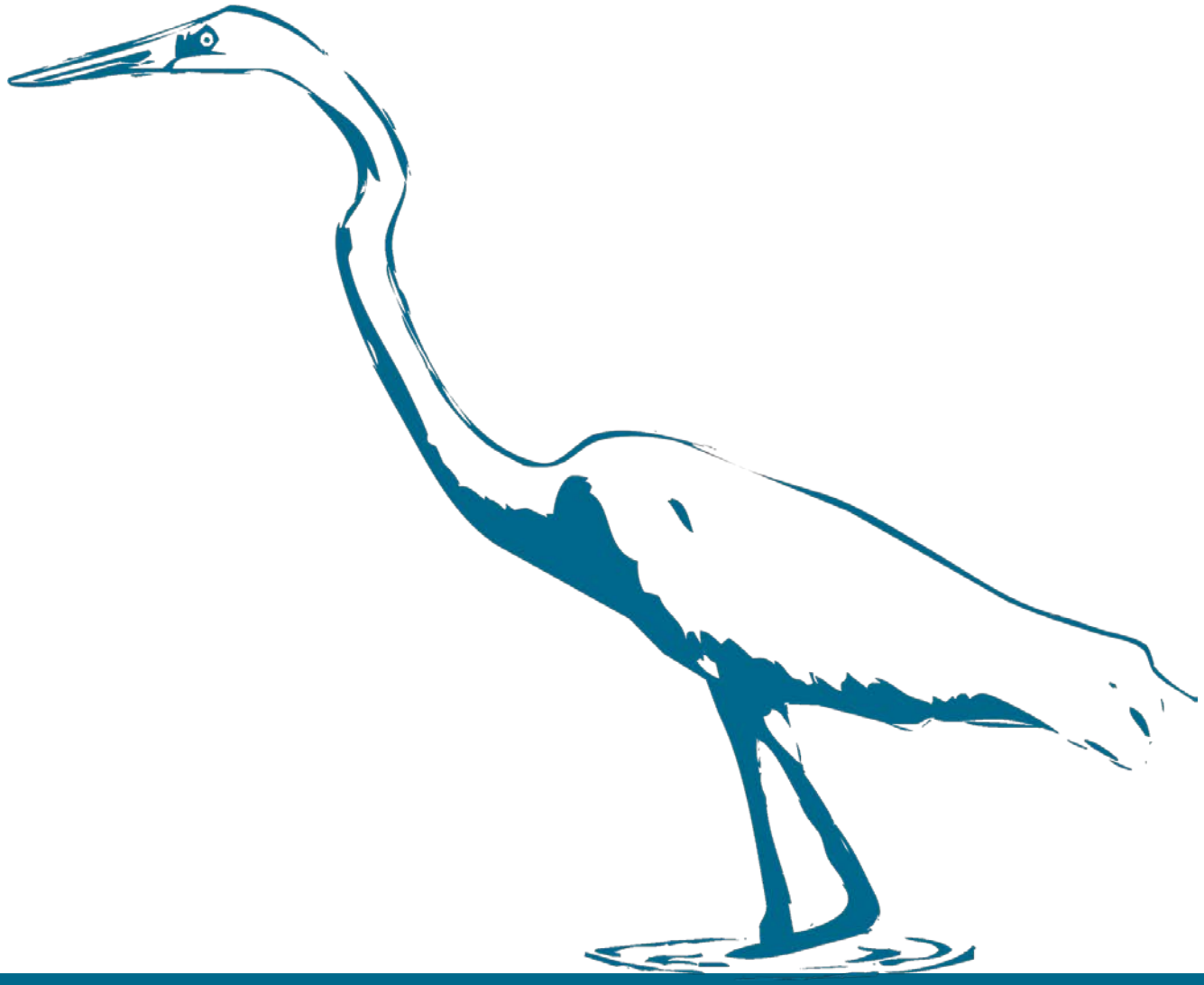
EGRET

Exploring the Geographical Region and Ecosystems of the Tar-Pamlico Watershed



Developed by the
UNC INSTITUTE FOR THE ENVIRONMENT

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EDDIE AND JO ALLISON SMITH FAMILY FOUNDATION

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Natural Environments of the Tar-Pamlico River Basin

Overview

The Tar-Pamlico River Basin is the fourth largest river basin in North Carolina. It is one of only four river basins entirely located within North Carolina. The Tar River begins in Person, Granville and Vance counties and flows in a southeasterly direction. When the river gets to Washington, it becomes the Pamlico River. The river empties into the Pamlico Sound estuary.

The land in the Tar-Pamlico River Basin is used in several different ways. Approximately 7% is developed area, 28% agriculture and 55% wetlands and forested areas. The remaining 10% is open water (river, lakes, and estuary). There are about 2,500 miles of freshwater streams that have been mapped, almost 4,000 acres of freshwater reservoirs and lakes, about 663,500 acres of estuary, and 17 miles of coastline. Wetlands can be found throughout the whole basin.

There are no natural lakes in the Piedmont, but there are a few reservoirs (lakes made by damming up a river or stream). These reservoirs provide drinking water supplies and help control flood water. Streams in the Coastal Plain are slow-moving and many go through swamps. The swamp streams often stop flowing in the summer and are stained a dark tea-like color from decomposing leaves. Because of this dark color they are called "blackwater" streams. There are a few natural lakes in the Coastal Plain, among them Lake Mattamuskeet, which is the largest natural lake in North Carolina.

The Tar River is thought to be named for the longleaf pine forests that were once an important source of tar, turpentine and other naval stores used in building wooden ships. The river was used as a major transportation route to move these products to the coast. The river is an important drinking water source for communities including Louisburg, Rocky Mount, Tarboro and Greenville. The river's name changes to the Pamlico River in Washington and is thought to be named for a local Native American tribe. At Washington, the river widens. Wind tides sometimes push salty water up this far, although generally the water is fresh. Forty miles south of Washington, the river empties to the Pamlico Sound.

The Pamlico Sound is an estuary, where the freshwater of the Tar-Pamlico River mixes with the saltwater coming in from the ocean through inlets between the islands of the Outer Banks. This mixture of fresh and salt water is called brackish water. Estuaries are nurseries for many types of fish and provide excellent habitat for oyster reefs. Young fish and crab spend their early years living among the coastal marsh vegetation and the vegetation that grows at the bottom of the sound. The blue crab is one of the most popular species fished for commercially and recreationally in the Pamlico Sound. Oysters are also found in the Pamlico Sound, although they are not as plentiful as they used to be. Many people are working hard to restore the oyster population.

Tar River Headwaters: Outer Piedmont

The headwaters, or beginning, of the Tar River are in Person County. The river begins as a freshwater spring just east of Roxboro. The river then travels in a southeast direction toward Rocky Mount. This first part of the river is in an ecoregion* called the **Outer Piedmont**. It is the most "hilly" land in the Tar-Pamlico Basin. In Granville County, just past highway 96, the river enters a narrow valley with rocky sides and boulders in the river called a gorge. After the gorge, the river slows down and widens and starts to meander, or bend and turn a lot. The bottom of the river here is made of rocks and gravel. Most land in this area used to be farms. Now there are mostly loblolly pine plantations or the trees are growing back into forests. In the Outer Piedmont ecoregion, the original forest was called an oak-hickory-pine forest. The trees you can find in these forests include white oak, southern red oak, post oak, mockernut

ECOREGION
a large unit of land that contains similar soils, vegetation and landforms where similar types of ecosystems can be found.

hickory, pignut hickory, shortleaf pine and loblolly pine. The upper part of the Tar River is home to the endangered dwarf wedge mussel. The habitat of this mussel is muddy sand of streams and rivers. It requires water movement and good water quality. Poor water quality is causing the loss of this endangered mussel.

Rolling Coastal Plain

In Nash County, the Tar River enters an ecoregion called the **Rolling Coastal Plain**. The river is still rocky until it reaches Edgecombe County. Then the river soils turn to sand, silt and clay. This region is a mixture of cropland, pasture, pine plantation and forest. The natural vegetation used to be mostly longleaf pine with smaller areas of oak-hickory-pine forest with white oak, southern red oak, post oak, mockernut hickory and pignut hickory. Near where the river passes under I-95, it begins to widen because of the backup of water from the Tar River Dam. This reservoir, called the Tar River Reservoir, is a drinking water supply for Rocky Mount.

Southeastern Floodplain

After passing through Rocky Mount, the river enters an ecoregion called the **Southeastern Floodplains**. The water slows down and the floodplain spreads out. A floodplain is the land area next to a river onto which water will spread when there are large floods and the river overflows its banks. Here the soils are made of sand, clay and gravel that have been eroded from the Piedmont and carried by the river. In this region, you will find backwater ponds and swamps. The forests here are called oak bottomland hardwood forests (which include swamp chestnut oak, cherrybark oak, laurel oak, water oak, willow oak, sweetgum, green ash, shagbark hickory, bitternut hickory, water hickory and American elm). There are also some river swamp forests with bald cypress and water tupelo. Until it reaches Tarboro, this part of the river meanders a lot.

Around Tarboro, two large streams that began in Vance, Warren and Halifax Counties join the Tar River. These streams are called Swift Creek and Fishing Creek. Before the Civil War, Tarboro was a thriving town because it was the farthest point up the river that large boats could go. It was very difficult to travel through the dense forests and swamps over land, so rivers were a main transportation route. Boats carried supplies that were brought into the region from other towns along the coastline and carried wood, tar and other naval stores back down to the shipbuilders along the coast. From Tarboro to Pitt County, the river is much straighter. This is because the river was intentionally straightened and deepened by the federal government in the late 1800's to help larger boats get up to Tarboro.

Mid Atlantic Coastal Plain

Just before Greenville, the Tar River enters the **Mid Atlantic Coastal Plain** ecoregion. This region is low, flat and contains many swamps, marshes and estuaries. This region was once dominated by longleaf pine but is now mostly loblolly pine. The river's floodplain is similar to that near Tarboro, but you are more likely to see bald cypress and sweetgum swamps along with bottomland hardwood forests (with trees such as swamp chestnut oak, laurel oak, cherrybark oak, water oak and willow oak, green ash, red maple, and a variety of hickories). The soils in this region do not drain well so agriculture is primarily pine plantation with some areas of cropland.

Natural Environments of the Tar-Pamlico River Basin

Pamlico Lowlands

At Washington, the name of the river changes to the Pamlico River. This is also where the river enters a new ecoregion called the **Pamlico Lowlands**. The river widens because of the nearly level landscape. This area can be affected by wind tides which push saltier water up the river from the sound. Some major areas of cropland are found in the region growing corn, wheat, soybeans, and potatoes. Lake Mattamuskeet, the largest natural lake in North Carolina, provides valuable wintering areas for geese, swans, ducks, and other birds.

This region also contains a lot of swamp and peatlands. The soil here is dark reddish-brown and sometimes black in color and often contains logs and stumps from bald cypress and Atlantic white cedar trees. Pocosin lakes occur in some areas. The vegetation of the pocosins contains a thick shrub layer, along with pond pine, swamp red bay, and sweet bay. Swamp forests contain swamp tupelo, bald cypress, and Atlantic white cedar. The uplands used to contain longleaf pine but now primarily contain loblolly pine and a mixture of hickory and oaks similar to those named in areas above. Fire during drought periods, logging, and construction of drainage ditches has affected natural vegetation growth.

Barrier Islands and Coastal Marsh

The Pamlico River drains to the Pamlico Sound. The Pamlico Sound is one of the largest estuaries in the United States. It has more species than the Chesapeake Bay. It is the nursery for 90% of the seafood caught in North Carolina. The sound is protected and separated from the Atlantic Ocean by the **barrier islands** we call the Outer Banks. Wetlands around the edges of the sound and behind the barrier islands are called **coastal marshes**. Maritime forests can be found growing on the remains of ancient sand dunes along the barrier islands including Ocracoke and Hatteras Islands. These forests are adapted to sandy soil with few nutrients and can handle strong, salty winds. The maritime forests include live oak, laurel oak, loblolly pine, red cedar, yaupon holly, wax myrtle and dwarf palmetto.

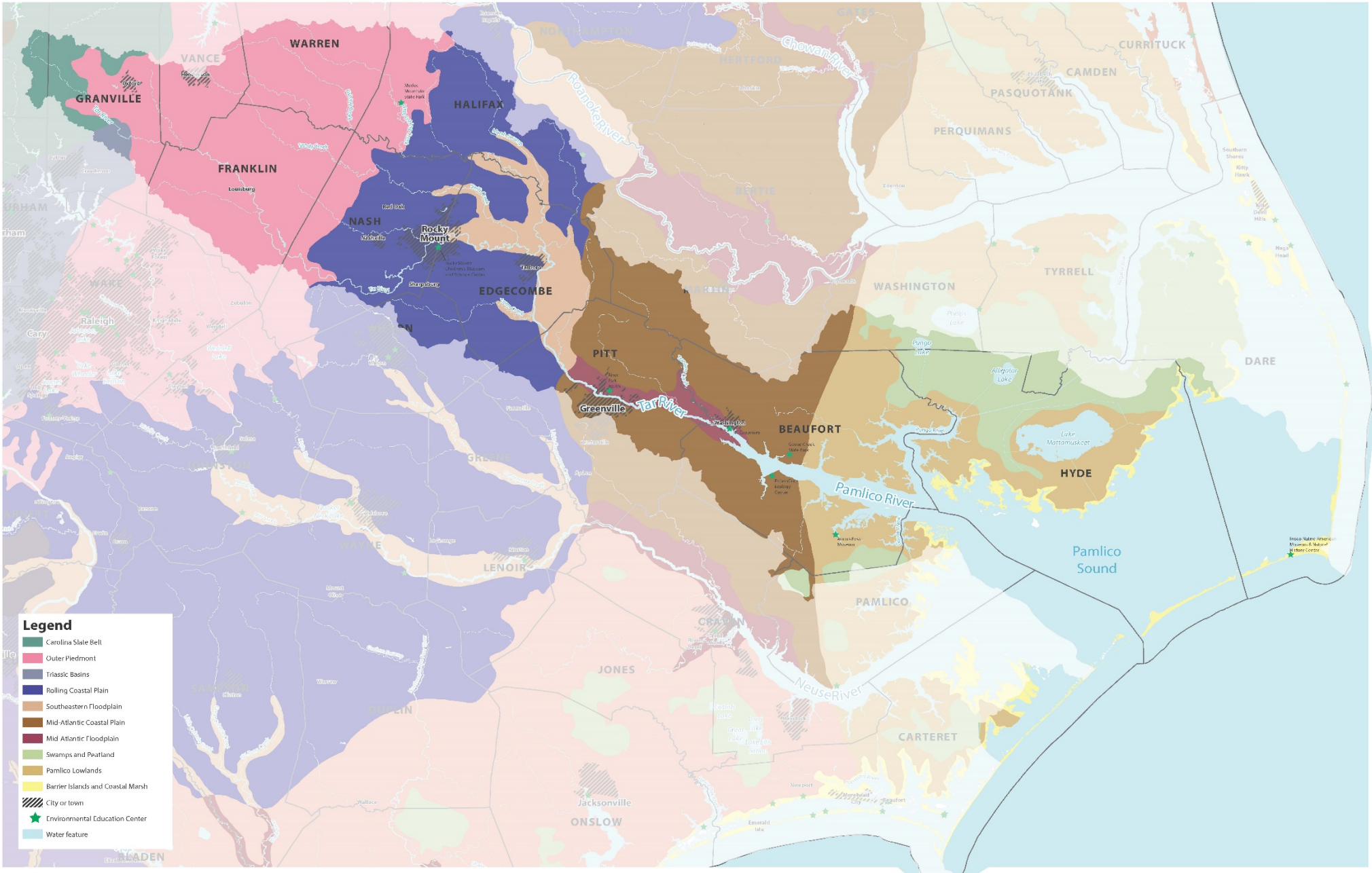
How to Identify Your Stream

Directions

Using Google Maps, locate your school. Streams are indicated by blue lines. Look for the closest blue line stream and find its name.

