Stream Ecology and Water Quality Field Test Methods

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Abstract

Benthic macroinvertebrates are important indicators of water quality of streams and rivers. Macroinvertebrates commonly found in Delaware's streams include insects, clams, mussels, snails, worms, grass shrimp, amphipods, crayfish, and crabs. In Delaware streams there are thousands of different macroinvertebrate species, each with its own unique requirements for survival. Basic visual, physical, and chemical data are valuable for a more complete picture of the water quality. This field study will focus on collecting visual, chemical, and biological data in the field at a local piedmont stream. Participants will then learn to interpret these data to determine the water quality. Teaching students outside offers the benefit of real world experiences, appealing to many different learning styles and heightened interest due to the always changing natural environment. The unique aspects of teaching a lab in the field will be highlighted.

Introduction

In this laboratory students will learn how to collect data in the field and to interpret this data in a meaningful way. They will collect biological, physical, chemical, and visual data that will be used to determine water quality. They will be able to explain how these parameters influence each other. The students will learn how to measure dissolved oxygen and pH and how to perform a titration as part of measuring dissolved oxygen. In order to properly collect useful data, they will learn basic classification and identification techniques including using various keys. They will be able to identify four basic types of stream pollution and ways to avoid polluting streams.

This lab is appropriate for beginning biology majors or non-majors fulfilling science requirement. This should be considered an introductory course. Set up time is minimal, basically consisting of time needed to collect equipment and materials to be used in the field. This laboratory can be held in a 2 - 3 hour time span depending on how long it takes to get to the site and how large the class size is.

Student Outline

A healthy stream contains a variety of habitats for aquatic life. Aquatic insects, larval fish, and tadpoles live and feed among vegetation, rocks, and logs on the stream bottom. Schooling fish dwell in the deeper pools. Frogs sit along the stream banks, and turtles lurk near the bottom or bask in the sun on logs. Water naturally carries many substances including oxygen, carbon dioxide, nitrates, phosphates, calcium compounds, and sediments. The amount of each substance in unpolluted water depends on the geology, topography, water velocity, water temperature, climate, and vegetation of the surrounding area. Aquatic organisms have adapted over thousands of years to living in their specific chemical environment and therefore are adversely affected by uncharacteristic changes.

The water quality of streams and rivers can be assessed easily and effectively using benthic (bottom-dwelling) macroinvertebrates. Macroinvertebrates are those organisms which lack a backbone and are large enough to be seen with the naked eye. Macroinvertebrates commonly found in piedmont streams include insects, clams, mussels, snails, worms, grass shrimp, amphipods, crayfish, and crabs. A monthly or quarterly survey of a stream's macroinvertebrate community is a helpful tool in monitoring a stream's health. Benthic macroinvertebrates are generally found either on various substrates (surfaces) including rocks, logs, sticks, leaf packets, exposed roots, undercut banks, and aquatic or overhanging vegetation; or burrowed in the stream bottom. A few organisms live on top of or hang on the underneath of the water surface. Many organisms require high levels of oxygen and cannot tolerate substantial amounts of toxic substances. Organisms that can withstand very low oxygen levels or high toxicity are known as pollution-tolerant species. Differences in their sensitivity to pollution is one of the main reasons macroinvertebrates can be used to assess water quality.

Macroinvertebrates are suitable for assessing water quality for several other reasons. They can't move around much; therefore they can't easily escape from changes in water quality. When pollution impacts a stream, the macroinvertebrate populations are adversely affected and require considerable time to recover. They are easily collected and many can be found in streams all year round. Unlike chemical parameters which indicate stream health at the time of testing, macroinvertebrate populations reflect past influences on the stream. A pollution event that occurred a few days ago will not be detected by chemical testing, but may still be reflected in the macroinvertebrate community. Adding some basic physical and chemical parameters gives a more complete picture of overall water quality.

