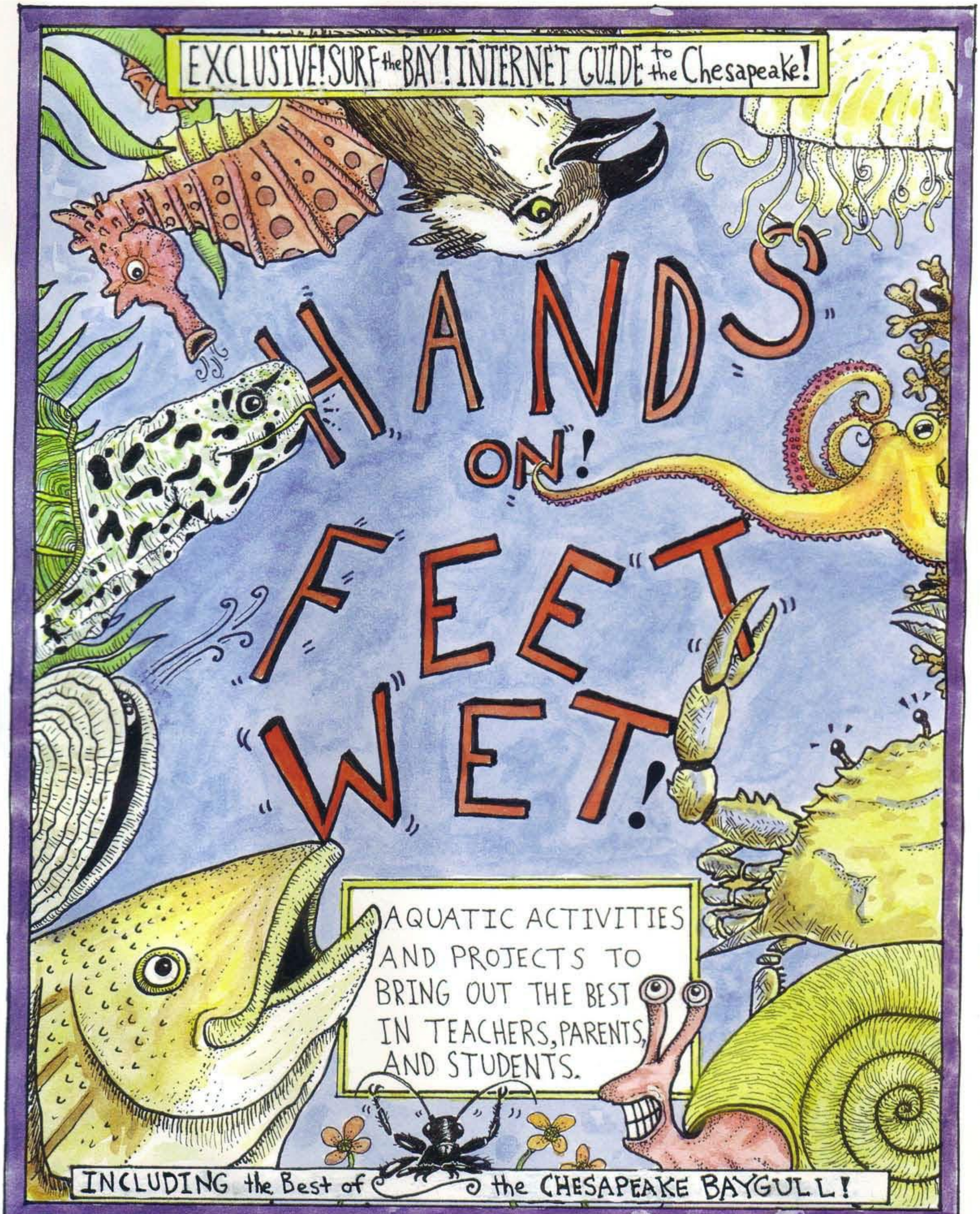

EXCLUSIVE! SURF the BAY! INTERNET GUIDE to the Chesapeake!
HANDS ON! FEET WET!
AQUATIC ACTIVITIES AND PROJECTS TO BRING OUT THE BEST IN TEACHERS, PARENTS, AND STUDENTS.
INCLUDING the Best of the CHESAPEAKE BAYGULL!

Table of Contents

Introduction

At Echo Hill Outdoor School, we explore and study a variety of natural and human environments. Our activities challenge students to observe, question, and evaluate how ecosystems form, sustain themselves, and evolve. We also seek to have students consider how ecosystems interrelate and how they are impacted by human activity. Students gain a heightened awareness of the interrelationship and interdependence of all living things.

Our approach to learning is experiential. It is based on the following premise:

What the student "hears," they may forget.
What the student "sees," they may remember
What the student "experiences," they KNOW.

We have created and collected a variety of projects that you can use to bring an experiential approach to aquatic studies into your classroom. Although any given activity may be geared towards a stream, pond, or estuary, many of them can be applied anywhere (ie: Water Sampling). Others are readily adaptable to different aquatic habitats (ie: customize the animal and plant list in the Estuary Food Chain Mural).

These projects include applications in science, math, language arts, geography, current events, history, and human development. In each case, we attempt to create an actual experience that allows students to explore, observe, respond, evaluate, and apply.

Overall, the aim of this manual is to:

1. Increase knowledge of aquatic ecosystems.
2. Increase knowledge about the biology of these ecosystems.
3. Heighten awareness of the interrelationships and interdependence of these ecosystems.
4. Heighten awareness about human interdependence and impact on surrounding environments.
5. Enable students to recognize their potential for implementing change in their home communities regarding environmental issues.

The following activities are intrinsically compatible with outcome-based learning goals and the Next Generation Science Standards. Each is based on real life situations incorporating core level thinking skills. They are meant to be conducted in small groups using an integrated approach. Students play an active part in gathering and interpreting data, formulating questions, defining and discussing issues, and determining solutions. These activities demonstrate the interaction and interdependence of life through the gathering and interpretation of scientific information, foster positive attitudes towards science, and encourage the role of science in addressing environmental issues.

Next Generation Science Standards (NGSS)

The Next Generation Science Standards (NGSS), published in 2013, have been adopted in many school systems across the United State, including in Maryland, Delaware, and the District of Columbia. The NGSS framework includes three dimensions to learning science: Crosscutting Concepts (CCCs), Science and Engineering Practices (SEPs), and Disciplinary Core Ideas (DCIs).

The table below aligns each activity in this Hands On! Feet Wet! resource with specific DCIs. For more information about how Echo Hill Outdoor School curriculum aligns with the NGSS, visit http://www.ehos.org/curriculum/index2.php.

Activity	DCIs (from NGSS)
Ecosystem Modeling	LS2.A Interdependent relationships in ecosystems LS2.B Cycles of matter and energy transfer in ecosystems
Playing with Sea Level	ESS1.C The history of planet Earth ESS2.A Earth materials and systems (9-12) ESS3.D Global climate change LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans
Estuary Food Chain Mural	ESS2.C The roles of water in Earth's surface processes LS2.A Interdependent relationships in ecosystems LS2.B Cycles of matter and energy transfer in ecosystems
Biophysical Survey	ESS3.C Human impacts on Earth systems LS2.C Ecosystem dynamics, functioning, and resilience
The Great Estuary Hunt	ESS2.B Plate tectonics and large-scale system interactions (3-8) ESS2.C

	The roles of water in Earth's surface processes
Urban Planning	ESS3.A Natural resources ESS3.C Human impacts on Earth systems ESS3.D Global climate change LS4.D Biodiversity and humans
Tributary Modeling	ESS1.C The history of planet Earth ESS2.B Plate tectonics and large-scale system interactions (3-8) ESS3.C Human impacts on Earth systems ESS3.D Global climate change LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans
Three Rs	ESS3.A Natural resources ESS3.C Human impacts on Earth systems LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans
Estuary Web of Life	LS2.A Interdependent relationships in ecosystems LS2.B Cycles of matter and energy transfer in ecosystems LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans
Water Quality Testing	ESS2.C The roles of water in Earth's surface processes ESS3.C Human impacts on Earth systems LS2.C Ecosystem dynamics, functioning, and resilience

Meaningful Watershed Educational Experience (MWEE)

What is a MWEE?

Meaningful Watershed Educational Experiences (or MWEEs) are multi-stage project based learning experiences recommended or required in educational systems across the Chesapeake Bay Watershed. For more information on the history and definition of MWEEs, visit https://www.noaa.gov/education/explainers/noaa-meaningful-watershed-educational-experience.

MWEEs and EHOS

Each MWEE has four essential elements that describe the students' actions during the project: Issue Definition, Outdoor Field Experience, Synthesis and Conclusion, and Action Project. For more information on MWEE design and the essential elements, visit: https://www.cbf.org/join-us/education-program/mwee/.

A trip to Echo Hill Outdoor School (EHOS) can provide an exciting and meaningful Outdoor Field Experience as part of a larger MWEE. Educators can use activities from this Hands On! Feet Wet! (HOFW) resource along with EHOS curriculum to plan a comprehensive and community-based MWEE.

Potential MWEE Progressions

Below is a list of all the MWEE essential elements, along with the HOFW activities that fit best into those essential elements. Educators can choose and adapt the activities as needed for their classroom in order to design a MWEE that works best for their grade and location.

Essential Element	*Issue Definition*	*Outdoor Field Experience*
HOFW activities	• Great Estuary Hunt • Estuary Food Chain Mural • Estuary Web of Life • Playing With Sea Level • Ecosystem Modeling • The Three Rs: Taking a Trash Survey • Tributary Modeling	• Biophysical Survey • Water Quality Testing • EHOS Science and Ecology Classes (as part of an EHOS trip!)

Essential Element	*Synthesis and Conclusion*	*Action Project*
HOFW activities	• Discussion of the results of Outdoor Field Experiences (including potentially comparing bodies of water near EHOS to bodies of water closer to the school)	• The Three Rs: Packing a Zero Waste Lunch, and Hold a Local Swap Meet or Yard Sale • Urban Planning • Watershed Penpal

Example progression for a seventh-grade science class:

- *Issue Definition*: Tributary Modeling
- *Outdoor Field Experience*: Water Quality Testing at a local water source and at EHOS
- *Synthesis and Conclusion*: Comparison of those water qualities
- *Action Project*: Watershed Penpal, where students communicate with an organization about improving local water quality

Vocabulary

Students should have a working understanding of these terms as applied to aquatic studies.

Algae – Tiny, non-flowering plants including seaweeds and microscopic phytoplankton

Brackish – Water that ranges in salt content (salinity) from 33 parts per thousand (ocean water) to less than 1 part per thousand (freshwater). Less than 1% of the world's water is brackish.

Ecology – The study of living systems and the physical environment.

Ecosystem – A community of organisms and their interrelated physical environment.

Erosion – The process in which rain and other natural forces wash soil away.

Estuary – Ecosystem where fresh and saltwater mix to create brackish water. Estuaries have free access to the ocean.

Eutrophication – The process in which nutrients from the land and other sources fertilize surface waters.

Food Chain/Web – A complex arrangement of organisms in an ecosystem in which each member depends on others for nourishment.

Fresh Water – water that holds no salt in it. Fresh water makes up a little less than 3% of the world's water supply. Fresh water can be found in the atmosphere in the form of water vapor; frozen in the polar ice caps; in ponds, rivers, lakes, and streams; and in underground aquifers and ground water.

Habitat – The physical environment in which a plant or animal naturally grows or lives.

Nutrients – Generally, things that provide nourishment for living things. Specifically, phosphates, nitrates. and any other material which stimulates the growth of algae and other phytoplankton.

Photosynthesis – the process by which plants use energy from the sun to produce their own food.

Plankton – Drifting or weakly swimming organisms transported by currents. Includes plants (phytoplankton) and animals (zoo plankton).

Pollutant – Any substance produced by humans that, when discharged into the environment, alters the natural balance of the ecosystem.

Salt Water – salt water (33 PPT) is found in a marine or ocean environment. Nearly all the water in the world is salty (about 97%). Salt is a natural mineral (sodium chloride) found all over the world.

Submerged Aquatic Vegetation (SAV) – rooted plant life that grows under water.

Watershed – a watershed or drainage basin is the specific area of land that collects water for or drains into a specific body of water. Each body of water has its own watershed, which may be a part of a lager watershed. For example, the Susquehanna River watershed is a part of the larger Chesapeake Bay watershed

Ecosystem Modeling

Objective: To explore the differences among ecosystems found in a watershed and learn how they are interrelated.

Materials: Shoebox or small wash tub, dirt, cardboard, crayons.

Begin by dividing the class into groups of two to three students. Each group selects an ecosystem found in the watershed to study and model (forest, swamp, meadow, stream, marsh, tidal mud flat, etc.). Each group starts by researching its ecosystem. Particular emphasis should be placed on discovering what types of organisms live in each ecosystem and the specific adaptations they have made to their environment.

What sorts of food do the different plants and animals need? Do they spend all of their lives in this ecosystem or just certain phases of their lives? Students should also be able to describe the most important phys-ical traits that define their ecosystem.

Once the groups have completed their research, they begin constructing models of their ecosystems. The models can be made in a shoebox or some similarly sized container. When possible, students should be encouraged to use actual materials found in their ecosystem (mud, dirt, rocks, etc.). Cardboard cutouts or magazine pictures can be used to represent plants and animals.

When the models are complete, each group makes a presentation to the class describing their ecosystem, emphasizing how it is different, both physically and in terms of plant and animal life, from other ecosystems in the Chesapeake Bay watershed. This activity can also be enhanced by discussing how the ecosystems are interrelated.

Playing with Sea Level

Imagine that the Atlantic seashore is fifty miles further east-or that a large coastal city like Baltimore has fish swimming down Charles Street. Both these events are possible in a world where sea level is constantly adjusting to slow changes in global climate.
In the earth's history, sea level has been higher and lower than its present level, depending on the average temperature of the earth. Currently, sea level is rising at about 1/8 in per year, because of human caused climate change.

Objective: To visualize how shorelines change as sea level adjusts to global climate conditions.

Materials: Coastal marine charts showing bathymetric contour lines or water depths, topographic maps with altitudinal contour lines, and colored pencils. Marine charts are available directly from the National Oceanic and Atmospheric Administration. Topographic maps are available from state and U.S. Geological Surveys.

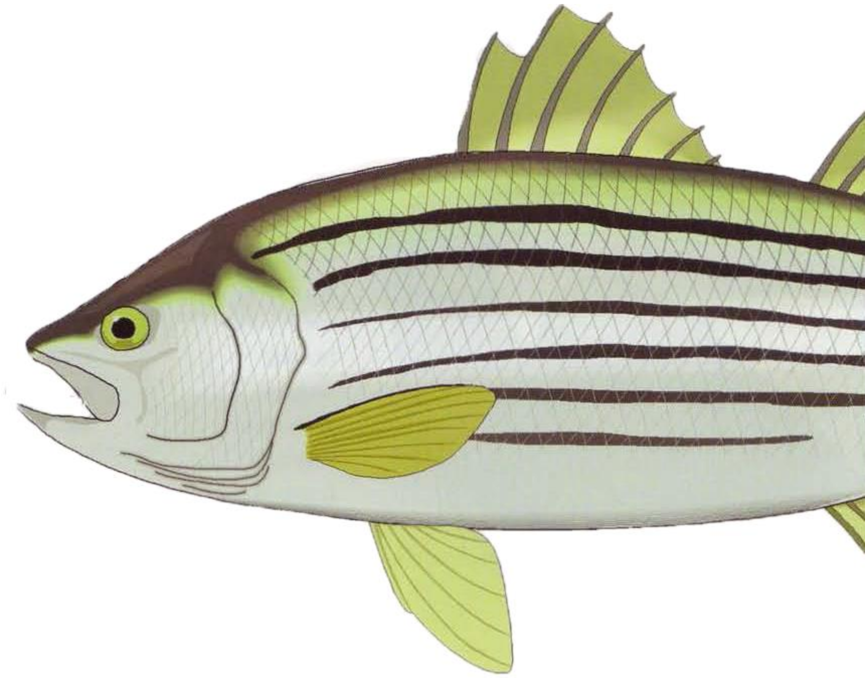
In small groups, students follow or trace contour lines and use colored pencils to shade in areas of the map. For example, on a topographic map, shade in the area of land that would be under water if sea level rose twenty feet. The twenty foot contour is the first line in from the coast. Different color shading is used to show additional rises in sea level. At the present rate, how long would it take sea level to rise 100 feet? What would the area of land covered by your map look like?

Another group uses the coastal marine chart. Given that sea level was about 320 feet lower during the last ice age, locate the continental shelf on the chart and determine where the coastline would have been 20,000 years ago. Shade in this area to see how much land has been given back to the sea.

Here is a progression of questions to spark discussion about sea level changes:

- What is ice?
- What happened to the polar ice caps as the earth entered each ice age?
- Where did the water come from to make the polar ice caps?
- What happened to sea level as the ice caps grew?
- What happened to the shoreline as sea level dropped?
- What has happened to the polar ice caps since the end of the last ice age?
- How has sea level changed since the end of the last ice age?
- How has the shoreline changed since the end of the last ice age?
- What will happen to sea level if the ice continues to melt?
- What does sea level change mean for animal and human

communities living near the shore?



Estuary Food Chain Mural

Objective: To have students develop an understanding of the interdependence of life in an estuary and how human activity affects these relationships.

Materials: Paper, crayons, markers, scissors, string, and glue.

Part I: Have each student select a plant or animal from the next page and research the following:

1. Organism's habitat-salinity range; deep or shallow water; top, middle, or bottom dweller.
2. Average size of the adult organism.
3. What the organism eats (how it obtains nutrients) and what eats the organism.
4. Location and means of reproduction.
5. Identify organism by phylum, class, and species (optional).

Students proceed by constructing a two-dimensional replica of their organism and attaching a 3 by 5 fact card. When the replicas and fact cards are complete, each student gives a brief oral report to the class on their organism. At the end of each report, the replica and fact card are attached to a collective class mural. To complete the mural, use pieces of string to connect organisms that are directly connected in the food web.

Part II: Once the mural is complete, the class discusses the effect of human activity on the estuary food chain. Possible topics of discussion are:

1. Eutrophication
2. Agricultural runoff
3. Industrial pollutants
4. Increased erosion and runoff caused by increased development and clearing of land
5. Household activities-including water usage and waste, sewage, use of detergents, waste disposal, and recycling
6. Population density in the watershed-particularly cities and their proximity to the water

Part III: Students discuss and research what is being done in their communities to combat the problems discussed in Part II. Make suggestions about what steps could or should be taken, and talk about what they could do every day to help lessen their impact.

Optional: Add replicas of pollutants to the mural to enhance discussion of human impact on the ecosystem.

