Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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Long Island Sound

Curriculum Unit 97.06.08
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Teaching science is always easier when students can connect what they learn to their everyday lives. Long Island Sound is their backyard. Students go there in the summer to swim in its waters. For three seasons of the year, they fish and go boating in the Sound. Yet, they have all had their plans ruined due to beach closings, fishing limits, and storms such as Noreasters and hurricanes.

This unit is intended for either an eighth or ninth grade Earth Science class. It is also assumed that students have covered curriculum on the atmosphere, weather and global oceanology. An understanding of the relationships between the aforementioned topics is essential.

In addition, chart interpretation, graphing and data collection will be an integral part of this unit. I plan on beginning a data base that will be added on to yearly. CAPT and Mastery Test objectives will be included in this unit.

Most of my classes meet for a hour, four times a week, so the lesson plans are set up based on this, but they can easily be adjusted.

The culmination of this unit is a “Town Meeting,” involving all of my students. It is also set up as an interdisciplinary project between Science, Theater, Study Skills and Reading Lab classes. More information pertaining to the Town Meeting can be found in Introduction section prior to our four units.

In this unit I plan on exploring the past, present and future of Long Island Sound. Within this, I will be focusing in on Nonpoint Source Pollution, resulting from human impact within its watershed. Students will be examining its causes, impacts and cures through discussions, and hands-on activities and labs.

How important is Long Island Sound? The following is a list of “Sound “ fact which should help to answer that and many other questions:

> Beaches, rivers and lakes are the number one vacation choices for Americans. (Update, 1996)
> The average American spends 10 recreational days a year at the coast. (NOAA, 1994)
> On average, the value of real estate along desirable increases by about 30%, as compared to similar inland properties. (NOAA, 1994)
> Human activities have long focused on our coastline. For example; Native American fishing

camps, and today's harbors, marinas, homes, cities and suburbs. Today, there are thirty harbors in Connecticut. (Bell, 1985)
The U.S. coast supports 28 million jobs, which equals 34% of our work force. (NOAA, 1994)
The commercial fishing and shellfishing industry is worth $45 billion per year. (NOAA, 1994)
15 pounds of fish/ shellfish is consumed per person, each year. (NOAA, 1994)
The "Clean Water" technology industry generates sales exceeding $64 billion per year in the United States, and $170 billion per year abroad. (Update, 1996)

Long Island Sound Facts —(from The Long Island Sound Study, 1996)

90% of its freshwater comes from the Connecticut, Thames, and Housatonic Rivers.
110 miles long; 600 miles of coastline (271 miles belonging to Connecticut).
21 miles at its widest point.
1300 square miles (787,000 acres) = 0.04% of the world's coastal ocean.
Surface temperatures; 32-73 degrees fahrenheit.
Salinity ranges from 23ppt-33 ppt(at the Race).
Currents strongest at eastern end.
Tides greatest at western end. Two high tides and two low tides each day.
5 million people living within fifteen miles of its coast.
14.6 million people living within its drainage basin.
2 states bordering the Sound.
5 states contributing to the Sound's watershed (Ct, MA, NH, NY, VT).
3 New York counties and 24 Connecticut towns with coastlines on the Sound.
40% of Connecticut's population lives on its coast.
44 sewage treatment plants discharging directly into the Sound.
248 miles of beaches, 95 miles publicly owned.
200,000 boats registered "Sound-wide."
Sport fisheries worth $70-$130 million to the economy in 1987.
6 million people visited state-owned beaches in 1988.
Commercial fisheries worth $36-$40 million to the economy in 1987.
750,000 recreational fishermen.
20,000 boat slips.

Long Island Sound, unlike most other estuaries, has two connections with the ocean. Through the East River/NY Harbor to the west and through the Race to the east. The water entering through the Race has a higher salinity.

