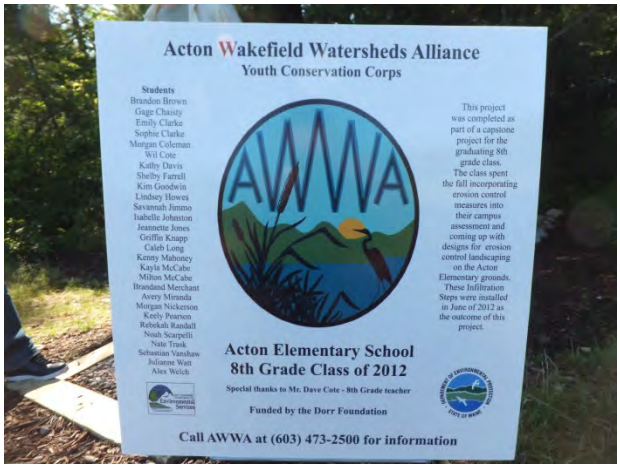
AWWA in the Schools:
Watershed Education for Future Community Leaders



A report to the Dorr Foundation:

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Watershed Education for Future Community Leaders project

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AWWA in the Schools:

Watershed Education for Future Community Leaders

Background

The Acton Wakefield Watersheds Alliance (AWWA) has been educating local youths since 2006 through its Youth Conservation Corps (YCC) program. AWWA has also been in and out of the local classrooms during that period. Through the development and publication of its Watershed-Based Management Plan in 2010, five "key action categories" were identified in order to continue the protection of the local lakes and economy. One of these "key action categories" was education.

In the spring of 2011 AWWA went into the schools with a renewed vigor. The lessons being taught were similar to what AWWA had been teaching for the previous five years, but more attention was paid to how it fit with what the teachers were teaching and how it fit into the school's curriculum. After the spring lessons, AWWA went to the drawing board with the information they gathered in the spring and began working out how they could develop a more broad-based, fully encompassing education program.

AWWA applied for a grant from the Dorr Foundation in the fall of 2011 and was awarded $14,948 to develop the curriculum that could be instituted in the local schools as well as be used anywhere that watershed education was desired. AWWA is very grateful for the support of the Dorr Foundation.

Development

Over the course of the summer and early fall, the AWWA Program Manager developed a series of four modules that address key areas of watershed education. AWWA's Executive Director and Program Manager met with the Wakefield Paul School and Acton Elementary School science teachers in the fall to discuss the implementation of the modules. The modules were well received and timing was worked out so that the various modules could be executed during periods of similar lessons in the classrooms.

The curriculum is titled "*AWWA in the Classroom: Watershed Education for Future Community Leaders*" and is made up of a series of four modules. Modules one and two are designed for 6th grade classes, module three for 7th grade classes, and module four for 8th grade classes. The ultimate goal of these modules is to see how students approach water quality after undergoing three consecutive years of watershed-based education.

The first year had its ups and downs when trying to educate 7th and 8th graders who had not had the introductory modules and also implementing new activities to AWWA repertoire. The first class that was taught under the new curriculum was the Acton Elementary 8th graders. In the fall of 2011, the AWWA Program Manager gave a lecture to students on erosion control and stormwater management. The following day, students were taken on a field trip around their campus (which has a stream running through it) to identify areas of erosion and impacts to water quality. Students then took this information and combined it with the previous two months of mapping, soil analysis, and water sampling to create a design proposal. The best designed project was chosen for a demonstration site in the spring.

The next series of classes was performed during the winter in the Wakefield Paul School 7th grade. Module three is designed to be a winter activity as it involves students bringing in their own well water samples and running them through a series of tests. The original module was designed for a series of lessons including groundwater exploration and well water testing. The teachers for both 7th grades have only been able to find time for the well-water testing portion but the module does include the lesson plans for the groundwater exploration pieces, yet to be delivered. This module requires several classes complete and will be discussed in the "pro/cons" section.

In the spring of 2012, AWWA was able to reach the 6th graders at the Wakefield Paul School to implement modules one and two. These two modules are the base of our watershed education program. Students learn about watersheds, water quality, invasive species, and the importance of macroinvertebrates. AWWA was also able to get into the Acton Elementary 5th and 6th grades to do the "Biomonitoring" section of Module Three. At the end of the modules, AWWA brought the students from both schools (different days) down to Portsmouth for a trip on the newly restored Gundalow. This program could not have been a better fit to drive home the concept of watersheds as the majority of lakes in Wakefield are the headwaters to the Salmon Falls River and Piscataqua River. Students were able to see where the water that leaves Wakefield inevitably ends up.

After completing the first full year of AWWA in the Classroom, the AWWA Executive Director and Program Manager sat down and evaluated the pro and cons of the modules and instituted some edits and changes to streamline the results.

Year Two

After a year of experience with the new curriculum, AWWA started the second year in the fall of 2012 in the Acton Elementary 8th grade to prep for another erosion control demonstration project. Despite still not having any background, the 8th graders did a great job and enjoyed the classes tremendously.

In year two AWWA was able to do its Well Water Testing Module with both the Acton Elementary and Wakefield Paul School. The series of classes was conducted in February and students had a great time learning about their well water and performing scientific tests during class. After the second year, some of the same problems hold evident, this will be discussed in the "pros/cons" section.