Organisms

Animals

bald eagle
osprey
sea nettle
comb jelly
bluefish
rockfish
grass shrimp
bryozoa
copepod
killfish
silverside
catfish
flounder/hogchoker
oyster, clam, mussel
white perch
yellow perch
bay anchovy
sunfish
scud
carp
menhaden
sand shark
bacteria
American eel
blood worm
gizzard shark
blue crab
great blue heron

Plants

phragmites
algae
eel grass
coon tail
cat tail
saltmarsh
cordgrass

Recommended References

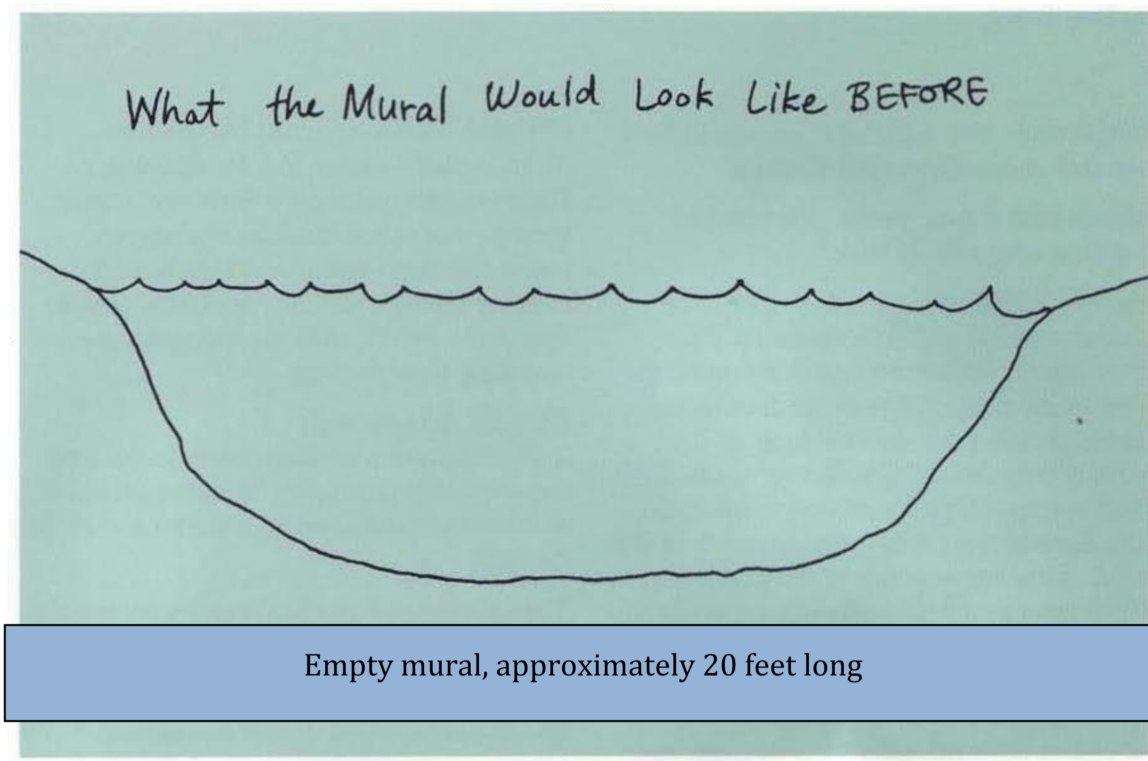
Bell, *Awesome Chesapeake*
Lippson and Lippson, *Life in the Chesapeake Bay*
White, *Chesapeake Bay: Nature of the Estuary*
Kiddle Chesapeake Bay Facts:
https://kids.kiddle.co/Chesapeake_Bay
NOAA Planet Arcade: https://games.noaa.gov/

Suggested Use of Class Time

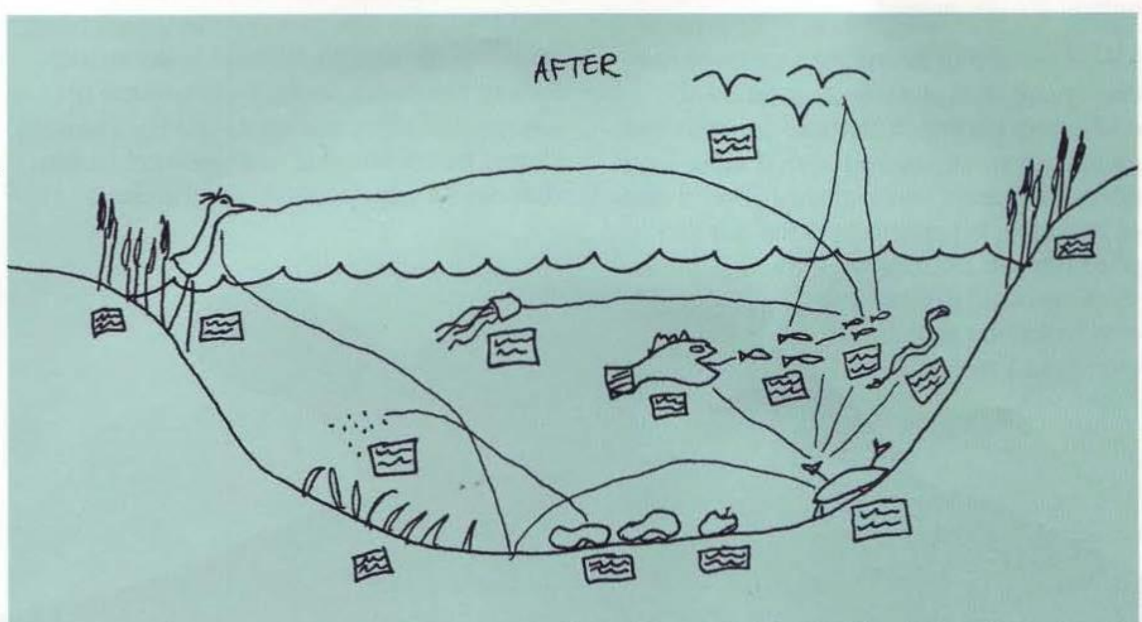
Day 1: Give out and discuss vocabulary.
Day 2: Assign students a plant or animal to research. Review library, internet, and other research sources.
Days 3-4: Research days.
Day 5: Write a paragraph on the selected plant or animal (to be posted on the mural when completed).
Day 6: Make a two dimensional replica of the organism (to be posted on the mural as well).
Days 7-8: Oral presentations.
Day 9: Connect organisms on the mural with string according to their place in the food chain/web.
Day 10: Discuss human effects on the food chain/web.

Day 11: Discuss solutions to pollution problems in the community

Example Murals



Empty mural, approximately 20 feet long



Finished product: The mural has been filled in with the children's replicas of Bay-dwelling organisms and accompanying info cards.

Biophysical Survey of a Wetland Ecosystem

Objective: For students to engage in field research and analyze their findings.

Materials: Paper, pencil, poster board, markers. **For field version:** long poles or sticks, local pond. **For online version:** Internet access for four teams of students.

Part I: Field version: Students divide into four teams. At the pond, poles or stakes are installed around the edge of the pond in five or ten foot increments, gridding the site (see **Example Chart of Our Pond**). The work is then divided among the four teams. First team is responsible for recording information. Second team measures the depth of the pond at the intersections of the grid lines. Third team performs a physical survey of the site, recording the features of the bottom, (i.e. sandy, rocky, muddy, etc.). Fourth team performs a biological survey of the site, recording the type and variety of plant and animal life discovered.

The physical and biological aspects of the survey can be as ambitious as time and equipment permit. With more accurate sampling equipment, students could more accurately determine water quality. Also, consider collecting organisms by seine net and plankton net. If funds are limited, students could design their own collection gear from improvised materials.

(Window screen stretched between two sticks to make a seine net, for example.) Once the first quadrant is surveyed, teams meet to share their findings and suggest improvements. Then, teams switch roles, rotating through all four jobs. Upon completion of the survey, students meet as a group to discuss their findings.

Part I: Online version: Students divide into two teams as in the **Field version**. Every team finds the same local pond on Google Maps.

Part II: Classroom: In the classrooms, students tabulate the data they recorded during the "secretarial" phase of the survey and develop a working chart of the data.
Then, they develop a final presentation style chart that can be integrated with the other groups' charts to form a complete image. The charts can be as detailed as time and equipment permit. The scope of the chart could be expanded to show the surrounding 50-100 yards of land, especially if students completed the **Online version** of Part I. It could indicate such factors as erosion, sources of chemical or natural pollution, and water quality. Students should be encouraged to suggest other data that can be incorporated into the chart.

Along with the chart, each group is responsible for submitting a report to the class that deals with one or more of the following factors:

- The process by which the group completed the project.
- The biological, physical, and aesthetic properties of the site.
- A brief history of the site derived from primary sources.
- Conclusions drawn from the information gathered.
- Suggestions to future researchers from lessons learned during the survey.

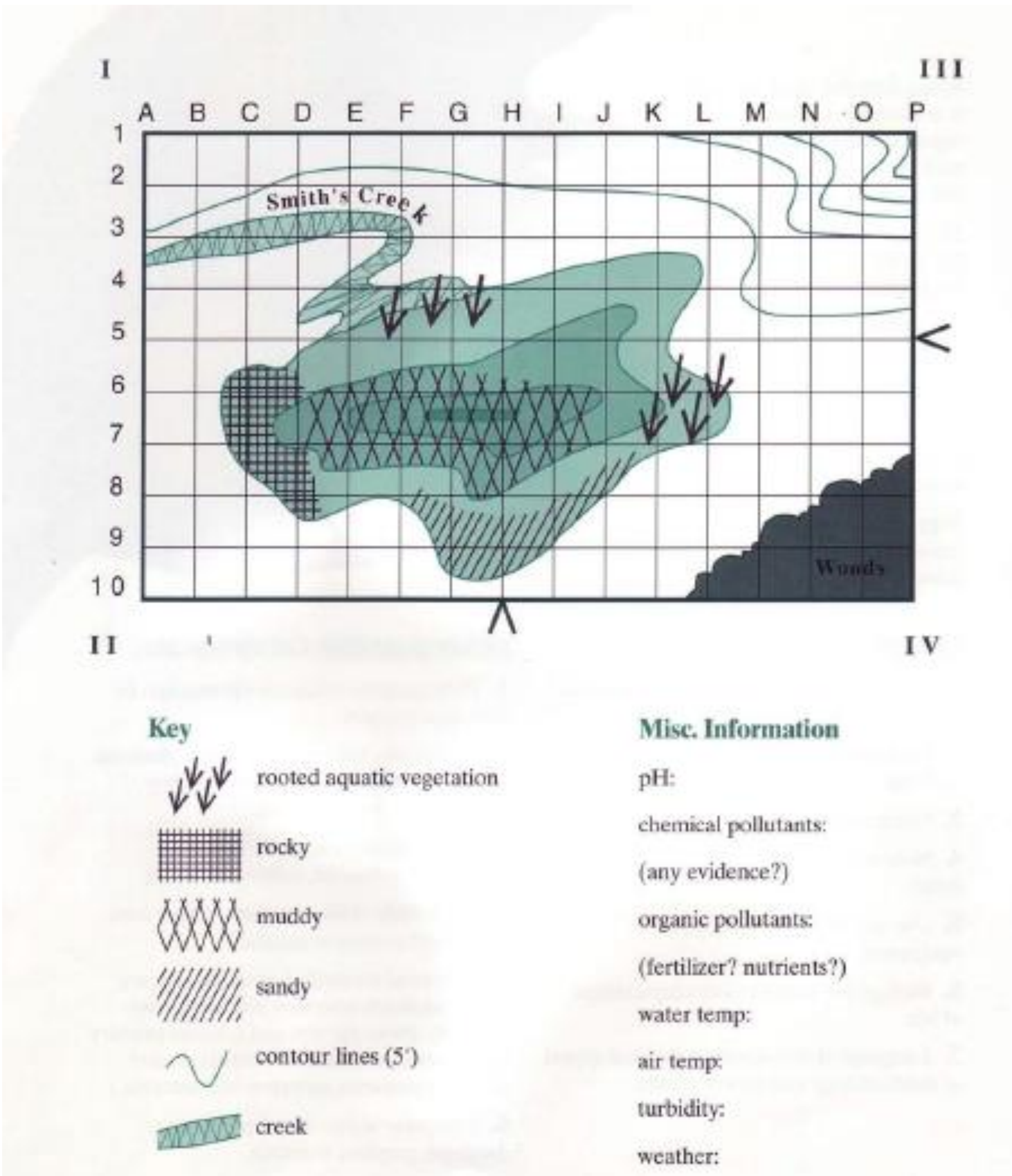
Components of the activity:

1. Teamwork – share information, cooperatively create chart and survey.
2. Mathematics – tabulate and interpret findings.
3. Learn and practice survey techniques.
4. Note-taking with careful attention to detail.
5. Use and improvisation of survey equipment
6. Biology/life studies – interdependence of life.
7. Language skills – create a detailed report of methodology and survey results.

Other possible components:

1. Photography/videography – students photograph or record project.
2. Laboratory microscopy – using plankton net and microscope, inventory as many microorganisms as possible.
3. Water quality tests – pH, dissolved oxygen, phosphorous, salinity, turbidity.
4. Leadership skills – students return next year to act as project mentors.
5. Historical research, journalism, library skills – students interview sources knowledgeable about the site and conduct primary source research (i.e. farm records, county survey documents, narrative accounts etc.)

Example Chart of Our Pond



The Great Estuary Hunt

Objective: To enhance understanding of estuarine ecosystems.

Materials: World map/Google Maps map or chart of Chesapeake Bay or other local estuary (online or physical)

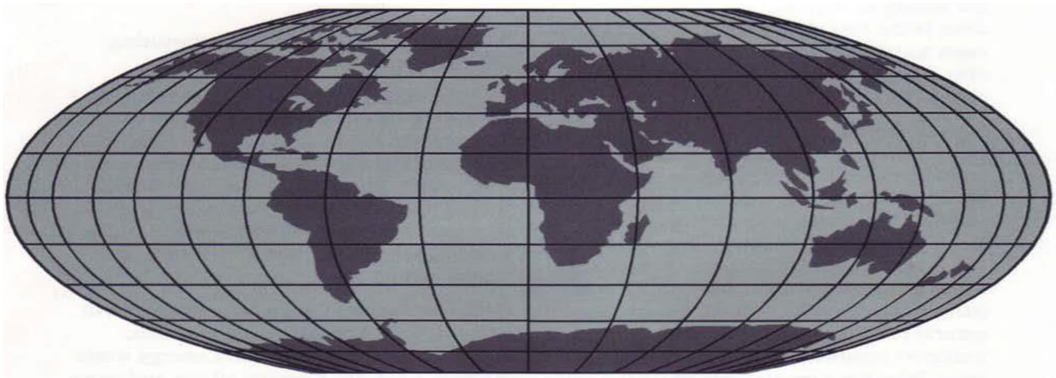
Part I: Begin by reviewing the vocabulary words on page ___ through a question and answer session focusing on a map of the Chesapeake Bay or a more local estuary.

Part II: Discuss the importance of the estuarine system from a global perspective.

Question: Who or what besides people could benefit from estuaries?

Answer: The oceans and their inhabitants. Approximately 70% of oceanic animals depend on estuaries—for spawning grounds, for feeding grounds, or as a source of food. Think of estuaries as roots of the oceans.

Part III: Look at a world map, or



search Google Maps and attempt to locate estuaries. This could be done in small groups, with each group charged with addressing particular coastlines or continents around the world.

a) Assign groups to work toward identifying the most important estuary in their study area

b) Have groups determine how their estuaries are different and similar from other groups'.

c) Optional: Students could write reports on important estuaries in the world, comparing them in terms of ecological productivity and environmental degradation. How have humans altered these ecosystems?

Note: *The Life and Death of the Chesapeake Bay* (see Resources) includes information about some of the world's major estuaries.

Urban Planning Project

Objective: To encourages students to think about the necessary and complicated nature of urbanization.

Materials: Paper, colored pencils, access to the Internet.

Cities are often criticized as sources of environmental pollution while their beneficial aspects are often overlooked. On the following page are links to three articles that comment on “low impact living” and the benefits of environmental urban planning. Distribute copies or have students look up the articles: “An Elitist View of Nature” 1994 Baltimore Sun, “Urban Planet: How growing cities will wreck the Environment unless we build them right” 2012 Time Magazine, “Urban Threats" 2019 Nat’l Geographic. **Optional:** High school students can also read/scan the article “Future cities and environmental stability”, 2016 to get ideas for the planning project.

Have each student spend time researching the basics of urban planning and the history of urbanization. Why are there cities in the first place? What are their advantages and disadvantages? Are there any benefits, from an environmental point of view, to expanding upward rather than outward?

Students should compile a list of materials cities need to operate (land. water, energy, building material, transportation, etc.) and a list of waste products cities must dispose of (sewage, trash, toxic waste, etc.). How is this list different in composition and degree from a similar list compiled for suburban and rural settings? Meaningful comparisons can be made among the amount of natural resources used to house, heat, and transport inhabitants of these different areas. Who has a greater impact on the environment – the inhabitant of an urban, suburban, or rural area?

After the students have developed a basic understanding of the obstacles faced in urban planning, have them design their idea cityscape employing the following parameters:

1. One million inhabitants.
2. 100,000 commuters entering and leaving the city every day.
3. Water source is a reservoir 200 miles away.
4. City occupies land bordering a major river.
5. 30% of work force in manufacturing, 45% in service industry.

Using these basic guidelines, students should attempt to make informed estimates about the amount of resources needed to keep the city going and the waste products that must be disposed. How much water do 1,000,000 people need every day? How much trash do they produce every day? How much does it weigh? How much space does it take up? Where should it go? Help the students think about all aspects of a city – parking spaces, roads, railroads, water mains, housing, industry, energy, waste disposal, food, etc. Keeping all this and more in mind, have the students make a plan of their ideal city.

Tributary Modeling

By: Jenny Wilderman

Objective: This activity is designed to give students a general idea of which materials and pollutants are coming into the Chesapeake Bay and their origins.

Materials: Map of the Chesapeake Bay. Assorted containers Plastic bag or sheet.

This activity utilizes a satellite map of the Chesapeake Bay with a key indicating urban areas, wetlands, farmland, etc. It could also be done using a standard outline map of the Bay with students researching the different environments.

Each student begins the activity by selecting a tributary of the Bay and researchingc what sort of environment (wetlands, urban development, agriculture) borders that body of water. Students should attempt to determine the general water quality (ie. presence of sewage nutrients, pesticides, etc.) of their tributary.

After completing their research, each student chooses a glass or plastic container proportional in size to the tributary they researched. The Susquehanna River would have the largest container. Students fill up their containers with water and any other substances that are found in their tributary (dirt, fertilizer, oil, etc). Actual materials can be used where appropriate, and food coloring can be substituted for more hazardous materials.

When each student has filled up their container, the class comes together around a plastic sheet or bag. The plastic should be either clear or white. Students arrange themselves around the plastic sheet to mimic the geographical layout of the Chesapeake Bay. The student representing the Susquehanna would be at the top or north side of the plastic, and the student representing the James River would be at the bottom or southwest side.

Two cups of salt water are poured onto the plastic to represent the two tides coming into the Bay each day. One by one, each student pours their container onto the plastic while explaining what sorts of things are found in their tributary. The result of this activity is a syrnbolic representation of what's in the Bay and its sources?

Follow up with an exploration of how these substances impact life in the Chesapeake.

How, why, should, or can they be controlled?

The Three R's

From the Chesapeake Bay Gull, by David Owen Bell

Getting rid of all our trash is not easy and whatever we do with it usually has some negative impact on the environment. Landfills take up a lot of open space and when not properly controlled, can pollute surface and ground water, breed rats and flies and just plain smell bad.

Incinerators are costly, and need a large amount of trash to run efficiently. This may actually encourage more waste. Much of the heavy metals and other toxic substances that aren't destroyed by burning are either released into the air or become part of the unburned ashes, which often end up in landfills.

People often argue about these issuing especially when someone wants to locate a landfill or incinerator nearby. While people continue to debate which disposal method is "less bad" for the environment, here are things that each of us can do every day to simply make less trash (treat the disease, not just the symptoms).

First of all, **REDUCE**. This means making choices not only about what you buy, but how you buy.

Then **REUSE**. This means finding ways of giving products and packages second, third, and fourth uses.

Finally, **RECYCLE**. This means returning used newspapers, glass bottles, aluminum cans, and other recyclable stuff to be made into new paper, bottles, cans, and other....stuff.

HEY! Wait a minute!

Isn't this book supposed to be about water?

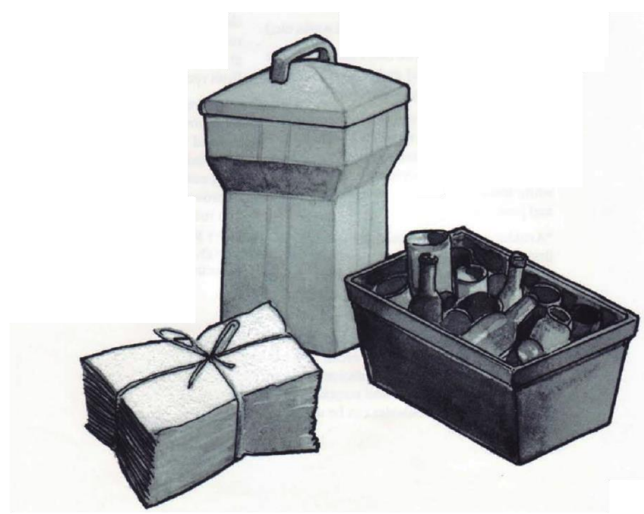
Hey! Guess what? It is.

