



# ***Saving the Bay with Dollars & Sense & SOLs***

Using the Chesapeake Bay to Teach SOLs and  
Using SOLs to Save the Bay --  
Lessons for Commonwealth Middle & High Schools

Virginia Council on Economic Education  
Virginia Tech Center for Economic Education  
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## **Lessons**

*I. What is the Chesapeake Bay?*

*II. Why should I Care about the Bay?*

*III. How can We Save the Bay?*

*IV. Can We Afford to Save the Bay?*

*V. Can We Afford Not to Save the Bay?*



These are not simple questions. In studying the Chesapeake Bay – declared a “National Treasure” by President Barack Obama in 2009 - our goal is to help Commonwealth teachers and students conceptualize and integrate the complex issues (social, environmental, economic) critical to ensuring the sustainability of this enormous national asset. This curriculum is passionate about the Bay, People, and Logic ... bringing reason to bear on workable and affordable strategies for *Saving the Bay!*

As a not-for-profit educational organization devoted to promoting economic literacy among youth, the Virginia Council on Economic Education (VCEE) is committed to providing a balanced approach to the teaching/learning process in Commonwealth schools. Our mission is to integrate economic perspectives into K-12 curricula. Bringing focus to a challenging issue like the Bay offers a pedagogical vehicle to engage students and educators in developing economic ways of thinking and problem solving regarding other social and environmental issues.

## **Approach**

Though there is already a lot of literature and curricula on the Chesapeake Bay, much of it lacks the economic dimension – a serious deficit in terms of preparing leaders capable of comprehending the true benefits and costs of “Saving the Bay!” This secondary education curriculum addresses this educational need.

The curricula’s framework is holistic and judicious, for there is no immediate magic bullet to shape the Bay’s future. It is designed as a starting point for student discussion and additional analysis. Identification of key questions for focused discussion, accompanied by lessons developed with scientific content, economic analysis, and pedagogical activities, give youth an overview of the interrelated problems, interstate aspects, intergenerational challenges, and potential solutions to sustaining the Bay.

In light of the VCEE’s mission to “train the trainers,” we believe that helping teachers teach environmental economics translates into educating hundreds or thousands of students in Commonwealth schools to understand the Bay’s uncertain future and think creatively about policy formulation (local, regional, and perhaps national) to ensure a healthy and affordable future.

## **SOL’s Addressed**

*Saving the Bay with Dollars & Sense & SOLs* specifically focuses on five Standards in Virginia's Curriculum Framework for Science, six Standards in its Curriculum Framework for Civics and Economics, six Standards in its Curriculum Framework for Virginia and U.S. Government, and one Standard in its Curriculum Framework for Economics & Personal Finance:

### Science

LS 6.7 - "Location, structure and health of Virginia's watersheds, wetlands and estuaries; natural processes, human interactions and conservation issues." [*Lesson 1*]

LS.7 - "Complex relationships within marine ecosystems." [*Lesson 1*]

LS.12 - "Population disturbance and environmental issues (water, air, energy, waste)." [*Lesson 1*]

ES.9 - "Identification of Virginia watersheds and Chesapeake Bay." [*Lesson 1*]

ES.11 - "Economics and public policy issues of Chesapeake Bay." [*Lessons 2 - 5*]

### Civics and Economics

CE.7c – States have responsibility for “protecting natural resources and the environment,” including “water quality in the Chesapeake Bay.” [*Lesson 3*]

CE.8a – Local governments possess “powers to promote public health, protect the environment, and regulate land use.” [*Lesson 3*]

CE.11a – Students will demonstrate knowledge of “natural resources as factors of production” and the reality of “opportunity costs.” *[Lesson 1]*

CE.12d – Students will demonstrate knowledge of Virginia’s connections to the “global economy” and “impact of technological innovations.” *[Lesson 2]*

CE.13b - Students will demonstrate knowledge of “how government provides goods and services” that “individuals and businesses acting alone could not provide efficiently.” *[Lesson 2]*

CE.13e - Students will demonstrate knowledge of the “role of property rights” in “protecting contracts and public health and safety.” *[Lessons 3-5]*

### Virginia and U.S. Government

GOVT.9c - Students will demonstrate knowledge of "the role of the state in the process by which public policy is made." *[Lesson 3]*

GOVT.9e - Students will demonstrate knowledge of "the role of individuals, interest groups and the media in the process by which public policy is made." *[Lesson 3]*

GOVT.12c - Students will demonstrate knowledge of "the role of the U.S. in a changing world and global economy." *[Lesson 2]*

GOVT.15c - Students will demonstrate knowledge of “natural resources as factors of production.” *[Lesson 1]*

GOVT.16b - Students will demonstrate knowledge of the “creation of government goods and services not readily produced by the market.” *[Lesson 2]*

GOVT.16c - Students will demonstrate knowledge of the “government’s role in environmental issues and protecting property rights.” *[Lessons 3-5]*

### Economics & Personal Finance

EPF.8b - Students will demonstrate knowledge of the government's role in protecting property rights." *[Lessons 3-5]*

## **Educational Partners**

Collaborative organizations are identified that offer regional or statewide activities, websites, or materials designed to stimulate student discussion and analysis about the Bay. In particular, the *UVA Bay Game* is highlighted as a major resource for educators with large classes to simulate the impacts on the Bay’s health of real-world decisions made by farmers, landowners, crabbers/fishers, and regulators.

## Curriculum Outline

Recognizing the informational limitations required to study the complex Chesapeake Bay, the following five lessons have been designed to introduce students to basic challenges regarding the Bay's current and future health:

- *I. What is the Chesapeake Bay?* ..... *Pages 5-13*
- *II. Why should I Care about the Bay?* ..... *Pages 14-24*
- *III. How can We Save the Bay?* ..... *Pages 25-33*
- *IV. Can We Afford to Save the Bay?* ..... *Pages 34-18*
- *V. Can We Afford Not to Save the Bay?* ..... *Pages 39-44*



## Characters

This curriculum incorporates three unique characters whose conversation brings up questions to help students engage in the material and find connections between concepts introduced about the Bay and their own lives.

1. *Bay Jay* represents citizens whose livelihood are dependent on the Bay and its resources such as fishers, seafood restaurants, or boaters.
2. *Penny Smart* embodies scholars who question how much it will cost homeowners, farmers, golf courses and factories to alter their behavior to help *Save the Bay*.
3. *SOL-O-Man* poses science and civics questions addressed by the SOLs.

## Authors

Mike Ellerbrock, PhD – Director, Center for Economic Education, Virginia Tech.  
Tammie A. Gingras Moore – Center for Economic Education, Longwood University.

Consultants:

Katie Register – Executive Director, Clean Virginia Waterways.  
Sarah H. Finley, J.D. – President, Virginia Council on Economic Education.  
Melanie Marks, PhD - Center for Economic Education, Longwood University.

Virginia Tech Research Assistants: Rob Arthur, Alyssa Cultice, Caitlin Shaw

# Lesson 1

## *What Is the Bay?*

### Description

- The lesson explains key facts and figures about the Chesapeake Bay.

### Objectives

- Students will learn about the history, geology, magnitude, biodiversity, and economic significance of the Bay.

### Materials

- Copy of the “By the Numbers Bay Game” worksheet for each student

### SOLs Addressed

LS 6.7 - "Location, structure and health of Virginia's watersheds, wetlands and estuaries; natural processes, human interactions and conservation issues."

LS.7 - "Complex relationships within marine ecosystems."

LS.12 - "Population disturbance and environmental issues (water, air, energy, waste)."

ES.9 - "Identification of Virginia watersheds and Chesapeake Bay."

CE.11a – Students will demonstrate knowledge of “natural resources as factors of production” and the reality of “opportunity costs.”

GOVT.15c - Students will demonstrate knowledge of “natural resources as factors of production.”

**Introduction:** In an important reminder about the true size of the “Bay,” restrooms on the campus of the University of Virginia have this label on the sink faucets: *The Bay Begins Here!*

**Lecture Synopsis:** Teachers might lecture about the history and size of the Bay and then use the worksheet as a review, or you can use the worksheet as an introduction to your lecture. The lecture exactly matches the questions on the worksheet with additional information in order to give students some context. All numbers and facts on the worksheet are from the Chesapeake Bay Program website at [www.chesapeakebay.net](http://www.chesapeakebay.net).

## Bay Fax

**Chesapeake Bay:** There are several theories regarding the origin of the name “Chesapeake.” The most commonly accepted one is that it is an Algonquian (Native American) word meaning “great shellfish bay.” Alternative translations include “great salt water” and “mother of waters.” Some people believe that it was also the name of a Native American village that sat at the mouth of the Bay.

**Formation and History of the Bay:** 35 million years ago a large crater was formed. Science has not reached a consensus on whether it was caused by a meteor, an asteroid, or a comet. Around 10,000 years ago, melting glaciers began to fill the crater that would become the Bay. It was not until 2000 BCE that the Bay as we know it took its current shape. Agriculture began along the Bay shores around 1000 BCE. But it was not until 600-900 CE that crops along the shores became common. Fishing and agriculture were the beginning of humanity’s impact on the environment of the Bay. In 1607 Jamestown was built along its banks.



**Watershed:** A watershed is the combination of all the rivers and streams that drain into a larger body of water. A watershed is made up of the land that drains into these moving bodies of water and the thousands of small bodies of water that drain into it. The Chesapeake Bay watershed includes parts of six states (Virginia, Maryland, Delaware, Pennsylvania, New York, and West Virginia) and Washington D.C. Approximately 17 million people live in the Bay watershed, including 10 million along or near its shores. It encompasses about 64,000 square miles of land and 150 major rivers and streams that provide about 50% of the Bay’s water. This is important because the actions of someone who lives many miles from the Bay can still have an impact on the Bay.



*Bay Jay asks: Which 6 states directly affect the Chesapeake Bay environment through its watershed?*

**Estuary:** An estuary is a partially enclosed body of water on the coast where fresh and salt water meet. Many bays and harbors are estuaries. Because they are partially closed from the open ocean, estuaries are protected from heavy surf and storms, making them ideal habitats, breeding grounds, and shipping areas. They are home to countless species and provide important resources for people. There are 130 estuaries in the United States and the Chesapeake Bay is the largest.

**Habitat:** Where a species lives (permanent or migratory) and reproduces.

**Ecosystem:** Complex relationships exist between all the living and nonliving things in an area, similar to a web. When one thing is affected, many other living and nonliving things and organisms may be affected. Because of the complexity of these relationships, it is hard to know the impacts that actions may have; for example, the impact of DDT on the Bald Eagle population.