In the spring AWWA took module one and two to the Wakefield Paul School with great success. Student engagement was at an all-time high. Since Acton Elementary had done the "Biomonitoring" class for both their 5th and 6th graders, AWWA lined up this year's schedule to address Module One and the Invasive Species section of Module Two with just the 6th graders at Acton. At this point everything is back on track in Acton. Due to funding restrictions and that Acton brought their 5th and 6th graders to the Gundalow last year; they will not be attending the field trip this year. The Wakefield Paul School will be returning with their 6th graders to the Gundalow on June 14th.

Program Results and Pros/Cons

After two full years of implementing AWWA in the Classroom, we find the program to be a great success. However, some modules are still in need of some minor tweaking that is being addressed this summer and fall. In order to assess the success of each module, before and after quizzes were given to students to see what they learned from their experiences. The following section will address each module, the pros and cons, and the results from the quizzes.

Module One - Introduction

Module One is our introduction to watersheds and water quality module. This module is designed for 6th graders and takes place over one 45-60 minute class period. This module is a great beginner's tool to get gets thinking about where water comes from and where it goes. The module consists of one 15 minute presentation and two, 15 minute, hands-on activities. Student's average scores for the pre-test were 45%. After the lesson, student's scores showed an improvement of 31.5% with no students showing a decrease in their score.

Module Two - Biodiversity

Module Two follows up the introduction in Module One with two lessons over two classes. These lessons are still designed for 6th graders. The first lesson involves discussion and hands-on identification of invasive species. The second lesson involves a discussion and hands-on identification of macroinvertebrates and biomonitoring. These classes are also well structured and the kids really enjoy the hands-on work they do with plants, crabs, and bugs.

The invasive species lesson includes a 15 minute presentation followed by two 15-20 minute hands-on identification groups. One group looks at aquatic plants while the other looks at aquatic animals. Student's scored an average of 63.5% on the pretest and showed an average improvement 21.3%. Student's scores improved across the board.

The biomonitoring/macroinvertebrate lesson includes a 15 minute presentation followed by about 45 minutes of macroinvertebrate sampling, identification, and stream health analysis. This lesson breaks the class into three groups to observe and work with their own "ponds" with the goal of categorizing the water quality. Student's pretest scores averaged 48.7% but showed an average improvement of 33.9% and again, all students bettered their scores.

Field Trip to the Gundalow

Connecting the headwaters to the sea is a terrific way to cap off the 6th grade programming and we have been fortunate to partner with the Gundalow Company to bring the Wakefield and Acton students to Portsmouth for a day on the Piscataqua learning about saltwater habitats,

human impact and maritime history. The Wakefield and Acton students demonstrated their increased knowledge from the AWWA programs and were highly engaged with the discussions about invasive species, diversity and human impacts to the water quality.

Module Three - Groundwater

Module Three starts our work with the 7th grade. Students build on their knowledge of watersheds and water quality to incorporate the importance of ground water and clean drinking water. AWWA has only focused on the "Well Water Testing with AWWA" lesson as it is difficult to take any more of the teacher's time for this module. This is one of the largest hurdles we have been working on with this module. The water testing lesson takes at least three classes to complete. It starts with a presentation class that includes the distributing of sample bottles and paperwork.

The second class is where the students have the most fun! Students bring in their sample bottles full of their well water or family members water. They then proceed to run their samples through a series of six basic tests; pH, conductivity, hardness, chloride, iron, and nitrates. They record their data and fill in a data spreadsheet that includes the address from where they sampled their water.

During the third class, students are given maps of the data and broken into groups to begin developing a presentation. Students research their topic and begin working on a way to present their information. While this class tends to go well, the final product remains difficult to extract. Teachers have had to move away from this topic in order to get back to their curriculum. We have been able to get a few brochures about clean water from one class this year, but failed to get final projects or presentations from the other. Work is being done to assess how we can pull the

final product together. While the most important classes workout quite well, the lack of a final product is a definite gap in the curriculum. No pre or posttest is currently issued for this module.

Module Four - Capstone

The fourth module in the series is designed to pull everything together. AWWA has only been able to perform this at Acton Elementary School due to their more flexible schedule and curriculum as well as access to a wonderful campus with a stream running through the center. Work is being done to find a way to incorporate the Wakefield Paul School into a capstone project, but their class schedules and rigid curriculum make this difficult task. Wakefield also has limited access to areas where demonstration projects would work.

In Acton, students go through a presentation class and a campus walk the following day. They then take this information and combine it with other information gathered in the previous few months of school. The resulting project identifies sites on campus where erosion control is needed and they also recommend potential fixes.

In the spring, the AWWA Program Manager and Crew Leaders install the chosen feature. Students do not participate in the construction of the feature due to the danger in a construction site and having too many students for it to be helpful. They do revisit water quality, erosion, and get to see how a certain feature is installed. In 2012 AWWA installed 17 infiltration steps and in 2013 they completed a series of waterbars and erosion control mulch along the access path.

How Do We Proceed

The past two years have been both successful and educational. AWWA has learned a great deal about what works and what needs some attention. Overall, the modules are a huge success with the students. They love to see AWWA coming in to their classroom and show a great deal of learning during that period. We aim to continue these modules while building on them and developing new more programs for other grade levels.

