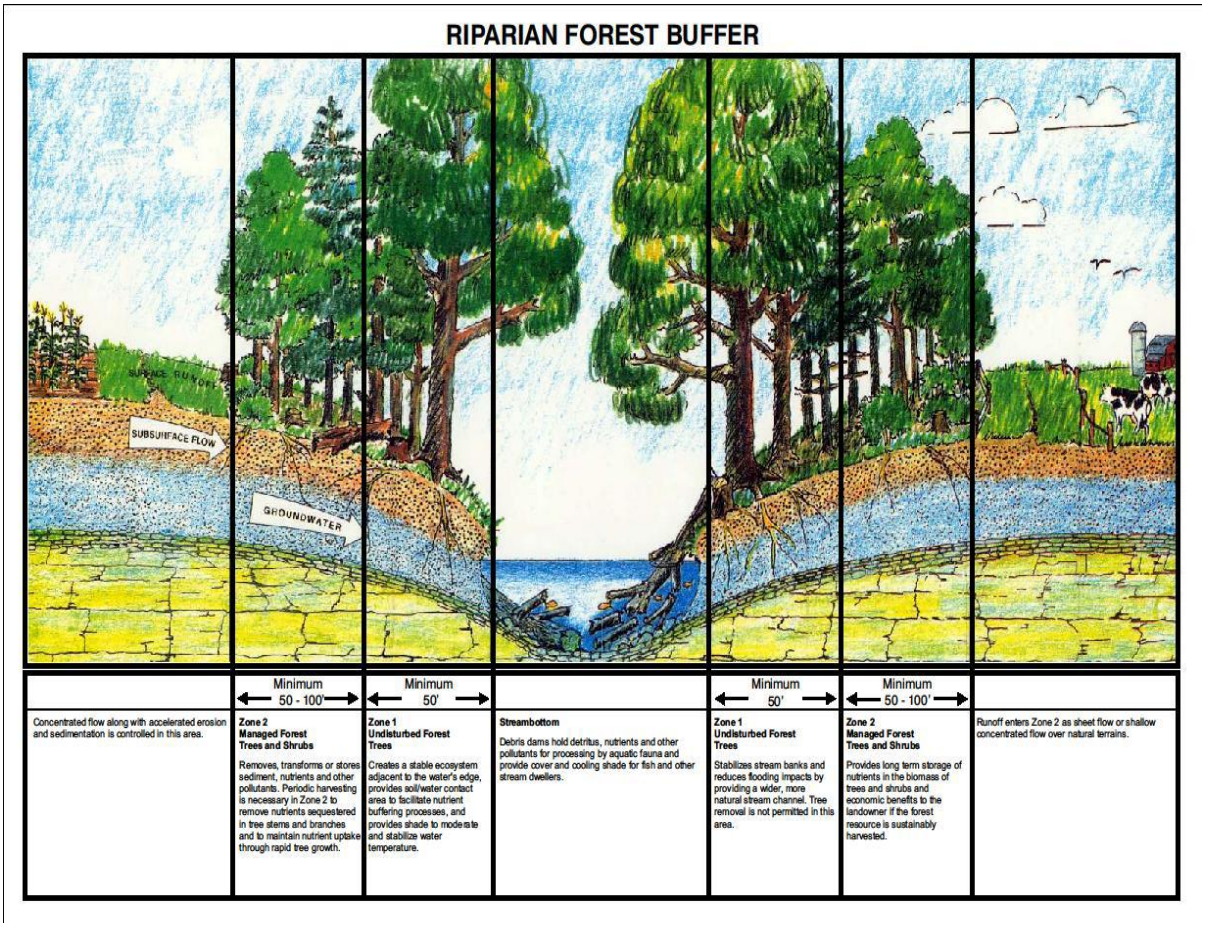
Streamside Trees in the Classroom

An Innovative Approach to Watershed Education

"How to" Manual &
Curriculum Guide



A partnership between Dan River Basin Association
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DAN RIVER BASIN ASSOCIATION

US Army Corps of Engineers ®
Wilmington District

This document was compiled as a resource by DRBA and USACE for teachers participating in the STIC program. Any collected resources are credited and permission was granted prior to publication of document.

Mission

Streamside Trees in the Classroom (STIC)
An Innovative Approach to Watershed Education

STIC is a hands-on environmental education program that educates students on the importance of streamside vegetation, referred to as a riparian buffer, primarily for the positive impact it has on water quality. Riparian buffers keep our rivers and streams healthy by reducing runoff and bank erosion and they also provide habitat for wildlife. Streamside vegetation not only benefits water quality and wildlife, but also people. Streamside Trees in the Classroom encourages each of us to become better stewards of our most valuable resource, water, starting by planting trees along streams.

Background


Degraded riparian area


Repaired riparian area


Healthy riparian area

What is a streamside buffer?

Streamside or riparian buffers are vegetated strips of land adjacent to rivers and streams. The vegetation often includes native grasses, low-growing shrubs, flowers and trees. Trees and shrubs are the stream's last defense against buffering waterways from pollution and damage. With strong root systems supporting the bank, streamside forests are nature's water filters, shock absorbers and sponges.

Why are healthy streamside buffers important?

Streamside buffers are important for good water quality. They help prevent pollutants, pesticides, nutrients and sediment from getting into our rivers and streams. If sediment and other pollutants get into our streams, it can make the process of municipal waste treatment very expensive and more difficult.

Riparian buffers are also essential to good wildlife habitat and productive fisheries. Streamside forests provide food to creatures at the bottom of the food chain and also provide travel corridors for other wildlife like deer and raccoons. The root systems hold the soil in place so sediment does not wash into the stream and smother out fish eggs or other benthic insects while the shade from the taller trees helps keep the stream at a cooler temperature.

What kind of impact do humans have on streamside buffers?

Most people live near a river a stream and want to be able to see the beauty of it, so they cut down all of the trees to have a river view. This could be the start to causing stream bank erosion and sediment pollution as there are no root systems present to help 'cement' the bank in place.

Agricultural areas also contribute to damaging riparian areas. If farmers use pesticides or fertilizers and there is no streamside buffer, all of the runoff ends up in the stream. Farm animals such as cows or pigs should not be allowed to access rivers and streams for drinking water. Most of the time they like to use the same area to access the stream causing erosion of the bank and they also defecate in the water causing harmful bacteria to enter our streams.