Reducing waste helps keep harmful substances out of landfills and ground water that may connect to other bodies of water. Reducing waste means less trash for incinerators to burn, so there's less pollution entering the air shed.

Reducing waste saves energy, which means less fossil fuels burned which means less chemical nutrients and sulfur oxides in the air shed.

Reducing waste saves natural resources. More trees mean more habitat for wildlife. Less mining means less mining waste and erosion.

Reducing waste means fewer trips to the landfill or incinerator which saves truck fuel and tires and causes less air pollution, and so on, and so on, and so on....Get the picture?



Take a Trash Survey

Challenge students to measure how much trash is produced at home or in school every week, and then figure out ways to cut it in half.

Start by weighing the week's trash output on a scale or counting how many garbage bags or cans it fills. Estimate how much of it is made up of food waste, cans and bottles, paper, plastic, etc. If you can, presort the trash during the week of your survey by having different containers for each type. Record the totals or estimates.

Classify your trash and record totals. How much of it is made up of:

Disposables: things made to be used once, then thrown away, such as disposable pens, razors, diapers, and lighters, styrofoam cups etc.)

Compostables: Food scraps, yard waste, etc.

Reusables: things you don't need anymore but that could be fixed and reused, such as clothing, furniture, appliances, or toys

Recyclables: stuff you don't need anymore that is made of recyclable materials such as glass aluminum, some plastics, newspapers magazines, stationery and other white and colored paper, including memos and junk mail)

Avoidables: things you don't need in the first place, such as mail order catalogs extra copies of newspapers and magazines, unnecessary clothing, toys, gadgets, or other stuff you really don't need)

Analyze your trash. How much of it can be recycled or composted? How much of it can be reused? How much of the disposables can be replaced by reusables and recyclables? How much of the avoidables can be avoided?

Go to the source to find ways of reducing waste. At home, this means the kitchen, bathroom, home office, and yard. At school, start with the classroom then checkout the cafeteria, offices, science and art rooms and janitorial department-anywhere trash is made.

Apply the three R's. Can you reduce by having your name taken off junk mail and catalog lists and by using both sides of a sheet of paper? Can your school wash and reuse sturdy plastic or metal lunch trays instead of buying disposable styrofoam ones? Can teachers and parents use their own washable mugs for coffee and tea instead of one-time disposables? Can your school buy recycled paper? Can you start recycling and composting programs at home and at school? Can you use washable cloth napkins and washcloths instead of paper towels? Can you buy rechargeable batteries? Refillable pens? Cloth grocery bags? Can you buy products made from recycled materials?

Measure your trash output again. Did you meet your goal? Keep applying the three R's and measuring your trash output every now and then. Sort your trash to make recycling easier and to identify areas that can be improved. Remember, every aluminum can you recycle, every empty box you reuse, every piece of styrofoam you refuse saves energy, resource, and landfill space while reducing pollution.

Packing a Zero Waste Lunch

Learning Waste Free Ways to pack their lunch is a way students can help conserve resources and make less waste. Offer them these guidelines from the Center for Environmental Education.

No Disposables-Use a lunch box or fabric bag to carry your lunch. If you bring a paper bag, reuse or recycle it when possible

Avoid Prepackaged Single Serving Containers- Many parents buy these for convenience and their "treat value". Since each "treat" creates a single serving of waste, ask parents instead to buy large sizes of things you like, such as yogurt, chips and cookies, and pack them in reusable containers

Use Reusables- Get durable plastic food containers, or washout plastic margarine tubs, yogurt cups, etc. when they're empty and reuse them over and over again. Empty water and soda bottles, and thermoses can be used over and over again.

Use Recyclables- Make sure the container you choose can actually be recycled in your area. Aluminum is accepted everywhere, but plastic containers and juice boxes are not easy to recycle.

Avoid Buying Plastic Sandwich Bags-Keep and reuse the bags that your food comes in (such as bread bags). These can be easily wiped, rinsed, and left to dry again and again. If you must buy food wrapping, look for unbleached wax/beeswax paper or cellulose bags.

No Styrofoam (polystyrene)-Ever. This is a one-use item that is not easily recycled. Pollution is a by-product of making polystyrene, an item whose useful life can usually be counted in minutes

Take Leftovers Home- Even these don't have to be garbage when you take them home for the family pet or compost pile.

Once you've mastered a low or zero waste lunch, see where else in your home or school you can practice the three R's. How about zero waste birthday parties? Or camping trips?

The Next Step

Take a tour of your home or school. Look for ways that we all impact water quality every day. Water drains, electrical switches and outlets, garbage cans and wastebaskets are ideal places to start.

Whatever enters your home or school must eventually leave. What choices can we make that will lessen our impact?

Estuary Web of Life

By: Theolonius Wolfgang Dutton,
Adapted from Sharing Nature With Children,
By: Joseph Cornell

Objective: To involve every child in a display of the interconnections among animal and plant life, habitats, and human activity.

Materials: Ball of string.

Prepare students with an age-appropriate foundation of how an estuary works. For example, with older children, how soil erosion in Pennsylvania can increase the amount of nutrients in the Chesapeake Bay, causing increased algae resulting in more decomposition and lower oxygen and fewer underwater plants because of less penetration by sunlight. How might this affect fish or the bald eagles that eat them?

Have all the students sit down in a circle facing each other. The first student is handed the string and picks an animal from the list below. The student wraps one end of the string around a finger. Ask the class " Who can name something that eats or is eaten by this animal?" Pass the string to the student who names the second item.

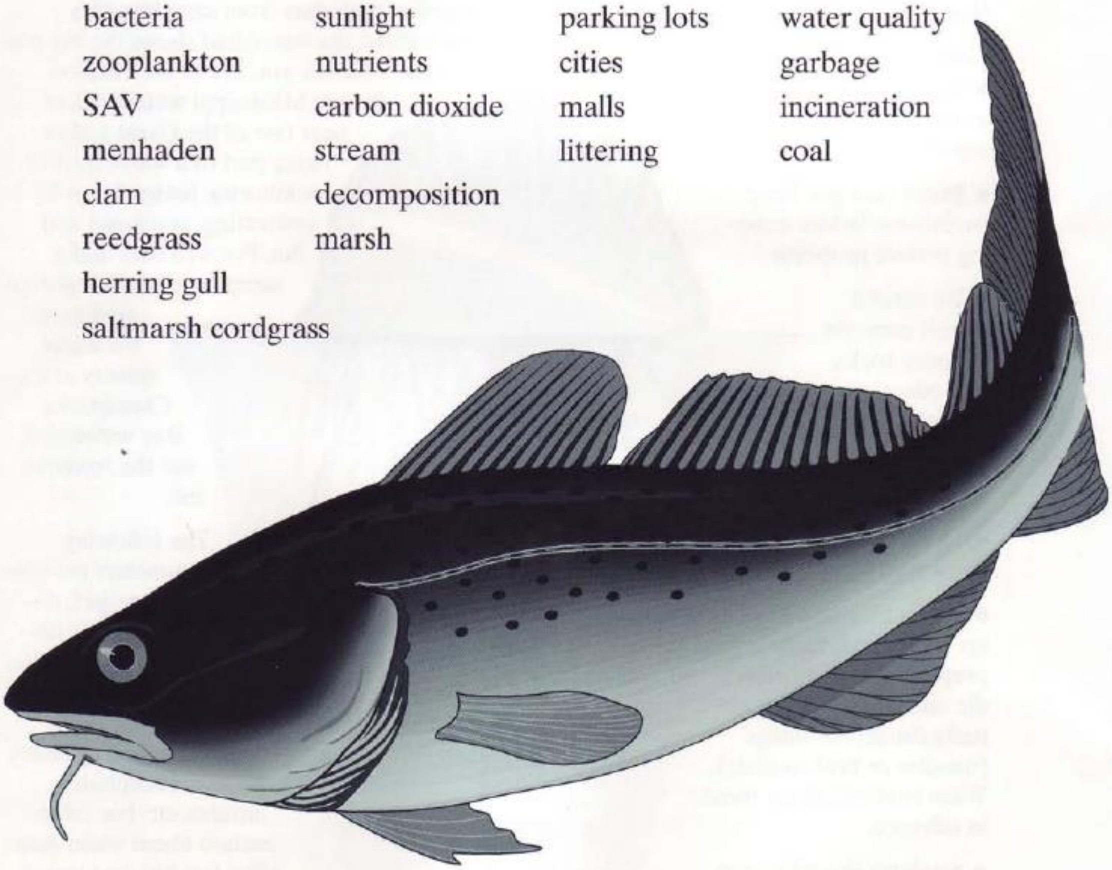
As each student picks an item from the list, they wrap the string around a finger. The string should be taut but not tight. For younger children, limit items from the list to a simple food chain. With older children, introduce other elements such as human activity, tributaries and sunlight. After the last person gets the ball of string, it goes back to the start. Now everyone is linked within the Estuary Web of Life. Students should be silent at the start of the game so as to experience the sensation of being signaled without vocal or physical contact.

Begin by introducing a situation that impacts directly on one of the items on the list. For younger children, this could be filling in a marsh to build condos.

An example for older children could be increased erosion. The student representing erosion gives a single tug on the sting. Those who feel the pull wait ten seconds and then pull on their string. Those who feel the second pull wait ten seconds then pull their string and so on, until everyone feels the impact.

Ask students what caused the person connected to them to pull the string. Discuss the interrelationships among roles. Explore such ideas as a population explosion or decline of one species or large scale development in the watershed.
Add or subtract items, or create new lists of relationships as necessary.

A.	B.	C.	D.
oyster	erosion	farmers	sewage
eagle	rain	watermen	exhaust
white perch	runoff	oil drilling	pesticides
blue crab	tributary	shipping	acid rain
catfish	pond	development	fertilizer
striped bass	wetland	electricity	landfills
algae	dissolved oxygen	highways	air quality
bacteria	sunlight	parking lots	water quality
zooplankton	nutrients	cities	garbage
SAV	carbon dioxide	malls	incineration
menhaden	stream	littering	coal
clam	decomposition		
reedgrass	marsh		
herring gull			
saltmarsh cordgrass			



Water Quality Testing

from the "Chesapeake BayGull", by David Owen Bell

Objectives:

- To determine the health of a specific body of water.
- To integrate math and science skills by sampling, collecting, testing, recording, tabulating, and analyzing.
- To foster ownership of a nearby body of water, identify possible sources of pollution, and seek ways to improve water quality as appropriate.

Materials:

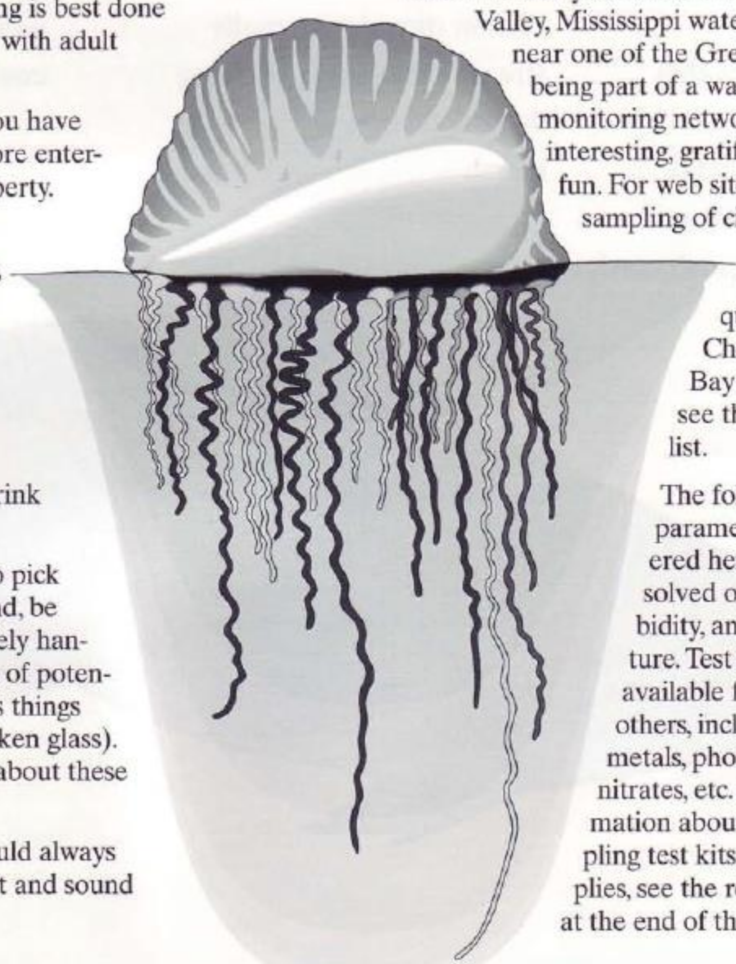
Varied by activity.

Guidelines:

- Water sampling is best done in small groups with adult supervision.
- Make sure you have permission before entering private property.
- Be careful of fast currents, slippery rocks, and other dangers.
- Dress appropriately.
- Don't ever drink the water.
- If you plan to pick up trash you find, be prepared to safely handle and dispose of potentially dangerous things (needles or broken glass). Warn students about these in advance.
- Students should always stay within sight and sound of a buddy.

Additional activities can include:

- Chart the different parameters over time.
- Test school or home drinking water for pH and other parameters.
- Obtain test results of local municipal water supplies and compare these to your tests. What are the similarities and differences between a healthy stream, pond, or estuary and healthy drinking water?



Testing your local stream or river can tell you about its health. Putting this information together with data from sampling sites throughout the watershed shows the big picture. Whether you live in the Hudson Valley, Mississippi watershed, or near one of the Great Lakes, being part of a water quality monitoring network can be interesting, gratifying, and fun. For web sites and a sampling of citizen groups that monitor water quality in the Chesapeake Bay watershed, see the resource list.

The following parameters are covered here: pH, dissolved oxygen, turbidity, and temperature. Test kits are available for many others, including heavy metals, phosphates, nitrates, etc. For information about water sampling test kits and supplies, see the resource list at the end of this manual.

Turbidity

Turbidity (cloudiness of the water) is caused by particles which scatter the sunlight passing through it. Two main sources of turbidity are sediments from runoff of eroded soil, and increased numbers of algae caused by too many nutrients in the water. Sediments and algae block sunlight that underwater plants need. Sediments also bury fish eggs and creatures that live on the bottom.

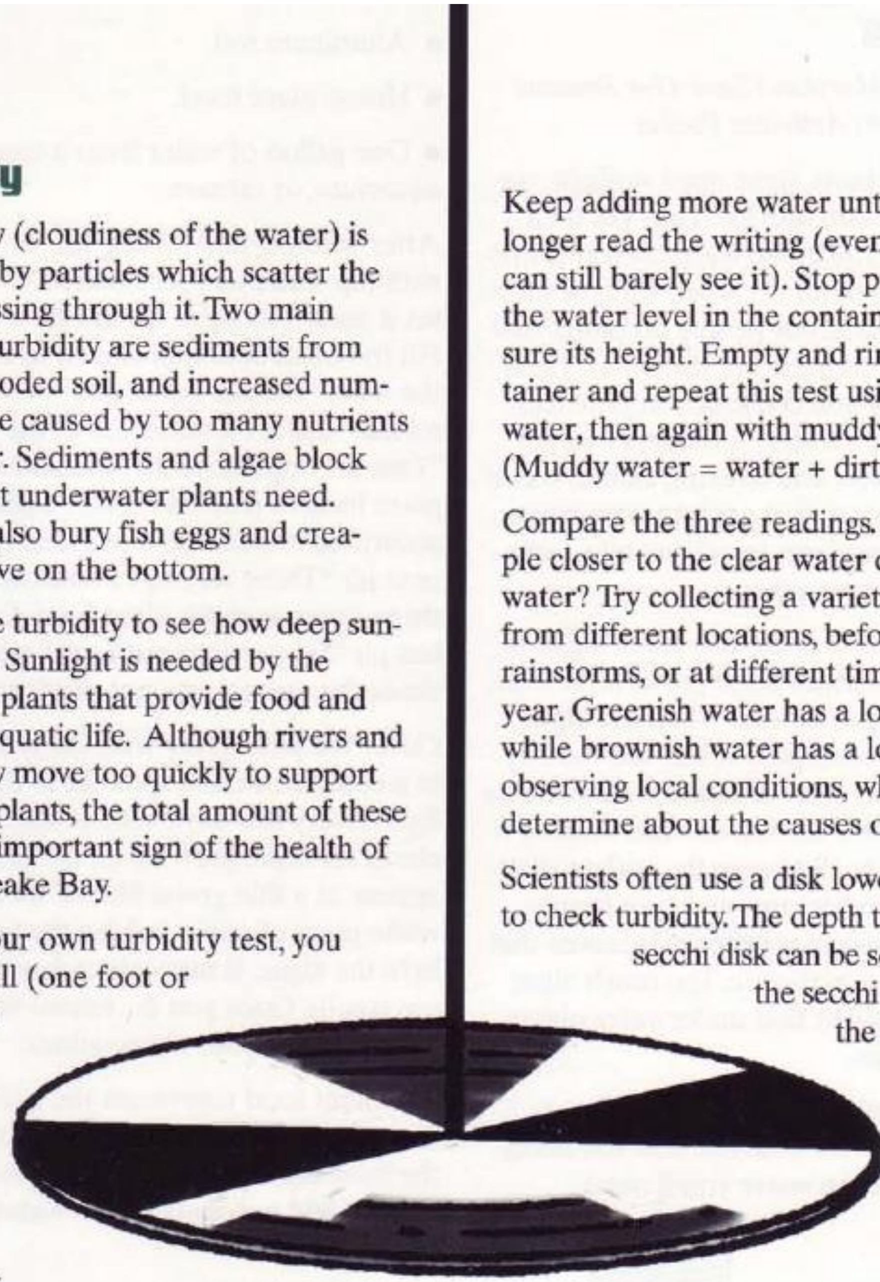
We measure turbidity to see how deep sunlight can go. Sunlight is needed by the underwater plants that provide food and shelter for aquatic life. Although rivers and streams may move too quickly to support submerged plants, the total amount of these plants is an important sign of the health of the Chesapeake Bay.

To make your own turbidity test, you can use a tall (one foot or more) clear flat-bottomed test tube or glass, a ruler, a bucket, and a newspaper. Collect your water sample in the bucket. Place the clear container over a "turbidity target" (the small black on white print in the newspaper) and look down through the container at the words. You should be able to read them clearly through the bottom of the container. Pour the water sample slowly into the container, stopping now and then to see if you can still read the words.

Keep adding more water until you can no longer read the writing (even though you can still barely see it). Stop pouring, mark the water level in the container, and measure its height. Empty and rinse the container and repeat this test using clear water, then again with muddy water. (Muddy water = water + dirt.)

Compare the three readings. Is your sample closer to the clear water or the muddy water? Try collecting a variety of samples from different locations, before and after rainstorms, or at different times of the year. Greenish water has a lot of algae while brownish water has a lot of dirt. By observing local conditions, what can you determine about the causes of turbidity?

Scientists often use a disk lowered by rope to check turbidity. The depth to which the secchi disk can be seen is called the secchi depth. Since the light travels through the water twice (once down and again reflected back to the observer), the light actually goes deeper. A secchi depth of at least 1 meter should be expected in the Bay and large rivers. Plants could then grow in water up to 2 meters deep.



Secchi Disk

Chesapeake Bay "old timers" use their toes. Walk out into the water about 1 meter deep without disturbing the bottom sediments. If you can see your toes, the water is pretty clear.