Project Budget

	Grant	Match	Total Project Cost
ED (137 hrs@$40/hr)	5,480	0	5,480
PM (324 hrs@$25/hr)	7,671	429	8,100
Partners *	0	5,200	5,200
Supplies (lesson supplies & erosion project materials)	1,797	350	2,147
Travel (1500 mi@$0.55/mi)	0	825	825
Totals	$14,948	$6,804	$21,752

*Met with principals and teachers for planning, 78 hours of classroom time with teacher assistance. We did not track the time for the classroom aides.

AWWA In the Schools Modules Detail

MODULE 1 - INTRODUCTION

Hydrologic Cycle

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- *Weather and Water* - Inquiry: Communicate scientific procedures and explanations.
- *Weather and Water* - Physical Science: Explain the processes that drive the hydrologic cycle i.e. heat energy.
- *Weather and Water* - Earth Science: Develop student's understanding that water circulates through Earth's crust, oceans, and atmosphere in the water cycle.
- Identify and define a watershed.

Summary: As part of the introductory presentation to the *"Watersheds"* and *"Sum of the Parts"* activities, the hydrologic cycle is covered. This presentation touches on the primary components of the water cycle (e.g. evaporation, precipitation, etc.), the differences between phases (i.e. solids, liquids, and gases), how much fresh water is on earth, and how that water is recycled.

Estimated Time: 10-15 minutes

Materials:

- Projector with connection cables

Create Your Own Watershed

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- *Weather and Water* - Inquiry: Communicate scientific procedures and explanations.
- *Weather and Water* - Inquiry: Develop descriptions, explanations, predictions, and models using evidence.
- Identify and define a watershed.
- Explain the difference between "pristine" and "polluted" watersheds and waterways.

Summary: Students will create their own "miniature" watersheds and make it rain on them. Students will be able to observe flow paths, open watershed systems, and closed watershed systems. After raining on a "pristine" watershed, students will observe what happens when a watershed becomes polluted.

Estimated Time: 15-20 mins

Materials:

- Aluminum pie plates
- Scrap paper
- Permanent markers
- Water soluble markers
- Spray bottles
- Salt shakers filled with different colored sprinkles or iced-tea mix

NOTE: The teacher or facilitator is encouraged to make a "permanent" model watershed before the activity starts. This allows for a wrap up of information on a "watershed" specifically designed to cover all the areas in the activity. To do so place several medium sized rocks in an aluminum pie plate. Cover the rocks and bottom of the plate with plastic wrap. Apply strips of papier-mâché to the rocks (the more, the sturdier the model). Make sure to form peaks, valleys, and basins. Allow the model to dry and coat with a water proof sealant and water proof white paint. This model can be used with the students at the end to reiterate aspects of a watershed.

Procedure:

1. Form groups of two (three if necessary) and pass out a pie plate and a piece of scrap paper to each student.
2. Crumple the paper into a ball and then carefully unwrap the wrinkled ball.
3. Place the paper in the pie plate and gently form a "mountainous" landscape with the paper.

4. Take the permanent marker and mark all of the watershed boundaries (drainage divides) or high areas where water will flow one way or another.
5. Take the water soluble markers and have students draw in where they think rivers will form and color in areas where they think lakes/ponds will form.
    a. Have one person from each group take the shakers with "pollution" inside and shake it on their model.
6. First the students without "pollution" or the "pristine" watersheds will spray their watersheds with "rain". Have them observe where the water flows. Was it close to where they thought it would flow? Does it pool in areas they drew lakes/ponds?
7. Next, have the students with the "polluted" watersheds spray their watershed with "rain". What do they see that is different about their watershed compared to their partners?
8. Dispose of all wet materials appropriately.

Wrap-Up:
Once the materials are cleaned up and spray bottles are put away, ask the students to explain the differences they saw between their watersheds. Was the water clean or dirty? What sort of landscapes contribute polluted water to waterbodies? What can they do to keep their watersheds clean?

Sum of the Parts

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- *Weather and Water* - Inquiry: Communicate scientific procedures and explanations.
- *Weather and Water* - Inquiry: Develop descriptions, explanations, predictions, and models using evidence.
- Identify and define a watershed.
- Explain the difference between "pristine" and "polluted" watersheds and waterways.

Summary: Students will create slopes and their own "miniature" watersheds to observe how water runs off steep and shallow surfaces, how water drains in different directions based on contours, and how water flows into wetlands and lakes.