What can we do?

- Repair any damaged streamside buffer by planting appropriate trees or shrubs. Organize planting projects for damaged areas.
- Stop mowing all the way down to the creek.
- Maintain a healthy native stand of trees and shrubs along waterways. For streamside buffers, the wider the better. Allow at least 50 feet of vegetation.
- Avoid using fertilizers or pesticides near waterways.
- Keep cattle and ATV's out of waterways.
- Plant areas where bare soil is exposed and control erosion when disturbing soil.

Table explaining the results of water flowing over different types of surfaces and the effects on water quality. ***Virginia Department of Education Science Enhanced Scope and Sequence – Grade 4 pg. 123**

Surface	**What happens when water runs over**	**Effects on water quality**
Large area of pavement	Water flows rapidly, causing increased erosion after leaving the pavement.	Negative: Erosion causes increased sediment pollution.
Parking lot	Water flows rapidly, causing increased erosion after leaving the pavement. Also, water picks up oil	Negative: Erosion causes increased sediment pollution; automotive products contribute to toxic pollution.

	and engine fluid deposited in the lot.	
Bare soil	Water erodes and carries away soil.	Negative: Erosion causes increased sediment pollution.
Mulch	Water travels slowly over bumpy mulch and soaks into the ground without carrying away soil.	Positive: Slower and reduced runoff decreases erosion and, therefore, decreases sediment pollution.
Grass	Water travels slowly over uneven surface and soaks into the ground; roots take in water and hold soil in place. Grass can filter out harmful toxins.	Positive: Erosion and sediment pollution are further decreased; filtering decreases toxic pollution.
Forest	Water travels the slowest in a forest. As it drips down through branches and leaves, much is taken in by trees' and other forest plants' roots, which also hold soil. The forest has the most plants, so it can filter out the most toxic pollution.	**Positive: The slowest and cleanest runoff comes from forests. It has the least sediment pollution and the least toxic pollution when compared to other surfaces.**

This “how to” manual was written specially for the Streamside Trees in the Classroom program by Mr. Joel Bunn, Science Teacher at Magna Vista High School. Thank you!

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Streamside Trees in the Classroom

Training Manual

1. Introduction

Take a deep breath. Does it feel clean? Do you feel your lungs inflate? Your body suddenly gets a tiny little jolt. The Oxygen provided in the breath is being transferred to your blood. It is carried throughout your body, and your cells absorb it, respire it to make energy, and then release other molecules to be eliminated from your blood. These flow back to your lungs, you breathe out, and they are released.

Now imagine taking that same deep breath with dirt and dust swirling in the air around you. You cough – your lungs take in pieces they can't deal with – it's hard to get enough Oxygen from that air. Some of it moves on into your blood – small hairs in your lungs capture others, but they have no way to get rid of them. They are clogged – stuck – with these little pieces of trash. You don't feel as good, and you don't feel as strong. If this keeps up, how will you move?

Our aquatic environments are the homes for many species of invertebrates (organisms that have no skeletal backbone), as well as vertebrates (organisms with a skeletal backbone). The fish that swim in our rivers take their Oxygen directly from the water. They breathe through specialized structures called gills. These structures have a lot of surfaces, and as the water passes over these surfaces, Oxygen in the water is absorbed directly into the blood stream. Some of our invertebrates breathe this way too. Others breathe through pores in their body. Imagine if something blocked these pores. Would it be hard to breathe?

When large amounts of dirt or silt are washed into our streams and rivers, the organisms that live there experience this type of stress. They can't "breathe" well, and they don't get enough Oxygen. If the smaller organisms and invertebrates can't breathe, they will die off and the fish that consume them for food will go hungry. If the silt and sediment is bad enough, the larger fish have trouble breathing – their gills become blocked by particles and pollution, and they can't get enough Oxygen to their body to make energy. Either way, the creatures that live in our streams and rivers begin to die off – and when they do, they set off a chain reaction that will affect all of the organisms in our water, up to and including, us.

2. Erosion:

Have you ever seen water running across a parking lot during a rainstorm? It moves like a large sheet of paper – sliding down and carrying small pebbles and pieces of trash in its flow. Now, have you ever seen a very hard rain, which caused small trenches and cracks to appear, carrying mud and dirt with it as it runs downhill. Both of these types of water movement are called "Erosion" Erosion means that the water that is flowing is carrying soil and other types or particles or trash with it. It may be paper, or pieces of trash, or even chemicals, but regardless, it will ultimately end up in the stream or river that it

flows into. Once it is in that stream or river, it will begin to change the way the creatures and plants that live in that river can collect food and Oxygen to survive.

So, how do you stop erosion? One way, of course, is to build a wall. But it's almost impossible to build a wall all of the way around our streams and rivers. Besides, a wall isn't perfect, is it? How do we get to the water? How do other organisms like deer, rabbits, and foxes reach the river to drink? Creating a wall around our streams and rivers wouldn't be very effective, would it?

What about if we find a way to use one type of organism to help protect other creatures? Can you think of a way to help slow down Erosion? What about plants? Tree and plant roots are very effective on holding tight to soil, even when water is flowing past them. So let's use a plant to help us reduce the amount of soil and material that washes into our rivers. That will help protect our invertebrates and our fish and will make for a healthier environment for all of us.

3. The Black Willow:

The Black Willow, *Salix nigra*, is found in our area, and offers us an opportunity to help protect our local streams and rivers from the damaging effects of erosion. Black willows are often found along stream banks and rivers, and they have extensive root systems that help stabilize and reduce the amount of soil that can wash into a river or stream. In addition, they are excellent sources of food for herbivores and provide a healthy dose of leaves in the fall to enrich the soil around them. Black Willows are also easy to "Propagate" a large term that simply means "to grow more of". For our program, we have chosen Black Willows as an ideal source of material to grow and transplant new seedlings in order to help grow and protect stream banks from additional erosion.

a. Propagation:

Propagation is a term that means "to artificially reproduce more of". Huh? What this means is instead of waiting for one tree to create many, many seedlings naturally we can use to transplant and protect our stream banks, humans can help create these new seedlings. Propagation is a type of reproduction – making offspring. As humans, we reproduce and have children. Plants, like the Black Willow, do the same – only they have several ways of accomplishing this.

