NOAA Teacher at Sea Program Lesson Plan

Activity Title: "Student CTD Activity on the Harlem River"
Subject (Focus/Topic): Environmental Science and Mathematics.
Grade Level: Middle School Level; 6th, 7th, and 8th Grade.
Average Learning Time: This lesson can be taught in 3 class periods of 45 minutes, per week, in 1 semester.
Lesson Summary (Overview/Purpose):
Students will develop understanding of how and why data on **Conductivity, Temperature, and Depth** is collected as part of NOAA's Ocean Surveys.
Overall Concept (Big Idea/Essential Question):
What is the impact of changes in the levels of Salinity and Temperature in the health of marine life?
Specific Concepts (Key Concepts):

1) Effect of Climate Change in our world oceans.
2) Effect of Rising Global temperatures in the Melting of Glaciers.
3) Effect of Melting Glaciers in Oceans Salinity Levels.
4) Impact of Change in Ocean Salinity Levels on Marine Ecosystems.

Focus Questions (Specific Questions):

1. What is an Ecosystem? What is a Marine Ecosystem?
2. What is Conductivity and how is it measured?
3. How Salinity does affect marine life?
4. How water temperature is measured?
5. What if the impact of water temperature on marine ecosystems?
6. What is the relation between water temperature and the depth of water?
7. What is Dissolved Oxygen and why is it important for aquatic life?
8. What is the impact of water temperature on dissolved oxygen?

Objectives/Learning Goals:

1) Students will make a prediction about what will be the readings for the water temperature, salinity, dissolved oxygen and water depth data from the Harlem River.
2) Students will collect data on water temperature, salinity, and dissolved oxygen at different depths of the Harlem River and record it on a chart with 80% accuracy.
3) Students will use the data to create a graph on Excel computer software with 80% accuracy.
4) Students will determine if their predictions for the readings water temperatures, salinity, dissolved oxygen and water depth data from the samples collected were accurate and if there is connection between them.

Background Information:

Source: http://www.epa.gov/bioiweb1/aquatic/marine.html **Marine ecosystems are a part of the largest aquatic system on the planet, covering over 70% of the Earth's surface. The habitats that make up this vast system range from the productive near shore regions to the barren ocean floor**. Some examples of important marine ecosystems are:

- Oceans
- Estuaries and Salt Marshes
- Coral Reefs and Other Tropical Communities (Mangrove Forests)
- Coastal areas like Lagoons, Kelp and Sea grass Beds and Intertidal systems (rocky, sandy, and muddy shores)

Marine ecosystems are home to a host of different species ranging from tiny planktonic organisms that comprise the base of the marine food web (i.e., phytoplankton and zooplankton) to large marine mammals like the whales, manatees, and seals. In addition, many fish species reside in marine ecosystems including flounder, scup, sea bass, monkfish, squid, mackerel, butterfish, and spiny dogfish. Birds are also plentiful including shorebirds, gulls, wading birds, and terns. Some marine animals are also endangered including whales, turtles, etc. In summary, many animal species rely on marine ecosystems for both food and shelter from predators. **Marine ecosystems contain several unique qualities that set them apart from other aquatic ecosystems**, the key factor being the presence of dissolved compounds in seawater, particularly salts. **This total gram weight of dissolved substances (salts) in one kg of seawater is referred to as salinity**. In general 85% of the dissolved substances are Sodium (Na) and Chlorine (Cl) in seawater. **On average seawater has a salinity of 35 parts per thousand grams (ppt) of water. These dissolved compounds give seawater its distinctive "salty" taste, affect species composition of particular marine habitats**, and prevent oceans from freezing during the winter. **Daily changes in factors such as weather, currents, and seasons as well as variations in climate and location will cause salinity levels to vary among different marine ecosystems.** In areas such as estuaries, tidal marshes, and mangrove forests, tidal and freshwater influences from river and streams makes it necessary for marine organisms to adapt to a wide range of salinity levels. These organisms such as mussels, clams, and barnacles, are called euryhaline (salt tolerant) organisms**. Other organisms, in particular finfish, are unable to tolerate such changes in salinity. These organisms are considered to be stenohaline (salt intolerant). These species require more constant levels of salinity, forcing them to either migrate to new areas when fluctuations in salinity levels occur or to seek out areas where salinity change is minimal (e.g., the deep ocean).** Like other aquatic ecosystems, marine ecosystems require nutrients and light to produce food and energy.