**Wetlands:** The transition area between water and land. They might be “wet” all the time or part of the time. Wetlands can be swamps, bogs, or marshes. Some, like many near the Bay, are tidal, meaning they are wet when the tide is in and dry when the tide is out. For many years wetlands were seen as negative and useless land filled only with snakes, bugs, and mud. Today, people are beginning to understand the importance of wetlands:

- Wetlands prevent sediment, pollutants, and excess nutrients from being eroded into the Bay by runoff. Sediment can fill the Bay and make it cloudy. Pollutants can have many different affects depending on the type. Nutrients such as phosphorus and nitrogen are responsible for major algal blooms in the Bay.
- Wetlands serve as vital habitats for many species.
- Wetlands are like big sponges; they can hold a lot of water and help to prevent flooding.
- Hunting, hiking, fishing, boating, bird watching, and nature photography are just a few examples of some recreational activities that occur in wetlands.
- People consume products, e.g., wild rice, blueberries, fish, and timber, from wetlands.

**Bay Size:** With 11,600 miles of tidal shoreline, the Bay is 200 miles long and stretches from Virginia to Maryland. The Bay is 35 miles wide at it widest point and 3.4 miles wide at its narrowest point. The total square footage of the Bay is 125 billion square feet. It includes several islands and tidal wetlands.



A fun way for students to get a feel for how big this is students is to have them find the square miles of different states and then convert them to square feet. Or you can tell students that that one square mile is equal to 27,878,400. This makes the Bay about 4,484 Square Miles. To put this into perspective, Connecticut is 4,845 sq miles and Rhode Island is only 1,045.

- To find square miles for each state go to [www.usgs.gov](http://www.usgs.gov)
- Then go to the Simple Science Website at <http://www.sciencemadesimple.net/area2.php> to convert to square feet.

**Bay Depth:** The Bay (including tidal tributaries) averages about 21 feet deep. The deepest point is 174 feet deep near Bloody Point, MD. According to the Chesapeake Bay Program website “...a person who is 6 feet tall would be able to wade through over 700,000 acres of the Bay and barely get his or her hat wet.” The Bay holds 18 Trillion gallons of water.

**Bay Life:** The Bay is home to more than 3,600 different species of plants, fish, and animals. There are 348 different species of finfish, 173 species of shellfish, and over 2,700 species of plants. There are 29 different species of waterfowl that make their home in the Bay. According to Estuaries.gov more than two thirds of the fish we eat spend at least some time in an estuary. They also state that estuaries are one of the most “biologically productive ecosystems on the planet.” The Chesapeake Bay Program website states that “Perhaps the most valuable function of the Chesapeake Bay region is its role as a habitat for living organisms.”

**People:** More than 17 million people live in the watershed and 10 million people live along the shores (or near them) of the Bay. The population for the entire state of Virginia was 7,642,884 in 2006 according to the US Census Bureau. This means that more people live near the Bay than in the entire state of Virginia.

**Seafood:** The Bay produces over 500 million pounds of seafood each year. According to the United States Fish and Wildlife Service's Chesapeake Bay Office Website (<http://www.fws.gov/chesapeakebay/fishpage.htm>) the Bay is the 3<sup>rd</sup> best fishery for the United States. It is beaten only by the Atlantic and Pacific Oceans!



*Penny Smart wonders: Can you think of three different attractions or outputs of the Bay in your life?*



**Pollution:** According to The Chesapeake Bay Program, [www.chesapeakebay.net](http://www.chesapeakebay.net), there are 4 major types of pollution that impact the Bay.

- I. Sediment - Dirt that washes into the Bay takes time to settle. High amounts of clay, sand, and silt that are suspended in the water block sunlight. Water plants that cannot get adequate sunlight cannot perform photosynthesis and thus they die. Animals that eat the plants cannot live without them. When the sediment does settle to the bottom it can cover and smother benthic (bottom-dwelling) creatures. As it settles it can begin to fill the Bay, blocking ports and waterways. Additionally, sediment can contain toxic materials.
- II. Air Pollution - Air pollution can deposit nitrogen, acid rain, and chemical contaminants in the Bay. Scientists are just beginning to understand the link between air pollution and the health of the Bay. The major sources of air pollution are stationary and area sources, mobile sources, agricultural sources, and natural sources.

- *Stationary Sources:* manufacturing sources such as industrial plants. Stationary sources include large utility and chemical manufacturing plants, as well as clusters of small plants that are located in a given geographic area.

- *Mobile Sources:* things that move like planes, trains and automobiles. It also includes things like lawn mowers, boats, farm equipment, and gas powered tools.

- *Agricultural Sources:* two major origins. Manure from farm animals can runoff into the Bay. Chemicals that are not applied correctly can become air pollution.

- *Natural Sources:* volcanoes, fires, and dust storms can all have an impact.





III. Toxics Pollution - Toxics are chemicals and metals that can harm living things. Some common toxic chemicals in the Bay come from pesticides and industrial waste. They enter the Bay in two main ways.

- Point Sources: facilities you can literally point your finger at, such as a sewage drainage pipe or a business that dumps chemicals in the Bay or its tributaries.
- Non-Point Sources (NPS): these are harder to identify than point sources, yet have a major impact. NPS come from things like storm runoff. A person living in the watershed who dumps antifreeze on the ground that washes into the Bay is contributing to NPS toxic chemical pollution in the Bay.
- Air Pollution: can contribute toxic chemicals to the Bay.



IV. Nutrient Pollution - While all living things need nutrients in order to survive and grow, there can be too much of a good thing. Nutrient pollution focuses on nitrogen and phosphorus (usually in the phosphate form). Fertilizers, animal waste, runoff, wastewater treatment facilities, and septic systems can all contribute to nutrient pollution in the Bay. Because all plants need these nutrients to grow, they are used in agriculture. The problem is that they can get washed into the Bay in excessive amounts. When there are high levels of nutrients in the Bay, phytoplankton and algae grow at incredible rates. These can result in “blooms,” major explosions of these populations.



*SOL-O-Man inquires: If, instead of crabbing, a waterman could either A) use his boat and equipment to earn \$40,000 profit per year by offering private charter fishing trips, or B) \$36,000 per year as a school teacher plus \$10,000 per year giving weekend boat rides to eco-tourists, what are his Opportunity Costs of being a professional crabber?*

Nutrient runoff poses a major challenge. The USGS estimates that the Bay watershed contains 3.8 million acres of lawns and turf grass, now the largest "crop" grown in the watershed at 9.5 % of its land area. At a yearly cost of approaching \$5 billion, approximately 215 million pounds of nitrogen fertilizer are applied annually, enough to grow two million acres of corn. Summer irrigation removes 7,875 cubic feet per second (cfs) from river flow into the Bay, more than the combined inflow from the Choptank, Pamunkey, Monocacy, Rappahanock, Patuxent, James and Patapsco Rivers.

**Dead Zones:** One of the most serious threats to the future of the Bay is known as “hypoxia”, a lack of oxygen in the water that inhibits the growth and health of a wide range of Bay inhabitants. Increased nutrient runoff from various sources causes an increase in algae growth. Algae blooms

group on the surface of the water, block the sunlight, and then absorb the oxygen when they decompose, leaving less oxygen to support the rest of the ecosystem. Areas suffering from hypoxia are known as “Dead Zones.” They continue to expand, especially during summer. See **Map** in Lesson Three.

Nitrogen and Phosphorus are the two nutrients most affecting the health of the Bay. A majority of the Nitrogen runoff stems from fertilizers—most common sources include farms, golf courses, and homes that lie within the Bay’s huge watershed. Most of the Phosphorus that is found in the Bay comes from the industrial aspect of our economy, which includes the huge span of industry in the watershed, especially power plants. Sediments also play a significant role in the health of the Bay. Due to increased levels of rainfall and snow, these are becoming a bigger concern each year.

Although dead zones affect the overall health of the Bay, the species most affected by growth in the dead zone is shell fish, who live at the bottom and have no way to escape the harmful effects of hypoxia. Crabs have a chance of reaching the surface before being harmed, and fish can usually get away. A recent study by David Malmquist by the Virginia Institute of Marine Sciences (VIMS) explored the changes in habitats and ecosystems in dead zones. Not only are these areas of the Bay poor habitat, they also cause stress on the organisms, including crabs and shellfish, which can decrease their health and make them more susceptible to disease.

There is reason to hope. According to the *State of the Bay Report 2010* published annually by the CBF, the level of toxics in the Bay has actually decreased since 2009. This could be attributable to efforts by localized groups dedicated to saving and improving the Bay. Although Money Point, at the mouth of the Elizabeth River, was long considered a dead zone, the Elizabeth River project can be credited for cleaning up tons of sediment ... enabling a significant return of aquatic life!

## Resources:

- Chesapeake Bay Program’s website [www.chesapeakebay.net](http://www.chesapeakebay.net) and the Maryland Department of Natural Resources website <http://www.dnr.state.md.us/bay/cblife/fish/index.html>.
- The Mariners Museum website <http://www.mariner.org/chesapeakebay/index.html> details life for the Native Americans before Jamestown, Colonial America, Oyster Wars, the 20<sup>th</sup> Century, Economy, and Watermen.
- The Chesapeake Bay Program website provides a wonderful timeline on the Bay and provides other links <http://www.chesapeakebay.net/about.htm> and <http://www.cbf.org>.
- The U.S. Geologic Survey website (<http://www.usgs.gov/>) has resources that are perfect for teaching about the Bay. One section titled Ecosystem History and Change shows the impact that we have had on the Bay and links to the Investigating the Chesapeake Bay Impact Crater website. <http://chesapeake.usgs.gov/ecosystem.html>.
- Estuaries.gov is the National Oceanographic and Atmospheric Administration (NOAA) program that teaches students all about estuaries. There is information on why they are important, what they are, etc. There are also many activities and links to other websites. <http://www.estuaries.gov>
- U.S. Geological Survey has a quiz on how much water a person uses in a day and shows different amounts needed for different activities: <http://nd.water.usgs.gov/index/quiz.html>.
- The United States Fish and Wildlife Service’s Chesapeake Bay Office Website has an area dedicated to the threatened and endangered species in the Chesapeake Bay region.

