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Our Ocean: How It Works

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Introduction

Water is one of the most important natural resources known to humans. Without this natural resource, the human race cannot survive. It is important that our students become active participants in the preservation of this precious resource. In order for them to do so, we must provide the necessary information for them. We also must grant them the freedom of scientific inquiry, and a thirst for solving the problems we are faced with!

The Oceans, with all their challenges and mysteries, draw attention from many different kinds of people. The freshest, and most naive response comes from the young people we are around. Oceans evoke a range of emotions from the human race, especially from the youth of today. While it can evoke fear, both of the known and unknown, it also brings out a wide-eyed excitement and eagerness for knowledge.

The students of New Haven have an enormous benefit of living on one of New England’s largest and most substantial resources, the Long Island Sound. However, our students have a limited knowledge on how valuable this habitat really is. They must be provided with the proper background knowledge, and encouraged to inquire about, and participate in the development of solutions to preserve our “backyard”.

When I began researching the vast array of information about the Ocean, I was slightly overwhelmed by the tremendous amount of information out there. Imagining bringing all this information to my students seemed a bit much. That is how I narrowed my unit to deal with how the Earth’s coastlines were formed and properties of the Long Island Sound. In doing this, I am provided with another classroom for my children to learn in. A classroom they can see, touch, and feel the impact they have on it! I do not feel that students should be dismayed by the tiny details, but should be given a basic understanding and be encouraged to take matters of interest under further consideration and investigation. My hope is to use the abundance of information about the Long Island Sound, and spark curiosity amongst my students.

What This Unit Hopes To Accomplish

My hope for this unit is to bring the more difficult content information to a level in which all my students will be able to understand. In doing so I will be providing relevant information, hands-on activities, field trips, and videos that will spark their interest. The students will embrace this newly found knowledge, critically think about it, and become actively involved in the learning process. I also wish to spark an awareness of the surrounding environment in which they live. Ideally, the students will take it upon themselves to expand their knowledge base and further empower themselves. The process of creating independent learners is one of the most rewarding parts of teaching.

The Structure of the Earth

Before students can begin to study about the properties of the Long Island Sound, they need to have a knowledge of how the Earth is structured. Through study during earthquakes, scientists have been able to learn alot about the structure of the Earth. Scientists have been able to identify three main zones according to their densities: the thin outer crust, the mantle, and the core in the center.

The **core** and **mantle** lie deep within the Earth's crust. The **mantle** is about 1,740 miles thick and is made of rock. The central zone of the Earth is called the **core** . It is divided into inner and outer zones. The inner core is solid, but the outer core is liquid. Both are very dense and hot and consist of mainly nickel and iron.

The **mesosphere** is the layer that sits upon the top of the core and is very hot. The **asthenosphere** is the layer beneath the lithosphere which is in a "plastic" state, so that it behaves like an extremely thick liquid. The **lithosphere** is the upper layer of the Earth. It includes the crust and the top, brittle part of the mantle. This layer can be up to 186 miles thick. The **hydrosphere** is the water (mainly the oceans and seas) on the Earth's surface.

The Earth's **crust** is divided into two parts: **oceanic crust** and **continental crust** . The thicker continental crust can vary from about 22 miles thick to as much as 31 miles beneath mountain ranges. This crust is made mostly from pale, granite-like rocks. The oceanic crust is less thick and is formed from volcanic activity. The main elements that make up the crust are: oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium.

To demonstrate the structure of the Earth to your students, you can recreate a picture and label it. Another activity could include building a model of the Earth's structure with your class. Using different colors of clay, recreate by molding each different color as a different layer. After layering the clay around each other, carefully slice out a chunk from the crust to the inner core. Take out the chunk and the different layers of clay should grant the students with a visual representation of the Earth's structure. Make sure to provide a chart or key for the different colors and what they represent. Keep this model on display for the children to look at.(see figures 1 and 2 in the appendix for a visual representation of the structure of the earth)

Plate Tectonics and Continental Drift

What many people can recognize is that the coastlines of eastern South America and West Africa could fit together like a jigsaw puzzle. This was noticed in the 17th century, and it was not until 1912 that Alfred Wegener proposed that all the land masses of the world had originally been connected as one super-continent, which he called **Pangaea** . In the 1960's scientists were able to explain this when they discovered that the rocky plates of the Earth's lithosphere were moving, floating on more mobile rock that was below.

