Orientation and Training Workshop for GMU Field Interpreters and FCPA Naturalists and Field Interpreters

Leading Meaningful Watershed Education Experiences (MWEE)

Using the FCPS MS Science "Testing the Waters" Field Investigation

Opening Activity:

- ❖ Below, jot down some notes about what you already know about the MWEE

- ❖ What questions do you have about the MWEE? (make sure you leave with answers today!)

How are MWEEs Delivered Across the County?

1. GMU or FCPA-Interpreter-led MWEE
2. School funded MWEE on/near school grounds or local nature center

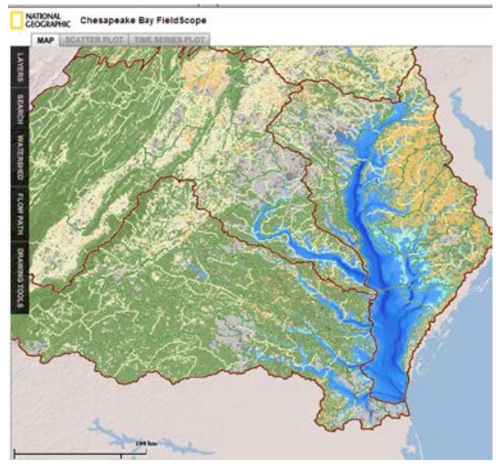
Who Coordinates the MWEE?

- Cindy Smith - GMU Interpreters (with Matt Helfinstein as Site Manager in the field)
- Tammy Schwab - FCPA Interpreters (with Terry Tomasulo as Site Manager in the field)
- Linda Peterson – FCPS curriculum, communication with teachers, schools and funding

Who Participates in a MWEE?

- MWEE is for FCPS Life Science students
- MWEEs all use the “Testing the Waters” lesson that is part of the FCPS middle school science curriculum (a copy of both the student and teacher documents are posted to Kids2Bay site http://kids2bay.pbworks.com/w/page/35177396/Overview)
- FCPS School Board has designated the MWEE as a “stewardship” model for middle school students

What is the “Testing the Waters” Lesson?



All FCPS Life Science students complete the **Understanding Our Environment** unit during the first semester of each academic year. The “Testing the Waters” is the culminating lesson in the unit and is conducted in Fall or Spring when the weather is conducive to field investigation. The lesson has three parts.

- Part 1: Getting the Lay of the Land
- Part 2: Meaningful Watershed Education Experience (MWEE)
- Part 3: Environmental Stewardship

Testing the Waters: Part 1: Getting the Lay of the Land

Students use the NOAA Chesapeake Bay Program to learn about the state of the Bay. They use the web-based Fieldscope site to gather additional information about the Bay’s watershed and their field experience site

Testing the Waters: Part 2: Meaningful Watershed Education Experience (MWEE)

Today, you will learn how to lead Part 2

- Interpreter-led field investigation to collect data
- Students rotate through four 12-minute stations: (1) Land Use, (2) Water Quality and Habitat, (3) Biodiversity, and (4) Macroinvertebrates
- Schools also run two additional stations but interpreters are not involved
- Data is analyzed back in the classroom

Testing the Waters: Part 3: Environmental Stewardship

- After data is analyzed, possible student stewardship projects might include
  - Growing and planting native trees or shrubs
  - Creating a schoolyard habitat or rain garden
  - Creating and maintaining a school-wide recycling program
  - Growing and planting underwater grasses
  - Raising fish such as shad or trout in the classroom and releasing them into a local stream
  - Creating a manmade wetland
- Schools can also elect to become an Eco-School to fulfill their stewardship goals

What Happens at Each of the MWEE Stations?

Data collection by students is the MOST IMPORTANT goal of the MWEE. Students will analyze their data when they return to their school so it's vital that they collect valid data while they are in the field. **Students should be engaged in data collection and discussion rather than listening to a presentation.**

Rotating Through the Stations

- After a brief introduction, pre-divided students walk to first station with their first station interpreter
- Students remain at each station for approximately 25 minutes until they hear the horn/whistle at which time they rotate to the next station
- Interpreters remain at same station and point students towards their next station in the rotation
- Stations 5 & 6 are school led and often composed of both red and blue groups
- For more information check http://kids2bay.pbworks.com/w/page/35177396/Overview

Station 1: Land Use

- This station combines two levels of looking at land use.
- The "Micro" view is the measurement of buffer characteristics
- The "Macro" view is looking at the current and historical maps to see how development has changed over time
- Interpreters can start with either view but must make sure the students have time for data collection

Station 2: Water Quality and Habitat

- Students examine the bottom habitat and stream banks then conduct water chemistry tests using probeware and LabQuest
  - Students should be familiar with water quality testing as they have monitored their own "model ecosystem" during the unit
- Students EACH collect water quality data and compare with classmates

Station 3: Biodiversity

- Students examine and compare the diversity in two different locations

Station 4: Biology (Macroinvertebrates)

- Students collect and identify macroinvertebrates and use the diversity to indirectly determine stream health

How Does Each MWEE Start?

