
% Mixed Veg. (non-deciduous)	60%
% Natural Fish Cover (all types)	21.5%
LWD Density (m^3/m^2)	0.004
EPA RBP Score	78.5%

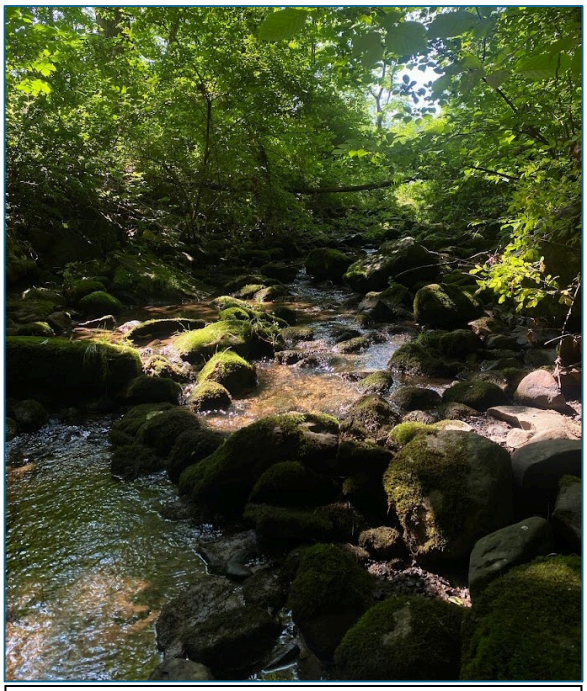
Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
3.3	1	192.7	0.023	1660.6	56.8%	13.6%	13.4%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
Anguilla rostrata (*N*)	1	1
Lepomis macrochirus (*I*)	9	0
Notropis amoenus (*N*)	1	0
Rhinichthys atratulus (*N*)	129	46
Salvelinus fontinalis (*N*)	2	0



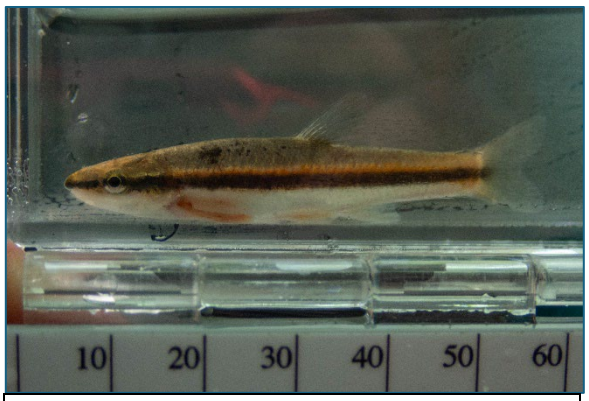
Reach Upstream End – 2023: Opens into fallowed pasture with young deciduous trees

White Brook 15 was the only reach on White Brook, a small, short tributary that flows from an impoundment through marshy meadows along New Jersey Route 206. This reach had the highest percentage of agricultural land use, the lowest percentage of forest, and moderate levels of development with several commercial buildings. The anthropogenic land use was a likely contributor to the relatively high specific conductance, which was the greatest (405 µS/cm) of all DEWA reaches. The reach began in a forested ravine with mixed deciduous and coniferous trees, before opening into a meadow with herbaceous plants and few trees. The substrate was mostly cobble, composed of flat, broken shale over bedrock, with substantial deposits of fine sediment in pools. The meadow portion resembled a ditch, with sand and mud substrate. In-stream habitat, including LWD, was very sparse.



Upstream portion of reach – end of forested section just before meadow; cobble covered with thick moss mats

The fish community resembled that of a small headwater stream with poor water quality and somewhat degraded habitat, as blacknose dace was the only species consistently encountered in 2023. One American eel was captured on the third visit at the upstream end of the reach. Both species are tolerant to a wide variety of conditions. The bluegill and comely shiner from 2013 were likely transient individuals from the upstream impoundment, which could be why they were not detected in 2023. Additionally, the reach was adjusted since 2013 to include riffle habitat for benthic macroinvertebrate monitoring, so species previously inhabiting the meadow could have been less available for detection. Considering only one brook trout was found in 2013, along with overall lack of pool habitat, stressful water temperatures, and relatively poor water quality, it was not surprising that none were captured in 2023. More sampling may be needed to confirm the absence of brook trout at this reach.



Blacknose dace from reach

DEWA.3030 – Yards Creek 07



Reach Downstream End – 2015 (no photo from 2013):

Water Quality	
Avg. Annual Max. Temp. (°C)	25.4
Avg. # Annual Days with Daily Mean Temp. > 20 °C	21
Avg. # Annual Days with Daily Max. Temp. > 20 °C	72
Avg. Julian Day of Annual Max. Temp.	202
Avg. DO (mg/L)	8.27
Avg. pH	61
Avg. Specific Conductance (µS/cm)	21.1
Avg. Discharge (m^3/s)	0.008



Reach Downstream End – 2023: low flow

Reach Habitat	
Avg. Width (m)	7.12
Avg. Depth (cm)	4.64
Max. Depth (cm)	46
Avg. % Substrate Embeddedness	21.6%
Mode Substrate Class	CB
Avg. Substrate Diameter (mm)	41.5
% Sand/Fines	0%
% Substrate > Fine Gravel	76%
% Canopy Cover	99.4%
% Mixed Veg. (non-deciduous)	0%
% Natural Fish Cover (all types)	84%
LWD Density (m^3/m^2)	0.017
EPA RBP Score	78%

Landscape Habitat							
Watershed Size (km^2)	Stream Order	Elevation (m)	Slope	Distance to River (m)	% Forest	% Developed	% Ag
3.3	1	335.4	0.044	17070	83.1%	1.5%	0%

Fish Counts (Total over 3 visits)		
Species (Nativity)	**2013**	**2023**
N/A	0	0



Reach Upstream End – 2023: No above ground flow for the upstream-most ~25 m, but water was heard trickling below the boulders.

Yards Creek 07 was the only reach on Yards Creek, which drains from Catfish Pond. Only a short, headwater segment of Yards Creek is present within park boundaries, where it runs along Camp Mohican Road before flowing out of the park and into Lower Yards Creek Reservoir. From there, it eventually joins the Paulins Kill River, which then flows into the Delaware River south of the park. The Appalachian Trail crosses the stream at the upstream end of the reach. The channel was not well-defined and there were a few braided sections. The substrate was mainly cobble and small boulders, with little to no sand/fines except in pools and near the beginning of the reach. The stream bed in the upstream half of the reach was largely a boulder field. In mid-summer, the upstream-most ~ 25 m of the reach was visibly dry but with audible subsurface flow. Only one, nearly isolated pool near the midpoint held significant water. The water temperature in this pool was warm, likely due to the upstream impoundment and low flow.

No fish were captured during either sampling period, although it was only sampled once in 2023 since it remained “fishless” on the first visit. Because this stream appears prone to drought, it is unlikely that fish could occupy this reach consistently; however, Catfish Pond upstream does contain fish, so it is possible fish could occasionally get flushed out and persist in the deep pool. Given the extreme distance to the Delaware River, the steep gradient with many natural barriers, and the presence of several impoundments along the way, it is essentially impossible for river species to colonize this reach.