Note: This investigations contains the new Biodiversity Station for field testing

Testing the Waters (LabQuest)

Evaluating the Condition of a Local Ecosystem TEACHER NOTES

Standards

LS.1 A The student will construct and interpret data tables.

2. Generate lists, tables, or charts to classify, group, or order objects or events according to observations and/or similarities or differences in properties.

LS.1 C The student will select appropriate tools to accurately measure using, and making conversions, among metric units.

1. Utilize correct tools and techniques for collecting qualitative and quantitative data.
   a. Report measurements using the International System of Units (SI).
   b. Recognize metric prefix units for length, temperature, and liquid volume and make common conversions within the same metric base unit applying appropriate prefixes.
   c. Record measurements accurately (i.e., estimate to one more decimal place).
2. Use principles of mathematics to collect and analyze data.

LS.1 I The student will formulate valid conclusions after analyzing data and observations.

1. Formulate conclusions that are supported by the gathered data.
   a. Make inferences, predictions, or interpretations.
   b. Recognize cause and effect relationships.
   c. Determine patterns, trends, and relationships in data.
   d. Develop/support explanations, hypotheses, and models based on evidence.

LS.1 J The student will develop and reinforce an understanding of the nature of science.

5. Apply science concepts to everyday personal experiences.

FS.1 K The student will use chemicals and equipment safely.

1. Follow guidelines for the safe handling and use of chemicals and equipment.

6.7 A The student will investigate and understand the effects of natural and human interactions on the health of a watershed.

1. Understand the causes and effects of changes in abiotic factors that affect water quality such as turbidity, nutrients, sunlight, air quality, and oxygen availability. (Also see LS.7 C).
2. Relate human activities to their effect on the biotic and abiotic components of an ecosystem (e.g., water supply).

6.7 G The student will monitor and analyze water quality using field equipment and hand-held technology.

1. Measure and record a variety of water quality indicators using field equipment including hand-held technology.
2. Analyze and evaluate indicators of water quality.
   a. Relate the cause and effect(s) of changes in pH, dissolved oxygen, conductivity, and temperature on the health of organisms in an aquatic ecosystem.
3. Explain the factors that influence water quality in a watershed and how those factors can affect organisms in an ecosystem (e.g., nitrogen produced by cars; sewage treatment plant overflow; planting trees to reduce erosion and pollutants; runoff from parking lots; using construction fences to reduce erosion, etc.).
   a. Propose ways to promote high water quality for wildlife and human use within a watershed.

LS.12 B The student will investigate and understand the effects of human actions on habitats.

1. Identify examples of ecosystem dynamics.

Science Process Skills

Collecting data, inferring, observing, measuring, interpreting data, using number relationships

Unifying Concepts and Processes (NSES)

Systems, order, and organization

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Lesson Overview

Part 1: Students use a variety of electronic resources to learn about the Chesapeake Bay Watershed and the site they will visit on their Meaningful Watershed Education Experience (MWEE).

Part 2: Students visit a local waterway and model the procedures and processes used by water quality monitors to collect data related to land use, water quality, habitat, and biological indicators. They analyze the data to determine the relative health of the waterway and compare the abiotic conditions of their model ecosystem to those in the tested waterway.

Part 3: Students investigate possible stewardship activities that they can undertake to positively impact the health of the Bay and its ecosystem.

Suggested Time

Part 1: two 45-minute class sessions.
Part 2: pre-field experience - two 45-minute class sessions for background reading, discussion, and Macromania game; time for the actual field experience will vary by location and activities; post-field experience – one 45-minute class sessions for data analysis and debriefing
Part 3: 45 minutes

Preparation

Forms and Planning

- ☑ Obtain FCPS Unusual Field Trip http://www.fcps.edu/DIT/kam/docmgmt/forms/fs141.pdf and other permissions (i.e., principal, parents).
- ☑ Contact transportation and reserve buses for the date(s) of the MWEE http://www.fcps.edu/fts/tran/fieldtrips/index.htm for the 2010-2011 academic year mileage rate is $2.17 per mile and driver rate is $32.42 per hour. Buses generally accommodate between 44-52 students; check with the transportation office to confirm the number of students each bus can carry to the MWEE site to ensure that enough buses are reserved ahead of time.
- ☑ Contact substitutes and parent volunteers. Parent volunteers will help students with data collection during the field experience. One adult per 4-5 students is ideal.
- ☑ Copy emergency care forms.
- ☑ Send MWEE plan to the MS Science Curriculum Specialist even if the experience will be funded with school funds.
- ☑ Prepare a plan for the day's activities.
- ☑ Prepare a volunteer responsibilities checklist.
- ☑ Plan a volunteer training session.

Pre MWEE Site Visit

- ☑ Choose a suitable site that has a relatively shallow stream (less than 1 m deep) with an easily accessible stream bank. **Safety (and common sense) is a top priority** when working with students near water.
- ☑ Visit the site to determine the location of stations, bathrooms, where students will eat lunch, etc. Draw a simple map to hand out to volunteers and teachers.
- ☑ Classify the stream you will be evaluating as either a rocky bottom or muddy bottom (see **Station 3: Habitat** directions for further details).

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- ☑ Place LaMotte Leaf Pack in stream 1-2 weeks prior to the MWEE.

Materials and Equipment Preparation

- ☑ Gather two fiber glass 50-m metric tape measure(s).
- ☑ Obtain wet wipes and paper towels for wiping probes, etc. Also, depending on the site, bring toilet paper.
- ☑ Provide one clipboard for each student or pair of students to hold the Field Data Collection Sheets for each group.
- ☑ Macroinvertebrate Identification Sheets (laminated) for each group.
- ☑ GPS units and extra batteries for each group.
- ☑ Digital camera for one or more groups.
- ☑ Wooden dowels or unsharpened pencils for **Station 1: Land Use**
- ☑ Waste bucket or bottle for rinsing probes after use as well as the used nitrate testing solution for each group at Station 2 at a given time. Suggest that a separate bottle be used for nitrite waste.
- ☑ If students will be collecting and identifying macroinvertebrates at the field site, order a LaMotte Leaf Pack kit. Prepare the LaMotte Leaf Pack bag(s) ahead of time and place them in the stream 1-2 weeks prior to collection on the day of the field trip http://www.lamotte.com/pages/edu/3-0030.html. Note that it is advised to have a trained professional (teacher or naturalist) assist students in collecting and categorizing macroinvertebrates.
- ☑ Dip nets for collecting macroinvertebrates (optional)
- ☑ Obtain 4 plastic dishpans and/or 4 white, plastic ice cube trays for macroinvertebrates
- ☑ 8 Two-way magnifying viewers which have been previously provided to schools (Item T-1245 from Acorn Naturalists).
- ☑ For every four students completing **Station 2: Water Quality** at a given time, **one fully charged LabQuest**.
- ☑ For every four students completing **Station 2: Water Quality** at a given time, gather and prepare ONE SET of the following items: 1 LabQuest, 1 dissolved oxygen probe, 1 pH probe, 1 temperature probe and 1 conductivity probe. For example, if there are eight students completing Station 2 at the same time, TWO complete sets of LabQuest and probeware will be required.
- ☑ pH 4 buffer solution for refilling pH sensor storage vials.
- ☑ Dissolved Oxygen electrode filling solution.
- ☑ Nitrate testing solution and other related materials.
- ☑ Additional turbidity testing equipment such as a Secchi disk or Vernier turbidity sensor (optional).
- ☑ Prepare the dissolved oxygen probe by removing the blue protective cap from the tip of the probe. Unscrew the membrane cap from the tip of the probe. Using a pipette, fill the membrane cap with 1 mL of DO Electrode Filling Solution. Carefully thread the membrane cap back onto the electrode. After data collection, remove the electrode filling solution and rinse with distilled water. Replace

the protective cap and blue tip. Refer to the Vernier website for helpful tips on setting up, handling and storing the dissolved oxygen probe http://www2.vernier.com/sample_labs/WQV-05-COMP-dissolved_oxygen.pdf

- ☑ One plastic bin or basket to hold materials required at each station for each group.
- ☑ Supply distilled water in a wash bottle with a spout at the stream site with which to rinse probes. Store the pH probes in pH 4 buffer solution between uses – NOT in distilled water. This probe can be stored in AGED water for the length of the activity but must then be stored appropriately thereafter. Rinse the storage vials and refill them with pH 4 buffer solution when the field experience is complete.

