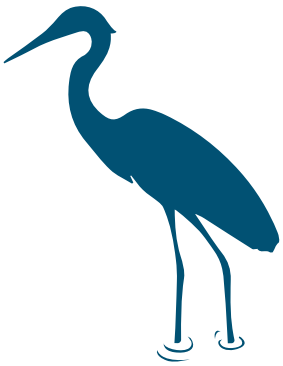
EXPLORING TAMPA BAY



A TEACHERS GUIDE TO
Florida's Largest Estuary

TBEP
TAMPA BAY ESTUARY PROGRAM
PARTNERSHIP FOR A HEALTHY BAY

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ABOUT THE TAMPA BAY TEACHERS GUIDE

From the freshwater streams of the Hillsborough River to the salty mouth of the Gulf of Mexico, Tampa Bay provides a rich mosaic of underwater and coastal **habitats** that harbor hundreds of species of fish and wildlife. Its beauty, bounty, and economic importance make preserving the Bay in everyone's best interest.

Tampa Bay was recognized as an "estuary of national significance" in 1990 by President George H. W. Bush. The Tampa Bay National Estuary Program was established in l991 to assist the region in developing a comprehensive plan for bay restoration. The Program is a partnership of EPA; the state of Florida; the Southwest Florida Water Management District; the Bay's three surrounding counties and its three largest Cities—working together with hundreds of area scientists and citizens. In 1996, the NEP released Charting the Course, a community blueprint for bay restoration capping five years of scientific research into the Bay's most pressing problems and strategies to address them. Implementation of the Bay master plan began in l997. Since then the plan has been revised every 10 years, the most current 2017 plan is now being implemented.

Your kids can help create a bright future for Tampa Bay by learning about this estuarine waterworld, how people use and affect the bay, and how they can give the bay a hand by becoming more aware and involved.

The Teachers Guide to Tampa Bay is designed to assist teachers and parents in this effort. The guide was originally produced by the Tampa Bay National Estuary Program (NEP) and the Tampa Tribune's Newspaper in Education program for students in grades 6-8 as a companion to the NEP's special 12 page newstab, Charting the Course for Tampa Bay. The Tampa Bay Estuary Program has recently updated this guide to reflect the 2017 revision of Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay.

Each of the six units features information and fast facts, brain teasers to test student's Bay IQ, and learning activities. Resources and a glossary for kids also are provided. The curriculum concludes with ideas on ways to give the Bay a hand.

THE ESTUARINE MACHINE
Teacher Introduction

TAMPA BAY WATERSHED

SIZE: 2,200 Square Miles

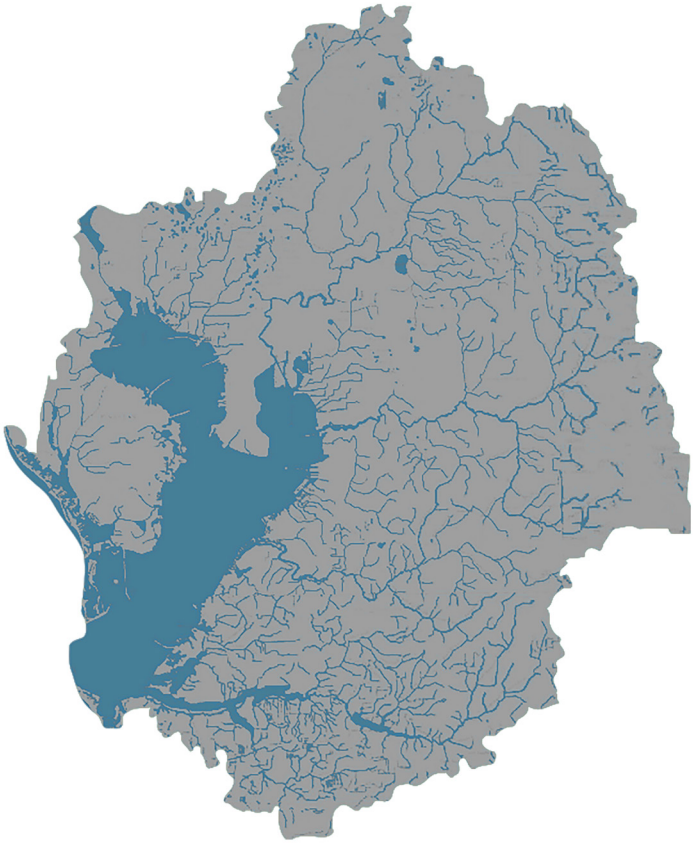
COUNTIES: Hillsborough, Manatee, Pinellas, Pasco, Polk, and Sarasota

AVERAGE DEPTH: 11 Feet

MAXIMUM DEPTH: 43 Feet (Main Shipping Channel)

SALINITY RANGE: 20-35 parts per thousand in Bay proper; 1-25 parts per thousand in Tidal Tributaries

MAJOR TRIBUTARIES: Hillsborough, Alafia, Little Manatee, and Manatee Rivers

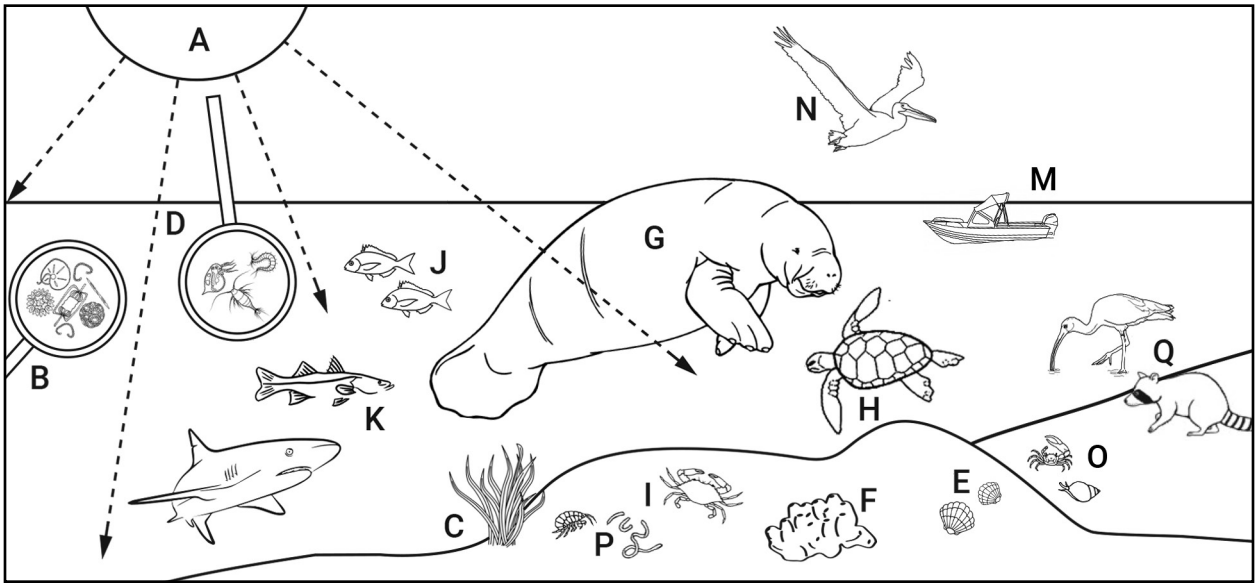


Introduce your students to Tampa Bay by having them read the timeline entitled A History of Tampa Bay on page 6 of the 2017 revision of Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay. Discuss with them the history of the Bay and the water quality improvements that have occurred in recent years. You also may wish to ask the students what Tampa Bay means to them and ask them to list ways in which they use or benefit from the Bay.

Unit 1 provides basic information about Tampa Bay, and previews topics to come, emphasizing major problems facing the Bay. The section explores the definition and function of **estuaries**, along with the concept of a Bay that extends far beyond its obvious borders to encompass the streams, **wetlands** and other landscapes of the Bay's sprawling **watershed**. The Bay's intricate and interconnected food web also is introduced in this unit.

An excellent way to begin your classroom's explorations of Tampa Bay is to encourage students to survey people about their perceptions of the Bay, using the Bay Views activity at the end of this unit.

THE ESTUARINE MACHINE



Tampa Bay's food web provides a "who eats who" perspective of the **ecosystem**. But in reality, it is far more complex. The marine food web, as its name implies, travels in various directions, bound together by common, interdependent threads. Impacts to any part of the food web affect the health of the whole.

- The bay's food web begins with sunlight (A), which penetrates through the water column.
- The sun's energy is absorbed by my one-celled organisms called **phytoplankton**, (B) microscopic **algae** that are the most prolific plants in the bay. Light also is absorbed by **seagrasses** (C) and other underwater plants. There are 270 spaces of phytoplankton in Tampa Bay, and a single quart of Bay water may contain as many as 1 million of these minuscule creatures, which give the water its greenish cast. By comparison, the Bay harbors only four major seagrass species.
- Small grazing animals called **zooplankton** (D) and larger bottom-dwelling filter feeders form the next thread in the web. Filter feeders such as the bay scallop (E) and the sea squirt (F) are a prime cleaning service for the bay, siphoning in water containing phytoplankton, skimming off the tiny plants, and discharging clear water. Larger herbivores, such as manatees (G) and green sea turtles (H), consume bigger plants like seagrasses.
- Carnivores and omnivores (opportunistic feeders that eat plants and animals) prey on the zooplankton and the filter feeders. Small carnivores such as the blue crab (I) and pinfish (J) are in turn eaten by larger carnivores such as snook, (K) redfish and trout, which are eaten by sharks (L), dolphins and humans (M). Some birds, such as pelicans (N) and cormorants, also eat the small fish and **invertebrates**.
- When plants and animals die, their remains sustain another thread in the web, the scavengers. Some of these, such as fiddler crabs (O) and snails, live in burrows along the shoreline. Others, like worms and shrimp (P), dwell in the muds at the bottom of the bay. The muds of the shore and bay bottom may look barren to a casual observer, but they teem with life.
- The scavengers begin another circle of life, providing food for a variety of shorebirds(Q) such as the white ibis and the roseate spoonbill, which frequent the bays shallows. Small mammals such as raccoons also prey on crabs and snails.

Scientists also assess the Bay's health by measuring other components, Because fish and plants need oxygen just like us, the amount of dissolved oxygen in the water provides valuable information about the Bay's ability to support life. Measuring how acidic the water is, or its "pH" also provides clues about what kinds of creatures can survive in the Bay.

Salinity, or the amount of salt in the water, is another important test of the Bay's health. The range of salinity in estuaries such as Tampa Bay provides many places for fish and other animals to live in and reproduce Some Bay animals need salty water at some stages of their life, and fresh water at other times. Very few animals spend their entire lives in one salinity.

