Nature's Report Card (MWEE)
Field Investigation

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

Opening Activity:

- Below, jot down some notes about what you already know about the MWEE field investigation?

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

What is a MWEE?
Meaningful Watershed Education Experiences (MWEE) are learner-centered experiences that focus on investigations into local environmental issues that lead to informed action and civic engagement.

View the Nature's Report Card GIS Story Map to learn more about the reasons for this field experience.

Who Coordinates and Implements the MWEE?

- Linda Peterson – develops FCPS Middle School Science curriculum, provides training, engages in communication with teachers/schools, provides overall funding
- Cindy Smith - GMU recruitment and leadership of interpreters (with Matt Helfinstein as site manager in the field)
- Tammy Schwab – In charge of FCPA interpreters (Sarah Oberther is site manager in for Scott's and South Run; Christine Malm for Cub Run)

Who Participates in a MWEE?

- FCPS Life Science students.
  - About 2/3 of the schools use the GMU-FCPA MWEE
  - The rest of the schools (1) conduct MWEE on their school grounds; (2) use one of the nature centers, (3) do nothing

MWEE Stations
Station 1: Land Use and Runoff
Station 2: Water Quality
Station 3: Biodiversity (land)
Station 4: Water Quality (macroinvertebrates)

Chronology of a MWEE

1. Buses arrive around 10:00am
2. Students line up behind the interpreter for their first Station
3. Site manager delivers a brief introduction and releases interpreters to lead their students to the Station. Some key ideas to convey to students include -
    - 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.
    - Point out specific safety hazards (such as tree roots and Canadian geese)
    - 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!
4. Students collect data and observations at their Station for ~20-30 minutes. The site manager blows a whistle when it's time to rotate to the next station. Interpreters point students to their next Station (students don't rotate in numerical order)
5. Stations 5 & 6 are led by the school and combine both the red and blue groups

Role of the MWEE Interpreter

- The interpreter's role is to facilitate student data collection.
- QUESTIONS guide the student discussions. Ask students 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.
- Interpreters are not expected to "deliver" any type of lecture or speech about the Station.
- Set up each Station so that students must actively make observations and collect data. Students should never be sitting or standing passively at any time – even if there is a picnic table nearby!

Station 1: Land Use and Runoff

Station Set-Up:

- Ground Cover – Unroll 10m of the tape measure. Students will estimate the percentage of ground covers in this buffer zone.
- Erosion – select one or two areas for students to observe.
- Development - Have copies of the aerial maps for Shenandoah National Forest and the MWEE site for comparison
- Soil – select students to push the wooden dowel into the soil (medium force) and see how far it penetrates. Do this at 1-meter intervals and take the average (divide by 10).
- Other – tailor this to the specific site. If nothing stands out as a "other" consideration, simply use stream shade cover.
    - *Almost none of the water is shaded – 0*
    - *Between 20-50% of the water is shaded – 2*
    - *Half to most of the water is shaded – 3*
    - *80% or more of the water is very shaded – 5*

Procedure

1. Start by asking students what they already know about the connection between land use and water quality. Accept all reasonable answers.

2. Explain that they will be collecting data determine how the land use affects the runoff into the body of water.

3. Divide the students into 5 groups – one group for each factor at this Station.

4. Briefly explain how they are to collect data at this station. Include any safety considerations relevant to the site.
    - Consider performing the following demonstration: Pour some water on an impervious surface (rock, pavement, etc.) and ask students where the water goes. Next, pour the same amount of water on the grass, or other vegetation. Again, ask where the water goes. The key idea here is that vegetation slowly the flow of water.

Station 1: Land Use & Runoff

Factor	Observations and Data	Points
Ground Cover	Mostly bare earth, rocks, or mud; few plants = 0 pts 50% bare earth and 50% grass or other sparse vegetation = 3pts Mostly trees, shrubs, wetlands, or other vegetation; little or no bare earth = 5 pts	
Erosion	60-100% of the bank is bare or eroded = 0 pts 30-60% of the bank is bare or eroded = 2 pts 10-30% of the bank is bare or eroded = 3 pts Less than 10% of the bank is bare/eroded = 5 pts	
Develop-ment	Compare the development shown on the aerial map of your MWEE location to the aerial map of the Shenandoah National Park. Low or no development - 5 pts	
Soil	Dowel easily goes into soil less than 1 cm = 0 pts Dowel easily goes into soil 1-3 cm = 2 pts Dowel easily goes into soil 3-5 cm = 3 pts Dowel easily goes into soil 5 cm or more = 5 pts	
Other		
Total Points		

5. Set a timing device to 2 minutes and instruct students to rotate through each of the five factors to collect data. Facilitate students coming to consensus on the points for each Factor and total for the Station.