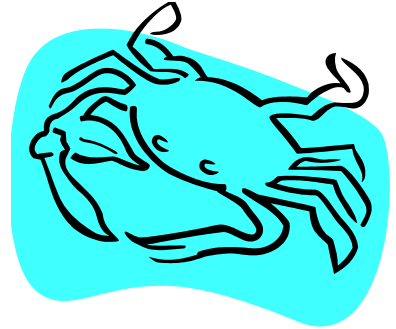
Information about these species can be found at <http://www.fws.gov/chesapeakebay/EndSppWeb/INDEX.HTM>.

- The United States Census Bureau website provides information about population by state, city, and county. Students can look at population growth for cities around the Bay. The website is [www.census.gov](http://www.census.gov).
- NOAA's Chesapeake Bay Office has a website that provides information on fisheries. <http://noaa.chesapeakebay.net/fishmain.aspx>.
- Maryland's Department of Natural Resources Fisheries Department can be found at <http://www.dnr.state.md.us/fisheries/>
- The Virginia Marine Resources Commission's website has information on recreational and commercial fishing. <http://www.mrc.virginia.gov/>

**Activity:** Make a copy of the “By the Numbers Bay Game” worksheet for each student. Students should select the correct number from the bottom of the page and place it in the blank. Each of the numbers will be used once.



## ***By the Numbers Bay Game*** **Worksheet**



1. The Bay was formed about \_\_\_\_\_ years ago.
2. There are \_\_\_\_\_ estuaries in the United States. Out of these, the Chesapeake Bay is ranked number \_\_\_\_\_ in terms of size.
3. The Bay's watershed includes \_\_\_\_\_ states and the District of Columbia. The Bay's watershed is comprised of about \_\_\_\_\_ square miles of land. There are about \_\_\_\_\_ major rivers and streams in the watershed. These rivers and streams provide about \_\_\_\_\_ percent of the water that is in the Bay.
4. The Bay is \_\_\_\_\_ miles long, stretching from Maryland to Virginia. The widest part of the Bay is \_\_\_\_\_ miles across (near the mouth of the Potomac River) and the narrowest part is \_\_\_\_\_ miles across (near Aberdeen, MD). This makes the square footage of the Bay and its tidal tributaries \_\_\_\_\_ square feet.
5. The Bay, including its tidal tributaries, averages about \_\_\_\_\_ feet deep. The deepest points can be \_\_\_\_\_ feet deep. The Bay holds more than \_\_\_\_\_ gallons of water.
6. The Bay is home to more than \_\_\_\_\_ different species of plants, fish, and animals. There are \_\_\_\_\_ different species of finfish, \_\_\_\_\_ species of shellfish, and over \_\_\_\_\_ species of plants. There are \_\_\_\_\_ different species of waterfowl that make their home in the Bay.
7. More than \_\_\_\_\_ people live in the watershed and \_\_\_\_\_ people live along the shores or near them.
8. The Bay produces over \_\_\_\_\_ pounds of seafood each year.

130	15 Million	174	35	64,000
21	18 Trillion	6	125 Billion	3,600
29	173	1	2,700	50
500 Million	10,000	150	348	3.4
10 Million	200			

## ***By the Numbers Bay Game***

### **Answer Key**

1. The Bay was formed about 10,000 years ago.
2. There are 130 estuaries in the United States. Out of these, the Chesapeake Bay is ranked number 1 in terms of size.
3. The Bay's watershed includes 6 states and the District of Columbia. The Bay's watershed is comprised of about 64,000 square miles of land. There are about 150 major rivers and streams in the watershed. These rivers and streams provide about 50 percent of the water that is in the Bay.
4. The Bay is 200 miles long, stretching from Maryland to Virginia. The widest part of the Bay is 35 miles across (near the mouth of the Potomac River) and the narrowest part is 3.4 miles across (near Aberdeen, MD). This makes the square footage of the Bay and its tidal tributaries 125 Billion square feet.
5. The Bay, including its tidal tributaries, averages about 21 feet deep. The deepest points can be 174 feet deep. The Bay holds more than 18 Trillion gallons of water.
6. The Bay is home to more than 3,600 different species of plants, fish, and animals. There are 348 different species of finfish, 173 species of shellfish, and over 2,700 species of plants. There are 29 different species of waterfowl that make their home in the Bay.
7. More than 15 Million people live in the watershed and 10 Million people live along the shores or near them.
8. The Bay produces over 500 Million pounds of seafood each year.

## Lesson 2

### *Why should I Care about the Bay?*

#### **Description**

- Students will explore linkages among the Bay, Virginia economy, and biodiversity. Students will role play various motivations people have for protecting the Bay.

#### **Objectives**

- Students will understand how people who live across the Commonwealth are impacted by the health of the Bay.

#### **Materials**

- Copy of the “Why Do I Care about the Bay?” cut into individual cards.
- Map of Virginia

#### **SOLs Addressed**

ES.11 - "Economics and public policy issues of Chesapeake Bay."

CE.12d – Students will demonstrate knowledge of Virginia’s connections to the “global economy” and “impact of technological innovations.”

CE.13b - Students will demonstrate knowledge of “how government provides goods and services” that “individuals and businesses acting alone could not provide efficiently.”

GOVT.12c - Students will demonstrate knowledge of "the role of the U.S. in a changing world and global economy.”

GOVT.16b - Students will demonstrate knowledge of the “creation of government goods and services not readily produced by the market.”

## **An American Treasure**

In 2009, President Obama declared the Chesapeake a “National Treasure.” Perhaps he did so for two reasons: First, to validate the Bay’s unique significance to human and biological life in America; and Second, to heighten our sense of urgency about *Saving the Bay!*

The challenge calls for the public to develop a complete vision of the Bay in terms of its economic benefits and costs. In this Lesson, we examine some of the Bay’s contributions to our quality of life. In Lesson 4, we examine the costs of sustaining the Bay for future generations. In Lesson 5, we explore the opportunity costs of not sustaining the Bay.

## Economic Impacts of the Bay

To fully capture the impacts of the Chesapeake Bay on the Virginia Economy, several variables need to be considered. Different activities contribute to the economic impact, including:

- Fishing - when Virginia fishers and crabbers export seafood, the economy benefits;
- Tourism - when tourists rent hotel rooms and dine out, the economy benefits;
- Multiplier Effect - when new jobs are created to meet these demands, the economy benefits;
- Intrinsic Value – when people value the environment for its own sake, they also benefit.



*SOL-O-Man asks: What are some of the businesses around you that could affect or influence your personal intrinsic value of the Bay?*

### Fishing

Fishing in the Chesapeake Bay has a major impact on Virginia's economy. The Virginia Institute of Marine Science Website, [www.vims.edu](http://www.vims.edu), provides three reports on the economic status of the Bay. These reports are joint efforts from several different Virginia Institutes.

- The 1994 report *Virginia's Commercial Fishing Industry: It's Economic Performance and Contributions* is available at [www.vims.edu/library/Kirkley/Kirkley2.pdf](http://www.vims.edu/library/Kirkley/Kirkley2.pdf).
- The 1994 report *Saltwater Angling and its Economic Importance to Virginia* is available at <http://www.vims.edu/library/Kirkley/Kirkrec.pdf>.
- The 2005 report *The Economic Contributions of Virginia's Commercial Seafood and Recreational Fishing Industries: A User's Manual for Assessing Economic Impacts* is available at [http://www.vims.edu/newsmedia/pdfs/fishing\\_economics.pdf](http://www.vims.edu/newsmedia/pdfs/fishing_economics.pdf).

The 2005 report states that recreational and commercial fishing generated \$1.23 billion in sales, \$717.4 million in income, and provided 13,015 jobs in Virginia in 2004. However, between 1994 and 2004 there has been a 30% decrease in sales from the commercial sector of the fishing industry.

The impact of the fishing industry is far reaching. It is not just the people who fish and the people working on the docks who are impacted.

- Have students picture a grocery store owner in the mountains of Virginia. He sells fresh fish in his store.
- If the supply of the fish in the Bay drops, then the cost is going to increase and he will need to raise prices in his store.
- Because the price of fish is higher, a person planning on making fish for dinner might decide to purchase something less expensive, or decide that they cannot serve a fancy dessert because they spent so much on the meal, and the grocery store owner loses a sale. (Remind students about opportunity cost.)

The same concept can be applied to a server in a seafood restaurant.

- If the health of the Bay is poor, and there are not many fish caught this year, the price of fish will go up.

- As people find their meals costing more in the seafood restaurant, they might decide to go to less expensive places, causing a drop in business.



*Penny Smart wonders: If in the future the number of fish in the Bay drops significantly, what will be the impact on the price of seafood in your local grocery store? (Remember the positive relationship between the quantity supplied of a good and its price.)*

## Tourism

The health of the Bay has major economic impacts on tourism in Virginia. The Virginia Tourism Corporation will help students see the impact the Bay has on the Commonwealth's economy. Information on individual counties can be found on their website, <http://www.vatc.org/>, by clicking on the "research" button, then selecting "economic impact."

One example is Accomack County located on the Eastern Shore of Virginia, adjacent to the Bay.

- The Virginia Tourism Corporation reports that in 2005 the population of Accomack was 39,424 people and 1,811 were employed in "direct travel-related jobs" closely tied to the tourism industry. Examples of this include jobs in hotels, restaurants and airports. There may be other businesses that are peripherally impacted. For instance, the grocery store might not be directly travel related, but it might have to hire extra employment during the tourist season.
- Travel to the area generated over \$121 million in expenditures and \$28 million in payroll. The impact of these dollars is even greater when you consider the multiplier effect.
- In addition, \$3.8 million was generated in taxes for the county. This means that some of the costs of running the county are passed on to people who do not live there.
- Tourism in Accomack also contributed over \$6 million in state taxes. This is good for all Virginians because some of the costs of delivering providing public goods and services are passed on to visitors from other states.

## Multiplier Effect

Money changes hands repeatedly. Therefore, a one dollar increase in economic activity can have more than a one dollar impact on the economy. For example, when the captain of a fishing vessel sells his catch, he may use the money to buy gas for his boat, paying the wages of the people who work in the gas station, who subsequently use their income to purchase goods and services for their families from other businesses. This cycle is ongoing and multiplies the positive impact to the Virginia economy (as long as the money is spent in Virginia).

A typical multiplier might fall between two and four, meaning that a one dollar increase in economic activity can generate between two and four dollars in the economy. If a family spends a thousand dollars vacationing on the Bay, the overall impact on the economy is between two thousand and four thousand dollars. Conversely, imagine how many jobs and dollars would be lost without tourism to the Bay area.



