Field Data Sheet/Site Map

Reproduce for use

SITE INFORMATION

Organization/Group Name: _____

Waterway: _____

Major Watershed: _____

Sub-Watershed: _____

Closest Town/City: _____

Site Code: _____

Investigators: _____

Total Time Spent Monitoring: _____

Number of Participants: _____ HH/MM

Latitude: _____

Longitude: _____

Site Name: _____

PACK DATA

Placement Data		Retrieval Data	
Date:		Date:	
Number of Packs:		Number of Packs	
Air Temp[° C]:		Air Temp ° C]:	
Water Temp [° C]:		Water Temp [° C]:	

Leaf pack contents/weight:

Habitat type for placement: ☐ Pool ☐ Riffle ☐ Run

STORM & NON-STORM EVENTS

A. Did any storm events occur while your leaf packs were in the stream?

☐ Unknown ☐ Yes ☐ No

B. Did flooding occur?

☐ Unknown ☐ Yes ☐ No

C. Was this site experiencing a drought during your monitoring?

☐ Unknown ☐ Yes ☐ No

If YES for A, list the following:

Storm Date	Precipitation (cm)
Total Amount (cm)	

COMMENTS

Submit data to the online portal at MonitorMyWatershed.org

Site Map

Sketch the stream area. Show the position of each leaf pack in the stream and note any landmarks that may help in locating them when it is time to retieve them.

Field Data Sheet/Site Map

SITE INFORMATION

Organization/Group Name: white Clay Creek Club
Waterway: White Clay Creek
Major Watershed: Delaware
Sub-Watershed: Brandywine-Christina
Closest Town/City: Avondale
Site Code: WCC-US1

Investigators: Vince , Mandy , Steve , Tara
Total Time Spent Monitoring: 03:15
Number of Participants: 4 HH/MM
Latitude: 39.85914
Longitude: -75.78369
Site Name: White Clay Creek above Spencer Rd

PACK DATA

Placement Data		Retrieval Data	
Date:	04/01/2019	Date:	04/22/2019
Number of Packs:	3	Number of Leaf Packs	2
Air Temp[° C]:	15.5	Air Temp ° C]:	16.0
Water Temp [° C]:	12.0	Water Temp [° C]:	12.3

Leaf pack contents/weight: # Each leaf pack has 10 g beech + 10 g elm + 10 g Sycamore

Habitat type for placement: ☐ Pool ☑ Riffle ☐ Run

STORM & NON-STORM EVENTS

A. Did any storm events occur while your leaf packs were in the stream?

☐ Unknown ☑ Yes ☐ No

B. Did flooding occur?

☐ Unknown ☑ Yes ☐ No

C. Was this site experiencing a drought during your monitoring?

☐ Unknown ☐ Yes ☑ No

If YES for A, list the following:

