District of Columbia
Office of the State Superintendent of Education

MACROINVERTEBRATES

High School Environmental Science Instructional Sequence

This high school environmental science instructional sequence was created to support teaching the Next Generation Science Standards through the Biological Sciences Curriculum Study (BSCS) 5E instructional model. Developed by District of Columbia teachers, these lessons include real-world contexts for learning about environmental science through a lens that encourages student investigation of local issues.

The lessons also support Scope and Sequence documents used by District local education agencies:

Unit 1: Ecosystems: Interactions, Energy, and Dynamics

Advisory 1 and 2

Acknowledgements:
Molly Mus, Anacostia High School

This curriculum resource can be downloaded online:

https://osse.dc.gov/service/environmental-literacy-program-elp

Overview and Goal of the Lesson:

This goal of this lesson sequence is to introduce students to biodiversity and the key role that indicator species play in the health and wellness of an ecosystem. Students will identify macroinvertebrates present in two separate stream sites using real data from previous years, count the population of these various macroinvertebrates, calculate the health of the stream, and compare and contrast the two sites. By the end of the lesson sequence, students will be able to use their counts and comparisons of two stream sites to draft a stream site report card. This stream site report card can be used for an actual project in which students engage stakeholders, community members, and other students within their school about the status of streams in Washington, DC.

Essential Question(s):

- What are the limiting living and nonliving factors that affect the population of each type of organism in the streams that feed into the Anacostia River at the time of the field studies?
- How can we alleviate one of the causes of limited biodiversity within the streams that feed into the Anacostia River? Make a recommendation using our data.

NGSS Emphasized and Addressed in this Lesson Sequence:

PERFORMANCE EXPECTATIONS	SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
Students who demonstrate understanding can: • **HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] • **HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.**	**Using Mathematics and Computational Thinking** • Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1) • Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS- LS2-2) **Engaging in Argument from Evidence** • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6) ***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** • Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/ or reinterpretation of existing evidence. (HS-LS2-2), (HS-LS2-3) Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2- 6), (HS-LS2-8)	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. **If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.** (HS-LS2-2, HS-LS2-6)	**Scale, Proportion, and Quantity** • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2) **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6, HS-LS2-7)

Materials

ITEM	QUANTITY	PURPOSE
Macroinvertebrate Identification Key OR Creek Critters App	1 per partner in each group	identification of macroinvertebrates
Biological Monitoring Data Sheet	1 per partner in each group	calculation of the pollution tolerance index (PTI) of each stream site
Identification Cards	at least 2 sets (1 per stream site)	identification of macroinvertebrates
Stream Floor Decal	1 @ $7.97 from Oriental Trading Company OR collected	2 simulated stream sites (w/ extra section)
Leaves	1 @ $3.48 from Oriental Trading Company OR collected	simulated leaf pack
River Rocks	1 @ $8.99 from Oriental Trading Company OR collected	simulated benches and steps that alter the flow of water, particularly from stream restoration
Branches	1 @ $7.99 from Oriental Trading Company OR collected	simulated benches, steps, and habitat
Macroinvertebrates List	enough to match data selected	print and cut around labels to add macroinvertebrates to stream sites in appropriate amount dependent on data
Stream Macroinvertebrate Sampling Kit	1 @ $41.40 http://bit.ly/2yCC9iv	Can be used instead of creating a model stream or taking a field trip to a local stream

5E Lesson Sequence

TOTAL DURATION: 300 MINUTES				
5E MODEL STAGE		**TEACHER AND STUDENT ACTIONS**		**NOTES**
Engage	15-20 minutes	What Teacher Does	1. Teacher will show students images of some local DC streams (Supporting Document 2). 2. Teacher will ask students to assess the health of the stream based on these images. Teacher will then ask students if they can think of other ways to assess stream health. 3. Teacher will show students a video about how macroinvertebrates are used as an indicator to assess stream health.[1] • Macroinvertebrates and Water Quality	This part of the lesson sequence will seek to make a local connection by showing students images of local streams and asking them to make assessments about stream health. After discussing the images, the teacher will show the students a video about how macroinvertebrates are used to make assessments about stream health.
		What Students Do	1. Students will observe images of local streams and make predictions about the health of those streams based on the images shown by the teacher. Students will then work in small groups to discuss other potential ways to make an assessment of stream health. Students will share their ideas with the class. 2. Students will watch video about macroinvertebrates and water quality.	
Explore	120 minutes (more if walking to local stream, add travel time)	What Teacher Does	1. Set up a field trip to a local stream site to collect and identify macroinvertebrates with students. Teachers are strongly encouraged to partner with a local environmental education organization, such as Audubon Naturalist Society, for this lesson. *Proper permits are needed for macroinvertebrate sampling.* If possible, set up a field trip with Audubon Naturalist Society to utilize their Creek Critters app to collect and identify macroinvertebrates. The Creek Critters app walks students through the proper process of how to safely collect and identify critters from the stream. If a field trip is not possible, teacher can set up a simulated stream in the classroom using natural materials. To prepare for the in-class version of the macroinvertebrate sampling exercise: • Make black and white copies of: ○ Macroinvertebrate Identification Key[2] ○ Biological Monitoring Data Sheet[3] (see Supporting Document 3 for a sample) • Make color copies of: ○ Identification Cards[4] • Set up two different sample streams using the information from Supporting Document 4 (Stream Site 1 – Watts Branch and Stream Site 2 – Pope Branch) : ○ Use Stream Site 1 and Stream Site 2 information sheets to guide you in the setup of the mock stream sites. Be sure to add simulated features to the stream site according to the descriptions. ○ Additionally, using the data charts for both streams will help teachers add the appropriate amount/diversity of macroinvertebrates per site. ○ The goal of the stream simulation is to give the students an idea of what it is like to “collect” and identify macroinvertebrates.	In this section of the lesson sequence students will collect and identify macroinvertebrates in their local stream. Note: Audubon Naturalist Society has an app called Creek Critters that can be used to facilitate the macroinvertebrate sampling activity. Alternatively, teacher can use the *Biological Monitoring Data Sheet* as a way for students to record their data. There are multiple options for how a teacher can facilitate the macroinvertebrate sampling portion of the lesson sequence. Ideally, the teacher will take the students to a nearby stream to conduct an authentic macroinvertebrate survey with a partner organization such as Audubon Naturalist Society. If this is not possible, teacher can purchase this kit: http://bit.ly/2zPF7Pd If funds are not available to purchase a kit, a teacher can create two model streams in the classroom and add appropriate quantities and diversity of various macroinvertebrates (using created flash cards). Students will then “collect and identity” macroinvertebrates from this simulated stream. Whichever option is chosen, the goal is for students to understand the data collection portion of using macroinvertebrates as a way to assess stream health.