## Intrinsic Value

Environmental resources may be valued by people simply because they exist, independent of their instrumental value as recreational commodities or role in the ecosystem. Harvard Biologist E.O. Wilson theorizes that humans have an innate affinity for wildlife and love of nature. He makes the case that people are better because of the living things that exist, a theory he calls “Biophilia.” For example, people seem to have an appreciation for the Humpback Whale, Manatee, and Sea Turtle (species known to visit the Bay). Yet, they may have never seen these species personally. Though it is real and sometimes quite large, intrinsic value is difficult to measure. Using travel cost data, consumer surveys, and/or riparian property values, economists have developed creative techniques to estimate intrinsic value. For example, see Activity 8 below.



*Bay Jay asks: Even if you do not live near the Bay, what businesses around you could affect the Bay and how?*

### Activity:

1. Copy the activity “Why Do I Care about the Bay?” on to cardstock or heavy paper. Cut each box/scenario into individual cards.
2. Present a lecture to students on why people care about the Bay. The Background Information above should help get you started.
3. Hang a Map of Virginia on the wall so students may refer to the locations mentioned in the cards.
4. Present each student or group of students with a “Why do I Care about the Bay?” card. Ask them to determine the individual’s motivation for caring about the Bay. Tell them that they should think about the content of the lecture and apply what they learned directly to the person described. Students should look at the map to see where the town, city, or county referred to is located.
5. Allow each group several minutes to discuss their answer. Ask them to defend their answer. Students should be able to tell you if their “answer” is an intrinsic or economic reason for caring about the Bay. They might want to consider if the situation on their card impacts:
  - Someone’s job or profession?
  - Someone’s income, finances, business profits, etc.?
  - Someone’s costs associated with something he or she likes to consume?
  - Someone’s feeling of well being or enjoyment?
  - Someone’s recreational opportunities?

6. When students are finished, have them present their reasoning to the class. Students should also place a mark or marker on the map to indicate the location their card deals with. (Answers are provided at the end of this unit and may be used to prompt students when needed.)

*Note:* By the end of the activity it should be pointed out to students that every region of Virginia is impacted by the health of the Bay, as well as other states.

7. Discuss the reality that people have different reasons for caring about the Bay. Help students understand that not everyone will have the same reasons for caring.
8. Have students compare property values among similar homes in three locations: adjacent, near, and distant from the Bay.



## Activity 1: Why Do I Care About the Bay?

<p>Why do I care? Card 1</p> <p>Bill owns a grocery store with a large fish counter in Franklin, Virginia. He does not like to visit the beach and has never been to the Chesapeake Bay. Why does he care about the health of the Bay?</p>	<p>Why do I care? Card 2</p> <p>Doris says that she does not care about the environment, even though her grandchildren are always telling her how important it is. She lives in Charlottesville and hates to travel. What reasons could her grandchildren give to convince her to care about the Bay?</p>
<p>Why do I care? Card 3</p> <p>Kris and Lisa own a small hotel in Onancock, Virginia. Why do they care about the health of the Bay?</p>	<p>Why do I care? Card 4</p> <p>Mike owns a chain of gas stations with locations around Virginia and at every exit on Interstate 64. He has just opened a dockside gas station for boats in Virginia Beach. What is one reason that he might care about the health of the Bay?</p>

<p>Why do I care? Card 5</p> <p>Fred is an avid fisherman. He spends as much time catching fish as he can. He has many favorite fishing spots in the Bay. Why does he care about the health of the Bay?</p>	<p>Why do I care? Card 6</p> <p>Alexis loves to visit beautiful vacation spots where she can spend time bird watching. Why does she care about the health of the Bay?</p>
<p>Why do I care? Card 7</p> <p>Riley is a wildlife biologist who is passionate about saving endangered species. Why does Riley care about the health of the Bay?</p>	<p>Why do I care? Card 8</p> <p>Why do YOU care about the health of the Bay?</p>
<p>Why do I care? Card 9</p> <p>Jim owns a restaurant in Kilmarnock, Virginia. Jim is passionate about saving the Bay. What are some reasons that might explain why Jim cares so much about the Bay?</p>	<p>Why do I care? Card 10</p> <p>Sharon lives in Richmond, Virginia and owns “Sharon’s Shipyard,” a store that builds custom boats and accessories for recreational boating. Why does she care about the health of the Bay?</p>

<p>Why do I care? Card 11</p> <p>Peter lives in Cape Charles, Virginia. He owns his own refrigerated trucking company. Why does he care about the Bay?</p>	<p>Why do I care? Card 12</p> <p>Monica is a college student at Longwood University. She is from Vienna, Virginia. During the summer, she works at a local seafood restaurant. Why does she care about the health of the Bay?</p>
<p>Why do I care? Card 13</p> <p>Melanie lives in Farmville, Virginia. Her favorite food is crab cakes. Why does she care about the Bay?</p>	<p>Why do I care? Card 14</p> <p>Josh owns a construction company on the Eastern Shore of Virginia that builds new homes. He says that he is tired of all the regulations that “hurt” his business. He says he does not care about the Bay. Why should he care about the Bay?</p>
<p>Why do I care? Card 15</p> <p>Robert owns a restaurant in the Norfolk Airport. Why does he care about the health of the Bay?</p>	<p>Why do I care? Card 16</p> <p>Diana is a science teacher in Wise, Virginia. She has two kids who have never been to the beach. Why should she care about the health of the Bay?</p>

## Why Do I Care About the Bay?

### Suggested Answers

<p>Why do I care answer card 1</p> <p>Bill owns a grocery store in Franklin Virginia that has a large seafood counter. He does not like to visit the beach and has never been to the Chesapeake Bay. Why does he care about the health of the Bay?</p> <p>The Bay is likely to provide some of the Seafood that he sells in his store. If the health of certain species diminishes, then the yields to fishermen will fall. This means that prices will be higher to Bill and he will pass these on to customers. This may result in a lower sales volume. And, selection might be smaller.</p>	<p>Why do I care answer card 2</p> <p>Doris says that she does not care about the environment, even though her grandchildren are always telling her how important it is to care. She lives in Charlottesville and hates to travel. What are some reasons that her grandchildren might give her for caring?</p> <p>Biophilia and intrinsic reasons-if grandma cares about her the grandchildren then she will care. They may point out their own values for recreation, eating seafood, etc.</p>
<p>Why do I care answer card 3</p> <p>Kris and Lisa own a small hotel on the Eastern Shore of Virginia. Why do they care about the health of the Bay?</p> <p>Tourism will be an important determination of their livelihood. A polluted Bay will not attract tourists.</p>	<p>Why do I care answer card 4</p> <p>Mike owns a chain of gas stations with locations around Virginia and at every exit on Interstate 64. He has just opened a dockside gas station for boats in Virginia Beach. What is one reason that he might care about the health of the Bay?</p> <p>Fishing and tourism. Fishing boats need to purchase a lot of gasoline and people who drive to visit the Bay will also need to purchase gas (and I 64 is a major road leading to the Bay). A polluted Bay means less boaters, etc.</p>

<p>Why do I care answer card 5</p> <p>Fred is an avid fisherman. He spends as much time catching fish as he can. He has many favorite fishing spots in the Bay. Why does he care about the health of the Bay?</p> <p>Enjoyment/Recreation. Students must remember that Virginia competes with other states for tourist dollars. If the Bay is polluted, the fishing experience will not be good and Fred will go elsewhere.</p>	<p>Why do I care answer card 6</p> <p>Alexis loves to visit beautiful vacation spots where she can spend time bird watching. Why does she care about the health of the Bay?</p> <p>Enjoyment/Recreation. Students must remember that many other states offer nice destinations for bird watching. It is important that Virginia attract these tourists instead of having them go elsewhere.</p>
<p>Why do I care answer card 7</p> <p>Riley is a wildlife biologist who is passionate about saving endangered species. Why does Riley care about the health of the Bay?</p> <p>Biophilia/intrinsic value is one reason. Also, Riley may be concerned about the different species and how they impact each other in an ecosystem.</p>	<p>Why do I care answer card 8</p> <p>Why do YOU care about the health of the Bay?</p> <p>Answers will vary</p>
<p>Why do I care answer card 9</p> <p>Jim owns a restaurant in Kilmarnock, Virginia. Jim is passionate about saving the Bay. What are some reasons that might explain why Jim cares about the Bay?</p> <p>Tourism Jim's business benefits from the tourists who come to town. His livelihood will suffer greatly if there are few tourists. He will also need to lay off workers.</p>	<p>Why do I care answer card 10</p> <p>Sharon lives in Richmond, Virginia and owns "Sharon's Shipyard," a store that builds custom boats and accessories for recreational boating. Why does she care about the health of the Bay?</p> <p>Recreational and commercial fishing. If the Bay is not an attractive destination for boating, then her sales may decline.</p>

<p>Why do I care answer card 11</p> <p>Peter lives in Cape Charles, Virginia. He owns his own refrigerated trucking company. Why does he care about the Bay?</p> <p>Fish is often transported in refrigerated trucks when it is fresh. Peter may rely on the fishing industry in the Bay. If the yields are low, then his business suffers.</p>	<p>Why do I care answer card 12</p> <p>Monica is a college student at Longwood University. She is from Vienna, Virginia. During the summer, she works at a seafood restaurant. Why does she care about the health of the Bay?</p> <p>If fishing declines, then fish and seafood prices will rise. This may translate into fewer diners at the restaurant. Since she relies on tips, this would hurt her income. Students should remember that people have choices...and they may choose a steak restaurant instead.</p>
<p>Why do I care answer card 13</p> <p>Melanie lives in Farmville, Virginia. Her favorite food is crab cakes. Why does she care about the Bay?</p> <p>Crabs come from the Bay. If there are not many crabs then the price of crabs will rise. This, in turn, means that the price of crab cakes will rise. If crab populations were really in trouble, the government might regulate crabbing and crabs (and crab cakes) would be very scarce.</p>	<p>Why do I care answer card 14</p> <p>Josh owns a construction company on the Eastern Shore of Virginia that builds new homes. He says that he is tired of all the regulations that “hurt” his business. He says he does not care about the Bay. Why should he care about the Bay?</p> <p>This area is on the Bay. Why would people want to move to the area if the Bay was not nice? If no one wants to move to the shore then the demand for Josh’s houses will decrease. This directly impacts his well being.</p>
<p>Why do I care answer card 15</p> <p>Robert owns a restaurant in the Norfolk Airport. Why does he care about the health of the Bay?</p> <p>Tourism. As people fly out after a visit to the Bay, they might grab a bite to eat before their plane leaves. Fewer travelers means that there will be fewer meals served. This directly impacts Robert’s well being.</p>	<p>Why do I care answer card 16</p> <p>Diana is a science teacher in Wise, Virginia. She has two kids who have never been to the beach. Why should she care about the health of the Bay?</p> <p>As a science teacher she knows the environmental importance of the Bay. She also wants her children to see its beauty some day. Furthermore, Diana may be a lover of seafood, much of which will come from the Bay.</p>



## Lesson 3

### *How can We Save the Bay?*

#### **Description**

- The lesson explains key policies affecting the Chesapeake Bay.