Objectives

- Learn about stream health and ecosystems and why this is important
- Learn several ways to determine the water quality of a stream in terms of an aquatic habitat
- Learn to survey a stream and collect data and interpret that data
  - Chemical – learn how to perform a titration
  - Biological – learn basic classification, identify macroinvertebrates to Order
  - Learn what factors can affect the water quality of a stream

Visual Survey

A Visual Survey requires little time and no special equipment, yet provides important information about a stream's health. It is performed in conjunction with the macroinvertebrate and physical/chemical surveys and adds useful information to interpret the data collected in a more complete manner. The Non-Tidal Stream Data Sheet (APPENDIX A) provides space for recording your observations at each macroinvertebrate sampling station. Make sure you carefully complete the top part of the form entitled "Basic Data." Describe each station location using good landmarks such as road crossings, railroads, tributaries, or stream mileages. When describing the weather, note any heavy rainstorms, dry spells, or other unusual conditions.

Record the water color and odor and any stream surface or bottom coatings. Measure the width and depth of the stream at the riffle with a measuring tape or yardstick. If you can't make measurements, write down your estimates. Refer to the following items as you survey approximately a 100 yard long stream section and record the information on the Non-Tidal Stream Data Sheet:

1. Stream Velocity: Check the choice which most closely describes your stream site.
2. Width & Depth: Approximate the range of stream widths and depths in your survey section. However, the first time surveying a section, please base your values on a few measurements rather than guesses. Unless you measure distances frequently, a quick guess can be very inaccurate.
3. Bottom Type: Circle the description which appears predominant in your survey section. If equally divided, circle the most dominant types.
4. Water Condition: Note the water odor and color and the stream surface and streambed coatings in your survey section. See APPENDIX C to determine the cause of any unusual conditions.
5. Aquatic Vegetation: Record the abundance and colors of stream algal growths and the abundance and location of other aquatic plants.
6. Litter: Check the appropriate column for a rough estimate of the amount of each type of litter.
7. Biological Data: In this section record observed animals or plants which you can identify.

Chemical and Physical Survey

Air Temperature

Air temperature influences the water temperature greatly, especially where water is shallow and the area is open. Take the air temperature in the shade with the bulb end of the thermometer hanging freely in the air and record the result on your data sheet.

Water Temperature

Water temperature has great influence on the life in a stream. Colder water can hold more dissolved oxygen and thus may support a greater variety of organisms. Measure the water temperature with a good field thermometer attached to a long string. If the water is deeper than 5 feet, measure the temperature at more than one depth using the string to lower the thermometer into the water. The water temperature in all of Delaware's streams should be less than 86^{o}F (DNREC, 2004). The temperature should only exceed 86^{o}F when due to natural conditions or outside of designated mixing zones. If the stream temperature consistently exceeds these standards, there may be a problem.

Dissolved Oxygen

The amount of oxygen dissolved in the water is one of the best indicators of stream health. The oxygen is absorbed directly from the atmosphere as well as being produced by aquatic plants. Levels of oxygen fluctuate daily in streams, falling at night, reaching the lowest level just before dawn, and then peaking in the late afternoon. Dissolved oxygen also varies at different temperatures (refer to solubility chart in APPENDIX F) and levels of salinity. As temperature and salinity rise, dissolved oxygen falls. Most natural streams require at least 5-6 mg/l of dissolved oxygen to support a diverse ecosystem. Little or no oxygen indicates unhealthy water, possibly due to excessive organic enrichment. In freshwater streams dissolved oxygen should average 5.5 mg/l and be no less than 4.0 mg/l (DNREC, 2004). If you find the dissolved oxygen levels to be consistently lower than the standards, there may be a problem. To measure the dissolved oxygen follow the procedure detailed below and use the LaMotte field kit provided.