Long Island Sound is really a combination of two systems, a sound and estuary. A sound is defined as a relatively narrow passage of water between an island (Long Island) and the mainland (Connecticut). (Random House, 1991)

The focus of this unit will be on Long Island Sound as an estuary. An estuary is defined as a coastal area where fresh water from rivers and streams, mixes with salt water from oceans. Examples include; bays, sounds and lagoons near the coast. Estuaries also include portions of rivers and streams connected to the above. (EPA, 1993)

Estuaries are safe spawning grounds and nurseries for organisms, that when young would not be able to survive in the open ocean. Marshes and other vegetation in estuaries, protect water quality by filtering out sediments and pollutants. These areas store large amounts of water and are barriers against storm waves and floods. (EPA, 1993)

Estuaries, such as Long Island Sound are highly valued for their recreational and economic value. About 31% of our GNP is produced in coastal counties. Almost one half of the United States population lives in coastal areas, including the shores of estuaries. Due to the above, estuaries all over the world are under stress, becoming polluted, upsetting the ecological balance and impacting our lives. (EPA, 1993)

Due to the above, Congress established the National Estuaries Program in 1987 as part of the “Clean Water Act.” Its mission is to protect and restore the health of estuaries, while supporting economic and recreational activities. NEP also helps to create partnerships between the government and people of the area, through grants and technical assistance. (EPA, 1993)

Estuaries are among the most productive ecosystems on Earth. Long Island Sound is no exception. In 1990, the value of the Sound was $5.5 billion per year. This included (in millions of dollars);

boating	3322.2
sportfishing	1065.2
swimming	842.8
commercial fishing	148.4
intrinsic value	151.6

(Long Island Sound Study, 1992)

Two-thirds of the U.S. commercial fish species depend on estuaries as nurseries and breeding grounds. Prior to the 1970’s, many estuarine wetlands were filled in for residential and commercial uses. (Metler, Tiner, 1992)

History of Long Island Sound

When the first settlers arrived, it is estimated that the Native American population in Connecticut was around 20,000. By the mid 1600's, four out of five of the established settlements were coastal communities. Today, almost half of the U.S. population lives in coastal communities (which make up 11% of our countries land). (Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991) The stresses that this population increase has had on the Sound will be discussed in the section on pollution.

During the past 1.8 million years, Connecticut's coastline has moved tens of miles landward when sea level rose, and tens of miles seaward when sea level fell. These changes in sea level are caused by periodic, cyclic global cooling and warming. (Patton, Kent, 1992) In addition, changes in sea level are in response to plate tectonics. Influencing the Atlantic Ocean is the activity of the Mid-Atlantic Ridge. This results in progressive deepening of the ocean, away from the ridge. (Turekian,1996)

22,000 years ago, the last glacier that affected CT. reached its southernmost point. Sea level was 350 feet lower. The coastline lay 75-115 miles off the south shore of Long Island, on what is today the continental shelf (150 miles south of its present position). The thickness of the ice sheet was approximately 1800 feet at New Haven and 2500 feet in Hartford. (Patton, Kent, 1992)

The following is a summary of a time line from, *A Moveable Shore* by Peter C. Patton and James M. Kent, 1992.

> 17,000-18,000 years ago: As the ice retreated to expose the present Connecticut coastline, rivers from the melting glacier formed a freshwater Lake Long Island Sound. Sea level was 260 feet below its present position. At this time, cave paintings were done in Valencia, Spain. These are believed to have indicated global warming.
> 11,000 years ago—Lake Long Island Sound overflows and a deep gorge is cut to meet the ocean. The oldest, undisbuted evidence of human occupation in North America is from this time period.
> 10,600—First occupation of humans in Connecticut, is thought to be around this time, due to evidence found in other New England states.
> 8000 years ago—Rising sea level (60 feet lower than today) starts the formation of present day Long Island Sound. Around this time, mammoth and mastodon become extinct. There is evidence of the climate rapidly warming and drying. Agriculture begins in Mexico.
> 4500 years ago—Sea level is 33 feet lower than it is today. Connecticut's climate is similar to the present one.
> 1000 years ago—Sea level is 3 feet lower then it is today. The first salt marshes appeared in the Connecticut River estuary. The Woodland Indian culture in Connecticut was hunting and gathering.

Today, sea level is rising at a rate of 2-3 mm(one-eighth inch) per year. This is equal to the thickness of 2 1/2 credit cards. This sea level rise of 2mm. per year is equal to 200mm.(8 inches) in one hundred years, or about 2.5 inches since Connecticut was settled. (Patton, Kent, 1992)

Many scientists believe that the current rise in sea level is due to global warming (human-caused) canceling out the effects of plate tectonics. (Turekian, 1996)

Scientists term Connecticut's coast, "a drowned coastline." This is because the sea has encroached over the land, flooding the coastal plain. (Patton, Kent, 1992)

Storms also help to shape our coastline. The 1938 hurricane had the greatest storm surge ever recorded in Connecticut. Sea level rose 10 feet during this storm. Storm surges are caused by the following:

Low barometric pressure of the storm, pulling the surface of the Sound upward.
Counterclockwise winds that push ocean water into the Sound.