Lesson Preparation

- ☑ Make copies of the Station directions for each of the Stations 1-4 and any additional stations students will complete. Laminate or place copies in protective sleeves.
- ☑ Make copi**es** of the student **Field Data Collection Sheet** for each student or pair of students (sheets are found at the end of these Teacher Notes).
- ☑ Copies of *Stream Insects and Crustaceans* identification sheets (laminate or place in plastic sheets)
- ☑ Macroinvertebrate sort cards (from Macromania game)
- ☑ Directions and materials for additional MWEE Stations (i.e., GPS Scavenger Hunt, Watershed Model, Ecology-related games, etc.). (laminate or place in plastic sheets)

MWEE Field Logistics and Readiness

- ☑ Complete the "Graphic Organizer for Group Division" chart to determine group size and specific students for each group.
- ☑ Create color-coded name tags for each student; indicate at which station students will begin.
- ☑ Discuss with students appropriate MWEE attire, behavior guidelines, and safety consideration.
- ☑ Share cell phone numbers with administration, teachers, parents, etc.
- ☑ Record the daily barometric pressure on the day of the field experience and instruct students to record that data on their observation sheets.
- ☑ Complete the MWEE Survey. Data from the survey will be reported to the FCPS School Board.
- ☑ Have students compose and send a thank you letter (or letters) to the parent chaperones detailing ways in which they enjoyed and engaged in the experience (please also send a copy to the MS Science Specialist. Some of the student comments can be used when reporting to the FCPS School Board).

Materials per Group:

Station 1: Land Use and Habitat
1 50-m plastic tape measure
1 wooden dowel or unsharpened pencil
digital camera (optional)
GPS unit, fully charged

Station 2: Water Quality

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1 LabQuest, fully charged
1 dissolved oxygen probe
1 temperature probe
1 pH probe
1 conductivity probe
1 distilled water wash bottle with spout
1 bucket for probe rinsing & nitrate waste
1 nitrate test kit
Turbidity testing materials (Vernier probe or secchi disk - optional)
wet wipes or moist paper towels

NEW Station 3: Biodiversity
Field Guides to local flora and fauna
**Linda P will create a wiki for this station; pages from the wiki should be printed (in color) and placed in plastic sleeves and binders for each group

Station 4: Biology
Macroinvertebrate data sheet
Stream Insects and Crustaceans ID sheet
Macroinvertebrate sort cards (optional)
Ice cube trays or dishpans
Leaf Pack (optional)

Station 5: GPS Scavenger Hunt (optional)
Garmin 60 GPS units (extra batteries) – as many as possible; consider borrowing from another school.

Station 6: Watershed Model (optional)
1 Enviroscape watershed model, materials, and directions.

Resources

- Discovery Education (Publisher). (2005). **Natural Focus with Laurie Sanders, A:** What is a Watershed? (05:00). [Motion Picture streaming video] from Discovery Education: http://www.unitedstreaming.com
- "Treasures of the Chesapeake" (video given to schools during MWEE Training 2006), 13 min, Fairfax County Government
- "Watershed Connections" (video given to schools during MWEE Training 2006) 10 min, VA Depart. of Conservation and Recreation.
- Chesapeake Bay Program: http://www.chesapeakebay.net/wquality.htm
- Fairfax County's Storm water Management Program: www.fairfaxcounty.gov/dpwes/stormwater. There are links off this page to:
  - Stream Protection Strategy Baseline Study – www.fairfaxcounty.gov/dpwes/environmental/sps_main.htm
  - Other reports – www.fairfaxcounty.gov/dpwes/stormwater/resources.htm
  - Volunteer opportunities – www.fairfaxcounty.gov/dpwes/stormwater/volunteer.htm
  - Calendar of Events – www.fairfaxcounty.gov/dpwes/stormwater/events.htm
  - Current stream information, with the URL being: www.fairfaxcounty.gov/dpwes/stormwater/streams.

Testing the Waters (LabQuest)

Evaluating the Condition of a Local Ecosystem **TEACHER NOTES**

Key Terms

water quality monitoring
salinity
turbidity
macroinvertebrate organisms

Essential Learnings

- An ecosystem is made up of the living community and the non-living factors that affect it. The health of an aquatic ecosystem is directly related to water quality.
- To evaluate the health of an aquatic ecosystem, **water quality monitoring** is conducted to collect and evaluate qualitative and quantitative data about land use, water quality, habitat, and biological indicators.
- Several important indicators of water quality include pH, temperature, salinity, dissolved oxygen, turbidity, and the relative abundance of different types of macroinvertebrate organisms.
- **Salinity** is related to the concentration of minerals, such as chloride and potassium, dissolved in water. Seawater has a high salinity whereas freshwater has low salinity.
- **Turbidity** relates to the amount of suspended particles in the waterway. Low turbidity means there are few particles present whereas high turbidity indicates that the water is very cloudy with many suspended particles. Suspended particles are a natural part of an aquatic ecosystem but, in high amounts, are harmful to plants and animals.
- **Macroinvertebrate organisms** are normal inhabitants of aquatic ecosystems and include insect larvae, aquatic worms, and mollusks. Each species has a range of conditions needed for survival with some organisms being very sensitive to pollution while others are very tolerant. By observing the types of organisms present (i.e., tolerant versus sensitive), water quality monitors can infer the degree of pollution in the waterway. Macroinvertebrates are often called "bioindicators" of water quality.
- Human activities can alter abiotic components of the ecosystem and, thus, affect the living things and natural processes that occur in an ecosystem. For this reason, local land use and habitat must also be considered when evaluating the health of an aquatic ecosystem.

Teacher Information

Land Use

Human land use (e.g., agricultural, residential, commercial, and industrial) around a waterway greatly impacts the quality of the water, habitat, and health of aquatic species. The type and amount of vegetation that separates a stream from human activities helps to filter out pollutants that might be carried by rain into the water. This area of vegetation is known as the buffer zone. Buffer zones slow down the water and filter nutrients and sediments out of storm water before they reach a waterway. Forest buffers also stabilize stream banks, reducing erosion. Forest buffers provide shade to waterways keeping temperatures within reasonable parameters. Trees and fallen logs provide habitat for many organisms important to the aquatic food chain. Forest buffers can also attract birds and wildlife, providing important habitat for many terrestrial species.

Testing the Waters (LabQuest)

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Habitat

Aquatic organisms need a suitable habitat in which to live. They must have access to food and places to hide from predators. Heavy amounts of sediments entering a waterway may cover and/or smother organisms and decrease the amount of usable habitat. The best habitat for aquatic organisms is one in which there is full water coverage of the streambed and there are a variety of materials (rocks, logs, etc.) to provide shelter and food.

Water Quality

There are many different tests that can be performed to evaluate water quality. The tests in this activity were chosen to be relatively easy for middle school students to perform while modeling the types of tests and techniques used by real water quality monitors in the field. Detailed information on the tests (and many others) is found in *Water Quality with Calculators* by Vernier which are available in each school as well as the online version at http://www.vernier.com/cmat/wqv.html

Several factors determine water quality, such as water temperature, pH, the amount of dissolved oxygen, and the amount of nutrients in the water. The optimal range for these factors that living things can tolerate varies from species to species.

Human activities dramatically alter the water quality of a stream. Cutting down trees surrounding a stream causes the water temperature to rise and accelerates the erosion of the stream bank which increases the amount of sediment in the water. It may also cause an increase in other kinds of pollutants entering the stream since tree roots help filter out certain pollutants before they enter the stream. When a stream bank is straightened or altered by man-made ditches or culverts, the speed of the current will increase, thus increasing erosion.

The water quality tests which students conduct in this lesson are the same as the ones they conduct with their model ecosystems in **Beneath the Surface** so students should be relatively comfortable using the probeware.

Factories, mines, and cars produce chemicals that can change the pH of a stream. This can be harmful or fatal to certain aquatic organisms which require a specific pH range. Air pollutants tend to dissolve in rain water and enter streams through precipitation. The rain water is slightly acidic (i.e., acid rain) and lowers the pH of the stream. In addition to run off from farms, another major source of nitrogen and phosphorus to the Bay is from vehicle exhaust.

Sewage and agricultural run-off increase the amount of nutrients entering a stream. An increase in the amount of nutrients in the water may cause an algal bloom. The excess algae covering the surface of the water blocks the sunlight needed by plants growing underwater. As the plants and algae die and decompose, the oxygen in the water is used up by decomposers. This process is called eutrophication and is a major concern in many aquatic ecosystems such as the Chesapeake Bay. By monitoring the amount of nitrogen and phosphorus in Bay tributaries, scientists can determine which streams carry heavy amounts of these nutrients. They can

determine the source and look for remediation practices to reduce them.

Information on the use of the Vernier temperature probe is found on pages 1-1 to 1-8 of *Water Quality with Calculators* and on the middle school science website.

Information on the use of the Vernier pH probe is found on pages 2-1 to 2-7 of *Water Quality with Calculators* and on the middle school science website. Make sure that the probe is washed with distilled water after use and stored in pH 4 buffer solution, NOT distilled water.

Information on the use of the Vernier dissolved oxygen probe is found on pages 5-1 to 5-11 of *Water Quality with Calculators* and on the middle school science web site. The membrane cap should be removed and rinsed inside and out with distilled water. It is to be shaken dry. The exposed anode and cathode inner elements are to be rinsed and gently dried. The membrane in the cap will likely be damaged if you try to "dry" it, however.