Estimated Time: 15-20 mins [15 minutes is tight]

Materials:

- Aluminum pie plates
- 5 gallon bucket with dry sand
- 5 gallon empty bucket for waste sand
- Spray bottles
- Waterproof tarp or tile floor
- Hand towels for wiping sandy hands

Procedure:

1. Pass out a pie plate and a spray bottle to each student [or pairs if more than 6]. Make sure the spray bottles are set to mist.
2. Explain that when you say "let it rain" they can spray and when you say "Sun's out!" they stop spraying. Also mention that the rain needs to land on their landscapes, not their neighbors.
3. Tell the students to spray some water into the pie plate for about 15 seconds.
    a. Does it runoff anywhere? [note that it flows to the lowest spot. Does water flow uphill?]
    b. Does it drain into the surface? [pie plate is not porous, what does that mean?]
    c. Why isn't it eroding? [talk about slopes and why steeper slopes are less stable]

    *If water falls on a flat surface it may not runoff and it may take a while to drain into the ground depending on the material.
4. Give each student a few handfuls of sand and have them flatten it out into a "beach".
    a. Ask them to predict what will happen when it rains on the beach. Do they think it will cause erosion? Do they think it will pool on top of the sand?

    b. Have them rain on the beach and make verbal observations about what is happening.
    c. Why is it soaking in? [get them to porous v. non porous surfaces]. If this were paved would it soak in?
5. Mold the sand into a slope on one side of the pan and drip or spray water onto the slope.
    a. Does the water runoff?
    b. What does the water look like? [notice the small particles turning the water brown. Why would the small particles erode first?]
    c. What would be different if this slope were covered with trees or plants? [Discuss how plants take up water and nutrients and the roots create a web that holds the soils together and slows down erosion]
    d. What might some of the things that we humans do to our landscapes affect the runoff? [discuss pollution in the form of trash, fertilizer, pet waste, oil and gas…..]
6. Now create a ridge down the middle of the pan with steep slopes or one steep slope and one gradual slope and drip/spray water onto the mound. This is a good time to let them set the spayers to stream so they can cause havoc with their landscapes.
    a. Which side of the slope does the water flow? [where the water lands defines which way it flows]
    b. The top of the slope represents a boundary between watersheds.
    c. Note that the steeper slopes collapse sooner and discuss what you would want to put on those slopes. [not a good place for building unless you take precautions to manage the stormwater. Really good place for vegetation to hold it all together.]

    *Watersheds are divided at their highest points.
7. Put your hand down on the mound of sand with your fingers spread wide (don't completely flatten the mound).
8. Drip/spray water over the new landscape.
    a. Does the water flow into pools?
    b. What watershed feature could these pools represent?

    *Large watersheds may contain many smaller watersheds, each with several lakes and streams.

Wrap-Up:

Once the materials are cleaned up, go back over the concepts you touched on during the activity.

- Is erosion more likely to happen on gradual or steep slopes?
- What are the things we do on land that can affect water quality?
- What kinds of landscapes are less likely to cause water quality problems? [forests v. developed landscapes]
- Can we develop watersheds and still protect water quality? [yes, as long as we manage the stormwater runoff]
- How are watersheds divided? Can small watersheds be part of larger watersheds? Are any two watersheds alike? [not sure this belongs here….]

Name: _____ Score:

Water and Watersheds Quiz

1. Which choice best defines a *watershed*? _____
   a. A tool shed where people can store water
   b. An area of land that drains to a body of water
   c. The area of a person's home where the pipes go

2. What watershed do you live in?

3. Which of the following best describes: "pristine/high quality waters" and "polluted waters". (circle your answer)
   a. Lakes that are clear with no algae… -Pristine/High Quality Polluted
   b. Lakes that have a layer of green algae and receive a lot of runoff…
   -Pristine/High Quality Polluted

4. What nutrient is of the greatest concern for fresh waters?

   Nitrogen Phosphorus Potassium

5. What can you do to protect water bodies from polluted runoff? _____
   a. Infiltrate runoff on site
   b. Vegetate the shoreline
   c. Build a rain garden
   d. All of the above

6. Name at least three parts of the water cycle. Draw a picture if necessary.

7. Give an example of water as a:
   Solid: _____
   Liquid: _____
   Gas: _____

8. True or False: All the water on the planet is all the water that has ever existed on the planet?

9. List three ways humans affect water quality.

MODULE 2 - BIODIVERSITY

Invasive Species

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- *Populations and Ecosystems/Diversity of Life* - Inquiry: Design and conduct scientific investigations.
- *Populations and Ecosystems/Diversity of Life* - Inquiry: Use appropriate tools and techniques to gather, analyze, and interpret data.
- *Populations and Ecosystems* - Inquiry: Think critically and logically to make the connections between evidence and explanation.
- *Populations and Ecosystems* - Inquiry: Understand that scientific explanations emphasize evidence.
- *Diversity of Life* - Inquiry: Develop descriptions, explanations, predictions, and models using evidence.
- *Populations and Ecosystems* - Life Science: Populations of organisms can be categorized by the function they serve in an ecosystem.
- *Populations and Ecosystems* - Life Science: For ecosystems, the major source of energy is sunlight.
- *Populations and Ecosystems* - Life Science: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition.
- *Populations and Ecosystems* - Life Science: Reproduction is a characteristic of all systems.
- *Diversity of Life* - Life Science: All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.
- Define “invasive” as pertaining to a plant or animal.
- Use a key to identify invasive and native aquatic plants.

Summary: Students will work between two stations. One station will require students to identify and tell the difference between native and invasive aquatic plants from local waterbodies using a dichotomous key. The other station will engage students with an invasive aquatic animal, allowing students to handle and describe the various aspects of the animal that make it invasive.