Sexual reproduction occurs within the flowers of the Black Willow, and will result in new seeds being made that can be planted and will ultimately grow into new plants. One problem with waiting for this type of reproduction is that many of the seeds may not grow, and those that do may take a very long time in order to develop into a large enough plant to help hold the soil in place. We need a way to make larger, faster growing seedlings for our purposes.

Asexual reproduction means that we will be using a part of the original plant in order to make copies of that plant. Asexual reproduction has less variety in the new plants we will have, but it allows us to start plants at a higher level of development so they can begin to hold the soil for us sooner, and protect our streams and rivers faster.

One method of asexual reproduction is utilizing "cuttings", which are actually pieces of the original tree or shrub that have been cut, and are placed in a material such as soil, or water, to allow new roots to develop. While many plants cannot be grown this way, Black Willows are interesting plants that can develop new roots and become new plants this way. So the Streamside program is designed to use cuttings from Black Willows to help create new plants to help us protect our streams.

4. The concept behind the method:

There are many ways that we can propagate *Salix nigra,* our Black Willow. Willows are traditionally an easy species to propagate. You can plant seeds, you can layer (burying long stems still attached to the tree underground until they grow roots), but the easiest method in the classroom is utilizing cuttings. Cuttings are pieces of growing stems that are placed, stem end down, in some type of material to encourage new roots to grow out of the stem. Once enough new roots have grown, the new seedling becomes a new plant – it will be able to grow and develop just like the original plant, which means we can transplant it beside our stream and it will grow and help protect our stream from erosion.

Cuttings are often grown in two ways: Either in pure water, or in a potting or soil mixture. There are advantages and disadvantages to both. In pure water, you don't have to worry about acquiring soil, and watching the moisture level, however some fungus and water molds may infect your seedlings, or they may simply not develop roots and "drown", meaning the cells will die off from a lack of Oxygen. In soil or potting mixtures, the plants have a longer time to begin to grow since they are reasonably dormant, however there is still the possibility of disease (particularly if you over-water or use old potting mixes), and some seedlings simply don't respond to the soil mix. However, any soil mix we use will need to be a "sterilized mix" to insure our plants aren't initially exposed to any disease "pathogens" (bacteria, fungus or viruses that cause disease).

For the Streamside Program, we are growing our cuttings in water. Experiments from the first few years of the program have shown us that rooting for our Black Willow cuttings works best when the cuttings are placed in water instead of soil. The roots that develop are typically strong and healthy, and most stems will develop multiple lateral roots that are 2 to 3 inches, or even longer! When it comes time to transplant, it is easy to remove the new saplings from the containers and place them directly into a planting hole or "wedge". Since water can become dirty or even allow for bacterial or fungal growth, it will be important to monitor your cuttings regularly to make sure the roots are white in color and appear healthy, with no growths, mold or algae on them. If you notice growing tips of roots turning

brown or appearing to shrink or wilt then it is important to change the water the cutting is growing in and even cleaning the container to make sure the plant roots are under less stress.

The cuttings will be collected from specific Black Willow trees within our region. This will help insure that growing seedlings are already adapted well to our climate. Because we are collecting the seedlings in the fall, it means we are using semi-hardwood to hardwood cuttings. This means the plant is already entering its dormant phase. Not to worry – even though the above-ground portion of the plant is dormant, the cells inside are very much alive and will eagerly seek new ways to extend and enhance their root systems.

It will be very important for you to help maintain a desirable environment for your cuttings. The seedlings need to be kept in a darker (not pitch black – but certainly not in a window) environment until new roots have developed. Imagine if the leaves suddenly reemerged, but there were no roots to provide them water yet? It is important that new roots develop before the seedling breaks dormancy. When roots are present and new leaves begin to form it is a good idea to move the plants closer to a light source, such as a window, or near some bright fluorescent lights.

5. The Process:

You will be growing new seedlings from "cuttings" - pieces taken from a mature, growing tree. Think about this from the standpoint of an animal – can you imagine cutting off a piece of an animal to grow a new one? Actually, there are some species that can do this, sponges in particular. However, for most animals this would be devastating. For many plants, however, this is an ideal way to develop new offspring. When we are taking cuttings from plants it is important that we pay attention to specific types of cells and layers to make sure our new cuttings will be able to grow roots.

All of our larger plants, including Willows, are called Vascular plants. This means they possess the types of cells and tissues to be able to transport food and water throughout their bodies, even as they get bigger. You have a vascular system as well – your veins and arteries. The blood they carry moves Oxygen and food throughout your body. Vascular plants have a system to move food, oxygen, and water throughout as well. When we take cuttings, we have to be careful not to damage these systems.

The cells in a vascular plant that carry water are called Xylem cells. Weirdly enough, they usually work when they have already died – they function much like straws to pull water up into the plant. The cells that carry food and other nutrients are called Phloem. They have to still be alive in order to work. To make sure we don't destroy these cells, we have to take a few special precautions when we prepare our seedlings.

Your seedlings have been provided to you having been cut and quickly placed in water a few days before. This is important, so the water in the Xylem stays constant – air bubbles in plants, much like air bubbles in our own veins or arteries (called "embolisms") are bad for them and us. So once the cuttings

were taken, they immediately went into water. Before you use them, you need to cut them one more time, under water. This will help make sure that the newly exposed surface is in contact with the water, which helps maintain a constant stream of water into the Xylem. You should place the base of the stems under water, and then cut about ½ inch off of the bottom under the water.

The cells that will become the new roots are actually in a ring inside the stem you have just cut. They are called the "Vascular Cambium" and they represent cells that can grow and divide quickly, but more importantly, can become either water carrying cells (Xylem) or food carrying cells (Phloem). While the Vascular Cambium under normal circumstances doesn't need our help, now that we've injured the plant a little bit, it will need a boost to start dividing again. We are using a plant hormone, which is a chemical that plants produce to help encourage their cells to carry out very specific functions. The hormone will help tell the cells of the Vascular Cambium to begin dividing again. You will take a paintbrush and collect a VERY small amount of the hormone to dust onto the cut stem. If you get too much, you can actually make the stem divide uncontrollably and turn into mush. Once you have dusted the stem, you will insert it into the water in your new container. Recycled soda bottles make great containers for this project as the narrow neck helps keep the stems upright so the roots can grow out all sides of the cutting!