FAST FACT: More than 200 species of fish are found within Tampa Bay.

BRAIN—TEASERS

Where would you expect the Bay to be most salty? Least salty?

How could rainfall affect salinity in the Bay?

Why is sunlight called "the engine that fuels the food web?"

ACTIVITY 1: BAY VIEWS

Teacher Instructions

Objective: To investigate public perceptions of the health of Tampa Bay.
Activity: Students conduct a survey of neighbors to ascertain how they feel about the Bay, and analyze their results as a class.
Materials: Pencils, Paper, Calculators (optional)
Subjects: Math, Social Studies
Duration: 2 hours (1 hour to prepare surveys and 1 hour to analyze results)
Procedure:

1. From reading the article in the companion tabloid and the introductory materials for Unit 1, students may begin to realize that their perceptions of the Bay may not be accurate. To investigate the concept of perceptions as they apply to the Bay and our interaction with it, instruct the students to create a survey that explores how people feel about the Bay. As the students progress through the curriculum and their knowledge of the Bay increases, they can see how the survey responses reflect the broader view the community holds of Tampa Bay, and compare and contrast those views With the information students have learned about the Bay.

In addition, a survey provides integrated lessons in social studies, language and math. By designing their own surveys, students will learn the important link between opinion polls that affect political decisions, they also will learn that the language used in the survey can influence the answers they receive. When the surveys are complete, they can calculate and graph the percentage of responses that fall within a certain category.

2. Divide the students into cooperative learning groups to develop their own questions. Make sure your students are familiar with the format of a survey; types of survey questions (open ended or multiple choice); and what makes a good survey question. To get them started, you may wish to give them one or two general survey questions that must be included in all the surveys, such as: ”Do you think the Bay is more polluted, less polluted or about the same as it was 25 years ago?” or “What do you think is the biggest problem facing Tampa Bay?”

3. Each student should be required to survey at least l0 people, and no more than one family member, help them decide how they will distribute the survey. Will they go door-to-door, or conduct the survey by phone or internet? If they choose a neighborhood door-to-door survey, make sure they do it safely by taking a parent or another adult with them.

4. When the surveys have been completed, ask each group to tabulate the responses received and report their results, in percentages, to the rest of the class. You also may wish to ask the students to write a short 3- or 4-paragraph summary of their results to inform their classmates of What they discovered.

TIP: At the end of the entire teaching unit, you may want to review the surveys again and have students discuss whether they agree or disagree with the responses based on what they have learned.

ACTIVITY 2: WHAT'S YOUR WATERSHED ADDRESS?

Teacher Instructions

Objective: To understand the connections linking our homes, schools and communities with Tampa Bay.

Activity: Students Will use a map of Tampa Bay to trace their connection to the Bay through streams. They Will locate the tributaries closest to their home and school, and calculate how long it would take them to travel by canoe down the nearest stream to the Bay..

Materials: Maps, colored markers or grease pencils

Subjects: Math, Science, Social Studies

Duration: 1 hour

Procedure:

1. introduce the concept of a **watershed**. Your students should understand that gravity causes water to move over land into creeks and streams that eventually empty into bays and oceans. Tampa Bay's watershed is almost six times larger (at 2,200 square miles) than the Bay itself. This watershed is composed of four major rivers and more than 150 smaller streams.

2. Have students read the informational text on watersheds and ask them to answer question 1 individually.

3. Divide students into cooperative learning groups to answer questions 2—5.

WHAT'S YOUR WATERSHED ADDRESS?

When someone asks you where you live, you usually give them your street address. Sometimes you might describe your home as being near some other landmark, such as a church, or shopping mall, or highway. But you also have another address that describes where we you live in relation to Tampa Bay. Use the Tampa Bay Water Atlas to find your "watershed address." In this exercise, you'll discover what your **watershed** address is and investigate how your community is physically linked to the Bay.

1. Review What you have learned about the Bay and its watershed. List three ways that you think you are connected to the Bay.

2. Use the locate me button on the Water Atlas to see where you are located. Now identify the waterway (stream, river, or the bay itself) that is closest to you. What is the name of the waterway nearest to you?

3. Most of us live closer to a stream that we realize. To find out if this is true for you, use the "near me" tab next to the map to find the distance from you to the nearest water resource. Assuming that it takes the average person 20 minutes to walk one mile, how long would it take you to walk to water? Is this closer or farther away than you thought it would be?

4. Before cars were invented people often used streams and rivers to get from one place to another. Imagine that you are traveling in a canoe down the waterway closest to you. Find the route you would follow to reach Tampa Bay. Use the "topographic" layer and list some landmarks (towns, highways, parks, etc.) you would pass on your way to the Bay.

True Colors

The first unit explores why Tampa Bay's shallow waters make it vulnerable to pollution since shallow water is less able to dilute contaminants than deep water. To help understand the concept of dilution, you can perform a simple experiment using green food dye and several containers of varying sizes filled with water. Add three drops of food dye to each container and stir the water. The container with the most water should be the lightest in color, since large quantities are better able to dilute the food dye. You can see that shallow waterways such as Tampa Bay are less able to assimilate pollutants.

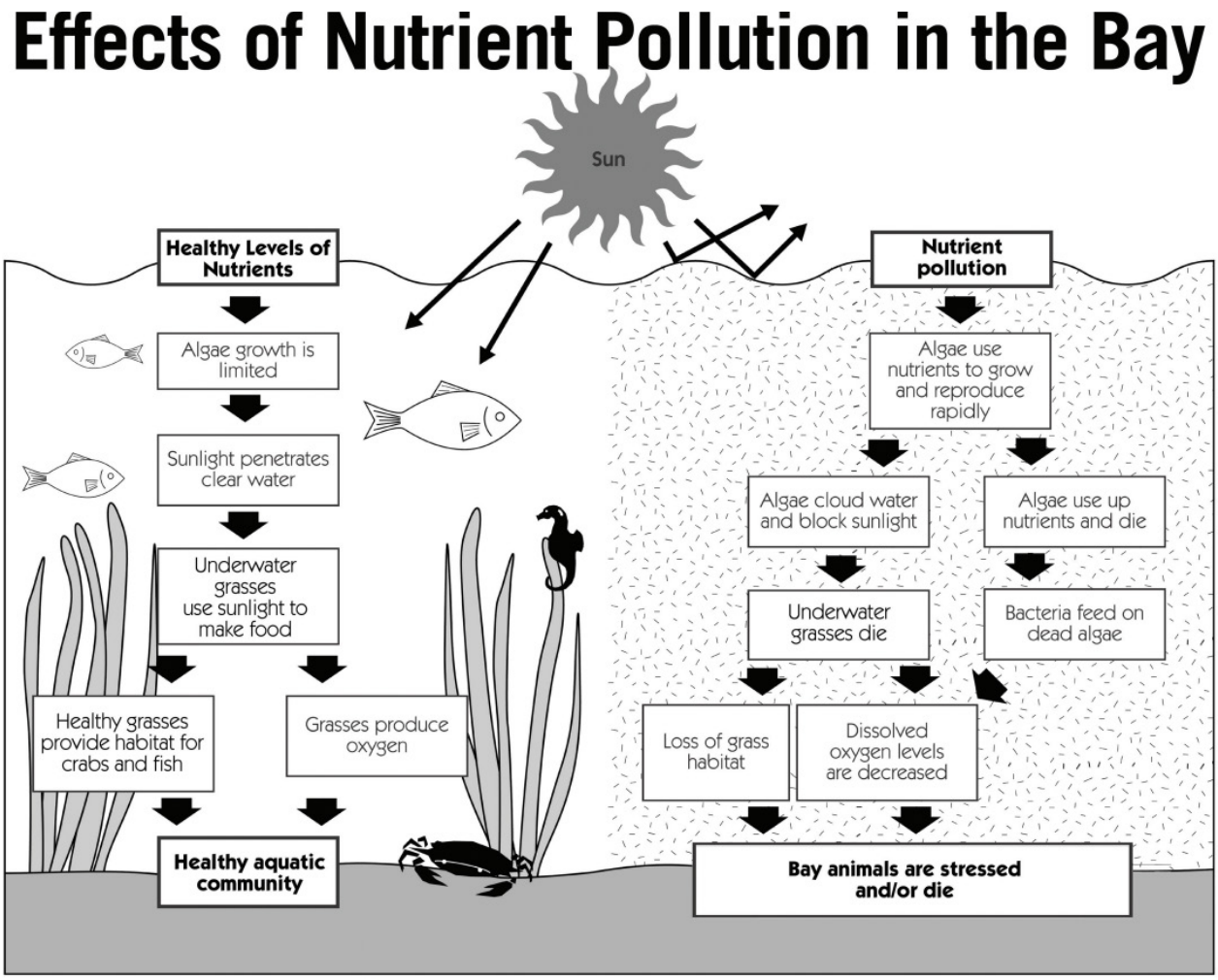
RESEARCH EXTENSIONS

1. Estuaries are near-shore bodies of water where fresh water and salt water mix. Write a paragraph explaining why estuaries are such a valuable natural resource. Search online for a newspaper or encyclopedia article mentioning another kind of water habitat. Read the article and explain to the class why you think this habitat is important.

2. A **watershed** is a collection site for all the water in an area. Look around your yard. Is there an area where water collects? Do you have a watershed? What does it look like? What paths does water take to get to the watershed? Search online for a newspaper article about activities that may affect your water. Why do you think those activities may harm your water?

3. Search online for newspaper articles about different kinds of pollution or environmental problems and arrange them in categories in a journal or notebook. Some categories might be noise, air, water, and solid waste. How are the categories connected to each other? How might one type of pollution affect more than one natural resource?

KEEPING THE BAY ON A HEALTHY DIET
Teacher Introduction



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Two of Tampa Bay's greatest problems are excess nitrogen and **toxic** contaminants. Excess nitrogen enters the Bay in **stormwater runoff**, treated sewage and through the air (this pathway is explored more fully in the following unit). In this section, students Will investigate the sources of excess nitrogen and toxic contaminants and the ways in which these pollutants reach the Bay. Students also will learn the effects these pollutants have on the Bay's water quality and animals, and understand ways in which they can reduce their own contribution to these problems.

Information on these topics are located on pages 14-30 of Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay. Students may read these pages at any stage of this unit.

KEEPING THE BAY ON A HEALTHY DIET

As we learned in the first unit, rain that falls within the Tampa Bay **watershed** can either run off the surface of the land or be absorbed by it. Water that washes off the land is picked up by streams and carried to the Bay. The type of land that rain encounters determines whether it becomes groundwater or runoff.