Nutrients-Too Much of a Good Thing

Adapted from Maryland Save Our Streams
Adopt-A-Stream Activities Packet

Like other plants algae need sunlight, water, and carbon dioxide. They get their nutrients from soil in the water. Soil gets into bodies of water naturally when wind or moving water erodes it, but people do things that add even more nutrients to the water. These include farming and construction practices that cause more erosion fertilizers that get washed into rivers and streams, animal waste and human sewage that get into waterways, and chemical nutrients in automobile, factory, and power plant exhaust.

All these nutrients cause too much algae to grow. When too much algae grows all at once, it's called an algae bloom. When the algae dies, bacteria decompose it and use the oxygen that fish and other animals need. Bacteria also give off more carbon dioxide, making it harder for fish to discharge the carbon dioxide in their bloodstreams and take in oxygen. Decomposition releases substances that are harmful to aquatic life. Too much algae also blocks sunlight that underwater plants need, so they die.

Kits that test for certain nutrients are available. To see for yourself how too many nutrients affect the water you'll need:

- Five clear quart jars.
- Aluminum foil.
- House plant food.
- One gallon of water from a stream, pond, aquarium, or estuary.

After washing and rinsing the jars, fill one with tap water as your control. Label it and set it aside. No algae should grow in this one. Fill the other four jars almost to the top with the water sample. Label one" No nutrients added" and set it aside. Label the next jar "One serving nutrients" and add enough plant food to make a regular solution according to package directions. Label the next jar "Three servings nutrients" and add three times as much plant food. Label the last jar "Six servings nutrients" and add six times the normal amount of plant food.

Cover the jars lightly with foil and put them in a cool and well-lit spot not in direct sunlight.
Every few days, stir the water and check for algae growing on the glass. It might appear as a thin green film or splotch. Hold a white piece of paper behind the jars to highlight the algae. It may take a few weeks to see results. Once you do, record the dates and results of your observations. The plant food represents the nutrients that are added to waterways. Which sample had the most algae growth? Why? What do people do that add nutrients to our waterways?

pH

pH is tested to determine whether water is acidic or alkaline. The pH scale runs from 0-14, with 7 being neutral. A pH below 7 indicates acid, above 7 shows alkaline (or base).

A difference of one number on the pH scale means a factor of ten. For example, sea water at 8.0 is ten times as alkaline as distilled water. Each additional number on the scale multiplies the factor by ten, so that orange juice is about 1,000 times as acidic as distilled water, and more than 1,000,000 times as acidic as milk of magnesia.

pH is important to life in the water. Fish, especially young ones, need to be within a pH range of about 6.5-8.5 to survive. The pH of a body of water can be changed by adding something with a different pH. People do this all the time to maintain their fish tanks, swimming pools, and stomachs.

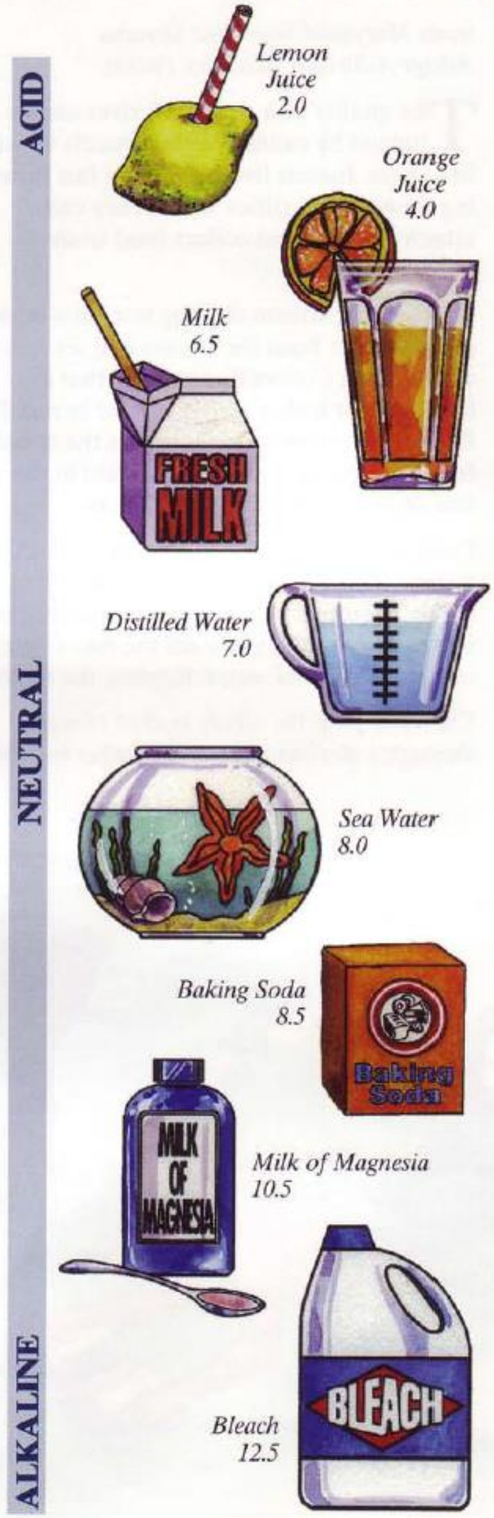
Most rain water is naturally slightly acidic because of the carbon dioxide it picks up in the atmosphere as it forms and falls to earth. On earth the weak acid rain dissolves minerals—salt, calcium, iron, and zinc for example, and carries them to the ocean, where they stay. Some of these minerals neutralize the water's acidity and raise its pH.

Burning fossil fuels, such as coal and oil, puts sulfur and nitrogen oxides in the air where they form sulfuric and nitric acids. This acid rain is harmful to plant and animal life. It is a problem in Europe and in the eastern United States.

Litmus paper turns red in acid, blue in alkaline water. It is a simple test, but not very precise. Test kits from pet and pool supply stores will give greater accuracy, but they contain a chemical which should be used and disposed of carefully. (Ask the salesperson if it can be recycled.)

A pH below 7.0 could be caused by acid rain or industrial pollution. A high pH could be caused by salt, lime, and other minerals which occur naturally. Lime is also used on fields and lawns to increase the pH of soil. It often gets into our waterways in the springtime, after it is applied and then carried away by seasonal rains.

Here Are Some pH Examples



Looking For Life In Streams And Rivers

from *Maryland Save Our Streams Adopt-A-Stream Activities Packet*

The quality of a stream or river can be judged by examining the insects which live there. Insects live in shallow, fast flowing areas called riffles where they can attach to rocks and collect food from the water flowing by.

To give your stream the bug test, fill a bucket with water from the stream and set it in a stable place. Collect three stones that are four to eight inches across, bathed in rapidly flowing water, and lying loose on the stream bed. Avoid stones which are buried in the bed or lying in slow moving waters.

Look for stoneflies, mayflies, and caddisflies (larvae or cases) on the surface of each stone. Thoroughly scrape all the insects, casings, and everything else off the rocks and into the bucket of water. Replace the rocks.

Carefully pour the whole bucket of water through a strainer, then add another bucketful. Use tweezers to move around material in the strainer and look for insects. Use a magnifying glass to help identify and count them.

Stoneflies have armor-like bodies, two tails, and distinct antennae. The toe of each leg has two claws. Mayflies have shrimp-like bodies and three tails. Caddisflies have long curved bodies. Their larvae look like small caterpillars. Their cases are made of sand grains, small pebbles, leaves, or twigs glued together.

Stream quality is rated excellent when stoneflies, mayflies, and caddisflies are present. If both mayflies and caddisflies are present, but stoneflies are missing, the stream is in good condition. If only caddisflies are present, stream quality is rated fair. A fair quality stream probably supports few game fish and would be a poor water supply source. If none of the insects are present, the stream is rated poor. A poor quality stream is unfit for most human uses and probably has no fish.

Dissolved Oxygen

The air we breathe holds up to 30 times as much oxygen as water does. When the oxygen level in water drops, aquatic life is in danger.

Oxygen is added to water by the photosynthesis of plants. Wind, rain, and waves also do their part by stirring in oxygen from the atmosphere. This is one reason why there is more dissolved oxygen near the surface. Quickly moving water normally has more oxygen than still water does because it has more interaction with the air.

Oxygen is used up by bacteria when they decompose waste and dead plants and animals. Since decomposition mostly takes place on the bottom where the waste is, there is less oxygen there.

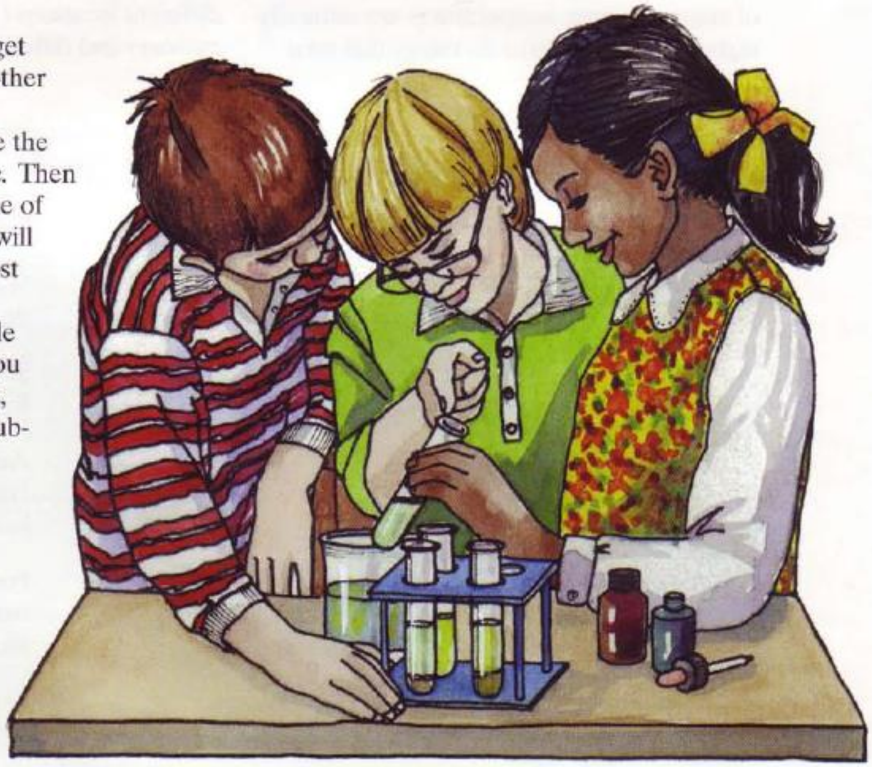
The temperature of a liquid determines how easily things can dissolve into it. Solids dissolve more easily in hot liquids (try dissolving a sugar cube into cold water and another one into hot water), but gases dissolve more easily in cold liquids.

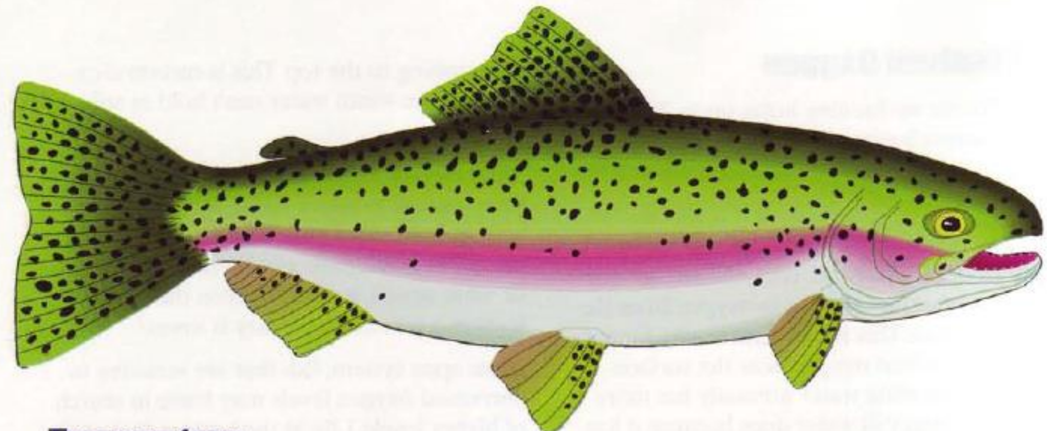
To observe this yourself, get two bottles of seltzer or other clear carbonated drink. Refrigerate one and leave the other out in a warm place. Then open the cold bottle. Some of the gas (carbon dioxide) will escape with a fizz, but most will remain in the water. Now open the warm bottle carefully. Not only will you get a lot of gas fizzing out, but you'll notice lots of bubbles rushing to the top. This is carbon dioxide that the warm water can't hold in solution.

Since oxygen is also a gas, it does not dissolve as well in warm water, so cool water is able to hold more of it. Late summer, when the water is warmest and there is little wind or wave action, is usually when the oxygen level in a pond, lake, or bay is lowest.

In an open system, fish that are sensitive to decreased oxygen levels may leave in search of higher levels. Life at the bottom that can't travel (oysters, clams, etc.) is more threatened by low oxygen levels. Trout need a lot of oxygen, so they seek cool, fast streams.

Oxygen levels should be in a range of 7–14 parts per million. (That means 7–14 parts oxygen per million parts water.) A danger reading would be below 4–5 parts per million. Dissolved oxygen can be checked with a test kit or meter.





Temperature

Bodies of water change temperature slowly compared to land. That's why you find the seashore not as hot in the summer and not as cold in the winter as inland locations. The more stable water habitat is important to the cold-blooded animals that can live only within a certain range of temperatures.

Because warm water can't hold as much of the dissolved oxygen that fish and other aquatic animals breathe, it doesn't support as much life as cool water. Towards the end of summer, water temperatures are naturally higher, but people also do things that turn up the heat.

Cutting down trees along stream and riverbanks means less shade and higher temperature, especially in shallow water that heats up relatively quickly. Some power plants use water to cool their reactors. The hot water discharge can be harmful to nearby aquatic life.

Water temperatures vary greatly, but to support life they should generally not be above 27 degrees centigrade (24 degrees in trout streams). A rugged thermometer on a string is all you need to check temperature. Try different locations (sunny or shaded, still or moving) and different depths.

PUTTING IT ALL TOGETHER

Test	Healthy level	Unhealthy level	Cause
Dissolved oxygen	7-14 parts per million	less than 4 ppm	Warm, still water, decomposition
Nutrients	varies, but less than 1 ppm	higher than normal	Sewage, erosion, fertilizer, exhaust
pH	6.5-8.5	below 6.5 above 8.5	Acid rain, industrial acids. Natural minerals, lime used on fields
Temperature	varies by location and season	above 27 degrees C	Power plant cooling, cutting down trees along river banks.
Turbidity	1 meter or more secchi depth	less than 1 meter	Sediment, algae

Watershed Pen Pal

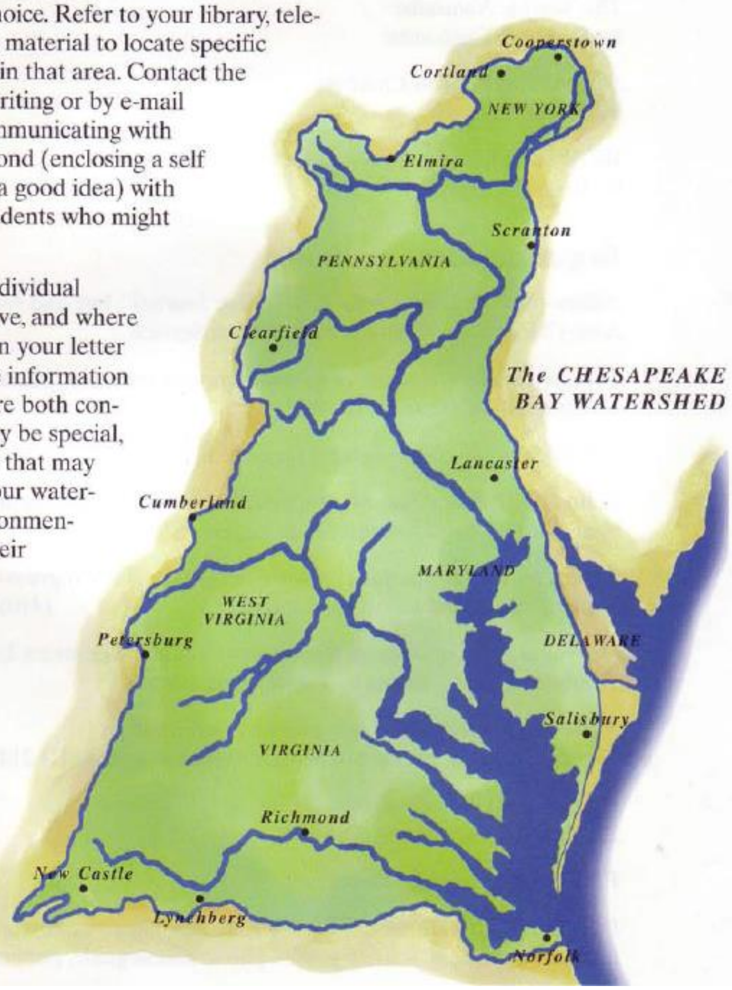
by Debbie Grigsby

Objective:
To research and locate a pen pal who also lives in the watershed. Contact that student, classroom, or school as a writing assignment and share your experiences and your new or increased knowledge of aquatic issues and concerns.

Materials:
- Paper, envelopes, and stamps or e-mail capability.
- Regional map covering your watershed.

Examining a map of the watershed, locate the names of towns or counties in an area of your choice. Refer to your library, telephone books, or other reference material to locate specific names and addresses of schools in that area. Contact the principal or science teacher in writing or by e-mail and indicate your interest in communicating with their students. Ask them to respond (enclosing a self addressed, stamped envelope is a good idea) with specific names of teachers or students who might be interested in corresponding.

Write a letter to or e-mail the individual describing yourself, where you live, and where you go to school. Explain early in your letter your purpose in writing: to share information about the watershed, how you are both connected to it, why you think it may be special, and things you can do every day that may help improve water quality in your watershed. Ask about particular environmental concerns they may have in their area. Ask them to write back.