Information on the use of the Vernier conductivity probe is found on pages 12-1 to 12-12 of *Water Quality with Calculators* and on the middle school science website. The conductivity probe measures the amount of total dissolved solids in the water, whether they are from natural or unnatural sources. Each waterway has a different "normal" amount of dissolved solids in it depending on the natural minerals found in the area. Therefore, one cannot readily determine from a single conductivity reading whether the measure is unusually high or low, or good or bad for that stream. The reading is only meaningful when compared to a baseline conductivity measurement. Students collect conductivity information in this activity but should consider this information slightly less definitive in determining the overall health of the waterway.

Students use simple colorimetric testing kits for nitrite. Although they will not be using the Vernier probes to collect this data, the information on pages 8-1 to 8-18 and 10-1 to 10-8 of *Water Quality with Calculators* may be helpful to teachers in understanding these tests. For more information on the sources and effects of nitrogen and ammonia in the Chesapeake Bay watershed, read the information on the Chesapeake Program's website http://www.chesapeakebay.net/nutr1.htm

Biodiveristy

Linda P needs to add notes here on biodiversity and its importance as well as the connection between terrestrial biodiversity and aquatic biodiversity

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Biology

Macroinvertebrate organisms such as insect larvae, aquatic worms, and mollusks found in a waterway are "bioindicators" of the relative health of the ecosystem. An abundance of very sensitive organisms such as stonefly, caddisfly, and mayfly larvae indicate that the water quality is very good. Conversely, when only pollution-tolerant species such as aquatic worms and mollusks are found, this indicates that the water quality is poor. Streams in Fairfax County may range from good to poor depending on the sum effects of other factors such as land use, habitat, and water quality indicators that affect the waterway.

More detailed information on macroinvertebrates may be found at the following websites:

- http://www.epa.gov/bioindicators/html/crayfish.html
- http://www.people.virginia.edu/~sos-iwla/Stream-Study/StreamStudyHomePage/StreamStudy.HTML
- http://www.watersheds.org/teacher/StreamInsectsIDKey.pdf

Teaching Suggestions

Part 1: Getting the Lay of the Land

Before:

1. Bookmark Internet sites.

2. Inform students that they will be using a variety of Internet-based tools to learn about the Chesapeake Bay and its watershed. It may be useful to instruct students to read over the information before class to save time.

During:

3. For Steps 1 & 2, have students work in pairs to summarize the information on the Chesapeake Bay Program website. Provide support for those students who need help in summarizing main ideas. No summary should be more than 3 sentences.

4. There are many maps to choose from in Step 3. Help to scaffold students' thinking by showing them the map of "congressional districts" and ask which summary the map would best illustrate (answer: none). Have all students look at summary 1 about Bay Health and ask what type of information the summary contains (answer: water quality, habitats, fish and shellfish levels). Ask students to find a map (any map!) that relates with these topics. In this way students should begin to see that data can be reported in both words and images and that both are useful when studying a complex system.

5. Steps 4-10 are meant to acquaint students with a general overview of the types of information and data available with Fieldscope GIS interface.
6. In Steps 11-12 students apply their understanding of the Fieldscope site to input and search for the site of their MWEE (Part 2).

7. Students save an image file (png) of their MWEE site to the location specified by their teacher.

8. Steps 14-18 are optional and require the teacher to sign up for an ESRI International User Account.

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Part 2: Meaningful Watershed Education Experience (MWEE)

Before:

1. Students should have already gained proficiency using probeware by conducting water quality testing in their model ecosystems in **Beneath the Surface** prior to doing this field activity. They should have a general understanding of the four basic water quality tests of temperature, dissolved oxygen, conductivity, and pH as well as the effect of excess nutrients, such as nitrite, in the ecosystem.

2. Prior to going to the lake or stream with students, go to the site yourself and complete the activity. Decide if additional MWEE Stations such as a GPS Scavenger Hunt, Enviroscape Watershed Model, dichotomous keys, would be applicable to the site and the time frame within which you are working. Make note of potential risks and how to avoid them.

3. macroinvertebrates. You may elect to have students collect macroinvertebrates using dip nets or by placing the LaMotte Leaf Pack® in the water about two weeks prior to the MWEE.

   Not all sites will be suitable for collecting and identifying. If your students will not be collect macroinvertebrates in the field using either dip nets or the LaMotte Leaf Pack, obtain from the middle school science specialist a set of data that approximates the types of macroinvertebrates found in your location. Students can then use this data to determine the types of organisms at the site.

   If a Leaf Pack is used, students can sort the organisms into ice cube trays in the field. **All aquatic organisms should be returned to their original environment at the conclusion of the observations.**

4. Play the Macromania game with students to help them understand how living organisms can be used to provide information on water quality. Each middle school has been given this game. The directions are found on p. T309.

5. Copy an extra set of station directions for each team of students to use before (and after) the field experience. Students should read the directions for each station, discuss, and plan how members of their group will work together to accomplish data collection in the field. There are many terms in this activity with which students may not be familiar. Have them find the meaning of these words and/or draw pictures to help them understand the directions.

6. Take students out into the school yard to show them how to use the Garmin GPS unit to record geographic coordinates for their testing site. Stress the need to be patient as the GPS unit will take several minutes to show the coordinates as it searches for satellites orbiting the Earth. Once the satellites are acquired, the location quickly appears on the GPS screen. No

additional buttons need be pushed! Tell students that their GPS and water quality data will later be sent to the Fieldscope website.

7. Obtain the barometric pressure reading at the stream location for the day of data collection. This can be obtained from local weather-related websites such as http://www.weatherforyou.com/. Give this information to students when they return to the classroom to analyze their data (water quality, dissolved oxygen) and help them make the necessary conversions and calculations.

8. Review safety and collection procedures with students.

During:

9. Teachers and volunteers should monitor students closely at the waterway to ensure safety and proper use of the probeware and other equipment.

10. Place the waste water bucket or bottle in a convenient location near **Station 2** so that students can dispose of the nitrite testing water easily.

11. Have students take several digital photos at each station. Data and digital photos will later by uploaded to the Fieldscope website. Students should exclude faces and other images that might identify individuals.

12. Students should focus on collecting accurate data while they are in the field. Stress the need to be very careful and methodical in all data gathering.

After:

13. Direct students to use the data they have collected on their **Field Data Collection Sheet** to complete the **Data** section of their own lab books. Have copies of the station directions available for this purpose in the classroom.

    Students will need to synthesize what they have observed in order to evaluate the relative health of the waterway. Help students discuss the results they obtained, determine if they are reasonable, and to decide which are "good" scores and which are "poor" scores in relationship to water quality.

14. Students will need to put together what they have learned about factors that can affect water quality to answer **Data Analysis** question #2. Students should be allowed to work and talk with one another to formulate their answers. However, their **Conclusion** should reflect their own personal thoughts and conclusions.

15. As in the **Beneath the Surface** activity, students are asked to "Make Connections" between the waterway tested, their model ecosystem, and the Chesapeake Bay. They should see that many of the same water quality factors are important in each ecosystem. Ask students for the similarities and differences between the three to help them see the connections.

Part 3: Stewardship

1. An important component of "meaningful watershed education

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experience" (MWEE) is to help students understand what actions they can take to improve the water quality in the watershed (i.e., environmental stewardship). After completing the MWEE, facilitate a class discussion of the merits of each of the bulleted items in the **Application** section and decide which actions listed (or others they may think of) would have a positive impact on the water quality of the tested waterway or the watershed in general.

2. A rubric for evaluating the sustainability of Stewardship Projects appears at the end of these Teacher Notes.

3. Assist students in following through with these actions.

Going Further

- Students may revisit the waterway multiple times throughout the unit and look for changes in the four parameters over time.

- Contact local water quality experts to be a guest speaker and/or to be the person to whom students report their findings.

- Write letters to local authorities about problems that have been observed and suggest actions to be taken to improve the health of the waterway tested.

- Become part of the "Growing Native" project to collect, grow, and plant native tree species on stream banks within the watershed http://www.potomac.org/growingnative

- Contact the National Wildlife Federation for information on creating a Schoolyard Habitat http://www.nwf.org/backyardwildlifehabitat/programoverview.cfm

- Virginia Naturally site has many suggestions for promoting environmental stewardship within the watershed http://www.vanaturally.com/volunteer.html

- Read and discuss the *Bay Journal* with students http://www.bayjournal.com/

- Teachers can "go further" with their own knowledge by taking a summer course offered by the Chesapeake Bay Foundation http://www.cbf.org. Grants and scholarships are available!

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Field Data Collection Sheet

Student Names:

_____ _____

Directions: Follow the directions for testing the health of the stream at each station. Record observations and data in the charts provided. Calculations, if needed, may be completed in the classroom.