When rain hits hard or impervious surfaces, such as paved roads, roofs and parking lots, it cannot soak into the ground and becomes runoff. This water, known as stormwater, may pick up many "hitchhikers" on its journey to the Bay.

Take a look around your neighborhood the next time it rains. You'll see that some of the rainfall soaks into the ground while some of it runs down driveways, off rooftops and roads and into storm sewers that eventually drain to the Bay. When rain falls very rapidly, even less is absorbed by the ground, causing erosion and flooding. What kinds of pollutants could the water in your neighborhood accumulate on its voyage to the Bay? Perhaps there is an oil stain in your driveway or parking lot. Traces of that oil might be carried to the Bay. Maybe the people in your neighborhood use fertilizer on their yards. That also may wash into the Bay, Maybe someone recently sprayed a pesticide on their flowers to kill bugs. Some of that chemical may be carried in the stormwater as well.

The runoff generated by your neighborhood may not seem like such a large amount, but multiplied by all the neighborhoods, parking lots and streets in the watershed, it poses a serious threat to the Bay's water quality.

FAST FACT: Most people believe businesses are the major sources of pollution in the Bay, but residential areas actually contribute more nitrogen to the Bay.

Stormwater runoff is known as **non-point pollution** because it comes from a variety of sources that are difficult to trace, as compared with the pollution that comes from a single, visible "point," such as a wastewater treatment plant or industrial facility. Both types of pollution contribute to one of the Bay's greatest problems — too much nitrogen.

Tampa Bay needs a balanced diet to be strong and healthy just as we do. Nitrogen is an essential part of the Bay's diet, because it helps plants grow. But just like eating too much of any one food isn't good for us, too much nitrogen isn't good for the Bay.

Nitrogen is contained in treated sewage, fertilizer and many other things that people put in the Bay directly or that reach the Bay through stormwater runoff. When too much nitrogen is "fed" to the Bay, it causes **phytoplankton**, or **algae**, to grow very rapidly. As the algae multiply, they can turn the water a green, cloudy color that prevents the sun from reaching **seagrasses**. When the algae decays, they consume oxygen needed by fish and other aquatic animals.

In past decades, excess nitrogen from sewage discharged to the Bay caused massive algae blooms that clouded the water so much seagrasses could not survive. The algae

blooms also caused periodic fish kills. Some residents who lived along the Bay in Tampa 50 years ago even complained that they couldn't dare open their windows because of the stench of the rotting **algae** and fish along the shore. Improvements in the treatment of sewage have dramatically lowered the amount of nitrogen contained in wastewater. One turning point for the Bay came when Tampa's sewage treatment plant was upgraded in 1979. The wastewater discharged from the new plant was much cleaner, and gradually the Bay became clearer and underwater **seagrasses** began to return.

But **stormwater runoff** remains a major threat to the long-term welfare of the Bay. In fact, most of the excess nitrogen in the Bay now comes from the stormwater that washes from farm fields, streets, shopping centers, and neighborhoods. in other words, it comes from all of us.

Slowing runoff helps to decrease the amount of nitrogen flowing into the Bay by thg the land a chance to absorb the water. Protecting **wetlands** and other natural landscapes also helps, since those areas work like a sponge to collect water and filter pollutants.

Besides excess nitrogen, stormwater can also carry other types of pollutants, such as chemicals and metals that are harmful to plants and animals. These pollutants are known as **toxic** contaminants. Many of the items we use in everyday life, such as paint, oil and grease, and cleaning solutions, contain toxic chemicals. Farms, industries, ports and marinas also release toxic pollutants to the Bay.

These pollutants latch on to soils, or sediments at the bottom of the Bay. They are then consumed by animals that feed along the Bay bottom, such as worms, crabs and catfish. As those animals are eaten by others, the toxic contaminants travel through the food web. The chemicals become more concentrated each time they are consumed, so that animals at the top of the web — predators like sharks and dolphins — have the greatest amounts of the pollutants in their tissues. People can consume these chemicals by eating contaminated fish, so health officials regularly test fish for sale in seafood markets and grocery stores and issue warnings if they detect harmful levels of toxic substances.

Many toxic contaminants are persistent meaning they can remain in the environment for a long time. Even chemicals that are no longer used may still be found in the Bay. A pesticide called DDT is still present in some Bay sediments, although it was banned more than 25 years ago. Lead also remains in some areas of the Bay, though it is no longer used in gasoline.

FAST FACT: One gallon of gasoline can pollute 750,000 gallons of water. One quart of oil can pollute two acres of the Bay.

Scientists have discovered that the health of some Bay creatures is being impaired by toxic contaminants. Tumors have been found on the livers of some catfish in the Bay, and the growth and reproduction of some oysters is being affected by toxic contaminants.

People can reduce the amount of nitrogen and **toxic** pollutants in the Bay by using less fertilizer or chemicals, and by disposing of chemicals properly so they do not wind up in the Bay. We also can use environmentally friendly products that don't harm the Bay.

Only about one percent of the Earth's water is fresh and available for people, plants and animals to use. is there a way to efficiently use what we have? Using the same water over and over again can really help the water shortage problem. Washing a car on a lawn or watering a plant with part of a glass of water you didn't finish, are some good examples of how water can be reused.

BRAIN—TEASERS

Name some ways fertilizers and chemicals are used in your community.

Imagine an office complex, a city park and a subdivision. Which one would generate the most stormwater runoff, and why? Give an example of a green infrastructure technique that could reduce the runoff.

Explain how a toxic contaminant can travel along the Tampa Bay food web. What plants and animals are impacted? What is their role in the web?

ACTIVITY1: DISAPPEARING RAINDROPS

Teacher Instructions

Objective: Students Will explore how different surfaces affect the flow of runoff to Tampa Bay. They will learn that some surfaces cause runoff to reach the Bay more quickly, while others slow the rate of runoff so that it can be absorbed by natural landscapes such as **wetlands**, helping to cleanse it of pollutants.

Activity: Students conduct a Simple experiment to test runoff rates by pouring beakers of water over various surfaces and timing how long it takes for the water to be absorbed by the surface. They also identify structures in their school yard that might prowde pathways for runoff to reach the Bay.

Materials: Beakers, milk jugs or other containers for holding water, stopwatch or watch with secondhand

Subjects: Math, Science, Geography

Duration: 1 hour

Procedure:

1. To help your students understand how different surfaces affect the amount of runoff from an area, have them perform a “percolation test“ in your schoolyard. Take them outside and have them pour water on different surfaces, such as grass and parking lots.

2. Instruct the students to record how long it takes for the water to disappear from these surfaces. Ask them to draw conclusions about what surfaces produce the greatest runoff.

3. Ask the students to explore the pathways rain takes through their schoolyard by identifying mechanisms for transporting water, such as gutters and storm sewers, and having the students draw a map explaining how rain moves through those pathways.

4. Ask the students to identify ways of slowing or treating **stormwater runoff** from various surfaces (i.e., swales, **wetlands**, directing gutter downspouts onto grass and away from paved surfaces)

ACTIVITY 2: POLLUTION MIX—MATCH

All the pollutants listed can be carried to the bay in **stormwater runoff**. For each pollutant, list a possible source. Most of the pollutants may have more than one source.

1. Fertilizer

Select source

2. Laundry detergent

Select source

3. Paints

Select source

4. Furniture Strippers or Varnishes

Select source

5. Batteries

Select source

6. Gasoline, oil or other fuels

Select source

7 Chlorine Bleach

Select source

8. Ammonia-based cleaning solutions

Select source

9. Roach and ant killers

Select source

lO. Anti—freeze

Select source

11. Weed killers

Select source

Answers:

1. Homes/Neighborhoods, Farms, Office Complexes, Apartments/ Condominiums

2. Homes/Neighborhoods, Apartments/Condominiums

3. Homes/Neighborhoods, Automobiles, Industrial/Manufacturing Facilities, Office Complexes, Apartments/ Condominiums

4. Homes/Neighborhoods, industrial/Manufacturing Facilities, Apartments/ Condominiums

5. Homes/Neighborhoods, Automobiles. industrial/Manufacturing Faculties, Office Complexes, Apartments/Condominiums

6. Homes/Neighborhoods, Farms, Automobiles, Industrial/Manufacturing Facilities, Office Complexes, Apartments/Condominiums

7 Homes/Neighborhoods, WastewaterTreatment Plants, industrial/Manufacturing Facilities, Office Complexes, Apartments/Condominiums

8. Homes/Neighborhoods, industrial/Manufacturing Facilities, Office Complexes, Apartments/Condominiums

9. Homes/Neighborhoods, Farms, Office Complexes, Apartments/ Condominiums

10 Homes/Neighborhoods, Farms, Office Complexes, Apartments/Condominiums

RESEARCH EXTENSIONS

1. Pollution sources have two main categories, **point** and **non-point**. Point source pollution is easy to recognize. It comes from something very directly related to it such as waste being dumped into a river. Non-point source pollution is harder to recognize. It could be stormwater carrying a variety of pollutants. Each week during the estuary program, search the internet for photographs that depict pollution sources or potential pollution problems. Copy and paste them into a document. Identify each photograph as being a point or non-point source.

3. People affect the quality of water. Search the internet for a newspaper article that talks about how a human changed, or plans to change, an area. Do you think there will be any impact on the water resource or to plants and animals? What would they be? Are there positive or negative results of the change, Perhaps there are both. What are they? Have a class discussion as to whether the positive outcomes outweigh the negative impact and why.

THE SKY IS FALLING! WHAT'S IN IT?

Teacher Introduction

Pollutants in the air can enter Tampa Bay, either by falling directly on the Bay or by failing on land within the Bay **watershed** and then entering the Bay in runoff. Scientists working with the Tampa Bay National Estuary Program have discovered that air pollution is a major source of nitrogen to the Bay — accounting for 17% of the Bay's nitrogen burden. Air emissions also may contain potentially **toxic** contaminants, such as cadmium and mercury. In this segment, students will explore the link between air quality and water quality. They will learn where air pollution comes from, how it affects the Bay, and how they can reduce pollution by conserving energy.

The companion pages for this unit are 31-34 of Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay. Students may read these pages at any stage of this unit.

THE SKY IS FALLING! WHAT'S IN IT?

In the previous unit, you learned why too much nitrogen is bad for the Bay. You also learned that the primary way in which nitrogen reaches the Bay is through **stormwater runoff**. Stormwater runoff picks up contaminants with rainfall and washes them into the Bay. What you may not know is that air pollution also can affect the Bay's health in fact, Scientists believe that exhaust from automobiles and emissions from power plants and other industrial facilities may be responsible for as much as one-third of the nitrogen entering Tampa Bay.

