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New Haven: Your Coastal Community

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by Maureen Taylor-French

Goals and Objectives

"New Haven: *Your* Coastal Community" is a thematic, interactive unit in which students explore their urban ecosystem which includes Long Island Sound and its estuaries. The unit presents ecological and public policy concepts, includes hands-on activities for student exploration and outlines cooperative research projects through which students enlist the aid of public and private sponsors for environmental service activities. Students will identify contemporary environmental policy issues, investigate ecological and social impacts of decisions, debate these issues and propose viable service projects given available resources.

This unit is prepared for students in grades six through nine. Although it is written as part of the New Haven Science curriculum, it may be used by other educators who wish to motivate their students to understand and embrace their own environmental community. The unit emphasizes service learning and is easily incorporated into any social science curriculum. Information regarding state, national, corporate and non-profit funding and support is provided, which may assist educators as they develop service learning projects for their students.

The unit includes research, analysis, reporting, cooperative problem solving, and science skills via hands-on application. As such, the unit spans the curriculum and provides students with an in depth application of reading/writing skills. Analytical skills assessed on both the CMT and CAPT are employed and strengthened, and the scientific method of inquiry that is engaged assists students as they prepare for the CAPT. As such, instructors in any subject area will find material in this unit helpful. The application of these skills in a practicable, realistic exercise enlists student interest as they further these skills.

The unit is divided into three sections: (1) a study of oysters and the oyster industry as an introduction to habitats and the effects of pollution; (2) identifying pollutants, our city's waste, and its impact on the Quinnipiac River Basin and Long Island Sound; and(3) environmental activism through service learning/projects.

Introduction: Defining Our Coastal Community

What do students really know about the city of New Haven and its natural and living resources? Before we engage in learning what students can do to improve their environment, student will first define what they perceive as “their environment.”

New Haven: *Your* Coastal Community explores students’ relationships with their community and New Haven’s water resources. The unit introduces New Haven as an urban ecosystem and defines the student’s environment as one where air, land and water are explored. Through this exploration, we will identify problems within this environment and opportunities for students to improve their environment.

New Haven is an urban ecosystem, a place that includes all living and non-living things, which interact with one another. There are many types of ecosystems that may be as small as a tiny drop of rain water, or as large as the earth. Ecosystems commonly studied include desert, wetland, grassland tropical/rainforest, and polar. Urban ecosystems are relatively new and include all man-made and natural elements—buildings, roads, and parks, as well as trees, wildflowers and insects.

We need to define an ecosystem to better understand the organisms and how they are connected to one another. Living things interact with one another in many different ways. For example, we eat bluefish, bluefish eat smaller fish, and smaller fish eat plants. All members of an ecosystem are related through this food chain. Members of a food chain as well as man-made impacts constitute an ecosystem in this unit. We examine Long Island Sound as one ecosystem that includes the Quinnipiac River Watershed, and estuaries that themselves may be examined as independent ecosystems. The size of an ecosystem is defined by the ecologist who is studying it and is not as important as the understanding of the relationships within the ecosystem, the community.

Like many other cities in the United States, particularly those along the east coast, New Haven has changed tremendously in a relatively short time. As the city has expanded and changed, so too, has the urban community and its demands. As the population in our city has grown, so have demands for housing, food and water supplies, fuel and electricity, transportation, and sewage and waste disposal. Railroads, bridges and highways are built to transport food and raw materials into the city and manufactured goods out. The city community is not self-sufficient, but depends heavily on transportation, energy and new technology to maintain itself. The effect on the environment can be overwhelming.

Another ecosystem, which can be examined independently, or as part of our urban ecosystem, is our aquatic ecosystems that surround the city: Long Island Sound, the Quinnipiac River and New Haven Harbor. We focus on the Quinnipiac River Watershed: which begins as Dead Wood Swamp in Farmington and includes six rivers: the Quinnipiac, Eightmile, Tenmile, Harbor Brook, Wharton Brook and Muddy River. The river empties into New Haven Harbor and Long Island Sound. (Figure 3, Appendix; Additional map resources: CT Department of Environmental Protection; Coastal Resource Maps). These waters hold their own interdependent communities but, as we shall see, their well-being is so affected by the city and the surrounding population centers, they will be included as part of our study of the New Haven urban ecosystem.