Station 1: Land Use

Feature	Observations and Data	Points
buffer zone	Location 1 _____(m) Location 2 _____(m) Location 3 _____(m) Mean (average) _____ (m)	
ground cover vegetation	Observations:	
hardness of the soil	Measurements (depth dowel sinks in cm): At _____2m _____4m _____6m _____8m _____10m Mean (depth of dowel)_____ cm	
condition of the stream banks	Observations:	
stream shade cover	What percent of the stream is shaded? Observations:	
development and land use	Observations:	

Field Data Collection Sheet

Station 1: Habitat

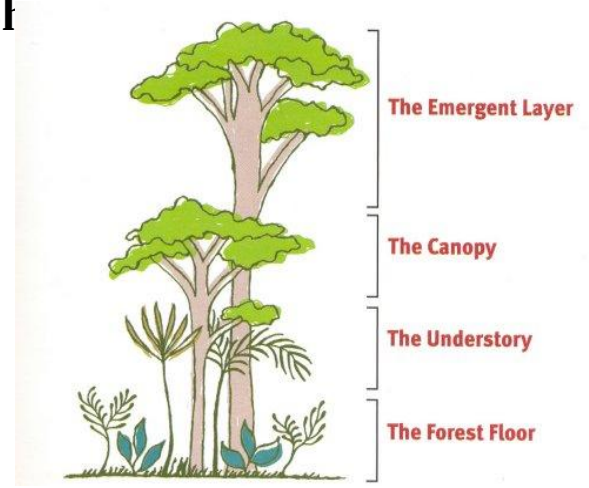
Feature	Observations	Points
bottom sediment		
bottom habitat		
amount of streambed covered by water		
waste water sewage pipes		
other pipes		
trash		
GPS Coordinates: Note: These coordinates and digital photos will be uploaded to Fieldscope site		

Field Data Collection Sheet

Station 2: Water Quality

Feature	Observations and Data	Points
temperature	Data:	
percent (%) saturation of dissolved oxygen	Record the amount of dissolved oxygen in the water: _____ mg/L Calculate: Today's atmospheric pressure _____ in Hg x 25.4 = _____ mm Hg Compute from Table 1: Measured _____ mg/L / Potential _____ mg/L = _____ x 100 = _____ % Saturation	
pH	Reading:	
conductivity	Reading:	
nitrite content	Reading:	
Turbidity sensor or Secchi disk reading (optional)		

Field Data Collection Sh



Station 3: Biodiversity

Using the procedure given to you, identify and count the following life forms found in the canopy, understory, ground cover, and soil of the marked area. *Tree Finder* pages are listed for trees you will likely find.

When done, you will assign a value to the variety of life forms found in this habitat and calculate the diversity per square meter.

Habitat Location	Group	Species	Tally
Canopy	**Plants (trees)**	American Holly (34)	
		Beech (35)	
		Hickory (27)	
		Maple (19)	
		Red & White Oak (56-58)	
		Tulip (55)	
Canopy	**Animals (birds)**	Blue Jay	
		Cardinal	
		Canada Geese	
		Crow	
		Duck	
		Heron	
		Robin	
		Woodpecker	
		Wood Thrush	

Field Data Collection Sheet

	Animals (mammals)	Squirrel	
Understory	**Plants (shrubs)**	Mountain Laurel	
		Viburnum	
Understory	**Animals (arthropods)**	Bees	
		Beetles	
		Caterpillars	
		Flies and gnats	
		Flying ants	
		Moths	
		Spiders	
Ground Cover	**Plants (mosses)**	Moss	
		Lycopodium	
	Plants (ferns)		
	Fungi		
Soil	**Animals (arthropods)**	Ants	
		beetles	
		Centipedes	
		Sowbug (roly poly)	

Field Data Collection Sheet

	Animal (mollusk)	Slugs and snails	
	Animal (annelid)	Worms	
Water at Surface	**Animals (arthropods)**	Water striders	
		Mosquitos	
		Flies and gnats	
	Animals (amphibian)	Frogs	
	Animal (reptile)	Turtles	

In the grid below, place a check mark in the box that best represents the tally for each organism type. Note that it is not the total number of organisms which is important but the number of different types of organisms in each category.

Biodiversity

Organism Type	**0-10 species** **2 points**	**11-15 species** **4 points**	**16-20 species** **8 points**	**20 or more** **10 points**
Plants				
Animals				
Fungi				
Total				

Field Data Collection Sheet

Soil Characteristics

Soil Sample		Description
Color		
Odor		
Clay	(%)	
Humus and organic matter	(%)	
Pebbles	(%)	

Field Data Collection Sheet

Station 4: Biology

In the grid below, circle each different type of macroinvertebrate found. Note that it is not the total number of organisms which is important but the number of different types of organisms in each category. For example, 2 mayflies carry the same point value as 50 mayflies.

Macroinvertebrate Point Values		
Sensitive to Pollution: 3 points for each type	**Somewhat Sensitive to Pollution: 2 points for each type**	**Tolerant of Pollution 1 point for each type**
mayfly	scuds	leeches
stonefly	clams	midge larvae
riffle beetle	crayfish	blackfly larvae
water penny	damselfly	aquatic worms
hellgrammite	dragonfly	flat-coiled snail
caddis fly larvae	beetle larvae	left-opening snail
right-opening snail	fishfly larvae	
	alderfly larvae	
	cranefly larvae	
	watersnipe fly larvae	
	sowbug	
Total points for this column:	Total points for this column:	Total points for this column:

Macroinvertebrates

Data and Observations	Points
Total macroinvertebrate points: _____ Observations:	

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Testing the Waters

STATION 1: LAND USE AND HABITAT

LAND USE

Directions

Step 1 The area of vegetation around the stream is called the buffer zone. Measure the buffer zone in three (3) different places by using a tape measure to mark a distance of 16 meters extending from the stream bank outward. Determine how much of the distance is covered with vegetation. If you see a drainage ditch or culvert coming into your waterway, you must take one of your measurements at that location. If time allows, determine the mean (average) for the three locations you have measured. You may also wait to calculate the mean when you return to the classroom.

Step 2 Record the point value for the choice which best matches the mean you calculated for the buffer zone. For example, if the mean buffer zone was 8 meters wide, you would choose 2 points in the chart below.

Buffer Zone	
Buffer zone is at least 16m wide	5 points
Buffer zone is between 11-15m wide	3 points
Buffer zone is between 6-10m wide	2 points
Buffer zone is less than 6m wide	0 points

Step 3 At least 16 meters of vegetation are necessary to protect a waterway. Which type of ground cover makes up **most** of the 16 meters surrounding your stream? Record the point value for the choice below which best matches the type of ground cover vegetation for your waterway.

Testing the Waters

Ground Cover Vegetation	
Trees or wetlands	5 points
Shrubs, unmowed grass, or pastureland	3 points
Mowed lawns or agricultural crops	2 points
Pavement	0 points

Step 4 Test the hardness of the soil surrounding the waterway by following the bulleted list below:

- Use a tape measure to mark 2, 4, 6, and 8 meters from the bank of the waterway.
- At each marked location, push a wooden dowel into the ground as far as possible and record the depth the dowel sinks into the ground (cm) and record this measurement on your Field Data Collection Sheet.
- Using the mean of all three depth measurements, determine the point value for the choice below which best matches the depth the dowel went into the ground.

Hardness of the Soil	
5 cm or more	5 points
3-5 cm	3 points
1-3 cm	2 points
Less than 1 cm	0 points

Testing the Waters

Step 5 Carefully observe the banks of the waterway you are investigating and determine which of the following most closely matches the conditions you observe.

Condition of the Stream Banks	
Little or no erosion: Boulders, shrubs, trees, and vegetation present	5 points
Small areas of erosion: A small portion (10%-30%) of the bank shows signs of erosion	3 points
Eroded soil: About half (30%-60%) of the bank is bare; banks are quite steep	2 points
Eroded soil: A lot (over 60%) of the banks look "raw" and have no vegetation; banks are very steep	0 points

Step 6 Carefully observe the banks of the waterway you are investigating and determine which of the following most closely matches the conditions you observe. What percent of the stream is shaded?

Stream Shade Cover	
The water is very shaded (greater than 80%)	5 points
Half to most of the water is shaded (between 50% and 80%)	3 points
Little of the water is shaded (between 30% and 50%)	2 points
Almost none of the stream is shaded (less than 30%) and the stream receives mostly direct sunlight	0 points

Step 7 What type of development and land use makes up the stream's watershed?

Testing the Waters

Development and Land Use	
Mostly undeveloped and rural with few houses	5 points
Suburban development but some rural areas evident	3 points
Mostly developed with few undeveloped areas	2 points
Almost no undeveloped areas; fully suburban and/or urban	0 points

HABITAT

Directions

Step 1 Ask for your teacher's help in determining if the stream bed (bottom) of the waterway is muddy or rocky and use the appropriate column below to choose the statement that best matches the sediment conditions you observe. Record your observations and the points on your field data collection sheet.

