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The New Haven Oyster Industry and Water Quality

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The oyster industry has made an enormous impact on New Haven's economy, culture and development. In the 1880's, million of oysters were harvested from the harbor in New Haven and riverbanks in Fair Haven. Today, however, oysters can't be harvested directly from oyster beds in these areas because the waters are too polluted. In order for these oysters to be ready for market they must be transplanted to cleaner waters offshore before they can be harvested.

The oyster industry in New Haven was devastated due to over-development, poor watershed management, industrial discharges and sewage waste. In the 1970's, water quality in Long Island Sound improved, in part, because of strict pollution guidelines established by the Environment Protection Agency. The result was a resurgence of the oyster industry in New Haven in the next decade. This industry, however, never gained the importance it had in the past and today there are only two major oyster harvesters in the New Haven area.

The Curriculum

This curriculum will be designed to help students understand the relationship between the water quality of Long Island Sound and the affect of pollutants on the shellfish living in its waters.

This curriculum will allow my students the opportunity to study a subject that is of great importance to their community. It will assist them in understanding that there is a direct link between their decisions and actions in the community and the health of Long Island Sound.

Designed for students in grades 9-12, this curriculum will investigate the importance of watershed management for the water quality in the Sound. It will trace how pollutants released in neighborhoods throughout Connecticut end up, often untreated, in Long Island Sound. It will also help students understand what they can do to prevent pollutants from entering Long Island Sound.

This curriculum will:

1. Examine the types, causes, and consequences of pollution in New Haven Harbor

2. Allow students to inspect water quality and the pollutants that are present

3. Explore how pollutants enter the waterways and what problems these pollutants cause

4. Understand the need for clean water

5. Help students analyze their environment by utilizing scientific journals, government reports, and other research material including the World Wide Web

6. Help them to research the current condition of the Long Island and New Haven Harbor habitat and its affect on the oyster population.

7. Assist students in understanding the economic impact that this industry has had on the development of New Haven and surrounding areas

Population

This curriculum will be taught to students who are visually impaired and blind in my course “Life Skills for Blind and Partially Sighted.” In addition, I will teach the unit in the summer school program and in the Extended Day Academy for visually disabled students. This unit will be of interest not only to visually impaired students but also their sighted peers. In addition, it can be modified for elementary and middle school or special needs students.

Modifications for Blind and Visually Impaired

This curriculum will greatly assist the visually impaired students that I teach. Science is an important but often difficult and challenging subject for blind and legally blind students to master. Visually impaired students need adaptations in equipment, teaching procedures, lessons and activities. Such adaptations will ensure that visually impaired students will acquire the skills necessary to complete assignments and gain scientific knowledge.

To derive maximum benefit from this curriculum visually impaired students should be presented with a multi-sensory approach that allows students to acquire information from other sources of sensory input to compensate for reduced vision. It should include tactile diagrams, audio narratives, and Braille and large-print translations

This curriculum will allow visually impaired students the opportunity to:

1. Practice the acquisition and recording of data

2. Use specialized tools and materials such as talking scientific instruments

3. Gain experience in using charts, diagrams, graphs, or measurements using recorded, tactile, large print or Braille materials

4. Research using translations of textbooks, videotapes, computers, journal articles, supplementary reading materials, and handouts in Braille, large print, or audiotapes

5. To participate in learning activities that develops scientific knowledge and skill.

6. Examine the types, causes, and consequences of pollution in New Haven Harbor and Long Island Sound

7. Inspect the water quality; explore how pollutants enter the water and what such as talking scientific instruments

History of the New Haven Oyster Industry

Timeline

1700's -Native Americans and European settlers gathered oysters as a food source

1762 -The first laws were passed limiting oyster harvesting to two bushels per day1

1850's -The Oyster industry becomes an important and prosperous commercial industry when New Haven oyster harvesters discovered how to plant seed oysters from Southern waters to increase production. Over 86,000 acres of oyster beds were cultivated.2

1880's -Over 15 million oysters harvested from New Haven Harbor and Fair Haven

1911 -The General Statutes and Health Regulations of New Haven prohibit the floating, fattening, or selling of oysters from the polluted waters of New Haven3

1970's -Strict pollution guidelines set by the Environment Protection Agency leads to improvement of water quality in Long Island Sound

1972 - Clean Water Act is passed.

1980's -Resurgence in the oyster industry in New Haven with 52,500 acres under active cultivation

1988 - Passage of he Safe Drinking Water Act. This bill limits the amount of lead in drinking water to 15 parts per billion. This legislation allows only lead free pipe, solder and flux to be used in constructing and repairing drinking water systems.

2000's -Only two major companies harvest oysters

History of the New Haven oyster harvesting

Oysters provided Native Americans and Colonial settlers with an important food source.