1. If your school is not right next to the blue line stream on the map, you will have to determine how the water gets from your school to that stream.
2. Use the Terrain feature on Google Maps. Sometimes more streams will appear but not always.
3. Now use the Earth view to see if there are any ditches or small streams you can see in the satellite photographs.
4. Finally, you may have to use a topographic map.
    - Go to store.usgs.gov.
    - Go to Map locator and Downloader.
    - Follow directions to download topo map/aerials.
    - Put name of your school in the search box, include town and state.
    - An orange bubble should appear on the map over your school.
    - You will able to see a topographic map on the screen.
    - Click on the orange bubble to see what maps are available.
    - Download the newest files, which will contain both aerials and a topographic map of what the area looks like now.
    - To see regular topographic maps, download one dated in the 1980s or 1990s.
    - Choose the download options and save to your computer.
    - Open topographic map and zoom into your school.
    - Go to Edit, take a snapshot and select the area of the map that contains the land area of your school.
    - Paste the snapshot into a word document.
5. Find out the name of this stream. If it doesn't have a name because it is too small, determine the name of the stream that it flows into. Your stream will then be called the "Unnamed Tributary to (named) stream."

Exploring the Tar-Pamlico River Basin



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Exploring the Geographical Region and Ecosystems of the Tar-Pamlico Watershed (EGRET)

Funded by the Eddie and Jo Allison Smith Family Foundation, Inc.

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We All Live in a Watershed

Alignment to NC Essential Standards

Science 5.P.1, 5.P.2

Math 5.NBT.1, 5.NF.6, 5.MD.1, 5.MD.3, 5.MD.4, 5.MD.5

Learning Objectives

- Students will be able to define watershed and the components of the water cycle.
- Students will describe how components of the water cycle occur in the school yard.
- Students will apply knowledge of the concept of gravity to determine which direction water flows.
- Students will interpret measurements to calculate area and volume of water.

Time Required:

Activity 1: 45 minutes

Activity 2: 60-90 minutes, preparation time 30 minutes

Activity 3: 30 minutes

Materials

- Wax paper or foil
- Spray bottles
- Markers
- Temporary spray paint or chalk
- Meter measuring tape
- One or more compasses
- Flags, beanbags or other items to mark corners of the plots in activity 2
- 1 copy per student of *Water's Amazing Journey* Worksheet
- 1 copy per group of 4 students:
  - *Schoolyard Plot* Worksheet
  - *Volume of Rain Fall* Worksheet

Vocabulary

water cycle, watershed, runoff, infiltration, evaporation, transpiration, gravity, volume, precipitation

Overview

We all live in a watershed, which is defined as an area of land that drains to a common point. Every piece of land is part of a watershed. Our homes, schools, businesses and natural areas are located within a watershed. Everything we do from planting trees to paving parking lots, from throwing trash on the ground to ensuring our car does not leak oil, has an impact on the quality of our watershed. In a learning context, watersheds enable us to cover the water cycle while also including gravity, volume and ecosystems. In addition, watersheds provide an opportunity to study human impacts on the physical environment and also understand how human settlement patterns were and are shaped by the physical environment.

Background

A watershed is an area of land that drains to a common point. A watershed can be very large, such as the watershed (most commonly called a basin) of the Tar-Pamlico River, which drains to the Pamlico Sound. A watershed can also be very small. A grassy patch in the school yard that drains to a low spot where a puddle forms can be considered a watershed for that puddle. **Watersheds are separated by landforms that form high points.** When it rains, the water will run from the high point toward the lowest point, due to **gravity**.

In the lesson, *Observing Ecosystem Response to Human Activity*, students will explore the ecosystems that were in place on the school grounds before the school was built. They will also observe changes in a variety of physical factors after the school was built. These changes can alter the movement of water and thus the **water cycle** on school grounds. On school grounds with more pavement and concrete and less vegetation, rain water (**precipitation**) will move quickly as **runoff,** over the surface of the landscape toward the lowest point which is the nearest storm drain, drainage ditch or stream. When the vegetation remains in place, water soaks into the ground (**infiltration**) or is taken up by the roots of vegetation. Without vegetation to slow water down, the amount, or **volume,** of water increases and speed increases, enabling water to carry a large amount of material with it. It can scour chemicals off the pavement, erode soil and carry large debris down the landscape and into our streams, rivers and lakes. Water can even absorb heat from pavement and transfer it to the nearest

aquatic ecosystem. Understanding how rain water moves through the school yard as runoff is critical to understanding how nearby streams and rivers may become polluted.

Preparation

- For Activity 1: Photocopy *Water's Amazing Journey* worksheets, handouts and gather materials.
- For Activity 2: Go out to the school grounds in advance and identify areas of the outdoor landscape where students can work safely. Use temporary spray chalk or other markings to indicate one corner of what will end up being a 5 x 5 meter plot (which the students will delineate). To make it uniform, mark the top right corner so you can direct the students to all work in the same direction. It is best (but not necessary) if each plot contains a mix of surfaces such as pavement, grass, and trees.

Procedure

ACTIVITY 1

Understanding How Water Moves

Time: 45 minutes

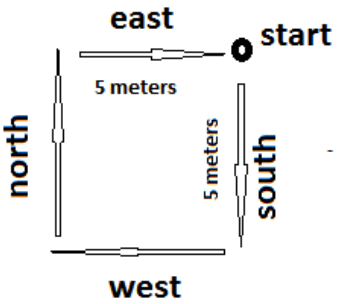
1. Post this definition of watershed: *A watershed is an area of land that drains to a common point. Watersheds are separated by landforms that form high points.* Ask: what direction does water move? It moves down, due to gravity, through the processes of runoff and infiltration. Water can move quickly as runoff over a paved surface or slowly, if it lands on forested ground and infiltrates the soil. Even when not easily observed, water moves down slope. Have students complete the activity *Water's Amazing Journey* and discuss the results.
2. Ask students: *what processes of the water cycle can make water move up?* Evaporation and transpiration. These processes cause water to move out of the ground and into the atmosphere. (Note that activity 1 focuses only on water movement at ground level).
3. Demonstrate water moving over landforms using a paper model. Have each student gently crumple a piece of wax paper or tin foil and then undo it. Ask them to draw lines on the tops of the paper ridges with marker. Ask them to draw arrows that point which way they think water would move. Finally, have them put an x at the low points where they think the water will pool. Now have them gently spray water with a spray bottle straight down on their paper and observe where the water moves. Were their predictions correct?

ACTIVITY 2

Determining Water Flow

Time: 60 to 90 minutes

1. Prior to taking the students outside, identify areas of the outdoor landscape where students can work safely. Use temporary spray chalk or other markings to indicate one corner of what will end up being a 5 x 5 meter plot (which the students will delineate). To make it uniform, mark the top right corner so you can direct the students to all work in the same direction. It is best (but not necessary) if each plot contains a mix of surfaces such as pavement, grass, and trees.



2. Divide the students into small teams (4 per plot). Using a compass and meter measuring tape, instruct each group to measure out a 5 x 5 meter square plot, assuming the chalk mark you made is the upper right corner of the plot. Use the compass to help make 90 degree angles. (See diagram below.) Give the students flags, beanbags or more spray chalk to mark off their other 3 corners.
3. Distribute *Worksheet 1: Schoolyard Plot*. Have the team draw their plot on the worksheet, indicating which way is north. Have each team calculate the total area of the plot.
4. Have students estimate, as best they can, how much of the plot area is covered with different land surfaces (pavement, grass, plants, shrubs, trees) and draw those on the map. Ask them to estimate the percentage of each surface type and write that down. The worksheet divides the plot into 25 squares, each representing 1x1 meter. Using this information, the students can count how many squares are covered with a certain land surface and then work out the fraction and percentage of the total plot.
5. Ask students to determine which end of their plot has the highest elevation and tell them to place an x on the drawing at the place with highest elevation.
6. Now ask them to imagine it is raining, and based on what they know about runoff, infiltration, evaporation and transpiration, what do they expect the rain to do when it hits their plot? If it runs off, which direction will it move? Have them draw arrows on their map indicating the direction of runoff. Note that even water that does not visibly runoff on the surface will infiltrate the soil and move down slope. Have them indicate that direction with arrows. Do they expect any evaporation or transpiration to take place on their plot?
7. ***Hint for which way water flows if the slope is not obvious***: All water that runs off the school grounds will go to the closest storm drain or ditch, which empties into the closest stream. Have students identify this stream. (Directions on how to identify your stream are at the end of this lesson.) The stream may not be big, it may even look like a ditch, but it is the lowest point and will move water to the next point, which will be a bigger stream and eventually the river.

ACTIVITY 3:

Measuring Volume of Rainfall

Time: 30 minutes

Determine the volume of water that falls on the student's plots using Worksheet 2: Volume of Rainfall.

1. Start with the area of their plot, which they have already calculated.
2. Provide students with average annual rainfall for your area. (Louisburg 45 inches, Rocky Mount 44 inches, Greenville 49 inches, Washington 49 inches). Make sure to convert measurements to meters. You can find average annual rainfall for other towns at this site: http://www.usclimatedata.com/climate/north-carolina/united-states/3203.
3. Multiply average rainfall by area of plot. Volume should be recorded in cubic meters (m^3).
4. Determine how many showers they could take with the volume that falls on just their plot each year. A 5 minute shower uses about 95 liters of water.

We All Live in a Watershed

DISCUSSION

As the students have probably experienced, even the amount of water coming through a hose can move a lot of dirt and oil on the ground. Water cleanses the parking lot and grassy areas, but it also carries the dirt and chemicals into the stream. This process of rain water washing off dirt and pollution from the land and carrying it to the streams, rivers, lakes and oceans is called *nonpoint source pollution* because there is not one point of pollution, it is an accumulation of pollution coming off the school yard, grass playing fields, parking lots and rooftops. If we can slow the water down, it will have less power to move a lot of pollutants. If the water can soak into the ground, the pollutants will settle in the soil and not be carried into water bodies.

Extensions

Confirming the movement of water

For activity 2, if weather permits, during a rainstorm, create a video of the movement of water on the student's plots. Show the class the video. Did the stormwater runoff move as they predicted? Another option is to bring a 5 gallon bucket of water outside, or a hose with a spray attachment and have the students pour the water onto their plot to see what happens.

Calculating total volume of water

In activity 3, unless the students' plots were heavily vegetated, most of the precipitation will move downslope toward the stream. In this activity, you will determine how much total volume of water will move to the stream during a 1-inch rainstorm.

- Add all of the student plot areas together.
- 1 in = 0.0254 m so determine total volume of water for a 1-inch rain.
- Convert to liter where $1m^3$=1,000 liters.
- Convert to kilograms where1 liter = 1 kg. Determine how many kilograms of water moves into that stream during a 1 inch rain from your plots.
- Convert kilograms to pounds. 1 kg = 2.20462 lbs.
- Just for comparison, the average car weighs 3,500 lbs.

Assessment

Have students draw a landscape in which they think the water will move most slowly toward the stream. They may incorporate trees and plants to include transpiration and vegetated soils that do not erode but enable infiltration. Ask them to label the drawing identifying biotic and abiotic features and include vocabulary used in the lesson. Have them write a paragraph explaining why they included what they did in their landscape.

We All Live in a Watershed

WATER'S AMAZING JOURNEY Worksheet

We have learned that water will flow down toward the lowest point.

But what determines how fast it will get there? Take a look out the window at the different types of ground surface. You might see pavement, dirt, grass and maybe leaves or pine needles if you're near a forest. Differences in the ground's surface will control how water flows on the ground.

Let's look at a few examples:

Pavement

Pavement makes travel safe and fast because it is a very durable surface for our streets and parking lots. However, pavement in the wrong place can be harmful to water. What happens when rain falls on pavement? Because it is a smooth surface and does not allow water to soak in, water becomes runoff on pavement. That's why we have to be smart about where and how we plan our new roads and parking lots.

Grass

Grass will slow water down far better than pavement. However, when we get a lot of rain at one time, grass can't hold all the water long enough for it to soak in, causing some runoff. Remember, runoff can carry pollutants with it. What pollutant can come from a lawn? Fertilizers can help your lawn stay healthy and green, but they aren't good for our streams. If we are careful with how much fertilizer we use, we can have healthy lawns and healthy streams.

Forest

We have saved the best for last. What happens to rainfall in a forest? Before it can even get to the ground, it is slowed down by the tree tops, branches and leaves. Once the rainfall does get to the ground, it contacts a thick layer of leaves and mulch that act like a big sponge, slowing the water down and allowing it time to soak into the soil. Many times, runoff in a forest is so small that it's hard to see. Since water gets filtered by the forest soil, the best water quality usually comes from a forest.

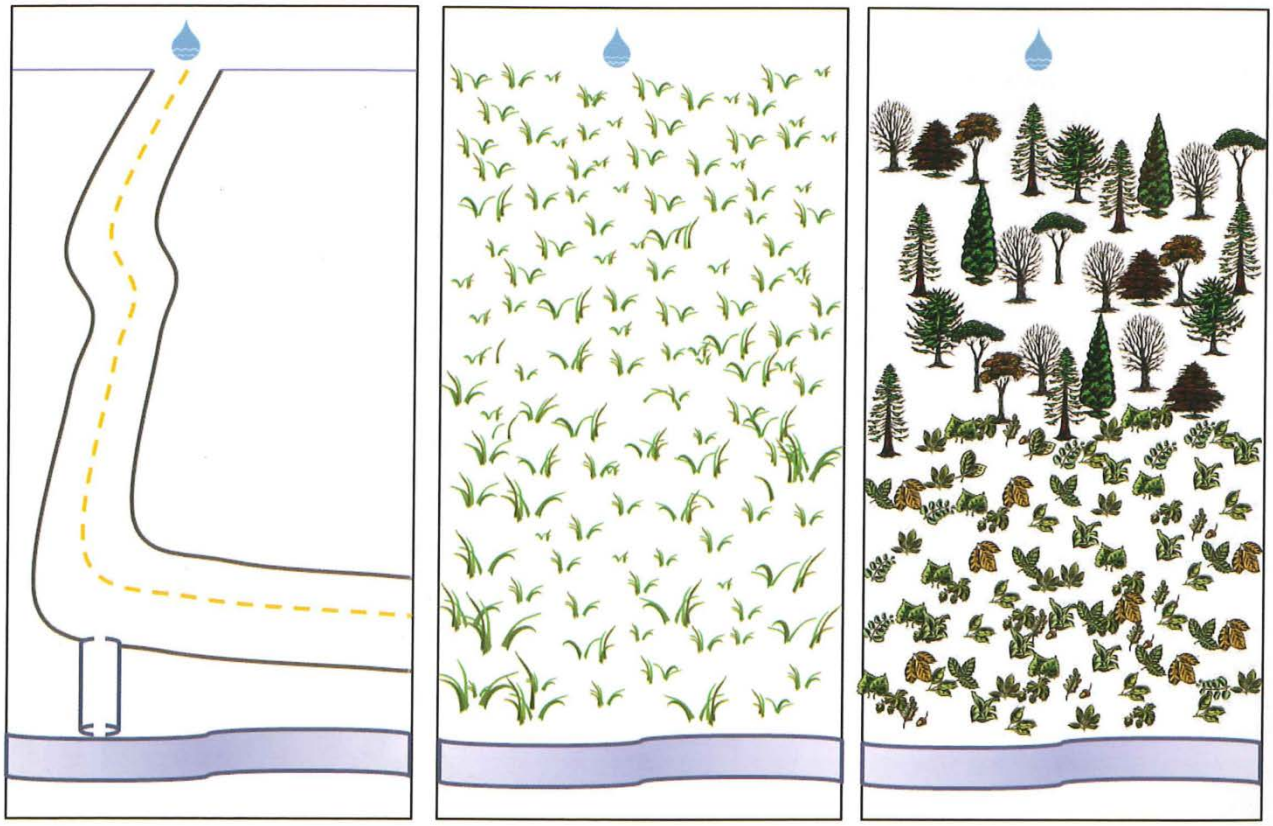
Trees aren't just for the woods!

Urban areas, such as towns or cities, have a lot of paved surfaces. As you now know, all that pavement can create lots of runoff which can harm streams and cause flooding. City managers are realizing that trees and forests can help fix these problems. By taking care of existing trees and planting new trees in the city, the amount of runoff from pavement can be reduced before it reaches the stream. Plus, trees offer shade, help to clean our air, provide a home for animals, and simply make the city a nicer place to be.

We All Live in a Watershed

WATER'S AMAZING JOURNEY Worksheet

You will see three simple mazes below. Draw a line that connects the water drop to the stream without touching any lines or objects in the maze. Measure how much time it takes to complete each maze.



How long did it take you to complete each maze?