Muddy Stream Bottom Sediment	
Less than 20% of the stream bottom is covered with loose sediment; only minor amounts of sediment has collected on vegetation	5 points
20%-50% of the stream bottom is covered with loose sediment; some sediment has collected on vegetation	3 points
50%-80% of the streambed is covered with loose sediment; sediment nearly fills shallow pools and covers most of the vegetation	2 points

Rocky Stream Bottom Sediment	
Very few or no sandbars (accumulated sand) visible; less than 5% of the stream bottom is covered with sediment	5 points
Some sediment build-up on the stream bottom and along its banks; 5%-30% of the stream bottom is covered by sediment	3 points
Large sandbars and sediment build-up behind logs, branches and rocks; 30%-50% of the bottom is covered by sediment	2 points

Testing the Waters

Muddy Stream Bottom Habitat		Rocky Stream Bottom Habitat	
The bottom of the stream has greater than 40% mix of branches, submerged logs, undercut banks, and other debris.	5 points	The bottom of the stream has at least 50% large rocks, gravel, logs, tree branches, undercut banks visible.	5 points
The bottom of the stream has 20-40% mix of branches, submerged logs, undercut banks, and other debris.	3 points	The bottom of the stream has 30-50% large rocks, gravel, logs, tree branches, undercut banks visible.	3 points
The bottom of the stream has 10-20% mix of branches, submerged logs, undercut banks, and other debris.	2 points	The bottom of the stream has 10-30% large rocks, gravel, logs, tree branches, undercut banks visible.	2 points
The bottom of the stream has less than 10% mix of branches, submerged logs, undercut banks, and other debris.	0 points	The bottom of the stream has less than 10% large rocks, gravel, logs, tree branches, undercut banks visible.	0 points
Stream flow is reduced to a narrow channel; mud, silt and/or sand fills pools and stops, or almost stops, water flow	0 points	Obvious sediment build-up; more than 50% of the bottom is covered by sediment	0 points

Step 2 Choose the statement that best matches the habitat conditions you observe. Record your observations and the points on your field data collection sheet.

Step 3 Use the Global Positioning System (GPS) Unit to determine the geographic position for this location. Record this information on your data collection sheet. If you have been provided with a digital camera, take a few photos of the location. Make sure not to include student faces in the photos or include any other means of identifying individuals. The photos may be posted to the Fieldscope website at a later time.

Step 4 When water in a stream dries up or covers very little of the streambed, there are fewer places for aquatic organisms to live. Observe the waterway and choose the answer below which best matches the amount of streambed **covered by water**.

Testing the Waters

The Amount of Streambed Covered by Water	
The banks of the stream on both sides and the bottom of the stream are covered by water.	5 points
Most (75%) of the stream is filled with water leaving most of the bottom covered with water.	3 points
About half of the streambed is covered with water leaving about half not covered with water.	2 points
Very little of the streambed is covered by water leaving areas that are not connected with water.	0 points

Step 5 Observe the waterway for signs of pipes and trash and choose the description below which best matches the conditions at this waterway.

Testing the Waters

Wastewater Sewage Pipes

There is no sign of sewage pipes; if present, they are buried. No manhole covers visible.	5 points
There is an exposed sewage pipe, but there is no visible damage. Manhole covers are present but secure.	3 points
There is evidence of past seepage (algae, toilet paper, etc.), a manhole cover is not tightly sealed, and/or the sewage pipe looks weak and worn.	1 point
Untreated sewage is flowing from a broken pipe or uncovered manhole.	0 points

Storm Water or Other Pipes

There are no visible pipes.	5 points
There is no evidence of harmful substances in the water.	3 points
Foam, oil, scum, or other unusual substances are in the water, but nothing is coming out of the pipe at this time.	1 point
A colored, odorous, murky, or warm liquid coming out of the pipe.	0 points

Trash

There is little or no trash of any sort.	5 points
There is paper, plastic, or glass. There is <u>no</u> rusting metal, oil cans, or batteries.	3 points
There are plastic bags, rusting metal, oil cans and/or batteries.	1 point
There is industrial waste (large drums of toxic materials) or sewage waste.	0 points

Testing the Waters

STATION 2: WATER QUALITY

Directions

Temperature

Step 1 Use your temperature probe to determine the water temperature.

- To use the temperature probe, connect the probe to Channel 1 of the **LabQuest**.
- Place the probe into the water.
- A temperature reading will be displayed in the top right-hand corner of the screen.

Step 2 Record the choice below which best matches the temperature data you have collected.

Temperature	
Under 32^{o} C today	+ 5 points
At or over 32^{o} C today	-- 5 points

Testing the Waters

Dissolved Oxygen (DO)

Step 1 Use the dissolved oxygen probe to find the DO level of the stream water.

- Prior to placing the dissolved oxygen probe in the water, prepare the probe for data collection by removing the blue protective cap and then gently unscrewing the tip of the probe and filling it with 1 mL of electrode filling solution. Gently screw the cap back in place. Do not replace the blue plastic cap at this time.
- Plug the **dissolved oxygen probe** into **Channel 1** on the **LabQuest**.
- Place the probe into a container of distilled water and, while connected to the LabQuest, allow it to "warm up" for at least 10 minutes prior to data collection at the waterway.
- When ready to collect data, place the probe in the stream and gently stir in a slow, circular motion. The membrane tip of the probe is very fragile, be careful not to push the tip of the probe into the sand or mud on the bottom of the waterway.

Step 2 Record the probe reading on your data collection sheet. (You may do **Steps 3-5** at another time.)

Step 3 To find the maximum Dissolved Oxygen Capacity for a body of water, your teacher will provide you with the barometric (atmospheric) pressure for the location on the testing day. Record the barometric pressure on your data collection sheet. If necessary, convert the pressure in inches to pressure in mm of mercury (Hg). This step can also be completed when you return to the classroom.

Step 4 Use **Table 1: 100% Dissolved Oxygen Capacity (mg/L)** found on the next page to determine the maximum amount of oxygen that could dissolve in the water at this temperature and pressure.

- Find the temperature of the water in the far left column of Table 1.
- Move to the column which represents the atmospheric pressure for this location today.
- Divide your answer from Step 4 by this number and multiply by 100.
- Record your answer on the data collection sheet.

Testing the Waters

Table 1: 100% Dissolved Oxygen Capacity (mg/L)												
	770 mm	**760 mm**	**750 mm**	**740 mm**	**730 mm**	**720 mm**	**710 mm**	**700 mm**	**690 mm**	**680 mm**	**670 mm**	**660 mm**
0°C	14.76	14.57	14.38	14.19	13.99	13.80	13.61	13.42	13.23	13.04	12.84	12.65
1°C	14.38	14.19	14.00	13.82	13.63	13.44	13.26	13.07	12.88	12.70	12.51	12.32
2°C	14.01	13.82	13.64	13.46	13.28	13.10	12.92	12.73	12.55	12.37	12.19	12.01
3°C	13.65	13.47	13.29	13.12	12.94	12.76	12.59	12.41	12.23	12.05	11.88	11.70
4°C	13.31	13.13	12.96	12.79	12.61	12.44	12.27	12.10	11.92	11.75	11.58	11.40
5°C	12.97	12.81	12.64	12.47	12.30	12.13	11.96	11.80	11.63	11.46	11.29	11.12
6°C	12.66	12.49	12.33	12.16	12.00	11.83	11.67	11.51	11.34	11.18	11.01	10.85
7°C	12.35	12.19	12.03	11.87	11.71	11.55	11.39	11.23	11.07	10.91	10.75	10.59
8°C	12.05	11.90	11.74	11.58	11.43	11.27	11.11	10.96	10.80	10.65	10.49	10.33
9°C	11.77	11.62	11.46	11.31	11.16	11.01	10.85	10.70	10.55	10.39	10.24	10.09
10°C	11.50	11.35	11.20	11.05	10.90	10.75	10.60	10.45	10.30	10.15	10.00	9.86
11°C	11.24	11.09	10.94	10.80	10.65	10.51	10.36	10.21	10.07	9.92	9.78	9.63
12°C	10.98	10.84	10.70	10.56	10.41	10.27	10.13	9.99	9.84	9.70	9.56	9.41
13°C	10.74	10.60	10.46	10.32	10.18	10.04	9.90	9.77	9.63	9.49	9.35	9.21
14°C	10.51	10.37	10.24	10.10	9.96	9.83	9.69	9.55	9.42	9.28	9.14	9.01
15°C	10.29	10.15	10.02	9.88	9.75	9.62	9.48	9.35	9.22	9.08	8.95	8.82
16°C	10.07	9.94	9.81	9.68	9.55	9.42	9.29	9.15	9.02	8.89	8.76	8.63
17°C	9.86	9.74	9.61	9.48	9.35	9.22	9.10	8.97	8.84	8.71	8.58	8.45
18°C	9.67	9.54	9.41	9.29	9.16	9.04	8.91	8.79	8.66	8.54	8.41	8.28
19°C	9.47	9.35	9.23	9.11	8.98	8.86	8.74	8.61	8.49	8.37	8.24	8.12
20°C	9.29	9.17	9.05	8.93	8.81	8.69	8.57	8.45	8.33	8.20	8.08	7.96
21°C	9.11	9.00	8.88	8.76	8.64	8.52	8.40	8.28	8.17	8.05	7.93	7.81
22°C	8.94	8.83	8.71	8.59	8.48	8.36	8.25	8.13	8.01	7.90	7.78	7.67
23°C	8.78	8.66	8.55	8.44	8.32	8.21	8.09	7.98	7.87	7.75	7.64	7.52
24°C	8.62	8.51	8.40	8.28	8.17	8.06	7.95	7.84	7.72	7.61	7.50	7.39
25°C	8.47	8.36	8.25	8.14	8.03	7.92	7.81	7.70	7.59	7.48	7.37	7.26
26°C	8.32	8.21	8.10	7.99	7.89	7.78	7.67	7.56	7.45	7.35	7.24	7.13
27°C	8.17	8.07	7.96	7.86	7.75	7.64	7.54	7.43	7.33	7.22	7.11	7.01
28°C	8.04	7.93	7.83	7.72	7.62	7.51	7.41	7.30	7.20	7.10	6.99	6.89
29°C	7.90	7.80	7.69	7.59	7.49	7.39	7.28	7.18	7.08	6.98	6.87	6.77
30°C	7.77	7.67	7.57	7.47	7.36	7.26	7.16	7.06	6.96	6.86	6.76	6.66
31°C	7.64	7.54	7.44	7.34	7.24	7.14	7.04	6.94	6.85	6.75	6.65	6.55

Testing the Waters

Step 5 Record the choice which best matches the percent saturation for this waterway.