How close was the storm's arrival to a spring high tide (a high tide that is higher than normal).

During the 1938 hurricane, erosion pushed the shoreline back 100 feet in places. (Patton, Kent, 1992)

More information on hurricanes and storm surges can be found in my Institute unit on "Severe Storms and Weather Forecasting," from 1994.

In addition, due to prior rainfall and the speed with which the rain fell during the 1938 hurricane, two days later Connecticut had its second worst flood in 350 years. (Patton, Kent, 1992)

Nor'easters are storms that form off of, and move up the coast. These storms can cause up to 36 hours of wind and rain. They also help to erode our coast. (Patton, Kent, 1992)

Winds, waves, and currents also help to shape the shoreline. Tides bring and carry away sand and sediment. The difference between high and low tide varies along the coast. In Greenwich, the difference is seven feet, four inches. In New Haven, the difference is six feet, two inches. In Stonington, the difference is only two feet, seven inches. I cover wind, waves, currents and tides in global ocean and plan to review them in this unit, with a Long Island Sound twist. The book, "A Moveable Shore," by Patton and Kent 1992, contains the above tide information. It also contains information about winds, waves and currents in Long Island Sound.

A sandy coast (beach) tremendously increases property value. When they erode due to natural forces and processes previously stated, property values drop. Thus, we attempt to stop the sand from eroding. In doing this, we are not always successful. Sometimes we make it worse and other times we only create temporary solutions. One example of this is the beach in West Haven. Their coastline has been pushed back up to 100 feet in 22 years. One million dollars has been put into projects to stabilize their shoreline. Much of this money has been wasted and some of the stabilization attempts have caused further erosion. (Patton, Kent, 1992)

Salt marshes are also important features of Connecticut's coast. They produce more plant matter per acre than any other ecosystem. This makes them fertilizers for Long Island Sound and the rivers of Connecticut.

They preform similar functions to the estuaries. Salt marshes are safe breeding and nursery grounds. They help to filter out pollutants. Marshes also act as buffers that reduce flooding and erosion. Since the time of the settlers, marshes have been drained, mowed for hay (I know a garden center that still sells salt marsh hay), ditched to prevent mosquito breeding. (Patton, Kent, 1992)

In Connecticut, we have lost 25-35 percent of the original marshes. Throughout New England, more than half have been destroyed. The destruction of marshes has slowed down due to regulations. Yet, almost 15,000 acres (about 23 square miles) of marsh has been destroyed in the last 40 years. (Patton, Kent, 1992)

Connecticut is known for its rocky coast, of which there are three types. Bedrock, bouldery and gravelly. Bedrock coastlines resist erosion, but get hit hard by storms. Bouldery resist erosion and all but the strongest storms. Gravelly coastline resistance falls in the middle of the other two. (Patton, Kent, 1992). An interesting activity is to go to the beach and separate out the sediment by size and percentage.

Physical Properties

Salinity in the Sound is less than that of the open ocean. The water with the highest salinity can be found at the Race. This is the area where Long Island Sound Lake met the ocean. This is the main area where saltwater flows into the Sound. The channel at the Race is 350 feet deep and very strong currents flow here. (Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991)

From personal experience, if the rest of the Sound is calm, the Race is still very choppy. Also, this area is great for bluefishing.

It is estimated that 470 cubic meters (120,000) gallons of fresh water enter the Sound every second. The Connecticut River accounts for 70% of this. (DEP, 1989)

Also, it is estimated that 19,000 cubic meters per second of saltwater enters the Sound at the Race. (DEP,1989)

Dissolved oxygen will be discussed in the pollution part of this unit.

Biotic Factors

Students will have completed an Oceanography report prior to this unit. Within this, they will have done some independent study work on organisms that live in the Sound. Also, students will have had a very close look at a Mollusk collection from the Sound.

Students will also have had experience collecting and mounting seaweed from a trip to Bluff Point and some local areas..

During this unit, I plan on having a guest speaker from DEP/ Sea Grant come, not only with slides, but live Long Island Sound organisms for the students to see and hold.

The Sound is a greenish color due to the plankton that live in it. During this unit they will see plankton from the Sound under a microscope and try to identify the different types. The importance of plankton to the food chain and Long Island Sound will be discussed in this section too.