#### **Objectives**

- Students will learn about strategies for Saving the Bay.

#### **Materials**

#### **SOLs Addressed**

ES.11 - "Economics and public policy issues of Chesapeake Bay."

CE 7.b – Relationship between state and national governments: whereas states are responsible for “public health and welfare,” the federal government is responsible for “regulating commerce.”

CE.7c – States have responsibility for “protecting natural resources and the environment,” including “water quality in the Chesapeake Bay.”

CE.8a – Local governments possess “powers to promote public health, protect the environment, and regulate land use.”

CE.13e - Students will demonstrate knowledge of the “role of property rights” in “protecting contracts and public health and safety.”

GOVT.9c - Students will demonstrate knowledge of "the role of the state in the process by which public policy is made."

GOVT.9e - Students will demonstrate knowledge of "the role of individuals, interest groups and the media in the process by which public policy is made."

GOVT.16c - Students will demonstrate knowledge of the “government’s role in environmental issues and protecting property rights.”

EPF.8b - Students will demonstrate knowledge of the government's role in protecting property rights."

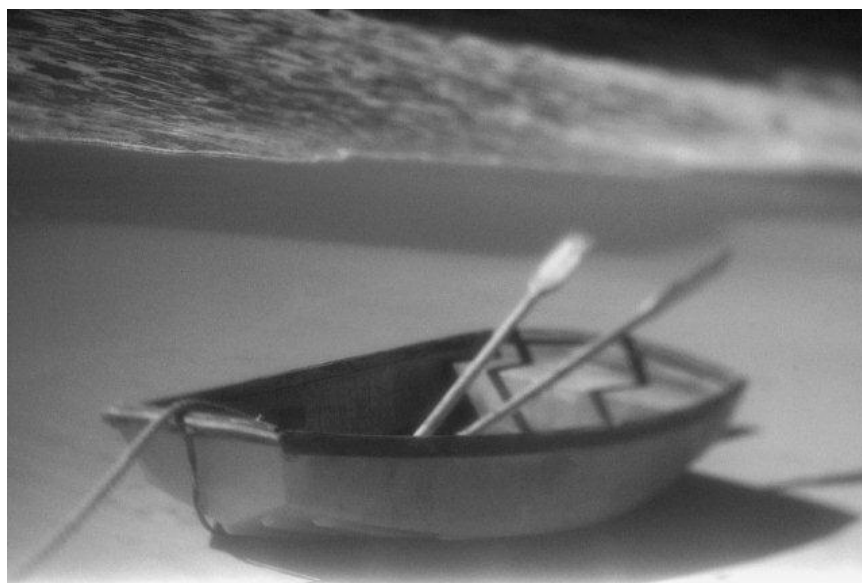
## Lesson Topics

- *The CBF Challenge* – current status of the Bay, estuary threats.
- *Reasons for Hope* – recent state actions and progress.
- *Virginia's Watershed Implementation Plan* – voluntary incentives, ambitious enough?
- *Non-Point Source Pollution Abatement* – market-based trading system, financial incentives.
- *Fisheries & Wildlife Management* – harvest quotas, economic competition, government role.
- *Externalities & Unintended Consequences* – cars, corn and feedback loops.

## The Challenge

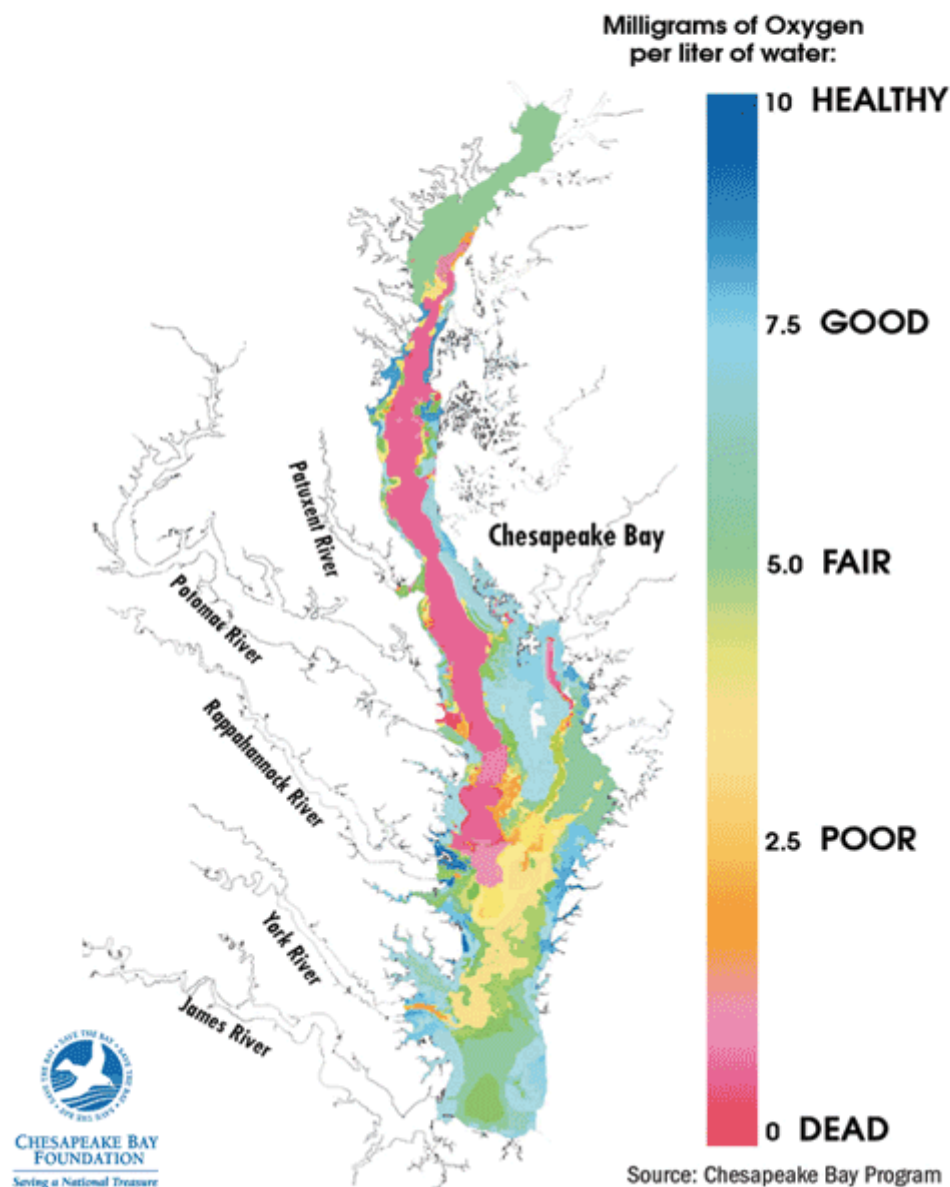
There is scientific debate about how to define the health of the Bay. The Chesapeake Bay Foundation (CBF) uses a 100 point scale to measure the health of the Bay. In 2002, it rated only 27/100, compared to the CBF goal of 40/100 by 2010.<sup>1</sup> And 2002 was a low rainfall year, which means NPS runoff could have been worse if it was a normal year. CBF President William Baker says, “We are in a race against time and a race against population.” In 2008, the Bay remained in critical condition. According to the CBF:

*The most insidious threats to the nation's largest estuary remain nitrogen and phosphorus pollution, which rain flushes off parking lots, farm fields, and suburban lawns, fueling algal blooms that die and rot – sucking oxygen out of the water and killing much of the life on the bottom.*<sup>2</sup>



# CHESAPEAKE BAY RECORD DEAD ZONE

AUGUST 2005



<http://www.vims.edu/newsandevents/topstories/2008-dead-zones-spread.php>

VIMS Professor Robert Diaz estimates that the number of “dead zones” - areas of seafloor with too little oxygen for most marine life - has increased by a third between 1995 and 2007. Diaz and collaborator Rutger Rosenberg of the University of Gothenburg in Sweden say that dead zones are now “the key stressor on marine ecosystems” and “rank with over-fishing, habitat loss, and harmful algal blooms as global environmental problems.”

Dead zones occur when excess nutrients (primarily nitrogen and phosphorus) enter coastal waters and help fertilize blooms of algae. When these microscopic plants die and sink to the bottom, they provide a rich food source for bacteria, which in the act of decomposition consume dissolved oxygen from surrounding waters. Major nutrient sources include fertilizers and the burning of fossil fuels

It was estimated in June 2011 that the Chesapeake Bay dead zone covers a third of the Bay, stretching from the Baltimore Harbor to the Bay's mid-channel region in the Potomac River, about 83 miles. Subsequent reports indicate that it has since expanded beyond the Potomac into Virginia.