Oysters were plentiful and could easily be gathered from the riverbanks at low tide. Early settlers, according to records from Colonial periods, consumed an average of 10 bushes of oysters per year.4 It was a common sight to see mounds of discarded oyster shells piled around the harbor.5

Like Native Americans, the early settlers also used dugout canoes to harvest oysters. Averaging 28 feet long, three feet wide, and one and a half feet deep, the canoes could navigate fully loaded in nine inches of water. Approximately thirty bushels of oysters could be stored in these canoes that were propelled by a sculling oar or by sail.6

By the 1800's this industry was thriving in New Haven.7 The development of larger, more seaworthy boats became a necessity as the oyster beds extended beyond the breakwaters. Local boat builders designed a vessel known as "the sharpie." This craft was ideal for oyster harvesting, in both shallow waters of the harbor as well as the deeper waters of Long Island Sound. The sharpie "drew little water and provided enough room for two oystermen to haul up their oysters and dump them on deck."8 Made in three different sizes, this vessel allowed even a single harvester the opportunity to work alone and yet gather up to 100 bushels of oysters. It was inexpensive and sturdy.9 Fair Haven boat builders, George Graves, Lester Rowe and E.H.

Thatcher were leading builders of “sharpies.”10

Harvesting and the sale of oysters grew dramatically by the 1850’s and commercial oyster harvesting developed into the dominant industry in Fair Haven. This was due, in part, by the building of the “sharpie;” the discovery that oysters could be transplanted from warmer waters in the South to increase the growing season and the improvement of transportation that allowed oysters from Connecticut to be quickly shipped into commercial centers.11

Throughout the 19th century the oyster industry employed thousands of people in Fair Haven and surrounding communities. Many times entire families were dependent upon oyster harvesting and related industries. Skilled and unskilled workers were needed to plant, harvest, shuck, prepare, sell and ship oysters.

In following decades the oyster industry slowly declined caused by “over-fishing, pollution, starfish, poor farming methods, and a disregard for spawning oysters to perpetuate the breed.”12 Urbanization of the surrounding area brought problems with pollution, habitat loss, and that resulted in closing of many shellfish beds. These factors caused a steady decline in oyster harvesting from the 1920’s to the 1970s.13 By 1930’s the oyster industry was nearly extinct with only one company, the Long Island Oyster Company, still in business.14

As the oyster business declined, heavy industry bought up the valuable land along the harbor and riverbanks. In the next three decades, factories and railroad tracks used to ship factory products surrounded the shores along the Quinnipiac, Mill River, and harbor.15

In the 1970’s, assisted by the Clean Water Act, concern for the environment resulted in cleaner water in Long Island Sound and waterways. As water quality in the Sound has improved, oyster harvests have improved.16 This improvement in water quality resulted in the re-opening of shellfish areas and larger harvests.17 In addition, State officials including the State Department of Agriculture’s Aquaculture lab in Milford, worked closely with the oyster industry to restore shellfish beds resulting in an increase the yield of oyster beds and production of high quality crops.18 The State of Connecticut created the Connecticut Seafood Council to promote consumption of Connecticut seafood and encourage public-private partnerships.

In recent years the industry had to deal with bacteria, toxins, overburdened treatment systems, pollution, pests, and further development along the shore and watershed.

Research and state assistance has helped to minimize the impact of pests and helped to restore shellfish beds. Shell fishing areas have reopened as water quality improved.19 However, today only two major companies harvest oysters in the New Haven area.

In spite of this, in 1998, Connecticut oysters were a $62 million dollar industry.20

Overview of Oyster Biology and Habitat

The Oyster

Family: Ostreidae

Species: Crassostrea virginica

Phylum: Mollusca

Class: Bivalvia or Pelecypoda

Order: Filibranchia

An oyster is an edible bivalve mollusk. This soft-bodied marine animal with no backbone lives in a thick, irregularly shaped shell. A thin membrane, the mantle, covers the body and lines the inside of the shell. Adductor muscles and a hinge between the two halves of the external shell allow the shell to open and close.21 Found in temperate and warm coastal waters of all oceans of the world, oysters prefer waters that are 60°to 78°F.22

The commercial species of oyster found in Long Island Sound is the Eastern oyster (Crassostrea virginica). This oyster lives at depths of 8-25 feet. The American, or common oyster, is also found off Long Island Sound. The American Oyster, known also as the common oyster, grows from 2 to 6 inches in length. This mollusk is harvested in artificial beds in the Delaware and Chesapeake bays, and off the coasts of Long Island Sound, Louisiana, and the state of Washington.23

Oysters have been cultivated for more than 2,000 years.24 Many species are small and are not used as a food source. However, many other species, such as the American (common) oyster grows to a length of 2-6 inches 25 and is widely consumed.

In fact, the oyster is an important food source and considered by many as a delicacy. The creamy-white flesh of the oyster can be eaten fresh, canned or frozen. Oysters can be eaten raw or cooked by grilling, deep-frying, steaming, or smoking. (11)

There are many varieties of oysters, however, most species are too small for food. The varieties are usually named after the geographic region in which they are located and each location produces an oyster with a distinct taste.

