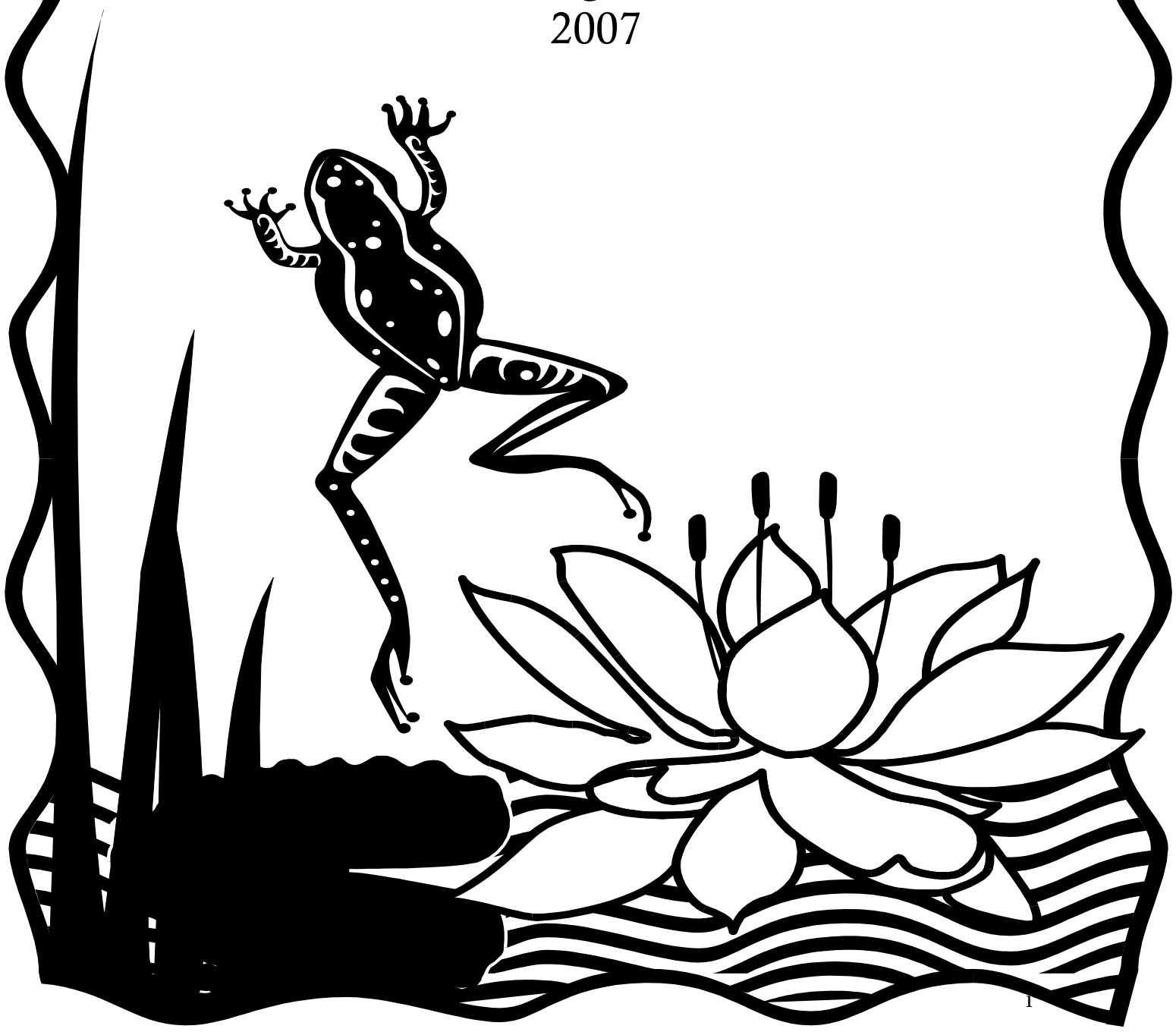
Water Quality Education

An Environmental Education Activity
Developed by
Airlie Gardens Environmental Education
Program
2007



This Environmental Education Activity was developed in 2002 by:

Kate Albertson
Environmental Education Program Coordinator

This Lesson Plan was revised in August 2007 by:

Nicole Mitchell
Environmental Education Program Manager

Matthew Collogan
Environmental Education Program Coordinator

Airlie Gardens wishes to acknowledge the following individuals and organizations whose efforts made this Environmental Education Learning Experience possible:

The Tidal Creeks Advisory Board

North Carolina Clean Water Management Trust Fund

Airlie Gardens Foundation Board

New Hanover County

Center for Marine Science

Landfall Foundation

Mary Duke Biddle Foundation

Shelly Miller, New Hanover Soil & Water Conservation District

Doug Parsons, Center for Marine Science

Tracy Skrabal, North Carolina Coastal Federation

Diana Rashash, NC Cooperative Extension Service

Table of Contents

Introduction to Airlie Gardens

Designed in the early 1900s, Airlie Gardens has become a valuable part of North Carolina's southern cultural and ecological history. Pembroke and Sarah Jones originally bought the property where Airlie stands in 1884. The 1920s saw the height of Airlie's botanical collections, with 5,000 camellias and a half million azaleas in bloom, as well as a collection of exotic plants. Area businessman Walter Albert Corbett and his wife Bertha Barefoot Corbett bought Airlie in 1948 and the family maintained it until 1999 when they sold it to New Hanover County.

A major grant from the NC Clean Water Management Trust Fund and the support of the residents of New Hanover County have made possible the purchase and restoration of the remaining 67-acres of Airlie Gardens to become a local, state, and national treasure.

Airlie Gardens as an Outdoor Classroom

The mission of Airlie Gardens is to be a historic public garden with cultural and environmental education programs that serve the residents and visitors of New Hanover County.

Airlie Gardens is a rich resource for environmental education. It is one of the last undeveloped tracts along Bradley Creek and provides us with the opportunity to teach firsthand about tidal creek ecosystems and North Carolina's horticulture.

We have also created a Water-Wise Garden that emphasizes the use of native plants in a constructed wetland to treat stormwater. This helps to reduce erosion and sedimentation as well as filter out pollutants before they reach the tidal creek. The Water-Wise Garden is a wonderful outdoor classroom, which helps students to learn about water quality through hands-on activities.

Groups are encouraged to schedule a field trip, making use of our Environmental Education Lesson Plan. See page 31 for scheduling a trip. Field trips will include a guided tour of two of our outdoor teaching areas with hands-on science education experiences. The program is correlated to the eighth grade science curriculum of the North Carolina Standard Course of Study. Activities focus on water quality, stewardship, and conservation.

Scheduling a Trip:

1. Please contact Airlie Gardens as soon as possible. At least two weeks advance notice is required to make a reservation. Call Airlie's Environmental Education Program at (910) 798-7564.

2. Complete the scheduling worksheet found on page 31 in the Forms section of this document or the worksheet found in the science kits and return it to Airlie Gardens as soon as possible.

Before the Trip:

1. Complete the pre-visit activities provided.

2. The group leader should discuss behavior expectations with students and chaperones. Airlie Gardens is not responsible for disciplining misbehaved students.

3. Each group should be divided into four teams prior to arrival. Each team must have an adult chaperone. Airlie recommends a 1:10 ratio between chaperone and students.

4. Make sure the students dress appropriately for the weather. **Comfortable, close-toed shoes are required.**

5. The group leader MUST obtain a parental permission form from each student, listing any medical concerns. Schools should use the form on page 32.

6. If you are going to be late or need to cancel, please notify Airlie Gardens as soon as possible. (798-7564)

While at Airlie Gardens:

1. When on hikes, students should walk behind the interpreter at all times. Running is not permitted.

2. All of the plants and animals are protected and should not be touched or removed unless the interpreter gives permission.

3. Please use the recycling bins and trash containers, do not litter.

4. In case of emergency, please contact Garden Staff immediately.

After the Trip:

1. Post-visit activities are designed to complement your field trip experience and are created for classroom use.

2. Encourage students to seek answers to any questions they may have after visiting the Gardens.

3. If appropriate, give evaluations or tests to find out if the students gained knowledge.

4. Please fill out and send the written evaluation on page 33 to the Garden Office. This is a very important step that allows us to make sure your experience is the best it can be.

Airlie Contact Info:

300 Airlie Road
Wilmington, NC 28403

Main Office Phone:
(910) 798-7700

Education Office Phone:
(910) 798-7564
Fax: (910) 256-5083

Website:
www.airliegardens.org

Office Hours:
8:00 am – 5:00 pm
Monday – Friday

Regular Season Garden Hours:
9:00 am – 5:00 pm
Tuesday – Sunday

Activity Summary

The Environmental Education Program entitled "Water Quality Education" was created to provide hands-on environmental education activities for an on-site visit as well as in the classroom. The packet provided includes pre-visit, on-site, and post-visit activities. All of the activities were designed for eighth grade students to meet the established curriculum objectives of the North Carolina Department of Public Instruction's Standard Course of Study.

An Airlie interpreter will conduct the on-site activities at the Gardens. The pre- and post-visit activities are designed for use in the classroom. We encourage the use of the pre-visit activities before the field trip so the students are prepared with the necessary background. We have developed the post-visit activity to reinforce the concepts and skills learned in the other activities.

The major concepts the students will experience are as follows:

- Water quality
- Wetland ecology
- Estuarine systems
- Wetland functions
- Indicator species
- Conservation of natural resources
- Human impact on water quality

Words that are in **bold face** are vocabulary words that are defined in the glossary (page 28). A list of references (page 30) that were used in the creation of this publication is also included.

Pre-Visit Activity #1 Water Quality DVD

Curriculum Links:
NC SCOS Grade 8

Science Competency Goal 3:
The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the hydrosphere.

3.02 Explain the structure of the hydrosphere…

3.07 Describe how humans affect the quality of water…

3.08 Recognize that the good health of environments and organisms requires monitoring, water quality standards, methods of water treatment, and stewardship.