Long Island Sound Watershed

No discussion of Long Island Sound can be complete without including its watershed. A watershed is the land that water flows across or under, on its way to streams, rivers or lakes. This water eventually ends up in the Sound, and will be part of the focus on nonpoint source pollution. (USDA, 1994)

We all live in a watershed and have an effect on both it and all parts of the water cycle. See appendix p. 1 for the Long Island Sound watershed.

Rainfall and runoff can pick up pollution throughout the cycle. Natural areas with vegetation help to slow runoff, reduce erosion, allowing water to seep into the ground. Problems come about in developed areas. Here runoff speeds, and amounts are greatly increased due to the large numbers of paved surfaces. This increases the amount of soil erosion, and decreases pollution processing by the soil. Increased surface runoff, along with storm drains and sewer overflows help to carry pollutants directly or indirectly to the Sound. (USDA, 1994)

Long Island Sound Pollution

Students will explore both point and nonpoint pollution sources, culmination in a “Town Meeting.” Six problems will be focused on;

Low dissolved oxygen (hypoxia)
Toxic contamination
Pathogen contamination
Floatable debris
The impact of these water quality problems and habitat degradation and loss, on the health of living resources.
Land use and development, resulting in habitat loss and degradation of water quality.

There was a major population influx to coastal area and watershed of the Sound after World War II. This increased population worsened pollution, altered land surfaces, reduced open spaces, and restricted access to

the Sound. Use of the Sound as a place to dispose of human and other waste increased dramatically. Paving over of land and habitat destruction, added even more stress to the Sound and its waters. Due to regulations, loss of tidal wetlands by filling, dredging and development has slowed down, but pollution and habitat loss are still a problem. (Atkin, Bangser, Jacobson, Smith, Wade Backer, 1991)

It took a few million years for the Sound to form, but only a couple of hundred years to pollute it. 32.6% of the Sound's watershed is found in Connecticut. 1.8% of the Sound's watershed is found in New York. These are the two states bordering the Sound. The rest of the Sound's watershed is found in Mass, NH., and VT. Imagine the Sound as a large pool, filled with saltwater that flows in and out. Add freshwater from rivers and streams. Add the plants and animals that depend on it. Finally, add the following; groundwater seepage, surface runoff, rainfall, storm drain overflow, sewage treatment plant outflow, and industrial wastewater. (Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991)

Many parts of the Sound are beautiful and healthy, some have really been cleaned up, but pollution in the Sound is still a major problem.

Sources of water pollution are divided into two types; point sources and nonpoint sources. Point sources are easy to see and understand. Any pipe or ditch spilling wastewater directly into the Sound is a point source. (Atkin, Bangser, Jacobson, Smith, Wade, Backer,1991)

Nonpoint sources of pollution are much harder to identify and understand. These sources, their damage and control will be the focus of the pollution part of this curriculum. Sources of nonpoint pollution include; runoff from construction sites, farms, paved surfaces, marinas, garbage dumps, contaminated groundwater, and overfertilized lawns. Stormwater runoff is a major source of this type of pollution and it can originate anywhere in the watershed. Your home is also a contributor to this type of pollution. Anything that you spread or spill in your yard (examples include overuse of pesticides), that gets into the groundwater, can end up into the Sound. If your septic system overflows or you litter near a storm drain, you might be a contributor. (Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991) See appendix

Atmospheric Deposition

This is one type of nonpoint source pollution that is not well known to most people. Pollutants can be added to the Sound when it rains or snows. These include; lead, sulfur, and nitrogen compounds (up to 23% of the total nitrogen load). (Beristain, 1989)

Pollution

Runoff is the major source of nonpoint pollution entering Long Island Sound. Rain washes contaminants, litter and soil into streams, rivers and bays. As water flows over or underground, it picks up pollutants. Farming can add nutrients and pesticides from animal wastes and fertilizers to the runoff. (Beristain, 1989)

In urban areas, where there is a lot of developed land, materials such as asphalt and concrete, along with buildings prevent rain from soaking into the ground. Here rain collects in storm drains, then goes directly into rivers and streams on its way to the Sound. This increase in runoff prevents water from being naturally filtered

by soil. (Beristain, 1989)

Cars, highways and parking lots add oil, grease, and lead to runoff into the Sound. One-fourth of a teaspoon of oil will form a 200 square foot oil film on the Sound's surface. Litter washes from the streets into storm drains, on its way to the Sound. (DEP, 1996) Storm drains are part of nonpoint source pollution. A misconception that many people have is that storm drains lead to a sewer treatment plant, but this is not the case. After water enters a storm drain it is usually transported directly to the nearest lake, river, stream or wetland. (DEP, 1996)