The Quinnipiac River flows into New Haven Harbor, which empties into Long Island Sound. The Sound is a natural harbor and an estuary, a place where salt water from the ocean mixes with fresh waters from the rivers and land. The Sound provides a habitat for diverse plant and animal life. It also provides recreational value and serves as a major commercial corridor. This large inlet, 110 miles long, which encompasses 1,300

square miles, empties into the Atlantic Ocean. 577 miles of coastline bordering this harbor. Therefore pollution problems evident in the Quinnipiac River are magnified in the Sound.

Long Island Sound is located in the middle of one of the most densely populated regions in the United States. More than 8 million people live in the Long Island Sound Watershed. Millions come to visit as well. More than $5 billion is generated annually in the regional economy. [1] The demands of so many people and business can destroy the sound if its resources are not managed.

Long Island Sound is comprised of a number of smaller ecosystems as well: shorelands, tideflats, beaches and dunes, estuaries and tidal flatlands. Shorelands are important influences on the natural systems of the coastline. The quality of freshwater draining from shorelands determines the salinity and water quality of all coastal waters. The salinity helps determine the types of plant and animal species in the estuaries. Tideflats are sandy or muddy areas exposed at low tide. They support large animal populations as well and microorganisms in the tideflats serve as natural filters for cleaning polluted water. Beaches and dunes protect marshes and uplands from storms and erosion, provide wildlife habitat and provide scenic and recreational value. Tidal wetlands, or salt marshes, trap and store energy in soil and plants. The daily movement of salt water washes microscopic organisms into the estuaries and Long Island Sound, where it serves as the primary link in the food web for marine life. Marshes also are pollution filters and remove contaminants from water flowing through them.

Estuaries are river mouths and bays where fresh and salt water meet. The mixing of waters creates a nutrient-rich habitat favorable to many forms of life, and helps to naturally clean polluted water. Nearly all of the fish in Long Island Sound are in one way or another dependent upon estuaries. Some species use estuaries as reproductive and nursery areas. They also provided habitat for blue crabs, oysters and other valuable shellfish. Because New Haven Harbor is itself an estuary, and we seek to examine the relationship of our urban and coastal ecosystems, we will further examine estuaries via a case study of oysters and the oyster industry.

I. The Oyster: Habitat and Value

What is an oyster? Why should students care about its existence in New Haven Harbors? Although students are aware of beach closings and may be impacted by these bothersome events, it is important they understand beach closings are only one result of water pollution. Another more dangerous and far-reaching consequence of pollution is the poisoning of our food and destruction of a vital business. Even if students do not eat oysters and may not care about their well-being, they will learn oysters provide a valuable balance to our surrounding waters. Oysters process deposited materials at the bottom of the Sound, helping to balance oxygen levels in our waters that enables swimming and fishing.

Oysters are mollusks that are an integral part of the food web of Long Island Sound and its waterways. (Anatomy, Figure 2, Appendix). Oysters thrive on photoplankton, microscopic plants, which are produced in the salt marshes. Because they feed on microscopic plants that are the beginning of our local food chain, and are consumed directly by people, a study of these creatures provides an excellent example of how we can poison ourselves by polluting our own food sources in the Sound.

The study of oysters illustrates a direct link between man and the productivity of the salt marshes and

wetlands. (Figure 3, Appendix) The oysters natural habitat is between the low tide mark and a depth of twenty to thirty feet. [2] They spawn in shallow waters, in harbors or estuaries where freshwater is mixed with salt. New Haven Harbor is ideal: it is four miles long, one and a half miles wide, has three rivers flowing into it and is shallow. [3] However, because it is so polluted, no oysters taken directly from the harbor can be eaten. They have to be transferred to safe waters for fourteen days. This increases the cost of oystering and limits their availability.

Oysters help balance the whole Long Island Sound ecosystem. They process estaurine materials and biofilter the water. Oysters reduce large amounts of phytoplankton, a microscopic plant that helps manage pH and oxygen levels in the water. Too much phytoplankton can endanger fish and other organisms in the system. The presence of oysters stabilizes the pH and regulates the oxygen concentrations in the water, reducing fish mortalities. They also cycle nutrients through filtration and excretion. [4]

A model was developed by Ulanowicz and Tuttle (1992) to determine how much the food web might be affected by the disappearance of oysters. In their model, oysters were “rehabilitated.” The results were a 150% increase in oyster stock and a 17% increase in carnivorous fishes; zooplankton and phytoplankton, which rob oxygen from the Sound, were reduced 89 and 11% respectively. So if students claim indifference to the fate of the oyster, they will discover their fishing, swimming and other leisure activities are at risk should pollution continue to erode their habitat.