Scientists have long known that air pollution damages human health by affecting the respiratory system. Acids associated With air pollution can also damage buildings and monuments, including marble statues that grace the ancient Acropolis in Greece. But experts are only now beginning to understand how much air pollution can also affect the health of bays, rivers and lakes.

You may have heard the phrase, "What goes up must come down." That is because gravity pulls objects back to earth. When auto exhaust or emissions from smokestacks are released to the air, they float down to the ground, along with the pollutants they contain. The pollutants may latch on to precipitation, and fall to earth in rainfall, snow, or sleet. Or they may Simply float back to land as dry dust particles. This process is called **atmospheric deposition**.

Some air pollution falls directly onto the Bay surface, while other emissions fall on land in the Bay's **watershed** and are carried to the Bay in stormwater runoff. Since air pollution may travel hundreds of miles before settling to earth. emissions produced in the Tampa Bay area may affect other parts of the state, and pollution generated elsewhere may drift over Tampa Bay.

FAST FACT: Florida's many tourists contribute to the state having the third-highest motor gasoline demand in the nation.

A majority of that air pollution contains nitrogen oxides or NOx, an airborne form of nitrogen. Remember that nitrogen is one of the primary nutrients causing **algae** blooms, loss of **seagrasses** and oxygen depletion in the Bay. Sources of NOx include automobile and boat exhaust, and emissions from power plants and industries that burn fossil fuels like oil and coal.

FAST FACT: The residential sector consumes just over half of the electricity used in Florida, and the commercial sector accounts for most of the rest.

Air pollution also may contain **toxic** contaminants such as cadmium and mercury, that often lodge in bay sediments and can travel up the food web. Some of these toxic pollutants come from materials we throw away that are burned in garbage incinerators, or substances that we once used extensively, but have been banned for many years.

FAST FACT: Lead is still found in bay sediments, although use of leaded gasoline was phased out decades ago.

Bay managers hope to reduce the amount of air pollution entering the Bay by promoting power plant upgrades, transitioning to alternate energy sources, and supporting initiatives to reduce atmospheric nitrogen pollution from vehicles energy conservation, like carpooling and other mass transit programs and expanding the use of cleaner fuels.

BRAIN—TEASERS

1. List five ways you can reduce energy use in your home or school.

2. You use many forms of transportation. Name two forms you think are not harmful to the Bay.

ACTIVITY 1: PUTTING THE BRAKES ON AIR POLLUTION

Teacher Instructions

Activity adapted from "Driving Choices: Calculating Car Emissions," produced by the NC Air Awareness Program

Objective: To understand the potential impacts of our travel habits on water quality in Tampa Bay.

Activity: Students will calculate the amount of nutrients, in the form of NOx, produced by their weekly travels and consider ways to reduce the amount.

Materials: For each group of students: A map application, Calculators (optional)

Subjects: Math, Science, Writing, Social Studies

Duration: 1 hour class time plus additional time outside school for the students to record their daily travels

Procedure:

1. Hand out copies of the "Last Week's Travel" chart and worksheet to each student and ask them to fill in the column marked "Day of the Week." Explain to them that they will need to fill in the columns labeled "Where You Went" "How You Got There" and "Miles Traveled" each day by recording every place they travel to and what mode of transportation (which vehicle) they used to get there.

2. At the end of the week, have the students calculate how much NOx they produced as a result of their weekly travels.

3. Divide the students into smaller groups to answer question 6 on the worksheet. Group members also should discuss and develop ideas for reducing their NOx emissions. Each group should make a presentation to the class on their ideas.

ACTIVITY 1: PUTTING THE BRAKES ON AIR POLLUTION

1. Calculate how much nitrogen oxide your family's car travels produce in a week. Start by filling in the day of the week column. Keep track of where you go each day, beginning with today, and fill in the column marked "Where You Went."

2. Next fill in the column marked "How You Got There." In this column, you will write your mode of transportation, such as Mom's car or Dad's truck. Each mode of transportation contributes a different amount of nitrogen oxides, or NOx, to the air.

3. Determine the NOx emissions per mile for your family's vehicle(s). Begin by visiting www.fueleconomy.gov. Under "Find & Compare Cars," click on "Compare Side-by-Side" and enter the Year, Make, and Model for up to four cars. Click on "Compare" and choose the "Energy and Environment" tab. Select "Florida" as your "State of purchase." Make a note of the vehicle(s) EPA smog rating, a number between 1 (worst) to 10 (best) that represents the amount of airborne pollutants a vehicle emits.

4. Next you'll need to convert the EPA Smog Rating (SR) into the amount of nitrogen oxides (NOx) the car emits. Because vehicles keep getting cleaner, the scale is recalibrated every couple of years to make better use of the entire scale. Use the model year of your car to translate Smog Rating into NOx emissions. Fill in this number in the next column, "NOx Production" every time you used that car.

2010 and earlier

SR	NOx g/m
0 →	.9
1 →	.6
2 →	.3
3 →	.2
4 →	.15
5 →	.1
6 →	.07
7 →	.04
8 →	.03
9 →	.02
10 →	0

2011- 2017

SR	NOx g/m
2 →	.2
3 →	.15
4 →	.1
5 →	.07
6 →	.04
7 →	.03
8 →	.02
9 →	.02
10 →	0

2018 and later

SR	NOx g/m
1 →	.16
3 →	.125
5 →	.085
6 →	.05
7 →	.03
8 →	.02
10 →	0

4. Fill out the "Miles Traveled" column for each destination. Use the "directions" function of a map app to look up how many miles you traveled - don't forget the return trip!

5. Multiply the numbers you've written in the "NOx g/m" column by the miles traveled to fill in the final column marked "NOx Emitted." At the end of the week, add up all these numbers to find the total grams of NOx your family's travel generated during the week.

6. After you've completed this exercise, write a short explanation of how you could reduce your NOx emissions by changing your travel habits. Are there times you could bike? Could you carpool?

DAY OF THE WEEK	WHERE YOU WENT	HOW YOU GOT THERE	NOx g/m FOR CAR	MILES TRAVELED	NOx EMITTED

ACTIVITY 2: NOx DETECTIVES

Teacher Instructions

Objective: To understand the far-reaching impacts of air pollution on both people and the environment.

Activity: Students will perform mapping exercises to identify states and waterways and communities within those states that could be affected by air pollution.

Materials: Maps or Atlases of the United States, showing cities, waterways, and other features; Rulers

Subjects: Math, Geography

Duration: 1 hour

Procedure:

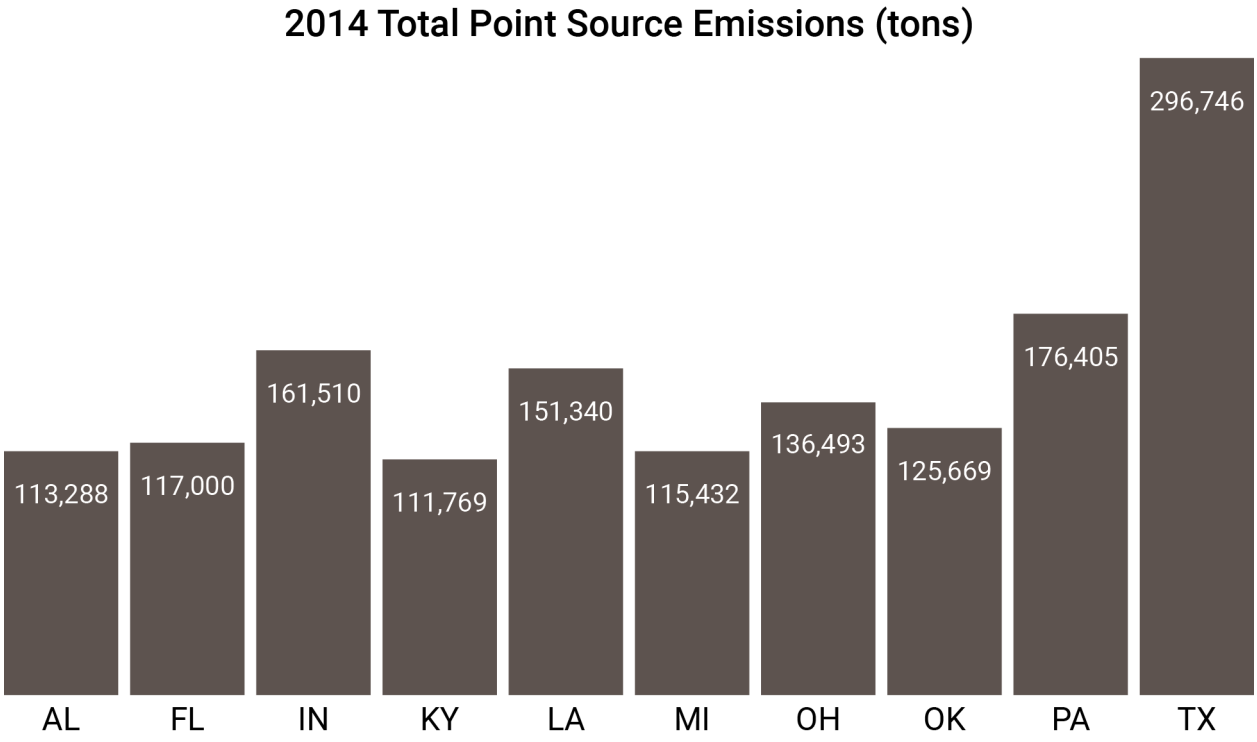
1. Hand out the worksheets to the students and divide them into smaller groups. They should work together to answer the questions and perform the exercises on their worksheets.

2. Provide them with additional maps or atlases of the United States that show cities, major highways and waterways.

3. When the students complete the exercises, have a class discussion about their responses. Encourage students to discuss why air pollution is such a problem in many areas of the country. Ask them to talk about what it would be like to live in an area with very bad air pollution. What could happen to the people in that area? What could happen to the environment?

ACTIVITY 2: NOx DETECTIVES

Not all NOx emissions come from **non-point sources** like cars. Power plants, airports, and manufacturing facilities, among others, can also emit NOx. Imagine that you are a NOx detective trying to find where NOx is hiding and what kind of environmental trouble it might cause. Use maps of the United States as clues to help you track down NOx and its possible escape routes in the 10 states with the highest **point source** NOx pollution.



I. The bar graph shows the 10 states with the largest emissions of NOx. What are those states?

2 Using maps or atlases provided by your teacher, name three waterways (bays, rivers, lakes, etc.) in each state that might be affected by NOx pollution.

3. NOx comes mainly from vehicle exhaust, power plants and industrial facilities that burn fossil fuels. Areas with large populations usually have a greater concentration of NOx emissions. Name two cities in each state that may have large amounts of NOx.