Rivers are also considered nonpoint pollution sources because their water condition varies depending on the activities within the watershed. (Beristain, 1989)

Hypoxia

Nitrogen is the major cause of the Sounds hypoxia problems. Hypoxia is a condition where the dissolved oxygen level in the water is too low for an organisms survival. 5mg/liter of dissolved oxygen is considered good. Hypoxia can occur naturally in estuaries during the summer. In warmer water, the solubility of oxygen is lowered. In calm water, little mixing occurs and water separates into layers called pycnoclines. See appendix p. 1-2. Here the warmer, less dense water stays on top and the cooler, more salty water stays on the bottom. Thus oxygen can't cross this boundary. Then the decomposers which break down oxygen use it up. Hypoxia usually starts during an algal bloom, fueled by warm temperatures, and a good supply of nutrients. Algae (which are short-lived) die, fall to the bottom. Here they become food for oxygen consuming decomposers. Human pollution, adding nutrients to the water has increased the hypoxia problem in the Sound. (Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991)

Nitrogen (in various forms) is the major nutrient that contributes to the hypoxia in the Sound. See appendix 00. In pre-colonial times, the bottom dissolved oxygen reading was 5 mg/l (see appendix p. 1-2). Since then, the total nitrogen compound load to the Sound has more then doubled. (EPA, 1993)

Nitrogen compounds in Long Island Sound, come from the following sources; 44 sewage treatment plants (see appendix p.4), stormwater runoff, acid rain/ precipitation, runoff from urban areas, septic systems, industrial wastes, agricultural lands, lawns and gardens (overfertilization), and livestock feedlots. (DEP, 1993) 1996)

Forms of Nitrogen delivered to the Sound include;

Organic nitrogen, incorporated into dead or living organisms.
Ammonia, a by-product of waste and bacterial decay.
Nitrate and nitrite, which are by-products of bacterial decay.
Nitrate from atmospheric deposition, originating from combustion of fossil fuels. (Beristain, 1989)

Human activities mostly responsible for the excessive nitrogen, include both point and nonpoint sources. They

are; sewage treatment plants that discharge directly into the Sound, alteration of land cover by developers, and agricultural and atmospheric deposition.(Beristain, 1988)

93,600 tons of nitrogen compounds are estimated to be delivered to the Sound each year. Of this, 39,900 tons come from natural sources and 53,700 tons come from human activities. (Dept. Of Env. Protection, 1993). 8400 tons of this nitrogen comes from nonpoint pollution sources. (Beristain, 1989)

Floatable Debris

Floatables are water-borne debris that wash up onshore. Sources of these include: street, beach and boat litter, overboard garbage disposal by boats, escape from landfills, loss during marine transfers of waste, and combined sewer overflows. See appendix p.1. Hospital waste washing onto beaches has been responsible for many closures. Harbors and tributaries are also sources of floatable debris. (Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991)

Floatables are a nuisance or hazard for beachgoers. They can harm wildlife. Animals ingest them, which can result in suffocation or starvation. Undigested plastic pellets can stay in an animals stomach, leaving no room for real food. (Long Island Sound Study, 1989)

Toxic Chemicals

Toxic chemicals can kill or harm living organisms. Examples include; PCB's, pesticides, petroleum, PAH's (a type of hydrocarbon), and heavy metals such as copper, lead, and mercury. Many of these chemicals have the ability to be toxic at low concentrations. Some of these become incorporated in the tissues of organisms, and then become amplified up the food chain. Others accumulate in bottom sediments. (Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991)

Sources of toxics include;

Copper from household plumbing.
Lead from runoff over surfaces exposed to leaded gasoline and paint.
PAH's from atmospheric deposition.
PCB's, though production stopped in the 1970's, they still persist in the environment.
Petroleum, it is estimated that 0.1% of the world's production gets spilled in the oceans.

(Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991)

See appendix p.2 for more information.