1. To avoid sample contamination, thoroughly rinse the Sampling Bottle (0688) with the water to be sampled three times.
2. Remove cap and allow the bottle to fill. Tap the sides of the submerged bottle to dislodge any air bubbles clinging to the inside of the bottle. Hold the inverted cap under water and replace the cap while the bottle is still submerged.
3. Invert the bottle and examine to make sure that no air bubbles are trapped inside. Once a satisfactory sample has been collected, proceed immediately with Steps 4 & 5.
4. Add 8 drops of Manganese Sulfate Solution (4167-G) and 8 drops of Alkaline Potassium Iodide Solution (7166-G) to each sample. Cap the bottle and mix by inverting gently several times. A flocculant will form. Allow the flocculant to settle below the shoulder of the bottle. Invert the bottle again and allow the precipitate to settle again.
5. Using the 1-g measuring spoon (0697), add one level measure of the Sulfamic Powder (6286-H) to the sampling bottle. Cap the bottle and gently shake to mix, until both the reagent and the precipitate have dissolved. A clear-yellow to brown-orange

color will develop, depending on the oxygen content of the sample. Note: Following the completion of Step 5, contact between the water sample and the atmosphere will not affect the test result. Once the sample has been "fixed" in this manner, it is not necessary to perform the actual test procedure immediately. The bottle will contain enough fixed sample to perform the titration at least twice.

6. Rinse Titration Tube (0299) with small amount of fixed sample and pour into waste jar. Pour 20mL of the solution from one of the Sample Bottles into the Titration Tube (white line). The bottom of the meniscus should be on top of the line.
7. Fill small Titrator (0377) to the zero mark with Standard Sodium Thiosulfate solution (4169-H). Insert the titrator into the center hole of the titration tube cap. The next step is called titration.
8. Add 1 drop of Sodium Thiosulfate to titration tube; swirl the titration tube to mix. Add another drop of the Sodium Thiosulfate and swirl the tube. Continue this titration process one drop at a time until the yellow-brown solution in the titration tube turns to light yellow. Then put the remaining Sodium Thiosulfate aside for a moment (leave syringe in cap, take cap off and set aside.)
9. Add 8 drops of Starch Solution (4170PS-G) to the titration tube. Replace cap and syringe; swirl the tube to mix. The solution should turn from light yellow to dark blue.
10. Now continue the titration process (described in Step 8) with the remaining Sodium Thiosulfate, until the titration tube solution turns from blue to colorless. When you get close to the end point, the solution will turn colorless where the drop hits and return to blue as you swirl it. Do not add any more Sodium Thiosulfate than is necessary to produce the color change. Be sure to swirl the titration tube after each drop.
11. Using the scale on the side of the syringe, count the total number of units of Sodium Thiosulfate used in the experiment. That number equals the number of parts per million (ppm) or milligrams per liter (mg/L) of oxygen in the water.
12. Carry out Steps 7-11 on a second sample.
13. Record the results of both tests on the data sheet and rinse test tubes with distilled water.

pH

A measure of the acidity or alkalinity of the water, pH is based on a scale of 0 to 14. A pH of zero is the most acidic, a pH of 14.0 is the most alkaline, and a pH of 7.0 is neutral. Rainwater normally ranges between 5.5 and 6.0. Each organism requires a certain pH range to survive and reproduce. Most organisms are very susceptible to changes in pH. The pH of unpolluted water depends on the local geology and physical conditions. For example, streams draining wooded swamps usually have a pH between 5.5 and 6.5 and occasionally substantially lower, while streams in limestone areas may have a pH of 9.0. Use a wide range pH test kit to determine the pH. The pH for all of Delaware's streams should be between 6.5 and 8.5 unless due to natural conditions (DNREC, 2004). Overly acidic conditions may be caused by effluent from various industries, sewage lagoons, or livestock yards. Alkaline conditions may be caused by water treatment plant discharges or raw sewage. Natural growth processes of aquatic and marsh plants can also increase pH significantly. Measure pH using the LaMotte field kit provided following the procedure outlined below.

1. Rinse the sample test tube (0230) supplied with the pH kit three times with sample water from the bucket.
2. Fill the sample test tube to the 5mL mark with sample water from the bucket.
3. Add ten (10) drops of the Wide Range Indicator Solution (2218-G).
4. Cap the tube and invert 10 times to mix the sample and reagent.
5. Place the tube into the Comparator (2195). Match the color of the sample against the colors in the Comparator. Read value with caps off test tubes and using a white background (a sheet of paper is fine, do not hold against colorimeter).
6. Record the pH and rinse the test tubes with distilled water.