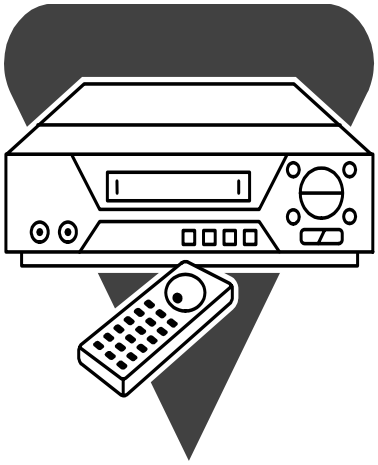
Location:
Classroom

Group size:
30 students
(entire class)

Estimated Time:
20 minutes

Materials Needed:
Provided by Airlie:
- Welcome to your Watershed DVD

Provided by educator:
- TV
- DVD player



Major Concepts:

- Introduction to Airlie Gardens
- Local water quality issues
- Types of pollution

Objectives:

- List two main types of pollution discussed in the video
- Name two strategies in use to help reduce non-point source pollution

Educator's Information:

This activity is designed to introduce students to the activities they will participate in when they visit Airlie Gardens.

Pre-Visit Activity #2 Watershed Model

Curriculum Links:
NC SCOS Grade 8

Science Competency Goal 3:
The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the hydrosphere.

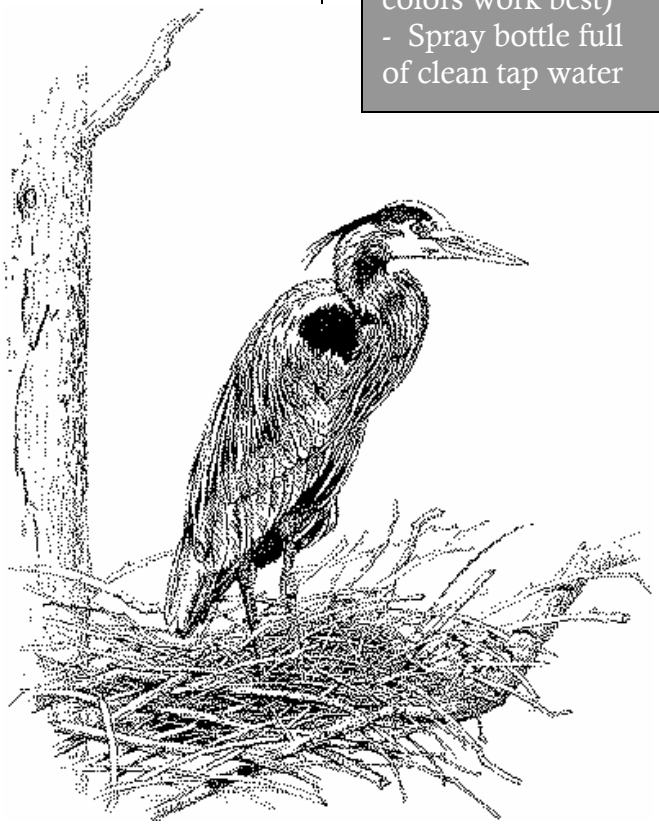
3.02 Explain the structure of the hydrosphere…

Location:
Classroom

Group size:
30 students (entire class)

Estimated Time:
45 minutes

Materials needed:
- Large piece of butcher paper or craft paper (approx 3'x5')
- Piece of cardboard the same size as the paper
- Tape
- Assorted colors of water-soluble markers (dark colors work best)
- Spray bottle full of clean tap water



Major Concepts:

- What makes up a watershed
- How water flows through a watershed

Objectives:

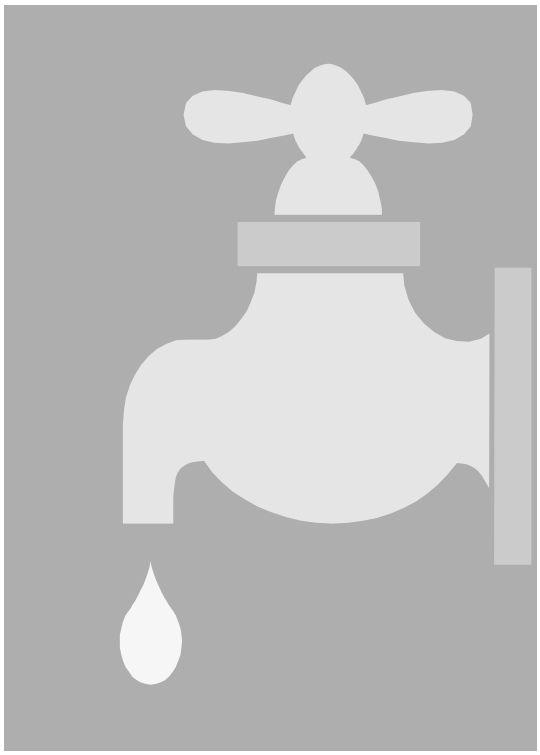
- Describe the difference between an open and closed watershed
- Understand that a large watershed is made up of lots of smaller ones

Educator's Information:

In this activity, students will create a large model of a **watershed**. They will learn how water moves through a watershed. They will also be introduced to the concepts of an **open watershed** and a **closed watershed.**

Instructions:

- Introduce the class to the concept of a watershed. Distribute the Student Information Sheet, which describes a watershed in detail.
- Take the large piece of butcher paper and crumple it up. Keep in mind, the more crumpled the paper is the more complex the watershed will be.
- Next, lay the crumpled piece of paper on top of the cardboard piece. Tape the four corners of the butcher paper onto the cardboard. Do not straighten out the paper too much.
- Lay your "watershed" model on a large tabletop. Give the students markers. Have them use a dark color but not blue, to color the tops of the hills or high areas.
- Explain to the students how these higher areas are the borders of different watersheds. Some are totally surrounded by ridges, making them a **closed watershed**. Others are open to the end of the paper and are **open watersheds**. It is important for the students to understand that a large watershed can actually be made up of lots of smaller watersheds.
- Next, have the children use blue markers and draw in where they believe the rivers and valleys are. They may also draw in where they think lakes would form.
- Now, it is time to test the students' predictions. Use the spray bottles to simulate rain and spray all over the paper. Have the students observe what the water is doing. You can spray the watershed yourself or have a few water bottles and let the students spray it themselves.
- Let the watershed model dry. When it is dry, have the students observe if their predictions were right.
- The final step is to have the students use a felt tip marker and outline the smaller watersheds within the large one. Explain to the students that we all live in the large watershed of the Cape Fear River Basin. But, we also live in many other smaller ones. One example of this is that Airlie Gardens is not only a part of the Cape Fear River Basin, but is also a part of the Bradley Creek Watershed.



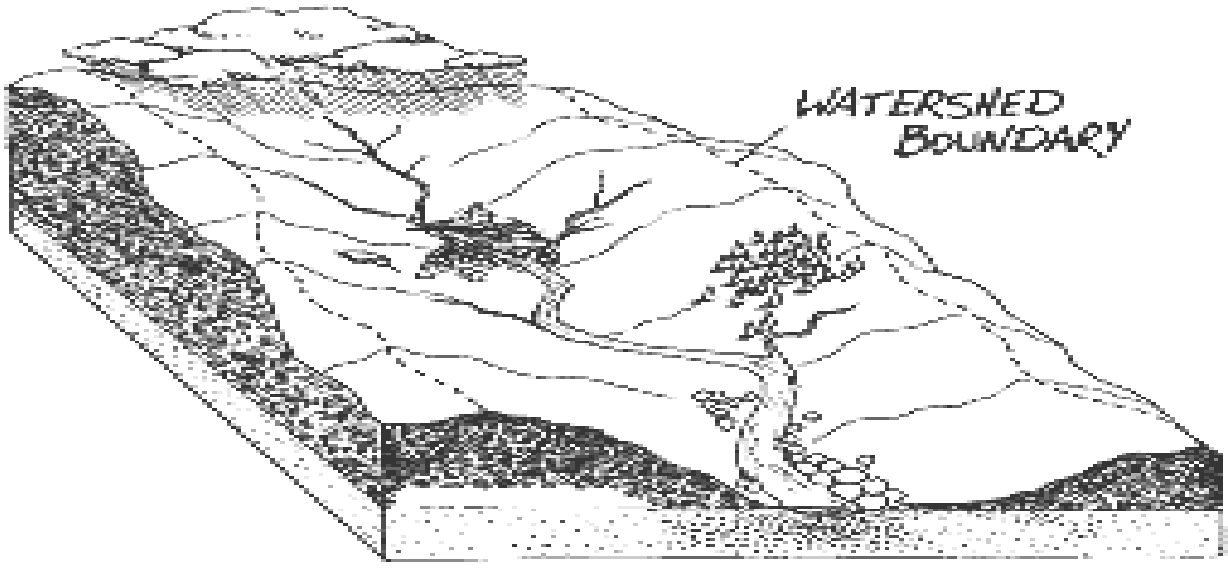
Student's Information

Every single one of us lives in a **watershed**. Because of this, each one of us has an impact on **water quality**. For us to better understand this concept, we must first look closely at a watershed to find out how is works.

A watershed may also be called a **drainage or river basin**. These are the areas in which all water, sediments, and dissolved minerals drain from the land into a common body of water. This body of water could be a lake, stream, large river, or even the ocean. Watersheds can vary in size from very large areas to very small areas, such as a backyard.
For example, New Hanover County is in the Cape Fear River Basin. This means that all of our water will drain into the Cape Fear River. There are many different watersheds that make up the Cape Fear River Basin. For example, here at Airlie Gardens, we are a part of the Bradley Creek Watershed.

Water quality is greatly affected by everything that goes on in a watershed. Farming, construction sites, septic systems, **runoff** from lawns and parking lots, sewage runoff, and forestry practices all affect water quality. Water quality can be negatively affected by simply washing your car on a paved driveway where the chemicals from the soap are washed into the sewers, then dumped in the river.

Understanding how a watershed works is the most important step to having a positive impact on water quality, instead of a negative one. Once you know the consequences of your actions on water quality, you can then make an informed decision on what kind of impact you will have.



Pre-Visit Activity #3 Dirty Water

Curriculum Links:
NC SCOS Grade 8

Science Competency Goal 3:
The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the hydrosphere.