Which one was the fastest: pavement, grass or forest?_____

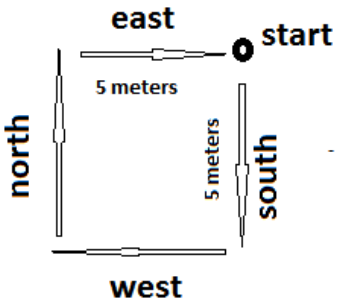
Which one was the slowest: pavement, grass or forest?_____

Next time it rains, watch how the water moves across the different surfaces around your home or school. You will be surprised how much you can learn about your environment just through what you see around you.

We All Live in a Watershed
SCHOOLYARD PLOT Worksheet

Team Members _____

1. Use the drawing to the right as a guide. Measure a 5 by 5 meter square. From the start point, use a compass to walk directly south for 5 meters. Mark that corner. Now walk west 5 meters. Mark that corner. Now walk north for 5 meters and mark that corner. You should now have a 5 x5 meter square.



2. Use the square on the back of this page to draw your plot following the directions below.

3. Turn your drawing so that the top is facing north.

4. You should have measured a 5x5 meter plot. What is the total area of your plot?_____ m^2

5. Decide which part of the ground in your plot is highest. Place an X on your drawing to show where the highest point of your plot is located.

6. Look at the different types of ground surfaces in your plot. How many different types are there? List all under your plot drawing.

7. Draw the different surface types onto your plot drawing and label them. Use the small squares to help you show the amount of different types of land surface. How much of your plot is covered by each surface type? Estimate your answer as a percentage of the whole plot. Write down the percentage of each below your drawing.

8. Imagine it is raining. What will the rain do when it hits each type of surface in your plot? For each surface write down what process you think will take place: **T**ranspiration, **E**vaporation, **R**unoff or **I**nfiltration. More than one process may happen on each land surface type. Write T, E, R or I on each surface type in your drawing.

9. If you expect runoff to take place, draw arrows showing which way the water will move down slope. (Hint: If you marked an X at the highest part of your plot, the water is going to move away from that high spot.)

We All Live in a Watershed
SCHOOLYARD PLOT Worksheet

N

Surface type 1 _____ % cover _____

Surface type 2 _____% cover _____

Surface type 3 _____% cover _____

Surface type 4 _____% cover _____

We All Live in a Watershed
VOLUME OF RAIN FALL Worksheet

Name _____

1. What is the area of your plot? _____m^2

2. Write the average annual rainfall (given to you by your teacher in inches) _____in.

3. Convert inches of rainfall to meters _____m

4. Multiply the area of your plot by the meters of annual rainfall _____m^3

5. 1 m^3 = 1,000 liters. How many liters of water fall on your plot? _____L

6. A five minute shower uses about 95 liters. How many showers can you take with the amount of water that falls on your plot each year? _____

Where does the water go?

If your plots were all forested, what would happen to the water?

Exploring the Waters of the Tar-Pamlico

Alignment to NC Essential Standards
Science 4.L.1, 5.P.2, 5.L.2.1
Social Studies 4.G.1, 5.G.1.1, 5.G.1.2, 5.G.1.3
Language Arts W.5.1, W.5.2, W.5.3, SL.5.1, W.5.10

Learning Objectives
- Students will identify components of a river system.
- Students will demonstrate an ability to find their location within the river basin using online resources and mapping tools.
- Students will describe the importance of water for human settlement.

Time Required:
Activity 1: 40-60 minutes
Activity 2: 40 minutes

Materials
- 1 copy per student or group of:
  - *Natural Environments of the Tar-Pamlico Basin* handout
  - *Mapping The Waters Worksheet*
  - *How To Identify Your Stream* handout
- Tar-Pamlico Basin map
- Computer and internet access to Google Maps
- Dot stickers or push pins

Vocabulary
headwaters, spring, reservoir, dam, riverine, ecosystem, floodplain, inlet

Overview

In the lesson *We All Live in a Watershed,* the students learned about watersheds, that their school grounds are part of a watershed, and that a significant amount of water drains from the school grounds and into the nearest body of water. In this lesson, the students will learn about the Tar-Pamlico watershed specifically by exploring maps and identifying key water features, which are important elements in understanding how physical environments influence human activity. Water is one of the primary physical elements that shaped early settlement patterns and continues to shape how we build our roads and communities today.

Background

The lesson will closely follow information in the *Natural Environments of the Tar-Pamlico River Basin* handout. The students will explore the basin from the headwaters to the sound to get a sense of the landscape from the perspective of the water. Because water is now piped to our homes or pumped from a well, we are not as aware of the location of water sources as were early settlers. Water used to serve as a key form of transportation (or a barrier to transportation), another quality that we do not think much about now that we have roads and bridges throughout the state.

Water is also a major component of aquatic ecosystems, which process large amounts of carbon and nitrogen, provide habitat for aquatic insects (which later, many become flying insects) and fish, and provide food for birds and humans alike. Clean water and healthy aquatic ecosystems are essential to our health, our communities and economy. But as we learned in the prior lesson, it is difficult to keep water clean when runoff carries pollution to streams.

Preparation

The first activity works best if students can explore the online maps on their own or with a partner, so plan to use the computer cart or schedule time in the computer lab and set up website links ahead of time.

Procedure

ACTIVITY 1
Mapping the Waters
Time: 40-60 minutes

1. Hang the Tar-Pamlico River Basin map on the wall, ideally over a corkboard if you are going to use pins to mark the locations. *Note: The students can find many items just looking at the wall map but will likely find it more engaging if they get a chance to "explore" these sites using Google maps terrain and earth features.*
2. Split students into small groups, and make sure each group has access to Google Maps or Google Earth. This activity can also be completed using a new tool developed by the NC DEQ Office of Environmental Education specifically for EGRET participants' exploration of the Tar-Pamlico watershed: http://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=6b03c62763074346957e6c5096814bee Students can choose to display different layers on the map to identify county boundaries, water bodies, ecoregions, environmental education centers, and other information.
3. You may also wish to share the *Natural Environments of the Tar-Pamlico River Basin* handout, which will provide some answers for the students.
4. If using the online map, have students work through the *Mapping the Waters* handout in small groups. Then, as a class, walk through the handout and have students come up to mark the location on the wall map using sticky dots or push pins.

ACTIVITY 2
Connecting School Grounds to the Watershed
Time: 40 minutes

1. Using the directions in the *How to Identify Your Stream* handout, locate the nearest stream to your school. You may find that water moves through ditches and then to a stream or the river or perhaps directly to the sound, if you are in the lower coastal plain. If your school is in an urban setting, the water may move through stormwater pipes, underground.
    - Ask students if they think the water that runs off their school yard and downstream will make it all the way to the ocean.
    - Brainstorm with students how water may be diverted from reaching the ocean. Examples could include removal for drinking water, industry or agricultural use, capture in a reservoir, evaporation, taken up by plants and transpired.
    - Have students imagine that they were going to take a canoe or kayak and travel all the way to the ocean from their schoolyard. Ask them to write about the obstacles they might encounter. Students could also make a map of their imaginary journey, noting obstacles along the way.
2. Ask students to consider where their school is located in light of the following questions.
    - If they did not have piped water and had to carry it from a nearby stream or river, would they place their school where it is now? If not, where would they consider placing their school?
    - What are some technologies that have been developed since the 1700s, when early settlers were coming to this area, that enable us to place our homes and schools farther away from the waterways?

Extensions

Where does your drinking water come from and where does it go?

Students can research online where their school drinking water comes from. Does it come from a well or surface water? Who collects the water and makes sure it is clean? Start with the school administration or head of maintenance to find out if your water comes from a well or a public water supply. If you are receiving municipal water, the city or town should have a website that describes where they get the water. Students can research this online starting with the UNC-TV Drinking Water Resilience Project site: http://drip.unctv.org/maps/.

Mapping the water of a river basin

Have students develop their own tour of a river basin. Key locations they should identify include the headwaters, dams or other features that obstruct the main river, changes in ecoregions (which often mean a change in topography and land uses), large streams entering the main river, where the river ends and any other interesting features, such as their school location.

Assessment

- Review completed worksheets to assess student understanding of concepts and proficiency using Google maps.
- Evaluate the students' responses to activity 2.

Exploring the Waters of the Tar-Pamlico

MAPPING THE WATERS Worksheet

Name(s)_____

1. Identify the location of your school on the map.

2. The headwater of a river is where it begins. The headwaters of the Tar River begin in Person County as a freshwater spring, just east of Roxboro. Use the Google Maps terrain feature to locate the headwaters. (Hint: Start in Louisburg where the river is easy to see and follow it up, toward the northwest. When the blue lines split, zoom in enough to see which line is labeled Tar River.) Once you find the headwaters, switch the map to earth view and look at what the landscape looks like. Is it forest, farms, homes, businesses? What evidence do you have to support your conclusions?

3. If you follow the river southeast of Louisburg, there is a lake called Lake Royale. Explore the lake on Google maps. Is it a natural or human made lake? What evidence did you locate to support your conclusion?

4. What stream flows through Medoc Mountain State Park? Where does that stream enter the Tar River?

5. Find the Tar River Reservoir on Google Maps. Locate the dam. To which city does the reservoir provide water? Research the Tar River Reservoir on the internet and write one interesting fact here.

6. After passing through Rocky Mount, the river enters a riverine ecosystem called the Southeastern Floodplains where the water slows down and the floodplain spreads out. Can you find that on the Tar-Pamlico wall map? Using Google Maps Earth view, follow the river out of Rocky Mount. Can you see how the land use changes to more agriculture? Why do you think that happens?

7. Where does the Tar River change names to the Pamlico River?

8. What is the largest natural lake in North Carolina? Find it in the Tar-Pamlico River Basin.

9. Locate Goose Creek.

10. If you were taking a boat from Bath to the Atlantic Ocean, what is the nearest inlet that you could use to get to the ocean?

Observing Ecosystem Response to Human Activity: *An Exploration of the School Yard*

Alignment to NC Essential Standards

Science 4.L.1, 5.P.2.1, 5.P.3.1, 5.E.1, 5.L.2
Social Studies 4.G.1, 5.G.1.2
Language Arts CCSS.ELA-Literacy.RI.5.7, RI.5.9, W.5.2, W.5.7, W.5.8, SL5.1, SL5.4
Math 5.G.1, 5.G.2

Learning Objectives

- Students will demonstrate an ability to collect and use quantitative and observational data to describe their school yard.
- Students will explain the positive and negative impacts of the school on the physical environment.
- Students will describe the local ecosystem and changes that have occurred.

Time Required

Activity 1: 60 minutes plus time to write essay, preparation 60 minutes
Activity 2: 90 minutes
Activity 3: Two 60 minute sessions

Materials

Tar-Pamlico Basin map
Topographic maps of school
Aerial photos from before school was built
1 copy per student or group of:

- *Maps Can Tell You Where the Water Is*
- *Natural Environments of the Tar-Pamlico River Basin*

For each group:

- *Common Forest Trees of North Carolina*
- *Schoolyard Observational Data* Worksheet
- one or more compasses
- one or more infrared thermometers
- one meter measuring tape
- small paper cups
- one notebook for data collection

Vocabulary

Ecosystem, conduction, convection, temperature, evaporation, topography, habitat, ecoregion

Overview

We come and go from our school every day without thinking much about the building locations and how the building and parking lots affect the land, water and ecosystem around us. Yet the school yard, parking lots, fields and school buildings provide ample opportunities for students to study ecosystems, the water cycle, weather, geography and environmental literacy.

Background

Have you ever wondered what the land was like around your school before it was a built? During construction of schools or other buildings, the landscape is commonly manipulated. Trees are removed, low and wet areas are filled in, hills are levelled, and streams are piped; but there are always clues as to what the land looked like before the building existed.

Depending on where you are located, the local town or county planning office may have maps and aerial photos for you to use. Topographic maps are helpful and often you can find maps that were drawn before the school was built. These maps are a primary, accurate source of historical information for your landscape. Aerial photos are also informative. Further directions on how to obtain this information are included in the preparation section.

In addition to modifications to the physical environment during school construction, once the building is there, it can affect temperature and movement of water and microclimates, creating new habitat conditions.

Preparation

For the first activity, obtain aerial photographs and topographic maps using one of the methods described below. If you are computer savvy, one of the first two methods may be easiest. However, contacting your local planning office (described in 3 and 4) will enable you to talk to a professional who should be able to provide you with what you need.

Parts of this lesson adapted from The MINTS Book, Chapter 5. Roofs, Walls and Eaves, Virginia Tech Museum of Natural History

Observing Ecosystem Response to Human Activity: *An Exploration of the School Yard*

1. If your school was built after 1993, Google Earth may have the historic aerial photos that you need.
2. For recent aerials and historic topographic maps, go to store.usgs.gov
    - Go to Map locator and Downloader.
    - Follow directions to download topo map/aerials.
    - Put name of your school in the search box, include town and state.
    - An orange bubble should appear on the map over your school.
    - Click on the orange bubble to see what maps are available.
    - Download the newest files, which will contain both aerials and a topographic map of what the area looks like now.
    - Download the older file option to see topographic maps from years past.
    - Choose the download options and save to your computer.
    - Open topographic map and zoom into your school.
    - Go to Edit, take a snapshot and select the area of the map that contains the land area of your school.
    - Paste the snapshot into a word document.
3. You can also contact the town or county GIS office. Tell them you are looking for historical aerial photographs of the area where your school now sits in order to see what was there before the school was built. It is helpful to know when your school was built so the GIS professional can find aerials before that time. You can locate links to your county or town GIS website here: https://www.lib.ncsu.edu/gis/counties.html
4. If your school is in a rural setting, you may also contact your county Soil and Water Conservation District office. They typically have aerial photos of all agricultural lands in a county.

Procedure

ACTIVITY 1
Understanding the Natural Landscape of Your School Grounds
Time: 60 minutes plus time to write essay

1. Review the concept of ecosystem with students. An **ecosystem** is the interaction between a **community** of living (biotic) things and the nonliving (abiotic) environment. Ecosystems can be small or very large.
2. Using the *Tar-Pamlico River Map*, ask your students to determine the ecoregion in which your school is located. An **ecoregion** is a region that contains similar soils and landforms where similar types of ecosystems can be found. Ecoregion boundaries follow the original extent of ecosystems prior to major changes of the land. For another basin, find your ecoregion and other key information on this map developed by the NC Office of Environmental Education and Public Affairs: http://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=6b03c62763074346957e6c5096814bee.
3. Next, tell the students they will learn about the native trees that existed on your school property prior to the school being built. *Natural Environments of the Tar-Pamlico River Basin* will provide sufficient description for the students to determine which native trees existed on your school property. Ask students to name those trees and use the tree identification book or online sources to see what they look like. A good guide is *Common Forest Trees of North Carolina: How to Know Them*, http://ncforestservice.gov/publications/IE0112.pdf. Look at the extension section for more ideas on integrating trees on school grounds into your activities.

4. Use the handout, *Maps Can Tell You Where The Water Is*, with your students to gain a basic understanding of topographic maps so they can use one to look for streams, buildings, ponds and hills. Ask your students to determine if the natural landscape of the school was hilly or flat. The class can observe a natural area nearby to make this determination, use topographic maps to see if the contour lines are close together (hilly) or far apart (flat) or read the description in *Natural Environments of the Tar-Pamlico River Basin*.
5. Have your students examine old aerial photo or topographic maps to find out what was on the land before the school was built. Can they see any streams or wetlands? Was it forested or farmland?
6. Essay: Using the information they have gathered (depending on where you live and what studies have been done in your area, more information will be available in some areas than others), ask the students to write an essay describing what they imagine the footprint of the school building and parking lot looked like before anything was built. They should describe the trees, the topography (whether it was hilly or flat), and the animals. (Students do not have to know specific species names.) Ask them to also include water sources (river, streams, wetlands) and describe them.
7. Now ask a few students to read their essays and, as a class, discuss what evidence they used to inform their description of the landscape. What additional information would they like to have to get a better idea of what was here before the school?