5E MODEL STAGE		TEACHER AND STUDENT ACTIONS		NOTES
		What Students Do	1. Students collect and identify macroinvertebrates from a local stream using the Creek Critters app. If a field trip to a local stream is not possible, then students will identify macroinvertebrates on flash cards in a simulated stream in the classroom. 2. Students have the option of using the Creek Critters app or the *Biological Monitoring Data sheet* to record the types of macroinvertebrates found in their stream.	
Explain	**60 minutes**	What Teacher Does	1. Teacher will have provided the students with a way to record and analyze the data they collected in the previous lesson.	This section of the lesson sequence is focused on understanding what the collected data means and explaining the results to the rest of the class.
		What Students Do	1. Students will use the Biological Monitoring Data Sheet to record and analyze their data. They will count how many of each type of macroinvertebrate there is in each site.[5] They will record how many types of each organism are present in each column within the "# of TAXA represented" box. • Students will then compare and contrast the biodiversity of the two sites, specifically using the Pollution Tolerance Index Rating. (See Supporting Document 5 for a sample Pollution Tolerance Index Rating.) • What does the "Pollution Tolerance Index Rating" measure? Have students discuss together and share their findings with the rest of the class. ○ EXEMPLAR RESPONSE: This is a calculation based on how tolerant to pollution the organisms present in the stream are. ○ EXEMPLAR RESPONSE: Rating scores the viability of a biodiverse macroinvertebrate population - the higher the score, the more possible it is for a "Group 1 - Intolerant" macroinvertebrate to survive and thrive.	
Elaborate	45 minutes	What Teacher Does	1. Teacher explains to students that they will now attempt to understand what factors influence the health of a stream. If a stream got a "poor" health rating, what does that mean? Why might this stream be in poor health? Students will investigate issues facing urban streams.	Up until this point the students have been using macroinvertebrates as one way to assess stream health. In this lesson they will examine additional background information about the streams to help determine additional ways to assess stream health. Students will come away with an understanding of what factors influence stream health. What factors influence the type and amount of macroinvertebrates found in a stream? Resources about local stream health: http://bit.ly/2yNAkiD Also see Supporting Document 6 for information about Watts Branch and Nash Run.
		What Students Do	• Give students the Stream Site 1and Stream Site 2 sheets for the first time (Supporting Document 4). • Allow students to compare and contrast the sites through writing. Some questions may include: ○ What was the Pollution Tolerance Index (PTI) of our stream? What does this mean in terms of "health" of stream (i.e., poor, fair, good, or excellent)? ○ How does this result compare to your initial prediction? ○ Do you think this is an accurate assessment of our stream? Why or why not? ○ What types of organisms would we expect to find in our stream if it were in excellent health? Why? ○ PTI is just one way we can assess the health of our stream. What are some other ways? Do you think we will find the same results as this? Explain.	

5E MODEL STAGE		TEACHER AND STUDENT ACTIONS		NOTES
Evaluate	**60 minutes**	What Teacher Does	1. Teacher will inform students that they are now going to create a site report for the stream they studied. Using the data that they collected and analyzed through the Pollution Tolerance Index form, students will generate a written report about the stream they studied. Teacher explains that students have flexibility in how they would like to provide their information, but the report must include an analysis of stream health as well as recommendations of what could be done to increase diversity and quantity of macroinvertebrates and therefore improve stream health.	Students will present their findings and make recommendations about what can be done to improve stream health.
		What Students Do	1. Students will end by creating a site "report" for the stream they studied using real, data. They will present to each other their conclusions and data to back their conclusions up. The essential questions they must answer at the end of the report are: • What are the limiting living and nonliving factors that affect the population of each type of organism in the streams that feed into the Anacostia River at the time of the field studies? • How can we alleviate one of the causes of limited biodiversity within the streams that feed into the Anacostia River? Make a recommendation using our data.	

Footnotes

1 www.youtube.com/watch?v=1HysvsXcmVI
2 stroudcenter.org/wp-content/uploads/MacroKey_Complete.pdf
3 www.in.gov/idem/riverwatch/files/resources_bio_monitoring_sheet.pdf
4 www.learnatboces.com/macroinvertebrates-id-cards
5 www.in.gov/idem/riverwatch/files/resources_bio_monitoring_sheet.pdf