Many different groups of people are dependent upon the oyster’s health, either directly or indirectly. For example, the industry has generated millions annually, employing thousands of people who are dependent upon unpolluted marshes. Because the processing of oysters is so expensive because of water pollution, they are now very expensive and not so popular. As a result, according to the *New Haven Register* of April 1, 1984, although 87% of all Connecticut seed oysters (oysters less than two years old) are grown in New Haven Harbor, its leaders are no longer New Haven men. The processing of oysters is now done by only two large companies—one in Norwalk and one in Long Island where the oysters are cleaned. So a local business that started and thrived in our community had to move because of pollution in our harbors.

The oyster has been an integral part of New Haven’s economy and culture for years. Since its discovery, New Haveners have been harvesting oysters. Each resident would gather whatever they needed. In 1762 the first laws were passed limiting oyster harvesting. A two bushel daily limit was implemented. Today few residents harvest oysters. Only two companies extract oysters from New Haven harbor and they are farmed in cleaner waters elsewhere. What happened?

Oystering had been easy those early days in Fair Haven—and profitable. The oyster is a creature that thrives in estuaries such as New Haven Harbor. Around 1850, a local resident discovered how to plant seed oysters to increase production. Oysters from Southern waters could be transplanted in New Haven harbor to increase production during our relatively short season. Harvesting and sales exploded. In 1880 2.5 million pounds were harvested in New Haven. By 1898, more than 15 million pounds of oysters were harvested per year. [5] From 1900 on, there has been a decline because of overharvesting, and the population had not returned, partially because of pollutants.

Not only was the early oyster industry tremendously beneficial to our local economy, but oysters themselves are an excellent, healthy food source. While the oyster has few calories, it provides vitamins A, B, C, and D. One pound supplies 7% of our total daily energy requirements, 28% of our total protein requirements, 35% of calcium, 53% of phosphorus and 136% of the iron requirements. [6] Furthermore, it was inexpensive as well.

The availability of local oysters is therefore dependent upon wastewater management, a critical issue in Long Island Sound and New Haven Harbor preservation. The pollutants from waste water settle on the bottom of our estuaries—where the algae are consumed directly by oysters. The overflow of wastewater processing plants is also responsible for more than three local beach closings this summer as well.

Three primary sewage treatment plant overflows empty into the harbor. Boulevard, East Street and East Shore Sewage Treatment Plants serve New Haven and other area residents. In addition, 24 overflows from combined sewers spill into Harbor waters, either directly or through storm sewers. This dumping disturbs Quinnipiac River and New Haven Harbor estuaries that need a nutrient-rich habitat for shellfish such as oysters. Brown algae, and the Sound's muck all but wiped out Long Island Oyster Farms, Inc. the biggest oyster farm on the Sound.

Students may directly contribute to wastewater, as well as larger corporate pollution culprits. Many groups of people contribute to non-point source pollution (NPS). If we wash our cars and permit the soaps or oils to run into groundwater, we have polluted our rivers, and by extension, Long Island Sound. As a result of our activities, we corrupt waters to the point where its habitants can poison us if eaten. Admittedly beach closings on a 90 degree day are bothersome. But beach closings are insignificant when compared to the fact where are poisoning our local food sources!

It is only since the 1980's that there has been a resurgence in the industry in New Haven. In the 1970's the Environmental Protection Agency issues strict new guidelines to polluters of the Sound that has resulted in cleaner waters and a resurgence in the oyster industry. Oysters have survived. The *New Haven Register* reported on April 1, 1984 that "Oysters are Happy as Clams in the Harbor." Stringent new laws require even small amounts of spillage must be reported and the Coast Guard and the Environmental Protection Agency must respond. A new sewage plant was in complete operation in the late 1980's which lessened pollution in the Harbor.

One-third of Long Island Sound's coastal wetlands has been destroyed by development, wrecking the irreplaceable habitat for fish, shellfish and plants. If all this damage is done to an important aquatic resource, why does waterside development and pollution continue? The residents of the city of New Haven demand paved streets for driving ease and safety. Paving street and parking lots destroys oyster beds miles away. Commuters need to get in and out of New Haven to work every day. The carbon dioxide pollutes the air and waters. Oil needs to be transported to the city for fuel. The oil spills end up in the estuaries' sediments, which poison the oyster. Parks and golf courses use fertilizers for green grass. Residents demand waterfront property and pay developers a premium for their views and water access. Construction workers need jobs developing these houses. In short, our urban community, New Haven, places exorbitant demands on a limited resource. Residents and commuters alike have demands which conflict with water preservation.