Percent Saturation of Dissolved Oxygen	
80% to 100% of the potential dissolved oxygen	5 points
60% to 79% of the potential dissolved oxygen	3 points
40% to 59% of the potential dissolved oxygen	2 points
Below 40% of the potential dissolved oxygen	0 points

Testing the Waters

pH

Step 1 Use the pH probe to find the pH of the stream.

- To use the pH probe, plug the **pH probe** into **Channel 1** on the **LabQuest**.
- Place the probe into the water. Gently swirl the probe in the water and wait at least 1 minute before taking a reading.
- A pH reading will be displayed in the top right-hand corner of the screen. Be careful not to damage the round glass bulb at the end of the pH probe as it is very fragile. Do not place it directly into the sand or mud on the stream bottom.

Step 2 Record the choice which best matches the pH for this waterway.

pH	
pH 6.5 – 8.2: perfect for most organisms	5 points
pH 5.0 – 6.5 or 8.2-9.0: not directly harmful to fish, but may harm delicate species or have indirect effects due to chemicals in the water	3 points
4.5-5.0 or 9.0-10.5: harmful to some fish; most eggs will not hatch; most insects absent	2 points
Below 4.5 or above 10.5: lethal to most fish	0 points

Step 3 When you are finished with the pH probe, rinse the tip of the probe in distilled water, then return it to its pH 4 buffer storage solution making certain the cap is securely fastened and that there is at least 1 cm clearance between the bottom of the storage bottle and the delicate glass bulb on the end of the probe.

Testing the Waters

Conductivity (Total Dissolved Solids)

Step 1 Use the conductivity probe to measure the conductivity of the stream.

- To use the conductivity probe, plug the **conductivity probe** into **Channel 1** on the **LabQuest**.
- Set the switch on the Conductivity Probe box to 0-2000 µS (2000 µS = 1000 mg/L TDS).
- Place the probe into the water. Wait at least 1 minute before taking a reading.
- A conductivity reading will be displayed in the top right-hand corner of the screen.

Step 2 Record the choice which best matches the conductivity for this waterway. Note that a high conductivity reading may be normal for this waterway. Further tests would need to be completed to determine *which* substances in the water were responsible for the high reading.

Conductivity	
Low conductivity 0.0 – 500 µS	5 points
Moderate conductivity 501 – 1,000 µS	3 points
High conductivity 1,001 – 1,500 µS	2 points
Very high conductivity 1,501 – 2,000 µS	0 points

Nitrite Content

Step 1 Use the directions on the nitrite test kit to measure the nitrite level in the water.

Step 2 Record the choice which best matches the nitrite level for this waterway. Use the colors on the side of the test kit to help guide you.

Nitrite Content	
Very low levels of nitrite (0 – 0.05 ppm)	5 points
Low levels of nitrite and/or ammonia (0.06 – 0.10 ppm)	3 points
Medium levels of nitrite and/or ammonia (0.11 – 0.25 ppm)	2 points
High levels of nitrite and/or ammonia (0.26 – 0.50 ppm)	0 points

Testing the Waters

Step 3 When you are finished with the nitrite testing vial, do not dump the contents of the vial back into the stream! Dispose of the used chemicals as directed by the teacher.

Step 4 Clean and pack all water testing equipment for transport back to the classroom as directed by your teacher. Remember to:

- Rinse the probes with distilled water, wipe off any mud or sand, and pack safely.
- Remove tip of the dissolved oxygen probe, rinse the inside of the cap with distilled water, and gently replace the cap on the tip of the probe. Replace the blue plastic protective cap on the tip of the probe.
- Make sure the pH probe is stored in pH 4 solution in such a way that the delicate glass bulb is immersed in the liquid.
- Temperature and conductivity probes are clean and dry.

Testing the Waters

STATION 3: BIODIVERSITY

Directions

Step 1 Use a field guide, and other materials supplied, to determine the type of organisms found in the area assigned to you and a partner.

Step 2 Record the number of each type of organism on your tally sheet

Testing the Waters

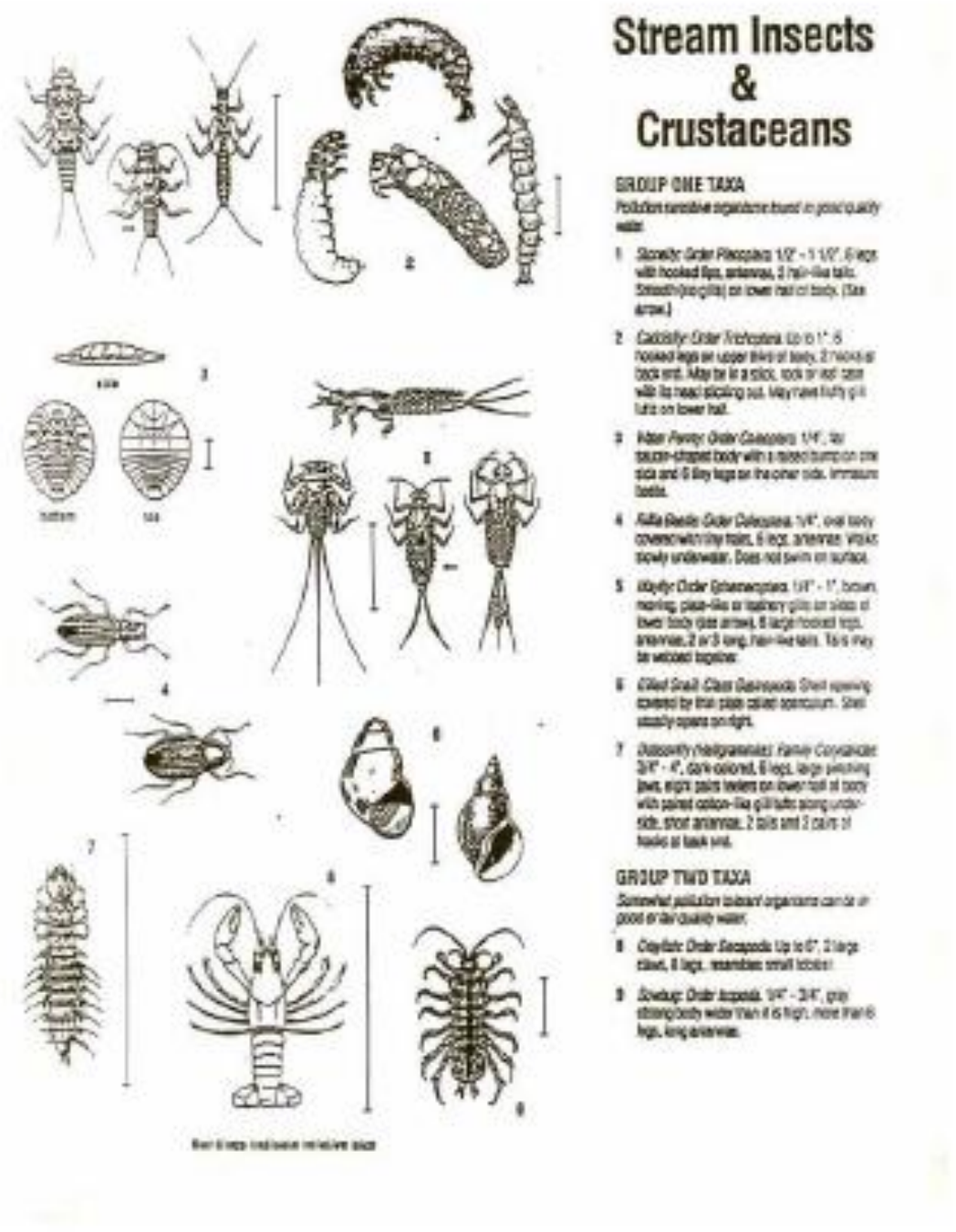
STATION 4: BIOLOGY

Directions

Step 1 With the assistance of a trained professional, collect and then use the *Stream Insects and Crustaceans* sheets to identify the types of macroinvertebrates found at the field site. Circle each ***different*** type of macroinvertebrate found. Find the total points for each column and then add those points to find the overall ***total*** macroinvertebrate points.