Estimated Time: 20 mins for each activity

Materials:

Invasive Aquatic Plants:

- Several plastic wash tubs (about 5 gallons)
- Aluminum pie plates
- Samples of native aquatic plants
- Samples of invasive aquatic plants
- Magnifying glasses
- Paper and Pencils
- Plant dichotomous key

Invasive Aquatic Animals:

- Several plastic wash tubs (about 5 gallons)
- Samples of invasive aquatic animals (e.g. Green crabs)
- Salt water
- Aerator
- Crab study worksheet
- Magnifying glasses
- Aluminum pie plates

Procedure (Aquatic Plants):

1. Divide students into groups of two or three. Explain the project and tasks, including how to use the dichotomous key to determine the names of the aquatic plant samples and whether they are invasive or native.
2. Pass out a pie plate to each student in the group.
3. Distribute one native plant and one invasive plant to each group.
4. Discuss with the groups what they observe (before touching).
    a. What is the leaf structure like?
    b. What is the root structure like?
    c. Can they make a prediction as to which is native and which is invasive? Why?
5. Let the students begin handling their samples while making more observations.
6. Pass out the dichotomous keys and give a quick tutorial on how the keys work. Using various features of the plant, students should be able to follow the steps to correctly identify their samples.
7. Have each group identify the samples to you.
    a. If correct, ask them to continue thinking of ways these plants are able to survive in their environment.
    b. If incorrect, ask students to take you step wise through the key to correctly identify their samples.
8. Discuss why monocultures are bad for the aquatic environments.
9. Clean up.

Procedure (Invasive Aquatic Animals):

1. Explain that the students will be caring for a live creature and must be careful and concerned for its survival.
2. Give each pair of students a pan with some saltwater and a crab.

3. Ask them to quietly observe the activity of the crab and its body characteristics.
4. Discuss ways that the crab satisfies all its living requirements.
5. Ask students to brainstorm ways in which the crab may be more successful than its competitors.
6. Have students draw a picture of their crab and answer the three questions.
7. If time, have students draw an imaginary invasive species.

Wrap-Up:
When all groups have correctly identified their samples, go around and have each group name one thing that makes invasive plants invasive, why they are able to dominate an environment, give specific examples from their samples, etc.

CRAB STUDY

NAME_____ PERIOD_____

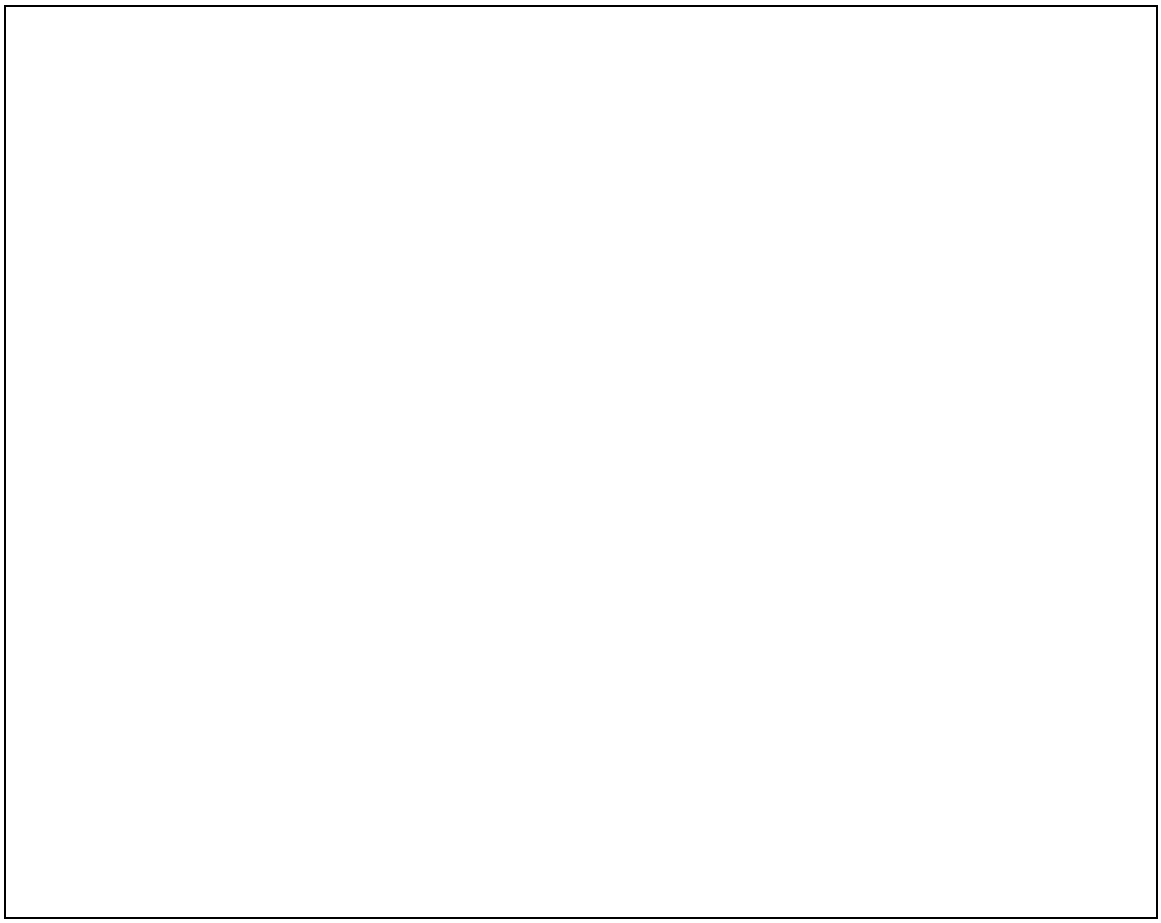
Draw a picture of your crab

1. Describe how it gets its food?

2. Describe how it protects itself?

3. What makes it an invasive species?

Invent your own non-native invasive organism and draw a picture of it below:



Biomonitoring - Aquatic Macroinvertebrates

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- Define "invasive" as it pertains to a plant or animal.
- Define "macroinvertebrate".
- Use a key to identify species of macroinvertebrate.