3.02 Explain the structure of the hydrosphere…

3.07 Describe how humans affect the quality of water…

Healthful Living Competency Goal 2
The learner will develop knowledge and skills to enhance personal and consumer health.

2.08 Predict the potential personal health consequences of global environmental problems.

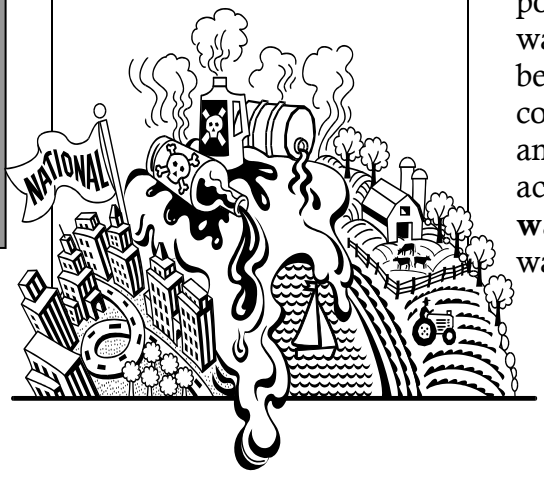
2.09 Evaluate how personal behaviors contribute to environmental improvement and destruction.

Location:
Classroom

Group Size:
30 students (entire class)

Estimated time: 45 minutes

Materials:
- Clear, gallon jug of water (half full)
- Small cups containing the following (separated): small amount of dry clay, crumbled dry leaves, ¼ tsp. vegetable oil, knot of nylon fishing line, ¼ cup vinegar (2 separate cups), ½ tsp. baking soda, ½ tsp. baking powder, 1 tsp. of blue/green food color and water, ¼ tsp. of red food coloring and water, misc. trash, handful of cereal pieces.



Major Concepts:
- What is a watershed
- How humans affect water quality

Objectives:
- Understand the different components of a watershed
- List different types of point source and non-point source pollution
- Describe three different ways they affect water quality

Educator's Information:

This activity will demonstrate to the students different **point source** and **non-point source** types of **pollution** that all contribute to the pollution of our waterways. They will be reintroduced to the concept of a **watershed** and discover how their actions can affect the **water quality** of that watershed.

Instructions:

1. Give each student, or group of two, one of the cups filled with a substance.
2. Explain to the students that the contents of each cup represent a different pollutant that can end up in our watershed.
3. Discuss what each substance could represent.
4. Use the pollution story to illustrate how different pollutants can affect the water quality of our watershed.

Pollution Story:

People have lived in the Lower Cape Fear region for thousands of years. In that time, they have grown and harvested food, fished the waters, and hunted for animals in the forests. Lets imagine this water was taken from the Cape Fear River 600 years ago.

How does the water look? Would you drink this water? Would you swim in it? Eat fish from it?

When this sample of water was taken, there was plenty of fish in the river, and lots of clean water to drink. Soon after, people starting moving to the Lower Cape Fear and colonizing the area. There was plenty to eat, plenty of fertile land, and lots of wildlife.
How do you think that colonists used the river and the surrounding land?

Do you think it has changed a lot since then?

Now, lets come back to the present and see what is happening to the Cape Fear River today.

Listen for the name printed on the outside of your cup. When the name is said, pour the contents of your cup into the river.

A tropical storm hits Wilmington and dumps five inches of rain. The rain starts to loosen the soil from a **construction site**. There are also high winds, which rip through the **trees** blowing lots of leaves and twigs into the river.

Is the water safe to drink? (If they say no, ask them if there was dirt and leaves in the river when the colonists drank it.) Would you swim in it? Eat fish from it? Is it safe for wildlife to drink and live in?

Soon after the storm passes, the sun comes out and people head out to have some fun. **Motorboats** head up and down the river, not realizing that they are leaking a little oil. Families are having **picnics** at parks along the river. Unfortunately some of these people left some trash behind. There are also some **fishermen** out on a dock. One of them snags their line on an oyster bed and breaks the line.

How is the water doing now? Would you drink from it? Swim in it? Is it safe for wildlife?

Farther up the river, there is a **power plant** that is releasing some gasses out of their smokestacks into the air. The gas then mixes with moisture in the air and forms acids. This then falls back down to earth in the

form of acid rain. There is also a **farmer** who has been fertilizing his soybeans. The rain from the tropical storm has washed some of the fertilizer into the river. Lots of people drive to and from work in their **cars.** Car exhaust fumes can also cause acid rain. If the car is not maintained, it may also leak oil or other chemicals, which would then be washed into the river by rain.

Would you drink the water now? Swim in it? Could fish and other wildlife live in water that was like vinegar?

If we now look around the neighborhood to see what people are doing regularly, we notice there are a lot of **gardeners** who like to keep their lawns looking nice. To get rid of those pesky weeds, many spread chemicals like pesticides and herbicides over their lawns. The next time it rains, those chemicals will wash into the nearest river. Your best friend is out walking their dog and the dog goes the bathroom. The pet waste was not picked up. If it rains, the **pet waste** will go into the storm drain and into the river. Next door you notice someone changing the **antifreeze** in his or her car. You know this because you see a trail of green liquid running down the driveway. And again, then next time it rains, it too will be washed into the nearest river. And last, but definitely not least, you notice the neighbor across the street is cleaning out his garage. He finds a can with a poison symbol on the outside of it, but does not know what it is. He doesn't want to keep it around the house, so he decides to pour this **unidentified liquid** down the storm drain. He thinks he doesn't have to worry about it anymore. What he doesn't realize is that it's headed for the Cape Fear River.

Would you drink the water now? Swim in it? Is it safe for wildlife?

Conclusion:
Think about what was in your cup. What could have been done to prevent it from going into the water? Is there something you could start doing today that could help clean up the Cape Fear River?

What is in the Cup:	What this Represents:
Small amount of dry clay	Construction site
Dry leaves and twigs	Trees
¼ tsp. vegetable oil	Motorboats
Knot of nylon fishing line	Fishermen
¼ cup vinegar	Power Plant
¼ cup vinegar	Cars
½ tsp. baking powder	Farmers
1 tsp. of blue/green food coloring and water	Antifreeze
¼ tsp. red food coloring and water	Unidentified liquid
Assorted litter	Picnics
½ tsp. baking soda	Gardeners
Pieces of brown cereal	Pet waste

Student's Information

Pollution can come from many different sources. Sometimes it is very easy to find the source, such as a pipe leaking green goo directly into the river. This is what we refer to as **point source pollution**. This simply means that it is easy to "point" to the source; the pollution is coming from one single point.

Other times, it is not so easy to determine the source of pollution. A parking lot with oil that has leaked onto the surface is a good example of what we refer to as **non-point source pollution**. This means that pollution is entering a waterway from many different places. When it rains, the pollutants are washed off of different surfaces and enter the waterway.

Stormwater can be a major non-point source of pollution. Stormwater not only refers to rain water, but also to water from washing cars, over-watering lawns, and other sources. Stormwater washes down storm drains on the curbs of roads and is then dumped directly into lakes, rivers and streams untreated. These could also be the same body of water that our drinking water supply comes from.

In downtown Wilmington, the stormwater that goes down the storm drains ends up in the Cape Fear River. All of the oil on the streets and parking lots, fertilizers on lawns, and chemicals on driveways end up in the River. The Cape Fear River provides the main source of drinking water for Wilmington residents.

There are many different ways to help filter stormwater before it empties into the waterway. At Airlie Gardens, we have created a **constructed wetland** to help filter pollutants. A pipe directs stormwater under the road and into our constructed wetland. The constructed wetland uses many different strategies to help filter water. When the water first enters the garden, it is filtered through a buffer area consisting of grass and rocks. This helps filter out **sediments** and clears the water. It then moves slowly through the garden. There are many **native** plants that help clean the water before it enters into Airlie Lake, and eventually Bradley Creek.

A constructed wetland is a great way to naturally filter storm water before it enters a larger body of water. Plus, they can be very beautiful and provide habitat for wildlife.

On-Site Activity #1 Water-Wise Garden

Curriculum Links: NC SCOS Grade 8

Science Competency Goal 3:
The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the hydrosphere.

3.05 Analyze hydrospheric data over time to predict the health of a water system (Temperature, Dissolved Oxygen, pH, Nitrates, Alkalinity).

3.07 Describe how humans affect the quality of water…

3.08 Recognize that the good health of environments and organisms requires monitoring, water quality standards, methods of water treatment, and stewardship.

Location: Water-Wise Garden

Group Size: Two teams.

Estimated time: 1 hour 20 minutes

Materials Needed: Provided by Airlie:

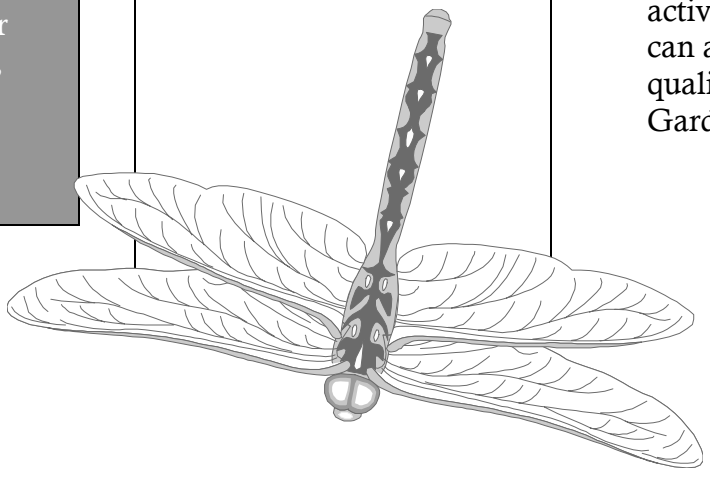
Water testing kits, thermometer, rubber gloves, eye protection, collection nets, containers, data sheets, id guides, and magnifiers.