4. Assume that air pollution generated in those cities is carried on the wind lOO miles away. What waterways could be affected by the pollution from each city? Use the scale on your map of the United States to calculate the mileage.

5. Explore the emission sectors dashboard on the National Emissions Inventory Report to think about why these states have the highest NOx point source emissions. What industry is responsible for more than half of this pollution?

RESEARCH EXTENSIONS

1. Some advertisements are used to sell a product or service. Others are used to "sell" or promote a message or idea. Can you find examples of each type in the Tribune? DeSign and write an ad promoting energy conservation or carpooling as a bright idea for a cleaner bay.

2. Some busses are powered by compressed natural gas, a cleaner, less expensive fuel that reduces pollution to the air and the Bay. Investigate what kind of busses your school or city uses. Are there alternatives available that would reduce NOx emissions?

3. Find the air quality index for your location at airnow.gov and monitor it each day for a week. Is it good, moderate or unhealthy? Find out what the index measures or represents. Can weather affect air quality? How about cars and trucks? Discuss your thoughts with your teacher.

EXPLORING THE BAY'S HABITATS
Teacher Introduction

Tampa Bay contains a mosaic of **habitats** that support a mind boggling diversity of plants and animals. This section explores the major habitat types found in Tampa Bay, and reinforces the connections that bind the residents of the habitats together through the food web. The unit also explores how animals use color, behavior and other mechanisms to adapt to their surroundings.

Because so many of the Bay's habitats have been damaged by development and dredging, restoring these degraded areas is crucial to bringing Tampa Bay back to health. Bay managers are working to repair these habitats, focusing their efforts on regaining areas that have been lost in disproportionate amounts, such as tidal streams. This concept of recovering the natural ratios of the Bay's historic habitats is called "restoring the balance."

The companion pages for this unit are 65-94 of Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay. Students may read these pages at any stage of this unit.

EXPLORING THE BAY'S HABITATS

We call the places where we live neighborhoods. But the creatures that live in Tampa Bay also live in neighborhoods called **habitats**. Habitats provide the same benefits to animals that our homes do for us: food, shelter and a secure place to raise their offspring.

Animals adapt to their habitats by developing physical traits that help them obtain food and protect themselves from danger. Some animals, such as the flounder, develop color patterns that help them blend into their surroundings. Others, like the horseshoe crab, develop armor that shields the soft parts of their bodies from hungry predators. The puffer fish, a common Tampa Bay reSident, has developed the ability to blow up its body like a balloon, making it appear much bigger than it really is. The next time you are outdoors, look at the birds you see and compare the shapes and sizes of their beaks. Each beak is adapted to help the bird catch certain kinds of food in specific habitats.

FAST FACT: The horseshoe crab is not really a crab at all, but is officially a member of the spider family.

There are many kinds of habitats in Tampa Bay, from the deep waters in the middle of the Bay to tiny creeks that meander through forests and fields. Each has its one unique cast of characters, and each serves an important role in keeping Tampa Bay healthy.

In the next section, we'll explore the fascinating world of the open bay, where sharks prowl and dolphins play. But for now, we'll concentrate on the habitats found closest to the shore. These include sea grass beds, salt marshes, **mangroves**, hard bottom communities and mud flats. Marshes, mangroves, and mud flats are all examples of **wetlands** meaning they are covered with water most of the time.

Seagrasses aren't true grasses, but flowering plants that grow underwater in shallow areas of the Bay. Most seagrasses do best in water that is less than 6 feet deep, since they need sunlight to grow and the sun's rays usually cannot penetrate deep water. Seagrasses are very important as nurseries for young fish, as well as shrimp and scallops. Manatees and some sea turtles also eat seagrasses. The most common types of seagrass in Tampa Bay are turtle grass and shoal grass.

FAST FACT: An adult manatee can eat up to 200 pounds of seagrass and other plants a day. Fortunately, they don't eat the roots, so the seagrass grows right back!

Salt Marshes feature tall grasses that like to get only their feet, or root systems, wet. Their roots are covered each day with water when the tide comes in, and exposed to the air when the tide goes out. Among the marsh grasses found in Tampa Bay are smooth cordgrass and needlerush. Salt marshes also harbor a variety of creatures like fiddler crabs and are popular dining spots for many birds. Salt marshes function like our kidneys do, purifying the water and removing pollutants.

Mangroves are a special kind of tree that grows in saltwater near the edge of the Bay. Mangroves are known for their gnarled root systems, called prop roots, that resemble nubby fingers. The most common mangroves in Tampa Bay are white, red and black mangroves. All are able to tolerate their salty surroundings by "sweating" the salt out through their leaves, thus adapting to their **habitat**. Mangroves help anchor bay sediments in place to prevent erosion, and the leaves that fall from their branches into the water gradually decompose Into a rich material called **detritus** that provides food for many fish and **invertebrates**. Redfish, also known as red drum, are among the creatures that call mangrove forests home.

Mud Flats are open, muddy areas of the Bay Shoreline. Because mud flats don't have grasses or other vegetation, some people may think them barren and lifeless. But they are ideal for bottom—burrowing creatures like worms and crabs, and birds flock to them. At low tide, mud flats are often blanketed with colorful wading birds that probe the muck for tiny, protein-filled animals. One of the Bay's most important mud flats is at McKay Bay, where the City of Tampa maintains a public park with a boardwalk and observation tower for birdwatching.

Hard Bottom Communities include oyster reefs, coral reefs and other types of iivrng organisms that form large, sturdy colonies underwater, similar to a condominium. Although not nearly as common here as in the Florida Keys, Tampa Bay does have a few colorful coral and sponge colonies that have attached to rocky ledges on the Bay bottom. Most of the Bay's coral reefs are located in lower Tampa Bay, near the Sunshine Skyway Bridge, the Gandy Bridge and in Terra Ceia Bay. Oyster reefs used to be very common in the Bay, and Tampa Bay oysters were sold to restaurants as far away as New York. Fish like the sheepshead can be found among the Bay's remaining oyster reefs.

FAST FACT: Mangrove islands in Tampa Bay support the most diverse bird nesting colonies in North America, annually hosting more than 25 differrent species of birds from great blue herons and pelicans to American oystercatchers.

The more **habitats** an area has, the more animals it is likely to support. That is why estuaries like Tampa Bay are so important. The measure of the types and number of animals found in an area is known as biological diversity.

FAST FACT: Each square meter of the Bay bottom contains an average of 10,000 animals — mostly tiny burrowing worms, crustaceans and other mud-dwellers that are known as benthic invertebrates.

Some animals have different habitats at different times of the year, or at different stages in their lives. Just like we do when we go on vacation or visit relatives. Aquatic animals often move, or migrate to neighborhoods that better suit them as they grow. Snook, for instance, are born near the mouth of the Bay, but move into protected streams and salt marshes as very young fish, where they find plentiful food and safety from predators.

As the fish grow and are better able to fend for themselves. They move out into deeper waters and even the Gulf of Mexico. Just like human "snowbirds," some birds migrate from as far as Canada to spend the Winter in Tampa Bay. while many others drop in for a short time to rest and refuel during even longer winter journeys to Central and South America.

People can change **habitats** by their actions. in Tampa Bay, for instance, people once thought of marshes and mangrove forests as useless wastelands and decided they would be more valuable as subdivisions, highways, industrial complexes and farm fields. They dredged the Bay's **wetlands**, and filled them with dirt to turn them into dry land. Dams also were constructed on some rivers, interfering with the natural flow of fresh water to the Bay and causing saltwater to move inland. The dams also prevented some fish from traveling up these rivers to spawn or lay their eggs.

Many of the habitats that existed in Tampa Bay 50 years ago are now gone or have been severely altered. In many of the habitats that remain, exotic plants have moved in and elbowed out native Florida plants that provide more water quality and wildlife benefits. The most common exotic plants found along Tampa Bay are Brazilian pepper and Australian pine. Both were brought to Florida decades ago as additions to backyard landscapes, but quickly spread into natural areas where they are difficult to control.

In the last decade, people have begun to realize how important the Bay's diverse habitats are. They are now trying to give nature a helping hand by restoring areas that have been damaged. Habitat restoration usually involves scraping layers of dirt from an area so that Bay water can again flow in, and planting marsh grass or **mangroves** to give the shoreline a head—start in returning to its natural state. Brazilian pepper and other exotic plants also are removed. Restoring **seagrasses** hasn't been as easy, but luckily seagrasses are sprouting on their own in many parts of the Bay as the water becomes cleaner.

Just as a patchwork quilt is incomplete until all of its varied pieces of cloth are stitched together. Tampa Bay won't be truly healthy without the various **habitats** it once had — and without the same proportions of those habitats. Scientists have learned, for instance, that the Bay has lost more tidal **marshes** along rivers than any other type of habitat. Because these low salinity marshes and the streams they border are so important as natural day care centers for young fish, Bay managers are concentrating restoration work on replacing these habitats, so that by the time you are grown, there will be many more healthy streams. This concept is called "restoring the balance," and it is a key part of the Tampa Bay National Estuary Program's plans to repair the Bay.

Restoring the balance also means creating more of other habitats that once were plentiful around the Bay, such as mud flats, pine forests and small, freshwater "frog ponds," so that every animal inhabitant of the Bay will have a neighborhood to call its own.

BRAIN—TEASERS

1. List three examples of how fish or birds are adapted to their environment.

2 Which wetland habitat functions much like our kidneys do, filtering the water and removing pollutants? What would happen if these natural filters were removed? Can you think of other ways these wetlands protect the water and the land?

3. Tampa Bay has lost more of this type of habitat—which acts as a natural day care center for fish—than any other. Name this habitat. These habitats border the rivers feeding into the bay. How salty do think the water is here?

4. What can you do to help protect the Bay's habitats?

ACTIVITY 1: CIRCLES OF LIFE

Teacher Instructions

Objective: Students will be able to explain how the aquatic food web functions in various **habitats**, and how animals are adapted for life in that habitat.

Activity: Using a lecture, discussion, and student-gathered information, students will create their own food webs for various habitat types.

Materials: Poster paper, Colored pens or pencils, Field guides, encyclopedias and other references (The Golden Guides and National Audubon Society Guides to fish and birds are helpful)

Subjects: Science, Language

Duration: 90 minutes

Procedure:

1. Divide the class into five smaller groups and provide each with poster paper and colored pens or pencils. Assign one of the habitats discussed in this unit to each group.

2. Using the Tampa Bay food web presented in Unit 1 as an example, ask each group to develop its own food web, or circle of life, for their particular habitat. Students may use some of the animals mentioned in the habitat descriptions, but also must incorporate different animals that they select by consulting field guides, encyclopedias or other resources. Since some animals are found in more than one habitat, it is likely that some of the food webs may feature the same animals, such as shrimp or crabs.