1. Interpreters arrive early (~8:00 am) and collect equipment/materials from the head interpreter. They take the materials to their assigned station and keep in contact with others to make sure they know the rotation progression for the site and if more materials will be coming from the school.
   - Setting up the station includes (but is not limited to) pounding in stakes, making sure probeware is ready, and macroinvertebrates are pre-collected and placed in holding tanks that are out of direct sunlight.

2. All Interpreters should be waiting near buses holding up their colored station number signs before the students arrive.

3. As buses arrive, an interpreter waves them to designated parking area. One or more people board the buses and remind the bus driver to drive a distance away before they turn off their engines or pump their brakes. Students should leave their lunches on the bus. They are instructed to exit the bus and line up behind the interpreter for their first station.

4. Students and their chaperones exit the bus and line up behind the interpreter for the first station. All interpreters hold up their hand to signal "quiet." The Site Manager says "Good Morning" (wait for good morning from crowd). "Welcome to ______ park, I'm _____ from GMU/FCPA and today you will be engaging in a Watershed Investigation of _______ stream/lake. As part of your science curriculum, you have conducted science investigations in the classroom related to ecosystems. Today, you will be conducting a science investigation ***in the field***. This field investigation is called "Testing the Waters" and is in your lab guide. You have already completed Part 1 of the investigation "Getting the Lay of the Land." Today, you will complete Part 2 in which you will collect data at several stations.

   In each of the stations you and your group will be collecting data that you will be analyzing back at school. Each station is designed to help you gather data with which to make an overall assessment of the health of this aquatic ecosystem. Helping you collect the data today are GMU or FCPA field interpreters (have them raise their hand and look happy and lively). We are fortunate to have these knowledgeable experts with us today.

   Pay careful attention to what you see, hear, measure and touch as you move through the park today, as all of this evidence will help you to understand and analyze this ecosystem. We want to thank all the chaperones who made time in their busy lives to join us today we count on you all to help make this Field investigation a great success.

   Before you depart for your first station we have a few rules for you: (rules vary depending on the site).

   Rule#1: When you hear the air horn (or whistle) that means it's time to rotate to your next station. Put your equipment safely back where you found it, make sure you/your group have your data collection sheets and walk quietly/quickly with your chaperone to your next station.

   Rule #2 - Canada geese believe you all have come today to feed them. When they find out this isn't true, they may try to bite your fingers. It's Ok to speak to them and look at their adaptations, but please do not reach out to the geese.

Rule #3 - If needed, point out safety hazards on site.

Rule #4 - Stay with your chaperone and your interpreter at all times. The interpreters will instruct you where to go when you are finished with each station. Stay with your group!

5. The Site Manager will give the signal for each interpreter to lead students and their chaperone to the first station. The Site Manager divides up time per station and will sound the horn or whistle when it's time to rotate. Pay careful attention to the rotation plan for the specific site. If you are not sure of the rotation - ASK.

6. All stations are about 20-25 minutes. The amount of time per station will vary each day depending on the time that the buses arrive and the time they need to return to the school.

Set Up Stations for Student Discovery and Movement

- **The overarching goal of the MWEE is to have students "discover" key ideas about factors that affect the health of an ecosystem through DATA collection and DISCUSSION.**
- Interpreters are not expected to "deliver" any type of lecture or speech about the station. Students have had classroom experiences that have prepared them to collect the data. They are familiar with how to discuss their data.
- Each station should be set up so that each student has access to the equipment, maps, and other data collection methods. The interpreter's job is to probe for prior knowledge, ask thought-provoking questions, facilitate data collection, and (if time allows) to help students make some larger connections. Kids should not be sitting or standing passively at any time!
- Let QUESTIONS guide the student discussions…Ask them what they already know about ___ (topic) and how what they are doing relates to that.
- Provide sufficient wait time for them to retrieve their ideas.

Station 1: Land Use

Station Set-Up: Stretch the measuring tapes out to the extent of the buffer. Have rulers and dowels ready to pass out to students in groups of two or three students. Historical AERIAL maps should be laid out on the ground, or on a bench/table, where students won't trample them when moving, but can gather around and easily see them.

<u>Aerial Maps</u>
Students will observe maps showing what the location looked like over the past few decades. They will consider how the land and vegetation have changed over time

<u>Topographic Maps</u>
Students will observe topographic maps of their MWEE location. They will compare the topographic features they observe areas of high elevation, ridgelines, and tributaries. at the site with those on the map.

1. Direct students to look at the stream or lake. Point out where the dam is located, steep slopes, houses, and the direction of water runoff flow.

2. Tell students that they will collect data about how **land use** affects water quality and aquatic habitats in the water body and in the watershed.
   - Ask: Who can give me an example of one way that we use land? *Accept all reasonable answers. Some possible answers include housing developments, schools, parking lots, parks, sports fields, etc.*

<u>Note</u>: Students will record their observations and measurements in the data table below (it's in their packet that they take with them to each station).

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:	

Buffer Zones

3. Tell students that a buffer is something that helps to reduce the impact of something. Ask them to think about the term "buffer zone" and how it might apply to the area in which they are standing.

4. Have students volunteer their ideas about a buffer zone but don't waste time if they are not familiar with the term. Have everyone point to the buffer zone and explain that a buffer zone is an area of vegetation (trees, shrubs, grasses) alongside a stream that helps to filter out pollutants. The wider the buffer zone, the greater the filtering of storm water and pollutants.
   - Ask: Where does the buffer zone start? Where does it end?