Macroinvertebrate Survey

These are some general guidelines for conducting the macroinvertebrate survey. Start with a set amount of time to search for macroinvertebrates – often 20 - 60 minutes. It is important to keep this time consistent when comparing data from a site over time or between sites. Collect from a variety of aquatic habitats. Once you have gathered all of the macroinvertebrates, you must identify them. The datasheet requires you to be able to identify macroinvertebrates down to Order and sometimes to Family. (Refer to APPENDIX F if you do not know what order or family means.) Use APPENDIX B and any keys given to you as supplements to this laboratory. Fill out the macroinvertebrate portion of your datasheet and include the number of each type of organism found (See a sample datasheet filled out as an example in APPENDIX G). Calculate the **Modified Percent EPT (%EPT)** developed by Stroud Water Research Center (2004) for their Leaf Pack Network® project. This measures how many of the macroinvertebrates sampled are intolerant (sensitive) to pollution. The three main Orders that are intolerant are; *Ephemeroptera* (Mayflies), *Plecoptera* (Stoneflies), and *Trichoptera* (Caddisflies). The modified version removes the relatively tolerant family of caddisflies called *Hydropsychidae* from the EPT portion of the calculation. This makes the score more accurate in determining intolerance. (See Sample Datasheet APPENDIX G). Some things to take note of:

1) Stream health is reflective of both the quality of the water and of the habitat.

2) The above rating system is only intended to give a rough estimate of stream health, is dependent upon obtaining a representative collection, and is most accurate when applied to streams in April, May, and June. For instance, later in the summer, few stoneflies will be observed. For that reason surveys at the same site can only be compared if done at the same time of the year.

3) Stream health may also be assessed by comparing the **%EPT** at several locations. If the **%EPT** score changes drastically in the same day from one sampling station to another in the same watershed, there may be a pollution source between the two stations, or the stream habitat at one location may be less favorable than at the other.

Table 1. Scoring the %EPT value.

Modified Percent EPT	Score
>65	Very Good (little or no organic pollution present)
20%>65%	Good (some organic pollution present)
<20%	Poor (substantial organic pollution present)

The following method has been adapted from several different monitoring programs including The Izaak Walton League of America's Maryland Save Our Streams (Klein, 1982). This method will produce the best results in April, May, and June when aquatic insects are most abundant; however, surveys in any season will yield specimens of many species.

Rock Scraping Method

1. Remove several stones from your chosen riffle. Each stone should be about six inches in diameter. Also, each stone should be bathed in rapidly flowing water and should be lying relatively loosely on the stream bed. Avoid stones buried in the bed or in slow moving areas.
2. Place each stone in a bucket or dishpan filled with stream water. While holding each stone beneath the water surface, brush each with your hands or with a soft brush. Try to dislodge every foreign particle from the surface of the stones.
3. When each stone has been thoroughly brushed, return the stones to the stream. Now you are ready to separate each different kind of organism into smaller containers. First transfer as many organisms as possible directly from the bucket using a scoop, paintbrush, or forceps. Then pour the bucket contents through your sieve.
4. When an inch of water remains, swirl the bucket to get the remaining contents in motion. Quickly pour the remaining water through the sieve. Fill the bucket once more and pour it through the sieve.
5. Identify the organisms retained on the sieve using the illustrations in APPENDIX B and record your results on the data sheet.

Handheld Sweep Net Method

A handheld net is useful for collecting samples along banks and bottoms of all types of streams. A handheld net is similar to a dip net used for fishing except that the handheld net has a much finer mesh. The net opening should always be facing upstream so the current washes the animals from the collecting area into the net.

1. To use the net, sweep it along submerged tree roots, undercut banks, and aquatic plants with a sideways motion.
2. Agitate the bed near the bank and any debris caught on snags, and sweep disturbed organisms into your net.
3. Dump or rinse organisms into a white dishpan or bucket on the bank and sort into smaller light-colored plastic containers such as margarine tubs.
4. Identify organisms according to the macroinvertebrate illustrations in APPENDIX B.
5. Record on your data sheet the kinds and numbers of organisms found. When finished, return all organisms to the stream.