ACTIVITY 2
Making Observations and Drawing Conclusions

Time: 90 minutes

1. Tell the students that in Activity 1 they did what an ecologist does before going out to do research. The ecologist studies available resources at his or her desk before going out to "the field." Now it is time for the students to go out and make their own observations and collect field data.
2. Before going outside, tell the students that they are going to make observations about the school building and the physical environment closest to the school building. Discuss with students what they may observe and the kind of data they may collect, using the following questions:
    - On which part of the school building does the sun shine during the hottest part of the day? (The walls of the building can absorb sunlight depending on what it is made of, and what color it is.)
    - From which direction is the wind coming? What part of the building does the wind hit?
    - Observing the vegetation around the school building, is it the same now as it was before the school was built?
    - Do you expect to see animals? What kind?
3. Go outside and have the students walk around the building. *It is best if you take them outside during a time of day when the sun is shining on one side of the building.* First they will collect observational data. Use worksheet titled *Observational Data* as a guide.
4. Once they've made observations and filled out the worksheet, find a place to gather outside. If necessary you can do the next section in the classroom.
5. Use the following questions to guide discussion of their observations and draw conclusions:
    - Did you expect the building to feel warmer where the sun was hitting it?
    - What do you call the type of heat transfer when you touch the building? (Conduction)
    - Did the temperature feel warmer standing near the building? (Convection)
    - What organisms might prefer the sunny side of the building versus the shady side?

- What observations did you make to support your answers?
- Which side of the building would you prefer?
- Which side of the building was the wind hitting?
- On a windy, rainy day, on which side of the building would you prefer to stand?
- How would the side of the building you chose be different than the other side?
- Do you think other living organisms would make the same decision? Why?
- How would you describe the changes in ecosystem from before the school was built to now?
- Would you say the changes in the physical environment have been positive or negative? What reasons can you give for your answer?

6. If the class cites negative impacts, ask the students what could be done to improve the physical environment around the school. How could the original ecosystem be brought back (without removing the school, of course)? (Note: Many, but not all, schools have preserved areas around the school where forest, wetlands and streams can be found.)

ACTIVITY 3
Measuring and Recording Data
Time: Two 60 minute sessions

This activity adds more depth and requires measurements, data recording and graphing. These data the students collect may be used to support or disprove some of their conclusions from Activity 2. They should use a notebook to collect data and record observations. They should place a date and time at the top of the page each time they collect data. Various nature journaling activities can be incorporated into this activity as well as weekly data collection. You can also do this activity just once, as written.

Temperature

1. During the same time of day that they went out to make observations in Activity 2, have the students measure the surface temperature using an infrared thermometer in the following locations:
   - On the side of the building where the sun is shining
   - On the ground next to the building
   - On the grass
   - On other surface features
2. Repeat on the opposite side of the building.
3. Have the students plot the temperatures against the surface types for each side of the building.
   - Why are the temperatures different between the building surface and the grass?
   - How does this ability of the building to "hold" heat affect the local ecosystem?

Wind

1. Keep a daily log of wind speed and direction. Use a wind vane or the flag to identify the direction (north, south, east, west) the wind is blowing. You can also look up the local weather for wind direction and speed. At the same time, record air temperature and precipitation.
2. Over time, ask students if they can identify any pattern among wind direction, temperature and precipitation. Once they have more data than they did in activity 2 ask: What side of the building would living organisms prefer to live, if they couldn't move every time the wind switched direction?
3. If there is a prevailing wind – have these winds affected the type of vegetation that grows on the windy side of the building vs. the protected side (Note: prevailing winds in NC are typically from the southwest or during Sept-Oct from the northeast with average speed 8-10 mph).

Evaporation

1. After a rain, on which side of the building do the students expect the water to evaporate more quickly? To test their hypotheses, have the students place paper cups with measured amounts of water in them on the sunny and shady sides of the building. Place a cup next to the building and then every meter further away from the building. Measure and record the change in the amount of water in each cup after 24 hours.
2. Ask students to graph their results.
   - Did their results support the student's assumptions? If not, what are some reasons for the difference?
   - How does this information explain the distribution of plants and animals around the building?

Extensions

All Things Are Connected – connecting biotic/abiotic components of the ecosystem
During activity 1, the students identified trees native to your area and found pictures of these trees. To extend activity 1, assign one tree species each to a small group of students. Take them outside to walk the school property and ask each group if they can find their assigned tree on school grounds. Ask the students to examine their tree and the surrounding biotic and abiotic components. Have them draw the ecosystem components and make connections with arrows or through some other creative method to show the relationship between the tree and its ecosystem. Have them write a poem about their discoveries.

Tree ID and Compass Course
This is a fun and orderly outdoor activity that allows students to practice compass work and tree identification, which have a role in all the activities in this lesson. Prior to going out, identify 5 trees on the school grounds and post a laminated number on each tree. Set a compass course using direction and paces from a starting point to each numbered tree. Provide a group of 4 students with course directions (direction and paces to each tree), a compass, a tree ID book (to make it easier, you can provide photocopies of the pages for just those trees), and a piece of paper labelled 1-5. Have each group follow the course and when they find the correct tree (it will have a number on it), they should identify it and continue on the course. You can either send one group at a time while the others are doing another activity or you can set another course in reverse to allow more groups to work at the same time.

Roofs, Walls and Eaves, micro habitats around your school building
During activity 2, students explored the physical environment in which organisms live. If students are finding a variety of organisms on the walls and in the plants and soil along the building, you may wish to delve more deeply into the habitat needs of these organisms. For background information and discussion questions, see *The MINTS Book, Chapter 5. Roofs, Walls and Eaves, Virginia Tech Museum of Natural History,* page 151 - 176, http://www.outreach.geos.vt.edu/museum/ERCmaterials/Kits/MINTS/The%20MINTS%20Book.pdf.

Assessment

Now that students have considered the landscape and organisms before and after the school was built, ask them to reflect on the following questions either through discussion or in writing.

- How did changes in the ecosystem where the school is located affect organisms that live there?
- How did these changes affect people?
- How did the animal population change or adapt?
- How are these changes or adaptations related to the change in plants and trees?

Observing Ecosystem Response to Human Activity: SCHOOLYARD OBSERVATIONAL DATA Worksheet

Name(s)_____

What time is it? _____

Below, draw the school building as if you are looking down on it. Use a compass to find north. Now stand so the top of your paper is facing north. Make sure the arrow in the drawing area below is facing north.

Observing Ecosystem Response to Human Activity: SCHOOLYARD OBSERVATIONAL DATA Worksheet

1. Draw an arrow showing what part of the building the sun is shining on right now. Draw a picture of a sun by the arrow so you know what it represents.

2. Based on what you know about the movement of the sun, will that side of the building always get the most sun (throughout the day) or will it change? If you do not know, what can you do to find out?

3. Place your hand on the building where the sun is shining. Does it feel warm or cool? Why?

4. Use a wind vane or the flag to identify the direction (north, south, east, west) the wind is blowing. You can also look up the local weather for wind direction and speed. Draw an arrow showing what part of the building the wind is hitting right now. Write wind by the arrow so you know what the arrow represents.

5. Look against the side of the building. What types of plants are growing there? Do you see an insects, spiders or signs of animals? Describe what you see.

6. Go to the opposite side of the building. Does the building feel warmer or cooler or the same as the other side? How can you explain your observations?

7. Look against the side of the building here. What types of plants are growing on this side? Do you see any insects, spiders or signs of animals? Describe what you see.

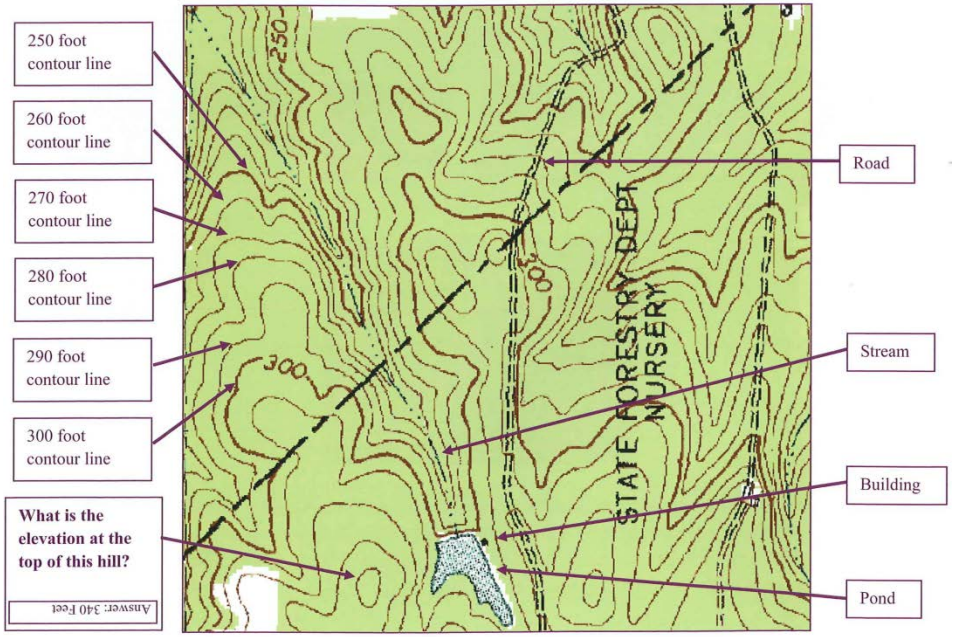
Maps Can Tell You Where The Water Is

A map can tell you a lot about your environment. You may have already seen many different kinds of maps, such as road maps, that help you find your way from place to place. When we want to learn about our environment, we often use a special map called a "Topographic Map" or "Topo Map" for short.

A topo map tells you about the shape or topography of the land. Topo maps can also show you where important land features such as roads, rivers, lakes, buildings and even hills are located. Look at the topo map below.

Can you find the pond?	Ponds and lakes are blue.
Can you find the stream?	Streams are blue dashed and dotted lines.
Can you find the building near the pond?	Buildings are small black squares and rectangles.
Can you find the dirt road?	Dirt or 'unimproved' roads are black double dashed lines.

The most important thing on a topo map is all those curvy brown lines. Those lines are called **contour lines,** and they tell us about the shape of land. Each contour line represents an elevation on the ground. For instance, look at the thick brown line that runs through the "F" in the word "Forestry" written on the map. Trace that line around to your left until you get to the number "300." That means that every place along that line is 300 feet above sea level. Each line on this map represents a difference in height of 10 feet from the one next to it. This means the line next to the 300 foot line represents 290 feet and the one on the other side represents 310 feet. Do you know which one is which? You can find out by locating the next thick brown line, which is the 250 foot contour line. If you count each line by 10 from that line back to the 300 foot line (250, 260, 270, 280, 290, 300) you will know which way is up and which way is down.



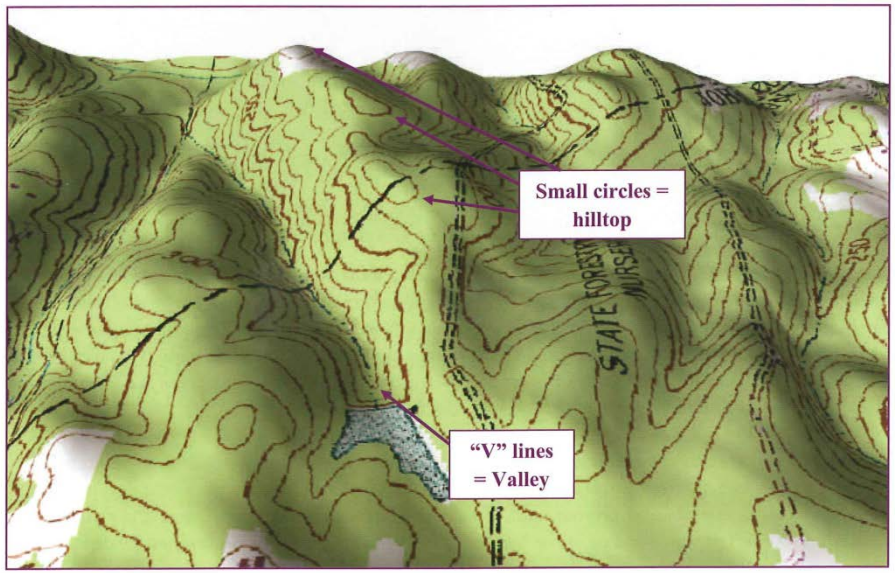
Does this look familiar? It is the same map you were just looking at. It has been enhanced with 3D features to help you understand what the land actually looks like.

Can you see the hills and valleys?

Look how the stream flows right down the lowest part of the valley, just like they do on the ground. You can see that contour lines always make a "V" where there is a valley. Because water always flows downhill, the streams flow right through the point of that "V'' in the bottom of the valley.

Do you also see where the topo lines make a small circle? Small circles mark the top of a hill.

Now, look back to the previous page and take a look at that map. You can tell all of this information from a regular topo map, too, now that you know how to read the contour lines.



Exploring the Ecosystems of Eastern North Carolina

Alignment to NC Essential Standards
Science 4.L.1, 5.L.2
Social Studies 4.G.1, 5.G.1, 5.G.1.2
Language Arts RI.5.1, RI.5.4, RI.5.7, W.5.7, W.5.10

Learning Objectives
- Students will describe and compare the characteristics of several common ecosystems found in eastern North Carolina.
- Students will compare and contrast local ecosystems found on their school grounds

Time Required:
Activity 1: 60 minutes
Activity 2: 20 minutes per ecosystem

Materials
For each student or group:
- 1 copy of *Natural Environments of the Tar-Pamlico Basin*
- 1 copy of *Ecosystems of Eastern North Carolina*
- 1 copy of *Ecosystem Datasheet*
- Thermometer
- Field guides appropriate to the ecosystems being studied

Vocabulary
ecoregion, ecology, ecosystem, estuary, salt marsh, Carolina bay, floodplain, hardwood forest, maritime forest, wetland, farm pond, barrier island, tidal freshwater marsh, food chain, biotic, abiotic, organism, biome, lake

Overview

Learning about ecosystems is more engaging when students can use local examples. This lesson provides information on a number of ecosystems specific to eastern North Carolina and the Tar-Pamlico river basin so that teachers may incorporate local ecosystems into their lessons. It also includes an activity that allows students to make observations and comparisons about the ecosystems they encounter.

Background

There can be some confusion among the various terms used to define natural communities and their surrounding environment. **Biomes** are ecological zones which are defined by the dominant vegetation that occur in particular temperature and rainfall (climate) conditions around the world. An **ecoregion** is a defined area that contains similar soils and landforms and where similar types of **ecosystems** can be found. The boundaries of ecoregions delineate the original extent of natural communities prior to major land use change by humans. Ecoregions are generally smaller and more defined units than biomes.

An **ecosystem** is the interaction between a **community** of living (**biotic**) things and the nonliving (**abiotic**) environment. Ecosystems can be small or very large. The biotic and abiotic components are linked together through energy flow and nutrient cycling. Landforms, soils, vegetation, climate, organisms, water, and nutrients all work together to create healthy, functioning ecosystems. Whether we realize it or not, many of our economies depend on healthy ecosystems.

There are still many things that we do not know about these natural systems and how human activities may be affecting them and, in turn ourselves. **Ecologists** study ecosystems in order to better understand how living and nonliving things are interconnected and how, if necessary, we can restore ecosystems that have been impacted by our human activities.

Preparation

Prior to activity 2, identify at least 3 different local ecosystems on or near school grounds that students can access and collect data.

Exploring the Ecosystems of Eastern North Carolina

Procedure

Activity 1

Introducing the Ecosystems of Eastern North Carolina

Time: 60 minutes

1. Students can work alone or in groups.
2. Review the concept of ecosystem with your students.
3. The handout, *Ecosystems of Eastern North Carolina,* describes a few specific types of ecosystems under the more general headings of forest, wetland, lakes and ponds, and coastal aquatic. These brief descriptions can be supplemented with the online resources, including:
   - NC Wildlife Coastal Plain Habitats http://www.ncwildlife.org/Learning/Habitats/Coastal.aspx
   - NC Natural Heritage Program Ecosystem Groups http://www.ncnhp.org/web/nhp/ecosystem-assessment.

   A few species of concern are listed in the handout, but the NC Wildlife Coastal Plain Habitats web page has links to documents that list all of the species of concern that are found in each ecosystem.
4. Ask students to read the descriptions of the three different types of forests in the Ecosystems of Eastern North Carolina handout.
   - What are common characteristics of each?
   - What makes them all forests?
   - What makes each type different?
5. Have students read about the various wetland ecosystems.
   - What are common characteristics of each?
   - What makes them all wetlands?
   - What makes each type different?
6. Have students read about freshwater aquatic ecosystems.
   - What is the difference between a wetland and a lake?
   - A reservoir can serve as habitat for fish, mammals and bird species, but if the reservoir is created by damming a river or a large stream, how does the dam affect the river ecosystem?
7. Have students read about the coastal aquatic ecosystems.
   - What are the differences between an estuary and the ocean?
8. Ask students what connections they can make between two or more ecosystems.
   - Are ecosystems distinct or are they interconnected with other ecosystems?
   - What evidence do they have for their conclusions?