Most oysters are the same species; however, they have unique characteristics that make them taste different such as the degree of salinity, water currents, and the physical surroundings. Oysters spawn during the summer months. They are softer and less desirable as a food source during this period. The prime season for oysters is fall and winter months.

Nutritional Information

Oysters are both delicious and one of the most nutritionally well balanced of foods.26 They contain protein, carbohydrates and lipids 27 but do not contain omega-3 fatty acids or fiber. In addition, they are an ideal food for low-cholesterol diets. In fact, the National Heart and Lung Institute include oysters as an ideal food for low-cholesterol diets.28

Oysters are an excellent source of vitamins A, B1 (thiamin), B2 (riboflavin), B3 (niacin), C (ascorbic acid) and D (calciferol). They are an excellent source of Zinc and Vitamin B12 as well. The recommended daily allowance of iron, copper, iodine, magnesium, calcium, zinc, manganese and phosphorus are contained in four to five medium oysters. Six raw, medium oysters contain the following: 57 calories, 5.9 grams of protein, 3.3 grams of carbohydrates and 2.1 grams of fat.29

Anatomy of an Oyster

Oysters breathe using both gills and mantle. The mantle is lined with numerous small, thin-walled blood

vessels that extracts oxygen from the water and expels carbon dioxide.30 Every hour two to three gallons of water continuing tiny organic particles are pumped through the oyster.31

Oysters have a small, three-chambered heart, which is found under the abductor muscle, and pumps colorless blood loaded with oxygen to all parts of the body. There also is a pair of kidneys located on the underside of the muscle that collects and purifies the blood of waste products 32

Shells

Oysters are housed in a four-to-eight inch, irregularly shaped shell that is divided into two halves (or valves) and held together with a hinge. An elastic ligament that holds the two valves together at their narrow ends controls this hinge. There is a large central muscle that allows the valve to close against the pull of the ligament.

Each of the two valves differs in shape. The upper valve is convex (higher in the middle than at the edge) and the larger, lower valve has smooth edges and is somewhat flat so that it can adhere to objects such as rocks or piers.33

Depending on the species, the shell can grow about one inch a year. The shell rough surfaces are generally dirty gray in color while the inner surfaces of the valves are smooth and white.34

The shape and size of an oyster varies depending on several factors including the type of bottom to which it originally attached and the number of other oysters that share the beds in which they grow.

Feeding

Oysters are filter feeders. While the valves are held slightly open, tiny hairline structures called cilia draws water inward with wavelike motions.35 The gills then filter minute organisms from the water and that the stomach digests. Oysters filter out nutrients and oxygen at a rate of up to five gallons per hour.36

The minute organic particles filtered from the water and providing nourishment for oysters include, algae, brine, decayed plants, and other microorganisms and microscopic plants such as photoplankton (marine algae) and nannoplankton which thrive in salt marshes.37

Reproduction

The shell of the oyster does not indicate whether the animal inside is male or female.

Most bivalves including oysters are either male or female. In some species, however, oysters are hermaphroditic, that is, the oyster may alternate gender seasonally or with changes in water temperature.38 In these cases, the oysters develop as males during their first year, but as they grow larger and they spawn as females.39

Oysters breed in summer months. They spawn in shallow waters or in harbors or estuaries where freshwater mixes with saltwater. When the water temperature rises it stimulates the male to release sperm and the female to release eggs into the water where they are fertilized. In other species, however, some eggs are fertilized within the shell of the female oyster.40

In their larval stage they are called “veligers” and swim freely for the first few weeks of their lives. Meanwhile

older oysters release a chemical that helps draw these ciliated spheres to the bottom of the waterways where they cement their mantles to rocks, shells, or other solid objects with the outer, flared edge of its shell tilted upward. These attached juvenile oysters are known as “spat.” The reminder of their life they attach their shell with a sticky substance to objects such as rocks, shells, or roots.41 It takes edible oysters three to five years to grow from spawn to maturity. 42

Oysters can reproduce billions of times in their lifetime. In fact, they can lay up to 500 million eggs at one time.43 However, of the many eggs they produce very few survive due to predators, pollution, and other environmental factors. Their natural predators are sea anemones, starfish, oyster drills, whelks, birds, sea nettles, flatworms and small crabs and fish such as skates.44 In addition, the oyster drill (Urosalpinx cinenea), is a common snail, that drills a tiny hole into the oyster shell with its tongue and sucks out the tissue.

During the growing period oysters are usually transplanted several times to enhance their food supply, stimulate growth and provide a growing environment in cleaner waters.45 First oyster beds are seeded with young oysters called spats. Oystermen scatter old oyster shells underwater so young oysters can anchor themselves on to them. Then the shells are moved to deeper water so that the oyster can develop in less crowded surroundings. Before harvesting the oysters are moved again to shallower, nutrient-rich waters where they can feed and grow larger.