SUPPORTING DOCUMENTS

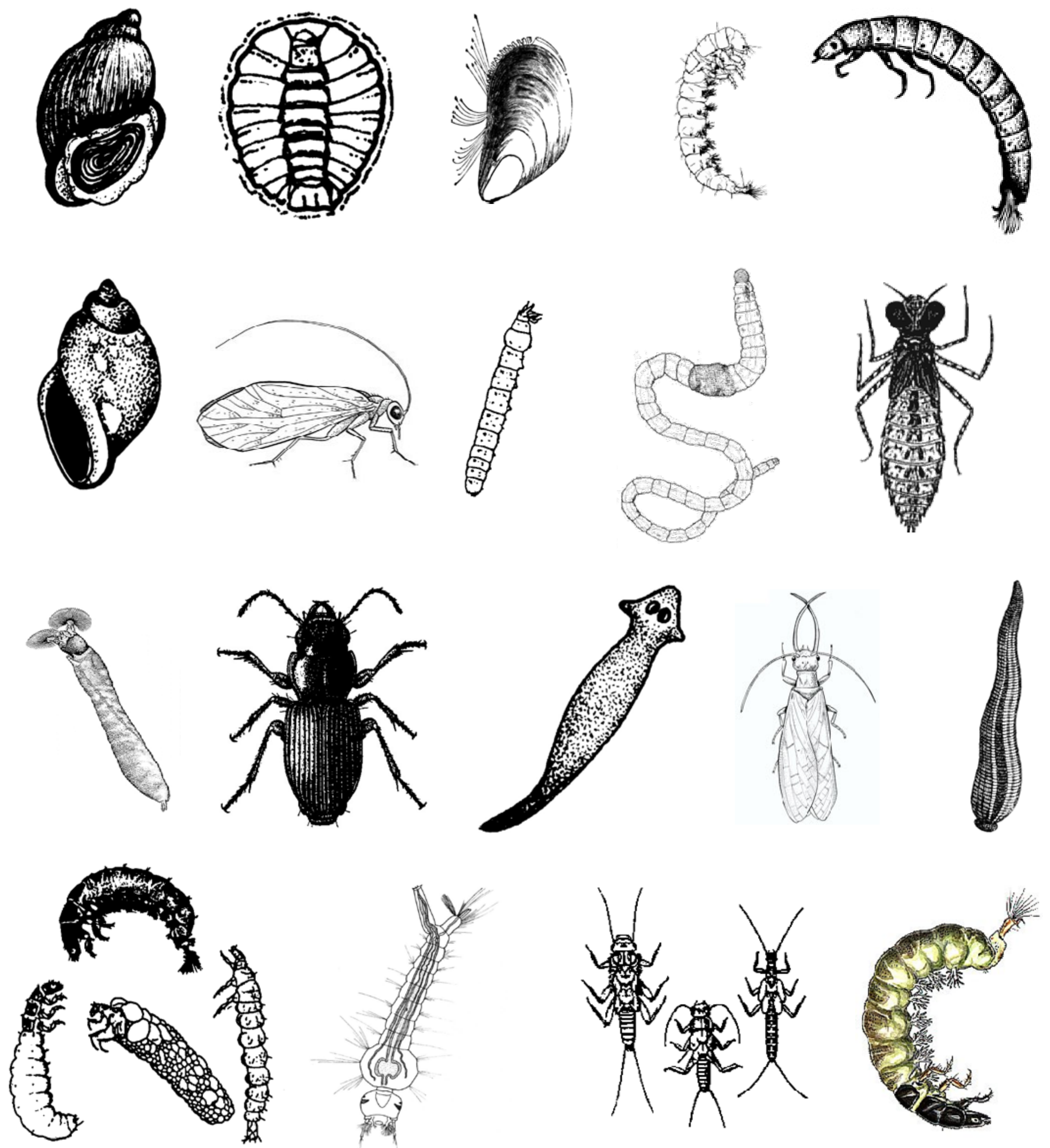
Supporting Document 1:

1. Creek Critters app – Audubon Naturalist Society https://anshome.org/creek-critters/

   This app guides students through a Macroinvertebrate sampling activity. Staff from Audubon Naturalist Society are available to help teachers facilitate a sampling session.

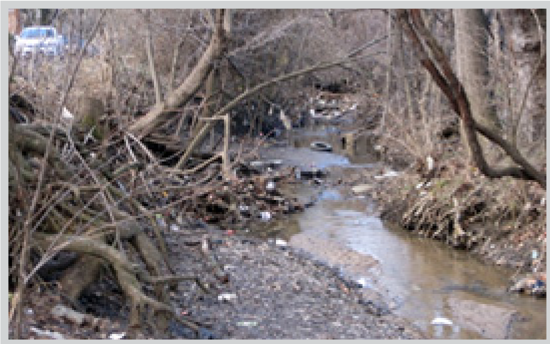
   Gregg Trilling | Gregg.Trilling@anshome.org

2. Macroinvertebrate Models for stream site models - to be printed and cut out according to data chart on following page



Macro Pollution Tolerance Index docs: www.in.gov/idem/riverwatch/files/volunteer_monitoring_manual_chap_5.pdf
Macroinvertebrate Key: www.stroudcenter.org/education/MacroKey_Complete.pdf

Supporting Document 2: Photos of local DC Streams



Nash Run – pre-restoration, a degraded stream

Nash Run – after stream restoration project completed

Supporting Document 3:

Hoosier Riverwatch
Biological Monitoring Data Sheet

Date: ____/____/____ **Volunteer ID:** __________ **Site ID:** __________

Stream Name: ______________________________ **Latitude:** _______ **Longitude:** _______

Time _____:_____ AM / PM **Time Sampling:** ______ **hrs** **Air Temp.:** __________ **°C**

Current Weather: ☐ Clear/Sunny ☐ Overcast ☐ Showers ☐ Rain (steady) ☐Storm (Heavy)

Worst Weather (past 48 hours): ☐ Clear/Sunny ☐ Overcast ☐ Showers ☐ Rain (steady) ☐Storm (Heavy)

Check Methods Used: ☐ Kick Seine Net (3 times) ☐ Dip Net (20 jabs or scoops)

Check Habitats Sampled: ☐ Undercut Banks ☐ Riffles ☐ Leaf Packs ☐ Snags/Vegetation ☐Sediment

Pollution Tolerance Index (PTI)

Record the taxa (group) represented in your sampling by either entering the number of organisms you counted or a ✓

Group 1 - Intolerant	Group 2 - Moderately Intolerant	Group 3 - Fairly Tolerant	Groups 4 - Very Tolerant
☐ Stonefly nymph	☐ Damselfly nymph	☐ Leech	☐ Aquatic worm
☐ Mayfly nymph	☐ Dragonfly nymph	☐ Midge larva	☐ Blood midge larva (red)
☐ Caddisfly larva	☐ Scud	☐ Planaria/ Flatworm	☐ Rat-tailed Maggot
☐ Riffle Beetle	☐ Sowbug	☐ Black fly larva	☐ Left-Handed or Pouch snail
☐ Dobsonfly Larva	☐ Cranefly larva		
☐ Right-Handed or Gilled snail	☐ Clam/Mussel		
☐ Water Penny	☐ Crayfish		
☐ **# of TAXA represented**	☐ **# of TAXA represented**	☐ **# of TAXA represented**	☐ **# of TAXA represented**
☐ Weighting Factor (x4)	☐ Weighting Factor (x3)	☐ Weighting Factor (x2)	☐ Weighting Factor (x1)