Storm Date	Precipitation
04/17/2019	6 cm
Total Amount	6 cm

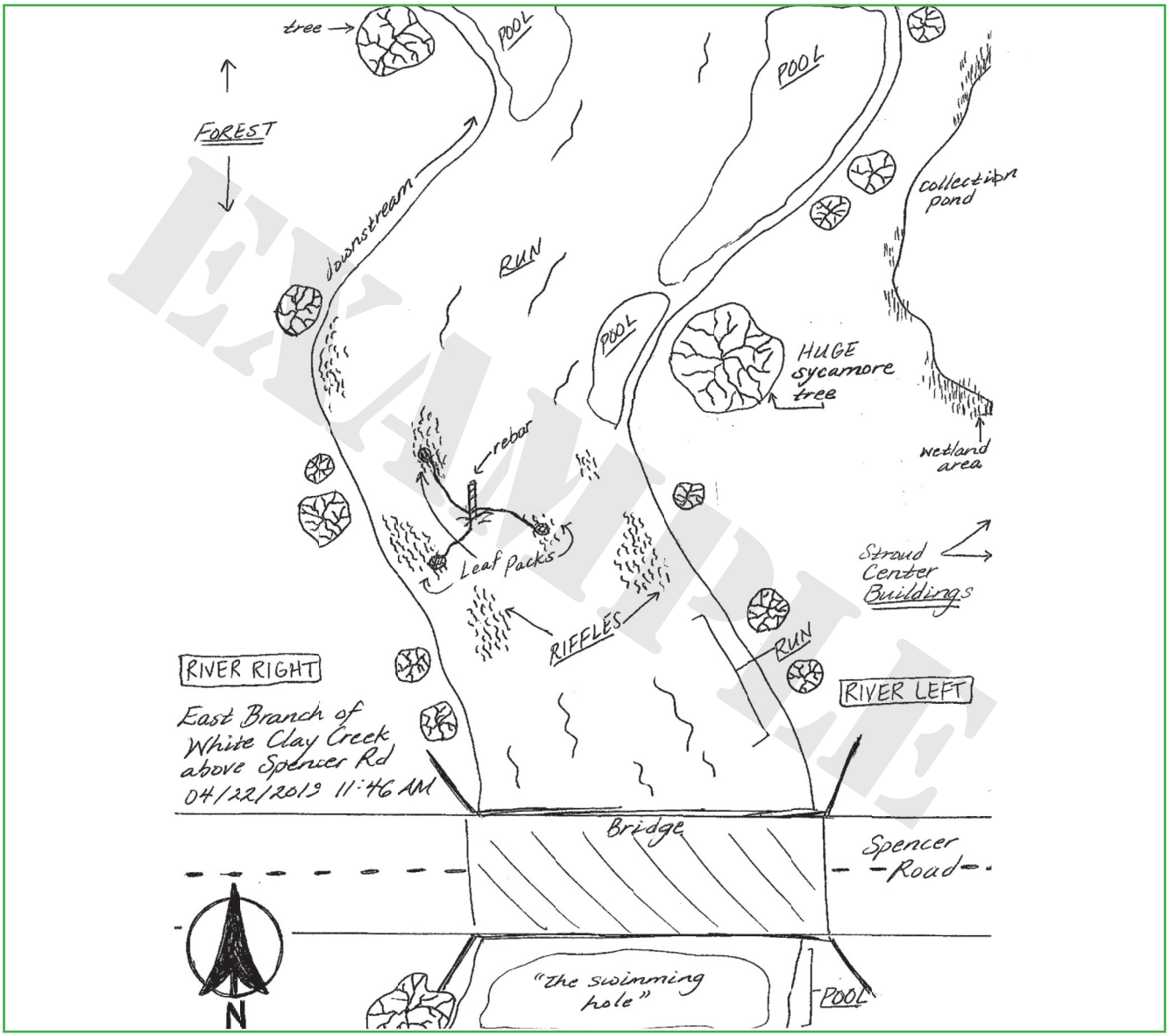
COMMENTS

We checked the leaf packs each week and they were there until week 2 when the storm hit! Our little stream went up a lot and looks like we didn't anchor one of our leaf packs in good enough. Will do better next time!

Submit data to the online portal at MonitorMyWatershed.org

Site Map

Sketch the stream area. Show the position of each leaf pack in the stream and note any landmarks that may help in locating them when it is time to retieve them.



Habitat Data Sheet

The Habitat Survey links the physical characters of the stream and the surrounding land use to the macroinvertebrate survey results. There are two major factors that influence macroinvertebrate presence and absence: the overall water quality and the amount of available suitable habitat. Therefore, poor availability and poor quality of habitat features could influence the biotic index score since habitat and macroinvertebrate diversity are closely linked. The presence of poor habitat is considered one of the major stressors on aquatic communities.

The habitat survey should be completed at the start of the monitoring period - near the time that the leaf packs are placed in the stream. If average stream width, average stream depth, stream velocity, and stream discharge are to be determined, complete sections 12-15 before the leaf packs are placed in the stream.

Definitions:

Survey Stream Reach: the total length of stream that is included in the survey. The recommended length is approximately 15-meters upstream and 15-meters downstream from the leaf pack placement location, for a total of 30-meters.

Right and Left Bank: determined by looking downstream with the flow of the stream. The right bank is on the right and left bank on the left.