Teacher Notes:

A forest is an ecosystem dominated by trees.

A wetland is land where the soil is saturated with water and the plants growing there can tolerate very wet soil.

A lake or pond has standing water all year, except perhaps during drought, and the water area is clear of vegetation. There can and should be vegetation around the edges.

A reservoir is a lake that is not naturally made. It is made by people, usually by damming up a stream or river.

Activity 2
Compare and Contrast Local Ecosystems
Time: 20 minutes per ecosystem

- Prior to this activity, identify at least three local ecosystems that the students can access.
- Review the *Ecosystem Datasheet* with the students and procedures for collecting the data.
- Divide the class into groups of 3 or 4. Assign one student to record data and the others to collect data. At each ecosystem, students can rotate roles.
- Have students write the name of each ecosystem in the first row of the Ecosystem Datasheet. Explain that they will collect the data described in the first column and record the results in the column under the name of the ecosystem.
- If visiting multiple ecosystems in one session, give each group one ecosystem to start and allow 20-30 minutes for data collection. Then have the groups rotate to the next ecosystem. Otherwise, if doing this activity over the course of several field experiences, allow about 20-30 minutes for data collection at each ecosystem that students visit.
- After data has been collected for all ecosystems, bring the group back together for discussion.
- Ask the students:
    - What data was easiest to collect, what data was hardest to collect?
    - Have them compare the plant life they found in each ecosystem. Why do they think there are differences (think about the interaction between biotic and abiotic components)?
    - Ask them to compare percent shade cover to temperature. Do they find any correlation between these?
    - What data results did they find interesting?
    - Did they observe something they perhaps would not have observed if they were just walking by?

Wrap-up: Learning about ecosystems is not just about science, it is about understanding where we live and how we impact our environment. We are still learning about interactions within ecosystems and also how human activity impacts ecosystems in different ways. Careful observations and data collection are important skills needed by ecologists in order to gain new understanding about ecosystems and our role in the environment.
You may wish to share the video *How Wolves Changed Rivers* with your students to illustrate this point and spark discussion about how data can be used to understand ecosystem changes. https://vimeo.com/86466357

Extensions

The Albemarle-Pamlico Estuarine System: Birds and Habitats
Conduct this activity, developed by the NC Coastal Research Program, to learn more about our estuarine habitats and the birds that use them. http://portal.ncdenr.org/c/document_library/get_file?uuid=ffe28dbe-429c-4887-bd1f-60fbd7edbcb2&groupId=61572

Guest Speaker or Field Trip
Coordinate with a contact from the North Carolina Natural Heritage Program, State Parks, NC Wildlife Resources Commission, U.S. Fish and Wildlife, or a local environmental education center, to either arrange a visit to a preserved natural ecosystem or have a guest speaker come to the classroom to present on a nearby preserved natural ecosystem. Contact information is located in the resources section below.

Exploring the Ecosystems of Eastern North Carolina

Assessment

Ask students to imagine they are ecologists and must pick their favorite ecosystem in the Tar-Pamlico Basin (or other basins in eastern North Carolina) to study. Ask them to write an essay addressing the following content:

- Describe your ecosystem including living and nonliving things.
- Can you describe at least one food chain in this ecosystem?
- How would changing part of that ecosystem affect the organisms that live there?
- Why is it important to protect or restore this ecosystem?

Resources

NC Natural Heritage Program Staff Directory http://www.ncnhp.org/web/nhp/contact

NC Wildlife Resources Commission Education Centers http://www.ncwildlife.org/Learning/EducationCenters.aspx

Medoc Mountain State Park http://www.ncparks.gov/Visit/parks/memo/main.php

Goose Creek State Park http://www.ncparks.gov/Visit/parks/gocr/main.php

A Time for Science http://www.atimeforscience.org/contact/

Lake Mattamuskeet Wildlife Refuge http://www.fws.gov/refuge/mattamuskeet/about/contact_us.html

Find an Environmental Education Center near you using the NC EE website
http://web.eenorthcarolina.org/net/content/search.aspx?s=0.0.108.37430&btid=3&tid=38022&basic=1&load=0

Ecosystems of Eastern North Carolina

Forest

Longleaf Pine
Longleaf pine ecosystems are spread across most of the Coastal Plain and into parts of the Piedmont in the southern part of the state. Longleaf pine ecosystems used to cover most of the Coastal Plain before Europeans settled in North Carolina. Longleaf pines need fire in order to survive. The plants on the ground below the longleaf pine are mostly wiregrass with a few other small plant types. When people stopped forest fires, other trees were able to outgrow the longleaf pines. Now there are not a lot of longleaf pine forests left. Two animals that love to live in the longleaf pine forest are the red-cockaded woodpecker and the eastern fox squirrel.

Oak-Hickory-Pine
Guess what types of trees are found in the oak-hickory-pine forest ecosystem? Different types of oak, hickory and pine trees. This ecosystem may also have other trees such as the tulip poplar, red maple, and sweet gum. Before people settled in North Carolina, there were not many oak-hickory-pine forests in the Coastal Plain, because that was mostly longleaf pine forest. Most of the original oak-hickory-pine forests were in the Piedmont. Many oak-hickory-pine forests took over longleaf pine forest in the Coastal Plain when forest fires were stopped by people. Now, most of the land has been cleared for farming or planting loblolly pines for wood. Animals that live in an oak-hickory-pine forest include the eastern mole, long-tailed weasel and the eastern fox squirrel.

Maritime Forest
Maritime forests are located on the barrier islands. The main trees in maritime forests are live oak, sand laurel oak, and loblolly pine. A big difference between a maritime forest and a forest on the mainland is that the maritime forest has to live near a lot of salt spray from the ocean. Only a few trees and shrubs can tolerate salt spray. Maritime forests grow behind the shelter of sand dunes and shrubs and trees that can handle salt spray, such as wax myrtle and live oak. Maritime forests also experience high winds, sand erosion and salt water flooding during big storms. One special animal that lives on the maritime forest is the white footed mouse.

Wetland

Freshwater Tidal Wetlands
Freshwater tidal wetlands can be found up the coastal rivers. In the Pamlico River, for example, freshwater tidal marshes can be found from the Pamlico Sound all the way up to Washington. Lunar (moon) or wind tides make the water rise and fall, just as they do in the coastal salt marshes, except that the water is freshwater. Large amounts of freshwater coming down from the river keeps the saltwater from coming up river that far. Freshwater tidal wetlands can also be found in the sound, far away from the ocean inlet. Cypress-Gum swamps are common in these areas and contain trees such as swamp black gum, swamp tupelo and bald cypress. Marshes can also be found in these freshwater tidal areas and contain different wetland grasses including cattail, saw grass, giant cordgrass (Spartina cynoceroides), black needle rush and marsh fern. Important birds in this ecosystem include several types of rail and bitterns. Anhinga, Little Blue Heron, Snowy Egret and American Bald Eagle are other well-known birds that thrive in this ecosystem. Mammals that live here include the Star-nosed Mole, Least Shrew and Marsh Rabbit.

Salt Marsh
Salt marsh ecosystems are found where tides regularly flood the area with seawater. The seawater rises and falls with the tide, which makes the saltmarsh alternately flooded and bare. There are only a few types of plants that can handle that kind of environment. Saltmarsh cordgrass (Spartina alterniflora) is the most common plant. In the salt flats, where water evaporates and leaves high levels of salt, salt grass and glasswort grow. On the higher edges of the salt marsh, black needle rush and salt meadow cordgrass (Spartina patens) grows. The salt marsh also contains many mollusks and crustaceans. Few mammals, reptiles or amphibians are permanent residents of the saltmarsh because of the high salt content and wet soils. Salt marshes are very important habitats for wading and water birds.

Cypress Gum Swamp
Cypress-Gum Swamps occur in the wettest, forested parts of the coastal floodplains. They have few tree species that can tolerate such long-term flooding including bald cypress, pond cypress and swamp black gum. The prevalence of this ecosystem has decreased significantly since Europeans arrived and altered the ecosystem through drainage, logging and farming. Cypress-Gum Swamps are habitat to many birds, mammals, reptiles and amphibians. Hollow cypress and black gum trees are important for bats, chimney swifts and other animals that live in trees. In addition, many water birds rely on swamp forest for nesting habitat.

Freshwater Aquatic

Natural Lakes
Natural lakes only occur in the Coastal Plain of North Carolina. These natural lakes form in low areas, or depressions, in the land. These lakes do not get their water from rivers or streams. Natural lakes in North Carolina, such as Lake Mattamuskeet, get all of its water from rain. Most of these lakes are very acidic (like lemons) and the main plant life is algae and plants that grow on the bottom of the lake. These lakes are important habitat to winter water fowl such as the tundra swan, Canada geese, snow geese and more than 18 types of duck.

Reservoirs
Reservoirs are lakes that have been created by people by blocking the natural flow of river or stream water with a dam. Reservoirs are created for water supply, flood control and sometimes even wildlife habitat. Though not naturally created, once a reservoir is there for a long time, it can become an important habitat for fish, amphibians, reptiles, mammals and birds. The large reservoirs in the Tar-Pamlico basin include Lake Royale and Tar River Reservoir. There are thousands of small mill and farm ponds.

Riverine
Rivers and streams are waters that flow in one direction. Rivers and streams have many important habitats for many land and water animals. Good water quality is important for these aquatic ecosystems. Many water quality problems begin higher in the watershed, in the streams and rivers, and are carried down to the estuary and ocean. Several rare mussels have been found in the upper Tar River; the endangered dwarf mussel is one example. The Tar River is important for drinking water and fish habitat. There are 100 freshwater fish species found in the Tar-Pamlico River. Two rare species are the Carolina madtom and the Neuse River waterdog. Both of these can only be found in the Neuse and Tar-Pamlico river basins.

Coastal Aquatic

Estuary

An estuary is an area where freshwater and saltwater mix. It is often protected from the open ocean and partially enclosed by land. The Pamlico Sound is an estuary which receives freshwater from the Tar-Pamlico River and the Neuse River. It is separated from the ocean by the Outer Banks. The main source of salt water comes from Ocracoke and Hatteras inlets, which are quite small. More than 70 species of fish and shellfish spend at least part of their lives in the Pamlico Sound. Striped bass, shad and herring are three examples of fish that lay their eggs in the freshwater, higher up in the Pamlico River. After the fish hatch, they work their way back toward the ocean. Blue crab and oysters are two important shellfish species found in the estuary.

Atlantic Ocean

The ocean floor, off the coast of North Carolina, has some soft bottom (sand beaches, flats and shoals) and some hard bottom (rock, coral, ship wrecks). The soft bottom floor is home to worms, clams and other burrowing animals that serve as fish food for spot, croaker, mullet and sturgeon. Shallow soft bottom areas are also breeding grounds for flounder and shrimp. Hard bottom ocean floors are more commonly known as reefs. As many as 47 fish species live in reefs off the coast of North Carolina. King Mackerel, grouper, snapper, black sea bass and damselfish are some of the fish that use these ecosystems.

Exploring the Ecosystems of Eastern North Carolina

ECOSYSTEM DATASHEET

Team Members:

Ecosystem Type					
Wind Direction/Speed					
Percent Shaded					
Topography (flat, hills, mountains)					
Soil	**Moisture** (wet, moist, dry)				
	Texture (sandy, clay, decaying leaves)				
	Smell (describe how the soil smells)				
Temperature	3 feet **above ground**				
	at **ground level**				
	1 inch **into soil**				

Exploring the Ecosystems of Eastern North Carolina

ECOSYSTEM DATASHEET

Ecosystem Type					
Water (if water is in this ecosystem)	**Temperature**				
	Color and Clarity				
	Flow (not flowing, slow or fast)				
Aquatic Plants (algae, submerged plants, plants growing out of the water)					
Terrestrial Plants (Groundcover, shrubs, trees and how much)					
Animal life Animals seen or signs of life (scat, tracks, burrows, chewed twigs, etc.)					
Other Observations					

Here's to the Land of the Longleaf Pine

Alignment to NC Essential Standards
Science 4.L.1, 5.L.2
Social Studies 4.G.1, 4.E.1.3, 5.G.1, 5.G.1.1, 5.G.1.2, 5.G.1.3, 5.G.1.4, 5.E.1
Language Arts RI.5.2, RI.5.4, RI.5.7, RI.5.9, W.5.1, W.5.7, SL.5.4

Learning Objectives
- Students will compare and contrast the positive and negative effects of human activity on the physical environment.
- Students will describe economic factors influencing human activity in the Tar-Pamlico basin.
- Students will evaluate the environmental and economic costs and benefits of land use decisions

Time Required:
Activity 1: 20 minutes
Activity 2: 40 minutes
Activity 3: 60 minutes

Materials
- Internet connection to show the video
- Computer/internet access for class to read *Naval Stores and the Longleaf Pine* at Learn NC. http://www.learnnc.org/lp/editions/nchist-colonial/4069

For each student
- 1 copy of the readings *Early Forests of North Carolina* and *Longleaf or Loblolly?*

For each team
- 1 copy of *The Value of Trees* worksheet

Vocabulary
naval stores, longleaf pine, ecosystem, fire tolerant, fire resistant, diversity, forest succession

Overview

In this lesson, students will explore how the market economy and technological advances have impacted and continue to influence human settlement and ecosystems of the Tar-Pamlico River Basin, by focusing on the longleaf pine ecosystem. In Activity 1, students are introduced to the landscape of the basin during the 1700's, which appeared forbidding and dense to the visitor. Activity 2 allows students to explore some of the economic benefits of longleaf pine forests and the results of human activity on the ecosystem. Activity 3 incorporates current knowledge, technology and views of managing forests for both ecological and economic gain.

Background

The physical environment had a significant impact on early settlement of the Tar-Pamlico region. Access by ship from the ocean was difficult because the inlets were shallow and the sound was wide. Most settlers moving over land came from South Carolina or Virginia. These travelers tended to settle near the Chowan River, if coming from Virginia, and in the Cape Fear region, if coming from South Carolina.

The upland was dense with forest and much of the coastal landscape was swamp and marsh. Only the most adventurous travelers were able to work their way to the Tar-Pamlico region. Bath was incorporated in 1705 as the port for the Pamlico Sound but the geographic constraints imposed by the Outer Banks kept Bath from growing like Wilmington.

Even so, the Naval Stores Act of 1705, passed by the English Parliament, provided enough stimulus to improve the economy of the Tar-Pamlico region. Naval stores are items used in building of wooden ships and included production of tar, pitch and turpentine and were obtained from the resin in longleaf pine. By the 1770s, North Carolina became responsible for 70% of the tar and 50% of the turpentine export from North America.

Longleaf pine forests once covered over 90 million acres in the south, but much of this ecosystem has vanished due to overuse. There are now less than 3 million acres of longleaf pine forest in the south and many of these acres are unhealthy.

Here's to the Land of the Longleaf Pine

More background information is provided in the attached readings *Early Forest in North Carolina* and *Longleaf or Loblolly?,* found at the end of this lesson, as well as the excellent LEARN NC article *Naval Stores and the Longleaf Pine* http://www.learnnc.org/lp/editions/nchist-colonial/4069.

Procedure

ACTIVITY 1
Settling the Wilderness
Time: 20 minutes

1. Have each student read *Early Forests of North Carolina.* This material was edited and adapted for the 5th grade reading level from the book *An Independent People: The Way We Live in North Carolina, 1770-1820* by Harry L. Watson.
2. Ask students to either discuss or write about the following:
    - Based on the descriptions, what did the forest look like in the late 1700's to early 1800's? Students could draw a picture to illustrate their understanding.
    - What types of knowledge, tools and supplies do you think early settlers would have needed to survive in this kind of wilderness?
    - Based on what the early travelers to this area wrote about the area, would you want to move to this land? Why or why not?