II. Urban Pollution and Long Island Sound

Pollution is a human activity that may put an ecosystem out of balance. Almost every activity—from how we get around to how we grow our crops—creates some type of pollution. As the city of New Haven has grown, its residents put more and more demands on its environment: both the land and services within the city and surrounding lands and waters. Our wastes create land, air and water pollution.

You can see many ways in which a city affects its surroundings as highways are built, forests are cut down, and ponds, lakes and other waterways are filled in or polluted. A city also produces more air pollution which ends up in our water through the water cycle. The effects of pollution can also be hazy. Pollution affects people in different ways. It can affect our health and it can limit our activities, harm wildlife and habitat, and disrupt the planet's natural systems *permanently* .

As New Haven has become more populated over the years, there has been a direct effect on Long Island Sound, the Quinnipiac, and other rivers and waterways. Because so many people now live around the Sound—14.6 million live in its drainage basin—demands are intense. Uses include shipping, transportation, electric power generation, industrial use, waste disposal, fishing, boating and other leisure and aesthetic activities.

20 million people use Long Island Sound each year!

Every one of Long Island Sound's many environmental problems, from sewage and toxic chemicals to overfishing and habitat destruction, stems from its location smack dab in the middle of the most densely populated regions in the world. The Sound is now a cesspool, drainage ditch, trash can, playground and food source to the millions of people who live and play in the region. This vast 16,000 square mile watershed stretches from northern Manhattan to Rhode Island and from Long Island all the way up the Connecticut River to southern Quebec. [7]

The Long Island Sound Study, working with state representatives from Connecticut and New York, The Environmental Protection Agency and 24 Connecticut towns assessed the level of pollution in the sound in the 1980's. They looked at oxygen depletion, toxins in the tissues of crustaceans and fish, and basic water quality. The biggest culprit polluting Long Island Sound is the waters from the rivers, including the Quinnipiac River. Waste water treatment plants, urban and agricultural runoff, and power plants all are major contributors to the Sound pollution as well.

For years, signs of the Sound's decline have been visible: the disappearance of dolphins, collapse of he flounder population, closure of more than on-half of its 120,000 acres of clam and oyster beds. [8] By most measures, the Sound is still deteriorating, or at best, holding its own. Reversing the damage will be difficult because much of the pollution is caused by everyday behavior of millions of people—the way we tend lawns and gardens, deal with wastes, build houses, roads and bridges, and commute to work.

Water Pollution: Culprits and Victims

Understanding what causes water pollution is the first step in solving our pollution problems. After examining these causes, we'll see how New Haven and its residents' livelihoods are threatened by often unseen pollution perpetrators. These pollutants can affect our jobs, food and health, cost of living and, as oystermen have discovered, our whole way of life!

Water is polluted at the surface, in rivers that fill lakes, bays and oceans, and in groundwater. Groundwater is water that fills the spaces between rocks and soil particles underground. There are a number of materials that get into surface or groundwater.

Water pollution is often defined by its origin and organized as *point*- source or *non-point source (NPS)* . Because non-point source (NPS) is responsible for so much of our water pollution *and* we can control NPS pollution, we will focus on this source of water pollution. Non-point source pollution is any water pollution

which is not attributed to any one perpetrator. It is any and all drainage pollution, street pollution that gets washed into the drains, and everyday trash. This is both surface and groundwater pollution, and it all empties into Long Island Sound. We also directly control how much of this pollution empties into Long Island Sound.

We directly or indirectly create all these toxic materials. (Figure 4, Appendix) For example, whenever we rinse something down the drain, flush a toilet, or do laundry, the wastewater goes to a sewage treatment plant to be purified. These plants remove dirt, biodegradable material such as food wastes, and many other pollutants. But remember, water treatment plants are a major cause of pollution in Long Island Sound. These plants do not remove all the chemical pollutants. For example, phosphates that are used in many detergents pass right through sewage treatment plants and go directly into our rivers and the Sound.

During heavy rainstorms, wastewater coming into the plants may back up and overflow directly into surface water without any treatment. Untreated human waste empties into Long Island Sound and spreads disease-causing bacteria, such as dysentery and hepatitis. Beaches on Long Island Sound are often closed because of these problems with water treatment plants. Beaches were already closed once this summer because of problems with wastewater disposal! (June 30 - July 2, 1997)

Untreated waste robs water of oxygen as well. Garbage needs oxygen to decompose. Certain wastes, such as fertilizers and detergents also destroy the valuable oxygen all aquatic creatures need for survival. Pollutants from wastes sink to the bottom of the harbor and creates a black, mayonnaise-like material, sapropelic mud (also called “muck”). This mud suffocates many of our crustaceans, such as clams, mussels, and oysters.