See the Glossary for unfamiliar terms.

IN-STREAM CHARACTERISTICS

This section is a survey of what attributes occur within the stream - not on the banks or in the riparian zone.

1A. Stream Habitats Present Enter the relative percentages for each category to total 100%.

_____ Pools _____ Riffles _____ Runs _____ Cascades _____ Log Steps _____ Boulder Steps

1B. Submerged Stream Habitats Present Check all that apply

☐ Woody Debris ☐ Leaves ☐ Aquatic Plants ☐ Submerged Roots

2. Stream Bottom Mineral Composition Check all that apply

☐ Cobbles [2.5 - 10" or 6.4-25.6 cm diameter ☐ Boulders [>10" or 25.6 cm] ☐ Fine Sediment and Silt ☐ Gravel [0.08-2.5" or 0.02-6.4 cm diameter] ☐ Bedrock ☐ Other: _____

3. Water Appearance Check all that apply

☐ Clear ☐ Turbid ☐ Foamy ☐ Oily Sheen ☐ Algae ☐ Colored (describe): _____

4. Human and Hydrologic Modifications to Stream Channel Check all that apply

☐ None ☐ Cement ☐ Rip Rap ☐ Pipe or Ditch Entering Stream

Upstream or Downstream from the packs? (Circle One)

☐ Bridge Upstream Downstream ☐ Dam Upstream Downstream ☐ Beaver Dam Upstream Downstream

5. Presence of Litter in Stream or on Banks Check all that apply

☐ None ☐ Tires ☐ Cans ☐ Plastic/Glass Bottles ☐ Other: _____

STREAMBANK CHARACTERISTICS

The streambank is the area of land immediately adjacent to the bed of the stream. It is important to maintaining the health of the waterway.

6. Percent of Streambank Covered by Vegetation (grass, shrubs, trees, etc.) Check the appropriate category for each bank.

Left Bank	☐ 0% (bare soil)	☐ <20%	☐ 20-50%	☐ >50%
Right Bank	☐ 0% (bare soil)	☐ <20%	☐ 20-50%	☐ >50%

7. Bank Slope (or Grade) Check the appropriate category for each bank

Left Bank ☐ <6% ☐ >6% **Right Bank** ☐ <6% ☐ >6%

To determine the slope or grade of a stream bank:

1. Have two people stand 100 feet apart and face one another; one uphill or further from the stream and one downhill, closer to the stream.
2. Have the person who is uphill hold a flat surface (e.g. notebook or clipboard) at horizontal sight level and look in the direction of the downhill person. If the uphill person can see any part of the downhill person's body, the slope is rated at less than 6%. If no part of the downhill person's body is visible, the rating is greater than 6%.

RIPARIAN ZONE

The riparian zone is the area of land immediately next to the stream and begins at the edge of the streambank. If vegetated, this zone is also called a streamside forest or buffer, and is a critical component to keeping a stream healthy. The trees, shrubs, and herbaceous plants stabilize the stream banks with their roots, provide shade to keep streams cool, and filter pollution within runoff.

8. Vegetation in the Riparian Zone Explore 30 meters from the stream edge into riparian zone of the left bank and the right bank. Check all that apply.

Left Side	☐	No Vegetation	☐	Grass	☐	Herbaceous	☐	Shrubs	☐ Trees
Right Side	☐	No Vegetation	☐	Grass	☐	Herbaceous	☐	Shrubs	☐ Trees

9. Width of the Riparian Zone within the 30 Meter Stream Reach Use a meter tape measure to determine the minimum and maximum width of the riparian zone within the 30-meter stream reach for both the left bank and the right bank.