Step 2 Choose the statement below which best matches the total macroinvertebrate data for your waterway. Record your choice on your data collection sheet.

Macroinvertebrate Data	
Excellent; 23 or more macroinverte points	5 points
Good; 17-22 total macroinvertebrate points	3 points
Fair; 11-16 total macroinvertebrate points	2 points
Poor; 10 or less macroinvertebrate points	0 points



Stream Insects & Crustaceans

GROUP ONE TAXA

Pollution sensitive organisms found in good quality water

1 *Stonefly: Order Plecoptera* 1/2" - 1 1/2", 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See above.)

2 *Caddisfly: Order Trichoptera* Up to 1". 6 hooked legs on upper three of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. Mayflies have fluffy gill tufts on lower half.

3 *Water Penny: Order Coleoptera* 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs on the other side. Immature beetle.

4 *Riffle Beetle: Order Coleoptera* 1/4", oval body covered with tiny hairs, 6 legs, antennae. Wiggles slowly underwater. Does not swim on surface.

5 *Mayfly: Order Ephemeroptera* 1/8" - 1", brown, moving, plate-like or feathery gills on sides of lower body (gills arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.

6 *Gilled Snail: Class Gastropoda* Shell opening covered by thin plate called operculum. Shell usually opens on right.

7 *Dobsonfly (hellgrammite): Family Corydalidae* 3/4" - 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

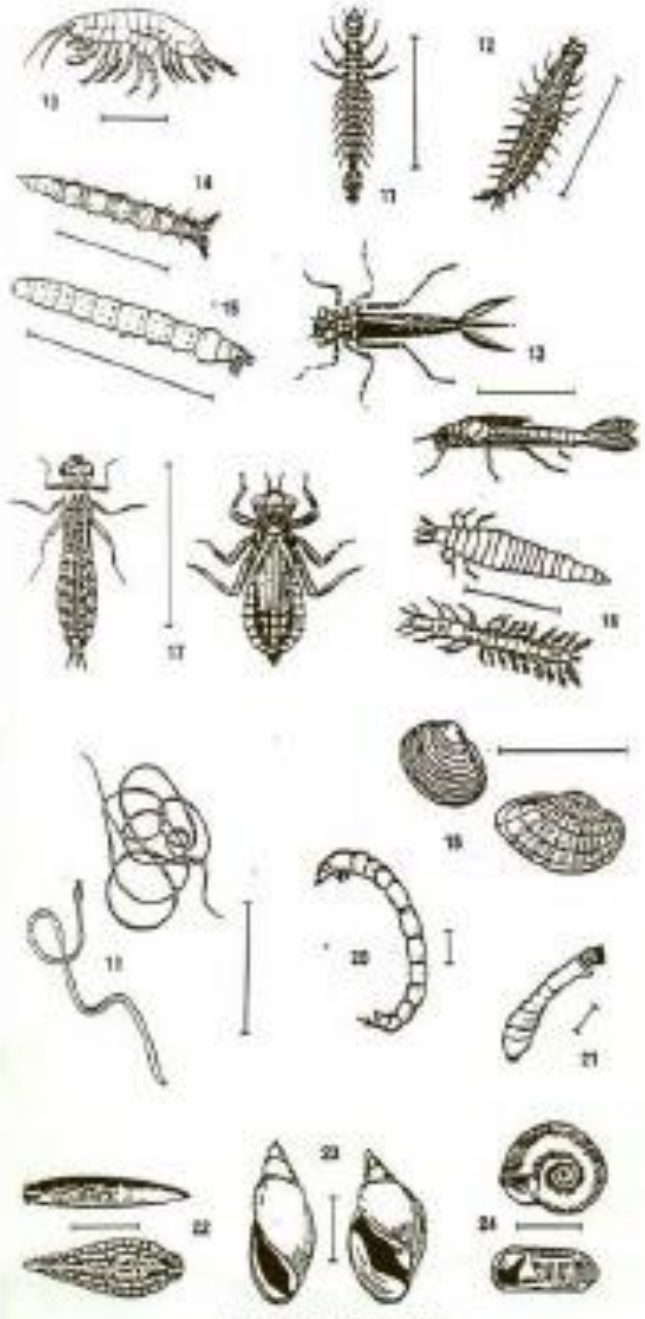
GROUP TWO TAXA

Somewhat pollution tolerant organisms can be in good or fair quality water.

8 *Crayfish: Order Decapoda* Up to 6", 2 large claws, 8 legs, resembles small lobster.

9 *Sowbug: Order Isopoda* 1/4" - 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Teachers: Download pdf file from http://www.watersheds.org/teacher/StreamInsectsIDKey.pdf



Bar lines indicate relative size

GROUP TWO TAXA continued

10 *Scud: Order Amphipoda* 1/4", white or gray, body higher than it is wide, swims sideways, more than 6 legs, members small-shrimp.

11 *Alderfly larva: Family Sialidae*. 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 *Fishfly larva: Family Corydalidae*. Up to 1 1/2" long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

13 *Damselfly: Suborder Zygoptera*. 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails positioned like a fan. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 *Watersnipe Fly Larva: Family Athericidae (Atherix)*. 1/4" - 1", pale to green, tapered body, many caterpillar-like legs, conical head, leathery "horns" at back end.

15 *Crane Fly: Suborder Nematocera*. 1/2" -2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 *Beetle Larva: Order Coleoptera* 1/4" 1", light-colored, 6 legs on upper half of body, tasters, antennae.

17 *Dragon Fly: Suborder Anisoptera*. 1/2" - 2", large eyes, 6 hooked legs. Widest body is round abdomen.

18 *Clam: Class Bivalvia*

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

19 *Aquatic Worm: Class Oligochaeta*. 1/4" - 2", do not see any legs, thin worm- like body.

20 *Midge Fly Larva: Suborder Nematocera*. Up to 1/4", dark head, worm-like segmented body, 3 tiny legs on each side.

21 *Blackfly Larva: Family Simuliidae*. Up to 1/4", one end of body wider. Black head, suction pad on end.

22 *Leech: Order Rhynchobdellida*. 1/4" - 2", brown, slimy body, ends with suction pads.

23 *Pouch Snail and Pond Snails: Class Gastropoda*. Has operculum. Breathes air. Shell usually opens on left.

24 *Other snails: Class Gastropoda*. No operculum. Breathes air. Small shell coils in one plane.

Macromania Game Instructions

1. Form teams of students with 2-4 students each.

2. Obtain the following items:
   - one deck of cards (yellow, blue, or green)
   - one sorting sheet (poster size)
   - one Site Map
   - one Stream Water Quality worksheet (need one sheet for each deck of cards)
   - Students can exchange decks and match cards again after round one to see how different sites will contain other macroinvertebrates.

3. Place the sorting sheet and map flat on a desk or tabletop where everyone on the team can easily see them.

4. Read the information on the cards and practice saying the macroinvertebrates organisms' names.

5. Gather the cards for your deck and shuffle them.

6. Find the site on the map that corresponds to the deck your group has received.

7. Sort your deck by matching the images on the cards of macroinvertebrates with the corresponding place on the sorting sheet.

8. Fill in the top portion of the Stream Water Quality Worksheet with information that pertains to your site.

9. Put an X on the box where there are cards on your sorting sheet.

10. Count the number of X's in each row. Write the numbers in Column A.

11. Multiply the numbers in Column A by the factor for that row. Write the answers in Column B.

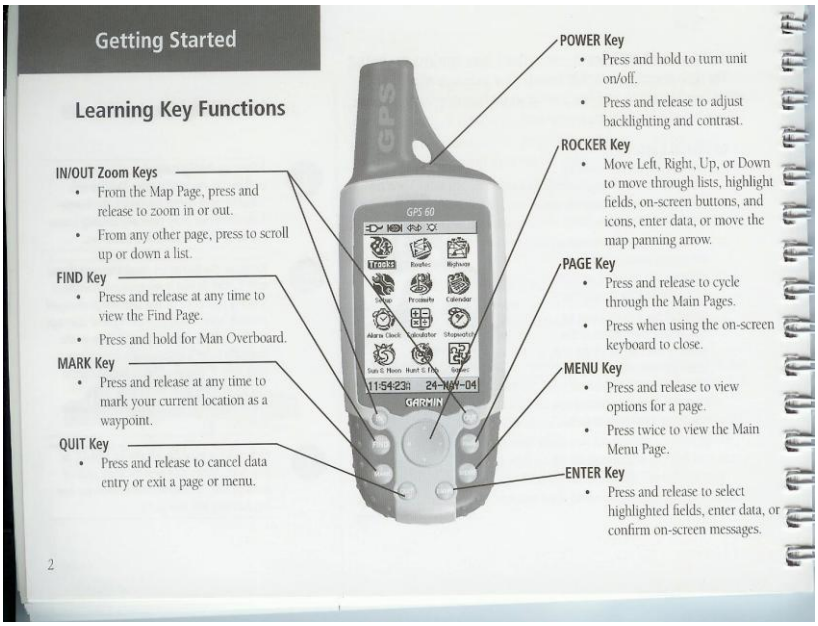
12. Add together the numbers in the boxes in Column B. Write the number in the box at the bottom of Column B.