5. Explain that a buffer zone that is at least 16m wide is usually wide enough to slow the flow of storm water. Walk with them, or send a friend with them to the end of the tape, looking at measurement. Have students record their answers in their packet.

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

Vegetative Ground Cover

6. Call students' attention to the plants in the buffer zone.
   - Ask: What types of plants do you see around you?
   - Is the ground totally covered or are there bare spaces, exposed roots, pavement?
   - Which is healthier for a stream, bare soil or vegetated soil? Why?
   - What helps keep the soil in place?
   - Why do we care if soil/sediment washes into the stream?

7. Have students record the predominant type of buffer ground cover and associated points.
- Ask: What are some of the types of plants that you would expect to find in a health ground cover? How might mowing an area next to the stream affect sediment and pollution entering the stream when it rains?

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.

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

Soil Hardness

8. Have students bend down and push down on the soil with their fingers and describe how it feels.

- Ask: How hard does the soil feel? Gather a few responses from students and then ask them how they could compare their responses?

9. Explain that scientists have a way to quantify hardness of soil. Show them how to use the dowel, push it into the soil (without breaking it). Mark depth with a fingernail and then measure it with a ruler or the large measuring tape used earlier to measure the width of the buffer zone.

10. Pass rulers and dowels out to groups of 2-3 students and direct them to measure soil hardness 2m, 4m, 6m, 8m and 10m along the tape.

11. Have each group to share their data. Have them total the data and then find the average.

12. Explain that the harder, more compact the soil is, the faster the storm water flows over the land, carrying pollutants and causing erosion. Storm water soaks into soft soil.

Step 4 Test the <u>hardness of the soil</u> 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

- Ask: How did the soil get so hard? *People trampling it, topsoil washing away…*
- What would do to improve the soil here and make it more porous, spongy. K*eep people from walking on it, plant trees, add organic matter, etc. encourage their ideas!*

Condition of Streambank(s)

13. Walk students to the edge of the stream and have them spread out along the edge. Select a visible segment, point to the boundaries (i.e. from this overhanging tree down to that big rock).
    - Ask: How would you describe the condition of the stream bank?
    - What percent is eroded?
    - Why do you think it's eroded?
    - Where did the water come from? (relate back to the maps)

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

14. Explain that steep slopes, impervious surfaces like rooftops, driveways and roads speed up the flow of storm water causing erosion. Ask: How might warm water running off from hot pavement into streams affect aquatic life?
    Explain that stream banks covered with vegetation, showing little erosion are healthiest for aquatic life.
    - Have them vote to assign points and discuss.

Stream Shade Cover

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

15. Instruct students to think about the water quality testing they did in their model ecosystem.
    - Ask: How does the amount of sun or shade affect water temperature: What effect does water temperature have on dissolved oxygen in the water?
    - How does the amount of sun or shade affect water quality?
    - What percent of this stream segment is shaded?

16. Have students hold up 5, 3, 2, or no fingers to share their ratings with one another.

17. Have students justify their answer with observations they can see at the field site. <u>Have students record their answers in their packet</u>.

18. Explain that the water temperature in shaded streams is cooler and holds more dissolved oxygen than streams with few shade producing trees along the banks. Warmer water supports less aquatic life.

Land Use

19. Call students' attention to the historical aerial maps and ask them to find examples of
    (1) housing develop-
    ments,
    (2) parking lots,
    (3) parks,
    (4) forested areas,
    (5) bodies of water (make sure they find the MWEE location on the map as well),
    (6) and paved surfaces.

    - Ask: How would you describe the

<u>Land Use Directions</u>

Step 1 The area of vegetation around the stream is called the <u>buffer zone</u>. 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 16 m wide	5 points
Buffer zone is between 11-15 m wide	3 points
Buffer zone is between 6-10 m wide	2 points
Buffer zone is less than 6 m wide	0 points

develop-ment in the area surrounding the park? *Most likely that will be housing developments, paved surfaces, schools, and parking lots.*

- Using the most recent map, ask them to estimate the number of homes in the nearest development.
- Have them trace, with their finger, the likely path of water from the development to the water body at which they are conducting their MWEE.
- Have them find the outflow pipes on the map.
- Have students hold up 5, 3, 2, or no fingers to share their ratings with one another
- Have students justify their answer with examples of different types of development and land use from the maps. Have students record their answers in their packet.

20. Explain that when storm water flows over highly developed areas with lots of houses, rooftops, roads, buildings and shopping malls, it heats up and speeds up, carrying warm water and pollutants into streams which can kill fish and other aquatic life.

Summation

21. Instruct students to look over the data they have collected at this station.
    - Ask: Using your data and observations, how would you SUM UP the Land Use conditions at this site? They should write 1-2 sentences to sum up and be ready to share their answer with the group.