									Minimum Width (m)	Maximum Width (m)
Left Side	☐	No Forest	☐	Forest (>5m tall; >40% interlocking canopy; >20% deep)	☐	Forest is: (Mostly evergreen)	☐	Forest is: Mostly deciduous		
Right Side	☐	No Forest	☐	Forest (>5m tall; >40% interlocking canopy; >20% deep)	☐	Forest is: (Mostly evergreen)	☐	Forest is: Mostly deciduous		

LAND-USE CHARACTERISTICS

The types of land use in an area surrounding a stream contributes greatly to the health of a waterway. From agricultural uses to forests, commercial spaces to wetlands, it is important to know how the land is being used in the stream reach and in the greater watershed. The questions in this section only begin to scratch the surface of this understanding, but the process of identifying what might be playing a factor in your leaf pack monitoring result is a start.

Describe the main land use within the 30 meter reach area – 15 meters upstream and 15 meters downstream from the leaf pack location.

10. Current Land use Observed from the Leaf Pack Location Check all that apply

- ☐ Row Crop (in growing season)
- ☐ Row Crop (non-growing season)
- ☐ Pasture with animals
- ☐ Meadow
- ☐ Hay Field
- ☐ Golf Course
- ☐ Parks and Recreation
- ☐ Sewage Treatment Plant
- ☐ Forest
- ☐ Resoration Area (tree planting)
- ☐ ATV Trails
- ☐ Trails
- ☐ Mowed Lawn
- ☐ Active Construction
- ☐ Residential/Commercial
- ☐ Industrial
- ☐ Other _____

11. Percent of Impervious Surfaces Observed from the Leaf Pack Location Check all that apply

☐ <20% ☐ 20-50% ☐ >50%

ADDITIONAL INFORMATION ABOUT YOUR STREAM

Simple measurements provide important supplemental information about the available habitat and size of the stream. Complete Activity 2 Determining Stream Discharge before placing any leaf packs in the stream to obtain the average stream width, stream depth, stream velocity and stream discharge.

12. Average Stream Width (m) _____

13. Average Stream Depth (m) _____

14. Stream Velocity (m/s) _____

15. Stream Discharge (m^3/s) _____

Biotic Index Data Sheet

Date: _____ Investigator Names: _____

Time: _____ AM/PM Leaf Pack Location: _____

1

Group 1: Sensitive	Group 2: Somewhat Sensitive	Group 3: Tolerant
☐ Stoneflies 	☐ Damselflies 	☐ Midge Flies 
☐ Mayflies 	☐ Dragonflies 	☐ Black Flies 
☐ Other Caddisflies 	☐ Sowbugs 	☐ Planarians 
☐ Dobsonflies, Fishflies, and Alderflies 	☐ Scuds 	☐ Leeches 
☐ Riffle Beetle Larvae/ Adults 	☐ Crane Flies 	☐ Left-Handed/ Lunged Snails 
☐ Water Pennies 	☐ Clams/Mussels 	☐ Aquatic Worms 
☐ Right-Handed/ Gilled Snails 	☐ Crayfish 	☐ Rat-Tailed Maggots 
☐ Aquatic Snipe Flies 	☐ Net-Spinning Caddisflies 	
3 ☐ Number of TAXA	☐ Number of TAXA	☐ Number of TAXA

2

☐ **Sum of All Individuals**
(Add the values from all boxes next to the taxa names)

4

Number of TAXA x 3 = INDEX VALUE ☐

Number of TAXA x 2 = INDEX VALUE ☐

Number of TAXA x 1 = INDEX VALUE ☐

5

☐ **Pollution Tolerance Index (PTI) Score**
(Add the three Index Values)

Calculating the Biotic Index

Sort the macroinvertebrates into taxa groups.

1. Count the number of individual macroinvertebrates for each taxa. Record the quantity in the box to the left of the taxa name.
2. Determine the **Sum of All Individuals** by adding the numbers in the boxes next to all of the the taxa names. Record the total in the **Sum of All Individuals** box on the far right.
3. Count how many boxes in each sensitivity group column have a quantity entered. (Group 1 and Group 2: maximum 8, Group 3: maximum 7). Enter the **Number of TAXA** in the box at the bottom of each column.
4. Multiply the **Number of TAXA** by the weighting factor (3, 2 or 1) at the bottom of the column to obtain the **Index Value** for each Sensitivity Group.
5. Add the **Index Values** for the three groups to determine the **Pollution Tolerance Index (PTI) Score**. Enter the **PTI Score** in the box.
6. Determine the **Pollution Tolerance Index Rating** from the PTI Score.