Resources

Books

Awesome Chesapeake by David Owen Bell

Chesapeake Bay-Nature of the Estuary by Christopher White

The Life and Death of The Chesapeake Bay by J.R. Schubel

Life in the Chesapeake Bay by Alice Jane Lippson & Robert L. Lippson

The Seaside Naturalist by Deborah Coulombe

Sharing Nature With Children by Joseph Cornell

WOW! The Wonders of Wetlands: An Educator's Guide by Britt Slattery

Organizations

Alliance for the Chesapeake Bay---"Bay Journal", bay and river fact sheets, Chesapeake Regional Information Service

www.allianceforthebay.org

Chesapeake Bay Environmental Center---Wildlife preserve focusing on restoration, investigative field trips for pre-school through adulthood focusing on local wildlife and ecology

www.bayrestoration.org

Chesapeake Bay Foundation---Membership organization, teacher training, field trips, educational publications, advocacy

www.cbf.org -and- www.cbf.org/about-the-bay/state-of-the-bay-report/

Chesapeake Bay Program Facts & Figures

https://www.chesapeakebay.net/discover/facts

Chesapeake Research Consortium---Collaborative research and education initiatives in MD, PA & VA

www.chesapeake.org

Chesapeake Bay Trust---Grants for education, restoration, and conservation

www.cbtrust.org

Echo Hill Outdoor School---Experiential learning, publications, educational boat charters, and Bayside conference center

www.ehos.org

Environmental Protection Agency Chesapeake Bay Office---Multi-state restoration programs

www.epa.gov/aboutepa/about-chesapeake-bay-program-office

Maryland Dept. of Natural Resources---Aquatics Resources Education Grants Program
---Grants to teachers and schools

www.dnr.maryland.gov/ccs/Pages/funding/fundingopp.aspx

National Oceanic and Atmospheric Administration Chesapeake Bay Office

www.chesapeakebay.noaa.gov/

Pennsylvania Bay Education Office

www.pacd.org/?page_id=82

Project Wild Aquatic Workshops

www.fishwildlife.org/projectwild -and- www.fishwildlife.org/projectwild/aquatic-wild

Smithsonian Environmental Research Center---Internships, fellowships, seminars

www.serc.si.edu

University of Maryland Center for Environmental Science Horn Point Laboratory
--- Interdisciplinary research, restoration, seminars, outreach programs and on-site environmental education programs for students K-12.

www.umces.edu/hpl

U.S. Fish & Wildlife Service Chesapeake Bay Estuary Program---
fact sheets, posters, activity guides, public access guide and publications

www.fws.gov/chesapeakebay/

Data Sharing/Water Monitoring

Pennsylvania Department of Conservation & Natural Resources---Activities, Water Monitoring databases throughout PA, grant opportunities, and maps

www.dcnr.pa.gov/Education/WaterEducation/Pages/default.aspx

Chesapeake Bay & Delaware Bay Fieldscope---Citizen science initiative for community members and students to input water quality data

www.chesapeake.fieldscope.org/v3/ -and- www.delaware.fieldscope.org/v3

Water Sampling Supplies and Test Kits

Hach Co.

www.hach.com

The LaMotte Company

www.lamotte.com

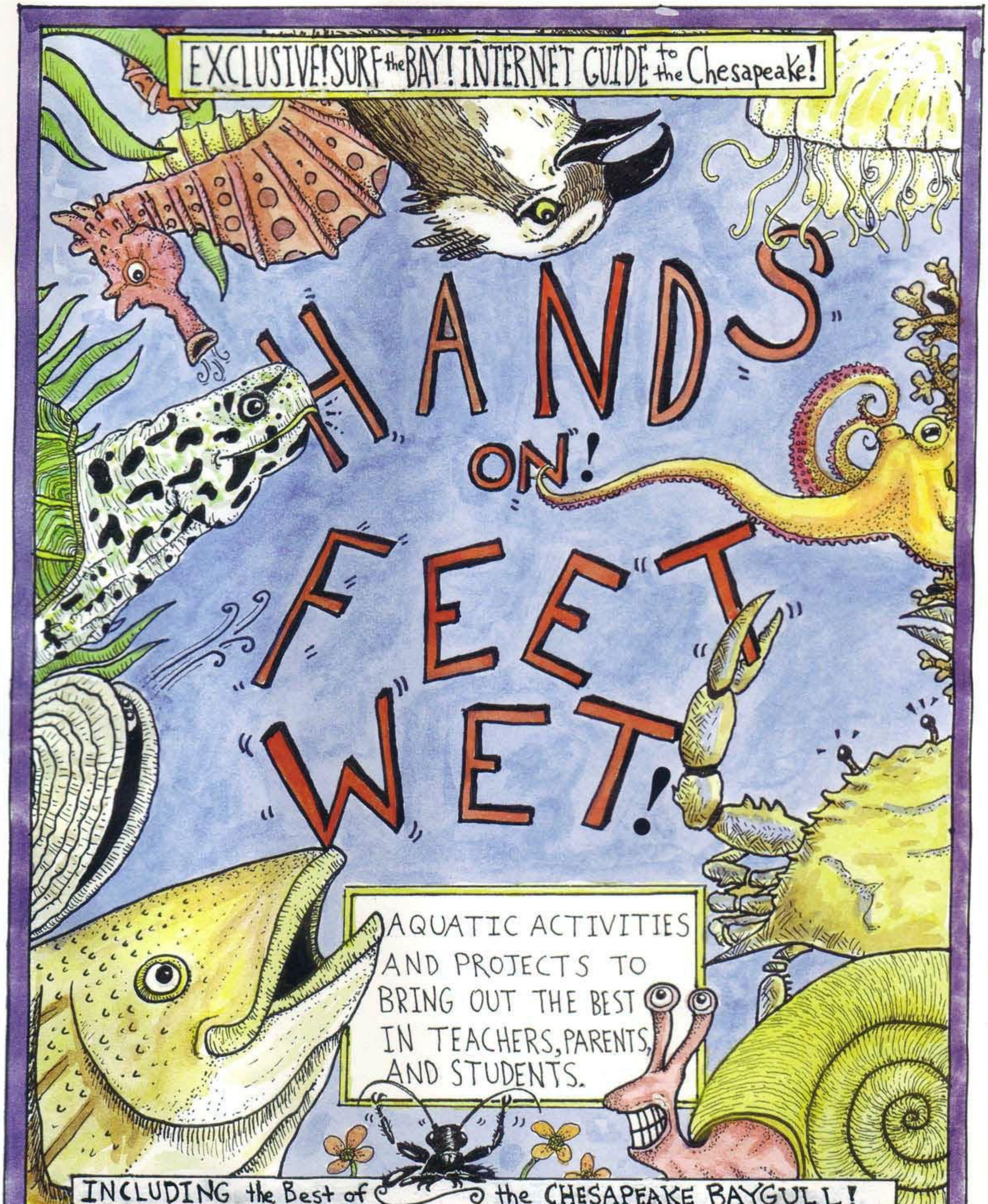

EXCLUSIVE! SURF the BAY! INTERNET GUIDE to the Chesapeake!
HANDS ON! FEET WET!
AQUATIC ACTIVITIES AND PROJECTS TO BRING OUT THE BEST IN TEACHERS, PARENTS, AND STUDENTS.
INCLUDING the Best of the CHESAPEAKE BAYGULL!

Table of Contents

Introduction

At Echo Hill Outdoor School, we explore and study a variety of natural and human environments. Our activities challenge students to observe, question, and evaluate how ecosystems form, sustain themselves, and evolve. We also seek to have students consider how ecosystems interrelate and how they are impacted by human activity. Students gain a heightened awareness of the interrelationship and interdependence of all living things.

Our approach to learning is experiential. It is based on the following premise:

What the student "hears," they may forget.
What the student "sees," they may remember
What the student "experiences," they KNOW.

We have created and collected a variety of projects that you can use to bring an experiential approach to aquatic studies into your classroom. Although any given activity may be geared towards a stream, pond, or estuary, many of them can be applied anywhere (ie: Water Sampling). Others are readily adaptable to different aquatic habitats (ie: customize the animal and plant list in the Estuary Food Chain Mural).

These projects include applications in science, math, language arts, geography, current events, history, and human development. In each case, we attempt to create an actual experience that allows students to explore, observe, respond, evaluate, and apply.

Overall, the aim of this manual is to:

1. Increase knowledge of aquatic ecosystems.
2. Increase knowledge about the biology of these ecosystems.
3. Heighten awareness of the interrelationships and interdependence of these ecosystems.
4. Heighten awareness about human interdependence and impact on surrounding environments.
5. Enable students to recognize their potential for implementing change in their home communities regarding environmental issues.

The following activities are intrinsically compatible with outcome-based learning goals and the Next Generation Science Standards. Each is based on real life situations incorporating core level thinking skills. They are meant to be conducted in small groups using an integrated approach. Students play an active part in gathering and interpreting data, formulating questions, defining and discussing issues, and determining solutions. These activities demonstrate the interaction and interdependence of life through the gathering and interpretation of scientific information, foster positive attitudes towards science, and encourage the role of science in addressing environmental issues.

Next Generation Science Standards (NGSS)

The Next Generation Science Standards (NGSS), published in 2013, have been adopted in many school systems across the United State, including in Maryland, Delaware, and the District of Columbia. The NGSS framework includes three dimensions to learning science: Crosscutting Concepts (CCCs), Science and Engineering Practices (SEPs), and Disciplinary Core Ideas (DCIs).

The table below aligns each activity in this Hands On! Feet Wet! resource with specific DCIs. For more information about how Echo Hill Outdoor School curriculum aligns with the NGSS, visit http://www.ehos.org/curriculum/index2.php.

Activity	**DCIs (from NGSS)**
Ecosystem Modeling	LS2.A Interdependent relationships in ecosystems LS2.B Cycles of matter and energy transfer in ecosystems
Playing with Sea Level	ESS1.C The history of planet Earth ESS2.A Earth materials and systems (9-12) ESS3.D Global climate change LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans
Estuary Food Chain Mural	ESS2.C The roles of water in Earth's surface processes LS2.A Interdependent relationships in ecosystems LS2.B Cycles of matter and energy transfer in ecosystems
Biophysical Survey	ESS3.C Human impacts on Earth systems LS2.C Ecosystem dynamics, functioning, and resilience
The Great Estuary Hunt	ESS2.B Plate tectonics and large-scale system interactions (3-8) ESS2.C The roles of water in Earth's surface processes
Urban Planning	ESS3.A

	Natural resources ESS3.C Human impacts on Earth systems ESS3.D Global climate change LS4.D Biodiversity and humans
Tributary Modeling	ESS1.C The history of planet Earth ESS2.B Plate tectonics and large-scale system interactions (3-8) ESS3.C Human impacts on Earth systems ESS3.D Global climate change LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans
Three Rs	ESS3.A Natural resources ESS3.C Human impacts on Earth systems LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans
Estuary Web of Life	LS2.A Interdependent relationships in ecosystems LS2.B Cycles of matter and energy transfer in ecosystems LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans
Water Quality Testing	ESS2.C The roles of water in Earth's surface processes ESS3.C Human impacts on Earth systems LS2.C Ecosystem dynamics, functioning, and resilience

Meaningful Watershed Educational Experience (MWEE)

What is a MWEE?

Meaningful Watershed Educational Experiences (or MWEEs) are multi-stage project based learning experiences recommended or required in educational systems across the Chesapeake Bay Watershed. For more information on the history and definition of MWEEs, visit https://www.noaa.gov/education/explainers/noaa-meaningful-watershed-educational-experience.

MWEEs and EHOS

Each MWEE has four essential elements that describe the students' actions during the project: Issue Definition, Outdoor Field Experience, Synthesis and Conclusion, and Action Project. For more information on MWEE design and the essential elements, visit: https://www.cbf.org/join-us/education-program/mwee/.

A trip to Echo Hill Outdoor School (EHOS) can provide an exciting and meaningful Outdoor Field Experience as part of a larger MWEE. Educators can use activities from this Hands On! Feet Wet! (HOFW) resource along with EHOS curriculum to plan a comprehensive and community-based MWEE.

Potential MWEE Progressions

Below is a list of all the MWEE essential elements, along with the HOFW activities that fit best into those essential elements. Educators can choose and adapt the activities as needed for their classroom in order to design a MWEE that works best for their grade and location.

Essential Element	*Issue Definition*	*Outdoor Field Experience*
HOFW activities	• Great Estuary Hunt • Estuary Food Chain Mural • Estuary Web of Life • Playing With Sea Level • Ecosystem Modeling • The Three Rs: Taking a Trash Survey • Tributary Modeling	• Biophysical Survey • Water Quality Testing • EHOS Science and Ecology Classes (as part of an EHOS trip!)

Essential Element	*Synthesis and Conclusion*	*Action Project*
HOFW activities	• Discussion of the results of Outdoor Field Experiences (including potentially comparing bodies of water near EHOS to bodies of water closer to the school)	• The Three Rs: Packing a Zero Waste Lunch, and Hold a Local Swap Meet or Yard Sale • Urban Planning • Watershed Penpal

Example progression for a seventh-grade science class:

- *Issue Definition*: Tributary Modeling
- *Outdoor Field Experience*: Water Quality Testing at a local water source and at EHOS
- *Synthesis and Conclusion*: Comparison of those water qualities
- *Action Project*: Watershed Penpal, where students communicate with an organization about improving local water quality

Vocabulary

Students should have a working understanding of these terms as applied to aquatic studies.

<u>Algae</u> – Tiny, non-flowering plants including seaweeds and microscopic phytoplankton

<u>Brackish</u> – Water that ranges in salt content (salinity) from 33 parts per thousand (ocean water) to less than 1 part per thousand (freshwater). Less than 1% of the world's water is brackish.

<u>Ecology</u> – The study of living systems and the physical environment.

<u>Ecosystem</u> – A community of organisms and their interrelated physical environment.

<u>Erosion</u> – The process in which rain and other natural forces wash soil away.

<u>Estuary</u> – Ecosystem where fresh and saltwater mix to create brackish water. Estuaries have free access to the ocean.

<u>Eutrophication</u> – The process in which nutrients from the land and other sources fertilize surface waters.

<u>Food Chain/Web</u> – A complex arrangement of organisms in an ecosystem in which each member depends on others for nourishment.

<u>Fresh Water</u> – water that holds no salt in it. Fresh water makes up a little less than 3% of the world's water supply. Fresh water can be found in the atmosphere in the form of water vapor; frozen in the polar ice caps; in ponds, rivers, lakes, and streams; and in underground aquifers and ground water.

<u>Habitat</u> – The physical environment in which a plant or animal naturally grows or lives.

<u>Nutrients</u> – Generally, things that provide nourishment for living things. Specifically, phosphates, nitrates and any other material which stimulates the growth of algae and other phytoplankton.

<u>Photosynthesis</u> – the process by which plants use energy from the sun to produce their own food.

Plankton – Drifting or weakly swimming organisms transported by currents. Includes plants (phytoplankton) and animals (zoo plankton).

Pollutant – Any substance produced by humans that, when discharged into the environment, alters the natural balance of the ecosystem.

Salt Water – salt water (33 PPT) is found in a marine or ocean environment. Nearly all the water in the world is salty (about 97%). Salt is a natural mineral (sodium chloride) found all over the world.

Submerged Aquatic Vegetation (SAV) – rooted plant life that grows under water.

Watershed – a watershed or drainage basin is the specific area of land that collects water for or drains into a specific body of water. Each body of water has its own watershed, which may be a part of a lager watershed. For example, the Susquehanna River watershed is a part of the larger Chesapeake Bay watershed

Ecosystem Modeling

Objective: To explore the differences among ecosystems found in a watershed and learn how they are interrelated.

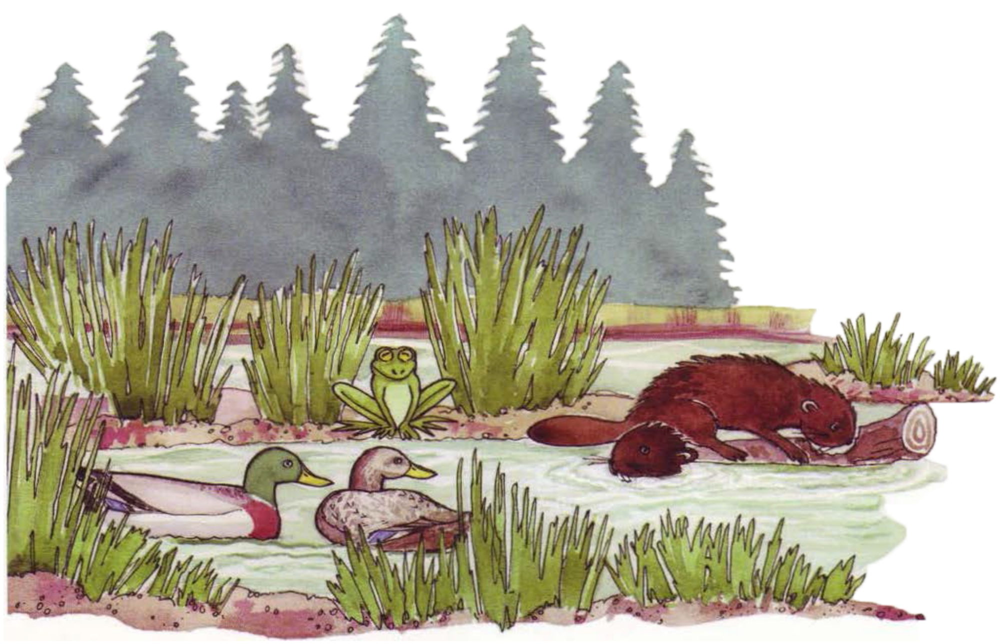
Materials: Shoebox or small washtub, dirt, cardboard, crayons.

Begin by dividing the class into groups of two to three students. Each group selects an ecosystem found in the watershed to study and model (forest, swamp, meadow, stream, marsh, tidal mud flat, etc.). Each group starts by researching its ecosystem. Particular emphasis should be placed on discovering what types of organisms live in each ecosystem and the specific adaptations they have made to their environment.

What sorts of food do the different plants and animals need? Do they spend all of their lives in this ecosystem or just certain phases of their lives? Students should also be able to describe the most important phys-ical traits that define their ecosystem.

Once the groups have completed their research, they begin constructing models of their ecosystems. The models can be made in a shoebox or some similarly sized container. When possible, students should be encouraged to use actual materials found in their ecosystem (mud, dirt, rocks, etc.). Cardboard cutouts or magazine pictures can be used to represent plants and animals.

When the models are complete, each group makes a presentation to the class describing their ecosystem, emphasizing how it is different, both physically and in terms of plant and animal life, from other ecosystems in the Chesapeake Bay watershed. Discussing how the ecosystems are interrelated can also enhance this activity.



Playing with Sea Level

Imagine that the Atlantic seashore is fifty miles further east-or that a large coastal city like Baltimore has fish swimming down Charles Street. Both these events are possible in a world where sea level is constantly adjusting to slow changes in global climate. In the earth's history, sea level has been higher and lower than its present level, depending on the average temperature of the earth. Currently, sea level is rising at about 1/8 in per year, because of human caused climate change.

Objective: To visualize how shorelines change as sea level adjusts to global climate conditions.

Materials: Coastal marine charts showing bathymetric contour lines or water depths, topographic maps with altitudinal contour lines, and colored pencils. Marine charts are available directly from the National Oceanic and Atmospheric Administration. Topographic maps are available from state and U.S. Geological Surveys.

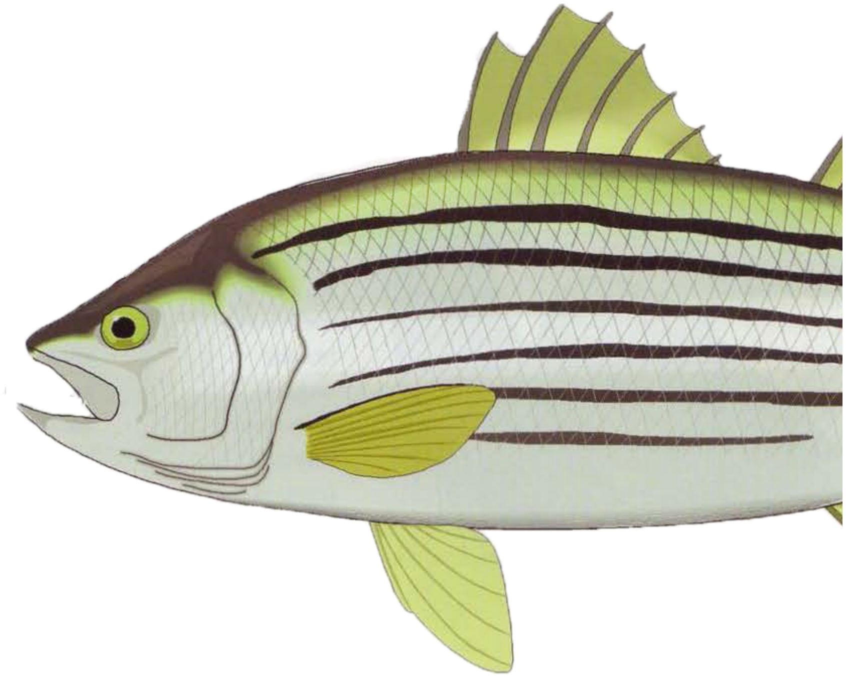
In small groups, students follow or trace contour lines and use colored pencils to shade in areas of the map. For example, on a topographic map, shade in the area of land that would be under water if sea level rose twenty feet. The twenty-foot contour is the first line in from the coast. Different color shading is used to show additional rises in sea level. At the present rate, how long would it take sea level to rise 100 feet? What would the area of land covered by your map look like?

Another group uses the coastal marine chart. Given that sea level was about 320 feet lower coastline would have been 20,000 years ago. Shade in this area to see how much land has been given back to the sea.