The fish-killing shortage of underwater oxygen known as hypoxia afflicts as much as 30% of the Sound every August. [9] When organoic materials decompose they use oxygen in the water to decay. Nitrogen, which is in fertilizers and combustion engines, and phosphorus, which is in detergents, also contributes to algae blooms. When the algae blooms, it also robs the water of oxygen necessary to support other marine life. When these blooms die and sink in the summer heat, their decomposition consumes virtually all the dissolved oxygen in the bottom waters. Because of years of pollution the oyster population has been eroded to the point where there are not enough beds to eat these blooms and preserve oxygen levels. The absence of adequate oysters, therefore threatens the fish population as oxygen levels are not sufficient.

Factories which produce our increasing demand for paper, medicine, automobile parts , computers and other gadgets create lots of pollutants. Since the early 1970’s many pollution-control laws have been passed to minimize pollution, but not all types of industrial waste is regulated and some experts feel these regulations are not strict enough.

Oil messes are a major problem in New Haven Harbor because of our local storage tanks. 120 million gallons of oil are stored on our waterfront, delivered by an average of 500 ships each year. As New Haven Harbor is the third largest seaport in New England, employing approximately 650 people, our transportation and oil storage issue is one that concerns many different groups of people, including environmentalists and departments of tourism.

The amount of oil spilled in accidents which we read about in the newspapers is only a part of the total amount of oil that contaminates our waters. For example, tankers dump oil into the oceans when they clean out their tanks and oil from the streets washes into surface water. Oil’s effects on wildlife can be devastating. Some animals, including birds, mammals and fish, may be killed by ingesting the oil. Others may die from eating contaminated prey or by getting their feathers or fur coated with oil.

There are more than 65,000 commercially available chemicals in the United States. These chemicals are ingredients in many products we use every day and are used in many industrial processed. Some of these chemicals are dumped directly into our water. But runoff carries tons of chemicals into surface water each year (Figure 5, Appendix).

Chemicals that get into surface water poison fish and other animals directly. They accumulate in bottom sediments as well, contributing to the toxicity of our harbor's black "muck". They also accumulate to toxic levels in the tissues of animals Because of two natural processes, *the food web* and *bioaccumulation* these pollutants are spread throughout our ecosystem, harming the food supply of all our animals, ourselves included.

The Food Web and Bioaccummulation

The food web of Long Island Sound begins with dead plant and animal matter and other sediments flowing into estuaries from upland areas. These materials are converted into food by marsh vegetation, marine algae, bacteria, and minute floating plants. The plants are eaten either by small fish, shellfish and other invertebrates, or by microscopic floating animals. Large fish, birds, mammals and man are at the top of the food web, having no natural predators. Other animals feed on dead plants and animals, reducing them into basic chemical constituents. These materials are used by plants, thus completing the cycle. Because all aspects of the biological system are interrelated, disruption of one part of the food web can affect many other parts.

Just as nutrients pass from one aquatic creature to another, so do toxic substances pass through the food web. If toxic substances are not excreted or broken down biologically, they are retained in the tissue of the organism. Over a period of time, if the organism continues to ingest the contaminated food, the chemical becomes more concentrated in that animal. Therefore pollutants that enter the food web become more concentrated by the time they reach the highest consumer in the food chain.

The location of an organism along a food chain is called its tropic or feeding level. A producer is always at the first tropic level. In New Haven Harbor and Long Island Sound, photoplankton, photosynthetic algae, and microscopic animals are at the first tropic level. (Illustration, Figure 3, Appendix). Each of the following tropic levels contain consumers. Energy as well as pollutants flow from the photoplankton to the oyster. The pollutants become more concentrated as they pass from each tropic level. The consumer eats and discharges the mass but the pollutants remain and become more concentrated. A person eats the oyster so the energy and pollutants from the oyster, which is concentrated, pass to the person eating the oysters, which is a greater percentage of total mass than the photoplankton absorbed.