Oysters live in colonies wherever they can create a firm footing including in mudflats, reefs, marshy creeks, among rock jetties and dock pilings, or in sandy or rocky ocean beds. Oysters live in water of various depths from shallow beds at the low tide mark to water at a depth of 8 and 25 feet. They can also be grown commercially on strings or nets in farming complexes.

Watersheds

The Connecticut landscape is composed of many interconnected watersheds and basins. In fact, there are over 17,500 acres of wetlands and 5,800 miles of rivers and streams in Connecticut.46 The water flows to the lowest point and eventually ends up in Long Island Sound. As it flows to the downward it passes through farms, forests industrial complexes, and city streets. Along the way the water picks up contaminants and carries them along to the Sound. Thus, human activities far inland contribute to marine pollution.

Along the way it carries debris and pollutants that are in its path. This complex system of rivers, streams, bays, estuaries and marshland directly contributes to the water quality in Long Island Sound. Pollution enters watersheds from landfills, sewer systems, urban and agricultural activities and depositions of heavy metals from current and past manufacturing.

The Quinnipiac River flows through the southern portion of the Central Lowland in Connecticut and through three medium sized industrial towns. The Quinnipiac empties into Long Island Sound at the City of New Haven. The Quinnipiac watershed includes a wide variety of environments ranging from unpolluted waterways to heavily industrialized and populated stretches. There are five sewage treatment plants on this watershed and two municipal landfills on the river.

The Habitat of Long Island Sound

Long Island Sound is a body of salt water bounded on the north by Connecticut and the south by Long Island, New York. The eastern end of the sound is connected with the Atlantic Ocean by Block Island Sound and Gardiners Bay. On the western end the East River connects the sound with New York Bay. Long Island Sound is

110 miles long, 21 miles wide and covers 1299 square miles. There are many rivers flowing into Long Island Sound including the Connecticut, Thames, and Housatonic.

There is a complex system of bays, estuaries and marshland that contribute to the quality of water in the Sound. This delicate balance is often upset by human activity due to commercial, recreational, and individual usage. Salt water tides wash microscopic organisms into the estuaries of Long Island Sound acting as natural pollution filters.

New Haven Harbor and Long Island Sound are ideal environments for oyster beds. Both are natural estuaries where salt water from the ocean mixes with fresh waters from the rivers and both of these areas provide an environment with cool water, rich nutrients, and countless nooks where oysters can be protected from predators.

In the past, some of the world's most productive natural oyster beds were found along the shores of Connecticut. The salinity of this water is ideal for growing plump delicious "Bluepoints"47

Oysters are an essential part of the food sources of Long Island Sound. Oysters feed on the smallest of organisms in the food chain. It is important for students to understand that the decline of oysters and their habitat has great implications on the health of the Sound and all the plants and animals living in it.

In addition, they provide a valuable balance the Long Island Sound ecosystem. They are a natural cleansing system filter and help to stabilize the pH and regulate the oxygen concentrations in the water.

New Haven Harbor

New Haven Harbor is an estuary in the central part of the north shore of Long Island Sound. This busy Connecticut port, located in one of the most densely populated areas of the United States, is at mouth of Quinnipiac, Mill, and West rivers. Each of these rivers runs through a salt marsh before reaching the harbor. At the mouth of the largest of these rivers, the Quinnipiac River, there is a large salt marsh immediately upstream from the harbor. The total area of the inner harbor is approximately 6.63 km with a watershed area of 630 km. There are a series of three breakwaters at the mouth of the harbor and water passes from the Sound into the harbor through narrow passageways. In addition, the harbor is divided into inner and outer section by breakwaters on the west and east. The depth of the inner harbor is between 1 and 7 meters while the dredged areas are between 9 and 10 meters. On the western shore, there are mud flats at low tide. The western section of the harbor is very shallow at about one meter48

New Haven Harbor is a complex and active environment. It also, according to some assessments of metals in sediments, is one of the most contaminated sites on Long Island Sound.49 New Haven has a long history of manufacturing including the finishing of brass and other metals and firearms production. There are also indications that these metals were mainly added in the past when industrial discharges were much greater and when treatment was not as strict.50

Today the watershed along the Quinnipiac continues to be highly industrialized. The inner harbor is also the site of the city's present and former sewage treatment plants. Past and present activity, therefore, provides the potential for significant metal pollution.51

Oysters and Pollutants

The shellfish harvested from Long Island Sound provide an important commercial benefit to Connecticut.

Water quality is an essential factor in the healthy development of shellfish. The harvesting of oysters in New Haven area has been greatly reduced. This is due to several factors including over-harvesting; parasites, pathogens and the destroying of habitats that are suitable to young oysters.

There are also a variety of parasites and diseases that affect the health and growth of oysters. The impact that disease and parasites have on the oysters depend on water quality, high salinity and temperatures, and nutrient loading.

The source of pollution is not always clear. Long Island Sound is polluted by many sources that originate over a large area. Many pollutants caused on shore end up in Long Island Sound. Rain mixes with fertilizer from lawns, farms, and golf courses. Grease from roadways and airborne pollutants combine with rainwater and enter the Sound through storm sewers.