Major Concepts:

- Water Quality
- Wetland Functions
- Water Testing
- Human impact on wetlands
- Macroinvertebrate sampling

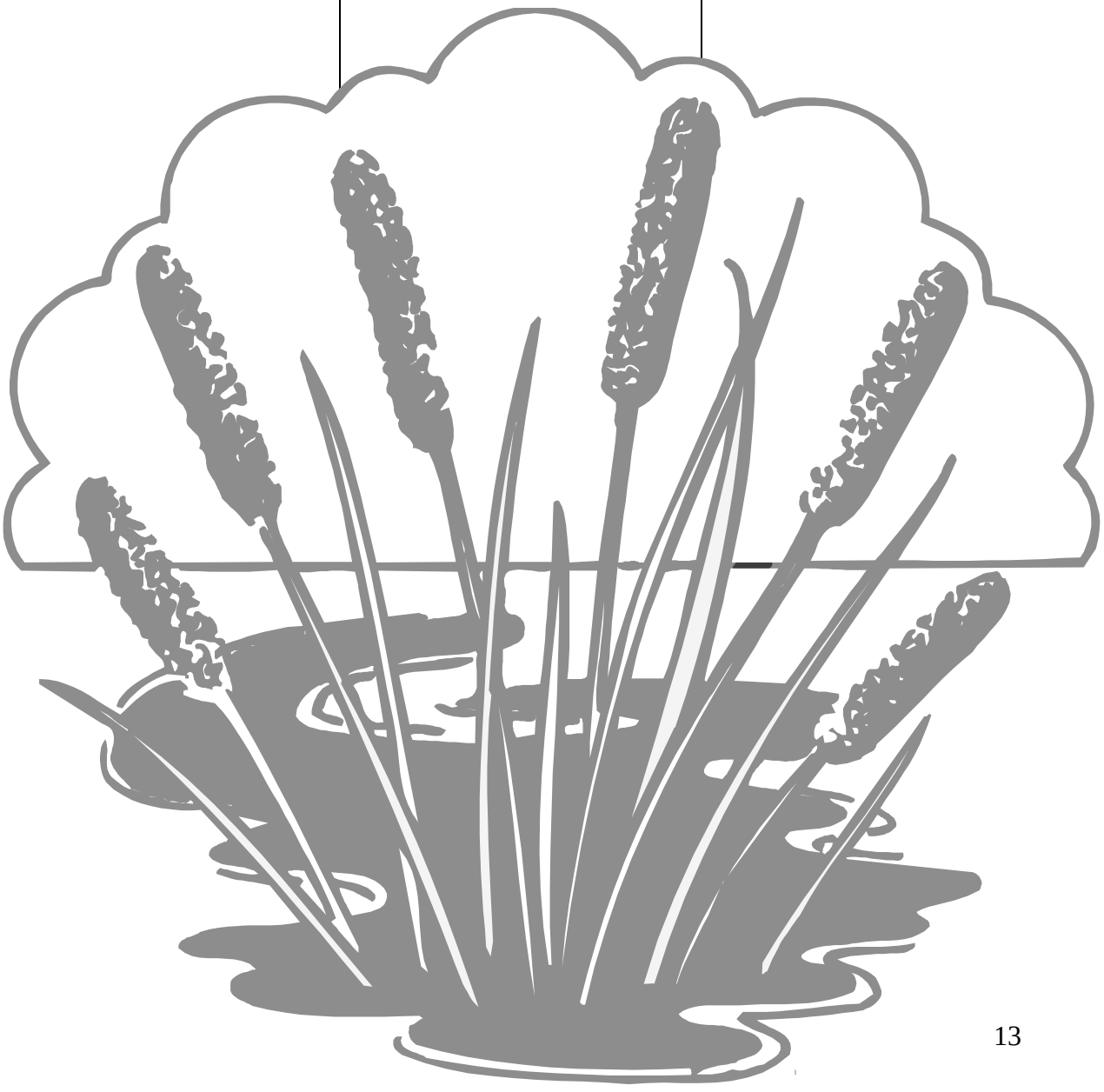
Objectives:

- Demonstrate the use of several water testing kits to determine: pH, dissolved oxygen (DO), alkalinity, nitrates, and temperature
- Analyze samples and compare results between wetland samples and Bradley Creek
- List 2 ways in which the constructed wetland functions as a filter
- Name three human activities, which can affect water quality at Airlie Gardens



Educator's Information:

The students will be involved in collecting water samples from our constructed wetland area and performing several tests to determine the quality of water. An interpreter will lead a team of students through four different teaching areas in the Water-Wise Garden. Students should be divided into four teams prior to arrival. Each team will visit all teaching areas and will be lead by an interpreter. Prior to your visit, please distribute copies of Student's Information so they are familiar with the subject.
If you desire, you may bring a sample of water from your school to test along with Airlie samples.



Instructions:

Interpreters will greet the students and give them a brief orientation of what they will be doing that morning. Each group will be separated into four teams and will be assigned an interpreter to lead them. The interpreter will take them through each of the four stations listed below.

Station #1:
What is a Watershed?
This station will be located at the entrance of the Water-Wise Garden. The interpreter will discuss how a constructed wetland works. Students will view maps of Wilmington Area Watersheds and NC River Basins. Students will brainstorm different types of human impact on water quality.

Station #2:
Nitrate and Alkalinity Testing
This activity will take place at the head of the constructed wetland, where the culvert empties. This water is pure stormwater runoff from the housing development across the street and nearby shopping centers. The students, wearing protective glasses and latex gloves, will perform two separate tests; one for nitrates and one for alkalinity. The interpreter will help the students gather water samples, use the test kits, and will assist the students in testing the samples. Students will record the results of the water tests on the provided sheet. The students will also compare their results with samples they will collect in Bradley Creek.

Station #3:
Macroinvertebrate Sampling
This station will be located on the viewing platform. The interpreter will give a brief introduction on macroinvertebrates; what are they and what they indicate about water quality. The interpreter will then hand out dip nets and a collection bin to students. After demonstrating how and where to collect, the students will have 10 minutes to collect as many different types of macroinvertebrates as they can.

The next step will be sorting the different types of specimens using the provided tray. Once they are sorted, the students will use an identification guide to discover what they have collected. The final step will be to investigate, using the materials provided, what the different macroinvertebrates indicate.

Station #4:
Temperature, pH, and Dissolved Oxygen (DO) Testing
This station will be located at the end of the constructed wetland, before the water empties into Airlie Lake. Students, with the help of the interpreter, will collect water samples from this site. Using the kits provided, the students will then perform the three separate tests. The interpreter will discuss what these factors indicate to us about the quality of the water. Students will record the results of the water tests on the provided sheet. The results for pH, DO, and temperature tests will be compared to the results at Bradley Creek.

Student's Information

Whether they are natural or man-made, **wetlands** are very important to North Carolina. They help to clean our waters of pollutants, filter sediment, hold water to reduce flooding, and provide a valuable habitat to many creatures.

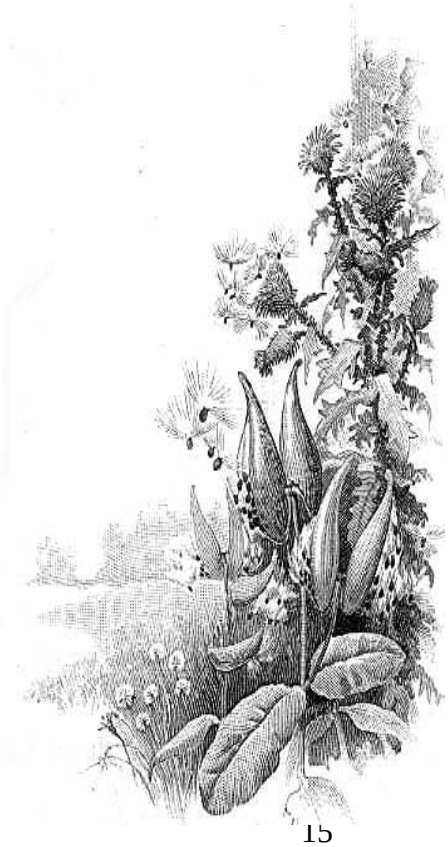
Here in New Hanover County, we are a part of the Cape Fear River Basin. The Cape Fear River Basin consists of over 6,000 miles of streams and rivers and is the largest river basin in North Carolina. It also encompasses more than 9,300 square miles of land and includes 26 different counties.

In the pre-visit activity, we learned what a **drainage basin**, or **watershed** is and what it does. We also learned that a large watershed could be made up of many smaller watersheds, even as small as a backyard.

Here at Airlie Gardens, we are not only a part of the Cape Fear River Basin, but we are more directly a part of the Bradley Creek Watershed. Airlie Gardens is one of the last undeveloped tracts located on Bradley Creek. We feel it is necessary to have a positive influence on the water quality in Bradley Creek. One way of doing this is by acting as a buffer zone between developed areas and Bradley Creek.

As a way of achieving this goal, we have created what we call a constructed wetland. As discussed earlier, the purpose of any wetland is to filter out pollutants and **sediments** using **native plants** to clean and slow down the water. After passing through the constructed wetland, the water then empties into Airlie Lake, which connects to Bradley Creek.

Pollutants can sometimes be very easy to see. Garbage floating in the water is one example that is easy to identify. Many other pollutants cannot be seen by just looking at the water. In order for us to identify if water is polluted, we must perform several water quality tests. When you come to Airlie Gardens, you will perform tests in our Water-Wise Garden and in Bradley Creek. Before we test anything, we must understand what the results of different tests will tell us about the health of the water.



Dissolved Oxygen:

Dissolved oxygen (DO) is simply the amount of oxygen available in the water (dissolved). The presence of oxygen in the water is a positive sign and the absence of oxygen is a sign of severe pollution.

Much of the DO in the water comes from the atmosphere. Atmospheric oxygen mixes with water when waves break or water flows quickly over rocks. **Algae** and other aquatic plants also deliver oxygen to the water through the process of photosynthesis.

Two main factors that affect DO levels are temperature and water movement. Cold water can hold more DO than warm water. Also, the faster the water moves, the more surface area there is where the oxygen mixes with the water.

DO levels also change between day and night. Because plants do not photosynthesize at night and aquatic animals continue to breathe, the DO levels drop during non-daylight hours.