Pollution Tolerance Index Rating ☐
(Add the final index values for each group)

PTI Ratings	
Excellent	23 or More
Good	17 - 22
Fair	11 - 16
Poor	10 or Less

Please check other Biological Indicators you observed:

☐ Native Mussels ☐ Zebra Mussels ☐ Rusty Crayfish ☐ Aquatic Plants ________ % Algae Cover ________ Diversity Index

Supporting Document 4: Stream Sites

Stream Site 1: Watts Branch

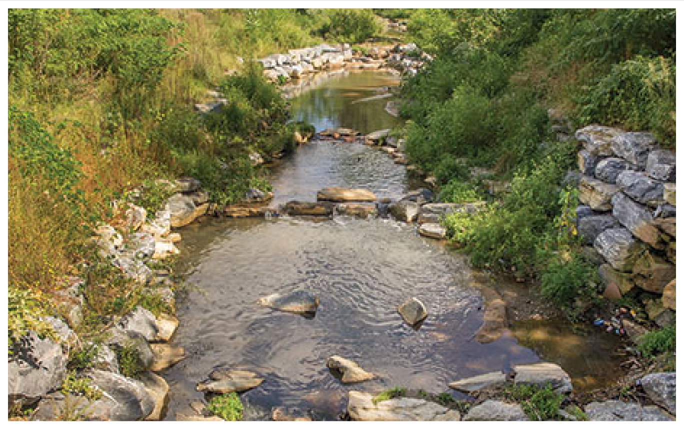


Figure 2. Project partners removed three feet of accumulated sediment and reconnected Watts Branch with its historical stream channel. Before the restoration effort, Watts Branch followed the path denoted by the yellow arrow.

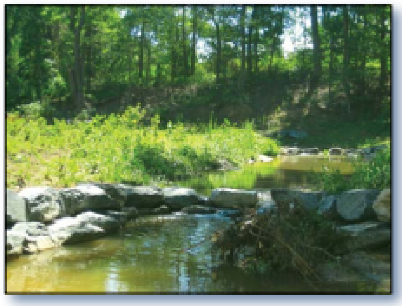
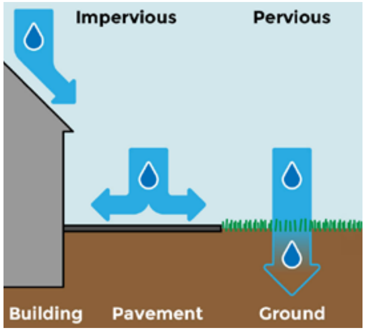
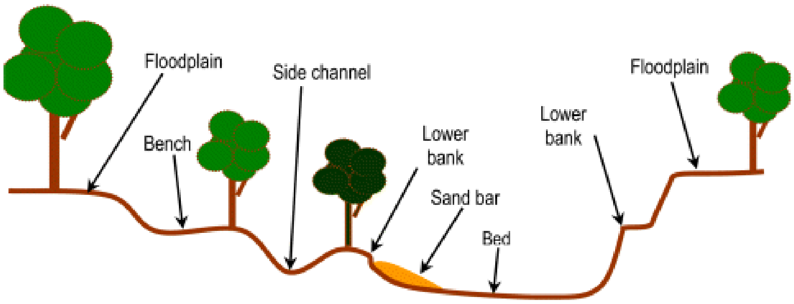


Figure 3. After restoration, vegetation is returning to the Watts Branch riparian restoration project site shown in Figure 2.



Stream Site Description:

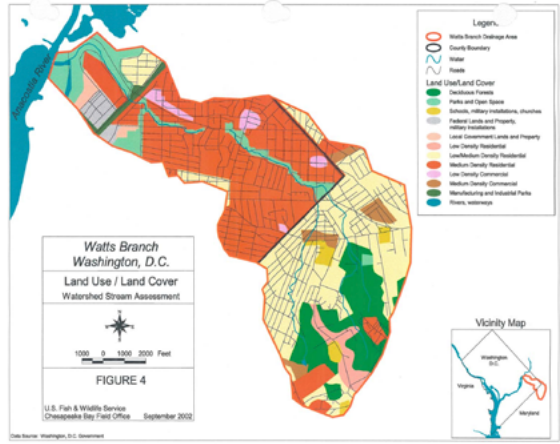
- The subwatershed is approximately 2,463 acres (3.8 mi^2) in size[1].
- Watts Branch subwatershed is about 31% impervious. This level of imperviousness is among the highest in the Anacostia watershed and is about 10% higher than the average for the 14 major subwatersheds of the Anacostia Watershed[2].
- Runs through a highly urbanized area.
- Polluted by urban runoff (stormwater), dumped trash and leaking sewer pipes.
- Much of the stream is in concrete channels or culverts.
- "In 2010, DOEE partnered with the U.S. Fish and Wildlife Service (USFWS) and the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) to restore a 1.7-mile segment of Watts Branch. These partners:
  - planted more than 10,000 trees, shrubs, grasses and plants along the stream,
  - created floodplain benches to reduce the energy of storm flows that reach bankfull stage by allowing the flows to spread over a larger area,
  - re-graded stream banks and installed more than 50 instream structures to control stream flows and stabilize the stream channel, including cross vanes, j-hooks and vane arms to relieve stress on the stream banks and to dissipate increased stream energy from high stormwater flows entering the stream (Figures 2 and 3),
  - created pools for fish habitat and improved fish passage,
  - and installed multiple low-impact development (LID) practices in upland areas to treat more than four acres of impervious surface runoff."[3]