These and other factors have contributed to the destruction of the native oyster population in Long Island Sound. These factors include: untreated sewage overflows, agriculture discharges, landfill runoff, leaking underground tanks, ground water runoff from cities, oil spills, litter, and industrial wastes, These pollutants, for the most part, remain near coastal areas changing the habitats of marine plants and animals including shellfish.

Each of these problems pollutes our waters and degrades the shellfish habitat resulting in the loss of recreational and commercial harvesting of shellfish. In addition, these problems increase the risk to human health because eating contaminated shellfish spreads diseases such as hepatitis and cholera. Despite the pollution problems affecting Long Island Sound, the commercial oyster industry remains an important industry.

Sewage treatment plants

Currently five secondary treatment plants located in this watershed discharge material directly into the river. In 1980, New Haven replaced its three existing sewage treatment plants with a single facility. The smaller Mill and West rivers have watersheds that are not as developed and are managed to supply drinking water.

In many Connecticut communities sewer systems and storm sewers are combined into one system. The result is that during heavy downpours sewage and storm waters overflows into rivers without being treated. Many Connecticut communities are making an effort to eliminate these combined sewer systems. They are especially working at reducing these systems upstream in an effort to see some impact and improvement of this problem.52

However, overflowing sewers continue to cause serious problems for many towns. For instance, overflowing sewers after rainstorms result in the closing of beaches in some towns. It should be noted that beach closings due to sewer runoff and overflows are often linked to rainfall patterns. In relatively dry summer such as 1999, there were fewer closings than in rainy years such as 2000 when there was a sharp increase in beach closing due to sewer problems. 53

Sewage treatment plants are often implicated as key contributors of metals and other contaminants to natural waterways. Today, however, there are very low total concentrations of metals due to treatment of the water. This seems to be the result the effective removal of metals in modern treatment plants.54

Industrial discharges

Manufacturing has been an important part of Connecticut history. For many years industries dumped chemicals and toxic substances into the rivers and Long Island Sound. From the mid-1800's to the end of World War II, metal plating and fabricating factories were important industries in the Quinnipiac Valley. The discharges of metals during those times has left pollution problems that we are still dealing with today. This past contamination of the Quinnipiac watershed continues to be found in the sediments of many harbors of the Sound.55

Toxic substances have negative effects on the ecosystem and the health of humans, plants and marine life. Sewage treatment plants (STPs), industrial discharges, urban runoff, sediments and bank erosion are all potential sources of heavy metals, PCBs and other toxic substances that eventually end up in the Sound. 56

Regulations concerning clean water (Clean Water Act, Safe Drinking Act) reduced the amount of heavy metal that could be directly discharged into the waterways. At the current time, due to the reduction achieved by this legislation, direct industrial input is a minor contributor to heavy metal deposits in most estuaries in the New Haven area. Instead, the majority of input is a combination of storm drains and cooling water discharges. However, two metal finishing plants are permitted to discharge heavy metals into the harbor. H.B. Ives, is allowed to discharge five heavy metals and Sargent and Company, is permitted to release six heavy metals.57

Heavy Metals

Heavy metals pose a health risk when they are present in high levels. Pollutants such as metals are directly toxic to vulnerable juvenile oysters and other marine life. In fact,

Heavy metals are among "the most toxic and persistent contaminants of estuaries."58 Many of these metals find there way into ground water due to their use in industry, mining, construction and farming.

Small business such as gas stations and dry cleaners also use hazardous chemicals. Unfortunately improper disposal and accidental spills of these chemicals and industrial waste are a source of ground water contamination.

From the mid-1800's to end of World War II metal plating and fabricating factories were important industries in the Quinnipiac Valley. The discharges of metals during those times has left pollution problems that we are still dealing with today.59

Agriculture

Factory farms, also known as Concentrated Animal Feeding Operations, are farming operations that raise thousands of animals in a small area. The animal wastes and manures result in water supplies that are threatened by pathogens and nutrient problems. Groundwater can also be polluted from the high levels of salts that are found in manure.

Fertilizers and pesticides are often heavily used on farms, golf courses, and suburban lawns to promote growth and protect from insects. Fertilizer is a problem because they often contain nitrogen that can break down into harmful nitrates. Underground agricultural drainage systems collect fertilizers and pesticides and pollute the groundwater, streams, rivers, and lakes. Orchards often have high levels of arsenic because it used to be used as a pesticide.

The type and amount of chemicals used, how the chemicals are applied, as well as, the soil type and amount of seasonal precipitation, determines how much of these pollutants end up in ground water.

Other sources of pollution

Chemicals, petroleum products and wastes are often stored in underground storage tanks and pipes. When these tanks and pipes corrode with age the chemicals stored in them leak into the groundwater. This is often are problem on farms, however, the EPA rules do not apply to petroleum and chemical tanks found on farms.