ACTIVITY 2
Fall of an Ecosystem
Time: 40 minutes

1. Share with the class that the longleaf pine forest ecosystem was so vast that it is hard to imagine now. For visuals of a healthy longleaf pine forest, play the first minute of the video from The Nature Conservancy https://www.youtube.com/watch?v=NYo3r-qNdXo
2. Longleaf pine became a huge economic factor in coastal North Carolina. Students can read about the naval stores industry in the Learn NC article, *Naval Stores and the Longleaf Pine* http://www.learnnc.org/lp/editions/nchist-colonial/4069. Students can either read the whole article or, if time is limited, ask them to read at least the *Introduction* and the *Tar, Pitch and Turpentine* and *Growth of an Industry* sections.
3. Ask students to address the following either through discussion or essay:
    - What does "store" mean when talking about naval stores?
    - Why did naval ships need these materials? How were they used?
    - Why did North Carolina produce more naval stores than other states?
    - How did these naval stores get transported from places like Tarboro to the coast?
    - What impact did this industry have on the longleaf pine ecosystem?

ACTIVITY 3
Making Management Decisions
Time: 60 minutes

1. If they haven't done so previously, have students read the *Decline of the Longleaf Pine Forest* section in the Learn NC article, *Naval Stores and the Longleaf Pine.* You can also show them the rest of The Nature Conservancy video https://www.youtube.com/watch?v=NYo3r-qNdXo.

Here's to the Land of the Longleaf Pine

1. Ask the students to brainstorm either as a group or individually, some positive and negative effects of human activity related to the longleaf pine ecosystem (these could economic, environmental, aesthetic, etc.).
2. Tell students: *Longleaf pine ecosystems can still have value to the economy in the Tar-Pamlico region today. However, the longleaf pine ecosystem will not return on its own due to a number of human activities that keep this ecosystem from thriving. We now have the knowledge and technology to create conditions in which the longleaf pine ecosystem can be restored in some places.*
3. Divide the students into teams.
   - Tell them that your county has just received a donation of 400 acres of land. The previous landowner managed this land as a loblolly pine plantation and all of the trees were removed for timber just before the county received it.
   - Each team has been appointed by the county government to determine the best trees to plant on this land in order to bring the "most value" to the community.
4. Take a few minutes to brainstorm with the entire class ideas of what would be of "most value" to the community (examples are timber to sell, wildlife habitat, hunting, hiking, birding, bike trails).
5. Provide each team with a copy of *The Value of Trees Worksheet* and the *Early Forests of North Carolina* and *Longleaf or Loblolly?* readings. The teams must research their options, determine what trees would be the most value to the community and explain why they made that decision. You can also let them do research on the internet or provide copies of some of the readings in the resources section.
6. Have each group present their results. Ask them if this was their private land, where they were only concerned about the benefit to themselves, would they have made a different decision?

Answer Key –The Value of Trees worksheet

	Loblolly	Longleaf
How quickly does it grow?	Grows fast	Starts out growing slowly
Can it compete with other plants?	Tolerant of competition when young	Not tolerant of competition
Is it fire resistant?	Not fire resistant when young	Fire resistant and requires fire
In what kind of soil does it grow best?	Prefers moist soil	Productive on dry soil
How resistant is it to high winds and insects?	Less resistant to high winds, insects, fire	More resistant to high winds, insects and fire
Do you want hardwoods trees (such as oak and hickory) to grow with it?	Early succession species – which will be replaced by hardwoods as the climax forest	Climax species, fire keeps out hardwoods
Does it have a diverse ecosystem (lots of wildlife)?	Low diversity if managed for timber, higher diversity if growing in forest with other tree species	One of the most diverse ecosystems in the world. Most diversity is on the forest floor in the shrub, grass level
What is the wood used for?	Used for poles, pulp, paper, cardboard, fuel	Grows straighter and has stronger wood than loblolly. Used for poles and saw timber. Pine straw used for landscaping

Here's to the Land of the Longleaf Pine

Assessment

Assessment will be based on student responses and written results of Activity 3.

Resources

Learn NC's Naval Stores and the Long Leaf Pine http://www.learnnc.org/lp/editions/nchist-colonial/4069

North Carolina Longleaf Coalition http://www.nclongleaf.org/

The Nature Conservancy Long leaf pine video https://www.youtube.com/watch?v=NYo3r-qNdXo

Introduction to Longleaf Pine http://ncforestservice.gov/publications/LongleafLeaflets/LL01.pdf

Longleaf Pine Forest: Superior Economic, Environmental and Historical Value
http://ncforestservice.gov/publications/LongleafLeaflets/LL02.pdf

Longleaf Pine Ecosystem, Clemson University
http://www.clemson.edu/cafls/sclife/documents/Longleaf%20Pine%20LP

Longleaf Leaflet, NC Forest Service http://ncforestservice.gov/publications/LongleafLeaflets/LL07.pdf

Here's to the Land of the Longleaf Pine
THE VALUE OF TREES Worksheet

Your county has just received a donation of 400 acres of land. This land was most recently a loblolly pine plantation and all of the trees were just cut down and harvested before the land was donated. Your team has been selected by the county government to decide what trees would be best to plant on this land now in order to bring the "most value" to the community.

Brainstorm a list of what land uses your team thinks would provide the "most value" to the community.

The county environmental staff provided your team with some reading material so that you can learn more about two species of trees that can be planted on the land. **Use the information in these readings to fill out the table below.**

	Loblolly Pine	Longleaf Pine
How quickly does it grow?		
Can it compete with other plants?		
Is it fire resistant?		
Does it require fire?		
In what kind of soil does it grow best?		
How resistant is it to high winds and insects?		
Do you want hardwoods trees (such as oak and hickory) to grow with it?		
Does it have a diverse ecosystem (lots of wildlife)?		
What is the wood used for?		

Here's to the Land of the Longleaf Pine
THE VALUE OF TREES Worksheet

Which species (loblolly or longleaf) of tree do you think will provide the most value to the community?
Support your answer with as much information as you can.

Here's to the Land of the Longleaf Pine

READING: Longleaf or Loblolly?

Understanding the Original Forest
From Longleaf Pine Ecosystem, Clemson University

Longleaf pines form the natural climax forest for much of the Sandhills Region and once covered large areas of the Coastal Plain as well. Periodic wildfires spread across the region burning up any competitor species while the adaptations of the longleaf pine enabled it to survive. Loblolly pines were originally confined to wetter areas of the Coastal Plain and were the first trees to colonize areas opened by fire or early logging operations. Under natural conditions, loblolly pines would eventually be crowded out by hardwood trees that would then populate the climax forest.

In the original forests of the South, loblolly pine was a minor species both on the uplands, which were dominated by longleaf pine or mixed upland hardwoods, and in the wet river bottoms and swamps, which were dominated by mixed bottomland hardwoods. It was, however, an important species on moist sites that were not subject to regular burning. In the Coastal Plain, loblolly pine grew best mixed with hardwoods along stream margins and around swamps on sites that were not subject to long periods of flooding or to serious fires. Under natural conditions, it rarely formed pure stands, and these seldom exceeded more than a few acres in size. When natural disasters created openings, seeds from nearby trees quickly became established. However, because loblolly pine has limited tolerance to fire, it generally could not compete with longleaf pine on well-drained Coastal Plain lands subject to regular fires.

Loblolly Pine (Pinus taeda L.)
From Common Forest Trees of North Carolina, NC Forest Service, 2012

Loblolly pine is the most important commercial timber tree in North Carolina. It is a fast-growing member of the yellow pine group, which grows in an area extending from the Coastal Plain throughout the eastern Piedmont. Within this area, loblolly is by far the most common pine.

Loblolly pine needles occur in clusters of three. They are slender and stiff, 6 to 9 inches long and pale green. They drop during the third season. The oblong cones are 2 to 6 inches long, light reddish to brown and are armed with a spine at the tip of each scale. Cones drop their seeds in autumn and winter but remain on the tree for another year. At 60 years, the mature bark is thick, bright reddish to brown and is divided by shallow fissures into broad, flat-topped plates covered with thin scales. The tree often reaches 90 to 110 feet in height on good sites, with a tall, cylindrical trunk 2 to 3 feet in diameter. The lower, short, thick branches on older trees droop, while the higher branches grow upward. The mature crown usually is compact and round-topped. The resinous wood is coarse-grained, with a marked contrast -- as in the other yellow pines -- between the bands of spring and summer wood.

Loblolly has a wide range of uses, such as lumber, pulpwood, plywood, poles and piling. Because it is useful and grows very quickly, loblolly is the target of much of the forest management in North Carolina -- and in the entire Southeast. It is the most widely planted forest tree, and many thousands of acres of productive loblolly pine plantations are now growing in North Carolina.

Here's to the Land of the Longleaf Pine

Longleaf Pine (Pinus palustris Mill.)
From Common Forest Trees of North Carolina, NC Forest Service, 2012

Prior to European settlement of the state, the longleaf pine forest dominated the eastern North Carolina landscape. Two hundred years of clearing for agriculture, logging without reforestation, hog grazing and ironically, wildfire control has reduced this forest to a mere remnant of its original size. Young longleaf pine forms one of the most striking features of the southern forest. As a seedling, it resembles a clump of grass. Longleaf begins height-growth between two to 10 years of age, when it forms a handsome plume of sparkling green. Longleaf pine is appropriately named for its long, drooping, lustrous bright green needles. The needles are 8 to 15 inches long in three-leaf clusters that are crowded into dense tufts toward the ends of the stout branches. The large, silvery white, shiny buds (called "candles" when they begin to grow) make longleaf pine easily recognizable among other forest trees. The longleaf cone is the largest of the southern pine cones, at 6 to 10 inches long. Cone scales are tipped with spines. Longleaf cones mature during their second season and drop shortly after releasing their seed in September to November. The thick bark of mature 70 year old trees is orange-brown or reddish-brown and is separated into large plates with thin scales. The tree commonly is 80 to 100 feet tall, with trunk diameter of 2 to 2 1/2 feet.

Longleaf pines grow on a variety of sites, the most favorable being well-drained, sandy soils. Longleaf pine has a tall, straight trunk and an irregular crown made up of stout and heavy gnarled or twisted branches. Longleaf once was used for commercial production of naval stores (pitch, tar, resin, and turpentine). Today, it primarily is used for poles, piling, lumber and plywood. The heartwood is heavy, hard, strong, tough and durable. The seeds are a favorite source of food for wild turkey, gray and fox squirrels and many other wild animals.

Converting Planted Loblolly Pine to Longleaf Pine: An Opportunity
From Clemson University

Many private forest landowners in the South are interested in restoring native longleaf pine forests because of the higher wildlife, recreational and aesthetic values associated with longleaf compared to other southern pine species. The appeal of the open, park-like longleaf woodlands typical of lands managed for bobwhite quail is strong for many landowners. In addition, longleaf has: greater insect, disease and fire resistance; and longleaf yields higher forest product values compared to other pines.

Here's to the Land of the Longleaf Pine

READING: Early Forests of North Carolina

Adapted from *An Independent People: The Way We Live in North Carolina* by Harry L. Watson

If you were to visit North Carolina during early settlement times in the 1600s and 1700s, you would encounter forests that seemed to go on forever. Trees were everywhere: tangled oaks and cypresses where the ground was swampy, stately pines where it was dry. To the west, oaks, hickories, walnut, chestnut, and poplars took over but always there were woods – dark, forbidding and dense. By 1770, permanent European settlers had lived in this environment for over a hundred years, but still the wilderness was everywhere. Whatever the people of North Carolina did took shape against a backdrop of seemingly endless forest.

In the winter of 1783, a German traveler made a trip through North Carolina. In his accounts of the trip he said, "The country is a continuous measureless forest, an ocean of trees in which only here and there cultivated spots are to be seen." Another traveler said, "A universal gloomy shade, made dismal by the intermixing branches of lofty trees, which spread over the whole country and which the sun never pervades." Another traveler noted that, "The mariners going up the coast in spring smell the pines when several miles out to sea."

Whether they were making a living from the forest or by farming, a constant factor in the lives of the people of North Carolina during the 18th century was the importance of the land and its rewards. The shape of the terrain, the nature of the soil, and the conditions of the weather all had a direct influence on the pattern of human life that later generations would not experience.

The River Food Web

Alignment to NC Essential Standards
Science 4.L.1, 4.L.2, 5.L.2

Learning Objectives
- Students will explain the role of bacteria as primary consumers in the food web.
- Students will describe how energy moves through an ecosystem and how ecosystems recycle carbon.
- Students will describe how scientists study ecosystems.

Time Required:
Activity 1: 30 minutes
Activity 2: 30 minutes
Activity 3: 15 minutes to set up, 30 minutes for the activity.

Materials
- 1 copy per student of *Connect the River Food Web Worksheet*
- 1 copy for the class of *Reading: Scientists Studying the Tar-Pamlico River*
- Cardstock cut to 2x2" with red, green and brown colors marked on them as indicated in the activity instructions
- Tape or nametag for each student to indicate whether they are zooplankton, bacteria or dissolved organic matter
- Measuring tape

Vocabulary
Food web, producer, consumer, decomposer, bacteria, carbon cycle, stormwater runoff, dissolved organic matter, heterotrophic, enzyme, microbial loop

Overview

This lesson introduces new and exciting research conducted on the Tar-Pamlico River while addressing essential terminology for understanding the interdependence of plants and animals with their ecosystems including food chain, food web, energy pyramid, adaptation, decomposers, producers and consumers. A fun outdoor activity demonstrates to the students concepts such as how energy moves through an ecosystem and how ecosystems recycle carbon and other nutrients. The students will learn firsthand what it is like to be a scientist, as this lesson introduces two young scientists who conducted research on the Tar-Pamlico River.

Background

When talking about the aquatic food chain, we usually start with primary **producers** in an **ecosystem**, or phytoplankton. These are eaten by the small **consumers**, zooplankton, which is eaten by macroinvertebrates, which are eaten by small fish, and so on. **Decomposers** break down the organic carbon and nutrients to be used again by the primary producers. But who are these decomposers, and what are they really doing? We typically envision small organisms eating dead flesh and leaves, but what about liquid substances? Scientists call the liquid that comes from living or once living things **dissolved organic matter**.

Organic matter comes from anything that used to be alive. Dissolved organic matter (DOM) is so small that it cannot be consumed by most organisms. Examples of DOM include blood, cellular fluid and leachate from leaves. (One quick hands-on example of dissolved organic matter is to put tea in a cup of water and watch the water get darker. What is causing this color change? The organic matter that is leaching from the tea leaves.) All of that organic material, which is primarily carbon, would be "lost" if it weren't for microorganisms, such as bacteria, that can eat these small, dissolved forms of organic material. Note: Scientists often interchange the terms dissolved organic matter and dissolved organic carbon primarily because while studying the dissolved matter, they are measuring organic carbon. You can choose to use either term.

Bacteria are naturally abundant in aquatic ecosystems. In addition, they can wash into rivers or streams during rainfalls,

The River Food Web

dramatically increasing their abundance. A typical amount that one might find would be a million bacteria in one milliliter of water. In polluted water, there can be hundreds of millions of bacteria in each milliliter. A teaspoon contains 5 milliliters. Often, when we learn about bacteria, we learn about harmful bacteria; those that make us sick. Most bacteria are not harmful and are, in fact, key to ecosystem functions. In this case we will be talking about **heterotrophic** bacteria, meaning bacteria that need outside sources of carbon and nutrients to eat. They are vital in the decomposition of organic matter and the cycling of nutrients.