3 The groups should be able to explain to their classmates how their food web functions, and why the animals they have selected are adapted to their particular habitat. The entire class can discuss what animals might be found in more than one food web, and what elements each food web has in common.

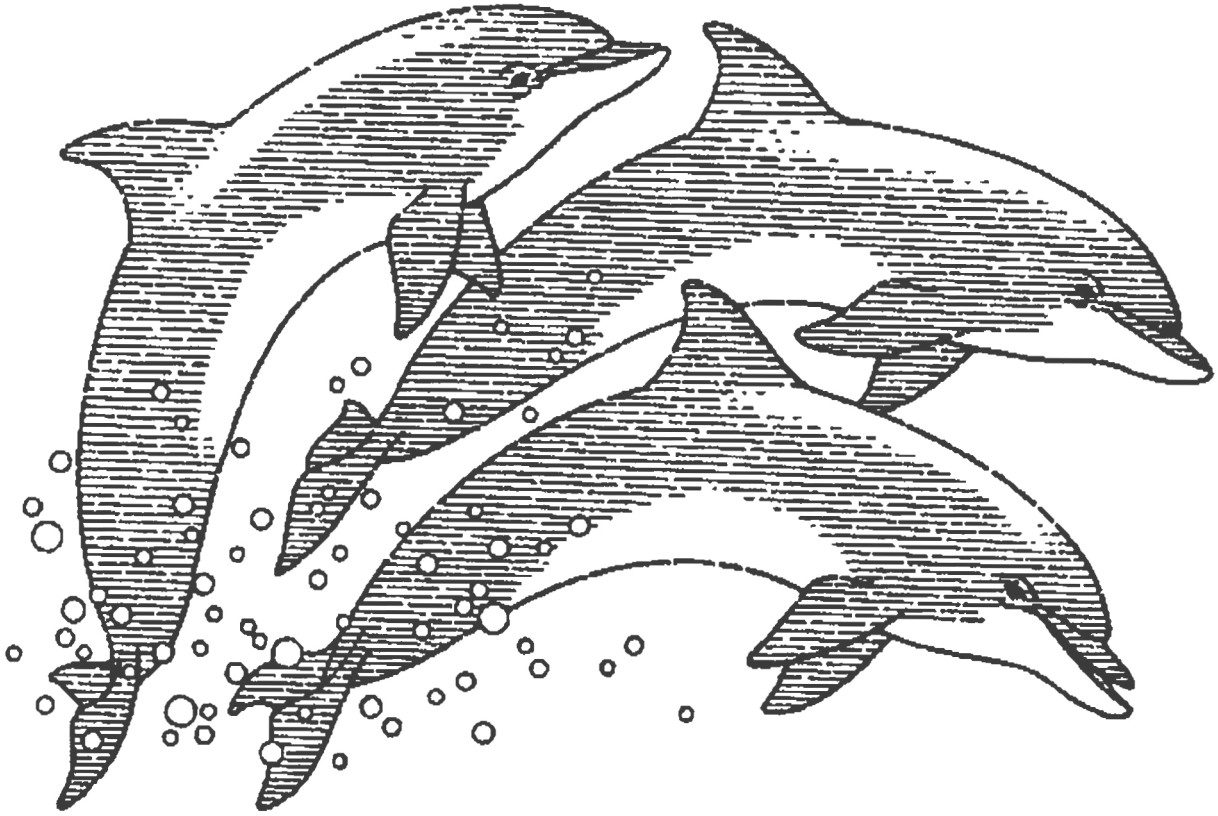
RESEARCH EXTENSIONS

1. Habitats provide animals with food, shelter and a place to live. Look for examples of things online that you and your family need to exist in your community. For example, articles about agriculture and food production, water resources, or housing might be included.

2. Write your own "Help Wanted" classified ad describing the habitat requirements for an animal, such as a manatee, pelican, or scallop, that lives in or near the bay. Research the habitat requirements for the creature you select to write an effective and creative ad.

3. Animals adapt to their environment by developing physical characteristics that help them obtain food or hide from predators. Look online for an article or picture that describes how someone has "adapted" to their environment or situation. For example, a wheelchair is used by people who cannot walk.

DENIZENS OF THE DEEP
Teacher Introduction



This unit explores the deeper, open waters of the Bay, which support their own unique collection of inhabitants. Since few plants can grow in the Bay's deep zones where sunlight does not penetrate, plants in this area generally are confined to floating, microscopic species of **phytoplankton**. With few plants to eat or hide in, mobility is important to animals residing in the Bay's deep areas, especially since the Bay's greatest predators, such as sharks, also live here. How animals get around — to escape from these predators or to find food or places to reproduce — also is investigated in this unit.

This unit also discusses the amazing ability of aquatic organisms to take advantage of their surroundings by colonizing virtually any stationary object placed in the water — including docks, bridge pilings and artificial reefs especially constructed to attract fish and other Bay creatures.

The companion pages for this unit are 95-110 of Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay. Students may read these pages at any stage of this unit.

DENIZENS OF THE DEEP

Now that we've learned about **habitats** that thrive in the shallow waters near the Bay's shores, we're ready to wade deeper into Tampa Bay.

Deep is a relative term in Tampa Bay, since the Bay averages only about l2 feet in depth. In comparison, the Gulf of Mexico is an average of 5,000 feet deep and the Atlantic Ocean about 13,000 feet deep. The deepest parts of Tampa Bay are the man made shipping channels that allow huge ships from all over the world to travel to and from Bay ports without running aground. The main shipping channel in Tampa Bay is 43 feet deep, the equivalent of a 4-story building on land.

"Deep" waters are called pelagic zones. Tampa Bay's pelagic zones are generally those that are more than 6 feet deep. In shallower waters, sunlight can reach the Bay bottom to nourish **seagrasses**. But the sun's rays cannot penetrate deeper waters, so plants in the open Bay consist primarily of microscopic **phytoplankton** that float on or near the surface where photosynthesis can occur. Some of these tiny plants, such as diatoms, drift aimlessly with the current, while others, like dinoflagellates can control their destiny to some extent by moving whiplike threads which trail from their body. People have come to know dinoflagellates mainly for two reasons. The first is because they are the organisms that cause the surface of bays and oceans to glow with light at night. This eerie blue or yellow—green light, called bioluminescence is a byproduct of the photosynthesis that dinoflagellates employ to convert the sun's energy into food. Dinoflagellates also are responsible for outbreaks of red tide occuring when environmental conditions cause them to reproduce in very large numbers. The masses of dinoflagellates release toxins that turn the water a reddish—brown shade and kill fish and other marine life. Red tides also irritate human respiratory systems.

Diatoms and dinoflagellates are eaten by tiny vegetarians called **zooplankton** which are eaten. in turn, by mud dwellers like worms, that create intricate burrows beneath Tampa Bay, and **crustaceans** like the brown shrimp, which must shed its hard shell as it grows.

FAST FACT: It takes 657 million individual diatoms to produce 1 gram of dry organic matter.

Sharing these same waters are some of Tampa Bay's largest inhabitants, making the pelagic areas of the Bay truly a world of extremes. Powerful hunters like blacktip sharks roam these dark valleys, along with sleek and playful bottlenose dolphins who delight in riding the bow wakes of passing sailboats and ships. Small, silvery baitfish like herring and menhaden form large schools that dart about in choreographed unity, seeking safety in numbers. Graceful manta rays and spotted eagle rays ply this deep zone too, gliding past fragile, transparent jellyfish at the mercy of winds and currents.

FAST FACT: A shark's sense of smell is so well-developed that it can zero in on a wounded fish from a quartermile away. There are 5 common species of sharks in Tampa Bay.

Like human mariners, many of the Bay's creatures use these open waters as a nautical highway on their travels to and from feeding or breeding grounds. Blue crabs scuttle and swim across the Bay, while newly hatched tarpon larvae must complete a perilous journey from the Gulf of Mexico to reach freshwater streams in the Bay's **watershed** where they spend the first year of their life.

Manatees also use Tampa Bay's deep—water interstates to reach seagrass feeding areas close to shore, using the same routes over and over again, and passing on their knowledge of these road maps from one generation to another.

With few plants, oyster bars or other places to hide, survival in the deep zone often depends on an animal's ability to escape from danger. Thus, the residents of the Bay's deep realm must be either very fast, equipped with powerful weapons such as sharp teeth or Stingers, or able to make themselves invisible to would-be predators.

FAST FACT: Dolphins communicate using clicks, squeaks and whistles. Each dolphin has its own unique signature or whistle, readily identified by other dolphins in its "pod" or family group.

Because of the perpetual housing shortage, deep zone inhabitants have taken advantage of the shelter afforded by bridges and other man made structures. An entire community of animals has colonized the pilings of the Sunshine Skyway Bridge and set up house among sunken boats and discarded automobiles In fact, marine creatures have an amazing ability to take over just about anything With a hard surface they can cling to or conceal themselves in.

Recognizing this fact, fishing clubs and government agencies have deliberately placed structures in the water to attract fish, crabs and other creatures. Tampa Bay has 8 artificial reefs mostly made from old tires, shipwrecks and construction rubble arranged in a pyramid shape. Scientists report that blue crabs and barnacles move into these man made reefs within a week of their installation. Within four months, large colonies of tunicates or sea squirts, appear, along with juvenile sheepshead, mangrove snapper and Atlantic spadefish. The abundance of fish at these reefs in turn attracts hundreds of area fishermen and divers.

FAST FACT: Artificial reefs in Tampa Bay may harbor as many as 40 different species of fish.

Getting Around

Aquatic animals employ a variety of techniques to move themselves through the water so they can flee from predators, capture food or find mates and reproduce. These are some of the ways Bay creatures "get around."

WALKERS

Lobsters, crabs, and shrimp use four of their five pairs of jointed limbs to walk about on the ocean or Bay floor, picking up the dead plants and animals they eat with their fifth pair of limbs. While this plodding gait serves their feeding needs well, it is not fast enough to get them out of danger. So when speed is of the essence, they scoot backwards by flipping their tails beneath their legs.

PADDLERS

Sea turtles use their flippers like paddles to push them through the water, much like human swimmers doing the breaststroke. Although clumsy on land, sea turtles are graceful and agile underwater, capable of reaching speeds of 10 knots. Penguins use their stunted wings in much the same way to propel themselves through the water.

FLAPPERS

Stingrays, skates and manta rays use their flexible, triangle—shaped fins like wings to flap their way through the water. By changing the pitch of the wing they can move up or down with incredible ease.

DRIFTERS

Animals such as seahorses, plankton and some species of jellyfish drift on currents. Some can control their movement to some extent (the seahorse, for example, can stay in one place by wrapping its delicate tail around sea-grass blades, but many others drift to and fro with the fickle wind.