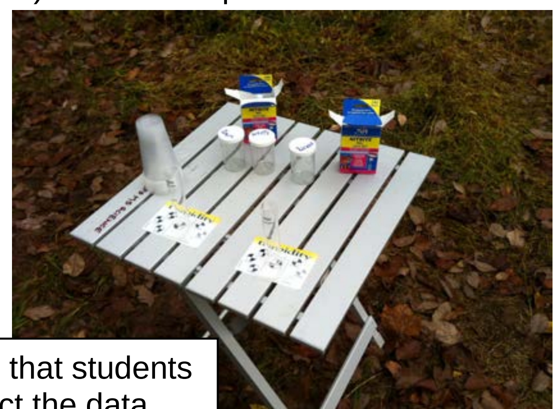
22. If time allows, explain that a stream with good habitat quality will have a wide, healthy forest growing along both stream banks; small amounts of erosion on the stream banks; riffles and pools; and vegetative debris in the stream.
    - Ask: Name three things contribute to stream degradation?
    - What could you do at home, in your school yard or even in a local park to help protect the water quality in local streams?

REMINDER: If this is their last station, remind participants to do a tick check in their cozy spots before getting on the bus AND when they shower at home.

STATION 2: WATER QUALITY AND HABITAT

Station Set up:

- There are two tables for this station. Set them up APART so that students have ample room to move around each table.
- VERY IMPORTANT: Prepare the dissolved oxygen and pH probes per the set up directions on the following pages.
- Set the probes in cups which are inside a container in the center of each table. Do not place the probes or LabQuest on the ground or where they can get wet.
- At one table, place the dissolved oxygen, temperature, pH, and conductivity probes. At the other table, place the turbidity and nitrate (or nitrite). You could place the temperature probe at this table if you wanted to have three tests at each table.
- If available, laminated expert cards can be placed in front of the tubs to spark interest.
- If stream access is challenging or unsafe due to fast water, the interpreter should collect the water samples for the students. Students can then safely test the sample at the folding tables.



Separate the tables so that students have to MOVE to collect the data. We don't want them just standing around or sitting passively.

Waste bucket

Water Quality

PROBE SET UP: Dissolved Oxygen Probe

Video: http://www.vernier.com/products/sensors/dissolved-oxygen-probes/do-bta/

Part A - Probe Preparation

1. Remove the blue protective cap from the tip of the probe.
2. Unscrew the membrane cap from the tip of the probe.
3. Use a pipet to fill the membrane cap with 1 mL of DO Electrode Filling Solution.
4. Carefully thread the membrane cap back onto the electrode.
5. Place the probe into a beaker filled with about 100 mL of distilled water.

Part B - Probe Warm-Up

1. Connect the Dissolved Oxygen Probe to the LabQuest and turn on.
2. It is necessary to warm up the Dissolved Oxygen Probe for 10 minutes before taking readings.
3. To warm up the probe, leave it in the water and connected to the interface with the data collection program running for 10 minutes. The probe must stay connected at all times to keep it warmed up. If disconnected for a few minutes, it will be necessary to warm up the probe again

Part C - Storage of the Dissolved Oxygen Probe

Long-term storage (more than 24 hours) Remove the membrane cap and rinse the inside and outside of the cap with distilled water. Shake the membrane cap dry. Also rinse and dry the exposed anode and cathode inner elements (blot dry with a lab wipe). Reinstall the membrane cap loosely onto the electrode body for storage. Do not screw it on tightly. Replace the blue protective cap.

Part D – Dissolved Oxygen Probe Callibration

Video: http://www.vernier.com/products/sensors/dissolved-oxygen-probes/do-bta/

1. Fill the tip of the probe with DO Filling Solution
2. Connect the DO probe to LabQuest and it will be auto identified
3. Leave to warm up for 10 minutes
4. On Labquest screen tap on the red square and select “calibrate now”
5. Put the tip of the clean probe into the sodium sulphite solution. Notice the live voltage displayed on the LabQuest screen, it will drop as the probe is inserted into the sodium sulphite solution.
6. When the voltage has reached its lowest point, select zero and keep
7. Rinse off the sodium sulphite solution and place the probe into distilled water in a small vial. Make sure the probe is in the vial but not touching the surface of the water. This humid environment provides the maximum oxygen saturation.
8. At the barometric pressure of the day, and temperature, look up the percent of maximum saturation. Select that value on the LabQuest screen. Keep.
9. IMPORTANT: Tap on the Storage tab on the top of the LabQuest screen. This stores the calibration in the sensor itself.

PROBE SET UP: pH Probe
Video: http://www.vernier.com/products/sensors/ph-sensors/ph-bta/

Part A – Probe Preparation

1. Remove the storage bottle from the electrode by first unscrewing the lid, then removing the bottle and lid.
2. Thoroughly rinse the lower section of the probe, especially the region of the bulb, using distilled or deionized water.
3. When the probe is not being stored in the storage bottle, it can be stored for short periods of time (up to 24 hours) in pH-4 storage solution. **It should never be stored in distilled water.**
4. Connect the pH Sensor to your lab interface, load or perform a calibration (as described in the next section), and you are ready to make pH measurements. **Note:** Do not completely submerge the sensor. The handle is not waterproof.
5. When you are finished making measurements, rinse the tip of the electrode with distilled water.
6. Slide the cap onto the electrode body, then screw the cap onto the storage bottle. Note: When the level of storage solution left in the bottle gets low, you can **replenish it with pH-4 storage solution** (see the section on Maintenance and Storage).