Once all of your seedlings have been trimmed, dusted and placed into their containers, make sure the containers are not in direct sunlight or bright light (fluorescent lights have a bad habit of mimicking natural light so if you can protect them from strong fluorescent lights please do so). The goal is to give the seedlings as much time as possible to develop new roots without breaking bud. If you notice mold or growths, excessive wilting (the plants are bent over sideways), or large cankers (sunken spots) appearing on the side of stems, remove them immediately. You may lose some of your cuttings while you are growing them. It is very rare to have 100% success.

If your seedlings begin to break dormancy and leaf out, you will need to provide an artificial light source, but it should be weak in order to maintain life, but not encourage excessive growth. Fluorescent lights suspended about 12" above the tank may suffice, or a sunny window may help (as long as it doesn't have a significantly frigid draft). If you experience significant leafing out, please contact us for additional help and support.

Curriculum Guide
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Lesson plans:

****Design Brief for Black Willow Tree Model Added at the end of the manual. This brief was contributed by Ms. Laurie Witt, STEM Teacher at Martinsville City Public Schools. Thank you!**

Reduce, Reuse, Recycle

Virginia Department of Education

Organizing Topic Investigating Natural Resources

Overview Students make planters out of recycled paper and plant seeds or seedlings.

Related Standards of Learning 1.1a, b, d, g, h; 1.8a, c

Objectives

The students should be able to

- recognize that many natural resources are limited;
- predict what would happen if natural resources were used up, and explain ways to prevent this from happening.

Materials needed

- Samples of various types of paper, including some made from recycled fibers. These could include cereal boxes (chipboard), magazines (coated with clay), newsprint (most has recycled content), white paper, construction paper, and paper made by students
- Magnifying lens
- Microscope
- Small (6 oz.) milk cartons or yogurt containers
- A few stacks of newspapers
- Seeds to plant in the paper planter (may be donated by nurseries)
- Approximately one cup of soil for each paper planter

Instructional activity

Content/Teacher Notes

Lumber mill wastes, together with wood that is unsuitable for use as lumber, are used to manufacture paper. To save transportation costs, paper mills are usually located near the forests where the trees are harvested. To make paper, the trees are debarked, chipped, mixed with chemicals, and processed in a large steam-heated pressure cooker called a digester. This helps to break down the wood into cellulose fibers. The fibers are then rinsed with water to remove chemicals, unwanted wood contaminants, and dirt. The remaining water-wood mixture, called slurry, is fed onto a screen and shaken to intermesh the cellulose fibers. Water is drained through the screen, and the remaining

sheet of paper passes through a series of rollers where it is pressed. Heated rollers dry the paper. The dried paper is cut and placed on smaller rolls or cut into large sheets.
In 1995, approximately 31 percent of residential waste consisted of paper. This wastepaper could have been recycled. The paper recycling process is very similar to the process of making paper in the first place. The paper is chopped up and mixed with water to make a pulp slurry. Then it is put through a series of washing and/or flotation de-inking processes in which water and/or soap-like chemicals (called surfactants) remove the ink from the paper. Water is drained through the screen, and the remaining sheet of paper passes through a series of rollers where it is pressed and dried. The dried paper is slit into smaller rolls or large sheets. Later it is cut to desired size.
Paper may contain new fibers as well as recycled fibers. Papermaking fibers can typically be recycled five to seven times before they become too short to be recycled again. Successful recycling requires clean used paper, which is free of contaminants such as food, plastic, metal, and other garbage. Corrugated boxes, newspapers, and office paper are kept separate because the different grades of paper are used to make particular types of recycled paper products. Recycling paper conserves natural resources. It

- saves trees (most of which are grown on tree farms);
- saves energy because it takes 30 to 60 percent less energy to produce recycled paper as it does to make the same type and weight of paper from trees;
- reduces air pollution from pulp mills by 74 to 95 percent and lowers water pollution by 35 percent;
- reduces the amount of paper going to the landfill, therefore extending the life of the landfill.

Introduction

1. Read the class a book about being a friend to trees and about recycling. Discuss the following questions with students:

- From what material is most paper made? From what category of natural resources is most paper made?
- What are some other ways that plants are important?
- Who and what depends on trees and other plants to survive?
- What can we do to conserve trees — that is, use fewer and avoid wasteful use of trees?

2. Provide samples of various types of paper, including some made from recycled fibers and some from nonrecycled fibers. Have students make observations, using a magnifying glass and/or microscope. Discuss the following questions with students:

- What do you see when you look at the paper through a magnifying glass?
- What differences did you see between paper made from recycled fibers and that made from nonrecycled fibers?

· How do you know if something is made from recycled materials?

Procedure

Have the students make paper planters, using the following steps:

1. Make a paper-pulp mixture by soaking newspapers overnight in water. Stir the mixture to break the fibers down into a substance that can be bonded together again to form recycled paper.
2. Divide class into groups of three or four students each. Provide each group with newspapers (to be spread in their work area) and a small milk carton with the top cut off, or a similar container.
3. Have students take a handful of the pulp mixture and squeeze as much water out of it as possible back into the bucket or pan. Then have them use dry pieces of newspaper to press out more excess water from the pulp mixture. This step is very important, or their paper planters will take too long to dry.
4. Have the students mold the pulp about ¼-inch thick inside a small milk carton or similar container.
5. Then show the students how to use additional pieces of newspaper to remove more excess water from inside the paper mold.
6. Allow the planters to dry completely inside the cartons (about 3 days). You might set these out in the sunlight for a few hours each day. Once dry, take the molded paper planters out of the milk cartons.
7. Provide students with soil, and let them plant a few seeds in their planters. If the seeds are from native wildflowers, once they mature, students may plant them at home or on the school grounds. Be sure they understand that when planting the seedlings, they should place the entire paper planter with the plant in the ground, as the paper planter will decompose.

Observations and Conclusions

1. Have the students repeat the observations of various types of paper and make conclusions, using the questions from the Introduction to the lesson, step 2:

· What do you see when you look at the various types of paper through a magnifying glass?

· What differences did you see between paper made from recycled fibers and that made from nonrecycled fibers?

· How do you know if something is made from recycled materials?

Sample assessment

· Have students make a list of the benefits of recycling and of using recycled paper.

Follow-up/extension

· Let students make recycled sheets of paper.

· Visit a paper mill plant.
· Plan and begin a paper recycling project in the school, if there is not one already.