Materials

Equipment for Field Laboratory including all three surveys (one for each group)

- Non-Tidal Data Sheet (use one copy per sampling station) – APPENDIX A
- clipboard
- map of stream section
- pencils

Equipment for Visual Survey

- instructions for visual survey
- one small **white** plastic container (e.g. margarine tub)
- measuring tape or yardstick
- <u>Optional:</u> camera, plastic bags or containers for samples

Equipment for a Physical/Chemical Stream Survey (one for each group unless stated otherwise):

- bucket (with rope if sampling from a bridge or from the bank of a deep or very soft-bottomed stream)
- armored thermometer
- paper towels or rag (for spills)
- jar for waste chemicals (plastic peanut-butter jar is a good size)
- 500 ml plastic squirt bottle filled with distilled water
- LaMotte Dissolved Oxygen Field Kit (code 7414) – **one for every two or three students**
- LaMotte Wide Range pH Field Kit (code 2120) – **one for every two or three students**

Equipment for a Macroinvertebrate Survey in a Piedmont Stream (one for each group unless stated otherwise):

- instructions for the rock scraping method
- macroinvertebrate illustrations
- magnifying glass or hand lens
- white bucket or dishpan
- small plastic containers, e.g. margarine tubs – **one for every two students**
- small handheld nets – **one for every two students**
- coffee scoop, small paint brush, and/or forceps
- mesh cloth sieve made with embroidery hoop
- <u>Optional:</u> camera, "D" frame net

Notes for the Instructor

A suitable site for the students to use needs to be assessed before the laboratory. In locating a suitable sampling station you want to take into account not only suitable stream habitat but access as well. You must have either public access or permission from private landowners. The size of the class you want to take to the site must be considered as well. You may wish to have the students sample several sites to compare branches or areas above and below suspicious outfalls. Choose an area which includes a riffle for the sampling site that is uniformly composed of moderate-sized particles, from 1inch gravel to 10 inch cobbles if possible.

Give a brief overview of the lab and go over the objectives. Explain what can affect the water quality both good and bad. Table 2 describes the four main categories of pollution in streams. Describe how these pollutants get into the water (70% is Non-Point Source – NPS). Define watershed and its relationship to this type of pollution. Discuss what is beneficial to water quality in streams including types of land use (forested is the healthiest), the presence of deep riparian buffers and better ways to manage stormwater such as using rain barrels. Present the concept of how to determine the water quality of a stream in terms of an aquatic habitat. Briefly discuss the three types of surveys that students will be doing during the lab; visual, chemical, biological.

Objectives

- Learn about water quality and ecosystems and why they are important
- Learn several ways to determine the water quality of a stream in terms of an aquatic habitat
- Learn to survey a stream and collect data and interpret that data
  - Chemical – learn how to perform a titration
  - Biological – learn basic classification, identify macroinvertebrates to Order
  - Learn what can affect the water quality of a stream
- Learn about water quality and ecosystems
  - Why Important – drinking water, recreation, water supply –unlimited?
  - Part of a healthy ecosystem – can it support life

Table 2. Types, sources, and problems caused by pollution.

Type	Source	Problem caused
Nutrient	excess fertilizer from garden or lawn	excess algae with eventual algae death and oxygen loss
Organic	untreated or incompletely treated sewage (faulty septic or treatment system, livestock, chicken industry)	excess algae with eventual algae death and oxygen loss, bacteria & virus presence
Sedimentation	soil washed into stream from construction site or anywhere protective vegetation was removed	smothers bottom dwelling organisms, may clog fish gills, may make stream wider & more shallow, removes habitat by filling in all the nooks & crannies
Toxic	household products (like paint, oil, cleaners, etc.), roadways & industry	kills sensitive organisms

Break the students up into two groups for the actual data collection if possible. All students should rotate through the two stations and perform all the activities to gather all the data, visual, chemical, and biological. The first group (Group 1) should start with the visual and chemical data collection. Go through the visual categories briefly as there is detailed information in APPENDIX C. The visual survey is the quickest to alert to a major problem but limited in scope. The chemical data collected is more specific but limited by which parameters are tested and a single point of data (only measures conditions at that moment not over time). The parameters measured are pH, dissolved oxygen, and temperature (physical parameter). Helpful hints for the dissolved oxygen and pH test procedures are located in APPENDIX E. All numbers associated with equipment in the materials section refers to LaMotte equipment for ordering purposes and in the student directions for clarity.