6. Instruct students to jot down some ideas from this Station on pages 6 and 7 of their Data Collection Booklet. Help them identify key ideas, if needed.

STATION 2: WATER QUALITY

Station Set-Up:

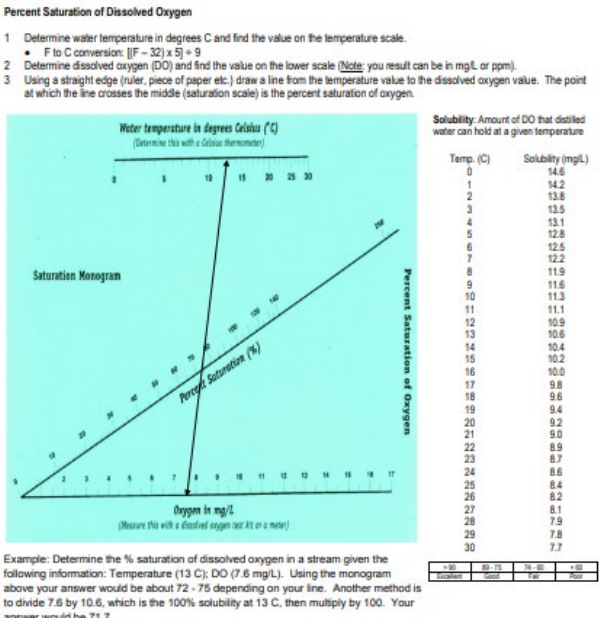
- Set up TWO (or three) tables so that students have ample room to move around each table while collecting data.
- Place one four-square plastic caddy at each of the two tables.
- Fill two disposable cups about 2/3 full of distilled or filtered water.
- Place two empty cups in the other two squares of the caddy.
- Prepare the dissolved oxygen (DO) and pH probes per the set-up directions on page 9 of this packet.
- The temperature probe needs to special set up.
  - Place the DO probe in one of the cups containing distilled water.
  - Place the pH probe in the other cup containing distilled water.
  - Put the temperature probe in the cup with the DO probe.
  - Place three or four of the DO Nomogram sheets on the table.
  - If available, place Expert Cards at this table as well.

- Set up the turbidity and nitrite tests at the other table. Place the waste container on the table as well.
  - If available, place laminated Expert Cards at this table as well.

Procedure

1. As students come to the station, ask for volunteers (or simply deputize) four students to quickly collect water samples and bring them back to you.

2. BRIEFLY review with students <u>how</u> they are to collect data for each of the Factors:
   - Gently swirl the DO, temperature, and pH probes in the sample and replace in distilled water when done.
   - How to read the Nomogram for DO saturation.
   - Read the results of the Nitrite test by comparing with the color chart.
   - Determining which JTU matches the water in the Turbidity column.



Percent Saturation of Dissolved Oxygen

1 Determine water temperature in degrees C and find the value on the temperature scale.
- F to C conversion: [(F – 32) x 5] ÷ 9

2 Determine dissolved oxygen (DO) and find the value on the lower scale (Note: you result can be in mg/L or ppm).

3 Using a straight edge (ruler, piece of paper etc.) draw a line from the temperature value to the dissolved oxygen value. The point at which the line crosses the middle (saturation scale) is the percent saturation of oxygen.

Solubility: Amount of DO that distilled water can hold at a given temperature

Temp. (C)	Solubility (mg/L)
0	14.6
1	14.2
2	13.8
3	13.5
4	13.1
5	12.8
6	12.5
7	12.2
8	11.9
9	11.6
10	11.3
11	11.1
12	10.9
13	10.6
14	10.4
15	10.2
16	10.0
17	9.8
18	9.6
19	9.4
20	9.2
21	9.0
22	8.9
23	8.7
24	8.6
25	8.4
26	8.2
27	8.1
28	7.9
29	7.8
30	7.7

> 90	89 - 75	74 - 60	< 60
Excellent	Good	Fair	Poor

Example: Determine the % saturation of dissolved oxygen in a stream given the following information: Temperature (13 C); DO (7.6 mg/L). Using the monogram above your answer would be about 72 - 75 depending on your line. Another method is to divide 7.6 by 10.6, which is the 100% solubility at 13 C, then multiply by 100. Your

3. BRIEFLY discuss why they are collecting data for each of the Factors:
   - How does oxygen get into the water? … why is it important for living things living in the water to have oxygen available?
   - What is pH (show them the chart below) and explain that the pH scale shows the RATIO of H+ to OH- ions. Provide an example to illustrate the concept of a ratio, if needed. What pH is generally best for living things?