Accumulation is especially pronounced in aquatic food webs, because there are four to six levels of consumers. Furthermore, many of the fish we eat have preyed on small fish and shell fish which have all been exposed to the same toxins, so their diet may consist exclusively of concentrated toxic materials. As human eat from the upper levels of aquatic food webs, we run the risk of ingesting large amount of toxic substances. The level of toxins in our waters, and these natural processes, the food web and bioaccummulation, have resulted in total bans on fishing, crabbing, claming and oystering in our harbors in our rivers. Again, this year, like the closing of Long Island Sound beaches, we have witnessed firsthand the effects of pollutants in our local waters. This Spring (1997) parts of the Quinnipiac River were closed to fishing because of pollutants

Current Issues & What you Can Do

New Haven has a number of contemporary issues that students may address. Students can examine air, water and land issues, and analyze the potential impact of current activities on a local species. Using some of the activities provided, for example, students can analyze the impact of expansion of the Q Bridge on the local flounder industry. Students may also examine a host of other local issues as well: the impact of New Haven's Living City Initiative, expansion of Wyatt's Oil Tanks on New Haven harbor, expansion of Tweed-New Haven airport, and construction on a new steel factory.

Students can examine the impact of pollution on another harbor resource: the flounder. Just the oyster production declined tremendously earlier this century, the flounder is currently as risk. The demise of the flounder is attributed to NPS pollution and affects students as consumers. Flounders are important to our local fishing industry.

A flounder faces high risk of toxic contamination because it spends much of its time half buried in sediment, where contaminants concentrate. Several studies have found elevated levels of copper, zinc and DDT in the tissues, which may cause sterility, threatening the population.

In just four years, from 1989 to 1993, the amount of winter flounder caught yearly fell 80%. Like the oyster, newly hatched larvae need the protection and food supply provided by wetlands. Factories and power plants are located near some of those nursery grounds. Students can write to the Connecticut Department of Environmental Protection for information of their fisheries program and the names and locations of these factories and power plants.

Analysis of the expansion of the Q Bridge serves as a model for a class activism project. Students will research the seven alternatives currently under consideration. Guest speakers from the City of New Haven may present these alternatives and the impact to the city. Students will study area water quality using data provided by the Connecticut Department of Environmental Protection, or gathered in conjunction with an Adopt-the-River program (see below). They may wish to examine water from New Haven Harbor, the Quinnipiac River or the Farm River. The Farm River is downstream from the highway crossing. Any runoff from the highway will affect this watercourse downstream of the crossing and testing of this river is encouraged.

Automobiles are a significant source of pollutants to water quality degradation, producing rubber from tire wear, asbestos, lead, chromium, copper and nickel from clutch/break wear, lead from fuel, and chlorides and sulfates from roadway wear and deicing compounds. Students may therefore examine one or more of these pollutant concentrations. Because chlorides and sulfates have been shown to contaminate bottom sediments which affect oysters and contribute to deteriorating oxygen levels, students should test these concentrations at various locations., Students should consider multiple water samples from locations which vary from their proximity to roadways.

Expansion of the bridge will also affect New Haven Harbor hydrodynamics. Hydrodynamics, the flushing times of the harbor, substantially affect pollution levels in estuaries. Flows from the area rivers, coupled with the effects of the tides, will mix pollutants and transport them seaward. Construction of the bridge will require dredging, which will affect Harbor dynamics and should be considered as students consider the Q Bridge alternatives. Flounder eggs are laid in harbors and any dredging for bridge expansion will severely cripple the population.

Adopt-the-River, sponsored by the Quinnipiac River Watershed Association provides water quality testing kits to document pollution sources. The kits are free of charge should the class wish to adopt a site along a local river. Free DEP and USDA technical support and advise are available as well. Members of the Quinnipiac River Association are very knowledgeable of and participant in the Q Bridge expansion debate. They may also wish to address your students as well.

Students may form teams which represent special interest groups affected by expansion of the Quinnipiac River bridge. Through this exercise, they will fully understand the affects of competing interests when addressing environmental policy concerns and current issues. For example, one team may be commuters from Clinton who seek expansion of the bridge. How long does it take to get to work? At 9:00 a.m., during rush hour? In the event of an accident? Students may monitor, record and chart current traffic conditions as reported in the morning traffic reports.

One team may represent the commercial fisherman, who caught only 550,000 pounds of winter flounder in 1993 but who had caught 5 million pounds in 1988. How much does a pound of flounder cost at the local market? How much money have commercial fishermen lost as a result of a deteriorating population due to pollution? What pollutants will increase if the Q bridge is expanded? How might their way-of-life be threatened?

One team may represent environmental impacts. Using data provided by the state, retrieved in research, gathered by students or obtained from speakers, students may examine the potential effect of Q Bridge expansion on the Flounder. Students will identify toxins (Chart, Appendix), trace the Flounder's food sources and present arguments why certain bridge expansion options are more environmentally friendly to the Flounder.