6

POLLUTION TOLERANCE INDEX RATING		
23 or more	**Excellent**	☐
17-22	**Good**	☐
11-16	**Fair**	☐
10 or less	**Poor**	☐

Biotic Index Data Sheet

Date: 04/22/2019 Investigator Names: Vince, Mandy, Steve, Tara

Time: 11:00 AM/PM Leaf Pack Location: White Clay Creek above Spencer Road

1

Group 1: Sensitive		Group 2: Somewhat Sensitive		Group 3: Tolerant	
55	Stoneflies	0	Damselflies	13	Midge Flies
30	Mayflies	5	Dragonflies	5	Black Flies
16	Other Caddisflies	3	Sowbugs	8	Planarians
0	Dobsonflies, Fishflies, and Alderflies	0	Scuds	0	Leeches
4	Riffle Beetle Larvae/ Adults	3	Crane Flies	0	Left-Handed/ Lunged Snails
6	Water Pennies	1	Clams/Mussels	1	Aquatic Worms
10	Right-Handed/ Gilled Snails	0	Crayfish	0	Rat-Tailed Maggots
2	Aquatic Snipe Flies	22	Net-Spinning Caddisflies		
3 7	Number of TAXA	5	Number of TAXA	4	Number of TAXA

2

184 **Sum of All Individuals**
(Add the values from all boxes next to the taxa names)

4

Number of TAXA x 3 = INDEX VALUE 21

Number of TAXA x 2 = INDEX VALUE 10

Number of TAXA x 1 = INDEX VALUE 4

5

35 **Pollution Tolerance Index (PTI) Score**
(Add the three Index Values)

Calculating the Biotic Index

Sort the macroinvertebrates into taxa groups.

1. Count the number of individual macroinvertebrates for each taxa. Record the quantity in the box to the left of the taxa name.
2. Determine the **Sum of All Individuals** by adding the numbers in the boxes next to all of the the taxa names. Record the total in the **Sum of All Individuals** box on the far right.
3. Count how many boxes in each sensitivity group column have a quantity entered. (Group 1 and Group 2: maximum 8, Group 3: maximum 7). Enter the **Number of TAXA** in the box at the bottom of each column.
4. Multiply the **Number of TAXA** by the weighting factor (3, 2 or 1) at the bottom of the column to obtain the **Index Value** for each Sensitivity Group.
5. Add the **Index Values** for the three groups to determine the **Pollution Tolerance Index (PTI) Score**. Enter the **PTI Score** in the box.
6. Determine the **Pollution Tolerance Index Rating** from the PTI Score.

6

POLLUTION TOLERANCE INDEX RATING		
23 or more	Excellent	✓
17-22	Good	
11-16	Fair	
10 or less	Poor	

Experiment Summary Data Sheet

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	MACROINVERTEBRATE TAXON	CONTROL # Leaf Packs: # OF INDIVIDUALS	EXPERIMENTAL # Leaf Packs: # OF INDIVIDUALS
GROUP 1: SENSITIVE	STONEFLIES (Plecoptera)		
	MAYFLIES (Ephemeroptera)		
	OTHER CADDISFLIES (Trichoptera)		
	DOBSONFLIES, FISHFLIES and ALDERFLIES (Megaloptera)		
	RIFFLE BEETLES LARVAE/ADULTS (Elmidae)		
	WATER PENNIES (Psephenidae)		
	RIGHT-HANDED/GILLED SNAILS (Gastropoda)		
	AQUATIC SNIPE FLIES (Athericidae)		
GROUP 2: SOMEWHAT SENSITIVE	DAMSELFLIES (Odonata)		
	DRAGONFLIES (Odonata)		
	AQUATIC SOWBUGS (Isopoda)		
	SCUDS (Amphipoda)		
	CRANE FLIES (Tipulidae)		
	CLAMS/MUSSELS (Mollusca)		
	CRAYFISH (Decapoda)		
	NET-SPINNING CADDISFLIES (Hydropsychidae)		
GROUP 3: TOLERANT	MIDGE FLIES (Chironomidae)		
	BLACK FLIES (Simuliidae)		
	PLANARIANS (Turbellaria)		
	LEECHES (Hirudinea)		
	LEFT-HANDED/LUNGED SNAILS (Gastropoda)		
	AQUATIC WORMS (Oligochaeta)		
	RAT-TAILED MAGGOTS (Syrphidae)		
	Sum of All Individuals		
	Pollution Tolerance Index (PTI) Score		
	Pollution Tolerance Index Rating		