Ratio of Hydrogen to Hydroxide Ions and pH Scale

Ratio of		pH Scale	
H+	OH-		
10,000,000	1	0	
1,000,000	1	1	
100,000	1	2	*lemon juice*
10,000	1	3	*vinegar and soft drink*
1,000	1	4	
100	1	5	
10	1	6	
1	1	7	*water*
1	10	8	*baking soda*
1	100	9	*detergent*
1	1,000	10	*ammonia*
1	10,000	11	
1	100,000	12	
1	1,000,000	13	
1	10,000,000	14	

   - Ask about turbidity and what happens to living things when its high (i.e., gills get clogged, light is limited for submerged aquatic vegetation to grow well. Where do the suspended particles, (other than the algae) come from? *Yards, roads, gardens, farms*. How might this sediment affect fish and macroinvertebrates?
   - Explain that nitrogen is an essential nutrient used by all organisms to build protein. Excess nitrogen, from fertilizer run off, animal water, septic systems, leaves breaking down, can cause DO to decrease. Ask why levels might change in the fall? Leaf breakdown increases nitrates.

3. Have students split up around the tables. Indicate how they are to rotate around each table and what they are to do between tests (i.e., look around them and make note of things that can negatively impact water quality; read the Expert Cards and be ready to answer questions, etc.)

Station 2: Water Quality

Factor	Observations and Data	Points
Dissolved Oxygen	Water temperature: _____ Low DO saturation (less than 60%) – 0 pts Medium DO saturation (74-60%) – 2 pts Medium-high DO saturation (80-75%) – 3 pts High DO saturation (80-90%) – 4 pts Near 100% DO saturation (90-100%) – 5 pts	
pH	pH is below 4.5, or above 10.5 – 0 pts pH is 4.6 - 5.0, or 8.2 - 9.0 – 2 pts pH 5.0 – 6.5, or 8.2 – 9.0 – 3 pts pH 6.5 – 8.2 – 5 pts	
Turbidity	100 JTU = 0 pts 80 JTU = 1 pt 60 JTU = 2 pts 40 JTU = 3 pts 20 JTU = 4 pts 0 JTU = 5 pts	
Nitrite	High nitrite (0.26-0.50 ppm) – 0 pts Medium nitrate (0.11 – 0.25 ppm) – 2 pts Low nitrate (0.06 – 0.10 ppm) – 3 pts Very low nitrite (0.0 – 0.05 ppm) – 5 pts	
Pollution	Visible oil, pollution, and/or trash – 0 pts Plastic bags, rusting metal, oil, batteries – 1 pt Paper, plastic, glass – 3 pts Little trash or other pollution – 5 pts	
Total Points		

4. Have students collect data for about 6 minutes at each table and then rotate to the next table.
   - Rotate between the tables to ensure that students are using proper protocols to collect data.
   - Help students use the Nomogram to determine the percent DO saturation
   - Give the chaperone something to do (such as asking questions from the Expert Cards or helping with the turbidity or nitrite tests).
   - Instruct students to place the DO and pH probes back into the cups with distilled water
   - Pour the water samples into the grass or on a tree.
   - Pour the nitrite waste into the waste container. Rinse the tube with water and place – along with the Nitrite test instructions and color chart - in one of the squares of the plastic caddy

5. Take the group on a short walk near the water quality Station to observe pollution.

6. Once data for all five Factors has been collected, spend a few minutes discussing the Points to be assigned. Have students "vote" (with fingers) to indicate the Points they would assign each Factor.

- Ask outliers to justify their thinking with data and observations.
- Have the group come to consensus, if possible.
- Total the points.

7. Instruct students to jot down some ideas from this Station on pages 6 and 7 of their Data Collection Booklet. Help them identify key ideas, if needed.

8. If it's the last Station of the day, quickly clean up and get the Lab Quests and Probeware ready for transport back to the school.
   - Empty the cap of the DO probe, rinse with water. Air or gently blot dry and replace the end cap. If there is a blue plastic tip, replace that as well.
   - Rinse the pH probe and return it to the screw-top plastic vial containing pH 4 storage solution. If the vial is dirty, or doesn't contain pH 4 storage solution, obtain some from the Site Supervisor.
   - Place any broken probes and/or LabQuests in a large Ziploc bag obtained from your Site Supervisor that has been labeled "BROKEN".
   - Make sure that the equipment going back to the school, and the plastic tub going back to the Site Supervisor is DRY, CLEAN, and ready for the next day.

Dissolved Oxygen and pH Probe Preparation and Storage Procedures

Note: If using the Optical DO Probe, no set up is required.

Dissolved Oxygen (not optical) Probe Set-Up:
Video: http://www.vernier.com/products/sensors/dissolved-oxygen-probes/do-bta/

DO 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.