## Reasons for Hope

In an Executive Order signed in 2009, President Obama directed federal agencies to coordinate efforts among themselves and with state agencies to hasten achievement of Bay restoration goals. Fortunately, progress<sup>1</sup> has been made, albeit modest steps forward:

- ✓ In the 2008 farm Bill, the U.S. Congress allocated \$440 million in new conservation funding for farmers in the Bay watershed for the next five years;
  - ✓ CBF and USDA worked with 66 dairy farmers to develop a “Precision Feeding” program that reduced the amount of phosphorus in their feed rations, with no adverse impact on herd health;
  - ✓ Montgomery County, Maryland drafted new storm-water management permits that incorporate maximum pollution limits for specific streams and rivers;
  - ✓ Pennsylvania has planted 2.2 million new trees to create forest buffer strips along Bay waterways;
  - ✓ In Virginia, volunteers collected 240,000 pounds of trash in Bay tributaries and planted 10 million juvenile oysters – nature’s water filters;
- ✓ Through its *Chesapeake Classrooms* program, the CBF has trained hundreds of teachers and thousands of students in becoming better environmental educators and activists;
- ✓ Maryland Gov. Martin O’Malley and Virginia Gov. Tim Kaine agreed in April 2008 to a plan to reduce the blue crab harvest by 33%;<sup>2</sup>
- ✓ The U.S. Environmental Protection Agency (EPA) and Bay states are determining and enacting Total Maximum Daily Loads (TMDLs) of specific nutrients (aka “Pollution Diets”) that each stream segment in the Bay watershed can tolerate ... an enormous, yet vital, scientific project.<sup>3</sup>



## Virginia’s Watershed Implementation Plan

Protecting the Chesapeake Bay involves both economic principles and political philosophy. Whereas some citizens view the Bay as a national issue in need of a plan overseen by the federal government, others believe that each state in the Bay watershed should develop its own policies because flexible approaches are generally more cost-effective. In other words, the political debate is over centralized vs decentralized government and uniform vs site-specific standards.

In September 2010, Virginia’s Department of Conservation and Recreation (DCR) released its draft *Watershed Implementation Plan*<sup>1</sup> (WIP) for protecting the Bay. DCR’s analysis estimates that new

agricultural practices like conservation tillage and stream fencing may cost farmers an additional \$800 million. Adopting a decentralized approach it calls “Adaptive Management,” the WIP advocates:

- ✓ Focusing on outputs rather than inputs - emphasizing “back-end” results rather than “front-end” strategies - for protecting the Bay;
- ✓ Tracking and rewarding voluntary adoption of BMPs by farmers, foresters, waste-water plants, industries and developers;
- ✓ Attainment of a minimum of 35 feet of grass or forest buffers;
- ✓ Total exclusion of livestock from streams;
- ✓ Monitoring Confined Animal Feeding Operations (CAFOs);
- ✓ Animal waste permits and mortality composters;
- ✓ Increasing populations of filter feeders and wetlands restoration;
- ✓ Expansion of Nutrient Credits Trading Program to include on-site systems;
- ✓ More scientific assessment of chlorophyll standards in the James River;
- ✓ Encouraging tax credits, grants and “Betterment Loans”;
- ✓ Improved municipal storm-water collection systems, construction permits, and certified inspectors;
- ✓ Officially approved conservation offsets to allow community growth;
- ✓ Public education programs on Bay stewardship.



Politically, the WIP is controversial.<sup>2-6</sup> The CBF asserts that it is inadequate to achieve the Bay Goals. Proponents assert that its flexibility makes it more feasible than a “top-down approach with mandated regulations.”<sup>7</sup> Time will tell.

## NPS Pollution Abatement

For each acre of water in the Bay, there are 2,4000 acres of land in its watershed. When Captain John Smith arrived in the early 1600’s, 95 percent of the Bay watershed was in forest cover, an important filter for water quality. Today, that figure is 58 percent ... no wonder nutrient runoff and sedimentation pose major threats to the Bay’s sustainability!

Nitrogen and phosphorus nutrients enter the Bay from a variety of sources: sewage treatment plants, stormwater, septic systems, farm runoff, and air pollution. Agricultural runoff is a perplexing problem because it is difficult to identify the exact source(s); hence the term, “non-point source” (NPS) pollution. The CBF, USDA, EPA, DCR and DEQ have advocated and helped design strategies to reduce NPS pollution, including:

- ✓ Agriculture conservation plans;
- ✓ Nutrient management systems on farms;
- ✓ No-till and conservation tillage;
- ✓ Cover crops on pastures;
- ✓ Fencing cows out of streams; and,
- ✓ Riparian forest buffers.<sup>1</sup>

In “A New Way to Save the Bay,” an economist advocates replacement of the voluntary standards of NPS pollution reduction, which have not attained the goals of the Chesapeake 2000 Agreement, with a market based system that sets overall tributary limits through a fixed number of pollution allowances. Individual polluters in each tributary could then decide whether to purchase allowances or reduce their runoff/emissions.<sup>2</sup> One of many approaches<sup>3-9</sup> to reducing NPS pollution, this approach avoids government micromanagement of industry and rewards economic competition.

*Bay Jay asks: What does the policy of TMDLs stand for? Which agency developed this plan for the Bay?*



## Fisheries & Wildlife Management

The menhaden fishery is a major industry that produces a variety of consumer products from the oily little fish that swims in large schools. A scientific mystery exists regarding whether menhaden forage on phytoplankton or zooplankton? Phytoplankton are propagated by nutrient sedimentation (nitrogen & phosphorus runoff). When they die, they cause hypoxia - “dead zones” in the Bay with no oxygen. If menhaden eat phytoplankton, that would enhance water quality. On the flip side, menhaden excrete harmful ammonia, though not nearly as much as the anthropogenic (human origin) sources in the Bay. *ProjectWild*<sup>1</sup> is an excellent curriculum reference.

Regarding the enormous blue crab industry, some scholars advocate for the Bay states’ Governors to adopt a quota system which would offer economic incentives among licensed watermen.<sup>2</sup> Quota shares could be bought and sold among watermen, thereby allowing the most efficient watermen to purchase shares from their struggling competitors, which might result in a fixed harvest achieved by fewer pots with less fuel and bait.

A complicating factor is that the primary habitat for male crabs is the northern section of the Bay in Maryland, whereas the females live in the southern Virginia Bay waters, except during mating season when both groups gravitate to the center. This ecological separation pits Maryland against Virginia watermen in angry disputes over who is to blame for the decline in the blue crab population.

## Externalities & Unintended Consequences

Two important lessons in economics are the realities of “externalities” and “unintended consequences” – when a policy or action generates consequences for innocent third parties (including the environment) or results different from its intent. Unfortunately, the Bay suffers from several such examples.



*Penny Smart wonders: Can you identify local environmental “externalities” in your neighborhood?*

In an effort to reduce our national dependence on foreign oil and protect air and water quality, our U.S. Congress enacted the Corporate Average Fuel Efficiency (CAFÉ) standards that require America's automobile manufacturers to produce a fleet of vehicles each year that attain a minimum average level of fuel efficiency (mpg). Though the law sounds logical from an environmental perspective, it has ironically corresponded with an increase – not decrease – in the number of miles driven annually per person (capita) in the U.S.<sup>1</sup> Why? Because higher mpg reduces the cost of driving a mile. In other words, the CAFÉ standards increase the price of *purchasing/owning* a car, but lower the cost of *driving/operating* it.

Though ethanol is a gasoline additive that can help reduce our nation's dependence of imported oil, it can unfortunately have a negative effect on the Bay. It is estimated that farmers in the Bay watershed will plant about 500,000 additional acres of corn for ethanol, to take advantage of higher corn prices. Yet corn generally requires more fertilizer than crops like soybeans or hay, which could increase nitrogen and phosphorus runoff into the Bay, with the unintended consequence of more algae blooms in the Bay that die and decay, creating “dead zones” deplete of oxygen and life.<sup>2</sup>

Ironically, if we enact policies that effectively reduce sedimentation from entering the Bay, without complementary policies that reduce nutrient runoff into the Bay, the result can backfire. With less sedimentation, additional sunlight enters the water, enhancing water clarity, which can lead to an explosion of algal growth ... a negative feedback loop. Hence, environmental policies must be coordinated and comprehensive.

*SOL-O-Man wants you to: Name one way the federal government regulates commerce in order to help the Bay?*



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3. [http://www.dcr.virginia.gov/soil\\_and\\_water/nps.shtml](http://www.dcr.virginia.gov/soil_and_water/nps.shtml) - Explains what NPS is and the four major types: Sediments, nutrients, toxic substances, pathogens.
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5. <http://www.dnr.state.md.us/bay/czm/nps/whatisnps.html> - Management strategies for NPS.
6. <http://www.dnr.state.md.us/bay/czm/nps/> - Maryland's NPS management program with links to clean water act, strategies, NPS monitoring conference, NPS program annual reports, and request for proposals like Coastal environmental design.
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## Lesson 3 Activity - How can We Save the Bay?



### Making a Difference Worksheet

Many people don't realize that our everyday actions have more effect on the environment than we thought. Many processes that create our food, energy, and other items often have unintended consequences on the environment, known as *externalities*, that we may not be aware of.

1. A carbon footprint is the direct effects a person's actions and lifestyle have on the environment in terms of carbon dioxide emissions. This measurement tells us how much of the Earth's resources we are using up.

Check out these websites in order to determine your own carbon footprint:

- o High School: <http://www.myfootprint.org/>
- o Elementary School [http://www.zerofootprintkids.com/kids\\_home.aspx](http://www.zerofootprintkids.com/kids_home.aspx)

What is your footprint? \_\_\_\_\_

2. Do you think your carbon footprint is too high? Now, re-do your carbon footprint, making some changes of goals you want to set for yourself (individually) to lessen your impact on the environment.

Goals: \_\_\_\_\_

What is your new footprint? \_\_\_\_\_

3. How do you think your changes could make an impact on saving the Chesapeake Bay specifically? (No matter how small they are!)
4. What are some reasons would you give your family members and friends to save the Bay? What would you suggest they do to help?
5. Pretend you are writing a quick note to the Governor of Virginia to try to convince him/her to save the Bay. What would you say?

## Lesson 4

### *Can We Afford to Save the Bay?*

#### **Description**

- The lesson explains key facts and figures about the Chesapeake Bay.

#### **Objectives**

- Students will learn about the history, geology, magnitude, biodiversity, and economic significance of the Bay.

#### **Materials**

- Copy of the “By the Numbers Bay Game” worksheet for each student

#### **SOLs Addressed**

ES.11 - "Economics and public policy issues of Chesapeake Bay."

CE.13e - Students will demonstrate knowledge of the “role of property rights” in “protecting contracts and public health and safety.”

GOVT.16c - Students will demonstrate knowledge of the “government’s role in environmental issues and protecting property rights.”

EPF.8b - Students will understand the "government's role in protecting property rights."