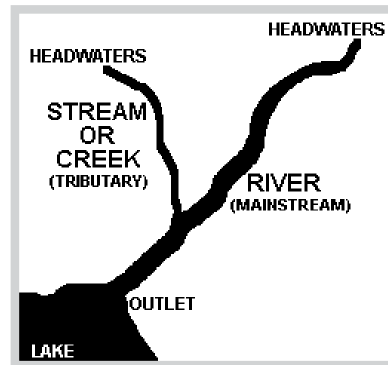
1 www.anacostia.net/Subwatershed/Watts.html
2 www.anacostia.net/Subwatershed/Watts.html
3 www.epa.gov/sites/production/files/2015-10/documents/dc_watts.pdf

Additional Information:

- [U.S. Fish & Wildlife Services Watts Branch, Washington D.C. Watershed and Stream Assessment (2002)]
- Current data for Watts Branch: [USGS 01651800 WATTS BRANCH current data]
- The [EPA's MyEnvironment website] gives examples of nonpoint source pollution and point source pollution:
- [Watts Branch Stream Restoration]
- [Restoration Efforts Stabilize Watts Branch and Reduce Sediment Loading]

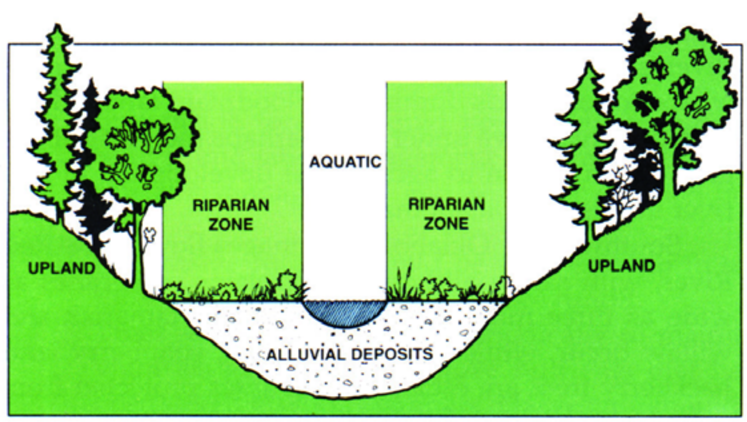


Stream Site 2: Pope Branch



Stream Site Description:

- Pope branch is a very small free-flowing tributary of the Anacostia River
- Meets Anacostia River in from the CSX Railroad Bridge in Washington, D.C.
- The entire subwatershed is located within the District of Columbia
- It should be noted that the lowermost 1,385 feet of Pope Branch, from Fairlawn Avenue downstream to the Anacostia River, is piped



- The main stem aquatic communities remain impacted from both uncontrolled stormwater runoff and episodic inputs of sewage from old leaking sewer lines[4]
- The restoration objectives are to stabilize nearly 5,000 linear feet of stream channel within Pope Branch Park to:

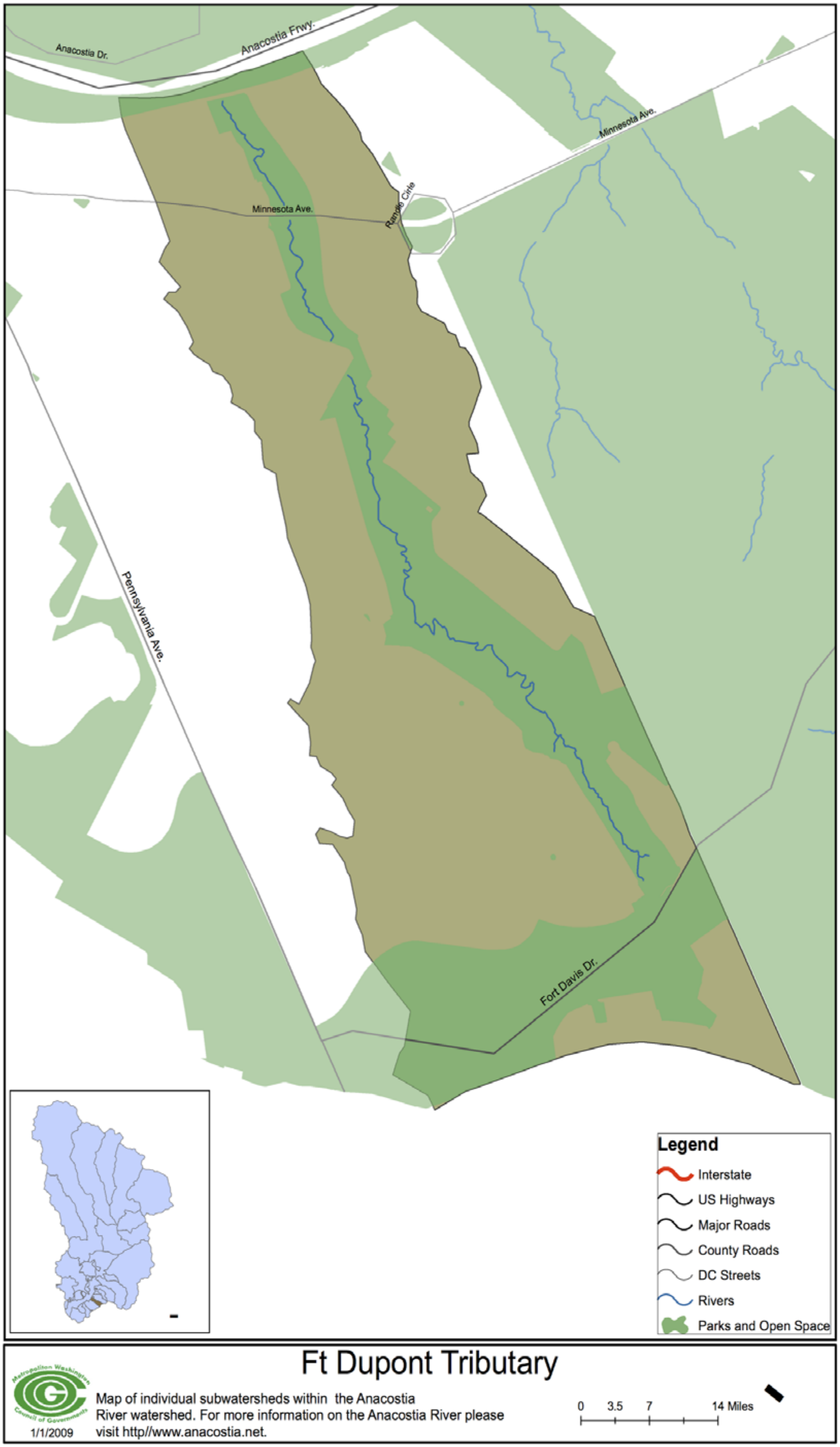
  - reduce the sediment load carried to the Anacostia River;
  - enhance in-stream habitat for resident fish and benthic communities; and
  - enhance the riparian and floodplain habitat.[5]