JET PROPELLERS

Jellyfish and squid achieve rapid bursts of speed by contracting their muscles quickly to force water out. The force of this "exhaled" water pushes them in the opposite direction like a blown-up balloon that is suddenly released, or like a jet airplane leaving the ground. Scallops achieve the same effect by snapping their shells shut, and some fish use a "jet-assisted take-off" by rapidly closing their gill covers to propel them forward.

SCOOTERS

Sea urchins and starfish have thousands of tiny tube feet that they can fill or empty with water. This water is expelled to push, or scoot the animal, along the Bay bottom. These tube feet also have suction cups that help them to climb slipper surfaces or to catch prey. The sea urchin also uses these suction cups to grab bits of bone, sponge or other material which it "glues" to its body as camouflage to hide it from predators.

SWIMMERS

Fins are the arms and legs of most fish, as well as some marine mammals like dolphins. Fins can be used for forward motion, stability, steering and braking; different fins serve different purposesThe tail, or caudal fin, is used to propel the animal forward, while the side, or pectoral fins, help the fish move up or down in the water. Dorsal, or top fins, keep the animal from rolling over on its side. But fins alone won't get the animal far. Most fish also use powerful muscles along their back and near their tail to add thrust to their fins. Dolphins and whales also harness muscle power in concert with their broad side fins, called flukes, to drive their bodies forward. Dolphins can fly as well as swim, using their powerful muscles and flukes to catapult themselves out of the water as if they are jumping for joy.

SLIDERS

Marine snails, whelks and **mollusks** like clams and oysters have only one foot, but this muscular appendage suits them admirably. By contracting and extending this appendage, they are able to slide along the Bay floor.

BRAIN—TEASERS

1. What causes ”red tides?” How do they affect fish and people?

2. Define the Bay’s pelagic zone and explain why survival here often depends on an animal‘s ability to escape from danger?

3. Explain how color patterns or behavior might help the following deep-zone residents avoid detection by predators: brown shrimp, bay menhaden, comb jellyfish.

ACTIVITY 1: MANATEES IN MOTION

Teacher Instructions

Objective: To explore the relationship between the Bay's deep waters and shallower shoreline areas.

Activity: Students will use boater's guide and/or online maps to track the movements of manatees across Tampa Bay to feeding areas and winter refuges.

Materials: Copies of maps for each cooperative learning group, Pencils, Paper, Rulers, Calculators (optional)

Subjects: Math, Science, Social Studies

Duration: 1 hour

Procedure:

1. Divide the students into cooperative learning groups. Give each group a map.

2. Have the students read the introductory text and work together to answer the questions.

3. Discuss and compare the answers as a class. You may Wish to explore other areas of the Bay that might be important **habitats** for manatees. For instance, you might ask the students Where manatees could take their young to find a safe, quiet sanctuary in the Bay, or where manatees might face the greatest danger from boaters.

ACTIVITY 1: MANATEES IN MOTION

Manatees are warm—blooded marine mammals that eat plants Such as **seagrasses** and water lettuce. To find these foods, they must travel great distances. Scientists have learned a great deal about where manatees go and what they do by attaching radio transmitters to manatees. The transmitter is fastened to a long tether that trails behind the manatee as it sWims. The tether is held in place by a belt placed around the base of the manatee's tail. When the manatee stops swimming, the transmitter floats to the surface and emits a radio signal that the scientists use to track the animal's movements. Researchers have followed some manatee's journeys for as long as six months.

Manatees also need fresh water to drink and shelter from cold weather. When the water temperature drops in the winter, manatees often bunch up in natural springs or near the toasty outfalls of power plants, which discharge water that has been heated to produce electrIcity.

Knowing these manatee facts, imagine that you are a manatee researcher trying to identify how far manatees travel and what environmental conditions they need to survive. Use the Tampa Bay Boaters Guide map to answer the following questions.

1. Manatees frequently travel across the Bay to feed in seagrass beds near the Bay shoreline. Calculate how many miles a manatee must travel to reach Bahia Beach in south Hillsborough County if it starts its journey at Weedon Island in St. Petersburg.

2. Would most of this journey be through shallow or pelagic waters of the Bay? Why?

3. If a manatee makes two round trips between Weedon Island and Bahia Beach a week, how many miles Will it have traveled in a year? Explain how you reached this number.

4. How many artificial reefs would a manatee pass on its journey from Weedon Island to Bahia Beach?

5. Estuaries like Tampa Bay contain a mix of salty and fresh water. Name two areas Where manatees might go in the Tampa Bay **watershed** to obtain fresh water to drink.

6. Name an area where a manatee might go in the Winter to find warm water.

7. List four areas of Tampa Bay that contain potential manatee feeding areas,

8. You have been asked to develop a management plan to protect manatees in Tampa Bay. Identify the areas of the Bay that you think are most important to manatee survival. Explain why you picked these areas.

ACTIVITY 2: I'LL HAVE THE PEANUT BUTTER & JELLYFISH!

Teacher Instructions

Are lemon sharks sour? Can you eat a sea cucumber? Do pinfish prick? Do grunts grunt? Do you straighten your hair With a combfish? Do hammerhead sharks use nails? Can you buy stuff With sand dollars? Can a nurse shark take your temperature? Can you Wish upon a starfish? What if a sea horse won the Kentucky Derby? And when was the last time you had a peanut butter and jellyfish sandwich?

What's in a name? Some marine animals have funny names. Perhaps it's because they look like or remind someone of something. Whatever the reason, their odd names help us to remember these creatures and open up a whole new world of ideas for outrageous art: Can you think of other animals with misnomers, names that are not what they appear to be?

Activity: Students draw a literal version of a marine critter with a misnomer or funny name. For example, a lemon shark made of lemons or a brush and combfish.

Materials: Paper, art supplies — and a little imagination.

Subjects: Art

Duration: 1 hour

Procedure:

Students whip up their imagination and draw a literal version of their favorite marine animals with a funny name. For cutting edge "estuarine cuisine," have students develop a "edible" platter of bay critters (lemon sharks made of lemons), sea cucumbers fashioned from cucumbers, and a PB&J sandwich made of peanut butter, jelly and goldfish crackers — slathered in jelly, of course!

RESEARCH EXTENSIONS

1. The deepest parts of Tampa Bay are the manmade shipping channels that allow huge ships from all over the world to travel to and from the Bay ports. The main shipping channel in Tampa Bay is 43 feet long! Search the internet for information about the Port of Tampa or one of the area's other major seaports and summarize it for your notebook. Share your information with your class.

2 Tampa Bay has lots of marine life. Some of the Bay's inhabitants such as the black tip shark are powerful hunters while others are playful creatures such as bottlenose dolphins. Also included among the Bay's inhabitants are herring, manta rays, jelly fish and manatees. Check local newspapers for an article that discusses a marine environment. Does the article written present a positive or negative situation? In your notebook, write an editorial either for or against what is being proposed in the article.

3. A newspaper's best writing is often found on the sports pages. Read the sports page of a local paper and observe how writers describe athletes and events. Pretend you are a sportswriter and write an article about the amazing feats of a creature living in Tampa Bay. Think of a creative headline or title for your article. For example: "Dolphins Leap Ahead in Race to Save the Bay" or "Bucs Draft Hammerhead Shark to Nail Opponents."

GIVE THE BAY A HAND
Teacher Introduction

This segment explores how people are helping to improve and protect Tampa Bay, from the landmark Bay restoration plan being developed by local communities and regulatory agencies under the guidance of the Tampa Bay National Estuary Program, to the individual efforts of citizens who participate in salt **marsh** plantings, coastal cleanups and other Tampa Bay conservation projects. By reading about what others are doing to give the Bay a hand, students are able to see they too can make a difference in Tampa Bay's future by caring for it wisely.

The companion pages for this unit are 129-135 of Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay. Students may read these pages at any stage of this unit.

GIVE THE BAY A HAND

Tampa Bay has made a remarkable comeback in recent years, thanks to concerned residents and elected leaders who have banded together to help make the Bay cleaner. But much work remains to be done.

In 1990, the federal government recognized the importance of Tampa Bay by naming it an "estuary of national significance." Other estuaries that have received this honor include Puget Sound in Washington, San Francisco Bay in California and Sarasota Bay and Indian River Lagoon in Florida. Along With this title came the creation of the Tampa Bay National Estuary Program (NEP), which has been working with local communities, industries, and citizens to develop a plan for continuing the Bay's recovery in future decades. The plan offers solutions to some of the Bay's greatest problems, including excess nitrogen loadings and the loss of natural **habitats** that fish and Wildlife depend upon. For the plan to be successful, everyone who lives in the Tampa Bay **watershed** must do their part to reduce pollution.

Many residents already give the Bay a hand by participating in volunteer efforts, such as planting **marsh** grass along the shore to create new **wetland** areas for Bay Wildlife. In fact, some high school students have constructed "wetland nurseries" in Which they grow marsh grass for planting along Tampa Bay. Other students have helped to create wildlife habitats at their schools by landscaping parts of their schoolyards with native plants that provrde food and shelter for animals, and help to filter pollutants from runoff.

Students and other residents also help the Bay by picking up trash and other marine debris along the shoreline or in the water. One popular "trash bash" is the annual Coastal Cleanup, held each September. Last year, more than 3,500 volunteers collected 38 tons of trash from beaches and shorelines around Tampa Bay. All the cleanup crews keep track of the types and amounts of trash they find. That information helps focus efforts to reduce marine debris where they are most needed.

FAST FACT: Florida's coastal cleanup now includes underwater cleanups, in which teams of divers go below the water to remove fishing line and other debris from artificial reefs, piers and bridge pilings.

Marine debris does more than make Tampa Bay ugly. It can also harm Bay animals. Pelicans and other birds can become entangled in fishing line that is thrown away, while sea turtles and some fish may eat plastic bags or bits of plastic foam that look like food to them. Fish also can become caught in six-pack ring wrappers that are used to bind soda cans together. Even balloons can be dangerous, since sea turtles may think they are jellyfish and eat them. For this reason, Florida has banned large releases of helium balloons.

FAST FACT: In the Pacific Ocean, an abandoned mile-long fishing net was found that contained 99 seabirds, 2 sharks and 75 salmon. The net was estimated to have been adrift for about a month and to have traveled more than 60 miles.

Some of the trash that is bagged comes from recreational boaters and huge commercial ships that toss garbage overboard. But most of it comes from people who just swim, play or picnic along the Bay's shores. Even trash thrown onto the ground many miles from the Bay may eventually be carried to the Bay in **stormwater runoff**. That's why it is important for all of us to give Tampa Bay a hand by disposing of trash properly, and by recycling as much trash as possible.