Resources

· *California Integrated Waste Management Board Publications.* "Closing the Loop: Exploring Integrated Waste Management and Resource Conservation." http://www.ciwmb.ca.gov/Publications/default.asp?pubid=834. This lesson is adapted from this source.
· *Outstanding Science Trade Books for Students K–12.* National Science Teachers Association (NSTA). http://www.nsta.org/ostbc.
· *Search for Literature: Literature for Science and Mathematics*. California Department of Education. http://www.cde.ca.gov/ci/sc/ll/ap/searchlist.asp. Web site with searchable database.

Riparian Buffers

Virginia Department of Education

Overview Students investigate how riparian buffers protect streams, rivers, and wildlife.
Related Standards of Learning 3.10a, c
Objectives
The students should be able to
· analyze the effects of erosion on organisms and habitat.

Materials needed
· Internet access
Per each group of students:
· Two aluminum roasting pans
· Soil
· Grass seed
· Food coloring
· Water
Instructional activity
Content/Teacher Notes
This activity is a revision of a lesson of the same name in the VDOE Web resource *Lessons from the Bay,* which includes a process model, outline of the key components of the Chesapeake Bay, lesson plans geared to students in grades 3–6, a glossary of wetland terms, and a project action guide. *Lessons from the Bay* is on the Web at http://www.doe.virginia.gov/VDOE/LFB/index.html.

A *riparian buffer* is a zone of vegetation located along the bank of a waterway and serving to protect the water from harmful runoff. The roots of plants and trees in the buffer stabilize the soil and control erosion. They also slow the flow of runoff water, reducing the threat of downstream flooding after heavy precipitation. By slowing water flow, riparian buffers allow the soil to absorb more water, and thus more water enters the underground water system. This water is naturally filtered as it slowly passes through the soil to replenish the aquifers.

In addition to being a natural water filter, riparian buffers provide habitats for wildlife. Songbirds live in the trees, and waterfowl are attracted to the cover at the edge of the water. Amphibians, turtles, eagles, foxes, and many other creatures utilize the buffer closer to the shoreline. Shad, herring, alewife, perch, and striped bass utilize forested streams and rivers to spawn, preferring the shaded areas near the edge of the water. The buffer's vegetation is a food source for wildlife in and out of the water.

Introduction

1. Conduct a class discussion of non-point source pollution in the watershed. Tell (or remind) students that non-point source pollution is pollution that is discharged from a wide land area and cannot be traced to a single specific source and location. Guide the discussion so that various sources of pollution are listed, including farms, lawns, golf courses, and roads. Also discuss the types of pollution that might come from each source.

Procedure

1. Divide the class into groups of four or five students. Instruct the groups to brainstorm and write a list of solutions to the problem of cleaning runoff and reducing the pollution that enters waterways.
2. Provide students with some of the resources listed at the end of the lesson, and allow them time to conduct research on riparian buffers. Tell groups to add to their lists of solutions any other ways they learned that toxic runoff can be prevented. Discuss as a class what the students learned from their research.
3. Assign students to groups of four or five. Give each group two aluminum roasting pans, soil, and grass seed. Provide them with the following instructions:

· Fill two-thirds of each pan with soil, leaving the other one-third empty.

· In one of the pans, plant grass seed in the soil in the middle portion of the pan. Do not plant grass in the other pan.

· Carefully add water to both pans as needed to keep the soil slightly damp but not wet to a depth of one inch. Do not disturb the location of the soil. (This might best be done with a spray bottle.)

4. Allow the grass to grow to the height of one inch. You might choose to have students monitor the growth of the grass and even chart the growth on a line graph.

5. When the grass has reached the height of one inch, provide each group with two cups of water colored with food coloring. Give students the following directions:

· Raise the soil end of each pan by placing a book underneath the pan's edge.
· Slowly pour one cup of colored water (representing polluted runoff) over the high end of each pan.
· Observe the erosion and the amount of polluted water that runs down into the empty one-third of the pan representing the waterway.

6. When the groups have finished, have each student write a paragraph reporting the results of the experiment. Instruct students also to interpret the results to explain how these models illustrate the role and benefits of a riparian buffer.

Observations and Conclusions

1. Have students bring their notebooks or journals out into the schoolyard. Direct students to find places where erosion is evident. Tell them to record their observations of erosion, including things such as location, appearance, and apparent reason for the erosion.
2. Return to the classroom, and instruct students to choose one of the cases of erosion and write a paragraph about their observations about it. Tell students to answer in their paragraph the following questions:

· What factors might contribute to erosion in these places?
· Why should we be concerned about erosion in the schoolyard?
· How does the water that flows over the schoolyard affect streams, rivers, and the Chesapeake Bay?
· What might be done to stop the erosion?

3. When students have finished writing, discuss as a class some of the possible solutions for erosion.

Sample assessment

· Discussion of non-point source pollution
· List of solutions for the problem of cleaning runoff and reducing pollution
· Watershed model and written report of experiment results
· Written description of erosion case in schoolyard

Follow-up/extension

· Have the students become Virginia Save Our Streams stream monitors. (See http://www.sosva.com/.)
· Have the students prepare a report about the importance of riparian buffers, supporting it with research from the *Lessons from the Bay,* "Riparian Buffers," Session 1 and with results from the experiment conducted in Session 2. Have them design the report so that it might be presented to community leaders to

convince them of the need for regulation requiring developers and farmers to plant riparian buffers.

Resources

· "Backyard Streamside Buffers – Have You No Shame?" *Alliance for the Chesapeake Bay.* http://www.acb-online.org/backyardbuffers.cfm.

· "Bay Buffers. Riparian Forests: The Final Frontier." *Watershed Action for Virginia's Environment (WAVE).* Chesapeake Bay Foundation. http://www.cbf.org/site/PageServer?pagename=edu_educators_curriculum_va_index, or contact the Virginia Office: Capitol Place, 1108 E. Main Street, Suite 1600, Richmond, VA 23219; phone 804-780-1392.

· "Build Your Own Rain Garden." Project Action Guide. *Lessons from the Bay.* http://www.doe.virginia.gov/VDOE/LFB/pag/projects/raingarden/index.html.

· "Building an Outdoor Classroom." Project Action Guide. *Lessons from the Bay.* http://www.doe.virginia.gov/VDOE/LFB/pag/projects/outdoorclass/index.html.