Older landfills pose a risk of leaking a wide variety of pollutants into ground water. Modern landfills are often designed to contain leaking liquids; however, even these facilities can fail when floods cause the contents to spill over into waterways.

When cleaning solvents used motor oil, paints, paint thinners, soaps, and detergents are improperly disposed they can pollute ground water. In addition, septic tanks and septic leaching fields can also be a problem when they leak or are improperly constructed.

Trash that floats in coastal waters and eventually washes up on beaches is called floatable debris. This debris harms wildlife and has other adverse effects on the environment. The majority of this garbage comes from storm drains. Rain washes the litter from neighborhoods into the storm drains and it end up in the Sound. A major source of marine pollution is the non-biodegradable plastic such as soda can packs.

Oysters Contaminated with Bacteria

Organic and inorganic contaminants accumulate in oysters and other mollusks.

When an oyster filters water to obtain food, organic and inorganic contaminants accumulate in the tissue of the animal.

Salmonella and campylobacter are two dangerous bacteria that may result in food-borne illness. Shellfish become contaminated because they often grow in estuaries where fecal runoff from sewage pollutes the water. As the shellfish filters water to gather nutrients, they also pick up fecal pathogens that can thrive in their tissues. The bacteria can remain and concentrate in their meat. Although it does not kill the host, consumers eating the meat of shellfish, often raw, are in danger of becoming ill.

States do regulate oyster farms. However, most states only require the water be tested for E. coli. Since salmonella and campylobacter concentrates in the tissues of the shellfish, it is not feasible to easily test for such bacteria since the only way to test for contamination is to test the meat.60

There are ways to combat these bacteria, however. Cooking to the temperature of 160 degrees, for instance, can kill the bacteria. However, it should be noted that most shellfish is eaten raw. Also, the acid in the human stomachs has the ability to kill many of these pathogenic organisms. Young children, elderly adults, and those with weakened immune systems, however, are at risk when this bacteria enters their intestines and causing acute food poisoning and other serious health conditions.61

Microorganisms, Bacteria and Nitrates Pathogens

There are some sources of water pollution that naturally occur in water including microorganisms such as parasites, bacteria and viruses. These pollutants are often due to runoff after a heavy rainstorm. As water flows over the surface of the land it may pick up waste from wildlife, farmlands, and soil. Pollutants also may enter the Sound through improperly treated sewage and the dumping sewage from boats.

A variety of illnesses can be caused by the organisms found in contaminated water including both long-term and short-term problems. Pathogens are microorganisms that cause disease such as gastroenteritis, salmonellosis, and hepatitis A. There are several ways pathogens can enter the human body including swimming in polluted waters and eating raw or partially cooked shellfish harvested from contaminated waters.

In Connecticut, beaches and shellfish beds are periodically closed due to sewer overflows after heavy rain storms, treatment plant malfunctions and other sources of runoff. Children, elderly, and people with weakened immune systems are most at risk when they are exposed to water-born bacteria. Nitrates are also a threat to infants because of a condition that disrupts oxygen flow in the blood called “blue baby” syndrome.

Hypoxia and Long Island Sound

When the oxygen level in water becomes too low to support life it results in a condition called Hypoxia. Defined as less than o62r equal to 3 mg/l of dissolved oxygen, hypoxia occurs because nitrogen stimulates excessive growth of aquatic plants. The result is that plant dies and is consumed by bacteria that thrive on oxygen.63

Hypoxia is greatly influenced by the yearly changes in weather patterns. The mild winter and cool summer of 1997 resulted in fairly uniform water temperatures and resulted in a significant improvement in the hypoxia problem. In 1999 there was a dry summer in this region and this resulted in less runoff and therefore less nitrogen flowing into Long Island Sound. The year of 2000, however, was rainy and so slightly more Hypoxia was recorded in the Sound.64

Hypoxia has been recorded in the western two-thirds of Long Island Sound. Approximately one-third of the nitrogen pollution found in Long Island Sound is contributed by Connecticut while New York contributes two-thirds.65

Tons of pollutants are discharged into Long Island Sound from Connecticut’s sewage treatment plants and large industrial facilities. Records indicate that 56% of the nitrogen discharged into Long Island Sound from Connecticut originates from industrial and sewage treatment plants. In 1990 Connecticut set a “no net increase” goal to keep nitrogen discharges at or below the current levels of that year. This proved to be a successful policy. When nitrogen removal technology was installed at several sewage treatment plants the result was an improvement in nitrogen discharge.66

In 1994 Connecticut and New York attempted to control the discharges of pollutants into Long Island Sound by developing a comprehensive plan. In addition, in 2001, the Federal Environmental Protection Agency approved a joint plan by Connecticut and New York that set an amount of pollutants that could be discharged yearly into Long Island Sound and still allow water quality standards to be maintained.67

Parasites

There are a variety of diseases and parasites that have affected oysters in the Northeast. They include:

1. MSX (Haplosporidium nelsoni) which is fatal to oysters within their first to year.

2. 2. Dermo (Perkinsus marinus) is very damaging and also fatal to young oysters.