Name(s):

Date:

After completing a Biotic Index Data Sheet for each control Leaf Pack and Experimental Leaf Pack, enter the averages for the Control Leaf Packs and the Experimental Leaf Packs on the chart.

Experiment Summary Data Sheet

	MACROINVERTEBRATE TAXON	CONTROL # Leaf Packs: 4 # OF INDIVIDUALS	EXPERIMENTAL # Leaf Packs: 4 # OF INDIVIDUALS
GROUP 1: SENSITIVE	STONEFLIES (Plecoptera)	55	0
	MAYFLIES (Ephemeroptera)	30	0
	OTHER CADDISFLIES (Trichoptera)	16	0
	DOBSONFLIES, FISHFLIES and ALDERFLIES (Megaloptera)	0	0
	RIFFLE BEETLES LARVAE/ADULTS (Elmidae)	4	0
	WATER PENNIES (Psephenidae)	6	0
	RIGHT-HANDED/GILLED SNAILS (Gastropoda)	10	0
	AQUATIC SNIPE FLIES (Athericidae)	2	0
GROUP 2: SOMEWHAT SENSITIVE	DAMSELFLIES (Odonata)	0	0
	DRAGONFLIES (Odonata)	5	0
	AQUATIC SOWBUGS (Isopoda)	3	0
	SCUDS (Amphipoda)	0	0
	CRANE FLIES (Tipulidae)	3	0
	CLAMS/MUSSELS (Mollusca)	1	0
	CRAYFISH (Decapoda)	0	0
	NET-SPINNING CADDISFLIES (Hydropsychidae)	22	0
GROUP 3: TOLERANT	MIDGE FLIES (Chironomidae)	23	30
	BLACK FLIES (Simuliidae)	5	21
	PLANARIANS (Turbellaria)	8	17
	LEECHES (Hirudinea)	0	4
	LEFT-HANDED/LUNGED SNAILS (Gastropoda)	0	6
	AQUATIC WORMS (Oligochaeta)	1	4
	RAT-TAILED MAGGOTS (Syrphidae)	0	1
	Sum of All Individuals	184	83
	Pollution Tolerance Index (PTI) Score	35	7
	Pollution Tolerance Index Rating	Excellent	Poor

Name[s]:

Vince , Mandy

Steve , Tara

Date:

04/22/2019

After completing a Biotic Index Data Sheet for each control Leaf Pack and Experimental Leaf Pack, enter the averages for the Control Leaf Packs and the Experimental Leaf Packs on the chart.

GLOSSARY

-artificial leaf pack	A mesh bag containing leaves or grass that is placed in a stream to simulate natural leaf packs. Used in the study of aquatic macroinvertebrates.
-bank	Where a stream or river meets the land.
-biodiversity	The variety of living organisms present.
-bioindicator organisms	Groups of plants or animals that tolerate specific levels of pollution that are used to indicate water quality.
-biotic	Living things.
-biotic index	A method of estimating organic pollution by comparing the abundance of organisms and their tolerance to environmental stress.
-collectors	Macroinvertebrates that collect small/fine food particles by gathering or filtering them from the water.
-complete metamorphosis	The process of completing a four-stage life cycle consisting of egg, larva, pupa, and adult stages. Examples of insects that undergo complete metamorphosis are true flies, beetles, caddisflies, and dobsonflies.
-control leaf pack	Leaf packs that do not contain the experimental variable that are used to evaluate the influence of the experimental variable that is present in other leaf packs.
-decomposer	Bacteria and fungi that break down (decay) organic substances, such as dead plants (leaves) and animals.
-detritus	Dead plant or animal matter.
-experimental leaf pack	A leaf pack that includes an experimental variable.
-experimental variable	The one tested difference or change between experimental conditions. The purpose of the variable is to test a specific influence that will affect the colonization of the leaf pack.