However, **both nutrients and light are limiting factors in marine ecosystem productivity.** Like many other aquatic plants, photosynthetic marine organisms (i.e., phytoplankton) rely upon sunlight and chlorophyll *a* to absorb visible light from the sun as well as nitrogen (N), phosphorus (P), and silicon (Si) to generate food and promote growth and reproduction. However**, the amount of light penetrating the ocean surface tends to decrease with increasing water depth; therefore photosynthesis can only take place within a small band near the surface of the water (called the photic zone).** In addition, nutrient availability often varies significantly from place to place. For example, **in the open ocean, nutrient levels are often very poor causing primary production to be very low. In contrast, near shore waters such as estuaries and marshes are often rich in nutrients, allowing primary production to be very high**. In some instances, near shore ecosystems have an excess of nutrients due to runoff and other terrestrial sources. Excess nutrients can cause an over-stimulation of primary production, depleting oxygen levels and causing eutrophic conditions to occur in coastal habitats.

Marine ecosystems are very important in to the overall health of both marine and terrestrial environments. According to the World Resources Center, coastal habitats alone account for approximately 1/3 of all marine biological productivity, and estuarine ecosystems (i.e., salt marshes, sea grasses, mangrove forests) are among the most productive regions on the planet. In addition, other marine ecosystems such as coral reefs provide food and shelter to the highest levels of marine diversity in the world.

The diversity and productivity of marine ecosystems are also important to human survival and well-being. These habitats provide us with a rich source of food and income, and support species that serve as animal feed, fertilizers for crops, additives in foods (i.e., ice-cream) and cosmetics (i.e., creams and lotions). Areas such as mangroves, reefs, and sea grass beds also provide protection to coastlines by reducing wave action, and helping to prevent erosion, while areas such as salt marshes and estuaries have acted as sediment sinks, filtering runoff from the land. Despite the importance of marine ecosystems, increased human activities such as overfishing, coastal development, pollution, and the introduction of exotic species have caused significant damage and pose a serious threat to marine biodiversity.

www.ky.gov/nrepc/water/wcpdo.htm

Why Dissolved Oxygen is Important

Dissolved oxygen analysis measures the amount of gaseous oxygen (O2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis.

When performing the dissolved oxygen test, only grab samples should be used, and the analysis should be performed immediately. Therefore, this is a field test that should be performed on site.

Environmental Impact:

Total dissolved gas concentrations in water should not exceed 110 percent. Concentrations above this level can be harmful to aquatic life. Fish in waters containing excessive dissolved gases may suffer from "gas bubble disease"; however, this is a very rare occurrence. The bubbles or emboli block the flow of blood through blood vessels causing death. External bubbles (emphysema) can also occur and be seen on fins, on skin and on other tissue. Aquatic invertebrates are also affected by gas bubble disease but at levels higher than those lethal to fish.

Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration of dissolved oxygen, the greater the stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills.

Environmental Stressors affecting the health of Aquatic Life on the Harlem River:
The Harlem River or Harlem Creek, which is how used to be known in colonial times, is not really a river but an arm of the Long Island Sound. It surrounds the island of Manhattan, and the Counties of Bronx and Queens in New York City. It is considered a part of the Hudson River Estuary, which means it is affected by the salt water tides from the Atlantic Ocean in the South, and by the fresh water currents of the Hudson River. During colonial times New York City used to be surrounded by salt marshes that were teaming with wildlife. The native Lenape from the Delaware Indian nation used to inhabit Manhattan and harvest an abundance of oysters, clams, blue crabs, and also fish for striped bass, Chad, alewife or American herring, eels, and several other species. Through the years human development had resulted in water contamination from sewers and factory waste that devastated the oyster and clam population, as well as destruction of the salt marshes that were nurseries of life to many aquatic species.

Nowadays contamination from PCBs and many other petro chemicals left by the illegal dumping of the industrial revolution still remains, limiting the safe consumption of fish caught on the Harlem River. In recent years contamination from city street runoff is a mayor threat to the estuarine waters. It is believed that runoff pollution was the cause of the recent destruction of the lobster fishing industry in the waters of the Long Island

Sound during the 90's. Today water pollution from New York City's outdated CSO (Combined Sewer Overflow) is a major threat to the health not only of aquatic life on the Harlem River, but to human residents as well. During rain events, millions of gallons of untreated sewer waste water are automatically dumped into the river forcing the closure of dozens of beaches for public safety, due to high levels of e-coli bacteria that can cause deadly poisoning.