Part B – Probe Calibration

If necessary, calibrate the Vernier pH probe using the following procedure:

1. Use buffer solutions of pH 4, 7, and 10. Linda P has capsules that can be mixed with distilled water to create these buffer solutions.
2. Each tablet is added to 100 mL of distilled water to prepare respective pH buffer solutions.
3. Use the 2-point calibration option of the LabQuest data-collection program.
4. Rinse the tip of the electrode in distilled water.
5. Place the electrode into one of the buffer solutions (e.g., pH 4).
6. When the voltage reading displayed on the computer or calculator screen stabilizes, enter a pH value, “4”.
7. For the next calibration point, rinse the electrode and place it into a second buffer solution (e.g., pH 7). When the displayed voltage stabilizes, enter a pH value, “7”.
8. Rinse the electrode with distilled water and place it in the sample.

Part C - Maintenance and Storage

Short-term storage (up to 24 hours): **Place the electrode in pH-4 storage solution. DO NOT STORE IN DISTILLED WATER!!!**

Make sure that all probes and LabQuests are neat and clean and packed up in the same containers in which they were delivered. Put any broken probes and/or LabQuests in a large Ziploc bag that has been labeled “broken”.

Station 2: Habitat

1. Remind students of the water quality testing they did of the water in their model ecosystem in the Fall. Explain that they will use those same tests to measure the water quality of the stream. They will also assess the habitat that the stream provides to living things.
   - Ask: With a neighbor, share what you already know about the term “habitat.” What might be an example of a habitat in this this area? *Accept all reasonable responses*.

2. Explain that the best habitat for fish and other aquatic life such as a crayfish or dragonfly nymph is rocky (gravely) with lots of hiding places, and not a lot of gill clogging sediment. Further explain that fine sand, like found in Burke Lake, doesn’t provide great hiding places and can irritate soft bodied invertebrates. Rocks, such as those placed to slow rapid storm flow and erosion, also provide substrate for invertebrates. Fallen trees, rocks not coated in sediment are great places to live.
   - Ask: Why might it be important for critters to have places to hide in their habitat? Students should relate to the idea of predators from their ecosystem unit.

Station 2: Habitat

Feature	Observations	Points
bottom sediment	**Student Data Packet**	
bottom habitat		
amount of streambed covered by water		
waste water sewage pipes		
other pipes		
trash		

Human Impact:
Observe the area and describe features that have been changed by human activity.

How might these changes affect species competition or survival?

3. To determine the type of stream bed you will use your observation skills.
   - Ask: What color the water is in local streams after it rains? *Brown.* Why?

   If necessary, explain that sediment runs off the ground and into the water. We have a lot of clay in this area and the particles are very tiny and easily run off during a storm. If you are measuring a stream in the coastal plain, the stream bed is usually sandy soil. Have students squat down at the stream edge and rub the bottom substrate between their fingers. Pick up a bit of the bottom substrate between your fingers. Close your eyes. Rub it. What does it feel like?

Students should ALL be looking at the stream. Point their attention to the bottom and have them vote on whether they think it's muddy or rocky (Burke Lake is muddy, Accotink Creek and Lake Fairfax are likely rocky).

Have them then vote on which of the descriptions (in the chart at right) best match the conditions of the bottom.

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
Stream flow is reduced to a narrow channel; mud, silt and/or sand fills pools and stops, or almost stops, water flow	0 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
Obvious sediment build-up; more than 50% of the bottom is covered by sediment	0 points

4. Next, have students consider the type of habitat that the stream bottom provides. Use the descriptions (in the chart at right)

Have them vote and then discuss their answers.

When the group has reached consensus, have them record their data in the field data collection packet.

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 When water in a stream dries up or covers very little of the streambed, there

Muddy 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 20-40% mix of branches, submerged logs, undercut banks, and other debris.	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 less than 10% mix of branches, submerged logs, undercut banks, and other debris.	0 points

Rocky Stream Bottom Habitat	
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 30-50% large rocks, gravel, logs, tree branches, undercut banks visible.	3 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% large rocks, gravel, logs, tree branches, undercut banks visible.	0 points

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**.

5. **The Amount of Streambed Covered by Water**. When water in a stream dries up or covers very little of the streambed, there are fewer places for aquatic organisms to live.

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

6. **Storm Water of Other Pipes and Trash** Have students observe the waterway for signs of pipes and trash and choose the description (in the chart at right) which best matches the conditions at this waterway.

Step 4 Observe the waterway for signs of pipes and trash and choose the description below which best matches the conditions at this waterway.

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 is 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

WATER CHEMISTRY

Temperature

1. Students should gently stir the probe in the sample cup and record the temperature reading on the data table in their packet.

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)		

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

- To use the temperature probe, connect the probe to one of the ports on the **LabQuest2**.
- 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° C today	+ 5 points
At or over 32° C today	– 5 points

Dissolved Oxygen

2. Explain that the amount of oxygen dissolved in the water that fish, macroinvertebrates and other organisms use to survive. DO enters the water from wind, riffles, and from algae that produces oxygen during photosynthesis. It is measured in mg/l, but to get the percent oxygen saturation, you will use today's atmospheric pressure (which can help 'push' more oxygen into the water) and convert it from mg per liter to % saturation. Do this back at school. Catfish and carp and macroinvertebrates like midge larvae and aquatic worms can tolerate very low DO. Stoneflies and hellgrammites as well as like trout and pike require high levels of DO. Waters of consistently high levels of dissolved oxygen are usually considered healthy and stable ecosystems, capable of supporting many different kinds of aquatic organisms.