Additional Information:

- [Stream Restoration Plan Overview]
- [Pope Branch Regenerative Stormwater Conveyances]

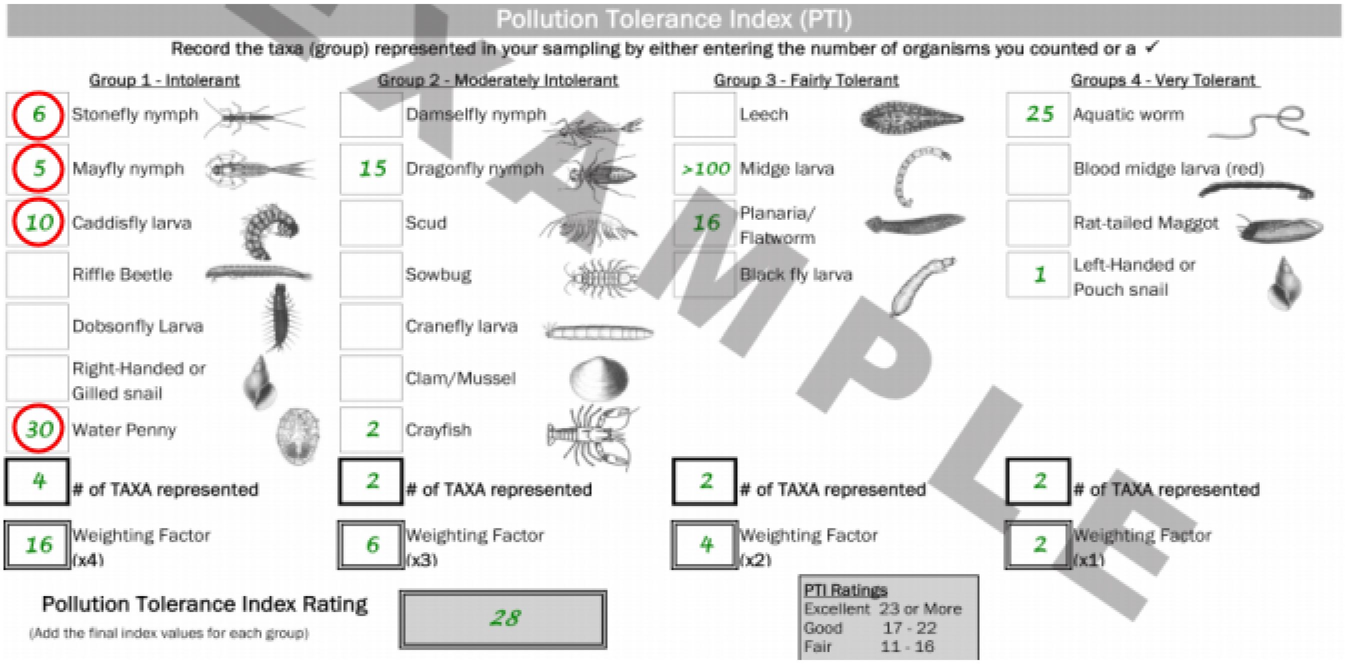
4 http://www.anacostia.net/Subwatershed/Pope_Branch.html

5 http://www.biohabitats.com/wp-content/uploads/PopeBranchStreamRestoration.pdf


Anacostia Dr.
Anacostia Frwy.
Minnesota Ave.
Minnesota Ave.
Pennsylvania Ave.
Fort Davis Dr.
Legend
Interstate
US Highways
Major Roads
County Roads
DC Streets
Rivers
Parks and Open Space
Ft Dupont Tributary
Map of individual subwatersheds within the Anacostia River watershed. For more information on the Anacostia River please visit http//www.anacostia.net.
1/1/2009
0
3.5
7
14 Miles

Supporting Document 5:

Sample Pollution Tolerance Index Rating



Pollution Tolerance Index (PTI)

Record the taxa (group) represented in your sampling by either entering the number of organisms you counted or a ✓

Group 1 - Intolerant		Group 2 - Moderately Intolerant		Group 3 - Fairly Tolerant		Groups 4 - Very Tolerant	
6	Stonefly nymph		Damselfly nymph		Leech	25	Aquatic worm
5	Mayfly nymph	15	Dragonfly nymph	>100	Midge larva		Blood midge larva (red)
10	Caddisfly larva		Scud	16	Planaria/ Flatworm		Rat-tailed Maggot
	Riffle Beetle		Sowbug		Black fly larva	1	Left-Handed or Pouch snail
	Dobsonfly Larva		Cranefly larva				
	Right-Handed or Gilled snail		Clam/Mussel				
30	Water Penny	2	Crayfish				
4	# of TAXA represented	2	# of TAXA represented	2	# of TAXA represented	2	# of TAXA represented
16	Weighting Factor (x4)	6	Weighting Factor (x3)	4	Weighting Factor (x2)	2	Weighting Factor (x1)

Pollution Tolerance Index Rating: 28

(Add the final index values for each group)

PTI Ratings

Excellent	23 or More
Good	17 - 22
Fair	11 - 16

Supporting Document 6:

Data sets from Metropolitan Washington Council of Governments Macroinvertebrate Sampling in 2012 (real data that can be used to analyze stream health, presence of various macroinvertebrates). This is a sampling of data from local streams. In order to obtain up to date data for DC streams, teachers can reach out to Phong Trieu at the Metropolitan Washington Council of Governments ptrieu@mwcog.org or Josh Burch at the District Department of Energy and Environment Josh.Burch@dc.gov.