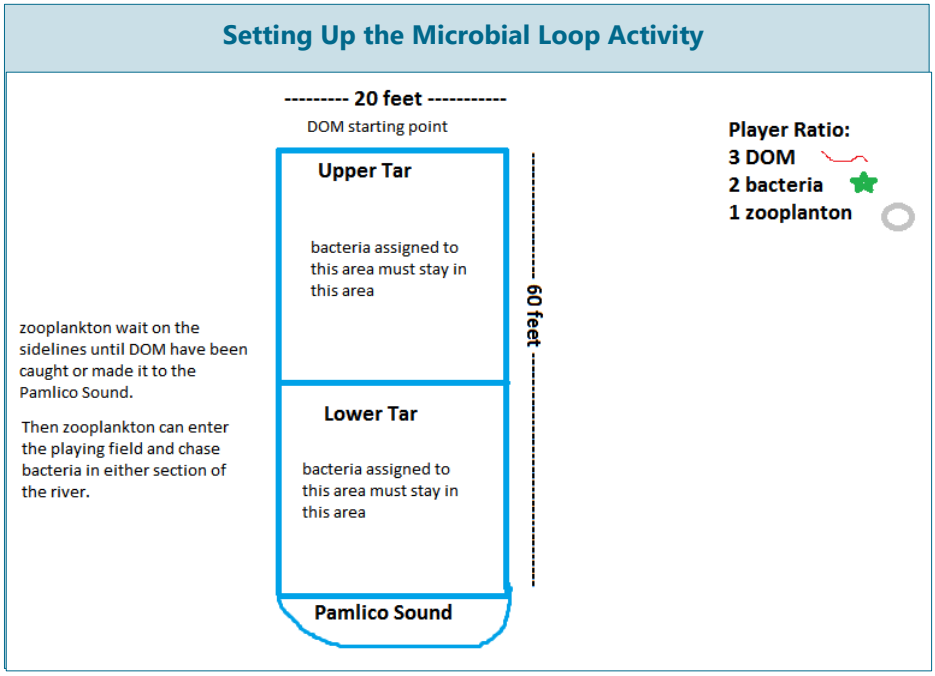
In order to break down DOM, bacteria need the right kinds of enzymes in their cells. **Enzymes** are molecules required for metabolic processes. If bacteria are eating DOM that is common to their stream, they will most likely have the enzymes needed to break down that carbon. If the material were swept into the stream from **stormwater runoff**, the bacteria may not be adapted to consuming that type of carbon and wouldn't have the proper enzyme(s). What happens to that material? If there is a lot of it, brought by a large storm, the few bacteria that can consume it may thrive, and the population will grow to consume the organic matter. If there are no species of bacteria that can consume the organic matter, it will either be buried in the sediment at the bottom of the river or carried downstream all the way to the estuary and then the ocean. There, it may be buried in the ocean sediment for thousands or even millions of years.

When bacteria eat this dissolved form of carbon, they thrive and become food for zooplankton. They also release carbon dioxide and other nutrients, which can be utilized by the phytoplankton. This aspect of the food chain is not shown in most food chain diagrams because it was not discovered until the 1970s. It was first studied in the ocean by marine biologists, and research on rivers began in the mid-1980s. Only in the past 15 years has the technology advanced to a level where ecologists can identify where the DOM originated (land vs. aquatic, animal vs. plant) and identify which species of bacteria are eating different types of DOM. This part of the food chain that focuses on how DOM is processed by bacteria is called the **Microbial Loop.**

Preparation

To prepare the activity playing field, mark off the parameters of the river. The river should be about 60 feet long and 20 feet wide. Divide the 60 feet into two 30 foot sections. At the bottom of the river is the sound (safety for the DOM). The area may need to be enlarged if you are playing with bigger kids.

Setting Up the Microbial Loop Activity



The River Food Web

Procedure

ACTIVITY 1
Drawing the River Food Web
Time: 30 minutes

1. Pass out copies of the river food web worksheet.
   - Review the concepts of food web, primary producer, consumers and decomposers.
   - Ask students to label the images as primary producers, consumers or decomposers.
   - Ask students where all energy comes from. (*The sun*)
   - Tell them to draw arrows to where the energy goes next or, in other words, what uses sun directly to make its energy. (*Plants, algae, phytoplankton*)
2. Now ask them to start thinking about other connections on their own.
   - What might eat the plants, algae or phytoplankton?
   - How do the leaves fit in? (*Leaves are organic matter that comes into the river from a terrestrial source. A lot of organic matter comes from trees and plants that grow on land*).
   - Can bacteria eat multiple things in the diagram?
   - Tell them that they can draw multiple arrows to or from one organism.
3. Someone might ask, "What is dissolved organic matter?"
   - Talk to them about waste from the organisms that float around in the water.
   - Have them draw dashed arrows from organisms that they think produce some sort of liquid waste, to the dissolved organic matter image.
4. Finally, ask what they think happens to this waste. (*Bacteria consume this dissolved organic matter*.)
5. *Note: If you discuss carbon dioxide with your class, this is a good place to let them know that through this process of energy transfer through the food web, carbon dioxide is released into the atmosphere.*

ACTIVITY 2
Scientists Studying Bacteria and Organic Matter in the Tar-Pamlico River
Time: 30 minutes

1. Select a student to read about the scientists who study bacteria and organic matter in the Tar-Pamlico River. Then select other students to read what each scientist said about their work.
2. Ask students to think about what the prefixes micro-, bio- and geo- mean based on what they already know. Once they provide answers, either share definitions with them or have them look up the definitions.
3. Other questions to ask:
   - Why would one scientist need to know all of these areas of science?
   - Where do these scientists work?
   - Does it sound like they like their work? Why?
   - Why is it important that scientists learn about bacteria?
   - Why is it important to study the health of the river?
4. Plan to ask these questions again after the game is played in Activity 3.

The River Food Web

ACTIVITY 3
The Microbial Loop
Time: 15 minutes to get the students set up, 30 minutes for the activity.

1. Tell students that what they are about to learn in the next activity comes from the work that JP and Avery did in the Tar-Pamlico River.
2. Define dissolved organic matter and bacteria.
3. Tell students that they are going to act out the part of the food web that is difficult to see. They will learn that a lot of carbon/energy moves through the river ecosystem. Bacteria consume the DOM if they have the right tools to do so (the right enzymes). The best way to describe it is that each type of bacteria has tools to break apart certain kinds of DOM so they can eat it. If the DOM comes from the land, but the bacteria are familiar with DOM that comes from the river, they may not be able to eat it (just like different types of animals have different types of teeth depending on what they typically eat). The more DOM the bacteria can eat, the more they multiply, and the more energy moves up the river food web.
4. Take students out to the already set up playing area and divide the students into roles. Numbers will vary based on how many students there are but the ratio should be 3 DOM : 2 bacteria: 1 zooplankton.
5. Secretly provide some students with colored cards. For example, if you have 24 students, 4 students playing DOM will get a red card, 4 will get green cards and 4 will get brown cards. Assign 4 students to be red bacteria in the upper 30 feet of the river and 4 students to be green bacteria in the lower 30 feet of the river. Assign 4 students to be zooplankton.
6. At the start of the game, the DOM will run from the top of the river toward the sound, trying not to get caught. The red bacteria will try and tag the DOM. If a DOM is tagged, he or she must show their card to the bacteria. If the red bacteria caught someone with a red card, then they have a match, and the DOM is eaten and becomes another red bacteria. If it is not a match, the bacteria have to let the DOM go. The DOM continues to run toward the sound while the green bacteria also tries to tag them and make a color match.
7. Once the DOM are either converted to bacteria or escape to the sound, the zooplankton come into the game and the bacteria now become the food. The bacteria can run around but must stay within their upper or lower 30 feet of river. If a zooplankton tags at least 3 bacteria, it survives. Otherwise, it does not have enough food and does not survive.

NOTE: There will be some chaos in the game. This is representative of how the food web really works in an ecosystem and provides an opportunity to let the students know that even though we often teach the food web in a clear way to make it easier to understand, in the natural world, a lot more is happening all at once.

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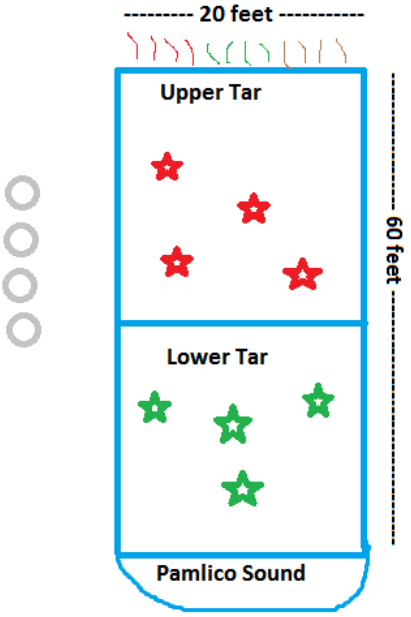
Scenario 1: Average Day at the River

8. Run through scenario 1 once so that students can learn the rules and then do it again so that they can begin to understand the concepts.



Player Ratio:
3 DOM
2 bacteria
1 zooplanton

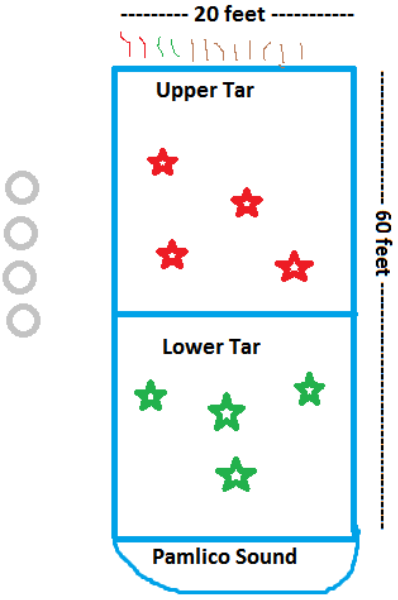
Instructions:
This grahic assumes 24 students in the class. Assign 4 students to be zooplankton, 4 to be red bacteria in the upper Tar and 4 to be green bacteria in the lower Tar. Do not tell the DOM what colors you assigned to the bacteria. Give the 12 students who represent DOM a card with a color marked on it. 4 should get red cards, 4 green cards and 4 brown cards.

The DOM will run from the start, to the Pamlico Sound. The bacteria must stay in their assigned upper or lower Tar. The bacteria must tag the DOM. If the DOM colored card matches the bacteria color, that DOM is consumed and becomes bacteria and stays in that part of the river. Once the other DOM have made it to the sound, the zooplankton enter the playing field and try to tag as many bacteria as possible.

The zooplankton that tag at least 3 bacteria, survive. The others do not.

Scenario 2: After a Large Rainstorm

9. In scenario 2, secretly give 2 DOM red cards, 2 DOM green cards and 8 DOM brown cards. The bacteria colors remain the same. In this scenario tell the students that a big rainstorm came and washed a lot of carbon material into the river from the land. Afterwards explain that in this scenario, the bacteria were not equipped to consume this carbon from the land. Don't forget to let the zooplankton eat!



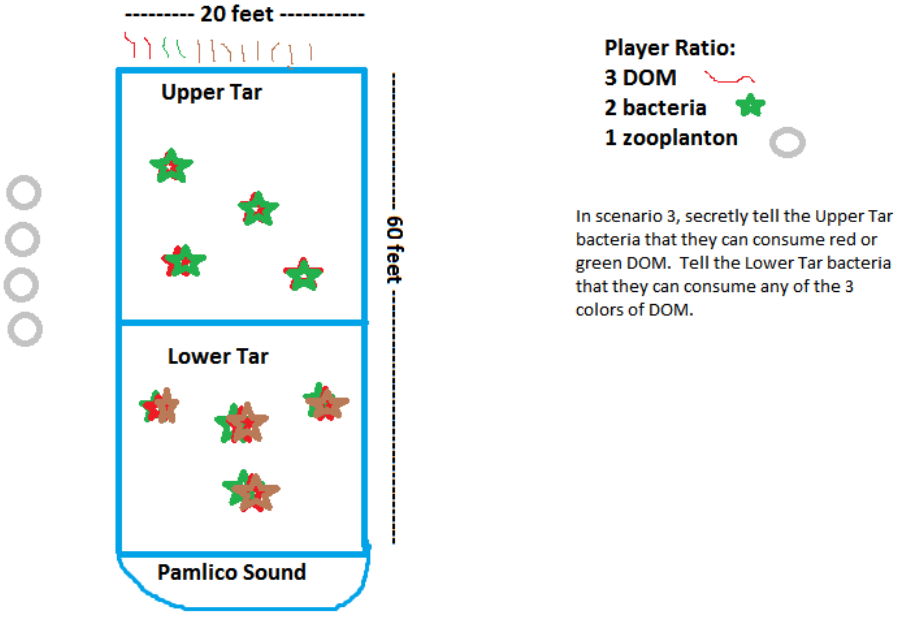
Player Ratio:
3 DOM
2 bacteria
1 zooplanton

In scenario 2, secretly give 2 DOM red cards, 2 DOM green cards and 8 DOM brown cards. Play the activity with the same rules as the first scenario.

The River Food Web

Scenario 3: Bacterial Communities Have Adapted to Consume More Organic Matter

10. In scenario 3, tell the first group of bacteria that they can now consume green or red DOM. Tell the lower river group that they can now consume any of the three colors. Alert the DOM that the bacterial communities have adapted to the new DOM sources and they may be eaten by bacteria that couldn't eat them before. The individual bacteria itself does not adapt. The types of bacteria that can eat the brown DOM have multiplied because there is now a food source.
11. If the students understand the activity well and you want to make it a bit more realistic, let the zooplankton feed on bacteria at the same time the bacteria is feeding on DOM.



12. Here are a series of discussion questions that can be done between scenarios or after all of them have been done.
    - What would happen if nothing could eat dissolved organic matter? *At some point in the day, all living organisms release dissolved organic matter into the ecosystem, whether it is blood, cellular waste, urine or respiratory byproduct. If this process continued, releasing carbon and other elements into the system, all of that energy would be lost.*
    - Why is it important that the bacteria consume the DOM? *Because they are the only ones that can consume such small matter and when they do, they multiply and become food for the rest of the food web, as represented by the zooplankton in the game.*
    - What happens to the DOM that does not get consumed by the bacteria? *DOM continues downstream where other types of bacteria may consume it. Another possibility is that it sinks to the bottom of the estuary and gets buried for a long time.*

14. Revisit the questions from Activity 2, step 3. Have the student's answers changed?

Assessment

Assessment will be based on teacher review of the food web worksheet and observation of the Microbial Loop activity, including student responses to discussion questions.

The River Food Web

CONNECT THE RIVER FOOD WEB Worksheet

Name_____

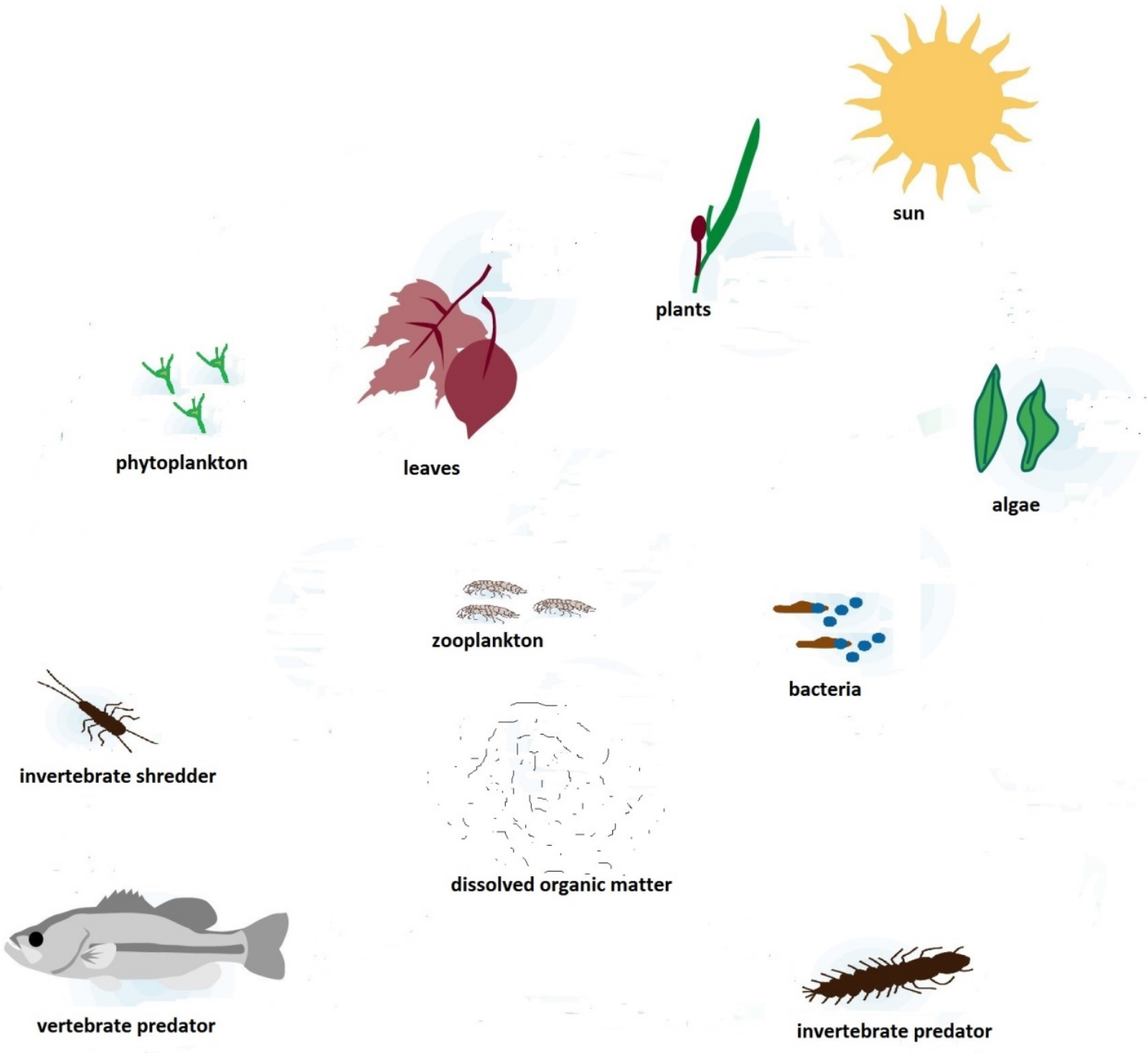


Image adapted from Stream Corridor Restoration: Principles, Processes and Practices, 10/98. Interagency Stream Restoration Working Group

Image adapted from Stream Corridor Restoration: Principles, Processes and Practices, 10/98. Interagency Stream Restoration Working Group

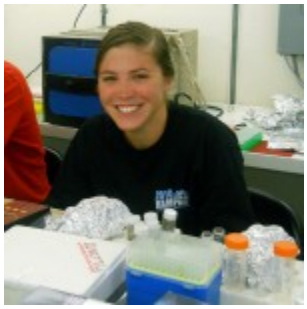
CONNECT THE RIVER FOOD WEB Worksheet

Scientists Who Study Bacteria and Organic Matter in the Tar-Pamlico River

There are scientists working in the Tar-Pamlico River to understand what types of bacteria live there and what kind of dissolved organic matter they eat. These scientists drive to many locations along the river, from the top to the bottom, and collect containers full of water. Back at the lab, some of the scientists study the bacteria and some study the types of organic material that is floating in the water. Scientists can actually figure out if organic material comes from animal waste, leaves from trees, or plants that grow in the water. The scientists study what kind of organic material is in the water and then compare their results with the scientists who are studying what kind of bacteria are in the water. This gives them an idea of what kind of "food" bacteria are eating, which is important because we are still learning about parts of the river food web and how energy moves through the river ecosystem.