## **A Matter of Dollars & Sense**

During 1976-83, the U.S. EPA spent \$27 million conducting a comprehensive research study of the Bay that determined “that the estuary required immediate action to save it and restore its health.”<sup>1</sup> Today, the Chesapeake Bay Foundation (CBF) estimates that it will cost \$8.5 billion to achieve the 2010 Goals, of which only 21 percent have been attained by 2008. Other analysts predict that the cost may be as high as \$20 billion.<sup>2</sup>

Part of the challenge is upgrading sewage treatment plants. In Pennsylvania, three dozen counties lie in the Bay watershed. Under the Chesapeake Bay Agreement, 63 facilities in those counties must be upgraded by 2010 at a cost of \$5.5 – 29 million, resulting in a cost increase to their customers of \$15 – 30 per month.<sup>3</sup> In Virginia, it is estimated that updating eight large treatment plants will cost about \$520 million, resulting in a cost increase to their 450,000 customers of \$100 per month.<sup>4</sup> In February 2012, the Virginia Senate recommended that the Commonwealth borrow and spend \$300 million to upgrade 85 treatment plants. The House tabled the bill for lack of funds.



Crabbers have traditionally relied on temporary workers from other countries to pick their crabs.<sup>5</sup> Though they pay these ‘guest workers’ about \$15,000 per season, some work in squalid conditions without access to legal and health services. Our U.S. Congress is debating whether to tighten restrictions on immigrants who return each year to seek these and other low-skilled jobs.

*Bay Jay wonders: What are some other innovative ways we have found to reduce “stress” that human activities and businesses put on the Bay?*



## Tragedy of the Commons: The Role of Property Rights

Regarding the management of natural resources, it has been said that, “If everyone owns it, no one owns it!” With public lands and waterways, if there is a lack of caretaker responsibility by users, the “Tragedy of the Commons” can occur ... leading to rapid exploitation of the resource.

The same phenomenon often occurs with endangered wildlife. If a hunter or poacher assumes that, “If I don’t shoot the last buffalo, the other guy will” ... the buffalo is doomed!

Hunted near extinction in America’s western grazing lands, the buffalo was saved when government established property rights and control of access over the range ... giving private landowners and tribes an economic incentive to manage the land and animals in a long-term sustainable manner.



*SOL-O-Man says: Name one way government policy protects Bay fishermen’s economic freedoms.*

Similarly, the Bay’s immense size and ecological resiliency have historically led to its current peril ... too many people and industries assumed that the Bay is indestructible. Today, we know better.

Throughout the Bay’s entire watershed, well designed property rights are essential for giving citizens and businesses economic incentives to behave in environmentally responsible ways ... thereby preventing runoff downstream into the Bay.

It is also critical that government policies not overly restrict the rights of private property owners to exercise freedom and initiative in managing their natural resources ... a political challenge in balancing the interests of individuals with society, jobs with nature, and current with future generations.



*Penny Smart reminds you that: Establishing and enforcing \_\_\_\_\_\* are critical to give landowners incentives to act more responsibly toward the Chesapeake Bay.*

## **Our Challenge - The Key Questions**

- 1) What changes in behavior and at what costs do we need the 17 million inhabitants of the Bay's 64,000 square mile watershed -- encompassing six states and Washington DC, 150 rivers and streams, and thousands of businesses -- to make in order to improve and maintain water quality downstream in the Bay?
- 2) What government/legal policies and financial incentives are necessary to elicit voluntary changes in environmental behavior to *Save the Bay*?

### Some Success Stories

With the research and technical assistance of neighboring universities, the EPA and Bay states have implemented several cost-effective measures<sup>6</sup> that reduce anthropogenic (human) stresses on the Bay, including:

- ✓ Winter cover crops to lessen soil erosion;
- ✓ Conservation tillage to reduce soil disturbance by farmers;
- ✓ Nutrient management plans for manure disposal/recycling;
- ✓ Technology that mixes the optimum amounts of phosphorus and nitrogen for specific crops ("Designer Manure");
- ✓ Wastewater treatment plant renovation;
- ✓ Subsidized installation of buffer fences on riparian farms;
- ✓ More efficient livestock feed conversion; and,
- ✓ Geographic Information Systems (GIS) to identify ideal locations for riparian buffers.



In a recent article on state economic policies concerning the Chesapeake Bay, a recent study has found that "every public dollar spent on implementing the practices (of restoring the Bay) will produce \$1.56 in new economic activity,"<sup>6</sup> what economists call a positive multiplier effect. These changes in practices come from all aspects that affect the Bay's health. In farming for example, simple changes such as "fencing cattle out of streams... reduces pollution, improves herd health, and increases weight gain by 5-10%". In the long run this is a win-win situation because there is less damage done to the Bay as well as more income for the farm and the farming industry. Furthermore, these practices would positively affect our economy directly, as the article states that "if fully implemented, the practices would generate almost 12,000 new jobs".

### Resources:

1. Virginia Department of Environmental Quality, *An Environmental History: Stories of Stewardship in Virginia*, (Richmond: DEQ), April 2008, 11.
2. Pope, C., "Chesapeake Bay cleanup seen as a model," *Seattle Post*, 11-22-2002.
3. Associated Press, "Cost of Chesapeake Bay deal worries Pa. counties," *Roanoke Times*, 3-19-2007, V-3.

4. Associated Press, “Reducing Chesapeake Bay pollution could cost \$520 million,” *Roanoke Times*, 1-3-2004, VA-4.
5. Aizenman, N.C., “Crab Processors Await Decision on Guest Worker Visas,” *Washington Post*, 10-13-2007, B01.
6. Young, D., “Saving the Chesapeake Bay: Restoring the Future,” *Virginia Tech Magazine*, 32(4): 14-17, Summer 2010.
7. <http://www.ers.usda.gov/publications/aer782/aer782c.pdf> - comparing options for addressing NPS solutions. Nonpoint-Source Policy Goals: Cost-Effectiveness.
8. <http://www.edf.org/article.cfm?ContentID=2015> – article on NPS and the problem along with Economic Incentives and a Performance Goal.
9. Niemerski, M., “Conservation Cuts a Blow To Bay,” *The Roanoke Times*, Thursday June 23, 2011.

## Activity

### TMDL Role Play

To establish a system of controlling pollution in the Chesapeake Bay the Environmental Protection Agency (EPA) came up with a set amount of waste that an area of water can withstand and still meet the set standards. This is known as a “Total Maximum Daily Load” or TMDL. Officials qualify and quantify pollution loading from identified sources. Once they complete that task, they can establish source load allocations that, if met, may result in standard achievement. A TMDL study incorporates both ...



1. point sources, such as municipal or industrial discharges, and
2. nonpoint sources, such as residential, urban or agricultural activities.

The TMDL study serves as a starting point for developing a TMDL Implementation Plan, which includes a set of specific strategies for achieving load reductions. Ideally, many stakeholders (including most importantly local, directly affected parties) participate in a negotiation and consensus building process generally lead by the responsible state agency that results in this set of strategies. In order to gain a better understanding of these practices let's put them to good use!

**Scenario:** The Casey watershed is located in Williams County, the northern end of Apple Valley. The Casey flows north into the Espie River, which empties into Crab Bay. The watershed includes Taylor City. Officials classify approximately 25% of its land uses as urban. The remainder of the watershed is split between agricultural (43%) and forested (32%) lands.



The Virginia Department of Natural Resources (DNR) lists Casey Creek as impaired due to fecal coliform bacteria and benthic/biological impairments. Failed or poorly maintained septic systems, cattle in streams, absence of riparian buffers and overuse of fertilizers and pesticides by urban and suburban homeowners have all been identified as sources of impairment. Over the course of the past few years, state and federal officials in cooperation with a diverse array of partners and local interests, have written a TMDL to cover the impaired section of the Casey Creek.

The EPA has approved the Casey Creek TMDL for the Virginia (VA) part of Casey creek. The Plan addresses benthic and bacterial impairments. The Plan details estimated costs of the minimum changes that will lead to sufficient load reductions to achieve water quality goals:

Reduction Strategy	Cost
Reduction in septic system failures/maintenance	\$90,000 (30 estimated systems – 15 in City)
Fencing to keep cattle from streams – 10 miles in County	10 miles (52,800 feet) X \$2.50/foot installation cost for three-strand poly-wire hot = \$132,000
Tree planting for riparian buffers – 15 miles in areas not covered by fencing (11 in City)	\$75,000 (plant cost only) \$95,000 (labor – 9,500 hours @ \$10/hr.)
Water quality monitoring program	\$15,000 (equipment) \$25,000/year (part-time coordinator, monitoring and lab costs)

Now that the EPA has approved the TMDL for Casey Creek, DNR must now develop an Implementation Plan (IP) that identifies corrective actions and lays out how the community will implement these to achieve Water Quality Standards in the impaired segment. The IP should identify tools available to help address the impairments: direct funding through cost-share programs, regulations for zoning and other land use controls and voluntary incentives such as tax credits and easements. In a typical TMDL, negotiation stakeholders will have different opinions regarding which strategies they should employ in the watershed. Often a daunting process leads to a final agreement on the right mix of tools for getting the job done.

In the Casey Creek effort, there has been opposition to the IP throughout the watershed. DNR recognizes the importance of public participation in creating such a plan. The DNR TMDL Program Manager has convened a focus group committee of key stakeholders representing the complex and conflicting interests in the watershed in the hope that the group can find a middle ground. The group challenge is to propose a strategy that DNR can incorporate into the final IP. A state-funded program could allocate up to \$200,000 over five years. Officials may spend the money for fencing, planting of riparian buffers, septic system repair, monitoring, or education. Funding agencies are likely to approve the full amount if a strong consensus emerges among the group about how they will spend the money to meet load allocations.

#### **Players:**

**(Source: IEN @ UVA)**

- Conventional farmer
- County planner
- City planner
- Department of Natural Resources staff – TMDL Program Manager(s)
- High school teacher and parent
- Farm Bureau staff
- Organic farmer
- Representative of Friends of the Casey Watershed



## Lesson 5

### *Can We Afford Not to Save the Bay?*

#### Description

- The lesson explores humanity's obligations to protect the Bay.

#### Objectives

- Students will view the Bay's future through three perspectives: science, philosophy and religion..

#### Materials

- Copy of the “My Roadmap to the Bay” exercise

#### SOLs Addressed

ES.11 - "Economics and public policy issues of Chesapeake Bay."

CE.13e - Students will demonstrate knowledge of the “role of property rights” in “protecting contracts and public health and safety.”

GOVT.16c - Students will demonstrate knowledge of the “government’s role in environmental issues and protecting property rights.”

EPF.8b - Students will demonstrate knowledge of the government's role in protecting property rights."