· *Conservation Trees for Your Farm, Family and Future.* Booklet available free from The National Arbor Day Foundation. Go to http://www.arborday.org/shopping/merchandise/merchlist.cfm, and search "conservation" under "Merchandise."

· "Riparian Buffers." *Center for Subtropical Agroforestry. Agroforestry Information System.* Institute of Food and Agricultural Sciences, University of Florida. http://cstaf.ifas.ufl.edu/riparianbuff.htm.

· "Riparian Buffers for the Connecticut River Valley." *Connecticut River Joint Commission.* http://www.crjc.org/riparianbuffers.htm.

· "Riparian Forest Buffers." *Chesapeake Bay Program.* http://www.chesapeakebay.net/ripar1.htm.

· "Using Poplars and Willows to Reduce Nitrate Leaching from Dairy Shed Effluent." *The Horticulture and Food Research Institute of New Zealand, Limited.* http://www.hortresearch.co.nz/projects/dairyeffluent/.

Dream Stream

designed for the NYC and NYC Watersheds Trout in the Classroom program

Objective:

To verify that students understand the anatomy of a healthy stream, purposes of various parts, and vocabulary to describe trout streams.

Background:

The clean cold streams of the Catskill Mountains provide an ideal habitat for trout and a reliable source of drinking water for over 8 million New York City residents. The health

of a stream depends on many factors including vegetation, surrounding land, forested cover and substrate. New York City's watershed steams and surrounding lands are monitored and taken care of in order to protect the valuable resource of clean, cool and fresh water.

A healthy stream has many important parts. First, it has a partially to fully rocky substrate (stream bed), such as gravel or boulders. As the cool water flows, it meanders (weaves back and forth) over and around this substrate. The pattern of rocks and gravel makes the water act differently in different parts of the stream. Sometimes, the water pools in flatter, calmer areas and the water flow slows. In other areas, the highly variable substrate creates riffles—the areas of bubbly, white water—that help oxygenate the water. When water flows quickly without interruption by substrate, this is a run.

A healthy stream also holds and is bordered by many living things. Aquatic macroinvertebrates, such as insects, mollusks, and crustaceans, live in every level of the water column. Fish and plants also live within the stream. Then, the riparian zone—the area next to the stream—must also be full of life. A healthy riparian zone has trees, shrubs, and/or herbaceous plants, as well as animal wildlife. This riparian zone (the roots and debris) helps filter surface water runoff and groundwater that might carry sediments and other pollutants that would otherwise enter the stream.

Materials:

images of healthy trout streams (start at www.tu.org), shoeboxes or other small boxes, construction paper, glue, glue sticks, saran wrap, clay, and natural materials such as sticks, rocks, leaves, small plants, etc.

Procedure:

1. Share trout stream images and vocabulary with your students, using magazines, books, or the internet. (Older students can do this research themselves.)
2. Ask the students to imagine, in their minds' eyes, the perfect trout stream. What is in the stream? What is the shape of the stream's path? What grows next to the stream? Where are the best trout hiding spots?
3. In their shoeboxes, ask students to delineate their "dream stream" path, using a pencil. This is a good first step to help them plan out everything else.
4. Now, let them go with materials. Students can use anything they brought or found, as well as share with others. Gravel makes great substrate. Sticks with leaves or paper make excellent trees, and stand up well in little balls of clay. As a final touch, it's nice to add saran wrap as the stream water.

Wrap-up:

In small groups or as a class, ask students to share their dream streams with each other. Have them give a tour. Perhaps they can give the tour as an angler, trout, or mayfly, pointing out what is most important to them from that perspective.

A River Runs Through It

Virginia Department of Education

Overview Students investigate the ways land use along a river impact it and, ultimately, the Chesapeake Bay.

Related Standards of Learning 3.10b, d

Objectives

The students should be able to

- describe how conservation practices can affect the survival of a species.

Materials needed

- Piece of drawing paper with edge cut to resemble the edge of a riverbank
- Long piece of blue bulletin board paper to represent a river
- 3 x 5 inch sticky notes
- Large piece of paper cut into the shape of a raindrop

Per each group of students:

- A scenario cut from the “Land Use Scenarios” (see p. 120)

Instructional activity

Content/Teacher Notes

This activity is a revision of a lesson of the same name in the VDOE Web resource *Lessons from the Bay,* which includes a process model, outline of the key components of the Chesapeake Bay, lesson plans geared to students in grades 3–6, a glossary of wetland terms, and a project action guide. *Lessons from the Bay* is on the Web at http://www.doe.virginia.gov/VDOE/LFB/index.html.

Rivers, creeks, and streams throughout the Chesapeake Bay watershed are lined with a wide variety of land types. The impact of the land use surrounding the upper portions of a river is felt all the way downstream, influencing the water quality of the river and, ultimately, the Bay.

Perhaps the greatest negative impact results from conditions that contribute to increased runoff, sediment, and nutrient levels in the water. Increased runoff causes erosion and flooding of waterways. The rapid water picks up and spreads pollutants. Erosion of exposed soil contributes sediment to the water. The sediment blocks the sunlight that underwater grasses need to produce the oxygen that benefits other

organisms in the water. Increased nutrient levels in the water cause algal blooms that also block sunlight. Several of the scenarios in this lesson also deal with air pollution and animal waste, another source of increased nutrients.

The most effective method of reducing erosion-causing runoff, sediment, and nutrient levels in the water is the maintenance of vegetation along the riverbank. Vegetation serves as a natural filter, slowing the flow of runoff and holding the soil in place. Vegetation also shades the waterway and prevents the water from reaching unhealthy temperature levels. Farmers who practice no-till farming and/or contour plowing help to reduce runoff and erosion. Developers who maintain a vegetated buffer along waterways help to reduce the potential runoff of pollutants and sediment. Contractors who use retaining fences also reduce the level of runoff and erosion from building sites.

Introduction

1. Divide the class into 10 groups of students (or into pairs). Give each group a piece of drawing paper and one of the Land Use Scenarios. Instruct each group to draw a picture of their piece of land, using the information given in their scenario. Impress upon them that they should include in their drawing all the details from the scenario.