Humans can also have an impact on DO levels. A build-up of **organic wastes** from either humans or their pets can lead to dramatic drops in DO levels as a result of **eutrophication** (this term will be explained in the next section). A large part of urban runoff is fertilizer or pet waste that can rapidly stimulate the growth of algae and other aquatic plants. This sudden increase in the amount of plants can eventually create extremely low DO levels at night (when photosynthesis stops) and can cause large **fish kills**.

Nitrates:

Nitrogen is needed by all living organisms, plants and animals, to build protein. Nitrogen exists in waterways in many different forms:

- Dissolved molecular nitrogen (N_2)
- Organic compounds and ammonia (NH_4^+)
- Nitrite (NO_2^-)
- Nitrate (NO_3^-)

This may seem a bit confusing, but it is important to understand that nitrogen can come in many different forms. Nitrate is usually the most important form when talking about water quality. Nitrite is usually only present in waters with a very low dissolved oxygen level. The nitrate form of nitrogen comes naturally from the atmosphere by rain, snow, fog, and from the decay of organic materials in the soil.

Humans have a huge impact on nitrate levels. Sewage and fertilizers are large contributors to increased nitrate levels in a body of water. Nitrates are a good thing to have in the water, but too much of it can cause **eutrophication**. This is when a body of water becomes so enriched with nitrates, generally a result of polluted stormwater runoff, that it sparks a growth of aquatic plants and algae. After

the runoff stops flowing into the watershed and the nutrients are absorbed, the plant material starts to die of because it is all out of nutrients. As organisms decompose, they 'burn' up dissolved oxygen. Without DO in the water, many animals die. **Eutrophication** can result in a decrease of biodiversity, changes in species composition, and toxicity effects including bad taste, odor, and water treatment problems.

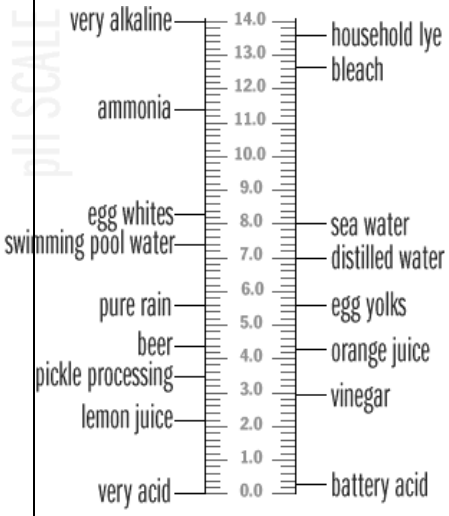
pH:

Water contains hydrogen ions (H^+) and hydroxyl ions (OH^-). The pH test measures the hydrogen ion concentration of liquids and other substances. pH means (p)otential (H)ydrogen ion activity, or simply the measure of the activity of hydrogen ions in a solution.

The **pH scale** is used to define levels of **acidity** or **alkalinity** in water and soil. The scale ranges from 0 (most acidic) to 14 (most alkaline, or basic). Pure water has a pH of 7, which is considered neutral. The chart provided shows the pH level of some common household items.

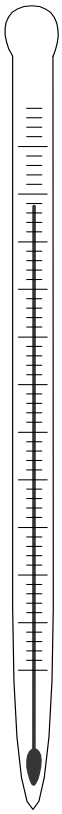
A very important aspect of the pH scale is that a one number change on the scale is actually a 10-fold change in the acidity/alkalinity of a substance. The pH scale is logarithmic, not linear. For example, a change of six to five on the pH scale means that the substance is 10 times more acidic; from six to four means it is 100 times more acidic.

Most lakes and streams have a pH value between 6.5 to 8.5. The pH of a body of water has a large impact on what can survive there. Most amphibians, fish and insects are not present in water with a pH below 4.



The largest human impact on pH values comes from automobiles and coal-fired power plant emissions. The emissions from cars and power plants contain sulfur dioxide and nitrogen oxide. When these chemicals mix with moisture in the air, it then falls back to the earth as acid rain.

Temperature:



Temperature is a very important factor of water quality. Temperature directly affects the following things:

- The amount of oxygen that can be dissolved (remember, cool water can hold more oxygen than warm water).
- Rate of photosynthesis by algae and other aquatic plants.
- Metabolic rates of aquatic organisms.
- Sensitivity of organisms to toxic wastes, parasites, and diseases.

Water temperature is largely determined by the amount of solar

energy, or sunlight, absorbed by the water. Obviously, the more sunlight, the higher the temperature will be.

Humans can also have a large impact on temperature. **Thermal pollution** by nuclear power plants and stormwater running off of warmed urban streets can have a large impact on water temperature. **Deforestation** can also have an effect by decreasing the amount of available shade to a body of water.

Alkalinity:

Alkalinity of water is its acid-neutralizing capacity. Acid can enter a stream through rain or snow, and sometimes through soil. Alkalinity is created when water dissolves rock that contains calcium carbonate, such as limestone and calcite. Alkalinity is different from pH. Alkalinity is a measure of how much acid can be added to a liquid without causing a great change in pH. Low levels make a body of water more vulnerable to acid rain and snow melts.

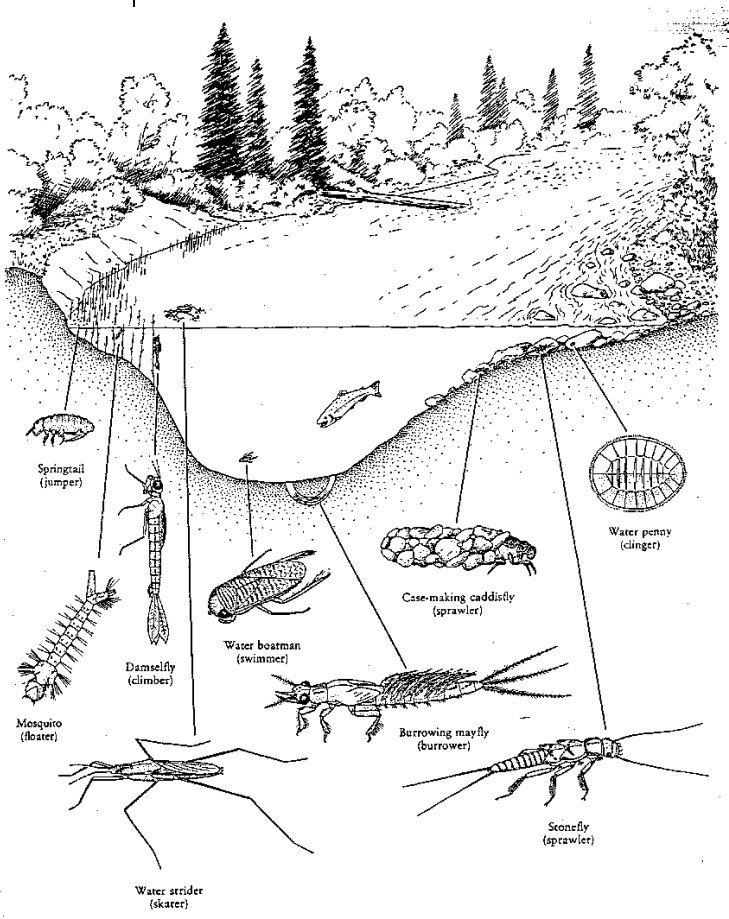
Benthic Macroinvertebrates:

Benthic macroinvertebrates are great **indicators** of water quality. Benthic means 'bottom dwelling' and 'macroinvertebrates' refers to invertebrates that can be see with the unaided eye. Most benthic macroinvertebrates in moving water are insects, either aquatic adults or aquatic stages of insects. Some examples are stonefly nymphs, dragonfly nymphs, and midge larvae. Non-insect macroinvertebrates include clams, snails, and worms.

These are good indicator species for a few reasons:

- Many are sensitive to chemical and physical changes in the water.
- Many live in the water for long periods of time.
- It is more difficult for them to escape pollution than it is a faster moving animal, such as a fish.
- They are easy to collect from streams and rivers.

Every species can only live in a certain range of chemical and physical conditions. Scientists have spent time studying benthic macroinvertebrates to understand which species can tolerate high pollution levels, and which cannot. By sampling an area to discover what species are present, it will indicate what the water quality is like.



On-Site Activity #2 Bradley Creek

Curriculum Links: NC SCOS Grade 8

Science Competency Goal 3:
The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the hydrosphere.

3.03 Evaluate evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms…

3.05 Analyze hydrospheric data over time to predict the health of a water system (Temperature, Dissolved Oxygen, pH, Nitrates, Alkalinity).

3.07 Describe how humans affect the quality of water…

3.08 Recognize that the good health of environments and organisms requires monitoring, water quality standards, methods of water treatment, and stewardship.

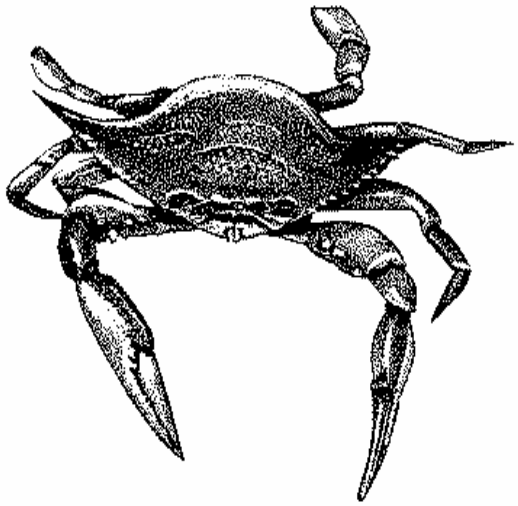
Location:
Bradley Creek Overlook

Group Size:
Two teams

Estimated time:
1 hour 20 minutes

Materials Needed:
Provided by Airlie:

Test kits, dip nets, plankton nets, turbidity tube, TV, microscope, Optec (microscope/TV adapter), slides, plankton id charts, model, collection containers.