3. Student should gently stir the DO probe in the sample cup and record the DO reading on the data table in their packet. They will find the % DO when they are back at their school.

pH

4. Ask: What do you know or remember about pH from the water quality tests of their model ecosystem. *Accept all reasonable answers.*

   Background Info for Interpreters (share if time permits): An easy way to remember pH is **P**ercent **H**ydrogen ions. pH scale 0 – 14, with 7 being neutral. Low, acidic pH can weaken shells and exoskeletons, disrupt egg laying and reduce food availability. Water boatmen are one of the most resistant, surviving at a pH as low as 4.0. Rain water is naturally acidic with a pH of around 5.6- 5.8. Mo st rainwater is naturally acidic, with a pH of 5.6 to 5.8, due to the presence of carbonic acid (H_2CO_3) which forms through the interaction of rainwater and CO_2 gas. The source of the CO_2 is the atmosphere, which presently contains about 380 ppm CO_2. Rainwater values of pH below about 5.6 are considered "acid rain;" Acid rain is usually caused by pollution from automobiles or coal-fired power plants located to the west of us. These sources emit nitrogen oxides (NOx) and sulfur dioxide (SO2), which are converted to nitric acid and sulfuric acid in the atmosphere resulting in acid rain or acid snow.

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

Conductivity (Total Dissolved Solids)

5. Background Info for Interpreters (share if time permits): Conductivity tells us the amount of solids in dissolved in the water but not what type of dissolved solids they are. Rainfall interacting with the atmosphere, soil, vegetation and ground surface carries most of the dissolved solids into the waterway.

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/Nitrate

6. Background Info for Interpreters (share if time permits): Nitrogen is an essential nutrient used by all organisms to build protein.

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

   When l eaves fall/w ash into a stream, nitrate levels increase as they are break down. Usable forms of nitrogen for aquatic plant growth are ammonia, NH_3 and Nitrate NO_3. Excess nitrogen, from fertilizer run off, animal water, septic systems, leaves breaking down, can cause algal blooms. As the algae die, sink to the bottom, bacteria break down this organic matter, potentially using up the DO, creating dead zones. Because nitrite is easily oxidized to nitrate, nitrate is the compound predominantly found in groundwater and surface waters.
   - Ask why levels might change in the fall? Leaf breakdown increases nitrates.

7. Remind students to dispose of the used chemical in the waste bucket.

Turbidity

8. Background Info for Interpreters (share if time permits): Turbidity is the amount of suspended particles in the water that cause the water to appear murky or cloudy. Gills get clogged, light is limited for submerged aquatic vegetation to grow well. Ask: Where do these suspended particles, (other than the algae) come from? *Yards, roads, gardens, farms*.
   - How might this sediment affect fish and macroinvertebrates?

Summation

9. Instruct students to look over the data they have collected at this station.
   - Ask: Using your data and observations, how would you SUM UP the water quality conditions at this site? They should write 1-2 sentences to sum up and be ready to share their answer with the group.
   - Ask them to list three things contribute to stream degradation?
   - What might be some things that you could do at home to help protect the water quality in local streams?

If this is your last station of the day: remind participants to do a tick check in their cozy spots before getting on the bus AND when they shower at home.

AFTER LAST STATION – INTERPRETER CLEAN UP/PACK UP INSTRUCTIONS:

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 storage solution in such a way that the delicate glass bulb is immersed in the liquid.
- Temperature and conductivity probes are clean and dry.

STATION 3: BIODIVERSITY

Station Set Up:
- Place one hoola hoop in an area with relatively high diversity and the other in an area with low diversity and/or lots of invasive species.
- Plan the spots you will have students use to make their observations.
- Consider having students rotate through the locations as they collect data for this station.

Introduction
1. Ask students to think about the word “BIO-DIVERSITY” for a few seconds.
   - Ask: Who can give me an example of biodiversity? *Accept all reasonable answers.*
2. Explain that, at this station, they will collect and analyze data on the biodiversity found in a small area of land adjacent or near the aquatic ecosystem we are studying. Since the land is part of the watershed that drains into the water body, it will impact the aquatic ecosystem health. After identifying signs of ecosystem disturbances, you will count the number of different species of animals, fungi, and plants and categorize the plants as invasive or native. These data will give you an idea of the bio-diversity in the area.
   - Ask: Look around…. How do we know if an ecosystem is disturbed or healthy?
   - Do you think you are standing in an area with high or low diversity?