Pathogens

Bacteria, viruses, and other microorganisms that can cause disease are called pathogens. The primary sources of these are older sewer systems that have combined stormwater and sanitary systems that overflow during storms. Other sources include; sewage treatment plant malfunctions, illegal connections to storm sewers, vessel sewage discharges, failed septic systems, stormwater runoff, and animal wastes. (Beristain, 1990)

Checking for these pathogens is done indirectly. Coliform bacteria, found in the digestive tracts of all warm-blooded animals are analyzed. Coliform bacteria are not harmful to humans but because they are always present in sewage and animal waste, they indicate the possible presence of pathogens. When high coliform counts are found, shellfishing is banned and beaches are closed to swimming. Diseases most often due to pathogen exposure, in this part of the world include; gastroenteritis, salmonellosis, and hepatitis. (Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991)

The estimated percentage of fecal coliform discharged yearly into the Sound comes from the following sources; 51.6% from rivers (from upstream sewer treatment plants) and nonpoint sources (ex. failing septic systems), 47.3% from urban runoff, which includes combined sewer overflows, and 1.1% from sewage treatment plants and industrial sources discharging directly into the Sound. (Beristain, 1990)

Erosion and Sedimentation

Soil erosion due to human activity is a major source of sediments and pollutants entering the Sound. This eroded sediment can remain in the water for a while, blocking out sunlight and reducing biological activity. Sediment can destroy spawning areas and choke out marine life and vegetation, thus adversely changing the ecosystem.

Construction puts 48,000 tons per square mile per year in runoff.

disturbed forest contributes 24,000 tons of sediment per year to the Sound.

Cropland contributes 4800 tons of sediment each year.

Grassland contributes 240 tons per year.

Undisturbed forces, 24 tons of sediment per year to the Sound.

(Atkin, Bangser, Jacobson, Smith, Wade, Backer, 1991)

The Future of Long Island Sound

Much effort has been made at the federal, state and local level to clean up Long Island Sound. As one can see in my Teacher Resource section, interest in the Sound is widespread. Some actions that have been taken to date to help clean up the Long Island Sound are;

> Nitrogen loads from certain point sources have been regulated and now they are 5000 pounds per day below 1990 baseline levels.
> Connecticut has one denitrification plant on line, and plans for another.
> CT and NY share a fund that is targeted to reduce nonpoint nitrogen sources.
> Broader efforts are underway in CT and NY to address nonpoint sources of pollution and stormwater management. This will help in the control of pathogens.
> New York City has reduced floatables by 70%, by placing booms across tributaries, and improving capture of combined sewer overflows.
> In CT and NY, beach cleanups have removed over 11,000 pounds of trash, over a distance of 53 miles.

(DEP, 1993)

Long Island Sound is our student's "backyard." A unit on the Sound is very meaningful to them, as they can all relate to it. The students are the Sound's future and hopefully they will continue in its restoration.

Unit Objectives

Students will gain more experience with open-ended problems, preformance-based labs, writing across the curriculum, and cooperative learning.

The following objectives are taken from *Benchmarks for Science Literacy* , 1993.

> As a result of this unit, students will be able to understand the following;
> Fresh water, limited in supply, is essential for life and also for most industrial processes. Rivers, lakes, groundwater and all other water bodies can be depleted or polluted, and unsuitable for life. The benefits of the Earth's resources, can be reduced by using them wastefully or by deliberately or inadvertently destroying them. The ocean and Long Island Sound have a limited capacity to absorb and recycle materials naturally. Cleaning up polluted water can be difficult and costly.

The global/ local environment is affected by policies and practices relating to energy use, waste disposal, ecological management, manufacturing, and population.
Waste management includes considerations of quantity, safety, degradability, and cost. It requires social and technological innovations, because waste-disposal problems are political and economic as well as technical.

In addition to the above, students will understand the impact Long Island Sound has on their lives, and the effect they have on its health.

Curriculum

Throughout this curriculum, data and chart analysis will be stressed. Statistical analysis of data will also be a theme (stem and leaf plots, scatter and line plots). CAPT and Mastery Test objectives will be included. Real data will be collected and utilized. Data will also be saved as part of a yearly database for use in future years.

The government is a tremendous and under-utilized resource. In the case of Long Island Sound, they are a wealth of both curriculum and informational materials. See the Teacher Resource section for details.

The following curriculum assumes that the students have already covered oceanography on a global scale. My unit culminates with a “Town Meeting,” which will be held sometime in early January.

Day 1

Review of prior knowledge of Long Island Sound. Have students fill out a questionnaire using the following; what they know, how the Sound has affected their lives, and what they want to know about the Sound.

Also, as an introduction to this unit, read to the students part of a book called, *Oscar Lobster’s Fair Exchang* e. Many scientific truths can be found in this book and related to the Sound.