Summary: After a short presentation, students will be able to observe and handle macroinvertebrates from a local stream to identify and characterize them. Students will use the data they gather from the species to determine the water quality of the stream in which they come from.

Estimated Time: 75-90 mins

Materials:

- Plastic wash tubs (about 5 gallons)
- Ice cube trays
- Pipettes
- Magnifying glasses
- Macroinvertebrate key
- Small bowls

Procedure:

1. Divide the samples evenly among groups of five students.
2. Have the students OBSERVE only to start.
    a. How many critters do they see?
    b. How many different critters are there?
    c. Can anyone identify a critter?
3. After careful observation. One student at a time can reach into the "pool" and pull out a specimen and place it an ice cube tray slot with water.
    a. Have the students discuss that critter.
    b. Have students use the key to identify that critter.
4. Continue this process until all the critters are out of the "pool".
    a. If larger crayfish are present, they can be left in the "pool".
5. Once all the critters are accounted for, have the students fill out their sheet. This requires a count of all the individual critters and how many of each species.
6. Help the students determine the biotic index of the "pool".

7. Quickly prepare the students to present their findings to the class, including how many critters they had, how many varieties of species, and what their “pool” biotic index was.
8. Clean up.

Wrap-Up:
The wrap up here is basically going on during the observations and interactions with the macroinvertebrates. Engaging the students to answer various questions about the critters and ask their own questions. Making sure everyone is clear on the information before presentation will be the primary wrap up.

Name: _____ Score:

Biomonitoring Quiz

1. A "*macroinvertebrate*" is:
    a. an animal with a backbone
    b. an animal that can only be seen with a microscope
    c. an animal without a backbone
    d. an animal that can be seen with the naked eye or without a microscope
    e. both a and b
    f. both c and d

2. Name two places a macroinvertebrate can live.

3. Why are macroinvertebrates so important to ecosystems?
    a. They provide habitat for other animals
    b. They are a major food source and the base of a food chain
    c. They eat invasive species

4. What can macroinvertebrates show us?
    a. the water quality of a river or stream
    b. the biodiversity of an ecosystem
    c. both a & b

5. Name two macroinvertebrates.

6. True or False: macroinvertebrates undergo metamorphosis?

MODULE 3 - GROUNDWATER

A Drop in the Bucket

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- *Weather and Water* - Inquiry: Design and conduct scientific investigations.
- *Weather and Water* - Inquiry: Use appropriate tools and techniques to gather, analyze, and interpret data.
- *Weather and Water* - Inquiry: Use mathematics in scientific inquiry.
- *Weather and Water* - Earth Science: Water circulates through the earth's crust, oceans, and atmosphere in the water cycle.

Summary: Students will be able to calculate the percent of fresh water available for human use and explain why water is limited resource.

Estimated Time: 20-30 mins

Materials:

- Beaker - 1000 mL
- Graduated cylinders - 100 mL
- Small dish or cylinder
- Bucket
- Pipette
- Salt
- Ice
- Water
- World map or globe

Procedure:

1. Have each student write down what they think the proportion of potable water is on earth.
2. Have the students fill a beaker to the 1000 mL mark. Tell them this represents all the water on earth.
    a. Where is most of this water located? Refer to map/globe.
3. Have the students pour 30 mL of the water into a 100 mL graduated cylinder.
    a. What does this represent? Earth's fresh water, about 3%.

    b. Add salt into the remaining 970 mL of water to simulate oceans and how unsuitable the water is for human consumption.
4. Ask students what is at the Earth's poles? Almost 80% of the Earth's fresh water is frozen in ice caps and glaciers.
5. Have students pour 6 mL of the fresh water into a small dish or cylinder.
    a. Place the remaining 24 mL into an ice bucket to represent ice caps and glaciers, and how difficult it is for humans to obtain this resource.
6. Ask students what this 6 mL represents?
    a. The water in the dish is about 0.6% of the total and represents non-frozen fresh water.
    b. Explain that about 1.5 mL of this is surface water while the rest is groundwater.
7. Have students use a pipette or glass stirring rod to pull out a single drop of water from the dish. Have the students release this drop into a bucket. Make sure everyone can see.
    a. This drop represents about the 0.003% of clean, fresh water that is not polluted or otherwise unavailable for human use.
    b. This drop must be managed properly!
8. Clean Up

Wrap-Up:
Discuss the results of this experiment with the students. How much water is available for human use? Refer to students estimates on the proportion of potable water and ask them to reveal their hypotheses and why they thought that. Ask students what they think the biggest consumers of water are (agriculture and industry). Discuss what human beings can do to conserve water e.g. eating less meat, planting native species in gardens, using low-flow shower heads, cutting down on shower times, etc.