Here is a progression of questions to spark discussion about sea level changes:

- What is ice?
- What happened to the polar ice caps as the earth entered each ice age?
- Where did the water come from to make the polar ice caps?
- What happened to sea level as the ice caps grew?
- What happened to the shoreline as sea level dropped?
- What has happened to the polar ice caps since the end of the last ice age?
- How has sea level changed since the end of the last ice age?
- How has the shoreline changed since the end of the last ice age?
- What will happen to sea level if the ice continues to melt?
- What does sea level change mean for animal and human communities living near the shore?

Estuary Food Chain Mural



Objective: To have students develop an understanding of the interdependence of life in an estuary and how human activity affects these relationships.

Materials: Paper, crayons, markers, scissors, string, and glue.

Part I: Have each student select a plant or animal from the next page and research the following:

1. Organism's habitat-salinity range; deep or shallow water; top, middle, or bottom dweller.
2. Average size of the adult organism.
3. What the organism eats (how it obtains nutrients) and what eats the organism.
4. Location and means of reproduction.
5. Identify organism by phylum, class, and species (optional).

Students proceed by constructing a two-dimensional replica of their organism and attaching a 3 by 5 fact card. When the replicas and fact cards are complete, each student gives a brief oral report to the class on their organism. At the end of each report, the replica and fact card are attached to a collective class mural. To complete the mural, use pieces of string to connect organisms that are directly connected in the food web.

Part II: Once the mural is complete, the class discusses the effect of human activity on the estuary food chain. Possible topics of discussion are:

1. Eutrophication
2. Agricultural runoff
3. Industrial pollutants
4. Increased erosion and runoff caused by increased development and clearing of land
5. Household activities-including water usage and waste, sewage, use of detergents, waste disposal, and recycling
6. Population density in the watershed-particularly cities and their proximity to the water

Part III: Students discuss and research what is being done in their communities to combat the problems discussed in Part II. Make suggestions about what steps could or should be taken, and talk about what they could do every day to help lessen their impact.

Optional: Add replicas of pollutants to the mural to enhance discussion of human impact on the ecosystem.

Organisms

Animals

bald eagle
osprey
sea nettle
comb jelly
bluefish
rockfish
grass shrimp
bryozoa
copepod
killfish
silverside

catfish
flounder/hogchoker
oyster, clam, mussel
white perch
yellow perch
bay anchovy
sunfish
scud
carp
menhaden
sand shark
bacteria
American eel
blood worm
gizzard shark
blue crab
great blue heron

Plants

phragmites
algae
eel grass
coon tail
cat tail
saltmarsh
cordgrass

Recommended References

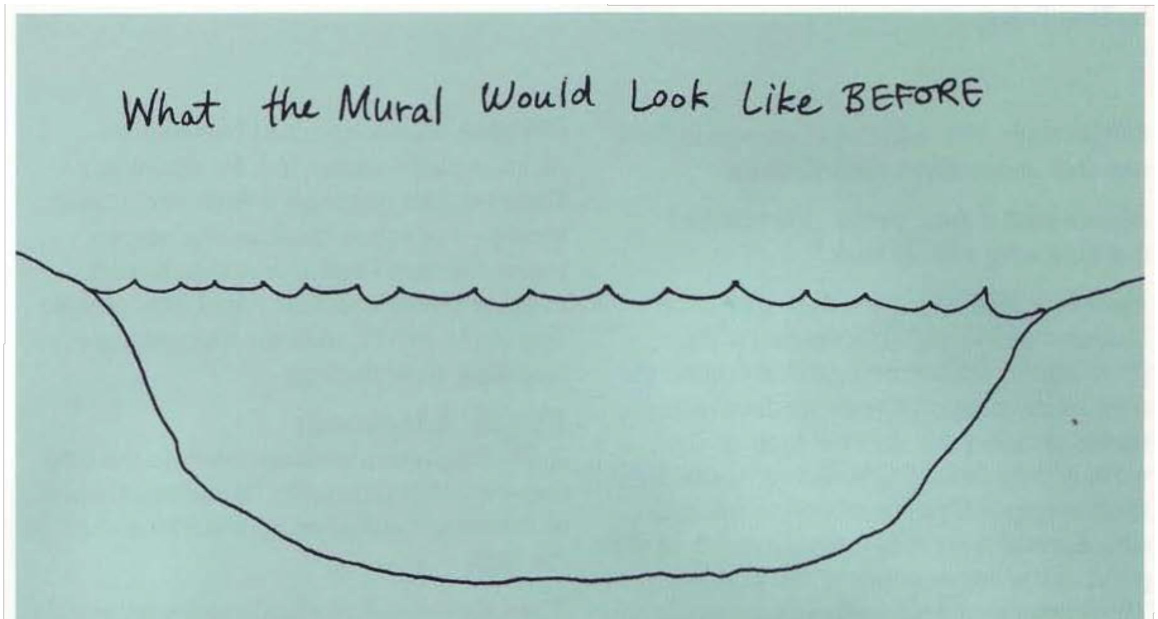
Bell, *Awesome Chesapeake*
Lippson and Lippson, *Life in the Chesapeake Bay*
White, *Chesapeake Bay: Nature of the Estuary*
Kiddle Chesapeake Bay Facts:
https://kids.kiddle.co/Chesapeake_Bay
NOAA Planet Arcade: https://games.noaa.gov/

Suggested Use of Class Time

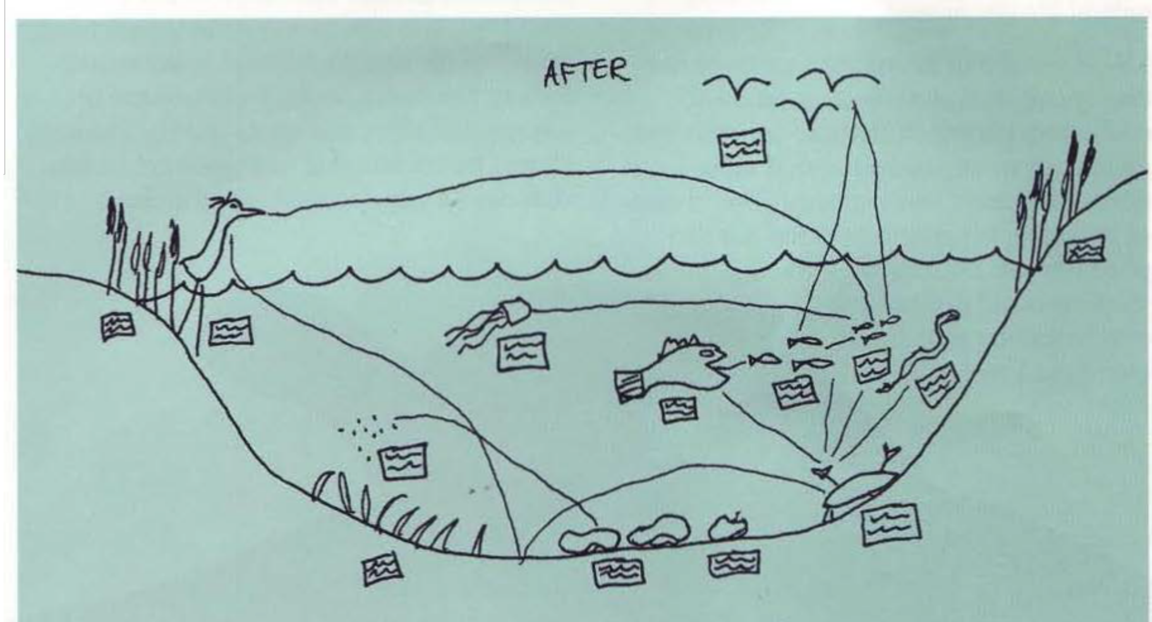
Day 1: Give out and discuss vocabulary.
Day 2: Assign students a plant or animal to research. Review library, internet, and other research sources.
Days 3-4: Research days.
Day 5: Write a paragraph on the selected plant or animal (to be posted on the mural when completed).
Day 6: Make a two dimensional replica of the organism (to be posted on the mural as well).
Days 7-8: Oral presentations.
Day 9: Connect organisms on the mural with string according to their place in the food chain/web.
Day 10: Discuss human effects on the food chain/web.

Day 11: Discuss solutions to pollution problems in the community

Example Murals



Empty mural, approximately 20 feet long



Finished product: The mural has been filled in with the children's replicas of Bay-dwelling organisms and accompanying info cards.

Biophysical Survey of a Wetland Ecosystem

Objective: For students to engage in field research and analyze their findings.

Materials: Paper, pencil, poster board, markers. **For field version:** long poles or sticks, local pond. **For online version:** Internet access for four teams of students.

Part I: Field version: Students divide into four teams. At the pond, poles or stakes are installed around the edge of the pond in five or ten foot increments, gridding the site (see **Example Chart of Our Pond**). The work is then divided among the four teams. First team is responsible for recording information. Second team measures the depth of the pond at the intersections of the grid lines. Third team performs a physical survey of the site, recording the features of the bottom, (i.e. sandy, rocky, muddy, etc.). Fourth team performs a biological survey of the site, recording the type and variety of plant and animal life discovered.

The physical and biological aspects of the survey can be as ambitious as time and equipment permit. With more accurate sampling equipment, students could more accurately determine water quality. Also, consider collecting organisms by seine net and plankton net. If funds are limited, students could design their own collection gear from improvised materials. (Window screen stretched between two sticks to make a seine net, for example.) Once the first quadrant is surveyed, teams meet to share their findings and suggest improvements. Then, teams switch roles, rotating through all four jobs. Upon completion of the survey, students meet as a group to discuss their findings.

Part I: Online version: Students divide into two teams as in the **Field version**. Every team finds the same local pond on Google Maps.

Part II: Classroom: In the classrooms, students tabulate the data they recorded during the "secretarial" phase of the survey and develop a working chart of the data.
Then, they develop a final presentation style chart that can be integrated with the other groups' charts to form a complete image. The charts can be as detailed as time and equipment permit. The scope of the chart could be expanded to show the surrounding 50-100 yards of land, especially if students completed the **Online version** of Part I. It could indicate such factors as erosion, sources of chemical or natural pollution, and water quality. Students should be encouraged to suggest other data that can be incorporated into the chart.

Along with the chart, each group is responsible for submitting a report to the class that deals with one or more of the following factors:

- The process by which the group completed the project.

- The biological, physical, and aesthetic properties of the site.

- A brief history of the site derived from primary sources.

- Conclusions drawn from the information gathered.

- Suggestions to future researchers from lessons learned during the survey.

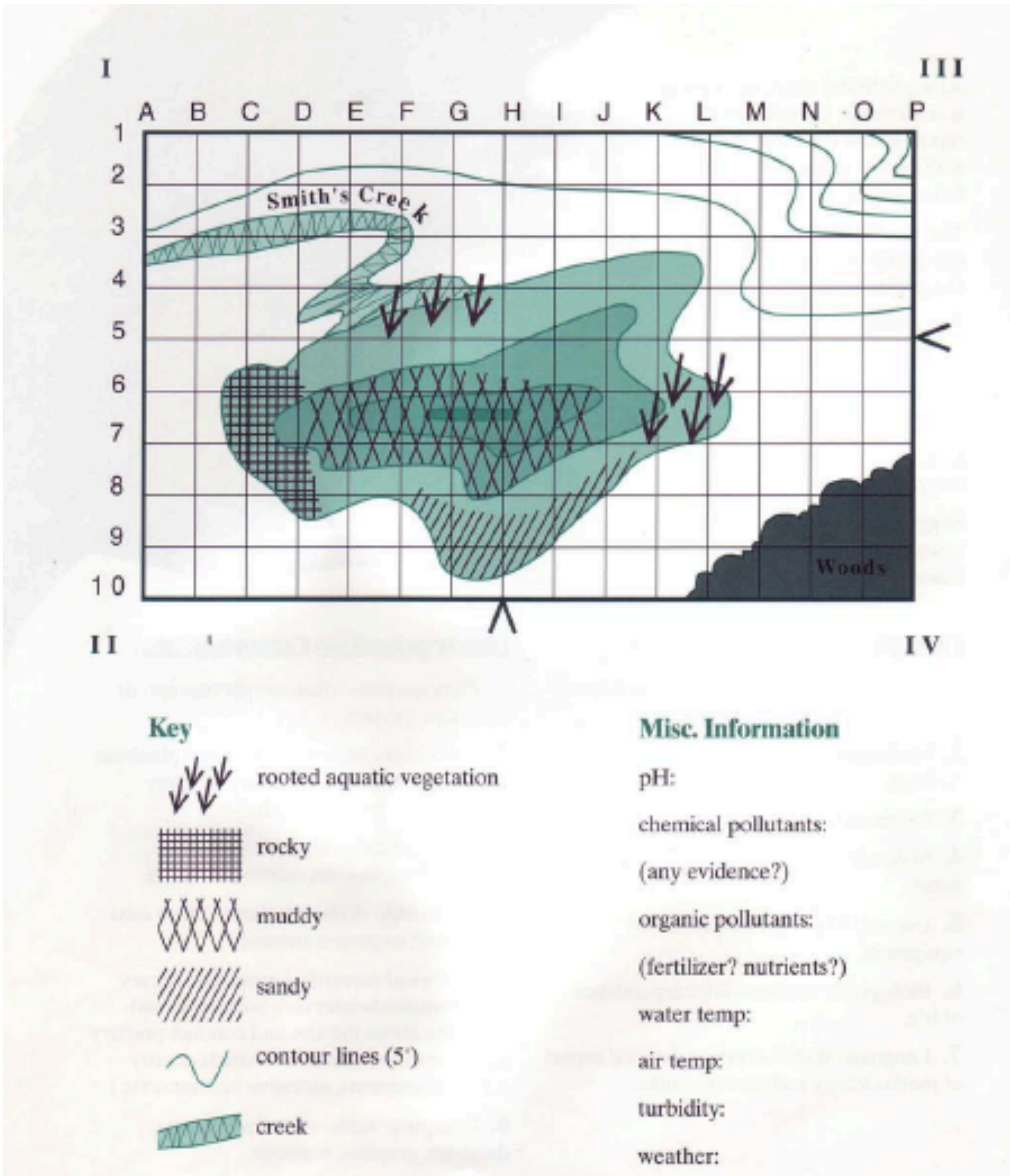
Components of the activity:

1. Teamwork – share information, cooperatively create chart and survey.
2. Mathematics – tabulate and interpret findings.
3. Learn and practice survey techniques.
4. Note-taking with careful attention to detail.
5. Use and improvisation of survey equipment
6. Biology/life studies – interdependence of life.
7. Language skills – create a detailed report of methodology and survey results.

Other possible components:

1. Photography/videography – students photograph or record project.
2. Laboratory microscopy – using plankton net and microscope, inventory as many microorganisms as possible.
3. Water quality tests – pH, dissolved oxygen, phosphorous, salinity, turbidity.
4. Leadership skills – students return next year to act as project mentors.
5. Historical research, journalism, library skills – students interview sources knowledgeable about the site and conduct primary source research (i.e. farm records, county survey documents, narrative accounts etc.)

Example Chart of Our Pond



The Great Estuary Hunt

Objective: To enhance understanding of estuarine ecosystems.

Materials: World map/Google Maps map or chart of Chesapeake Bay or other local estuary (online or physical)

Part I: Begin by reviewing the vocabulary words on page ___ through a question and answer session focusing on a map of the Chesapeake Bay or a more local estuary.

Part II: Discuss the importance of the estuarine system from a global perspective.

Question: Who or what besides people could benefit from estuaries?

Answer: The oceans and their inhabitants. Approximately 70% of oceanic animals depend on estuaries—for spawning grounds, for feeding grounds, or as a source of food. Think of estuaries as roots of the oceans.

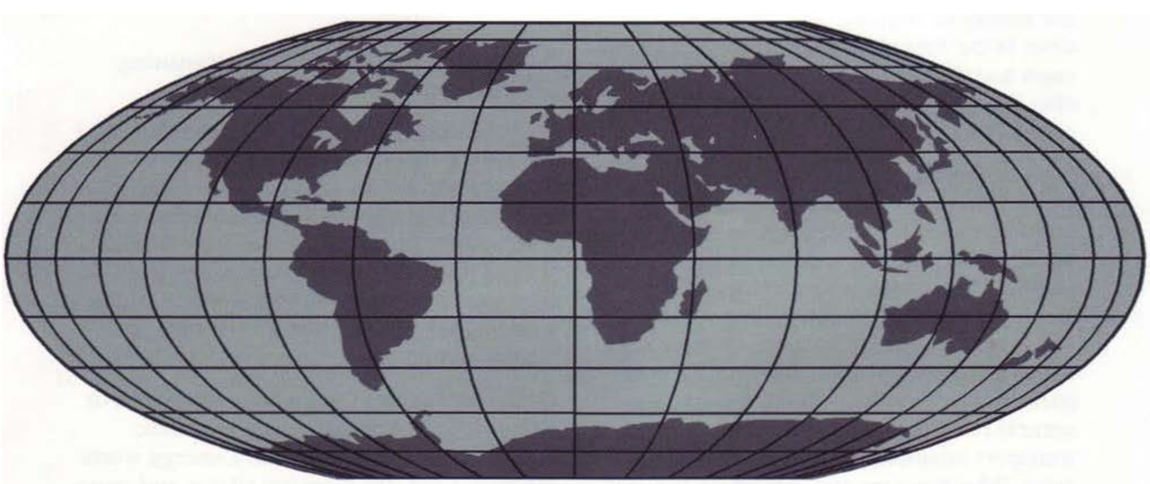
Part III: Look at a world map, or search Google Maps and attempt to locate estuaries. This could be done in small groups, with each group charged with addressing particular coastlines or continents around the world.

a) Assign groups to work toward identifying the most important estuary in their study area

b) Have groups determine how their estuaries are different and similar from other groups'.

c) Optional: Students could write reports on important estuaries in the world, comparing them in terms of ecological productivity and environmental degradation. How have humans altered these ecosystems?

Note: *The Life and Death of the Chesapeake Bay* (see Resources) includes information about some of the world's major estuaries.



Urban Planning Project

Objective: To encourages students to think about the necessary and complicated nature of urbanization.

Materials: Paper, colored pencils, access to the Internet.

Cities are often criticized as sources of environmental pollution while their beneficial aspects are often overlooked. On the following page are links to three articles that comment on “low impact living” and the benefits of environmental urban planning. Distribute copies or have students look up the articles: “An Elitist View of Nature” 1994 Baltimore Sun, “Urban Planet: How growing cities will wreck the Environment unless we build them right” 2012 Time Magazine, “Urban Threats" 2019 Nat’l Geographic. **Optional:** High school students can also read/scan the article “Future cities and environmental stability”, 2016 to get ideas for the planning project.

Have each student spend time researching the basics of urban planning and the history of urbanization. Why are there cities in the first place? What are their advantages and disadvantages? Are there any benefits, from an environmental point of view, to expanding upward rather than outward?

Students should compile a list of materials cities need to operate (land. water, energy, building material, transportation, etc.) and a list of waste products cities must dispose of (sewage trash, toxic waste, etc.). How is this list different in composition and degree from a similar list compiled for suburban and rural settings? Meaningful comparisons can be made among the amount of natural resources used to house, heat, and transport inhabitants of these different areas. Who has a greater impact on the environment – the inhabitant of an urban, suburban, or rural area?
After the students have developed a basic understanding of the obstacles faced in urban planning, have them design their idea cityscape employing the following parameters:

1. One million inhabitants.
2. 100,000 commuters entering and leaving the city every day.
3. Water source is a reservoir 200 miles away.
4. City occupies land bordering a major river.
5. 30% of work force in manufacturing, 45% in service industry.

Using these basic guidelines, students should attempt to make informed estimates about the amount of resources needed to keep the city going and the waste products that must be disposed. How much water do 1,000,000 people need every day? How much trash do they produce every day? How much does it weigh? How much space does it take up? Where should it go? Help the students think about all aspects of a city – parking spaces, roads, railroads, water mains, housing, industry, energy, waste disposal, food, etc. Keeping all this and more in mind, have the students make a plan of their ideal city.