Day 2

Discuss colonial expansion and the impact it had on the Sound. Also, go over the geological and glacial history of the Sound. If time allows, do a demonstration on glacial processes.

Assign the poster project for homework. The poster should be on Long Island Sound, its history and formation. It also should include examples of organisms that live in the Sound, and the causes and effects of pollution. Have it due on the eleventh day. It is worth one quiz grade and develop a scoring rubric for it.

Day 3

Biological factors should be covered today. Include a short video on the Sound. Go over the history of

oystering in Connecticut and modern day aquaculture, as they relate to our state.

Day 4

Go over plankton in the Sound, their impact on its waters and the food chain. Do a plankton lab. Develop a lab which includes identification. Have students develop a chart based on their findings. Students have a lot of fun looking at plankton under a microscope, especially when they find out that they swim with these creatures.

Day 5

Guest speaker on plants and animals of Long Island Sound. Have them bring live animals for the students to touch and hold.

Day 6-7

Abiotic factors of Long Island Sound. There are a bunch of activities from *Project Earth Science: Physical Oceanography* , by Brent A. Ford and P. Sean Smith. Examples include; a hydrometer activity and an estuary activity. Vary the labs based on student ability. Prentice Hall also, has a variety of activities including one on thermocline.

Day 8,9,10,11

Discuss the definition of a watershed. Show chart and diagrams related to this. See appendix. A groundwater model can be borrowed from DEP for $25. Introduce “The Fruitvale Story.” This is a series of labs relating to groundwater pollution and its spread throughout the watershed. The activities in the series include; water movement in aquifers and aquitards, serial dilution, finding the polluted “well,” using universal indicator and buffering solutions, and an activity on contamination plumes.

The Fruitvale Story lab series was developed by Lawrence Hall of Science and is a New Haven curriculum requirement.

To add and enhance the series of above labs, there are additional activities from another group of labs called, “Soda Bottle Hydrology.” This series from HAZWRAP can be obtained from the U.S. Dept. of Energy and was developed by the Hazardous Wastes Remedial Actions Program. Some of the activities in this series include; core sampling, solubility, pollution plumes and chemical changes in groundwater. There is also a glossary of terms to share with the English or Resource teachers. The activities on these four days are great precursors to a discussion on Long Island Sound’s pollution problems.

Collect the poster projects on the Sound on Day 11. Display them around the room and school.

Day 12

Human impact on Long Island Sound—pollution, flora and fauna changes. Include discussion on the spread of Phragmites and the impact of ballast water.

Oil Spill cleanup lab. Have students test the effectiveness of different materials and soaps on the cleanup of oil spills. Talk about oil fingerprinting, and how the U.S. Coast Guard at Avery Point in Groton has become the U.S. authority with spills in our waters.

Day 13

Go over the different types of pollution in the Sound, its causes, impacts and cures. Show chart and graphs and have students interpret the data. Compare pollution amounts and effects in different part of the Sound. Emphasize nonpoint source pollution, as it will be the focus of the Town Meeting.

Day 14

The Watershed Monitor , from DEP (summer 1996) contains an excellent activity called, “Long Island Sound in a Jar.” The author is Heather Crawford. Each group of students is given “polluted water.” This contains; vegetable oil, leaf litter, soil, fertilizer, detergent, food coloring, assorted litter, and vinegar.

Each group is given the following material to help clean up the water; 1 dishpan, 16” square of screening, 1 piece of cheesecloth, 1-2 eyedroppers, 1 container for waste cleanup, 2 funnels, three-fourths cup of clean sand, 1 empty quart jar, 1 quart jar half full of tap water, 1 small sponge, 1-2 spoons, and 1 tablespoon of alum.

Students are given very little other information, and have 20-30 minutes to clean up the water.

Have students decide which jar of water looks the cleanest, and check the pH of the samples. Compare the lab to what happens at water treatment plants. Ask the students which pollutants were the hardest to clean? Discuss dilution and bioaccumulation.

Day 15

Field trip to Bluff Point in Groton, CT. For us, this trip to collect data will have to be run prior to January due to the weather. If this unit is run in spring or fall, keep this trip within the unit time frame.

Bluff Point is a state coastal preserve. It encompasses a total of 778 acres. Here there are a variety of habitats to study, interpret and collect data. As you walk in from the parking lot, on the right is the Pequonic River and on the left woodlands. There is salt marsh, salt pond, sandy beach, rocky beach, tidal pools, and small dunes to study.