Field Data Collection Sheet

Station 3: Biodiversity

1. Signs of ecosystem disturbance (check all that apply)

____ mowed areas	____ branches chewed
____ erosion/exposed roots	____ trails
____ scat	____ trees blown over
____ garbage	____ debris from flooding
	____ other
Total Number of Disturbances ________	

2. Carefully survey the area and place a + sign in the chart below to tally the number of organisms you've seen, heard or found evidence of. Additional evidence of organisms include:

bird/Insect calls	bird nest	burrow	tracks
cavity	bones	scat	fur
web	snag	snake skin	animal trails
shell fragments	tree rubbing	egg clusters	bee hive or nest
decomposing			

Type of Organism		ID (common name) (i.e. - *American Beech, Gray Tree frog, etc.*)	Species Tally *1 tally for each **different** species*	Native (+) Invasive (--)
Plants	**Woody Plants** trees, shrubs, vines			
	Non-woody plants broad leaved dicots			
	Grass-like plants monocots			
	Mosses and ferns			

Disturbances

3. Tell students that one way to track the different types of organisms that live in an area is to look for the ways that they have disturbed the environment. Move the leaves, have them look. It's probably very compacted, why? Guide them into finding some of these disturbances within a defined area.

1. Signs of ecosystem disturbance (check all that apply)

____ mowed areas	____ branches chewed
____ erosion/exposed roots	____ trails
____ scat	____ trees blown over
____ garbage	____ debris from flooding
	____ other

Total Number of Disturbances ________

4. Send students to designated spots from which to make observations about different types of organisms in the area. They should look, listen, and move some leaves, etc. to see what's on the ground and high in the trees. Explain that they should also be on the lookout for woodpecker holes, chewed leaves, and other indirect evidence of organisms in the area.

5. Have students record the number of disturbances in the data table in their packet (sample shown below).

Step 1 Identify signs of ecosystem disturbance observed by circling all that apply on your data collection sheet.

Level of Ecosystem Disturbance	
0-1 disturbances	5 points
2-3 disturbances	3 points
3-4 disturbances	2 points
Greater than 4 disturbances	0 points

Step 2 Tally the number of different types of organisms on your data collection sheet for each of the groups indicated.

Species Diversity				
Organism Type	**0-10 Species**	**11-15 Species**	**16-20 Species**	**20 or More Species**
Plants	2 points	4 points	8 points	10 points
Fungi	2 points	4 points	8 points	10 points
Animals	2 points	4 points	8 points	10 points

Step 3 Using the tally of different organisms collected in Step 2, compare the number of invasive species (i.e., non-native) with the number of native species.

Comparison of Invasive versus Native	
More native species than non-native species	5 points
1-2 more invasive species than native species	3 points
2-3 more invasive species than native species	2 points
4 or more invasive species than native species	0 points

6. In addition to providing clues to what critters live in an area, disturbances can also create openings for invasive, non-native species to colonize, grow rapidly and take over a space. Non-native species might not have predators and can outcompete the native species. As students are counting different species, point out any invasives that you are aware of in your area. Share the photos with them. After tallying all organisms, compare the number of invasives (i.e. non-natives) with natives and score.

Carefully survey the area and place a + sign in the chart below to tally the number of organisms you've seen, heard or found evidence of. Additional evidence of organisms include:

bird/Insect calls	bird nest	burrow	tracks
cavity	bones	scat	fur
web	snag	snake skin	animal trails
shell fragments	tree rubbing	egg clusters	bee hive or nest
decomposing			

7. Students likely have little experience with lichens. Explain what a lichen is (they know about symbi

Type of Organism		ID (common name) (i.e. - American Beech, Gray Tree frog, etc.)	Species Tally 1 tally for each different species	Native (+) Invasive (--)	
Plants	***Woody Plants*** *trees, shrubs, vines*				
	Non-woody plants *broad leaved dicots*				
	Grass-like plants *monocots*				
	Mosses and ferns				
	Lichens				
Fungi	***Fungi***				
Animals	***Mollusks*** *clams, snails, slugs*				
	Annelids *earthworms, leeches*				
	Arthropods *insects, spiders, crabs, isopods, etc.*				
	Birds				
	Amphibians				
	Mammals				
	Reptiles				
	Species Total				
	Invasive versus native plants			(-)	(+)

Total number of plant species _______ Total number of animal species _______

Total number of fungi species _______ Number of invasive species _________

Summation

8. Instruct students to look over the data they have collected at this station.
   - Ask: Using your data and observations, how would you SUM UP the biodiversity at this site?

   They should write 1-2 sentences to sum up and be ready to share their answer with the group. Explain that many of the parks in Fairfax County have a great deal of ecosystem disturbance, which helps invasive species to take hold and thrive.

   - Ask: What could you do around your home, school, neighborhood or even this park to help keep this ecosystem healthy?
   - Ask them to list three things would increase biodiversity?

If this is your last station of the day: remind participants to do a tick check in their cozy spots before getting on the bus AND when they shower at home

STATION 4: BIOLOGY (MACROINVERTEBRATES)

Station Set Up:

- Before students arrive, begin collecting macros and place them in ice cube trays out of direct sun.
- Set up two tables far enough apart that students can easily move around
- Lay out the macro sorting posters and identification cards on each table.
- Place magnifiers on the table
- Have nets and strainers handy for students to use when collecting additional macros

Introduction

1. Explain that they will look at some of the organisms that live in the water and use them to determine the health of this stream.