As well as matching coastlines, there is other evidence that there was once a single continent. There are fossil and ancient mountain remains on the coastline of completely separate continents. The distribution of the continents can be seen over the past 200 million years.(see figure 3 in appendix) Today, this drift continues. The Atlantic Ocean is getting wider by a few inches each year, the Pacific Ocean is getting smaller, and the Red Sea is part of a crack in the Earth's crust that will widen to produce a new ocean millions of years in the future.(for further explanation see figure 4 in appendix)

Scientists think that the spreading may have been caused by the convection currents of hot mantle rising under the Earth's lithosphere plates. The hot mantle comes from deep within the Earth. When it rises, it presses against the lithosphere, pulling it apart. Finally, as the two plates continue to pull apart slowly, then orange-hot magma rises up to fill the gap much the same way a cracked egg oozes out when it is boiled. Throughout history volcanoes have erupted creating new crust and a ridge of mountains along the seams, or rifts.

The word "tectonics" comes from the Greek word *tekton* , meaning "builder." The theory suggests that the surface of the Earth is made up of the rigid plates of lithosphere which "float" on top of the more mobile asthenosphere. Reaction to the movements in the asthenosphere make these plates be in constant motion. This theory explains many of the major processes of the Earth, such as continental drifting, mountain building, ocean trenches and valleys, and earthquake and volcanic activity. All of the aforementioned are found along plate boundaries or former boundaries.(see figure 5 in appendix)

See activity for creation of different mountain. This also goes along with plate tectonics and continental drift.

How The Connecticut Coast Is Formed

The geologic history of the past 20,000 years tells us why the coast looks as it does. The two building blocks of the coast are *bedrock* and *drift.* The bedrock is the foundation, is found beneath the unconsolidated sand and soil. The bedrock one sees at the coastline is the earth's outer layer or crust. The two most common types of bedrock along the Connecticut coast are gneiss (pronounced "nice") and granite. Both of these are extremely hard and resist erosion. Drift is simply just sediment. It is made up of gravel, sand, silt, and clay that glaciers deposited over Connecticut. Drift is formed as glaciers chisel through the landscape grinding up rocks. One main type of drift is *till,* large angular boulders surrounded by sand, silt, or clay. The other main type is *stratified drift* , layered sand and gravel. Islands are also made up of these materials, but can differ. For example, both the Thimble Islands and coast of Branford are made of bedrock, while the coast and islands at Norwalk are stratified drift, sand and gravel. The Connecticut coastline was not only formed by the scouring and deposition of glaciers, but storms have caused continued shaping from erosion. These storms formed many large and powerful waves, which beat against the shore giving it its shape.

Long Island Sound

Long Island Sound is an ***estuary .*** *An estuary is a place where an oceans salt water mixes with the fresh water from rivers and the land. Approximately 11,000 years ago the site of the Long Island Sound was a glacial lake. This glacial lake began to overflow the moraine dam. The force of the flood cut a deep gorge and drained the lake across the coastal plain into the ocean. Due to the warming of the global climate, the ice caps and glaciers melt, returning water to the ocean and raising the sea level. About 8,000 years ago the rising sea level drowns the basin left by the drainage of the Glacial Lake Connecticut and starts the formation of Long Island Sound. However, in the past 100 years the sea level has risen only 25 cm. Another result of the rise in sea level was the creation of many salt marshes. These marshes, as well as the Sound, provide the area with a wealth of life. The area abounds with fish, plant life, shellfish, and waterfowl. The Sound provides recreational and commercial value to the area. Nearly 8.5 million people live along the Long Island Sound watershed. Many of these rely directly on the Sound for prosperity, and many for just plain fun.*

Wind and Waves

Waves are born when wind blows across a body of water and roughens its surface. **Oceanographers** think that waves occur because wind exerts uneven force on the

roughened surface of the water, pressing down water in one place and lifting it in another.

When a wave forms, the wind sustains it by exerting high pressure over the **crest** (the highest point in a wave) and low pressure over the **trough** (the lowest point in a wave). This difference in air pressure pushes down the crest and lifts the trough.(see figure 6 in appendix) Once waves are created, how big they get is determined by wind speed, **wind duration** (how long it blows), and **fetch** (the distance of water over which wind blows). Once a wave starts moving, it continues until it dissipates or breaks. Waves can break in several ways. They can spill forward, with the crest sliding down the front of the wave, or the can topple, with the crest curling over and plunging ahead of the rest of the wave. Less often they surge, with the crest peaking as if to plunge, but the base surging up the beach face so the crest collapses and disappears.(see figure 7 in appendix) Since Long Island Sound is relatively small, nearly all waves continue until they strike the coast. This striking of the coast causes the erosion that continues to shape our coastline.

An activity you can do with your class to illustrate this information would be to set up a long aquarium. In this aquarium have a side built up with sand and rocks. Have the students take notice of the shape of the sand and rocks which form a “coastline”. With a washable marker, draw the outline of the “coastline” on the outside of the aquarium. Next, set up a fan to blow on the water in the aquarium an the opposite end of your “coastline”. The fan blowing at various speeds will simulate calm and stormy weather. Turn the fan on and the wind from the fan should form waves in the aquarium water. These waves will crash into the sand and rocks that are representing the “coastline”. The crashing waves will reshape the sand and rock of the “coastline”. Turn the fan off and observe the newly formed “coastline”. Also, observe the difference from the line that represented the old coastline to the new. This activity gives the students a visual representation of the process of erosion and how our coastline was formed.