The second group (Group 2) should start with the biological data collection. The students have detailed information on where, how, and why they are collecting this data. Go over the three habitats to check; sand/sediment, stick & leaf, and stones in the riffle area. Also briefly go over how to collect macroinvertebrates even though it is in their handouts. Give a brief overview of the classification system. Be sure to reiterate the three basic lessons to be learned during this data collection; classification of organisms, basic identification of macroinvertebrates, and the concept that macroinvertebrate sensitivity to pollution is specific to type (order, family, genera, species).

If few organisms are found using the Rock Scraping or Handheld Net Method, you may wish to have the students try using a kick seine, "D" frame, or multiplate sampler. All of the equipment described in this section can be made simply and inexpensively with materials found at home or purchased at hardware and lumber stores. Feel free to make substitutions when necessary. Directions for making them are found in APPENDIX D. How to use this equipment is described in detail below.

The **kick seine** is helpful in surveying riffle areas of piedmont streams. The method works best with a team of two people. The seine consists of a fine mesh screen attached to two wooden poles. Choose a fast-moving, shallow riffle in which the bed is completely covered with stones, preferably 2 inches to 6 inches in diameter. Place your kick seine at a 45 degree angle downstream of this riffle area. Make sure that it is resting firmly against the bed and that no water can flow over the top of the net. While one person holds the net in place, the other should agitate an approximately 3 foot square area of the riffle bed directly upstream. Vigorously brush off rocks with your hands and feet. This will dislodge attached organisms so that they may be carried by the current and trapped in your net. When this area has been thoroughly worked over, carefully move your net to the bank and place it on a light colored background such as a newspaper. Using tweezers pick off anything that resembles a living organism, and place it in a white dishpan for examination.

The **multiplate sampler** is ideal for all streams but is especially helpful for deep sections of both tidal and non-tidal coastal plain streams. The sampler acts as an artificial habitat providing a surface to which organisms can attach and colonize. Four to seven weeks may be required for macroinvertebrates to become established. Secure the sampler to the bank of the stream. A strong nylon cord can be looped through the eyebolt and attached to a stake driven into the bank. The cord can also be attached to an overhanging tree limb. In any case, the sampler must be suspended in the current for approximately 4 to 7 weeks to allow organisms to colonize. Care must be taken when removing the sampler to prevent losing attached organisms. While the sampler is still submerged, gently slip it into a plastic bag. Using forceps, a paintbrush, or your fingers, pick off anything that resembles a living organism, and place it in a white plastic dish pan for examination. Separate the organisms into plastic containers according to groups of the same kind.

The **"D" frame net** is useful for collecting samples along banks and bottoms of all types of streams. A "D" frame net is shaped like the letter "D" rather than a circle. The flat side allows you to have more net surface scraping along the stream bank or bottom. A "D" frame net can be used either like a handheld net or like a kick seine to collect bottom samples in a swiftly moving piedmont stream by wedging the flat side against the stream bottom with the net opening facing upstream. You then vigorously brush off larger rocks with your hands and then use your boot tip to disturb the finer cobbles and gravel. The water current washes the dislodged organisms into the net.

Have the groups switch and do the rest of the lab. Summarize each survey as you do it or at end of the lab. Include discussions on the following questions. **What does this tell us about this stream's water quality? And what has affected the stream to cause this (good or poor) quality?**

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Literature Cited

Delaware Department of Natural Resources and Environmental Control (DNREC). 2002. State of Delaware surface water quality standards as amended, July 11, 2004. Dover.

Klein, Richard D. 1982. Stream quality assessment: Data collection and interpretation. Maryland Department of Natural Resources. Annapolis.