13. Use the number in Box B, and the chart below to determine the water quality at your site.

Greater than 22: Excellent	**17-22: Good**
11-16: Fair	**Less than 11: Poor**

Garmin GPS 60 Set Up and Operating Instructions

The Garmin 60 GPS unit is shown below. For more information see the owner's manual which came with the unit or online at the following site: http://www.garmin.com/manuals/GPS60_OwnersManual.pdf .



Setting the Time Zone

- Press the Page key until the Main Menu page appears.
- Using the rocker key select Setup and press the Enter key.
- Using the rocker key select Time and press Enter.
- Using the rocker key select Time Zone and press Enter.,
- Using the rocker key select US-Eastern and press Enter.

Setting Units

- Press the Page key until the Main Menu page appears.
- Using the rocker key select Setup and press the Enter key.
- Using the rocker key select Units and press Enter.
- Use the rocker key and select Position Format. Press Enter. Use the rocker key to select hddd.ddddd°. Press Enter.
- Use the rocker key and navigate to Map Datum. Press Enter. Select WGS 84 and press Enter.
- Use the rocker key to navigate to Distance/Speed. Set to Metric. Press Enter.
- Use the rocker key to navigate to Elevation. Set to Meters (m/sec). Press Enter.
- Use the rocker key to navigate to Temperature. Set to Celsius. Press Enter.
- Depth does not need to be set.

Selecting Number of Data Fields and Turning On Guidance Text

- Press the Page button until the Map page appears. Press Menu. Using the rocker key, select Data Fields and press Enter. Use the rocker key and select 3 data fields. Press Enter.
- Press the Page button until the Map page appears. Press Menu. Using the rocker key, select Change Data Field. Pres Enter.
    - Select the first "box" at the top of the page and press Enter. Select Elevation from the menu and press Enter.
    - Use the rocker key to navigate to the second "box" on the page and press Enter. Select Heading and press Enter.
    - Use the rocker key to navigate to the third box and press Enter. Select Location and press Enter.

Garmin GPS 60 Set Up and Operating Instructions

- The three boxes should show Elevation, Heading, and Location.
- From the Map page, press Menu. Using the rocker key, select Guidance Text and press Enter. Select Always Show and press Enter.

Compass Page

- Press Page to get to the Compass page. Press Menu. Select Course (or Bearing) Pointer and press Enter.
- Press the Page button until the Compass page appears. Press Menu. Using the rocker key, select Data Fields. Press Enter. Select 3 and press Enter.
- Press Menu and select Change Data Fields. Press Enter.
    - Using the rocker key, select the first "box" at the top of the page and press Enter. Select Elevation from the menu and press Enter.
    - Use the rocker key to navigate to the second "box" on the page and press Enter. Select Heading and press Enter.
    - Use the rocker key to navigate to the third box and press Enter. Select Location (lat/lon) and press Enter.
- The three boxes on the compass page should show Elevation, Heading, and Location.

Deleting Existing WayPoints

- To delete existing waypoints, press the Find key. Use the rocker key to select Waypoints and press Enter. Use the rocker key to select the waypoint to be deleted and press Enter.
- Use the rocker key to select Delete (at the bottom of the screen) and press Enter. Repeat this process for any/all waypoints to be deleted.

Acquiring Satellites Outside

- Take the GPS 60 **outside** where it has a clear view of the sky and turn the unit on by pressing the power key located on the top of the unit. Note that fully charged batteries are essential for successful field use of GPS units.
- Wait while the GPS 60 searches for satellites. This will take several minutes. The message "Acquiring Satellites" will appear.
- When the satellites are acquired, the geographic coordinates will appear above the satellite map (e.g., N 38.76029 and W 077.30183).

Marking New GPS WayPoints

- Standing at the location to be marked, simply press the Mark key. Using the rocker key, select **Avg** and press Enter. When the measurement count becomes greater than 25, press the Enter key to save the waypoint.
- The GPS unit will automatically assign a number to the way point. If desired, use the rocker key to select waypoint number, press Enter and change the name or number of the waypoint. Using the rocker key, navigate to OK and press Enter.
- Note the number of name of the waypoint and record desired data or observations on a field observation sheet for the waypoint and move to the next.

Garmin GPS 60 Set Up and Operating Instructions

Finding a Previously Recorded Waypoint

- Press the Find key. Use the rocker key to select waypoints. Select Enter.
- Using the rocker key select the desired recorded waypoint, and press Enter.
- Use the rocker key to select Go To at the bottom of the screen. Press Enter.
- Follow the pointer and other directions on the screen to locate the waypoint. Make observations and move to the next waypoint as appropriate.
- Alternatively, press Page and navigate to the Compass page. Follow the compass pointer to the desired waypoint.

Nullifying a Command

- To "erase" a command, press the Quit key.

Turning Unit Off

- Press the Power key.
- If a pop-up menu appears, ignore and press Power key again

Enviroscape Watershed Model

The EnviroScope® Watershed Model is interactive. You, the facilitator must keep the ball rolling by being prepared with the information you want to present. Read the ***Enviroscape User's Guide*** directions in their entirety prior to using the model with students. Below, are some abbreviated suggestions for using the Enviroscape Watershed Model in the field with students during **Part 2: MWEE of Testing the Waters**.

Preparation: (User Guide pages 14-15)
Place the watershed model on a flat surface, above ground, such as a picnic or folding table. Unpack and have ready all the items that are to be placed on the model as well as the "pollutants" that will be used during the interactive demonstration(s).

- Be sure the storm drains are connected properly.
- Slide one of the plastic containers under the drainage hole in the lake bottom.
- Place the plug in the drainage hole and fill the lake with 1 cup of water.
- Fill spray bottle with water and put nozzle setting on "mist".

Activating Students' Background Knowledge: (User Guide Steps 1 & 2)
Ask for 2-3 student volunteers to place bridges, vehicles, golf flags, trees, structures, cows, etc. on the model as shown in **Diagram A** in the **User's Guide**. Note that a small piece of modeling clay may need to be used to hold the base of flags and trees in place. Ask students the following questions:

- What is a watershed? *A watershed is a region of area draining to a particular watercourse of body of water.*
- In which large watershed do you live and go to school? *Students may name the watershed to which their school belongs. They should also state that their homes and school are part of the larger Chesapeake Bay Watershed.*
- What is a water body? *A waterbody is any river, lake, stream, ocean, pond or basin that receives runoff waters from a watershed.*
- What is the name of the waterbody we are observing today? *Answers will vary depending on MWEE site.*

Demonstration 1: Sources of Pollution (User Guide Steps 4 & 5)
Discuss sources of pollution – point source (PS), page 18 in the Enviroscape User's Guide and nonpoint source (NPS), page 21 in the Enviroscape User's Guide. Ask students the following question:

- What type of pollutants might we find here at our location? *Accept all reasonable answers*

Reference page 19 and set up a sewer overflow. Ask students the following question:

Enviroscape Watershed Model

- What might cause a sewer overflow? Excessive rain Is this considered a PS or NPS pollutant? (PS) Why are these pollutants potentially harmful?

Demonstration 2: Non-Point Source Pollution (User Guide Steps 6 & 7)

Reference page 23-24 and set up a non point source pollutant Ask students the following questions:

- What is happening? *As the rain (or melting snow) runs of the surfaces, soil and contaminants are picked up and carried into the waterbody.*
- Why are these pollutants potentially harmful? *Reference page 27*

Other pollutants to consider: Reference page 46 to observe soil erosion, fertilizer runoff, oil and grease spills. Reference page 35 to demonstrate how wind erosion is another carrier of nonsource pollutants.

Demonstrate 3: Turbidity (User Guide Step 9)
Ask students the following question:

- Do we see any evidence of turbidity here at our MWEE site *(answers will vary depending on site)?*

CONCLUSION: Reference page 57-59 to have students brainstorm everyday habits to manage water pollution.

- What have you learned from these activities and demonstrations?
- What do you think of now when you hear the word pollution?
- What benefits do we gain by reducing and preventing water pollution?

Clean and repack the model for future use.

Environmental Stewardship Planning Rubric

Criteria	Level 1 Low	Level 2 Moderate	Level 3 High
Is the project aligned to the VA SOL? If so, to what degree? (List SBI's)			
Will the project involve the community? If so, who and to what degree?			
What outcome(s) will likely result from the project?			
What are your top three objectives? Note: In a multiyear project, the first year's objectives might be different from the eventual outcome. 1. 2. 3.			
How will you measure the effectiveness of your project? Year 1: Year 2: Over time:			
What measures will be taken to ensure that the project is sustainable over time?			