Macroinvertebrate Data from Watts Branch

Waterbody	Coll Date	Taxon	Life_Stage	Count
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Lepidoptera	Larva	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Chironomus sp.	Larva	3
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Eukiefferiella claripennis gr.	Larva	11
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Lumbricina		1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Lumbriculidae		1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Micropsectra sp.	Larva	2
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Phaenopsectra sp.	Larva	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Potthastia longimana gr.	Larva	7
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Psychoda sp.	Larva	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Tanytarsini	Pupa	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Tubificinae w/out capilliform set		5
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Hydropsyche betteni	Larva	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Psectrotanypus sp.	Larva	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Tanypodinae	Pupa	12
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Thienemannimyia gr.	Larva	101
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Zavrelimyia sp.	Larva	5
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Physidae		7
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Cricotopus bicinctus	Larva	2
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Cricotopus sylvestris gr.	Larva	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Cricotopus tremulus gr.	Larva	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Polypedilum tritum	Larva	1
Watts Branch - WB2 - Capital Heights Metro	27-Apr-12	Tipula sp.	Larva	1

1	Macroinvertebrate Data from Pope Branch				
2	Waterbody	Coll Date	Taxon	Life_Stage	Count
3					
4	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Chaetocladius sp.	Larva	1
5	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Corynoneura sp.	Larva	6
6	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Eukiefferiella claripennis gr.	Larva	71
7	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Hydroporinae	Larva	1
8	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Limnophyes sp.	Larva	9
9	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Micropsectra sp.	Larva	1
10	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Naidinae		1
11	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Parametriocnemus sp.	Larva	1
12	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Phaenopsectra sp.	Larva	1
13	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Thienemanniella sp.	Larva	2
14	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Tubificinae w/out capilliform setae		1
15	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Tvetenia paucunca	Larva	6
16	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Rheotanytarsus exiguus gr.	Larva	1
17	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Simulium sp.	Larva	1
18	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Argia sp.	Larva	1
19	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Tanypodinae	Pupa	6
20	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Thienemannimyia gr.	Larva	44
21	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Zavrelimyia sp.	Larva	4
22	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Physidae		4
23	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Brillia sp.	Larva	3
24	Pope Branch (PBr1) – Upper, Reach B	30-Apr-12	Polypedilum illinoense gr.	Larva	1

1	Macroinvertebrate Data from Pope Branch				
2	Waterbody	Coll Date	Taxon	Life_Stage	Count
3					
4	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Chironomini	Pupa	1
5	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Psychodidae	Pupa	1
6	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Chaetocladius sp.	Larva	14
7	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Chironomus sp.	Larva	3
8	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Erioptera sp.	Larva	2
9	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Eukiefferiella claripennis gr.	Larva	6
10	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Hydroporinae	Larva	1
11	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Limnophyes sp.	Larva	30
12	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Lumbriculidae		1
13	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Orthocladiinae	Pupa	1
14	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Parametriocnemus sp.	Larva	2
15	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Tubificinae w/out capilliform setae		3
16	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Thienemannimyia gr.	Larva	86
17	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Tipulidae	Early Insta	1
18	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Zavrelimyia sp.	Larva	10
19	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Cricotopus sylvestris gr.	Larva	1
20	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Cricotopus tremulus gr.	Larva	1
21	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Cricotopus/Orthocladius sp.	Larva	2
22	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Polypedilum illinoense gr.	Larva	1
23	Pope Branch (PBr2) – Lower Reach A	30-Apr-12	Tipula sp.	Larva	1

1	Macroinvertebrate Data from Pope Branch				
2	Waterbody	Coll Date	Taxon	Life_Stage	Count
3					
4	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Chironomini	Pupa	1
5	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Culicidae	Larva	1
6	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Chaetocladius sp.	Larva	1
7	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Chironomus sp.	Larva	6
8	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Eukiefferiella claripennis gr.	Larva	4
9	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Hydroporinae	Larva	1
10	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Limnophyes sp.	Larva	3
11	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Lumbriculidae		1
12	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Micropsectra sp.	Larva	1
13	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Orthocladiinae	Pupa	1
14	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Psychoda sp.	Larva	1
15	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Smittia sp.	Larva	1
16	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Tvetenia paucunca	Larva	1
17	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Cheumatopsyche sp.	Larva	1
18	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Simulium sp.	Larva	1
19	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Argia sp.	Larva	1
20	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Erpobdellidae		1
21	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Sciomyzidae	Larva	1
22	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Tanypodinae	Pupa	11
23	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Thienemannimyia gr.	Larva	47
24	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Zavrelimyia sp.	Larva	33
25	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Physidae		8
26	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Brillia sp.	Larva	2
27	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Cricotopus bicinctus	Larva	3
28	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Cricotopus sp.	Larva	2
29	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Cricotopus/Orthocladius sp.	Larva	2
30	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Oribatida		1
31	Pope Branch (PBr3) – Lower Reach B	30-Apr-12	Polypedilum illinoense gr.	Larva	1