2. Tell them that they will observe and collect something called Benthic Macro Invertebrates. Explain that benthic means “living on or in the bottom of a lake, stream or ocean.”
   - Ask: What does macro mean?
   - What does invertebrate mean?
   - Putting it all together… what might we be looking at today? *Students should understand that we are looking at bottom-dwelling critters without a backbone!*

3. Explain that they have (or will) collect water chemistry data to see how “healthy” the ecosystem is. Another way that we gather information about the health of an ecosystem is by looking at the types of organisms that live there.

4. Each organism has its own niche in the community. Each organism has a range of abiotic factors within which it can survive. Some organisms have a wide tolerance for different factors than others. We say these organisms are “tolerant” of chemical, nutrient, and sediment pollution.

Identifying Pre-Caught Organisms

5. Hand out the macroinvertebrate ID charts. Ask students if they think they can identify any of the organisms in the containers. If they offer an ID, ask them why they think it is that specific one…encourage them to look carefully and the invertebrate, use magnifiers and viewers.
   - Ask: What characteristics are you using to identify the macro?
   - What adaptations do they have to help them live in their environment?

6. Hand out the magna viewers containing invertebrates to students who are tentative about touching. Ask them to find something on the organism, so it’s more about the task than about their fear.

Collecting and Identifying Additional Organisms

7. All students should have opportunity to collect. Help them connect to the "benthic" part of organism's habitat.
   - Ask: Where do might we find invertebrates?
   - Will they be swimming out in the open water?
   - Crawling along the bottom? Hiding in the plants?
   - Crawling around or under rocks? Why?

8. Model how to collect organisms using the best method for your site based on available equipment, stream conditions and stream access. Remind students that macros will initially freeze when caught, you have to wait at least 20 seconds for them to start wriggling.

9. **Rocks:** Model how to gently pick up a rock, flip it over, slowly count to ten waiting until so the organisms that have initially frozen in place will start to wriggle. Then try to find the tiny critters. Rocks should be returned to the exact same place where they were picked up.

10. **Metal colander/strainers**, students can set the strainers on their side, downstream of where they want to collect and gently pick up rocks, one by one and gently rub them and stir up the soil. Check the strainer to see what washed in.

11. **Dip nets or kick seines:** place the net downstream of where students wish to collect. Have a partner stir up rocks above the net dislodging attached invertebrates attached to rocks or in the sediment.

12. Remind all the students to always have wet fingers when handling invertebrates as well as amphibians, to avoid tearing the organism's skin.

Summation

13. Bring group together for last 5 minutes and help students record the data and tally the number of macroinvertebrates that we saw and they collected.

    Note that it is NOT the total number of organisms which is important but the number of different types of organisms, the diversity in each category. For example, 2 mayflies carry the same point value as 50 mayflies.

In the grid below, circle each different type of macroinvertebrate found.

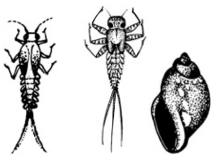
Macroinvertebrate Point Values		
Sensitive to Pollution: 3 points for each type	**Somewhat Sensitive to Pollution: 2 points for each type**	**Tolerant of Pollution 1 point for each type**
mayfly	scuds	leeches
stonefly	clams	midge larvae
riffle beetle	crayfish	blackfly larvae
water penny	damselfly	aquatic 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:	

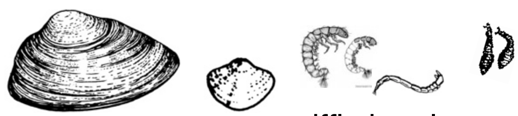
Macroinvertebrate Data	
Excellent; 23 or more macroinvertebrate points	5 points
Good; 17-22 total macroinvertebrate points	3 points
Fair; 11-16 total macroinvertebrate points	2 points
Poor; 10 or less macroinvertebrate points	0 points

14. Instruct students to look over the data they have collected at this station.
    - Ask: Using your data and observations, how would you SUM UP the health of the site based on the types of macros present?
    - What might be some reasons for a lot of tolerant macros? *Little buffer zone with high water temperature and lots of sediments flowing into the water; Water moving too fast scours the habitat and can wash larvae away; not enough food from leaves falling into the stream; accept all reasonable answers (have them connect to what they have learned at other stations!)*

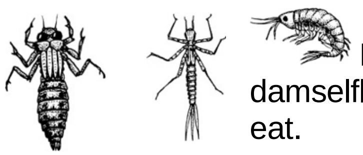


Scrapers, including some mayflies and snailswho graze algae that's attached to surfaces of rocks and leaves. These are most abundant in summer when algae production is highest.

Leaf Shredders, such as stoneflies, scuds and cranefly larvae are found where there are lots of leaves and other organic material in the stream.



Collectors/filter feeders (Mussels, clams, net spinning caddisflies, midge larva Black fly larva, riffle beetles, many mayflies…) are found in areas where there is a lot of fine particles, very finely shredded leaves.



Predators including omnivorous scuds, dragonfly and damselfly nymphs are found where there are other invertebrates to eat.

Images courtesy of: University of Wisconsin-Extension and the Wisconsin Department of Natural Resources

<u>Reflection:</u>

- What are the most important things you have learned from the orientation today?

- What further questions do you have?