Students can do studies along transect lines, and can key out a variety of flora and fauna. A seine can be used to collect, observe and then release organisms. Glacial geology and beach structure can be observed. Core sampling and sediment makeup are two other activities to choose from here.

Seaweed for pressing and shells for collecting are in abundance here. Nature journaling is another activity. Bring along field guides or laminated guide sheets for easy identification. Bluff Point is an excellent place for birding. A photography class could easily help document data for use in science.

For students, this is wilderness, we may only see a few other people out here all day. The only regular manmade noise is from the airport across the river. I will be making two trips to Bluff Point in the fall. One with my regular science classes and one with the Science Club.

Day 16,17

Town Meeting Preparation. Refer to the introduction of the Betsy Ross Team/ Long Island Sound units.

I will have more students involved in this compared to the other three teachers. Most of my students, not involved with the other teachers will been in the audience and they too will have an assignment. All students will be asked to come up with a questionnaire about nonpoint source pollution. These are questions that might possibly be asked during the Town Meeting.

My students will share their posters, first with classmates and then with participants in the Town Meeting, as they will be placed in the library (where the meeting will be held). All of my students will be asked to come up with a rap, poem or cartoon depicting the problems of and solutions to nonpoint source pollution. A number of these will be shared with the Town Meeting participants from all four classes and guests.

Day 18

The Town Meeting is a joint team project between myself (an eighth grade science teacher), Yel Brayton (a theater teacher), Linda MacNaughton (a study skills teacher), and Mary Alice Howley (a reading resource teacher).

We share many of the same students. The students that I have, while the other teacher's don't, will be active members of the audience and involved in the whole process as well. We believe that the students will greatly benefit from an interdisciplinary project such as this. They will be able to see how all aspects of their education are related to each other. The Town Meeting will be an opportunity for the students to see the effects of a problem (nonpoint source pollution), and the impact it has on their daily lives. It also gives them an opportunity to be "informed citizens," and to see how they can have an impact on their future.

We will be inviting some New Haven dignitaries and the New Haven Register to the Town Meeting. Lastly, we will be serving to all participants and guests, "a little taste of the Sound (Irish Moss Pudding and seafood)."

Day 19

Summary of the Long Island Sound unit and discussion about the Town Meeting. Tie-in to the Atlantic and other oceans. Discussion of the impact of global change, seen on a local scale.

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* This is useful to both teachers and students.

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Appendix

(figure available in print form)

(figure available in print form)

Teacher Resources

Bruce Museum, 1 Museum Drive, Greenwich, CT.06830, (203) 869-0377

Captain's Cove Seaport, One Bostwick Ave., Black Rock Harbor, Bridgeport, CT. 06605, (203) 335-1435

CT. Audubon Coastal Center, 1 Milford Point Road, Milford, CT. 06460, (203) 877-0668

CT. Sea Grant, Marine Advisory Program, UCONN Cooperative Extension System, P.O. Box 70, 1066 Saybrook Road, Haddam, CT. 06438-0070

Department of Environmental Protection, Office of Long Island Sound Programs, 79 Elm Street, Hartford, CT. 061065127, (860) 424-3034 (860) 424-4954 fax

Faulkner Island (open one day per year), (203) 299-2513

Hammonasset Beach State Park, Madison, CT., Nature Center (203) 245-8743

Long Island Soundkeeper Fund, P.O. Box 4058, Norwalk, CT., (203) 854-5330

The Maritime Aquarium at Norwalk, 10 N. Water Street, Norwalk, CT. 06854, (203) 852-0700

Mystic Marinelife Aquarium, 55 Coogan Blvd., Mystic, CT. 06355, (860) 572-5955

The Nature Conservancy, 55 High Street, Middletown, CT. 06457, (860) 344-0716 (860) 344-1334 Fax

Project Oceanology, Avery Point, Groton, CT. 06340, (860) 445-9007

Schooner, Inc., 60 South Water, Street New Haven, CT. 06519, (203) 865-1737

SoundWaters, Brewers Yacht Haven Marina, Washington Blvd., Stamford, CT. 06902, (203) 323-1978

UPDATE (newsletter for Long Island Sound), Free subscription, (516) 632-9216

U.S. EPA Long Island Sound Office, Stamford Government Center, 888 Washington Ave., Stamford, CT. 06904, (203) 977-1541