3. Juvenile Oyster Disease (JOD).

Connecticut Clean Water Act

In 1967 Connecticut passed its own clean water laws in order to assist in the cleaning the states water.68 It includes provisions for protecting and propagation of shellfish. In the 1970's federal grants for sewage treatment plants also assisted Connecticut in cleaning its waterways. Established in 1986, Connecticut's Clean Water Fund, provided funds so that some treatment plants could be upgraded and provided funds to separate some combined sewer systems.

According to report, the *Environmental Quality in Connecticut* , "most aspects of our air, water, and wildlife have improved measurably in the last ten years." There were improvements in the Farmington, Willimantic Rivers and the Naugatuck Rivers. However in 2000, beach closings, shad, drinking water and traffic concerns showed downward trends.

Summary

Protecting the health and well-being of tidal land and ensuring clean waters is important to all citizens. Schools can do their part ensuring that these resources remain productive by developing curriculums that help students learn about the marine life living in Long Island Sound. Understanding the problems these creatures encounter from pollution and microorganisms, bacteria and nitrates pathogens will help students understand how more complex creatures can be affected.

Lesson Plan: Researching the Sound

Objective: To collect and interpret data concerning the pollutants that are in the Long Island Sound

Goal: Students will learn how to locate and interpret data produced by governmental and private environmental agencies

Materials: Computer with "Jaws" and "Connect Outloud" software that allows blind and visually impaired students to access the Internet

Websites: 1. esp.gov2. ctseafood.org 3. ceq.state.ct.ct.us4. usgs.gov

In group of four including visually impaired and sighted peers, student will:

1. Locate current information on the substances found in New Haven harbor and Long Island Sound. They will discuss the studies located and their implication on shellfish industry.

2, Interview local oystermen, officials, business leaders, and environmental personnel concerning the current health and problems of water in Long Island Sound

3. Take field trips to locate watersheds, water treatment plants, environmental facilities

4. Research articles for a newspaper dedicated to Long Island Sound and environmental topics

Lesson Plan: Cooking Lesson

Notes: Check with parents to see if any students are allergic to oysters Teacher should open oysters for students.

Objective: To prepare a meal using oysters as a main ingredient

Goal: Student will follow steps of a recipe translated into Braille or large print

Goal: Students will examine oysters and describe various physical characteristics

Equipment for blind and visually impaired students

Tactile and large print measuring cups

Label stove with Braille labels

Talking scale

Knife with safety guide

Cutting board

Bowls for each ingredient

Labeled measuring spoons

Recipe: “Oysters Dunbar”

Ingredients

1 pint oysters and liquid, quartered3 tablespoons butter

1 onion, chopped 4 green onions, thinly sliced

2 cloves of garlic, minced1/2 pound fresh mushrooms, chopped

2 tablespoons flour1 small jar artichoke hearts, quartered

1 cup light cream1/2 cup freshly chopped parsley

1 tablespoon Worcestershire saucepinch of basil, thyme, and rosemary

1/4 teaspoon salt1/4 teaspoon black pepper

1 tablespoon pimento 1/2 cup dry bread crumbs

Steps

1. Microwave on high for 3 minutes: butter, onion, garlic, and mushrooms, covered

2. Stir in flour.

3. Add artichokes, oysters and liquid, cream, parsley, Worcestershire, herbs, salt, pepper, and pimento.

4. Microwave, covered, 5 minutes on high.

5. Stir in breadcrumbs and microwave another 4-5 minutes, or until thickened.

Serve with crackers for an appetizer or as main course.

LESSON: Watersheds

Objective: To provide students with an understanding of New Haven Harbor, Long Island Sound and its watershed

Goal: Students will create a tactile representation of New Haven Harbor, Long Island Sound, and its watershed

Goal: Students will trace the path of water traveling through the watershed into Long Island Sound

Goal: Students will pinpoint sources of pollution within the New Haven watershed

Goal: Student will participate in a forum that discusses the issues of watershed pollution and the need for citizens inland to be responsible for problems occurring in the Sound

Teams: Students will work in small groups that include visually impaired, blind, and their sighted peers

Modifications for Visually Impaired / Blind Students

1. Magnifiers (hand-held and stand)

2. Wide tipped magic markers

3. Closed circuit TV for magnification of prints materials

4. Braille label maker

5. Thermoform machine to create tactical imprints

Lesson: Tracing the Path of Water in a Watershed

Find the local watershed and streams that are closest to your school. Show major point and non-point sources of water pollution on the map. Locate additional watersheds and show major pollution sources such as factories, sewage plants, etc. Indicate the flow of the pollutants as they move toward The Sound.

Discuss the land uses, such industrial, urban agricultural, forestlands, around the river. What pollutants will likely be picked up on its way to The Sound?