Procedure

1. Give at least one 3 x 5 inch sticky note to each group. Direct each group to list on the note items from their land that could end up in the river with or without the aid of surface run-off.
2. When all groups have finished, have students place their drawings along the edge of the blue bulletin-board-paper river.
3. Beginning at the start of the river, move the paper raindrop downstream. As you pass by each land-use picture, ask the group that drew it to read their scenario to the class, describe what they have drawn, and read the list from their sticky note. Then, have the group place their sticky note on the raindrop. Proceed to the next land-use picture, and repeat the process.
4. Upon reaching the end of the river, read the sticky notes that are on the raindrop, and discuss the items. Ask students to help you list on the board the items that appear most frequently. Are some items more harmful to the water than others? Are there any that could be helpful? Discuss possible improvements to the land use in each piece of land that would decrease the negative impact on the river's water quality.
5. Have the groups modify their drawings to reflect better stewardship of the river. Discuss the meaning of *stewardship.*
6. Take the "river" and "raindrop" outside. Again, give the student groups sticky notes, and tell them to imagine that the river passes through the schoolyard.

7. Direct the groups to search the schoolyard for land-use practices that could impact the river. Tell them to look for both negative and positive impacts and to record their findings on the sticky notes.
8. When students have completed their investigation of the schoolyard, have them attach their sticky notes to the raindrop.

Observations and Conclusions

1. Return to the classroom, and discuss the items listed on the raindrop. Ask students to name and list the items that appear most frequently. Are some items more harmful to the water than others? Are there any that could be helpful? Discuss possible improvements to the land use that would decrease the negative impact on the river's water quality.

Sample assessment

· Conduct an informal assessment during the activity, determining whether or not students accurately report harmful/helpful impacts of the land area they were assigned.
· Assess students' solutions for solving land-use problems.

Follow-up/extension

· On a field trip to a local stream, creek, or river, have the students assess the land use along the waterway and offer recommendations for improvements.
· Have the students research best practices in land management. (See "Using the Library Media Center for Project Research" and "Using the World Wide Web for Project Research" in the Project Action Guide, Part 5, of *Lessons from the Bay*.)
· Have the students study maps to determine land-use practices along a river in your area and then write a story about water as it flows down the river.
· Have the students participate in the Chesapeake Bay Foundation's and Maryland Department of Natural Resources' "Bay Grasses in Classes" program. (see Resources below)
· Have the class write a letter to the principal recommending improvements in land-use practices in the schoolyard. Make sure the students support their recommendations with solid scientific reasoning. Prepare the students for both eventualities: that their letter will not be acted upon, and that it will.

Resources

· "Bay Buffers." *Watershed Action for Virginia's Environment (WAVE).* Chesapeake Bay Foundation. http://www.cbf.org/site/PageServer?pagename=

edu_educators_curriculum_va_index, or contact the Virginia Office: Capitol Place, 1108 E. Main Street, Suite 1600, Richmond, VA 23219; phone 804-780-1392.

· "Bay Grasses in Classes." *Chesapeake Bay Foundation: Save the Bay.* http://www.cbf.org/site/PageServer?pagename=edu_educators_restoration_grasses.

· "Build Your Own Rain Garden." Project Action Guide. *Lessons from the Bay.* http://www.doe.virginia.gov/VDOE/LFB/pag/projects/raingarden/index.html.

· *Chesapeake Bay Program: America's Premier Watershed Restoration Partnership.* http://www.chesapeakebay.net.

· *ChesSIE (Chesapeake Science on the Internet for Educators).* Virginia Institute of Marine Science and Chesapeake Bay Program. http://www.bayeducation.net. Supports watershed-wide Chesapeake Bay science education for K–12 teachers.

· "Sources of Sediment." *Watershed Action for Virginia's Environment (WAVE).* Chesapeake Bay Foundation. http://www.cbf.org/site/PageServer?pagename=edu_educators_curriculum_va_index, or contact the Virginia Office: Capitol Place, 1108 E. Main Street, Suite 1600, Richmond, VA 23219; phone 804-780-1392.

· "Using the Library Media Center for Project Research." Project Action Guide. *Lessons from the Bay*. http://www.doe.virginia.gov/VDOE/LFB/pag/toolkit/library_media/index.html.

· "Using the World Wide Web for Project Research." Project Action Guide. *Lessons from the Bay*. http://www.doe.virginia.gov/VDOE/LFB/pag/toolkit/wwweb/index.html.

Water Quality Problems and Conservation Strategies

Virginia Department of Education

Organizing Topic Investigating the Conservation of Living Resources

Overview Students investigate Virginia's watersheds, the negative impact humans have on water quality, and water conservation strategies.

Related Standards of Learning LS.1; LS.12d, e

Objectives

The students will

· describe ways human interaction has altered habitats positively and negatively;

· describe the relationship between human food harvest and the ecosystem.

Materials needed

· Shower curtain

· Newspapers

· Shallow pan

· Watering can

· Water

· Fishing line

· Index cards
· Scissors
· Permanent markers
· Food color
· Liquid soap
· Soil
· Baking soda
· String
· Construction paper
· Paper towels

· Copies of the attached “Pollution in the Chesapeake Bay Watershed” story

Instructional activity

Content/Teacher Notes

This activity requires preparation of many materials:

· small container of water colored blue-green to represent factory discharge
· small container of water colored yellow-red to represent motor oil from car and boat
· small container of water colored red-blue-green-yellow to represent manure from barnyard
· small container of soapy water to represent car washing waste
· container of soil to represent erosion from building site
· container of baking soda to represent fertilizer from farm field
· small piece of fishing line to represent fisherman’s snag
· small pieces of paper to represent picnic litter
· trees (one for each student) made from green construction paper and, optionally, laminated
· two role cards representing each of the following:

° a builder doing construction at a building site
° a farmer raising crops in a pasture
° a farmer raising cattle in a barnyard
° a manufacturer making a product in a factory
° a driver driving car on a road
° a son driving a motorboat on water
° a daughter washing car at home
° a college student fishing on a creek, river, or the Bay
° a family picnicking in a nice spot

Introduction

Review the concept of a watershed, and have students name some of the creeks and rivers in your local watershed. Ask them where the water in your watershed goes. (Chesapeake Bay for most of Virginia)