The study of the Quinnipiac River expansion on the environment, including analysis of impacts on special interest groups is only one example of a classroom activism project. Resources provided in the bibliography will provide many other ideas for class activism projects. Other projects are tremendously more simple: students may, for example, embark on a project in school where they recycle all non-biodegradeable materials. Students should prepare a plan detailing what they could do to improve an ecological issue. Students will use information assembled when researching resources and provide an outline of their team effort. Students will present a plan to the class. Of particular importance will be an aspect of their report that includes the process by which they developed their plan. Did they all agree on the problem? The solution? Will any particular group of people or creatures win or lose something because of this plan?

Learning Activities

Map a Local Ecosystem

Objective :	Students define an ecosystem by identifying its natural and man-made elements. Students identify several species, animals and/or insects. Students propose whether the plants and animals are native or nonnative species, and research disturbances in the ecosystem which may explain changes in the plant community.
Materials *:*	(Measuring Tape (String (8 stakes (Scissors

(Plant identification books (half-inch graph paper

(Plastic, zip-lock bag or film container

Procedures

1. Choose a neighborhood ecosystem which can be explored safely. Contact your local parks department if you need help finding a suitable ecosystem.

2. Before visiting the site learn its history and that of the surrounding area. How has the land been used in the past? What plant and wildlife species existed in the area before it was settled?

3. At the site, use the measuring tape, string and stakes to mark off a 50 foot by 50 foot section. Use the graph paper to make a map of the section. Draw compass symbols, and create a legend.

4. Starting one corner, systematically, walk through the section you have marked off. Use tree and plant identification books to identify trees or plants that seem to be the dominant species in the section. Make their approximate locations on your map.

5. Draw the leaves of the foliage in your journal when possible. Make notes on general environmental conditions. How much light does this ecosystem receive? Do plants seem to compete for light? Is the soil compact? Dry? Are there any signs of animal or insect life? How much, if any garbage is in the area?

6. Save some of the soil and/or any surface water for future testing in your plastic baggy or film container. Make sure to mark the container with the date and your name.

7. Summarize your findings in a brief report. Explain if and how the ecosystem that you studied has changed over time. What events or environmental conditions may account for the inhabitants in your environment?

8. What would you need to do to restore the ecosystem to an original or earlier state? What plants would you introduce?

Identifying the Quinnipiac River Basin and Other Long Island Rivers

Using the maps in the Appendix and those provided by the State of Connecticut (see Resources), students will identify the Quinnipiac River and other rivers which comprise the Watershed: The Dead Wood Swamp, Eightmile, Tenmile, Harbor Brook, Wharton Brook, and Muddy River. Students will answer the following questions:

1. Identify each of the Quinnipiac River Watershed rivers. Through which towns do each of these rivers flow?
2. Form teams of six. Each student will select one of the rivers and identify its tributaries—the smaller streams and rivers that flow into it. Have the team combine this information to illustrate one large detailed Quinnipiac River Watershed map.
3. Identify Long Island Sound. List the towns and cities which form the Sound coastline.
4. Identify other rivers which flow into Long Island Sound.
5. Three primary sewage treatment plant overflows empty into the harbor which serve New Haven, East Haven, Hamden and Woodbridge: Boulevard, East Street and East Shore Sewage Treatment Plants. Locate these treatment plants on a local map. Which river or estuary carries sewage overflow to Long Island Sound?
6. If the other large rivers emptying into Long Island Sound contain sewage treatment plant overflow, what effect might these rivers have on conditions in Long Island Sound?
7. Which nearby communities might be affected if farmers in Farmington used pesticides which washed into waterways? Which nearby communities are affected by chemical fertilizers used at the Orange Golf Course?

Water and All its Uses

Students will maintain a journal where they can log daily activities and record all the ways they use water. Remind students to consider water which is a component of something they use. For example, water is used in the car's engine, or cooling system. List all the uses the class may brainstorm. Which of these uses may contribute to pollution?

Start a Scrapbook

Create a class scrapbook from newspaper articles, magazine articles, pamphlets, photographs and other items related to the Quinnipiac River Basin, Long Island Sound and local water pollution. Maintain this scrapbook throughout the unit as it will serve as reference for projects in which students will take action on a specific problem or current issue which will impact water pollution locally. Start writing letters to the organizations listed in Appendix A requesting information. The class should decide how they should organize information in their scrapbook.