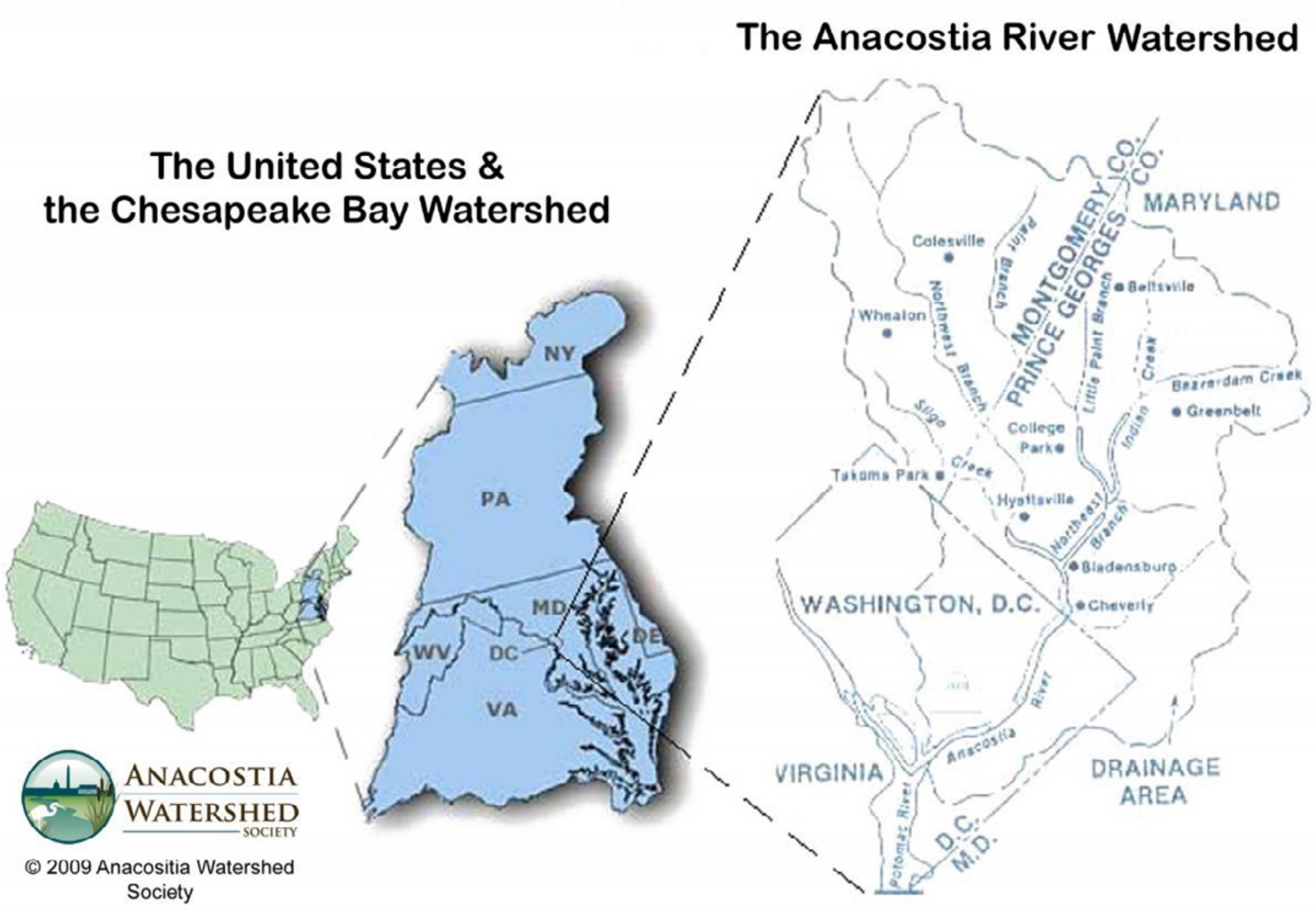
Supporting Document 7: Additional Recommended Resources:

- Teacher Trainings:
  - Aquatic WILD,[6] Growing Up WILD,[7] Project WILD,[8] and Project Learning Tree[9] are internationally recognized conservation education programs that provide content knowledge, critical thinking, and problem solving skills to youth to help them make prudent environmental decisions and foster stewardship of our nation's natural resources. Each program includes curricula featuring hands-on, inquiry-based lessons that are aligned to national education standards. View upcoming DC sessions and register for a workshop.[10]
  - Alice Ferguson Foundation's Bridging the Watershed (BTW) Program: Utilizing standards-based curricula in concert with teacher training, BTW provides students with meaningful watershed educational experiences through hands-on, curriculum-based outdoor studies in national parks and public lands.[11]
    - BTW Teacher Training Opportunities[12]
- Planning Resources for Student Reports:
  - An Educator's Guide to the Meaningful Watershed Educational Experience (MWEE)[13]
- Planning a Field Trip:
  - Audubon Naturalist Society:
    - Creek Critters App: walks users through finding and identifying the small organisms – or critters – that live in freshwater streams, and generating stream health reports based on what they find.[14]

      - Join them for an upcoming public Creek Critters event[15]
    - Stream Science Program: runs through environmental education
    - To the left is an image of their macroinvertebrate collection kit
  - The Aquatic Resources Education Center (AREC) is a multi-use environmental education and aquaculture center located in Anacostia Park in southeast Washington, DC.[16]
    - AREC provides excellent lessons on aquatic resources and watershed science for students. Check the link above for information about programs and lessons.
- Affordable Materials for a Field Trip:

MATERIAL	USE	AFFORDABLE ALTERNATIVE
D-net, drift net, sieve	collection of macroinvertebrates	medium-sized aquarium net
Sectioned tray	sorting and classification of macros	yogurt cups, white Frisbee, dish tub
Waterproof phone case	protection of phone during use of Creek Critters App	Ziploc bag, use of partner system (one person sorts while other person stands on bank with app)
Pipettes	easy handling of macros for sorting	plastic spoons
Field microscope	further classification of macros	magnifying bug boxes
Kitchen gloves	sturdy protection from stream contaminants	disposable gloves
Garbage bags (1 or 2)	for carrying out any waste from site	

6 www.projectwild.org/projectwildwebsite/aquatic/
7 www.projectwild.org/GrowingUpWILD.htm
8 www.projectwild.org/ProjectWILDK-12CurriculumandActivityGuide.htm
9 www.plt.org/
10 www.doee.dc.gov/service/environmental-education-workshops-and-training
11 www.fergusonfoundation.org/bridging-the-watershed/
12 www.fergusonfoundation.org/bridging-the-watershed/training-opportunities/
13 www.baybackpack.com/assets/documents/Educators_Guide_to_MWEE_Download.pdf
14 www.anshome.org/creek-critters/
15 www.anshome.org/conservation-events/
16 www.doee.dc.gov/arec



Watershed Connections image

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