Below, two scientists from UNC-Chapel Hill, Department of Marine Sciences, write about their work.

"My name is JP and I study bacteria in different environments -- from the rivers of North Carolina to the Arctic Ocean. I call myself a microbiologist. I am very interested in what types of bacteria are present in the environment and understanding why it is that they live there. For example, when we look at the bacteria community in a river, we find that they are made up of bacteria that always live in freshwater as well as bacteria that live in the soil on land and were probably washed into the water by rain runoff. Or as another example, in the Arctic, we have bacteria that can survive very cold weather. I do this type of research because bacteria, even if they cannot be seen without a microscope, are the ones that cycle nutrients and elements in the environment. This is important for every organism because they all need different types of nutrients and elements in their habitat. Bacteria are simply amazing!"



"My name is Avery and I am a marine biogeochemist, which means that I study how cycles (like the carbon cycles) interact with ecosystems (like rivers and oceans). I've always been interested in how bacteria make things happen in the natural world and in biology and chemistry, since they are the science behind life. I think there is something really cool about understanding how life works at the most basic level. In my job, I can go out to the river to collect water samples but I prefer to work in the laboratory."

Mills and the Changing Landscape

Lesson and related resources developed by Toni Stadelman, K-12 Science Specialist for Franklin County Schools, N.C.

Alignment to NC Essential Standards
Social Studies 5.G.1.1, 5.G.1.2, 5.G.1.3
Language Arts RI.5.1, RI.5.3, RI.5.5, W.5.2

Learning Objectives
Students will be able to describe how humans have changed the landscape to meet their basic needs.

Essential Question: How have humans changed the landscape to meet their basic needs?

I Can Statement: I can explain how humans have changed the landscape to meet their basic needs.

Time Required:
Activity: 2-3 class periods

Materials
- Computers, laptops, etc.
- Story Map for Exploring the Waters of the Tar-Pamlico
- Reading "Exploring the Mills of the Tar-Pamlico River Basin"
- Reading "How Have We Changed the Landscape of the Tar-Pamlico River Basin?"
- How Have We Changed the Landscape of the Tar-Pamlico River Basin? Worksheet
- Exploring Waters of the Tar-Pamlico River Interactive Map Worksheet
- Slide Set Corn From Farm to Home and/or corn kernels, cornbread mix, cornbread

Vocabulary
Mill, headwaters, millpond, dam

Knowledge
Students should know the definition of a river basin and the name of the river basin where they live.

Background

Discover North Carolina's River Basins Brochure:
http://bit.ly/NCRiverBasins
North Carolina River Basins Base map:
http://bit.ly/NCRBBasemap
Tar-Pamlico River Basin Story map:
http://bit.ly/TPRBasin
NC Environmental Education Webpage for River Basins:
http://www.eenorthcarolina.org/riverbasins.html

Engage:

Ask the following questions using the slide set titled Corn From Farm to Home

1. How many of you like cornbread?
2. How do you make cornbread?
3. How do you go from corn kernels to cornbread mix?
4. Where are the corn kernels ground? Show pictures
5. How did the corn kernels get to the factory?
6. How did the cornbread mix get to the store?
7. How did it get from the store to your home?
8. Where is corn grown?
9. How have farms, factories, stores, homes, & roads changed the landscape?

Farms, factories, roads, houses are all examples of how humans have changed the landscape to meet their needs. The examples shown and discussed are modern examples. What about our great-great grandparents? They had the same basic needs but they didn't have the technologies that we have today. How did they change the landscape to meet their needs?

Mills and the Changing Landscape

Explore:

- Have students explore, on their own or in pairs, the following story maps:
    - Tar-Pamlico River Basin Story Map: http://bit.ly/TPRBasin
    - Exploring the Waters of the Tar-Pamlico River Basin Story Map (Section 1 and 2 only): http://bit.ly/EXTPRIVERS

Explain:

Have students read the article: *How Have We Changed the Landscape of the Tar-Pamlico River Basin?* And answer the questions on the accompanying worksheet.

Explore:

1. Introduce the story map for *Exploring the Waters of the Tar-Pamlico*.
    a. There are 5 sections.
    b. Point out that the maps are interactive.
    c. The panel on the right side tells the "story" and is also interactive.
2. Let students explore the story map either individually or with a partner.
3. After they have explored the story map, then give them the Exploring the Mills of the Tar-Pamlico River Basin worksheet to answer. These questions go with the section: *Selected Mills on the Tar-Pamlico River*.
4. Have students click on the Mills in the Tar-Pamlico River Basin Interactive Map. Give them the Exploring Waters on the Tar-Pamlico Interactive Map Worksheet. This link is found in the section: *Selected Mills on the Tar-Pamlico River*.

Elaborate/Evaluate:

- Have students research an area around them that is being developed so they can create their own story map. Have them answer the following questions:
    - What is the development?
    - What basic need is this development helping to meet?
    - How is the landscape being changed?
    - What are the positive effects of this development?
    - What are the negative effects of this development?
- There is a link at the bottom of the Laurel Mill and Rock Mount Mill Information sheets that will take students to the National Register of Historic Places: Inventory Nomination Form. These forms will give students even more background knowledge about the mills and owners. Students could read and summarize this information.

National Register of Historic Places: Inventory Nomination Form for Laurel Mill

National Register of Historic Places Inventory-Nomination Form Rocky Mount Mills

***"We Recollect….."* An Anecdotal History of Nash County**-written by 7th & 8th grade students at Southern Nash Junior High- 1988. Students interviewed older citizens of the county. This provides some information about Webb's Mill.

Exploring the Mills of the Tar-Pamlico River Basin Story Map - Student Worksheet

Directions: Go to the ***Selected Mills on the Tar-Pamlico Rivers*** section to answer the following questions.

Find Louisburg Mill (red pushpin) and Byrd's Mill (purple pushpin) on the map. You will need to zoom in close to the pushpins to answer the following questions.

1. What town is between Louisburg Mill and Byrd's Mill?

2. Why do you think this town grew between these two mills?

3. What other man-made features do you think were developed around these mills?

4. Click on the pushpin for the Louisburg Mill. What do you think the people in the postcard picture might be doing?

Find Laurel Mill on the map and click on the pushpin. Zoom in and then click on the link for Information and pictures to answer the following questions.

1. When was the mill started?

2. What did the mill grind?

3. How do you think the river was affected by the building of the dam?

4. What town is located northeast of the mill?

5. What highway is close to this mill?

Find Rocky Mount Mills on the map and click on the pushpin. Zoom in and then click on the link for information and pictures to answer the following questions.

Exploring the Mills of the Tar-Pamlico River Basin Story Map - Student Worksheet

1. When did settlers begin to settle in Rocky Mount?

2. Where did Rocky Mount get its name?

3. Look at picture 2. Describe all the natural land features you see.

4. Look at picture 2 again. Describe all the man-made features you see.

5. What effect did building the mills have on the landscape?

6. How do you think building the mills affected landscape of the Tar River?

Find Webb's Mill on the map and click on the pushpin. Zoom in and then click on the link for information and pictures to answer the following questions.

1. The first picture of Webb's Mill shows the dam without water flowing over it. Where do you think the rocks to build the dam came from?

2. How do you think removal of those rocks changed the landscape?

3. The second picture shows the water running over the dam. How did constructing the dam change the river at this location?

4. What is the water behind the dam called?

5. Look at picture 4. Where do you think all the sand come from?

6. How do you think sand deposited affected the vegetation along the river bank?

Exploring the Mills of the Tar-Pamlico River Basin Story Map - Student Worksheet

Find Boddie's Mill on the map and click on the pushpin. Zoom in and then click on the link for information and pictures to answer the following questions.

1. Nathan Boddie opened one of the first grist mill in 1778 on what creek?

2. In 1834, another mill was built and ran until the 1970's. What was the purpose of this mill?

3. How does Boddies Mill still benefit the community today even though the mill is no longer running?

Using all the information you have collected from this story map, explain how and why humans have changed the land to meet their basic needs.

How Have We Changed the Landscape of the Tar-Pamlico River Basin?

Changing the landscape:

One of the first attractions to North Carolina was the abundance of Longleaf Pines. The wood from Longleaf Pine trees was used to build ships. Other parts of the trees were also used such as the pine pitch (sap). The pine pitch was used to make tar which was spread on the ship to keep it from leaking. Since the trees were transported on the river to the Pamlico Sound it became known as the Tar River. At least that's one version of how the Tar River got its name. The headwaters for the Tar-Pamlico River is in Person County. The river is called the Tar River until it reaches Washington NC. At the bridge for US Highway 17, the Tar River becomes known as the Pamlico River. The rivers flow down to the Pamlico Sound.

Settlers also came to North Carolina to become farmers. In order to farm, they had to clear the land. They used a technique called slash and burn. The farmers would cut down the trees and any other vegetation that was in the way and then burn them. The loss of this vegetation exposed the soil and increased erosion. The trees that were not burned were used to build their homes, barns, and other structures such as mills.

The mills used water to power the water wheel which in turn powered the stones to grind the corn and wheat. Since the mills needed water, they had to be located on a river or tributaries of the river. The waters of the river had to be harnessed to provide enough energy to keep the mill running. The flow of the river had to be changed so that the mill could operate whenever the farmers needed to grind their corn or wheat. The Tar-Pamlico River was harnessed in many different areas to supply power for the mills. So how was this done?

Harnessing the Tar-Pamlico River:

The people that built, ran, and maintained the mill were called millers. Mills couldn't be built just anywhere on the river. Certain land features were needed for the mill to be successful.

What is needed to build and maintain a successful mill?

- River with terrain that allows an efficient dam to be built.
- Rocks for building the dam
- Lumber for building the mill and parts to run it such as:
    - Water wheel
    - Sluice gate
    - Headrace
- A road that farmers could use to bring their corn and wheat to and from the mill.

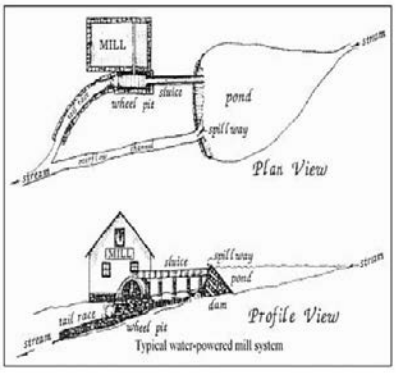


Illustration from:Mills on the Tsatsawassa:
Techniques for Documenting Early 19th Century Water-Power Industry in Rural New York,
by Philip L. Lord, Purple Mountain Press, Fleischmanns, New York, 1983.

Millers looked for areas of the river that were a little higher than the rest of the river. These areas were used to make dams. The dams raised the water level causing the water to get backed up and create a millpond. The height of the dam was important because it controlled how much water would be needed to start the waterwheel and keep it moving. The greater the height, the less amount of water was needed to start the waterwheel. The millpond stored the water that was used to

run the mill. The dam sent the water to the headrace where the water would fall onto the water wheel. A sluice gate was used to control the water flow. Opening the gate allowed the water to flow onto the wheel and closing the gate stopped the water flow. The water that flowed over the wheel was carried away from the mill through the tailrace.

After building the mill, the landscape was changed. The Tar-Pamlico River had an uninterrupted flowing river, but was now a river that had several man-made dams. These dams changed the flow of the water by creating ponds. The land surrounding the mills was changed by loss of vegetation which increased the amount of soil being deposited into the river.

Roads and Towns:

Roads were a necessity for the success of the mills and the farmers. When mills first started, roads were nothing more than game trails or paths used by Native Americans. As more and more wagons and horses used the trails, they began to widen. The effect of the widening roads led to the loss of vegetation and bare soil. When the rains came, the roads would get muddy and huge ruts would form due to the heavy wagons. Also, the topsoil on the roads would erode and end up in the rivers, streams, and creeks. The difference in the roads that we have today is that we use asphalt and concrete to build the roads. Even now we change the landscape to meet our needs.

Towns eventually began to grow around the mills. The farmers didn't use all their ground corn or wheat for their families. They also used some to trade or buy things they needed. As more people moved into the area, towns began to grow. This meant buildings were needed for general stores and homes. More of the landscape was changed because trees had to be cut for construction of these buildings.

Reservoirs, Lakes, and Ponds:

The purpose for building dams was to create a supply of water for the mills. These millponds became important to the community. Grinding the corn or wheat took quite a few hours so the farmers would sit around the millpond and talk. Other members of the community would also visit millponds where they would have picnics, fish, swim, have baptisms, and hold important meetings. Ever heard of a "rumor mill"? Going to the millpond was a great place to catch up on all the local news (whether it was real news or fake news.)

Some farmers created ponds on their land to help irrigate their crops and have a water supply for the livestock. The farmers would dig wells to provide a fresh supply of water for their families.

As communities began to grow, the people needed a bigger water supply than a well could provide. These communities created reservoirs for the townspeople. They would use an area of the Tar River or a tributary that would be suitable for a dam. Once the dam was built, water would back up just like a millpond. The difference was that the water wasn't supplying energy for a mill. It was supplying water for people to use for cooking, drinking, and washing. Of course, pipes had to be used to connect the water from the reservoirs to the people who lived in the towns. This is another example of how people have changed the landscape.

Student Worksheet: How Have We Changed the Landscape of the Tar-Pamlico River Basin?

Name: _____ Date: _____

Directions: Use the article, "How Have We Changed the Landscape to the Tar-Pamlico River Basin?" to answer the following questions.

1. Describe how the slash and burn technique was used by settlers and the effect it had on the landscape.

2. Why were the Longleaf Pine trees so valuable to the settlers?

3. Describe how building a mill on the river changed the landscape.

4. What does harnessing mean in the context of the article?

5. Why were roads important for the success of the mill?

6. What impact did roads have on the landscape?

7. Why were millponds important to the mill?

8. How did the community use millponds?

9. Mills not only affected the landscape surrounding the river. If the mill was successful, towns would begin to grow close to the mill. How did the building of towns change the landscape surrounding the river?

10. The bigger the towns became the more water they needed. How did they get this water?