Common Misconceptions/Preconceptions:

There is a common preconceived idea or misconception that students and residents of New York have that the waters of both the Hudson and Harlem River are very dirty and nasty. In fact both rivers are cleaner than ever. Since the passing of the Clean Air and Clean Water Act in the 70's which made it a federal offense the illegal dumping of any materials into any US waterways by any individual or company. Marine ecosystems such as the Harlem River-Hudson River Estuary are dependent on the temperature of the water, salinity levels, and dissolved oxygen levels for the health of its aquatic life. In order to conduct our lesson we will be collecting our water samples at Sherman Creek, a tidal salt marsh located on the banks of the Harlem River. Since 2005 we have been conducting citizen science data collection as part of the GLOBE program, National Estuary Day, and "Snapshot of the Harlem and Hudson River" were students and volunteer collect data on protocols such as temperature, dissolved oxygen, salinity, nitrites, nitrates, and PH. Also we get our waders wet by getting on the water to trawl our seine nets in order to identify any aquatic life such as minnows, silverside fish, mummychogs, eels, pipe fish, shrimps, and felly fish larvae. As you can see the waters of the Harlem River are alive with many species living there. Also we have to count all sort of water birds that inhabit the salt marshes of Sherman Creek, such as Great Egrets, Black Crown Night Herons, Cormorants, Canadian Geese, American Mallards, King fishers etc…They are attracted by all the aquatic life that they feed on and thrive on the waters of the Harlem River

Materials:

Clipboard, Data Sheet, pencils, LaMotte student water quality test kit, Hydrometer for salinity Student water sampler, armored alcohol thermometer (these items can be ordered from Forestry Suppliers.com), Metric Ruler/Tape.

Technical Requirements:

1) PC or Mac computer with Internet access; 2) Microsoft Excel Software; 3) Printer; 4) Smart Board or Screen with LCD projector.

Teacher Preparation:

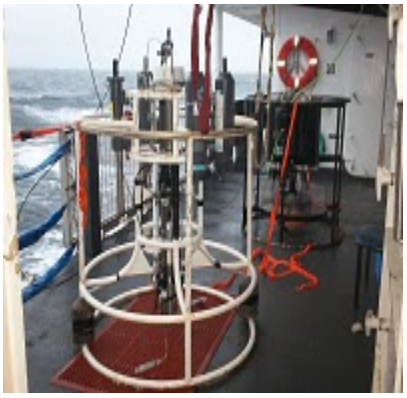
In order to teach this lesson most effectively it will be necessary to review the websites listed above.

Keywords:

1. Estuary 2. Marine Ecosystem 3. Salinity 4. Dissolved Oxygen 5. PPT (parts per thousands) PPM (parts per millionth)

Pre-assessment Strategy/Anticipatory Setting:

Using a KWL chart I ask students if they know the names of the bodies of water around New York City. I ask them whether we live on an island or mainland, whether we live near the ocean, and since most of my students are from the Dominican Republic if they can relate to living in an island or near the ocean back home. Once prior knowledge is activated and in order to get students motivated to take part in the lesson I will log on to my weblog at http://mrfulcar-teacheratsea2010.blogspot.com and display the website on the Smart Board or screen for students to see. Once there I explain to the students that as part of my duties as a Teacher at Sea I had to observe how the crew of the Oscar Dyson had to conduct CTD research as part of the Alaska Pollock Survey on the waters of the Bering Sea in Alaska. Then click on the "Riding the High Seas" entry log to read aloud to students what a CTD is and to see the pictures.



I ask them if they have ever been on a cruise ship or even rowed on a boat or canoe. I then proceed to talk to them about the Harlem River and the work I have done with my former students conducting water quality monitoring and cleaning up Sherman Creek. I also explain to them where is Sherman Creek located using a Google Earth maps online, making sure to point out to them the proximity of our school campus and their apartment buildings where they live to this site. Next I teach the mini lesson about marine ecosystems, estuaries, the Harlem-Hudson River Estuary, salinity, dissolved oxygen, water temperature and depth of the water. We discuss what kind of scientific instruments are needed to record the temperature, salinity, and dissolved oxygen. I introduce to them the LaMotte water quality kit, water sampler, hygrometer and the rest of the scientific

equipment used to conduct the student CTD activity, making sure to explain what each one is used for and how to use them. I describe to the students that they too can be young NOAA scientists and learn how to do citizen science by collecting data on the marine ecosystem of the Harlem River.

Lesson Procedure:

Step 1) Mark the line on the student Water Sampler Bottle using a Metric Ruler or Tape, as well as the line in the armored thermometer. Make the marks using a black permanent marker in Centimeters. Ask students to predict what they think will be the water temperature, salinity, and dissolved oxygen at 4 different depths (surface, 30cm, 60cm, 1 meter) and record in them their notebooks.

Step 2) Making sure to secure parental permission to bring students to the Sherman Creek Waterfront Park that can be easily reached by public subway. Once there we go over basic safety rules. A safety kit and sanitizer is recommended to bring. In order to conduct the CTD we locate and lower the water sampler from a bulkhead protected by safety railing.

Step 3) Students will work in groups of 2-3 rotating from one protocol to another. One student reads the data, while another confirms the reading and the third records the data on the Data Sheet. Information such as Date, Time, GPS location (can be obtain with a GPS enabled phone or website Google Earth).