Appendix A

Ordering Information and Resources

Ordering Information:

Dissolved Oxygen Kit, Wide Range pH Test Kit, Armored Thermometer, & Macro photo ID cards:
www.lamotte.com Phone: 1-800-344-3100 Fax: 410-778-6394

Order Code No.	
7414	Dissolved Oxygen Kit
2117	Wide Range pH Test Kit
1066	Armored Thermometer
5882-SA1	Aquatic Macroinvertebrates: Insect Identification Flashcards

A Guide to Common Freshwater Invertebrates of North America - J. Reese Voshell ISBN 978-0-939923-87-8
Flashcards and laminated brochure derived from Voshell's book:
QuickGuide to Major Groups of Freshwater Invertebrates. ISBN 978-0-939923-01-4, $5.95 US.
Flash Cards of Common Freshwater Invertebrates of North America. Three sets of 34 $39.95 US each
More complete descriptions and order info can be found on www.mwpubco.com Phone: 1-800-233-8787 Fax: 740-321-1141

*For free macroinvertebrate identification keys see:
http://www.stroudcenter.org/education/MacroKeyPage1.htm
http://www.wvdep.org/Docs/15667_Guide_to_Aquatic_Invertebrates.pdf

The following books may be helpful in understanding stream ecology and in identifying stream organisms:

Pond Life (A Golden Guide). 1967. George K. Reid. New York: Golden Press.

How to Know the Aquatic Insects. Lehmkuhl. Dubuque, Iowa: William C. Brown Company.

Pond and Brook: A Guide to Nature in Freshwater Environments. 1990. Michael J. Caduto. Hanover, Massachusetts: University of New England Press.

Aquatic Entomology: The Fisherman's and Ecologist's Illustrated Guide to Insects and Their Relatives. 1981. W. P. McCafferty. Boston: Science Books International.

Delaware's Freshwater and Brackish Water Fishes. 1991. Maynard S. Raasch and Vaughn L. Altemus, Sr. Dover, Delaware: Delaware State College.

How to Know the Freshwater Fishes. 1978. Eddy. Dubuque, Iowa: William C. Brown Company.

Freshwater Invertebrates of the United States. 1978. Robert W. Pennak. New York: John Wiley & Sons, Inc.

APPENDIX B

Monthly/Quarterly Survey **NON-TIDAL STREAM DATA SHEET**

BASIC DATA

Surveyor(s) ____

Name of Stream/River ________________________County/City_______________Time Started___

Tributary of ___________________________ Watershed # ______ Date _______________ Total

Time Spent ____

Sampling Site Location (Use county road #'s or street names when possible and ATTACH a copy of the site location map.)

____

Stream type: Piedmont ______ Coastal Plain ______

Today's weather ____

Recent weather ____

VISUAL DATA (Survey approximately a 100 feet long stream section.)

STREAM VELOCITY non-detectable ________ detectable ________

WIDTH & DEPTH range of stream width (ft.) ______________ range of stream depth (ft.) ______________

BOTTOM TYPE - Circle the predominant type: mud/silt sand pebble/cobble boulder

WATER CONDITION

Water Odor:* Water Color:* Surface Coating:* Streambed Coating:*

rotten egg _____ muddy _____ scum ____ orange to red _____

chlorine _____ green/blue-green _____ foam ____ green _____

fishy _____ tea _____ oily _____ black ______

sewage _____ milky _____ none _____ brown _____

musky _____ clear _____ grayish-white _____

none _____ none _____

*Specify below if condition not listed:

________________ ________________ ________________ ________________

AQUATIC VEGETATION

Algae Abundance: Algae Location: Algae Colors: Abundance of Other Aquatic Plants:

in most places _____ on streambed _____ light green _____ in most places _____

in spots _____ on surface _____ dark green _____ in spots _____

none _____ brown _____ none _____

LITTER Approximate number of litter items:

	0	1-10	11-50	50+
small items: paper, cans, bottles, etc.	______	______	______	______
large items: tires, carts, etc.	______	______	______	______

BIOLOGICAL DATA (optional)

Animals - List kinds and numbers of fish, amphibians, reptiles, birds, or mammals observed. (If a macroinvertebrate survey is conducted, record tally in that section; otherwise, include invertebrates here.)