Major Concepts:

- Water testing
- Plankton study
- Diversity of life in a salt marsh
- Riparian buffers

Objectives:

- Name three animals that depend on the marsh for survival
- Demonstrate the use of different water quality testing kits; nitrates, dissolved oxygen, pH, and temperature
- Analyze samples and compare results between the Water-Wise Garden results and the Bradley Creek results
- Understand the function and benefits of a riparian buffer

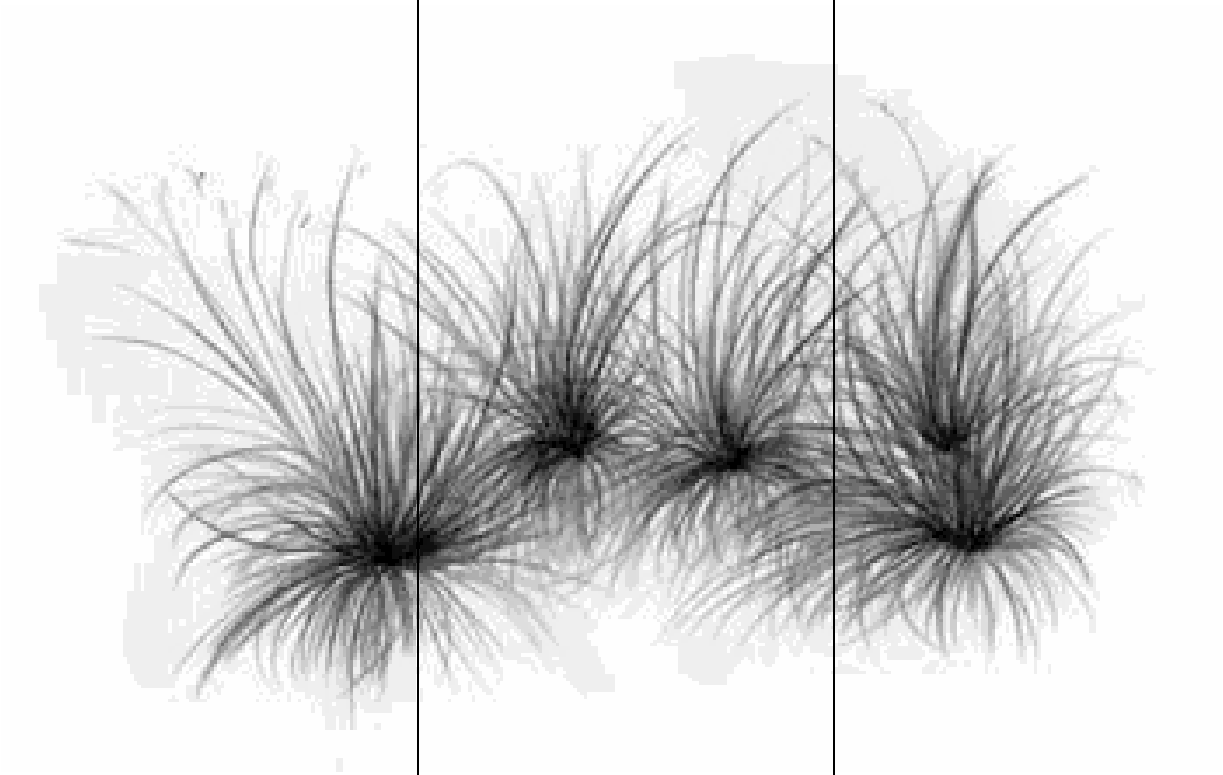
Educator's Information:

Students will be involved in collecting water samples from Bradley Creek and performing several tests to determine the quality of water. An interpreter will lead the students through four separate teaching stations.

Students should be divided into four teams prior to arrival. Before your field trip, please be sure to distribute copies of the Student's Information so they can become familiar with the subject.

IT IS VERY IMPORTANT THAT THE STUDENTS WEAR COMFORTABLE SHOES THAT ARE CLOSE-TOED AND CAN GET WET.

We will be collecting samples from the creek and will be getting wet. Please prepare your students for this ahead of time.



Instructions:

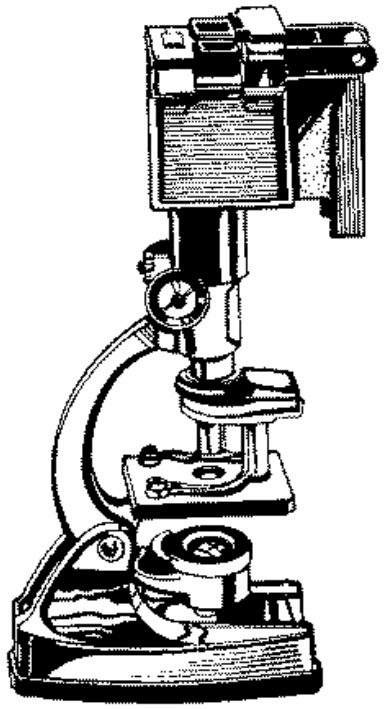
Airlie Interpreters will greet the students and give them a brief orientation of what they will be doing that morning. Each group will be separated into four teams and will be assigned an interpreter to lead them. The interpreter will take them through each of the four stations listed below.

Station #1:
Bradley Creek Boardwalk
Using a game called, "Marsh Metaphors", the team will discuss the different roles the marsh plays and why wetlands are so important. The interpreter will discuss some issues that have directly affected Bradley Creek. A demonstration riparian buffer will also be a large topic of this station. Students will discover how these buffers work and why many environmental groups encourage them.

Station #2
Nitrate, DO, Temperature, and pH Testing
The interpreter will help the students to collect a water sample and help the students perform four separate tests. The water samples will be taken where Airlie Lake empties into Bradley Creek. The results will then be analyzed and compared to the results of the Water-Wise Garden testing. Students will hypothesize what happens to the water as it leaves the Water-Wise Garden, flows through Airlie Lake and ends up in Bradley Creek. Based on the results of the water quality tests the hypothesis may be confirmed or rejected.

Station #3:
Marsh Collections
Using the Bradley Creek Dock, students will use dip nets to collect samples of life in the marsh. Plankton nets will also be used to collect samples of plankton that will later be analyzed at Station #4.

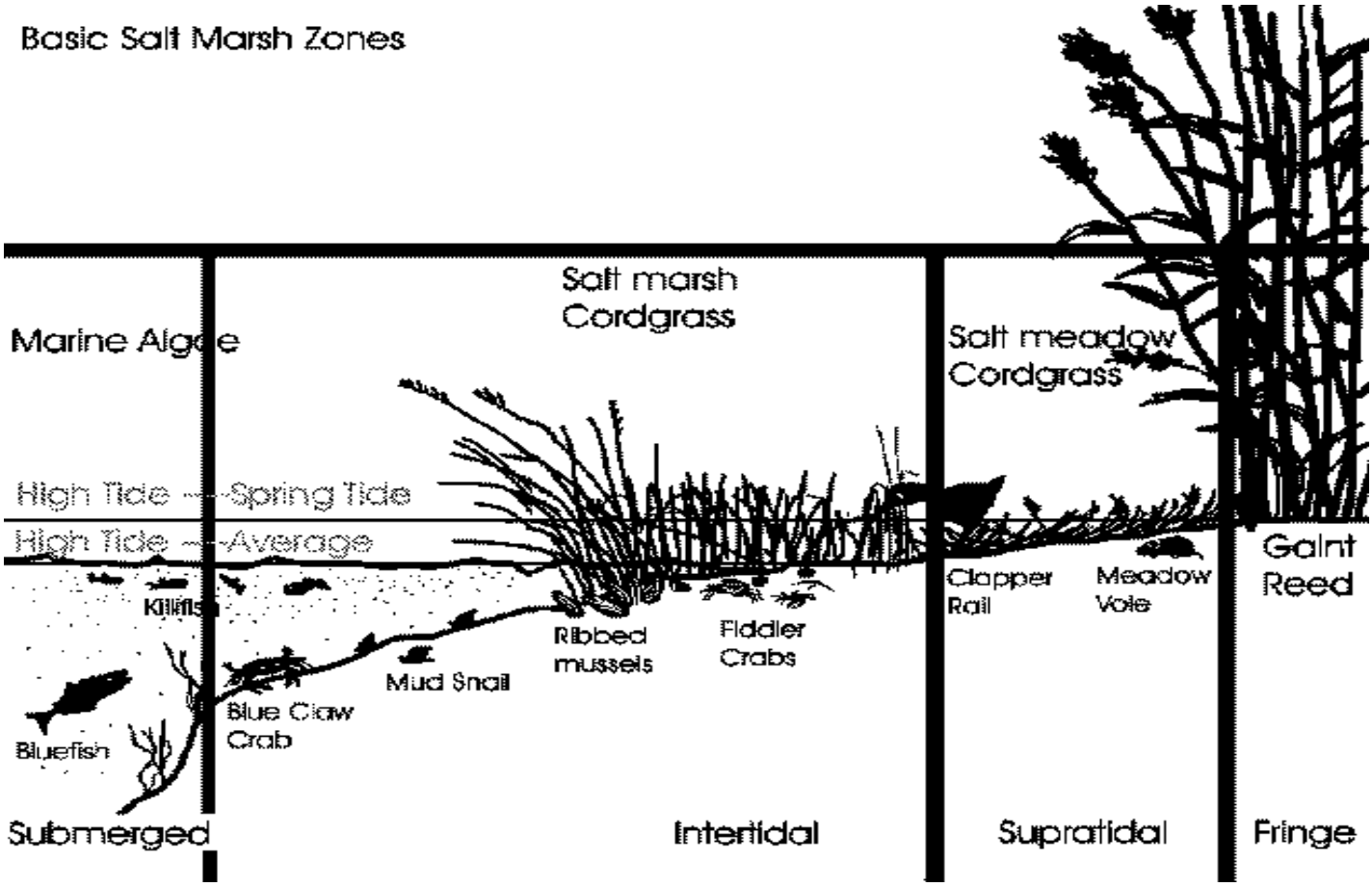
Station #4
Plankton Study
Students will exam plankton, which was collected earlier, in the classroom of the Garden Services Center. Once there, the interpreter will give a brief introduction of plankton, explaining the difference between phytoplankton and zooplankton. Using the microscope that is hooked up to the TV, students will be able to observe and identify different types of plankton.