-functional feeding groups	Method of classifying macroinvertebrates based on feeding adaptations and/or preferences.
-grazers/scrapers	Aquatic macroinvertebrates which feed on the algal coating of rocks and rubble. Often the bodies of these animals are flat, enhancing their ability to hold on in fast-flowing water. They include some caddisflies, water pennies, and certain midges and mayflies.
-habitat	The environment in which a plant or animal lives.
-incomplete metamorphosis	The process of completing a three-stage life cycle consisting of egg, nymph, and adult stages. Examples of insects that undergo incomplete metamorphosis are mayflies, dragonflies, damselflies, stoneflies, and true bugs.
-larval stage	Immature stage of an insect which undergoes complete metamorphosis.
-leaf pack	A naturally forming accumulation of leaves within a stream which provide habitat and food for aquatic organisms. The formation of leaf packs within a stream is directly related to the surrounding riparian vegetation and the forest canopy. See Artificial Leaf Pack.
-macroinvertebrate	Animal without a backbone and large enough to be seen with the unaided eye.
-nymphal stage	Immature stage of an insect which undergoes incomplete metamorphosis.
-percent EPT	The total number of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) divided by the total number of all macroinvertebrates, divided by 100.
-pollution tolerance index rating	A component of the biotic index, which gives a range of poor, fair, good, and excellent for grading the health of a stream or river.
-pollution tolerance index score	A component of the biotic index, which gives a range of 0 – 23+ grading the health of a stream or river.
-pool	Deep section of a stream in which the flow or current is slow.
-predators	Animals that feed on other animals.

-pupal stage The transitional stage between the larva and the adult in an insect that undergoes complete metamorphosis.

-replicate A duplicate (e.g., a duplicate leaf pack) of the same experimental condition.

-riffle/riffle area The shallow area of a stream through which water moves swiftly and there are many rocks.

-riparian Pertaining to the streamside; the area adjacent to a stream (e.g., riparian vegetation is the vegetation found growing alongside a stream).

-shredders Aquatic macroinvertebrates that feed on leaf matter, breaking it down into finer matter, making it available for the collectors (see Collectors) to consume. Shredders include the craneflies, some caddisflies or stoneflies, sowbugs, and scuds.

-taxa (taxon) Taxonomic (see Taxonomy) group, whatever its ranking (e.g., class, order, family).

-taxonomy The science of classifying organisms according to their shared characteristics and evolutionary relationships.

-water quality The overall health of a body of water, including the measured chemical, physical, and biological characteristics.

-watershed A land area bounded by a divide and draining to a particular body of water or watercourse.

RESOURCES

A Guide to Common Freshwater Invertebrates of North America
J. Reese Voshell
McDonald & Woodward Publishing Co.
431 E College St
Granville, OH 43023

Aquatic Entomology
W. Patrick McCafferty
Jones and Bartlett Learning
5 Wall Street
Burlington, MA 01803

Beautiful Images of Macroinvertebrates
http://lifeinfreshwater.net/

Bugs of the Underworld Videos:
Ralph and Lisa Cutter

http://bit.ly/2KZQQCR

*The full DVD can be purchase on LaMotte's website

Creek Critters App
https://anshome.org/creek-critters/

Dichotomous Identification Key to Freshwater Macroinvertebrates:
https://stroudcenter.org/macros/key/

Field Manual for Water Quality Monitoring, 11th Edition
Mark Mitchell and William Stapp
Kendall/Hunt Publishing Company
4050 Westmark Drive
P.O. Box 1840
Dubuque, IA 52004-1840

Gallery of 3D Macroinvertebrate Images and Learning Library
Macroinvertebrates.org