Groundwater

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- *Weather and Water* - Inquiry: Design and conduct scientific investigations.
- *Weather and Water* - Inquiry: Use appropriate tools and techniques to gather, analyze, and interpret data.
- *Weather and Water* - Inquiry: Develop descriptions, explanations, predictions, and models using evidence.
- *Weather and Water* - Earth Science: Water circulates through the earth's crust, oceans, and atmosphere in the water cycle.

Summary: Students will have an opportunity to observe and interact with a groundwater system and see what happens when pollution enters a groundwater system.

Estimated Time: 20 mins

Materials:

- Large plastic pan
- Naturally colored aquarium rocks (fill pan 2/3rd full)
- Hamster tube to represent well
- Bulb baster
- Spray bottles
- Pipettes
- Salt shakers filled with sprinkles or iced tea mix
- Bowls for expelling the water from the baster
- Sieve for washing rocks
- Access to water
- Gallon jugs for filling model

Procedure:

1. Ask students to mold rocks into uneven terrain to simulate hills and lakes, etc.
2. Ask them what they think will happen to rain water that falls on the high spots.
3. Insert well tube and explain that's where we'll imagine the drinking water comes from.
4. Ask students to describe where their drinking water comes from (well? Town? Many won't know…)
5. Pour water from the gallon jug into the model about half way. While doing so, have the student spray water onto the "landscape" to simulate rain.
6. Have students observe how clean the water in the "pond" looks.

7. Ask one student to draw some water out of the well with the baster and empty it into the bowl. Ask students to observe the quality of the water.
8. Have students take turns sprinkling the pollution (tea mix) on the landscape and describe what they think that will do to the water quality.
9. Have students take turns making it rain with the spray bottles. Ask them to theorize what they think will happen to the pollution when it rains.
10. Have students observe what happens to the color of the pond.
11. Draw water from the well and ask students to explain why the water quality may be different from the pond.
12. Continue to have it rain and draw water from the well. Does the well show an impact from the pollution? Why might it be slower to show the results? What might make it even slower to respond?
13. Talk about what activities on land may result in water quality changes.
14. Ask students to think of ways they might make a difference to water quality.

Wrap-Up:
Discuss the model with the students as it pertains to a real life system. How important is clean drinking water? What happens if our drinking water supplies become polluted? What can you do to prevent pollution from entering groundwater?

Well Water Testing With AWWA

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- *Weather and Water* - Inquiry: Design and conduct scientific investigations.
- *Weather and Water* - Inquiry: Use appropriate tools and techniques to gather, analyze, and interpret data.
- *Weather and Water* - Inquiry: Think critically and logically to make the connections between evidence and explanations.
- *Weather and Water* - Inquiry: Use mathematics in scientific inquiry.
- *Weather and Water* - Earth Science: Water circulates through the earth's crust, oceans, and atmosphere in the water cycle.
- *Weather and Water* - Science and Technology: Scientists work in many different settings.

Summary: Students will participate as real scientists to perform groundwater testing and data interpretation. Students will move between various testing stations to test their personal well water for pH, hardness, chloride, iron, conductivity, and nitrates.

Estimated Time: 45-75 mins

Materials (AWWA will provide the majority of these materials):

- For all stations:
  - Gloves
  - Goggles
  - paper Towels
- **Conductivity Station**
  - Conductivity Probe
  - Small beaker
  - 1 Gallon jug of rinse water
  - Waste bucket
  - Direction sheets
  - Cafeteria or other contained, plastic tray
- **pH Station**
  - pH Probe
  - Sample beaker
  - 1 Gallon jug of rinse water
  - Waste bucket
  - Direction sheets
  - Cafeteria or other contained, plastic tray

- **Chloride Station**
  - Chloride HACH test kit
  - 1 Gallon jug of rinse water
  - Waste bucket
  - Direction sheets
  - Cafeteria or other contained, plastic tray
  - Calculators
- **Total Iron Station**
  - Total iron HACH test kit
  - 1 Gallon jug of rinse water
  - Waste bucket
  - Direction sheets
  - Cafeteria or other contained, plastic tray
- **Hardness Station**
  - Hardness HACH test kit
  - 1 Gallon jug of rinse water
  - Waste bucket
  - Direction sheets
  - Cafeteria or other contained, plastic tray
  - Calculator
- **Nitrates Station**
  - Nitrates WaterWorks test kit
  - 1 Gallon jug of rinse water
  - Waste bucket
  - Direction sheets
  - Cafeteria or other contained, plastic tray
- **Computer Station**
  - 4-6 computers
  - 3 with a preformed spreadsheet for data
  - 3 with Google Earth for GPS information

Procedure:

Pre-Test Class

1. The well water testing curriculum is a series of at least three classes. The first class period is dedicated to a presentation about groundwater, wells, well contaminants, proper lab safety, the well water testing day procedures, and passing out sample containers and other applicable materials.
2. Students will take their sample bottles home to fill.
3. Student will need to return their sample bottles by the scheduled testing day, usually 3-7 days after the presentation.