Procedure

1. Have students study watershed maps of Virginia, which are available on the Internet and from the Virginia Department of Forestry, the U.S. Fish and Wildlife Service, the USGS, and the USDA Soil Conservation Service.
2. Have students create a watershed model on the classroom floor by draping a shower curtain over balled up newspapers to observe water sprinkled over it flow "downstream" toward the shallow pan. Have students form the watershed model so that it resembles your own "watershed address," and have them label towns, creeks, and rivers on the model, using index cards placed on the model.
3. Lead students in brainstorming the pollution problems of your local watershed and, ultimately, the Chesapeake Bay.
4. Give each student a paper tree and a Role Card. (Create more Role Cards as needed for classes with more than 18 students.)
5. Have students stand around the watershed model and place their trees somewhere on the model. This represents the environment before being polluted.
6. Read (or have students read) the attached story, "Pollution in the Chesapeake Bay Watershed." (You may want to adapt the story to your own locality so students connect to it more readily.)
7. In paragraph 3, at the words, "Builders…cut down trees…," have several students take some trees off the model. At the words, "construct houses, schools, churches,…," have students with Builder-Construction-Building Site cards put their cards on the model in places where they are constructing buildings along a creek or river and identify their building project (e.g., house, new school, subdivision). Have the builders sprinkle soil on their building sites to represent exposed soil. At the words, "Rains washed loose soil…," sprinkle rain from the watering can to wash the soil into the creek or river. Point out to students that sediment from exposed soil runoff is now the second worst threat to water quality in Virginia.
8. In paragraph 4, at the words, "farmers cleared the trees…," have several more students remove their trees from the model and several students with Farmer-Crops-Pasture cards put their cards on the model. Have the farmers sprinkle baking soda on their farms to represent fertilizer. Then, at the words, "Rainwater washed the fertilizer…," again sprinkle rain from the watering can to wash the fertilizer into the water. Point out to students that nitrates in runoff containing fertilizer and animal manure are the number one threat to water quality in Virginia. Nitrates also dump into rivers (and the Bay) because of ineffective municipal and private septic sewage-treatment systems.
9. Continue the story for each role and pollutant.

10. After making a mess of the land and water, challenge the class to think of ways to prevent or ameliorate each problem. As they think of solutions for each problem, remove the Role Card from the model. The object is to remove every Role Card.
11. Lead students to realize that one of the better solutions is to protect existing trees and plant new ones. Discuss the value of trees in preventing erosion, filtering out pollutants, providing habitat for wildlife, cooling down the air and water, and adding beauty to the landscape. Have students put their trees back on the model.

Sample assessment

· Have students identify their local watershed address.
· Have students name three ways humans pollute water and explain some ways to prevent or stop these three problems.
· Have students clarify and discuss how trees are helpful to the watershed.
· Have students list some things they could do in the next 24 hours to help the water in the watershed.

Follow-up/extension

· Show the video "It's Happening Today on the Chesapeake Bay."
· Have the class visit the local wastewater treatment plant.
· Invite a manufacturer to visit the class to discuss ways his factory meets environmental standards.
· Have students research one of the pollutants and find out how significant its impact is and what efforts are being made to minimize its impact.
· Have students participate in a tree planting/restoration project along a waterway in your community.
· Have students conduct chemical tests in local waters for such things as nitrates, pH, and dissolved oxygen.

Web of Life Game

designed for the NYC and NYC Watersheds Trout in the Classroom program

Objective:
To teach students the fragile nature of food webs in a typical trout stream and to learn about keystone species.

Background:
Plants and animals found in Catskill Mountains form a delicate food web which relies on the presence and good health of the watershed streams. These streams carry nutrient rich water feeding hundreds of species of small stream dwelling macroinvertebrates. The smaller macroinvertebrates feed the larger macrinvertebrates which in turn become a source of food for larger animals such as trout. Trout and other fish become prey to

larger fish, birds and mammals living in the forests. The cycle continues with the presence of decomposers and plant. A change in the size of one population in a food chain will affect other populations. This interdependence of the populations within a food chain helps to maintain the balance in the Catskill Mountain watershed habitats.

Materials:

Creature Index cards (one per student) - (Sample set: Sun, algae, plankton, leeches, minnows, mollusk, frog, salamander, mayfly, caddisfly larva, dragonfly, garter snake, crayfish, snail, trout, otter, worm, bacteria, damselfly, mink, bird), Ball of string or twine

Procedure:

1. Review with students how energy moves through a food web. Explain that the activity they will do helps demonstrate the connection among members of an ecosystem. Have students make a large circle. Distribute one card to each student.
2. Give the ball of string to the student with the Sun card. Have the Sun choose an organism that is dependent on it for survival (plant). The Sun should retain the end of the string and pass the ball to the plant creating the first string of the web. The plant chooses an organism that is dependent on it for survival (insect) and passes the ball to the insect.
3. After students have passed the ball several times, suggest to them that the organism holding the string has just died. Ask: What eats dead matter? (insects, worms) The organism holding the ball passes it on to an insect or earthworm. The game continues until all the students are holding the string by at least one point. There will be a large web of string in the circle.
4. Discuss with students what they observe about the activity. Ask what would happen if one of the organisms disappeared. To demonstrate, ask the student who has passed the ball of string most often to drop it. Have students directly affected by the loss gently tug the string. As the slack is taken up, ask other students to gently tug as the string as well until all of the students are affected.
5. After the activity, discuss what affect the loss of even the smallest organism will have on the food web. Ask: What do you think would happen if the acid rain or some other environmental pollution prevented the hatching of the insect larvae?

Wrap Up:

Discuss the possible consequences that invasive species such as the Japanese knot weed, Didymo and the Asian Longhorned Beetle can have on an established food web.

Works Cited

“Lessons From the Bay." VDOE. Virginia Department of Education, n.d. Web. 02 Nov. 2012. <http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/index.shtml>.

"Science Lesson Plans and Activity Ideas | Www.troutintheclassroom.org." *Science Lesson Plans and Activity Ideas | Www.troutintheclassroom.org*. Trout in the Classroom, n.d. Web. 02 Nov. 2012. <http://www.troutintheclassroom.org/teachers/lesson-plans/science>.

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Streamside Trees in the Classroom Partners:

- Blue Ridge Soil & Water Conservation District
- Reynolds Homestead/Virginia Tech
- VA Department of Forestry
- VA Department of Game and Inland Fisheries
- Patrick County Soil & Water Conservation District
- Booker T Washington National Monument/National Park Service
- Farm Service Agency
- USDA Natural Resources Conservation Service
- Master Naturalists
- Virginia Cooperative Extension
- Franklin County Farm Bureau Women’s Committee
- Magna Vista High School AP Biology Students
- Virginia Museum of Natural History


SMOKEY