Tributary Modeling

By: Jenny Wilderman

Objective: This activity is designed to give students a general idea of which materials and pollutants are coming into the Chesapeake Bay and their origins.

Materials: Map of the Chesapeake Bay. Assorted containers Plastic bag or sheet.

This activity utilizes a satellite map of the Chesapeake Bay with a key indicating urban areas, wetlands, farmland, etc. It could also be done using a standard outline map of the Bay with students researching the different environments.

Each student begins the activity by selecting a tributary of the Bay and researching what sort of environment (wetlands, urban development, agriculture) borders that body of water. Students should attempt to determine the general water quality (ie. presence of sewage nutrients, pesticides, etc.) of their tributary. After completing their research, each student chooses a glass or plastic container proportional in size to the tributary they researched. The Susquehanna River would have the largest container. Students fill up their containers with water and any other substances that are found in their tributary (dirt, fertilizer, oil, etc). Actual materials can be used where appropriate, and food coloring can be substituted for more hazardous materials.

When each student has filled up their container, the class comes together around a plastic sheet or bag. The plastic should be either clear or white. Students arrange themselves around the plastic sheet to mimic the geographical layout of the Chesapeake Bay. The student representing the Susquehanna would be at the top or north side of the plastic, and the student representing the James River would be at the bottom or southwest side.

Two cups of salt water are poured onto the plastic to represent the two tides coming into the Bay each day. One by one, each student pours their container onto the plastic while explaining what sorts of things are found in their tributary. The result of this activity is a symbolic representation of what's in the Bay and its sources? Follow up with an exploration of how these substances impact life in the Chesapeake.

How, why, should, or can they be controlled?

The Three R's

From the Chesapeake Bay Gull, by David Owen Bell

Getting rid of all our trash is not easy and whatever we do with it usually has some negative impact on the environment. Landfills take up a lot of open space and when not properly controlled, can pollute surfacea nd ground water, breed rats and flies and just plain smell bad.

Incinerators are costly, and need a large amount of trash to run efficiently. This may actually encourage more waste. Much of the heavy metals and other toxic substances that aren't destroyed by burning are either released into the air or become part of the unburned ashes, which often end up in landfills.

People often argue about these issuing especially when someone wants to locate a landfill or incinerator nearby. While people continue to debate which disposal method is "less bad" for the environment, here are things that each of us can do every day to simply make less trash (treat the disease, not just the symptoms).

First of all, **REDUCE**. This means making choices not only about what you buy, but how you buy.

Then **REUSE**. This means finding ways of giving products and packages second, third, and fourth uses.

Finally, **RECYCLE**. This means returning used newspapers, glass bottles, aluminum cans, and other recyclable stuff to be made into new paper, bottles, cans, and other....stuff.

HEY! Wait a minute!

Isn't this book supposed to be about water?

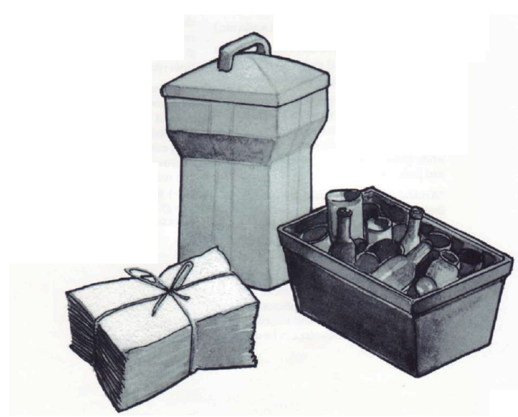
Hey! Guess what? It is.

Reducing waste helps keep harmful substances out of landfills and ground water that may connect to other bodies of water. Reducing waste means less trash for incinerators to burn, so there's less pollution entering the air shed.

Reducing waste saves energy, which means less fossil fuels burned which means less chemical nutrients and sulfur oxides in the air shed.

Reducing waste saves natural resources. More trees mean more habitats for wildlife. Less mining means less mining waste and erosion.

Reducing waste means fewer trips to the landfill or incinerator which saves truck fuel and tires and causes less air pollution, and so on, and so on, and so on....Get the picture?



Take a Trash Survey

Challenge students to measure how much trash is produced at home or in school every week, and then figure out ways to cut it in half.

Start by weighing the week's trash output on a scale or counting how many garbage bags or cans it fills. Estimate how much of it is made up of food waste, cans and bottles, paper, plastic, etc. If you can, presort the trash during the week of your survey by having different containers for each type. Record the totals or estimates.

Classify your trash and record totals. How much of it is made up of:

Disposables: things made to be used once, then thrown away, such as disposable pens, razors, diapers, and lighters, Styrofoam cups etc.)

Compostables: Food scraps, yard waste, etc.

Reusables: Things you don't need anymore but that could be fixed and reused, such as clothing, furniture, appliances, or toys

Recyclables: Stuff you don't need anymore that is made of recyclable materials such as glass aluminum, some plastics, newspapers magazines, stationery and other white and colored paper, including memos and junk mail)

Avoidables: things you don't need in the first place, such as mail order catalogs extra copies of newspapers and magazines, unnecessary clothing, toys, gadgets, or other stuff you really don't need)

Analyze your trash. How much of it can be recycled or composted? How much of it can be reused? How much of the disposables can be replaced by reusables and recyclables? How much of the avoidables can be avoided?

Go to the source to find ways of reducing waste. At home, this means the kitchen, bathroom, home office, and yard. At school, start with the classroom then checkout the cafeteria, offices, science and art rooms and janitorial department-anywhere trash is made.

Apply the three R's. Can you reduce by having your name taken off junk mail and catalog lists and by using both sides of a sheet of paper? Can your school wash and reuses sturdy plastic or metal lunch trays instead of buying disposable Styrofoam ones? Can teachers and parents use their own washable mugs for coffee and tea instead of one-time disposables? Can your school buy recycled paper? Can you start recycling and composting programs at home and at school? Can you use washable cloth napkins and washcloths instead of paper towels? Can you buy rechargeable batteries? Refillable pens? Cloth grocery bags? Can you buy products made from recycled materials?

Measure your trash output again. Did you meet your goal? Keep applying the three R's and measuring your trash output every now and then. Sort your trash to make recycling easier and to identify areas that can be improved. Remember, every aluminum can you recycle, every empty box you reuse, every piece of Styrofoam you refuse saves energy, resource, and landfill space while reducing pollution.

Packing a Zero Waste Lunch

Learning Waste Free Ways to pack their lunch is a way students can help conserve resources and make less waste. Offer them these guidelines from the Center for Environmental Education.

No Disposables-Use a lunch box or fabric bag to carry your lunch. If you bring a paper bag, reuse or recycle it when possible

Avoid Prepackaged Single Serving Containers- Many parents buy these for convenience and their "treat value". Since each "treat" creates a single serving of waste, ask parents instead to buy large sizes of things you like, such as yogurt, chips and cookies, and pack them in reusable containers

Use Reusables- Get durable plastic food containers, or washout plastic margarine tubs, yogurt cups, etc. when they're empty and reuse them over and over again. Empty water and soda bottles, and thermoses can be used over and over again.

Use Recyclables- Make sure the container you choose can actually be recycled in your area. Aluminum is accepted everywhere, but plastic containers and juice boxes are not easy to recycle.

Avoid Buying Plastic Sandwich Bags-Keep and reuse the bags that your food comes in (such as bread bags). These can be easily wiped, rinsed, and left to dry again and again. If you must buy food wrapping, look for unbleached wax/beeswax paper or cellulose bags.

No Styrofoam (polystyrene)-Ever. This is a one-use item that is not easily recycled. Pollution is a by-product of making polystyrene, an item whose useful life can usually be counted in minutes

Take Leftovers Home- Even these don't have to be garbage when you take them home for the family pet or compost pile.

Once you've mastered a low or zero waste lunch, see where else in your home or school you can practice the three R's. How about zero waste birthday parties? Or camping trips?

The Next Step

Take a tour of your home or school. Look for ways that we all impact water quality every day. Water drains, electrical switches and outlets, garbage cans and wastebaskets are ideal places to start.

Whatever enters your home or school must eventually leave. What choices can we make that will lessen our impact?

Estuary Web of Life

by Theolonius Wolfgang Dutton,
Adapted from Sharing Nature With Children,
by Joseph Cornell

Objective: To involve every child in a display of the interconnections among animal and plant life, habitats, and human activity.

Materials: Ball of string.

Prepare students with an age-appropriate foundation of how an estuary works. For example, with older children, how soil erosion in Pennsylvania can increase the amount of nutrients in the Chesapeake Bay, causing increased algae resulting in more decomposition and lower oxygen and fewer underwater plants because of less penetration by sunlight. How might this affect fish or the bald eagles that eat them?

Have all the students sit down in a circle facing each other. The first student is handed the string and picks an animal from the list below. The student wraps one end of the string around a finger. Ask the class " Who can name something that eats or is eaten by this animal?" Pass the string to the student who names the second item.

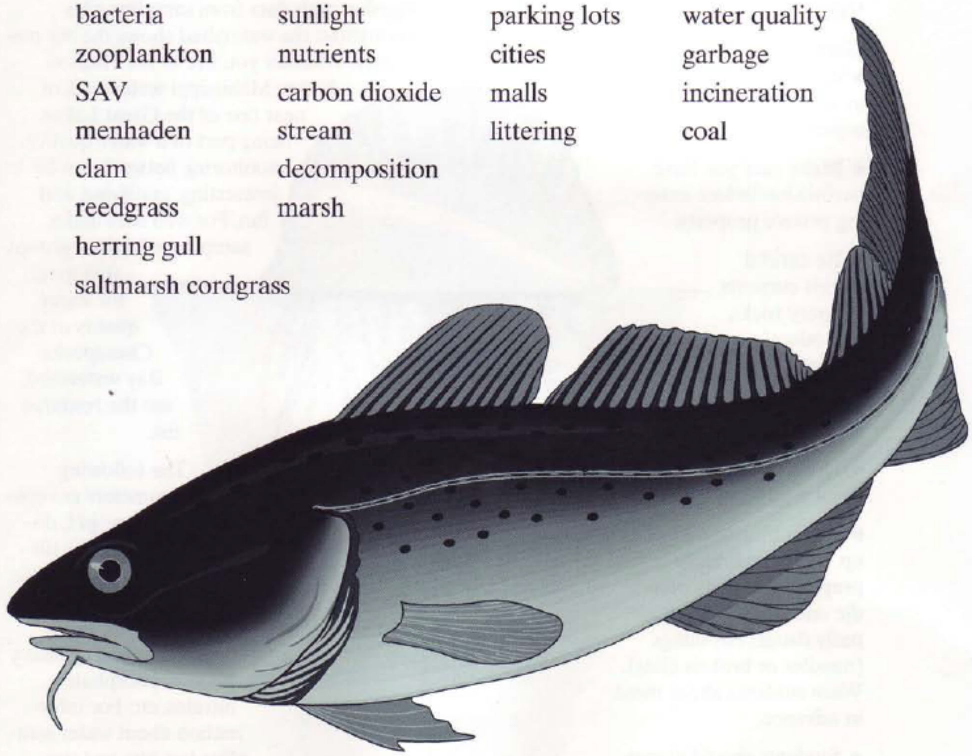
As each student picks an item from the list, they wrap the string around a finger. The string should be taut but not tight. For younger children, limit items from the list to a simple food chain. With older children, introduce other elements such as human activity, tributaries and sunlight. After the last person gets the ball of string, it goes back to the start. Now everyone is linked within the Estuary Web of Life. Students should be silent at the start of the game so as to experience the sensation of being signaled without vocal or physical contact.

Begin by introducing a situation that impacts directly on one of the items on the list. For younger children, this could be filling in a marsh to build condos.

An example for older children could be increased erosion. The student representing erosion gives a single tug on the sting. Those who feel the pull wait ten seconds and then pull on their string. Those who feel the second pull wait ten seconds then pull their string and so on, until everyone feels the impact.

Ask students what caused the person connected to them to pull the string. Discuss the interrelationships among roles. Explore such ideas as a population explosion or decline of one species or large scale development in the watershed.
Add or subtract items, or create new lists of relationships as necessary

A.	B.	C.	D.
oyster	erosion	farmers	sewage
eagle	rain	watermen	exhaust
white perch	runoff	oil drilling	pesticides
blue crab	tributary	shipping	acid rain
catfish	pond	development	fertilizer
striped bass	wetland	electricity	landfills
algae	dissolved oxygen	highways	air quality
bacteria	sunlight	parking lots	water quality
zooplankton	nutrients	cities	garbage
SAV	carbon dioxide	malls	incineration
menhaden	stream	littering	coal
clam	decomposition		
reedgrass	marsh		
herring gull			
saltmarsh cordgrass			



Water Quality Testing

from the "Chesapeake BayGull", by David Owen Bell

Objectives:

- To determine the health of a specific body of water.
- To integrate math and science skills by sampling, collecting, testing, recording, tabulating, and analyzing.
- To foster ownership of a nearby body of water, identify possible sources of pollution, and seek ways to improve water quality as appropriate.

Materials:

Varied by activity.

Guidelines:

- Water sampling is best done in small groups with adult supervision.
- Make sure you have permission before entering private property.
- Be careful of fast currents, slippery rocks, and other dangers.
- Dress appropriately.
- Don't ever drink the water.
- If you plan to pick up trash you find, be prepared to safely handle and dispose of potentially dangerous things (needles or broken glass). Warn students about these in advance.
- Students should always stay within sight and sound of a buddy.

Additional activities can include:

- Chart the different parameters over time.
- Test school or home drinking water for pH and other parameters.
- Obtain test results of local municipal water supplies and compare these to your tests. What are the similarities and differences between a healthy stream, pond, or estuary and healthy drinking water?

Testing your local stream or river can tell you about its health. Putting this information together with data from sampling sites throughout the watershed shows the big picture. Whether you live in the Hudson Valley, Mississippi watershed, or near one of the Great Lakes, being part of a water quality monitoring network can be interesting, gratifying, and fun. For web sites and a sampling of citizen groups that monitor water quality in the Chesapeake Bay watershed, see the resource list.

The following parameters are covered here: pH, dissolved oxygen, turbidity, and temperature. Test kits are available for many others, including heavy metals, phosphates, nitrates, etc. For information about water sampling test kits and supplies, see the resource list at the end of this manual.

Turbidity

Turbidity (cloudiness of the water) is caused by particles which scatter the sunlight passing through it. Two main sources of turbidity are sediments from runoff of eroded soil, and increased numbers of algae caused by too many nutrients in the water. Sediments and algae block sunlight that underwater plants need. Sediments also bury fish eggs and creatures that live on the bottom.

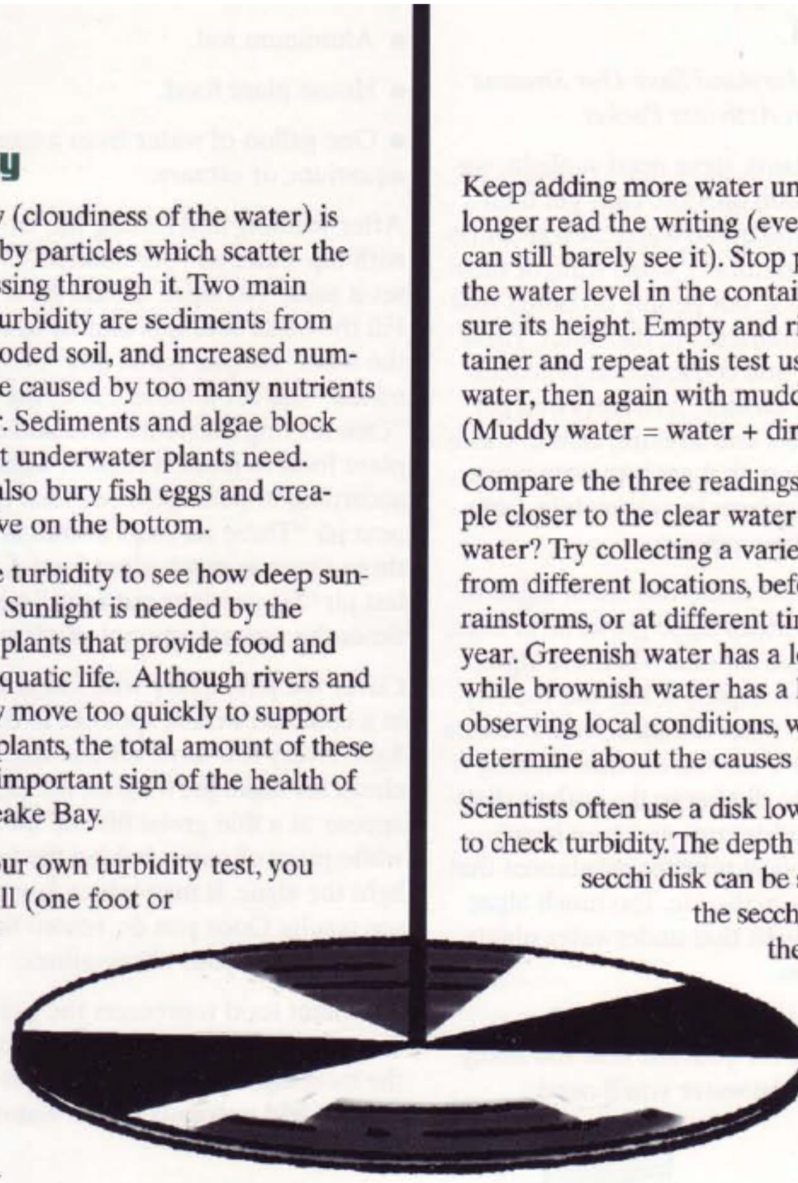
We measure turbidity to see how deep sunlight can go. Sunlight is needed by the underwater plants that provide food and shelter for aquatic life. Although rivers and streams may move too quickly to support submerged plants, the total amount of these plants is an important sign of the health of the Chesapeake Bay.

To make your own turbidity test, you can use a tall (one foot or more) clear flat-bottomed test tube or glass, a ruler, a bucket, and a newspaper. Collect your water sample in the bucket. Place the clear container over a "turbidity target" (the small black on white print in the newspaper) and look down through the container at the words. You should be able to read them clearly through the bottom of the container. Pour the water sample slowly into the container, stopping now and then to see if you can still read the words.

Keep adding more water until you can no longer read the writing (even though you can still barely see it). Stop pouring, mark the water level in the container, and measure its height. Empty and rinse the container and repeat this test using clear water, then again with muddy water. (Muddy water = water + dirt.)

Compare the three readings. Is your sample closer to the clear water or the muddy water? Try collecting a variety of samples from different locations, before and after rainstorms, or at different times of the year. Greenish water has a lot of algae while brownish water has a lot of dirt. By observing local conditions, what can you determine about the causes of turbidity?

Scientists often use a disk lowered by rope to check turbidity. The depth to which the secchi disk can be seen is called the secchi depth. Since the light travels through the water twice (once down and again reflected back to the observer), the light actually goes deeper. A secchi depth of at least 1 meter should be expected in the Bay and large rivers. Plants could then grow in water up to 2 meters deep.



Secchi Disk

Chesapeake Bay "old timers" use their toes. Walk out into the water about 1 meter deep without disturbing the bottom sediments. If you can see your toes, the water is pretty clear.

Nutrients-Too Much of a Good Thing

Adapted from Maryland Save Our Streams Adopt-A-Stream Activities Packet

Like other plants algae need sunlight, water, and carbon dioxide. They get their nutrients from soil in the water. Soil gets into bodies of water naturally when wind or moving water erodes it, but people do things that add even more nutrients to the water. These include farming and construction practices that cause more erosion fertilizers that get washed into rivers and streams, animal waste and human sewage that get into waterways, and chemical nutrients in automobile, factory, and power plant exhaust.