Student's Information

North Carolina has the third largest estuarine system in the country, encompassing more than two million acres. An **estuary** is defined as a place where freshwater from rivers and streams meets saltwater from the oceans. In these areas, saltwater and freshwater mix together creating what we refer to as **brackish** water. Brackish water is not completely salt water but not completely fresh water. Because of the influence of the ocean's tides, the salinity of an estuary can vary greatly, especially from one end to the other.

Estuaries consist of many different ecosystems. Salt marshes are a very productive part of an estuarine system. They are considered by many to be one of the most productive habitats in the world. If you were to walk by a salt marsh, the first thing you would probably notice is the marsh grass, *Spartina*



alternifola, which is the dominate plant in most salt marshes. You would probably notice the grass, mud and oyster beds, but not much else at first glance. You have to get into the salt marsh to realize how many organisms depend on the salt marsh for survival. For example, 95% of the commercial seafood that you eat spend part some of their life in an estuarine system.

At first glance, water in a salt marsh might look dirty and polluted. Even the cleanest salt marsh looks like that. Decaying marsh grass and other **detritus** causes the **turbidity** in the water. Detritus is a primary food source for many aquatic creatures. Salt marshes are also full of **plankton**. Virtually every marine creature depends either directly or indirectly on plankton for food. Plant plankton, **phytoplankton**, is the base of the aquatic food chain. Animal plankton, **zooplankton**, feeds on the phytoplankton, and in turn is then eaten by larger creatures, and so on and so on, up the food web.

The health of our estuarine systems is being threatened by human activity. Agricultural runoff, wastewater treatment plants, urban runoff and the development of marinas are all contributing to the degradation of estuarine habitats. Bradley Creek has been closed to shell fishing since the 1940s because of polluted waters.

Here at Airlie Gardens, we have installed a demonstration **riparian buffer**. The purpose of the buffer is to help control non-point source pollution by acting as a catch basin and filter. We hope to use our riparian buffer to educate our neighbors and inspire the creation of more buffers along Bradley Creek.

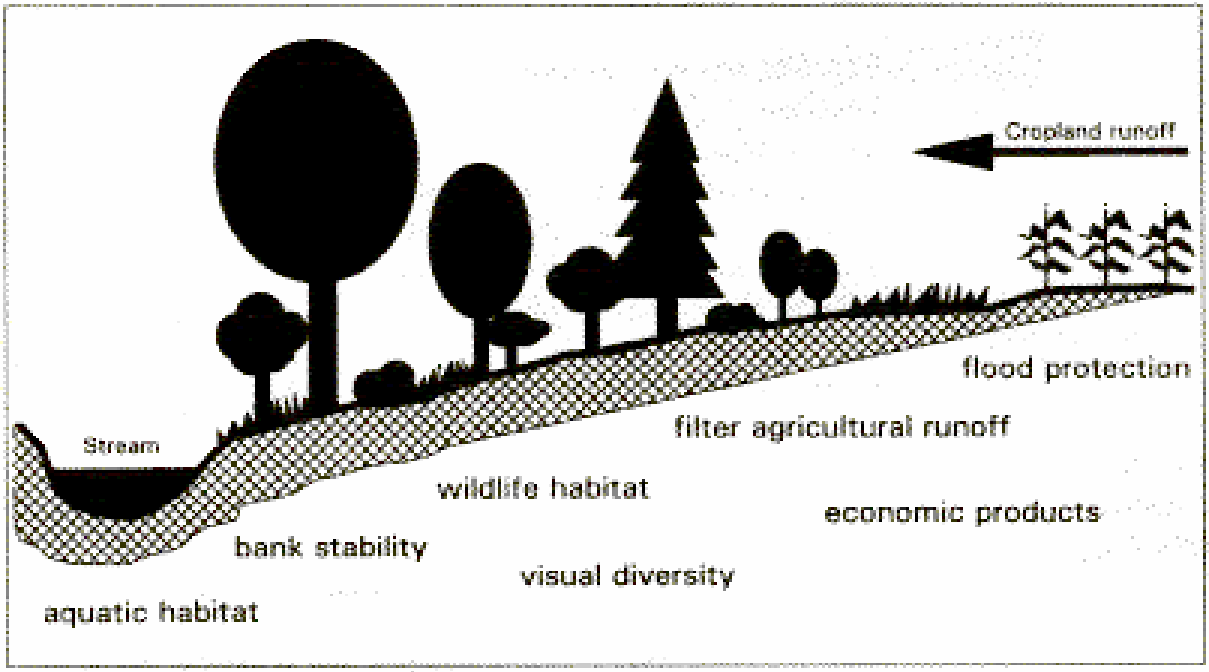


Figure 1 — Benefits that a riparian buffer can provide.

Post-Visit Activity #1 Town Meeting

Curriculum Links:
NC SCOS Grade 8

Science Competency Goal 3:
The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the hydrosphere.

3.07 Describe how humans affect the quality of water..

English Language Arts Competency Goal 3:
The learner will continue to refine the understanding and use of argument.

3.03 Evaluate and create arguments that persuade by:
-understanding the importance of the engagement of audience by establishing a context, creating a persona, and otherwise developing interest.

-noting and/or developing a controlling idea that makes a clear and knowledgeable judgment.

-arranging details, reasons, and examples effectively and persuasively.

-anticipating and addressing reader/listener concerns and counterarguments.

-recognizing and/or creating an organizing structure appropriate to purpose, audience, and context.

Location:
Classroom

Group size:
30 students
(entire class)

Estimated Time:
60 minutes

Materials needed:
- Background information sheet.
- Notepaper and pencils
- Stakeholder cards

Major Concepts:

- What is a stakeholder
- Types of pollution
- Human impact on water quality

Objectives:

- For students to understand how complicated water quality issues may be
- Name three different types of pollution

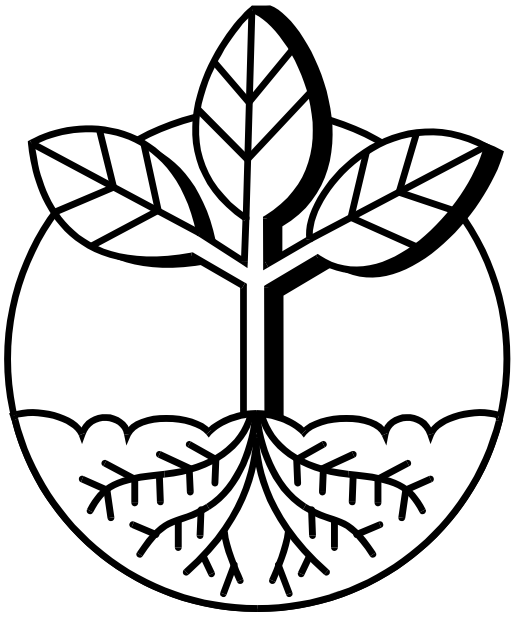
Educator's Information:

In this activity, students will learn about a specific water quality issue. The students will then be broken into smaller groups and given a stakeholder role. They will be given time to develop an argument using the character they were assigned. They will then make a brief presentation and answer any questions that the audience might have.

Instructions:

- Before beginning the activity, the students must read the background information provided. This is the information they will use to make their argument.
- Explain to the students that there are many sides to any issue. This activity will explore the idea of a stakeholder.
- After the students have read the information provided, split the class up into groups of three or four.
- Distribute one stakeholder card per group. The card will have the name of the stakeholder and a brief description of their position of the issue.
- Give the children about 15 minutes to come up with a detailed argument from their stakeholder's point of view. The student does not need to agree with their character but they must make an argument from their stakeholders' point of view.
- Once the students have formulated their arguments, gather the class back together.
- Each group will get three-five minutes to make their argument. It is very important that each student plays a role, no one should be silent. Each group will take their turn at the front of the class, they should be encouraged to use notes.
- After each group has made their argument, they will answer questions if needed. Remind the class that they are playing a character, and must form questions with that in mind.
- After each group has had their turn, bring the class back together as one group. Ask the students the following questions:

1. Was it difficult to stay in your character?
2. Did you agree with your character?
3. What were the main issues being discussed?
4. Can you think of a compromise that would make all of the stakeholders happy?
5. Can you think of any other water quality issues that might be similar to this situation? Any solution?



Student's Information

A local developer has plans to build a new condominium unit on Bradley Creek. Included in these plans is a new marina for the residents of the condos to use, and also boat slips for rental. Residents will enjoy private tennis courts as well as an unobstructed view of the water. With its spacious new parking lot, the development will offer easy access to creek side activities, and is in walking distance to a number of local shops thirsty for increased business. The planners believe that the condos will go quickly to local residents but a few of the units may be saved to accommodate and encourage tourism in the areas around Bradley Creek.

In order to start building, the construction company must receive permission from the city. A special city council meeting is being held to discuss this issue. Residents of the area and local businesses are welcome to come and voice their opinions. The meeting room becomes very full and it is easy to see that there are many people concerned with this issue. Each person is what we refer to as a stakeholder, or anyone who has an interest in the issue. Each stakeholder is given five minutes to state their argument and answer any questions that may arise. You will be given a particular stakeholder to construct an argument for. You will be using the information that you have learned about water quality issues surrounding Bradley Creek to make your argument. Remember to stay in your character, even if you do not personally agree with them. It is important to understand that for any issue, there are many different sides. It is a very difficult task to take all of the opinions and form a compromise. Your challenge is to find a compromise that all of the stakeholders could agree to.