Don't forget: You can make a big difference at home by reducing the chemicals you use in your yard and conserving water, Your county extension service can provide details on how to create and care for a true Florida yard that helps, rather than harms, the environment.

BRAIN—TEASERS

1. Volunteers collected 424,000 pounds of trash from 1,573 miles of shoreline in Florida in 1995. How many pounds of trash did they collect on average per mile?

2. Of the 424,000 pounds of trash collected, about 254,400 pounds were plastic, what percent of the total trash collected was plastic? Why is so much marine debris made of plastic?

3. Some of the trash that is found in Tampa Bay was manufactured in other countries. How do you think it gets to the Bay?

4. What are some ways you can give the Bay a hand at home? In your school? Along the Bay?

ACTIVITY 1: WORKING FOR THE BAY

Teacher Instructions

Objective: Students will learn how scientists, government offiCials or volunteers are working to make the Bay better.

Activity: Students Will interview a profeSSional or volunteer who works to improve the bay, write a short article about what this person does, and share their story With classmates.

Materials: Pencil, Paper

Subjects: Writing

Duration: 1 hour

Procedure:

1. Have the students visit the How You Can Help page of TBEP's website and say which of the 11 ways to save the bay they think is most important — and why.

2. Have the students interview and write a profile of someone who helps the Bay, either as part of their job or through volunteer efforts. The article should include information about any special training or education their interview subjects completed to learn about the Bay, and how they first became interested in Tampa Bay. One way to locate potential interview subjects is to contact a local university or research facility such as the Florida Marine Research Institute in St. Petersburg. To find volunteers who participate in Bay improvement projects, they can contact Tampa Bay Watch in St. Petersburg or The Florida Aquarium in Tampa. The Tampa Bay National Estuary Program in St. Petersburg also can help students find interesting people to interview.

3. Ask the students to read their profiles aloud to their classmates. Students can compare the various people interviewed and discuss other jobs or volunteer efforts that might help Tampa Bay.

ACTIVITY 2: BE A BAY BOOSTER

Teacher Instructions

Objective: To help students understand they are empowered by their actions and attitudes to shape a positive future forTampa Bay.

Activity: Students work in small groups to design a promotional poster, brochure, rap song or poem around the central theme, ”Give The Bay A Hand.” Each group presents its ”advertisement” to the entire class. The class as a whole also discusses how these materials could be distributed for maximum impact on the community.

Materials: Poster paper, colored pens or pencils, rulers

Subjects: Language, Art, Social Studies

Duration: 1 hour for preparation of group advertisements, 30 minutes for presentation and class discussion

Procedure:

1. Introduce this activity by telling the students that you are the owner of a large public relations company, and they are your staff members. Your company has been awarded a million dollar contract by the Tampa Bay National Estuary Program to create a series of promotional items about Tampa Bay. The theme of your advertising campaign is “Give The Bay A Hand” and your company must create the following:

- one billboard (poster) about Tampa Bay
- one bumper sticker that is 12 inches long and 3 inches wide
- one poem of 15—20 lines
- one song of 15-20 lines

2. Divide the students into cooperative learning groups and assign each group one of these items to develop. Tell the groups that each item is worth $250,000 of the $1 million advertising contract. Encourage the students to use terms and concepts they have learned in previous lessons on Tampa Bay to develop their promotional item.

3. You also might instruct the different groups to utilize certain words in their product. For example, the poster may have to contain the words “habitat” and “**wetlands**”; the bumper sticker may have to use the words “runoff” and “pollution”; and the song may have to include the words ”manatees” and ”dolphins.”

4. Have each group present its “product” to the class, explaining how it encourages people to help the Bay.

5. Discuss as a class how the advertisements could be distributed for maximum impact on the community. Where should the billboards be placed? How could the public hear the song or poem? Where could bumper stickers be given out?

ACTIVITY 3: PRIVATE EYE

Teacher Instructions

Objective: To investigate school practices and their effects on the environment and to research and recommend ways to prevent pollution and conserve resources.

Activity: Students investigate their school's maintenance and recycling practices, water and electricity use, research solutions and develop written recommendations for adoption by the school.

Materials: Student devised questionnaire

Subjects: Language, Art, Social Studies

Duration: 3 hours: 1 hour to prepare questionnaire, 1 hour to analyze results and discuss recommendations, 1 hour to develop and present recommendations

Procedure:

1. Assist students in developing a questionnaire (no longer than 2 pages) to obtain the following information from your school: water use (inside and outside for irrigation), electricity use, landscaping practices (amount of fertilizer and chemicals used), and recycling practices. Find out if your school uses water-conserving toilets/faucets or special energy-saving lights. Does your school use native or drought-tolerant plants in its landscape to reduce the use of water and chemicals? Make questions specific and review questionnaire to identify and address any gaps.

2. Write a cover letter to the appropriate school administrator explaining the purpose of your survey and providing a deadline for a reply. Explain that your class will use the information to make recommendations on ways the school can improve the environment and possibly save money. Attach the questionnaire and deliver to the appropriate contact.

3. Analyze and discuss results of the survey. Discuss areas where improvements are needed and develop written recommendations. Students may wish to consult with organizations listed on the Resources Page for help in an area. Try to identify ways for your school to save money while reducing pollution.

4. Present your recommendations to the school. You may want to invite school officials to your class for a formal presentation. Follow up on implementation and invite school administrators to come back to the class and discuss changes made as a result of survey.

TIP: Your local county extension service is an excellent resource for assistance and information. Contact them for earth-friendly ideas on ways to improve your school's landscape and maintenance practices.

Watergoats

Did you know that plastic beverage bottles, cigarettes and cigar tips, straws, styrofoam, grocery bags, and food wrappers are often found in Tampa Bay? Heavy rains carry litter to storm drains, and our garbage ends up in our waterways! Watergoats create a barrier that helps to capture litter before it's carried by the tides further into the Bay. The netting is safe for wildlife and does not stop water flow. Volunteers and staff of various organizations clean out the watergoats and properly dispose of trapped debris. Check out Tampa Bay Watch's page about watergoats to find out more.

RESEARCH EXTENSIONS

1. Improving Florida's natural areas is important to protect water resources. Look for an article online about something that was "improved" or "restored." What is mentioned as being restored? Why is it valuable? What might have happened if it was not restored?

2 Look through a job-postings site section for jobs related to the environment. How many different jobs can you find? In your notebook, write about one job you would like to have and why. Share your work with your class.

3. It is the responsibility of every indivIdual to help conserve and protect water resources. Make a list of the many different uses of water. Mark the ways you use water. Then list ways you can conserve and protect water resources.

GLOSSARY

ALGAE - simple plants that grow in aquatic environments. Excess nutrients may accelerate the growth of algae, resulting in an algal bloom.

ATMOSPHERIC DEPOSITION - refers to materials discharged to the atmosphere from natural sources and anthropogenic (manmade) sources, such as automobiles, power plants and industries, that fall on the surface of water or land in rainfall or as dry particles.

CRUSTACEANS - a group of mostly aquatic invertebrates with a hard, jointed shell (exoskeleton); examples include crabs, lobsters and shrimp.

DETRITUS - small particles of organic matter, largely derived from the decomposition of vegetation; an important food source for many small marine animals.

ECOSYSTEM - the system of ecological relationships between organisms (plants and animals) and their physical and chemical environment; a functional unit that includes both the organisms and their non-living surroundings.

ESTUARY - a partially enclosed body of water where fresh water from rivers and streams mixes with salt water from the sea.

EUTROPHIC - refers to water which is rich in nutrients such as nitrogen and phosphorous but often deficient in dissolved oxygen. Excess nutrients promote the growth of algae; as the algae dies and decomposes, it depletes the water of oxygen. Eutrophication occurs naturally in many bodies of water, but can be accelerated by pollution.

HABITAT - the sum of environmental conditions in a place where a plant or animal lives.

INVERTEBRATES — animals Without backbones; examples include insects, worms, crustaceans, mollusks and sponges.

MANGROVES — a salt—tolerant tropical or subtropical tree that grows near the shoreline; mangroves provide food and habitat for many types of Wildlife, stabilize shorelines and filter pollutants that run off the land.

MARSH - a wetland where the dominant plants are grasses and sedges, as opposed to a swamp, where woody plants like shrubs and trees are the dominant vegetation.

MOLLUSKS - a group of invertebrates including clams, snails, oysters, conchs and others soft—bodied animals. Most mollusks have a thick, hard outer shell; squid and octopus are exceptions.

NON-POINT SOURCE POLLUTION - refers to pollution that comes from many sources and cannot be traced to one specific point, such as pollution from stormwater runoff and the atmosphere.

PHYTOPLANKTON - free-floating aquatic plants and plant-like organisms, usually algae; an important food source for many animals.

POINT-SOURCE POLLUTION — refers to pollution that comes from a specific source or point of origin, such as a discharge pipe or outfall.

SEAGRASSES - true flowering plants (not grasses) that grow underwater in shallow bays and estuaries. Seagrass meadows provide food and refuge for many marine animals.

SHELLFISH - a generic term that includes both crustaceans and mollusks, especially those used for food. The term finfish, by contrast, refers to true fishes.

STORMWATER RUNOFF — water from rain or irrigation that flows over land. Runoff often carries pollutants such as oils, fertilizers and pesticides and is frequently a major component of non-point source pollution.

TOXIC — poisonous or directly harmful.

TURBIDITY — cloudiness of water from suspended material or particles. As the cloudiness increases, so does the turbidity; low turbidity indicates clear water and may be associated with good water quality,

WATERSHED - the geographic region that drains into a particular stream, river or body of water. The Tampa Bay watershed covers more than 2,200 square miles in six counties.

WETLAND — land Where the water table is usually at or near the surface. Some wetlands contain water year—round; others may remain relatively dry for months, becoming moist only during periods of heavy rain. Wetlands are vital habitats for many species of plants and animals; they are protected by local, state and federal regulations.

ZOOPLANKTON — free-floating aquatic animals ranging in size from microscopic, single celled organisms to large jellyfish. Zooplankton are an important source of food for many types of fish and animals

RESOURCES

To learn more about your marine world and local environmental protection efforts, contact the Tampa Bay National Estuary Program or any of the other agencies and organizations listed below.

Tampa Bay National Estuary Program

Florida Department of Environmental Protection

Fish and Wildlife Research Institute

Mote Marine Laboratory

Hillsborough County Cooperative Extension Service

Pinellas County Cooperative Extension Service

The Florida Aquarium

Clearwater Marine Aquarium

Tampa Bay Watch

Manatee County Cooperative Extension Service

Southwest Florida Water Management District