Importance of Streamside Forests
https://stroudcenter.org/restoration/streamside-forests/

https://stroudcenter.org/research/landmarks/streamside-reforestation/

Leaf Pack Network®
https://leafpacknetwork.org/

Share data with other groups using the Leaf Pack Stream Ecology Kit.
Stroud Water Research Center
970 Spencer Road
Avondale, PA 19311

Linking Trees to Streams
https://leafpacknetwork.org/learn/linking-trees-streams/

Macroinvertebrate Links
Macroinvertebrates.org

Mayfly Hatching Video:
https://www.youtube.com/watch?v=gtXX9J7iZQA

Monitor's Guide to Aquatic Invertebrates
www.iwla.org

The Monitor's Handbook
http://www.lamotte.com/en/environmental-education-resources/handbooks

LaMotte Company
PO Box 329
Chestertown, MD 21620

Pond and Brook: A Guide to Nature Study in Freshwater Environments
Michael J. Caduto
Prentice-Hall Inc.
Upper Saddle River, NJ 07458

River Continuum Theory
https://stroudcenter.org/continuum/

Super coolio website, navigating through a watershed, learning about river continuum:

https://stroudcenter.org/education/curriculum/navigate-a-watershed/

Save Our Streams Program
Izaak Walton League of America
707 Conservation Lane
Gaithersburg, MD 20878-2983

301-548-0151

Water Quality App:
For Apple devices:

https://apple.co/2KqRJoA

For Android devices:

http://bit.ly/31H8lh9

Watershed Tea

https://stroudcenter.org/research/landmarks/watershed-tea/

WikiWatershed Toolkit
Web toolkit designed to help citizens, conservation practitioners, municipal decision-makers, researchers, educators, and students advance knowledge and stewardship of fresh water. This includes Model My Watershed, Monitor My Watershed, Runoff Simulation, EnviroDIY, Leaf Pack Network, and Water Quality Mobile App

WikiWatershed.org

WoW! The Wonders of Wetlands: An Educator's Guide
Environmental Concerns Inc.
Education Department
PO Box P
St. Michaels, MD 21663

REFERENCES

Cummins, K. W., and M. A. Wilsbach. Field Procedures for Analysis of Functional Feeding Groups of Stream Macroinvertebrates. Frostburg, MD: Appalachian Environmental Laboratory, University of Maryland, 1985.

Hilsenhoff, W. L. "Rapid Field Assessment of Organic Pollution with a Family Level Biotic Index." Journal of the North American Benthological Society 7, no. 1 (1988): 65-68.

Kellog, Loren K. Save Our Streams Monitor's Guide to Aquatic Macroinvertebrates. 2nd ed. Gaithersburg, MD: Izaak Walton League of America, 1994, 60.

McCafferty, W. P. Aquatic Entomology. Sudbury, MA: Jones and Bartlett Publishers, 1998.

Merritt, R. W., and K. W. Cummins. An Introduction to the Aquatic Insects of North America. 2nd ed. Dubuque, IA: Kendall/Hunt Publishing Company, 1984.

Mitchell, M., and W. Stapp. Field Manual for Water Quality Monitoring. 11th ed. Dubuque, IA: Kendall/Hunt Publishing Company, 1997. 97-99.

Needham, J. G., and P. R. Needham. A Guide to the Study of Freshwater Biology. 5th ed. San Francisco: Holden-Day, Inc., 1974.

Pennak, R. W. Freshwater Invertebrates of the United States. 3rd ed. New York: John Wiley and Sons, Inc., 1966.

Sweeney, B. W. "Streamside Forests and the Physical, Chemical, and Trophic Characteristics of Piedmont Streams in Eastern North America" Water, Science, & Technology 26, no. 12: 2653-2673.

Sweeney, B. W. "Effects of Streamside Vegetation on Macroinvertebrate Communities of White Clay Creek in Eastern North America." Proceedings of The Academy of Natural Sciences of Philadelphia 144 (1993): 291-340.

Ward, H. B., and G. C. Whipple. Freshwater Biology. 2nd ed. Edited by W. T. Edmonson. New York: John Wiley and Sons, Inc., 1966.