All these nutrients cause too much algae to grow. When too much algae grows all at once, it's called an algae bloom. When the algae dies, bacteria decompose it and use the oxygen that fish and other animals need. Bacteria also give off more carbon dioxide, making it harder for fish to discharge the carbon dioxide in their bloodstreams and take in oxygen. Decomposition releases substances that are harmful to aquatic life. Too much algae also blocks sunlight that underwater plants need, so they die.

Kits that test for certain nutrients are available. To see for yourself how too many nutrients affect the water you'll need:

- Five clear quart jars.
- Aluminum foil.
- Houseplant food.
- One gallon of water from a stream, pond, aquarium, or estuary.

After washing and rinsing the jars, fill one with tap water as your control. Label it and set it aside. No algae should grow in this one. Fill the other four jars almost to the top with the water sample. Label one" No nutrients added" and set it aside. Label the next jar "One serving nutrients" and add enough plant food to make a regular solution according to package directions. Label the next jar "Three servings nutrients" and add three times as much plant food. Label the last jar "Six servings nutrients" and add six times the normal amount of plant food.

Cover the jars lightly with foil and put them in a cool and well-lit spot not in direct sunlight. Every few days, stir the water and check for algae growing on the glass. It might appear as a thin green film or splotch. Hold a white piece of paper behind the jars to highlight the algae. It may take a few weeks to see results. Once you do, record the dates and results of your observations. The plant food represents the nutrients that are added to waterways. Which sample had the most algae growth? Why? What do people do that add nutrients to our waterways?

pH

pH is tested to determine whether water is acidic or alkaline. The pH scale runs from 0-14, with 7 being neutral. A pH below 7 indicates acid, above 7 shows alkaline (or base).

A difference of one number on the pH scale means a factor of ten. For example, sea water at 8.0 is ten times as alkaline as distilled water. Each additional number on the scale multiplies the factor by ten, so that orange juice is about 1,000 times as acidic as distilled water, and more than 1,000,000 times as acidic as milk of magnesia.

pH is important to life in the water. Fish, especially young ones, need to be within a pH range of about 6.5-8.5 to survive. The pH of a body of water can be changed by adding something with a different pH. People do this all the time to maintain their fish tanks, swimming pools, and stomachs.

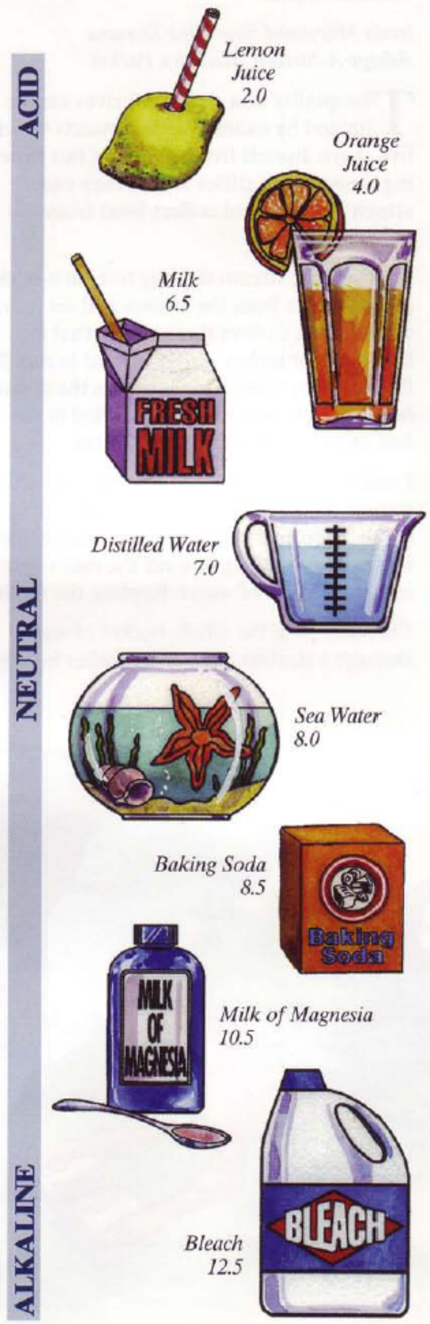
Most rain water is naturally slightly acidic because of the carbon dioxide it picks up in the atmosphere as it forms and falls to earth. On earth the weak acid rain dissolves minerals—salt, calcium, iron, and zinc for example, and carries them to the ocean, where they stay. Some of these minerals neutralize the water's acidity and raise its pH.

Burning fossil fuels, such as coal and oil, puts sulfur and nitrogen oxides in the air where they form sulfuric and nitric acids. This acid rain is harmful to plant and animal life. It is a problem in Europe and in the eastern United States.

Litmus paper turns red in acid, blue in alkaline water. It is a simple test, but not very precise. Test kits from pet and pool supply stores will give greater accuracy, but they contain a chemical which should be used and disposed of carefully. (Ask the salesperson if it can be recycled.)

A pH below 7.0 could be caused by acid rain or industrial pollution. A high pH could be caused by salt, lime, and other minerals which occur naturally. Lime is also used on fields and lawns to increase the pH of soil. It often gets into our waterways in the springtime, after it is applied and then carried away by seasonal rains.

Here Are Some pH Examples



Looking For Life In Streams And Rivers

from *Maryland Save Our Streams Adopt-A-Stream Activities Packet*

The quality of a stream or river can be judged by examining the insects which live there. Insects live in shallow, fast flowing areas called riffles where they can attach to rocks and collect food from the water flowing by.

To give your stream the bug test, fill a bucket with water from the stream and set it in a stable place. Collect three stones that are four to eight inches across, bathed in rapidly flowing water, and lying loose on the stream bed. Avoid stones which are buried in the bed or lying in slow moving waters.

Look for stoneflies, mayflies, and caddisflies (larvae or cases) on the surface of each stone. Thoroughly scrape all the insects, casings, and everything else off the rocks and into the bucket of water. Replace the rocks.

Carefully pour the whole bucket of water through a strainer, then add another bucketful. Use tweezers to move around material in the strainer and look for insects. Use a magnifying glass to help identify and count them.

Stoneflies have armor-like bodies, two tails, and distinct antennae. The toe of each leg has two claws. Mayflies have shrimp-like bodies and three tails. Caddisflies have long curved bodies. Their larvae look like small caterpillars. Their cases are made of sand grains, small pebbles, leaves, or twigs glued together.

Stream quality is rated excellent when stoneflies, mayflies, and caddisflies are present. If both mayflies and caddisflies are present, but stoneflies are missing, the stream is in good condition. If only caddisflies are present, stream quality is rated fair. A fair quality stream probably supports few game fish and would be a poor water supply source. If none of the insects are present, the stream is rated poor. A poor quality stream is unfit for most human uses and probably has no fish.

Dissolved Oxygen

The air we breathe holds up to 30 times as much oxygen as water does. When the oxygen level in water drops, aquatic life is in danger.

Oxygen is added to water by the photosynthesis of plants. Wind, rain, and waves also do their part by stirring in oxygen from the atmosphere. This is one reason why there is more dissolved oxygen near the surface. Quickly moving water normally has more oxygen than still water does because it has more interaction with the air.

Oxygen is used up by bacteria when they decompose waste and dead plants and animals. Since decomposition mostly takes place on the bottom where the waste is, there is less oxygen there.

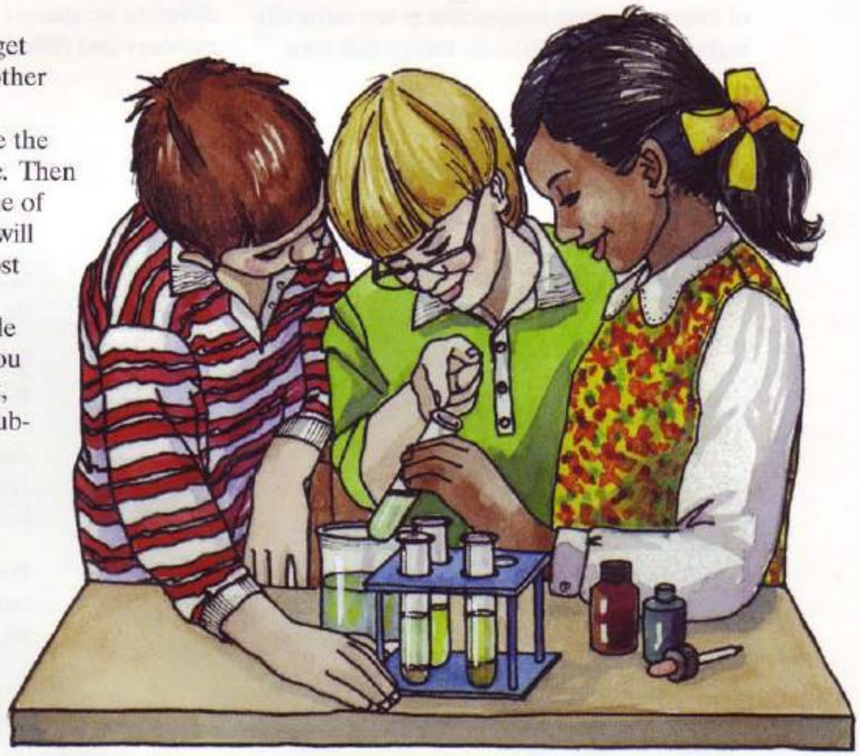
The temperature of a liquid determines how easily things can dissolve into it. Solids dissolve more easily in hot liquids (try dissolving a sugar cube into cold water and another one into hot water), but gases dissolve more easily in cold liquids.

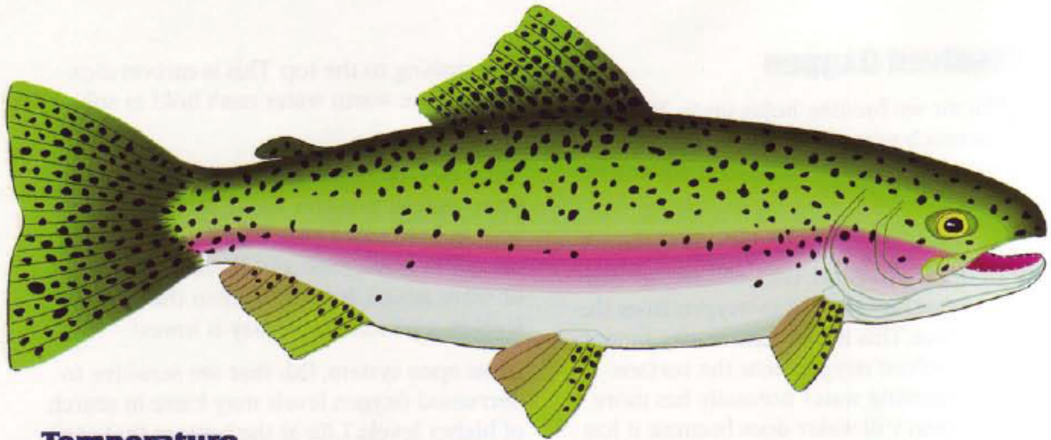
To observe this yourself, get two bottles of seltzer or other clear carbonated drink. Refrigerate one and leave the other out in a warm place. Then open the cold bottle. Some of the gas (carbon dioxide) will escape with a fizz, but most will remain in the water. Now open the warm bottle carefully. Not only will you get a lot of gas fizzing out, but you'll notice lots of bubbles rushing to the top. This is carbon dioxide that the warm water can't hold in solution.

Since oxygen is also a gas, it does not dissolve as well in warm water, so cool water is able to hold more of it. Late summer, when the water is warmest and there is little wind or wave action, is usually when the oxygen level in a pond, lake, or bay is lowest.

In an open system, fish that are sensitive to decreased oxygen levels may leave in search of higher levels. Life at the bottom that can't travel (oysters, clams, etc.) is more threatened by low oxygen levels. Trout need a lot of oxygen, so they seek cool, fast streams.

Oxygen levels should be in a range of 7–14 parts per million. (That means 7–14 parts oxygen per million parts water.) A danger reading would be below 4–5 parts per million. Dissolved oxygen can be checked with a test kit or meter.





Temperature

Bodies of water change temperature slowly compared to land. That's why you find the seashore not as hot in the summer and not as cold in the winter as inland locations. The more stable water habitat is important to the cold-blooded animals that can live only within a certain range of temperatures.

Because warm water can't hold as much of the dissolved oxygen that fish and other aquatic animals breathe, it doesn't support as much life as cool water. Towards the end of summer, water temperatures are naturally higher, but people also do things that turn up the heat.

Cutting down trees along stream and riverbanks means less shade and higher temperature, especially in shallow water that heats up relatively quickly. Some power plants use water to cool their reactors. The hot water discharge can be harmful to nearby aquatic life.

Water temperatures vary greatly, but to support life they should generally not be above 27 degrees centigrade (24 degrees in trout streams). A rugged thermometer on a string is all you need to check temperature. Try different locations (sunny or shaded, still or moving) and different depths.

PUTTING IT ALL TOGETHER

Test	Healthy level	Unhealthy level	Cause
Dissolved oxygen	7-14 parts per million	less than 4 ppm	Warm, still water, decomposition
Nutrients	varies, but less than 1 ppm	higher than normal	Sewage, erosion, fertilizer, exhaust
pH	6.5-8.5	below 6.5 above 8.5	Acid rain, industrial acids. Natural minerals, lime used on fields
Temperature	varies by location and season	above 27 degrees C	Power plant cooling, cutting down trees along river banks.
Turbidity	1 meter or more secchi depth	less than 1 meter	Sediment, algae

Watershed Pen Pal

by Debbie Grigsby

Objective:

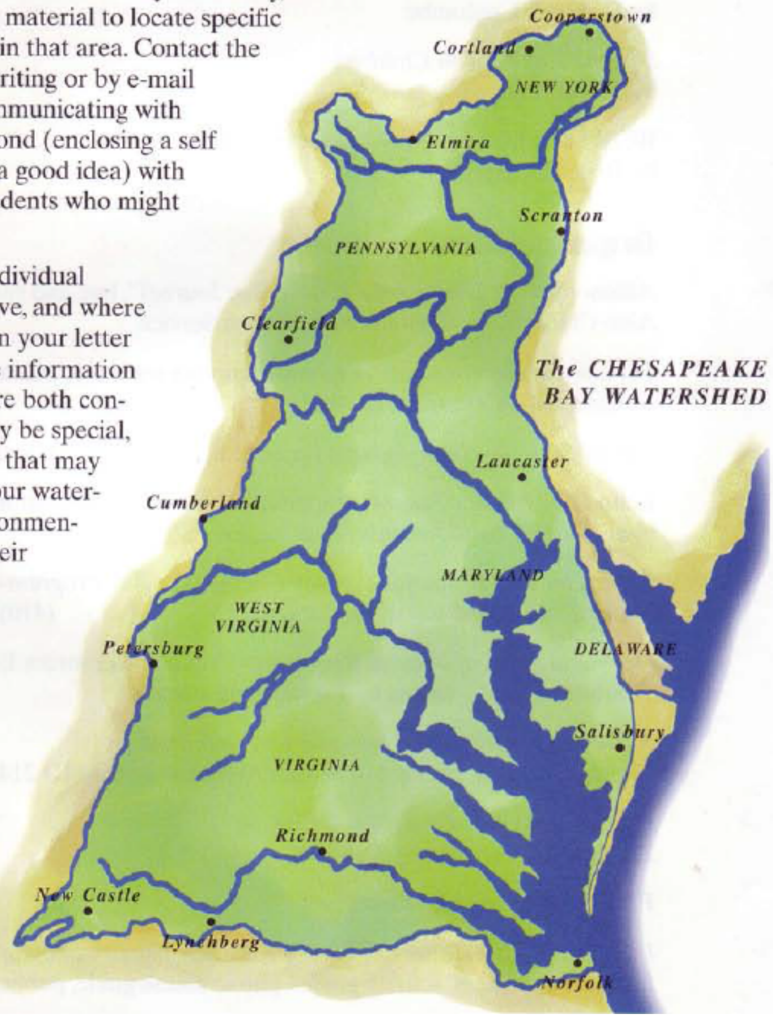
To research and locate a pen pal who also lives in the watershed. Contact that student, classroom, or school as a writing assignment and share your experiences and your new or increased knowledge of aquatic issues and concerns.

Materials:

- Paper, envelopes, and stamps or e-mail capability.
- Regional map covering your watershed.

Examining a map of the watershed, locate the names of towns or counties in an area of your choice. Refer to your library, telephone books, or other reference material to locate specific names and addresses of schools in that area. Contact the principal or science teacher in writing or by e-mail and indicate your interest in communicating with their students. Ask them to respond (enclosing a self addressed, stamped envelope is a good idea) with specific names of teachers or students who might be interested in corresponding.

Write a letter to or e-mail the individual describing yourself, where you live, and where you go to school. Explain early in your letter your purpose in writing: to share information about the watershed, how you are both connected to it, why you think it may be special, and things you can do every day that may help improve water quality in your watershed. Ask about particular environmental concerns they may have in their area. Ask them to write back.



Resources

Books

Awesome Chesapeake by David Owen Bell

Chesapeake Bay-Nature of the Estuary by Christopher White

The Life and Death of The Chesapeake Bay by J.R. Schubel

Life in the Chesapeake Bay by Alice Jane Lippson & Robert L. Lippson

The Seaside Naturalist by Deborah Coulombe

Sharing Nature With Children by Joseph Cornell

WOW! The Wonders of Wetlands: An Educator's Guide by Britt Slattery

Organizations

Alliance for the Chesapeake Bay---"Bay Journal", bay and river fact sheets, Chesapeake Regional Information Service

www.allianceforthebay.org

Chesapeake Bay Environmental Center---Wildlife preserve focusing on restoration, investigative field trips for pre-school through adulthood focusing on local wildlife and ecology

www.bayrestoration.org

Chesapeake Bay Foundation---Membership organization, teacher training, field trips, educational publications, advocacy

www.cbf.org -and- www.cbf.org/about-the-bay/state-of-the-bay-report/

Chesapeake Bay Program Facts & Figures

https://www.chesapeakebay.net/discover/facts

Chesapeake Research Consortium---Collaborative research and education initiatives in MD, PA & VA

www.chesapeake.org

Chesapeake Bay Trust---Grants for education, restoration, and conservation

www.cbtrust.org

Echo Hill Outdoor School---Experiential learning, publications, educational boat charters, and Bayside conference center

www.ehos.org

Environmental Protection Agency Chesapeake Bay Office---Multi-state restoration programs

www.epa.gov/aboutepa/about-chesapeake-bay-program-office

Maryland Dept. of Natural Resources---Aquatics Resources Education Grants Program
---Grants to teachers and schools

www.dnr.maryland.gov/ccs/Pages/funding/fundingopp.aspx

National Oceanic and Atmospheric Administration Chesapeake Bay Office

www.chesapeakebay.noaa.gov/

Pennsylvania Bay Education Office

www.pacd.org/?page_id=82

Project Wild Aquatic Workshops

www.fishwildlife.org/projectwild -and- www.fishwildlife.org/projectwild/aquatic-wild

Smithsonian Environmental Research Center---Internships, fellowships, seminars

www.serc.si.edu

University of Maryland Center for Environmental Science Horn Point Laboratory
--- Interdisciplinary research, restoration, seminars, outreach programs and on-site environmental education programs for students K-12.

www.umces.edu/hpl

U.S. Fish & Wildlife Service Chesapeake Bay Estuary Program---
fact sheets, posters, activity guides, public access guide and publications

www.fws.gov/chesapeakebay/

Data Sharing/Water Monitoring

Pennsylvania Department of Conservation & Natural Resources---Activities, Water Monitoring databases throughout PA, grant opportunities, and maps

www.dcnr.pa.gov/Education/WaterEducation/Pages/default.aspx

Chesapeake Bay & Delaware Bay Fieldscope---Citizen science initiative for community members and students to input water quality data

www.chesapeake.fieldscope.org/v3/ -and- www.delaware.fieldscope.org/v3

Water Sampling Supplies and Test Kits

Hach Co.

www.hach.com

The LaMotte Company

www.lamotte.com