Testing Day

4. Students will break up into six groups and start at one of the testing stations.
5. Volunteers are at each station to briefly discuss what the students will be sampling for, how to run the test, and make sure proper lab safety is adhered to.
   **The procedures for each test kit are available at each test station.*
6. After completing their tests, students will input their data into a spreadsheet.

7. The AWWA Program Manager will take the data back and interpret it and provide maps showing distribution for the following class.
   Research Day
8. Usually 3 to 7 days after the testing day, a research day is scheduled.
9. Students will be broken into groups that will research each of the groundwater parameters, as well as local geology, well water contaminants, and safe drinking water concentrations.
10. Students should begin putting any variety of final products together in this class. Options include, but are not limited to, posters, presentations, or infograms for display.

Wrap-Up:
If time is available, the students should compile all of their research and information into one fluid presentation form (poster, presentation, etc.). When completed, posters should go on display or a time should be set where the students give a presentation on their topics.

Name: _____ Score: /20

Groundwater and Well Water Testing Quiz

1. Is there more fresh water on the planet or salt water?

2. Name two sources from which we get our drinking water.

3. True or False, if your drinking water looks ok and tastes ok it is absolutely safe to drink?

4. List three potential drinking water contamination sources.

5. If you have iron in your drinking water, what is the most likely source of this contamination?

6. What does pH measure?

MODULE 4 - CAPSTONE

Erosion Control and Stormwater Management

Long-term Objective: To reduce pollution caused by erosion from stormwater runoff.

Medium-term Objectives:

- Expand students understanding between human activities and water quality.
- Have students demonstrate that clean water is essential to all aspects of life on earth and develop individual actions that they can take to keep waters clean.

Module Objectives:

- *Weather and Water* - Inquiry: Design and conduct scientific investigations.
- *Weather and Water* - Inquiry: Use appropriate tools and techniques to gather, analyze, and interpret data.
- *Weather and Water* - Inquiry: Develop descriptions, explanations, predictions, and models using evidence.
- *Weather and Water* - Inquiry: Think critically and logically to make the connections between evidence and explanations.
- *Weather and Water* - Inquiry: Understand that different kinds of questions suggest different kinds of scientific investigations; current knowledge guides scientific investigations; mathematics and technology are important scientific tools.
- *Weather and Water* - Inquiry: Use mathematics in scientific inquiry.
- *Weather and Water* - Earth Science: Water circulates through the earth's crust, oceans, and atmosphere in the water cycle.
- *Weather and Water* - Science and Technology: Science influences society through its knowledge and worldview.
- *Weather and Water* - Science and technology: Scientists work in many different settings.
- Define "Best Management Practice" (BMP).
- Make the connection between erosion on land and water quality.

Summary: Students will build on lessons in the fall to design their own best management practice (BMP) on a site at or near school grounds. This project will bring all previous AWWA modules together to show how erosion at the Earth's surface can lead to degrading water quality. Students will have an opportunity to take part in a demonstration BMP installation in the spring.

Estimated Time:

Day One: 45 mins
Day Two: 45 mins
Day Three: 2 hours +

Materials:

- Clipboards
- Local area aerial and/or tax maps
- Erosion worksheet
- Work clothes

Procedure:

Day One:

1. Students will participate in an involved presentation on erosion, stormwater management, and Best management Practices (BMPs).
    a. Ask students to define infiltration, erosion, BMPs, stormwater
    b. What causes pollution in lakes?
    c. What is the difference between "point source" and "nonpoint source" pollution?
    d. What are we concerned about when we see the land eroding and carrying runoff to lakes?

Day Two:

2. Handout clipboards, maps, and worksheets to students.
3. Take students outside to look at different areas where erosion is occurring or could potentially occur.
    a. Reinforce topics from the previous day's presentation.
4. Have students give suggestions as to what BMP may work best for each area visited.

***Teacher should follow up with class by creating a project that takes these topics into account. Either by letting students create their own designs for fixing an erosion problem or some other hands on activity to reinforce topics.**

Day Three:

1. Meet with teacher prior to following spring with student's projects and choose a group's design to do a demonstration project on site or in community.
2. Facilitator will prepare site for students to come and observe the installation of a Best Management Practice.

Name:_____ Score:

Erosion Control and Water Quality Quiz

1. Name the four items that ALL maps should have…

2. Which of the following is the first to consider when discussing "water quality"?
   a. how clean the water is
   b. what it is you want the water for
   c. what the pH of the water is

3. A watershed is_____.
   a. a tool shed where people can store water
   b. an area of land that drains to a body of water
   c. the area of a person's home where the pipes go

4. Define or draw a picture of the following terms…
   Evaporation:

   Infiltration:

   Runoff:

5. In freshwater systems (lakes, ponds, rivers) we are concerned with runoff that flows over land and into the water because of one specific nutrient. What nutrient is our largest concern in freshwaters?
   a. Phosphorus
   b. Nitrogen
   c. Potassium

6. Which of the following is the largest contributor of phosphorus to freshwater systems?
   a. septic systems
   b. the atmosphere
   c. soil erosion
   d. pet waste
   e. fertilizers

7. Name one thing that you can do to help prevent polluted runoff from entering our waters…