Step 4) Water sampler bottle is armed and lowered into the water until it reaches below the surface. The trigger is pulled and the bottle is the hoist. Using the attached hose use it to fill in water sample bottle or glass vials. Depth is also recorded. The armored thermometer is also lowered below surface and after 5 minutes then is hoist and temperature is then recorded as well as depth.

Step 5) Using the LaMotte water quality kit locate the dissolved oxygen tablets, and following the instructions place them in one of the vials, shake and wait 5 minutes to see the reaction. Compare the color reaction of the sample against the color coded mini chart and record the level on the data sheet.

Step 6) Pour water from the bottle sampler into the hygrometer to measure the salinity level. Record it on the data sheet, making sure one student calls the reading, another confirms the data and another records on the data sheet.

Step 7) Repeat at different water depths and record all data.

Step 8) Using Excel Spread sheet software or graphing paper, plot and graph the data. Look for any patterns: Does the data match your predictions? Does depth affects water temperature, dissolved oxygen or salinity?

Assessment and Evaluation:

Students' learning of the concept will be assessed based on their comparison between their Predictions on water temperature, dissolved oxygen, salinity on 4 different depths of the water and the actual data collected by them. They will look for any patterns and ask questions such as: does the data match your predictions? Does depth affects water temperature, dissolved oxygen or salinity? What happens to the readings as the water became deeper? Each group will write a report on PowerPoint and present their findings to the rest of the class.

Sample Data Sheet:

Date:	**Time:**	**Tide (High/Low**	**Air Temp:**	**Latitude:**	**Longitude:**
DEPTH Cm	**Water Temperature (Celsius)**		**Dissolved Oxygen (PPM)**		**Salinity**
No 1)					
No 2)					
No 3)					
No 4)					

Standards:

National Science Education Standard(s) addressed:

LIFE SCIENCE STANDARDS

LEVEL 5-8

Populations and ecosystems
Diversity and adaptations of organisms

SCIENCE AS INQUIRY STANDARDS

LEVELS 5-8
Abilities necessary to do scientific inquiry
Understanding about scientific inquiry

Ocean Literacy Principles Addressed:

1 The Earth has one big ocean with many features.

g The Ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments and pollutants from watersheds to estuaries and to the ocean.

5 The ocean supports a great diversity of life and ecosystems.

f Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is “patchy”. Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

i Estuaries provide important and productive nursery areas for many marine and aquatic species.

6 The ocean and humans are inextricably interconnected.

a The ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and nearly all Earth’s oxygen. It moderates the Earth’s climate, influences our weather, and affects human health.

b From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation’s economy, serves as a highway for transportation of goods and people, and plays a role in national security...

d Much of the world’s population lives in coastal areas.

e Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

f Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges).

g Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

7 The ocean is largely unexplored.

a The ocean is the last and largest unexplored place on Earth—less than 5% of it has been explored. This is the great frontier for the next generation’s explorers and researchers, where they will find great opportunities for inquiry and investigation.

b Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.

d New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

□ NY State Science Standard(s) Addressed:

STANDARD 7—Interdisciplinary Problem Solving

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Key Idea 2:

Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

2.1 Students participate in an extended, culminating mathematics, science, and technology project. The project would require students to:

¥ **Working Effectively:** Contributing to the work of a brainstorming group, laboratory partnership, cooperative learning group, or project team; planning procedures; identify and managing responsibilities of team members; and staying on task, whether working alone or as part of a group.

¥ **Generating and Analyzing Ideas:** Developing ideas for proposed solutions, investigating ideas, collecting data, and showing relationships and patterns in the data.

¥ **Common Themes:** Observing examples of common unifying themes, applying them to the problem, and using them to better understand the dimensions of the problem.

¥ **Realizing Ideas:** Constructing components or models, arriving at a solution, and evaluating the result.
¥ **Presenting Results:** Using a variety of media to present the solution and to communicate the results.

Additional Resources:

1) http://mrfulcar-teacheratsea2010.blogspot.com Mr.Fulcar Weblog

***2)* www.ky.gov/nrepc/water/wcpdo.htm Dissolved Oxygen Info**

3) http://www.epa.gov/bioiweb1/aquatic/marine.html Info on Marine Ecosystems

4) www.GLOBE.gov Inquiry Based Science Info

5) www.dec.ny.gov/lands/4920.html Hudson River Estuary Program

6) http://www.ldeo.columbia.edu/edu/k12/snapshotday/ Student Citizen Science Protocols on Data Collection on the Hudson/Harlem River

7) www.friendsofshermancreek.org
Sherman Creek Corps of Young Environmentalists Project

8) www.forestry-suppliers.com Environmental Science Equipment

Author:
Obed Fulcar
Special Education Generalist Teacher
MS319 Maria Teresa Mirabal Middle School
21 Jumel Place NY, NY 10032.
ofulcar@schools.nyc.gov
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