Stakeholder Cards

Jan and Bob Tomelson Potential condo buyers who would like to see the project continue because they have always wanted to live with a view of Bradley Creek. They also have a boat and would love to be able to dock it where they live.	**Bradley Marina** Owners of an existing marina do not think that another marina should be built on Bradley Creek. They are business owners and would see any new marina as competition.
Sarah and Sally Kayakers These two represent a group of people who love kayaking through Bradley Creek. They are not particularly happy with the existing marina, and are definitely opposed to another marina. The idea of a large condo in their view is not very appealing.	**Handyman Construction** The construction company wants the work. It would create a lot of jobs for people and help support many families.
Ken and Krista Council Members of the city council who want to see more money coming into the area and more projects that support jobs. They are also concerned about public opinion and would not want to anger the citizens.	**Environmental Advocacy Group** Environmental advocates who are completely opposed to this project and the pollution problems it would bring. They are advocates of conservation in Bradley Creek and want to see it cleaned up, not polluted.
Tom and Rhonda Bird Residents of a nearby neighborhood who are against the project. They do not want to see increased traffic, noise, or any visual disturbance to their serene surroundings and bird watching.	**David and Donna Developer** Developers who have brought this idea to the table. They of course want to get permission to go ahead. It is a big money making deal for them and they don't want to loose it.
Cathy and John Keeper Owners of "Carolina Gifts and Things" a shop close to the condo site. The Keepers would love to see increased business and tourism in the area, especially if the extra parking comes at no cost to them.	**Gregory Pickings** Owner of a popular waterside restaurant just downstream from the intended condo and marina. He could use the business, but many people come to his restaurant to enjoy the water and the scenery. If anything disturbs the health of the creek he may lose the business he already has.

Glossary of Terms

Acidic: An adjective describing a substance having a pH of less than 7 is acidic; the chemical state of a substance in which the hydrogen (H+) ions are greater than the hydroxyl (OH-) ions. See pH scale on page 17.

Algae: Plants without roots that grow in water and "feed" on nutrients (such as nitrogen and phosphorus) in the water.

Algae Blooms: Occurs when algae grows very fast because too many nutrients enrich the water. Algae blooms may color the water a deep red-brown.

Alkalinity: This is a measure of the ability of a solution to neutralize acids

Alkaline: A substance having a pH greater than 7; the chemical state of a substance in which the hydroxyl (OH-) ions are greater than the hydrogen (H+) ions. See pH scale on page 17.

Brackish: Describes a mix of freshwater and saltwater; water having a salt content between freshwater and saltwater.

Closed Watershed: A watershed that empties directly into an inland body of water.

Deforestation: The permanent removal of forest cover and withdrawal of land from forest use, whether deliberately or circumstantially.

Detritus: Non-living material resulting from the decomposition of dead organic remains.

Drainage Basin: The area of land that drains water, sediment, and dissolved materials as a result of precipitation to a common outlet such as a river, stream, lake, wetland, or ocean.

Estuary: A partially enclosed coastal body of water where freshwater rivers or streams meet the saltwater sea/ocean. This results in a mix of brackish water

Eutrophication: When a water body is choked by abundant plant life due to higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process. This process may result in increased toxicity, lowered DO levels, and decreased biodiversity.

Fish Kills: Refers to large numbers of fish being killed, usually because there is not enough DO in the water or because of a chemical spill.

Indicator: Any biological entity or process, or community whose characteristics show the presence of specific environmental conditions.

Native: Those species that occur naturally in an area and have not been introduced, accidentally or otherwise, by humans.

Non-Point Source Pollution: Refers to pollution that enters the environment from many places (such as rainwater washing over parking lots, lawns, or farms) and brings pollutants from all these sources into the watershed.

Open Watershed: A watershed that drains directly to the ocean.

Organic Waste: A by-product of living organisms.

Photosynthesis: the plant process of capturing light energy, converting it to chemical energy, and storing it by manufacturing sugar (photo = light; syn = with, together; thesis = an arranging). This process occurs in plants, including algae. Plants need only light energy, CO_2, and H_2O to make sugar. The process of photosynthesis takes place in the chloroplasts, specifically using chlorophyll, the green pigment involved in photosynthesis.

pH Scale: A range of 0 to 14, used to measure the degree of acidity or alkalinity of a substance. A pH of 7 is neutral.

Phytoplankton: That portion of the plankton community comprised of tiny plants; e.g. algae, diatoms.

Plankton: Tiny plants and animals that live in water.

Point Source Pollution: Refers to pollution that enters the environment from a single point, like a factory pipe.

Pollutants: Something that makes a substance physically impure, unclean, and unhealthy

Rain Garden: A garden using plants and soil to remove pollutants from stormwater. This garden slows down runoff and soaks it in, and should be placed in between a water body and impervious surface (a hard surface that doesn't drain, like roads and buildings).

Riparian Buffer: **A**n area of trees, shrubs, and native plants located adjacent to streams, lakes, ponds, and wetlands. Its purpose is to provide food and cover for wildlife, help lower water temperatures by shading water, and slow out-of-bank flood flows.

Runoff: Water that flows across the surface of the land and empties into a body of water.

Sediment: Mud, sand, silt, clay, shell debris, and other particles that settle on the bottom of rivers, lakes, estuaries, and oceans. Initially suspended in the water column, these particles settle on fish eggs and inside gills which kills fish.

Stormwater: Refers to rainwater as well as water from washing cars, over-watering lawns, and other sources. Stormwater can carry pollution directly into our natural water resources.

Thermal Pollution: Discharge of heated water from industrial processes that can kill or injure aquatic organisms.

Turbidity: A cloudy or murky condition in water due to suspended sediments or organic matter.

Watershed: An area of land that drains into a particular body of water.

Wetlands: An area that is saturated by surface or ground water with vegetation adapted for life under those soil conditions, such as swamps, bogs, fens, marshes, and estuaries. Wetlands can be natural or human-made, also known as **constructed wetlands**.

Zooplankton: The portion of the plankton community comprised of tiny animals; e.g. jellyfish, fish larvae, and crustaceans.

References

United States Environmental Protection Agency. 1993. *Voluntary Estuary Monitoring: A Methods Manual.* EPA 842-B-93-004

United States Environmental Protection Agency. 1997. *Volunteer Stream Monitoring: A Methods Manual.* EPA 841-B-97-003

Mitchell, Mark K., Stapp, William B. 1996. *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools.* Dubuque, Iowa: Kendall/Hunt Publishing Company.

North Carolina Department of Environment and Natural Resources, Office of Environmental Education. 2002. *Discover North Carolina's River Basins.* For information contact The Office of Environmental Education, 800-482-8724 or 919-733-0711

GLOBE. 1997. *Hydrology Investigation: A GLOBE Learning Investigation.* For information contact the GLOBE program at 1-800-858-9947.

Water Environment Federation. 1998. *Water Sourcebook: A Series of Classroom Activities for Grades 6-8.*

Coulombe, Deborah A. 1984. *The Seaside Naturalist: A Guide to Study at the Seashore.* New York, New York: Fireside Publishing

S.C. Sea Grant Extension Program, Clemson Extension. *South Carolina Coast-A-Syst: An Environmental Risk-Assessment Guide for Protecting Coastal Water Quality.* For information contact Farm-A-Syst/Home-A-Syst Programs at: 1-608-262-0024

Firehock, Karen. 1995. *Hands On Save Our Streams: The Save Our Streams Teacher's Manual for Grades One Through Twelve.* For more information, refer to their website at www.saveourstreams.org.

www.wikipedia.com. Retrieved August 2007.

Please photocopy or download this sheet and fill out the copied worksheet, since other teachers will be using this resource.

Scheduling Worksheet

1) Name of group (school): ____

2) Contact Person: ________________ ___________________________
   name phone (work) (home)

____
Address

3) Day/date request: ____

4) Number of students: _________

5) Number of chaperones: _________
   (Note: We require one adult for every 10 students)

6) Areas of special emphasis:_______________________________________

7) Special considerations of group (e.g. allergies, health concerns, physical limitations):

____

8) Please use the parental permission form provided on the following page. There is a photo release portion that must be returned to Airlie Gardens.

Call the Environmental Education Office at 910-798-7564 to schedule a fieldtrip, fax a completed form to 910-256-5083, or email nmitchell@nhcgov.com if you have questions.

- -

I, ____________________________, have read the entire Water Quality Environmental Education Learning Experience and understand and agree to all the conditions within.

Return to: Airlie Gardens
Attn: Environmental Education Program
300 Airlie Road
Wilmington, NC 28403

Parental Permission Form

Dear Parent:

Your child will soon be involved in an exciting, hands-on, learning experience at Airlie Gardens. He/she will be involved in many different activities in two of our outdoor teaching areas. Please understand that insects, poison ivy and other potential risks are a part of any outdoor setting.

In order to make your child's experience as safe and enjoyable as possible, please be sure they wear clothing appropriate for outdoor activity and likely weather conditions. Comfortable, close-toed shoes should be worn. We ask that you provide us with the following information:

Child's Name: _____

Does your child:

- Have any allergy to bee stings or insect bites? _____
  If so, please have the child bring their medication and make sure that they, or a group leader, know how to administer it.

- Have other allergies? _____

- Have any other heath problems that we should be aware of? _____

  _____

In Case of Emergency, I give permission for my child to be treated by the attending physician. I understand that I would be notified as soon as possible.

_____ _____
Parent's signature Date

Parent's name: _____ Home phone_____
(Please print) Work phone _____

Family Physician's name: _____ Phone: _____

Alternate Emergency Contact:

Name: _____ **Phone:** _____

I give permission for my child to be photographed by an Airlie staff member or a professional photographer, and I allow those photographs to be used in Airlie Gardens publications and on the Airlie website.

_____ _____
Parent's Signature **Date**

Airlie Gardens Program Evaluation

Please take a moment to evaluate the program you received. Airlie Gardens is committed to providing quality programs that meet teachers' needs**. By filling out the provided form, you are helping us to achieve this goal. Please mail completed forms to 300 Airlie Road, Wilmington, NC 28403 Attn: Environmental Education Program.**

Date of Program: _____

Program leader(s): _____

Did the program meet your curriculum needs? Yes ☐ No ☐

If no, please explain:

_____

_____

How would you rate the on-site program? Excellent ☐ Good ☐ Fair ☐ Poor ☐

Comments:

_____

_____

Would you recommend this program to other teachers? Yes ☐ No ☐

Are you likely to return for a program in the future? Yes ☐ No ☐

How would you rate the pre-visit activities?

Excellent ☐ Good ☐ Fair ☐ Poor ☐ Did Not Use ☐

Comments:

_____

_____

How would you rate the post-visit activities?

Excellent ☐ Good ☐ Fair ☐ Poor ☐ Did Not Use ☐

Comments:

_____

_____

Notes