DO Probe Storage
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.

pH Probe Set-Up:
Video: http://www.vernier.com/products/sensors/ph-sensors/ph-bta/

pH Probe Preparation
1. Remove the storage bottle from the electrode by first unscrewing the lid, then removing the bottle and lid. Place the storage vial in a safe place so that it won't get spilled.
2. Thoroughly rinse the lower section of the probe, especially the region of the bulb, using distilled 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 the LabQuest.
   Note: Do not completely submerge the sensor. The handle is not waterproof.

pH Probe Storage
1. When done taking measurements, rinse the tip of the electrode with distilled water.
2. Place the electrode back into the plastic vial filled with pH 4 Storage Solution; screw in place. NEVER store the pH probe in distilled water!

STATION 3: BIODIVERSITY

Station Set-Up:

- Mark off the areas in which students are to conduct their observations.
- Depending on the site, you may want to identify one area each for plants, animals, and fungi.
- Consider having students rotate, at 2-minute intervals, through the locations as they collect data for this station.
- Provide some identification keys but don't stress this. Its enough that students recognize different species without knowing exactly what they are. If too much emphasis is placed on identification, the students' data collection will slow down dramatically.
- Locate invasive species and be ready to tell students where to look. The number of invasives AND the amount of land them cover, are both important Factors.

Procedure

1. Ask students to think about the meaning of the words BIO and DIVERSITY for a few seconds. Elicit responses. Next, ask what biodiversity might refer to? Elicit responses.

2. Explain that they will collect and analyze data that will help them infer the biodiversity found in a small area of land adjacent or near the aquatic ecosystem they are studying.
   - Since the land is part of the watershed that drains into the water body, it will impact the aquatic ecosystem health.

4. Send students to designated spots from which to make observations about different types of organisms in the area.
   - Model how they are to 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, skeletons, shed skins, shells, and other indirect evidence of organisms in the area.

5. Students likely have little experience with lichens. Explain what a lichen is (they know about symbiosis) and have them decide where it should go on their chart. *Let the students decide as long as they can justify their ideas.*

6. Gather the students into a group and discuss which animals likely eat the plants and fungi. From this determine the Points for food web interactions.

7. Point out the invasive species at the site. Instruct students to use your information to determine the points for Native versus Invasive for this Station.

8. Instruct students to jot down some ideas from this Station on pages 6 and 7 of their Data Collection Booklet. Help them identify key ideas, if needed.

Station 3: Biodiversity

Factor	Observations and Data	Points
Plant Diversity	0-10 species – 1 pts 11-15 species – 2 pts 16-20 species – 3 pts 21-25 species – 4 pts 26 or more species – 5 pts	
Animal Diversity	0-10 species – 1 pts 11-15 species – 2 pts 16-20 species – 3 pts 21-25 species – 4 pts 26 or more species – 5 pts	
Fungi Diversity	0-3 species – 0 pts 4-8 species – 2 pts 9-12 species – 3 pts 12 or more species – 5 pts	
Food Web Interactions	0-5 interactions – 0 pts 6-10 interactions – 1 pt 11-15 interactions – 2 pts 16-20 interactions – 3 pts 21 25 interactions – 4 pts 26 or more interactions – 5 pts	
Native versus Invasive	4 or more invasive species – 0 pts 2-3 invasive species – 2 pts 1-2 invasive species – 3 pts 0 invasive species – 5 pts Also consider the amount of invasive vs native plants in the area being observed	
Total Points		

STATION 4: BIOLOGY (MACROINVERTEBRATES)

Station Set Up:

- Set up two tables
- 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 identification cards on each table
- Place magnifiers on the tables
- Have nets handy for students to use when collecting additional macros

Procedure

1. 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!*

Station 4: Macroinvertebrates

Macroinvertebrate Point Values		
Sensitive to Pollution	**Somewhat Sensitive to Pollution**	**Tolerant of Pollution**
may fly stone fly riffle beetle water penny hellgrammite caddisfly larvae right-opening snail	scuds c[illegible]s crayfish damselfly dragonfly beetle larvae fishfly larvae alderfly larvae cranefly larvae water snipe larvae sowbug	leeches midge larvae blackfly larvae aquatic worms flat-coiled snail left-opening snail
Assign 3 points for each species	Assign 2 points for each species	Assign 1 point for each species
Points	Points	Points

Factor	Observations and Data	Points
Macro-Invertebrate Organisms	10 or less macroinvertebrate points – 0 pts 11-16 macroinvertebrate points – 2 pts 17-22 macroinvertebrate points – 3 pts 23-26 macroinvertebrate points – 4 pts 27 or more macroinvertebrate points – 5 pts	
Total Points		

2. 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.

3. 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.

4. 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?

5. 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.

6. 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?

7. 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.

8. **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.

9. **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.

10. **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.

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

12. Bring group together for last 5 minutes and help students record the data and determine points for each group. Use the grand total to determine the points for this Station.

13. Instruct students to jot down some ideas from this Station on pages 6 and 7 of their Data Collection Booklet. Help them identify key ideas, if needed.