### *Top 10 Reasons Why We Must Save the Bay*

The Bay's:

- ✓ Fish and crabs feed families across the nation;
- ✓ Oysters and menhaden filter its water;
- ✓ Wildlife contributes to biodiversity on earth;
- ✓ Waves sequester carbon and moderate climatic extremes;
- ✓ Scenery inspires aesthetic hearts and poetic minds;
- ✓ Shores beautify neighborhoods and enrich property values;
- ✓ Industries provide people employment and cultural identity;
- ✓ Shipping lanes supply consumer goods to millions of citizens;



- ✓ Resources teach youth environmental lessons and host tourists;
- ✓ Linkages embrace past, present and future generations.

*Bay Jay asks: If the Bay dies, what does that say about us as human beings?*



Change any of the checkmarks above to an X and consider the consequences. Change enough of the checkmarks and – *at some tipping point* – the whole system collapses ... life as we know it would be irreversibly altered. Though some creatures would survive and even prosper, many others would suffer or perish.



*Penny Smart is concerned: What changes would our economy go through if we no longer had the resources or outputs of the Bay?*

As for humans, the opportunity costs of losing the Bay are enormous. Not only would we suffer tangible losses to our daily quality of life, we would diminish our moral souls as shepherds of the sea and stewards of its shores.

*SOL-O-Man wonders: How would our country's international trade market be affected if the Bay was no longer usable?*



## The Ultimate Opportunity Cost



The Chesapeake Bay represents one of the most important concepts in economics - Opportunity Costs (CE.11a) - what would we (current and future generations) lose if the Bay becomes unsustainable? Loss of the Bay would hurt consumers of its products (GOVT.15c) and Virginia's ability to prosper in the global economy (CE.12d). In their role of providing "services that individuals and businesses acting alone cannot provide efficiently" (CE.13b & GOVT.16b), the state (CE.7c) and local (CE.8a) levels of government have critical obligations to protect the Bay, while respecting "property rights" (CE.13e, GOVT.16c, EPF.8b). In *Saving the Bay with Dollars and Sense*, it is crucial that all stakeholders actively participate in the search for solutions in developing wise public policies (GOVT.9c & GOVT.9e).

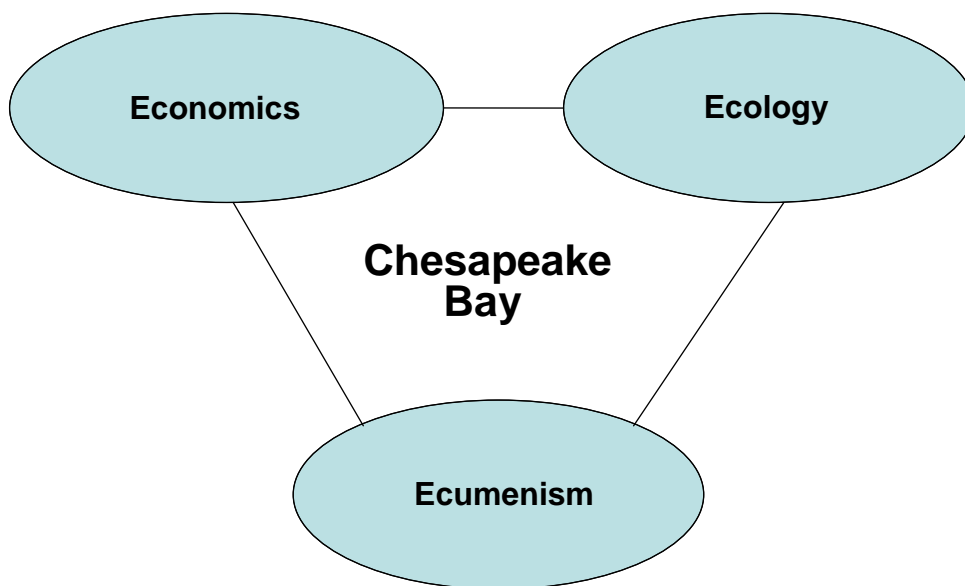


## Fixing or Facing a Broken House

We can view the Bay through the perspectives of science, philosophy and/or theology (Figures A, B, C). The Bay can be viewed as a three-legged home in which all three dimensions must be managed in harmony or else the house becomes dysfunctional and faces collapse.

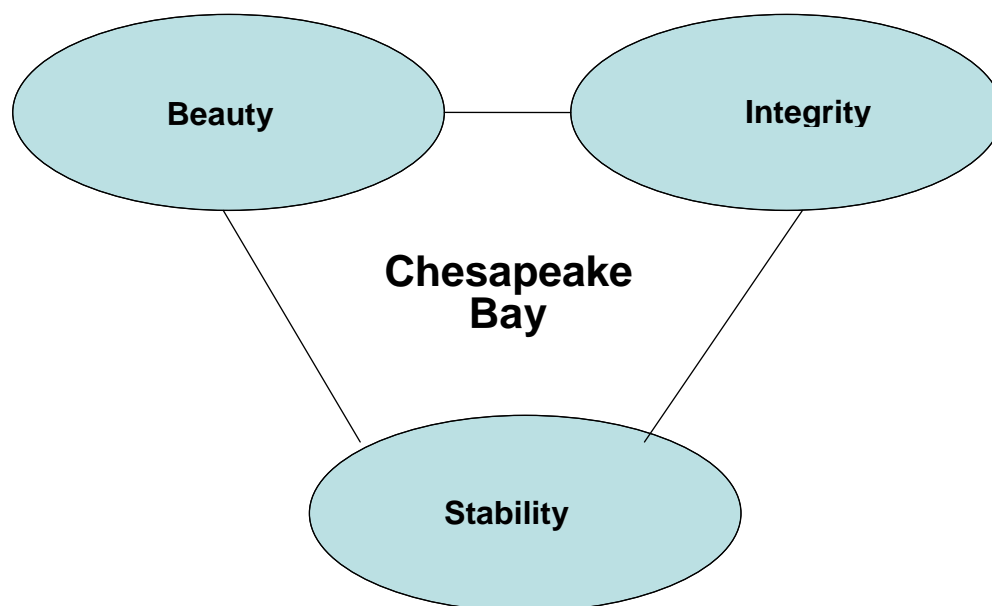
Rooted in the ancient Greek notion of an *Oikos* (house), the scientific disciplines of Economics, Ecology and Ecumenism represent the Social, Natural and Philosophic Sciences, respectively. Metaphorically and tangibly, we must pay the bills, clean up the pollution, and work together across cultural and social lines if the Bay is to survive and prosper. Otherwise, the system suffers, including everyone and everything related to the Bay.

**Figure A - Environmental Science Model**



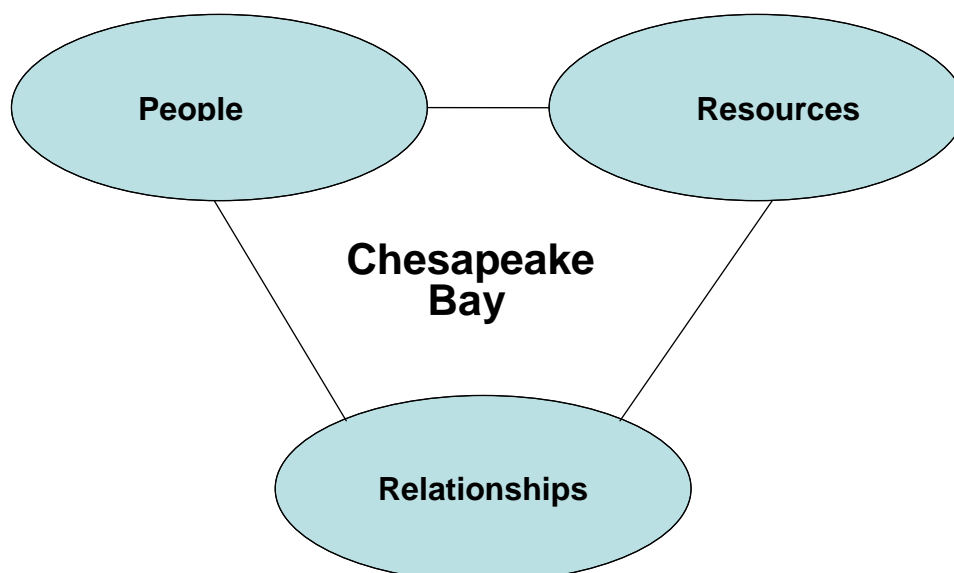
The famous environmental philosopher Aldo Leopold (*Sand County Almanac*) passionately and eloquently advocated respecting and protecting the beauty, integrity and stability of ecosystems. Riding on an earthly ark, humans are both curator and sojourner in this collective adventure. Otherwise, we fail in our leadership role as stewards of nature.

**Figure B - Environmental Philosophy Model**



In a paradigm of theology, God's kingdom on earth is the home we are given to manage with love. Jewish, Christian and Islamic scriptures repeatedly refer to humanity's behavior regarding people, resources and relationships in the *Oikumene*. Buddhism, Hinduism and Zoroastrianism also place deep emphasis on humans living with a fundamental reverence for each other and nature, as do atheism and agnosticism. Otherwise, we violate our obligation to nurture this sacred gift for future generations.

**Figure C - Environmental Theology Model**



## In Conclusion ...

To address the challenge with wisdom and reason, voices in science, philosophy and religion urge us to sustain the Bay with dollars and sense. Indeed, some elected officials agree. At a recent meeting of the EPA with Chesapeake Bay Watershed Governors and Mayor of DC, Maryland Gov. Martin O'Malley urged (*The Roanoke Times*, 7-16-11, p. 8) his peers to not lose sight of the big picture:

*"Cleaning up the Bay is expensive...letting her die is even more expensive, and we're not going to allow that to happen."*



## *My Roadmap to the Bay!*

### Assignment

Through this curriculum we have all come to learn how important the Bay and its diverse ecosystems are to our planet. We have also explored the Bay's linkages to businesses and how its emotional appeal impacts our consciousness as citizens of its watershed.

Now let's examine what the Bay means to each of us as individuals. Below, draw a flow chart (or roadmap) starting with YOU and making the Chesapeake Bay your final destination. Let each step along your roadmap identify a specific link -- positive or negative -- to the Bay (e.g., seafood market, bait shop, home/ golf course fertilizer, waste water treatment plant). Let's see how many links it takes!

***YOU***

***BAY***

Next, suggest affordable changes in their behavior that each of your links could make to reduce their impact on the Bay today! Write these solutions on your roadmap ... on your journey to the future.