Measure Water Quality

Phosphate and nitrate levels increase when excess fertilizers or sewage enters waterways. Nitrate levels above 1 part per million (ppm indicate contamination. Phosphate levels above .1 ppm may cause explosive algae growth. When this algae dies, the decay process depletes the water of oxygen.

The pH scale measures the "potential of Hydrogen", the concentration of hydrogen ions on a scale 1 of 14. On this scale, pH values of less than 7 indicate an acid, while those greater than 7 indicate a base (alkaline). Pure water is neither an alkaline nor a base; it is neutral with a pH value of 7. Rainwater is slightly more acidic with a pH of 6.5. Ammonia has a pH of 11 or 12. Most fish tolerate a pH range of 6 to 8.5.

Materials

Water samples

Plastic vials with tops

neutral litmus paper

nitrate and phosphate testing kit

Procedures

1. Collect water samples from around school, home, local rivers and waterways. Label each with location, date and time of day.
2. Test samples with litmus paper. Identify which are acidic.
3. Test samples using phosphate and nitrate testing kits. Are all water samples the same? Record data.
4. Collect samples again after a rainstorm. Record pH levels. How do they change? Record phosphate and nitrate values. Create bar charts showing the change.

Model Long Island Sound

One way to understand the ways people have damaged the Sound through pollution is to model the Sound as a 20-gallon fish tank. Students can set up the tank, adding plants and gold fish. Long Island Sound contains about 16 billion gallons of water, so the scale is about 1 to 800 million.

Add two teaspoons of raw sewage each day. Add a tenth of a teaspoon of toxic chemicals such as pesticides or solvents (using cleaners from school or home are ideal).

As soon as pollutants are added to the fish tank, remove the fish and examine the gills using a magnifying glass. Students should see the gills which process oxygen quickly respond to the pollutants. Point out that the goldfish would die if left in the tank. Remove the goldfish to clean water, the humanitarian way to complete this project.

Keep adding pollutants and observe water color and smell, and the effects on plants. Students will observe algae growth which blocks out light, absorbs oxygen and ultimately kills the plants, and would kill the fish if they were not removed. Observe the water under a microscope or test water quality, as describes previously.

Develop a Public Opinion Survey

Public information surveys are used to gather information to make generalizations about attitudes. Students will:

(1) Decide what they want to know

(2) Target a specific audience. For example, if they want to examine the opinions of commuters on the expansion of the Quinnipiac River Bridge, they will only Iinterview staff which commutes.

(3) Write questions, taking care to avoid bias. They should ask similar questions phrased differently to ensure consistency of responses

(4) Conduct the survey

(5) Analyze data and report findings. Pie charts are excellent tools for reporting survey findings.

Construct a Pie Chart

Pie charts are excellent visual representations of survey data because they show responses relative to other options.

(1) Students should select data they wish to illustrate.

(2) Convert raw numbers to percentages by dividing the number of those selecting a particular response by the total and multiplying by 100.

(3) Calculate the size of each pie section. The pie “slices” are developed by multiplying the percentage value by 360 (degrees in the circle).

(4) Draw the pie. Color coding each section is also an effective visual tool.

(5) Label each section and title the pie chart.

Figure 1

(Figure available in print form)

Figure 2

(Figure available in print form)

Figure 3

(Figure available in print form)

Figure 4

(Figure available in print form)

Figure 5

(Figure available in print form)

Figure 6

(Figure available in print form)

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Water Resources , U.S., Army Corps of Engineers, April 1997

Recommended Speaker

Peter Davis, New Haven Riverkeeper, (203) 389-1037; 63 Glenview Terrace, New Haven, CT 06515

Additional Resources

Earth Day Maze, $12, Friends of the Future, RR3 Box 250, Burnsville, NC 28714-9312

Earth Day in Your School and Community $12.50; Heartland All Species Project, 5644 Charlotte, Kansas City, MO 64110

EnviroAccount: Environmental Awareness Software $49.95; EnviroAccount Software, 605 Sunset Court, Davis, CA, 95616

Education Resource Catalog , Alliance for Environmental Education, PO Box 369, The Plains, VA 22171

Coastal Resources Maps and Photographs $3-$5; Office of Long Island Sound Programs, Department of Environmental Protection, 79 Elm Street, Hartford, CT 06106-5127

Outdoor Biology Instructional Strategies **, Delta Education, PO Box 915, Hudson, NH 03051-0915**

The Nature Conservancy Student Stewardship Program Manuals , $14 - $32 per book, Chadbourne& Chadbourna Inc., 18554 Haskins Road, Chagrin Falls, Ohio, 44023-1823

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