____

____

Vegetation - List major types of trees, shrubs, and smaller plants growing in or along the stream.

____

PLEASE FILL OUT REVERSE SIDE ALSO

NON-TIDAL STREAM DATA SHEET (continued)

CHEMICAL/PHYSICAL DATA - Record results of any tests performed (State standards in parentheses - where applicable)

Air Temp. ($^{o}F/^{o}C$) _______ pH(SU) _______ _______(6.5-8.5SU) Nitrate Nitrogen (mg/L) _____ _____(1.0-3.0mg/L**)

Water Temp. ($^{o}F/^{o}C$) _______(<86^{o}F/<30^{o}C) Dissolved Oxygen (mg/L) _______ ______(>4.0mg/L)

Conductivity (uS) ________(120-400uS*) Phosphate (mg/L)______ _______(0.1-0.2mg/L**) Turbidity Tube(cm)______________

*typical range for DE piedmont streams **suggested targeted range

MACROINVERTEBRATE TALLY (If surveyed, please record approximate numbers)

TIME SPENT ____________(in order to compare macro data the time spent collecting must be the same)

Macroinvertebrate	**Column A** **Number of Individuals Found**	**Macroinvertebrate**	**Column B** **Number of Individuals Found**
EPHEMEROPTERA (Mayflies)	**E**	DECAPODA (Crayfish)	
PLECOPTERA (Stoneflies)	**P**	GASTROPODA (Snails)	
TRICHOPTERA Caddisflies):		HIRUDINEA (Leeches)	
Hydropsychidae (Common Netspinners)		ISOPODA (Aquatic Sowbugs)	
Other Caddisflies	**T**	MEGALOPTERA (Hellgrammites & Alderflies)	
AMPHIPODA (Scuds)		OLIGOCHAETA (Aquatic worms)	
ANISOPTERA (Dragonflies)		TURBELLARIA (Planarians)	
COLEOPTERA (Beetles)		ZYGOPTERA (Damselflies)	

DIPTERA (True Flies):	
Chironimidae (Midges)	
Simuliidae (Black Flies)	
Tipulidae (Craneflies)	
Other True Flies	
Sub Total Column A	

OTHER	
Sub Total Column B	
Step 1) Add Total of **E+P+T=Total EPT** (All Mayflies, Stoneflies, and Other Caddisflies)	**1**
Step 2) Add column A + B =**Total of all organisms**	**2**
Step 3) Divide #**1** by **#2**	**3**
Step 4) Multiply #3 by 100 = % EPT	**4** **%**

ASSESSMENT USING % EPT (Rate the quality of the stream using a ratio of intolerant and tolerant taxa. The higher the % the healthier the stream. %EPT **<20% = Poor (substantial organic pollution present) 20%>65% = Good (some organic pollution present)**
>65% = Very good (little or no organic pollution) *from* Leaf Pack Network®, Stroud Water Research Center (2004).

If you rated the stream poor, did you verify chemical and/or macroinvertebrate results with a second sample?
What do you think caused the degradation? If you attempted to trace this degradation upstream, describe what you found.

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MISCELLANEOUS OBSERVATIONS/COMMENTS - Please list any other observations that have not been recorded above
that you think might affect stream quality.

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About the Author

Ginger North is the Citizen Science Coordinator for the Delaware Nature Society. She has been managing the Delaware Nature Society's Citizen Science programs since 1995. Ginger has held various positions within the Natural Resource Conservation Department, and in the Education Department of the Delaware Nature Society. She received a Master of Science degree in Genetics from the University of Delaware, and Bachelor of Science degree in Biology/Marine Biology from the University of Long Island. She taught biology laboratories for four years at the University of Delaware. Ginger also has an extensive background in Quality Control, both in a clinical microbiology laboratory and in a hospital endocrinology laboratory. She has given numerous presentations at National and Regional Conferences including the National Water Quality Monitoring Conference (NWQMC) in 2004, 2006 and 2008 and the EPA Region 3 Volunteer Monitoring Conference and Non Point Source/Total Maximum Daily Load/Water Quality Monitoring/Water Quality Standards Annual Meeting in 2008.