Prepare a large map and explanatory notes to show the path and final destination of the pollutants that enter the storm drains in a cities and towns throughout Connecticut.

Discussion Questions / Exercises:

1. Trace the path of pollutants that enter the water in your community and discuss where they are likely to end up.

2. Where are the reservoirs that provide drinking water for your community?

3. Are the watersheds protected?

4. If your water is drawn from a river, how many other communities upstream and downstream draw their drinking water from this river?

5. What changes are planned to meet future demands, such as building dams, reservoirs, and aqueducts?

6. Who is responsible for the pollution in Long Island Sound? What steps should be taken to prevent pollution from destroying the quality of water in the Sound?

Goal: To increase vocabulary of scientific terms

Objective: Student will participate in a quiz show format to test their skills in defining and understanding terms. Students will be divided into 2 teams. One student or teacher will serve as moderator.

Students will select a square and uncover a definition or term. Student must respond with the correct answer that defines term. Winning answers will be rewarded with points. Team with most points at end of game will win.

Definitions

1. **Bivalves:** a mollusk with two shells. Bivalves live in the ocean or fresh water. Examples: oysters, clams, mussels, and scallops

2. **Clean Water Act** -passed in 1972 this law dramatically increased the number of waterways that are once again safe for fishing and swimming

3. **Estuary** : The mouth or lower course of a river where the current meets the sea and is

affected by the tides or an arm or inlet of the sea 69

4. **Eutrohication** : The process through which waters become over-enriched with

nutrients. Nitrogen and phosphorus and leads to a severe depletion of oxygen.

5. **Hypoxia** : the condition when oxygen levels in water becomes too low to support life. Defined as less than or equal to 3 mg/l of dissolved oxygen. It occurs because nitrogen stimulates excessive growth of aquatic

plants.

6. **Mantle** : The thin membrane that covers the visceral mass. The mantle secretes calcium carbonate the material that forms the shell of the mollusk.

7. **Mollusks** : animals with soft fleshy bodies that are often covered by a hard shell. They have three distinct body parts the head, the foot, and the visceral mass (or inside of the mollusk which contains the digestive system, the excretory system, the reproduction system and the heart.

8. **Protandric** : the ability to change gender several times during their lifetime.

9. **Siltation** : a condition that smothers oysters and prevents them from feeding. It is caused from eroded soil at land development sites, farm fields and forestry harvesting

10. **Watershed** : a geographic area in which all sources of water, including lakes, rivers, estuaries, wetlands, and streams and ground water drain to a common surface water body.

Student Reading List

“How Do Oysters Make Pearls,” 1998 - 2003 HowStuffWorks,Inc.http://www.howstuffworks.com/question630.html

Access (14 Mar.2003)

An interesting website that will provide additional information on oysters and the pearls they produce.

“Oyster” *Encyclopedia Britannica* Online. Encyclopedia Britannica, Inc., www.britannica.com,

This entry provides an excellent summary of oysters including their physical makeup, nutritional and environmental needs. It is a good beginning for research on this subject.

New Haven Colony Historical Society. “Shallops, Sloops and Sharpies,” New Haven, Connecticut: New Haven Colony Historical Society, 1976.

An excellent little volume that will be of interest to students who are interested in the history of New Haven shipping and the oyster industry.

Townshend, Doris B. Fair Haven, “A Journey Through Time,” New Haven, Connecticut: New Haven Colony Historical Society, 1976.

A well-written and informative book on New Haven. It contains a wonderful chapter on the oyster industry in Fair Haven.

Teachers Reading List

“Mass balance of heavy metals in New Haven Harbor, Connecticut: predominance of nonpoint sources” Author: Rozan, Timothy F.; Benoit, Gaboury, Journal Name:

A detailed reported of the heavy metals found in New Haven harbor. This report is lengthy and may be difficult for students to understand. However, it provides current and important information on the problems of metals in New Haven harbor.

“2002 Water Quality Report,” June 2003, South Central Connecticut Regional Water Authority,”www.rwater.com

Current annual report from regional water authority. This provides and concise understanding of the condition of the region’s drinking water quality.

EPA, “Final Report of the National Watershed Forum, June27-July 1, 2001, published by Meridian Institute, Dillion, Colorado, www.merid.org

A summary of the information presented at his forum. It provides information that would be important to teachers and students on the efforts to reduce pollutants and habitat loss in our Nations Watersheds.

Websites

usgs.gov -a Bureau of Department of the Interior website that provides reliable scientific information that provides knowledge about how to manage resources such as water, biological, and energy and mineral resources

Water.usgs.gov/nawqua-the National Water Quality Assessment Program -this website allows individuals information on more than 50 river basins and aquifer systems.

EPA.gov/safewater.gov-an important website for anyone interested in research on water and water related problems

Endnotes

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2 http://www.coldspringschool.com/nhg/oyster.html, “The Oyster Industry”

3 Matthew Wilcox, Revised: 1/19/00, “Health Regulations of New Haven, Historical Documents and Information.”

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