*Make sure the students understand that this process takes many years.

Activity clearly explained in appendix.

Ecological Importance

A unique facet to the Long Island Sound is its lack of a major source of fresh water at its head. This fact makes it unlike a typical estuary. The water make up consists of different components. The lower salinity waters flow from the Upper Bay of New York Harbor through the East River and Harlem River tidal straights and enter the western part of the Sound. Past the race and Block Island, the higher salinity waters enter the eastern part of the Sound from the Atlantic. The Connecticut River provides the Sound with its largest source of fresh water. This mixing of fresh and saltwater creates very complex currents. The distribution of sediments thus becomes very complicated.

One must understand the behavior of currents in an estuary to comprehend the sediment distribution. The currents are created by *tides* , endless series of waves. The tides are created by the gravitational pull of the moon and sun.

The Long Island Sound is a productive ecosystem with a wealth of aquatic organisms and wildlife inhabiting it. The significant ecological components of the Sound are its diverse and unique habitats. These habitats include such places as beaches, bluffs, coves, dunes, embayments, headlands, tidal wetlands and flats, rocky intertidal areas, submerged aquatic vegetation (eel grass and kelp), artificial and natural reefs, and the sediment floor. These habitats provide the services of feeding, nesting, nursing, and shelter for the many organisms that inhabit the Sounds waters. Each of the habitats supports the organisms within it, while contributing to the overall productivity of the ecosystem known as the Sound.

At this point there are various activities you may choose to do:

You can watch the video *Seashore* that is put out by Eyewitness. This video can be found in most local libraries. It will give the students a visual aid to understand the wildlife, organisms, and habitats of seashores. Although it is not directly about the Long Island Sound, it can grant the students some prior knowledge before an actual trip to a seashore.

Take a trip to a beach. In New Haven, Lighthouse Point is an ideal area. You may have the students record observations and collect samples from their trip.

Take a trip to the Peabody Museum or a museum of the same nature. Many of the exhibits will be of value. Look especially on the third floor.

What About Water Quality

Pollution plays an important role in preservation of the viable habitats of the Sound. Due to the interconnectedness of the habitats, pollution can have a devastating effect on the entire ecosystem. A major source of pollution is sewage discharge. With initiatives such as the Clean Water Act, the states of Connecticut and New York have built sewage treatment plants to help restore degraded waters. Since the creation of the Clean Water Act, there have been many pollution control programs that have resulted in measurable improvement in the water quality. This improvement has allowed the Sound to remain a valuable estuary. Efforts of concerned citizens have forced these improvements, and have made the Sound a value today. However, the coupled storm and sanitary sewer systems for most New England cities undoes the effect of the sewage treatment during times of storm surges.

Despite the notable progress made, much work still remains to be done. The quality of the Sound is far from what it should be. The commercial, recreational, and residential development aforementioned have posed many threats. The density of the population living within the Sound's watershed increases with the close proximity to the coastline. This is in direct correlation to the use of the Sound to dispose of human and other wastes. In fact, over one billion gallons of treated effluent is dumped by over 60 public wastewater plants each day. Other problems such as increased runoff and reduced filtration have impacted the Sound greatly. These problems have caused habitat alteration and destruction and have harmed the population of the Sound. The problems need to be addressed and maybe our students can be a part of the solutions.

See activity in the appendix.

The students need to become aware of the problems that face the resources around us. With an awareness they can become problem solvers. If the proper knowledge and values are instilled in our students, then we can prevent our valuable resource, the Sound, from having further harm done to it. If the proper steps are taken, then maybe we can give Mother Nature a chance to revitalize.

In order to broaden the students' knowledge base, one of the following activities can be done:

1. Have the children brainstorm a list of questions they may have about water pollution and filtration. Then have them write a letter to an area business that deals in this subject. I am sure that the businesses will respond with information and possibly a speaker. The writing of the letter grants the students the knowledge of how to access information from different sources. This is an essential skill in order to be a problem solver.

    Businesses addresses in the New Haven area:

    Aqua Clear Systems Inc. 6 Industrial Cir. Hamden 06514

Connecticut Water Treatment	720 Woodward Rd.	Stratford 06497
GW Inc. Water Conditioning	1486 Highland Ave.	Cheshire 06410

2. You may also call the *South Central Regional Water Authority* to ask for more information or possibly to set up a trip to a water treatment facility. The phone number is (203) 287-1352
3. Another activity is to have the students make their own water filtration systems. This activity is explained in further detail later in the unit.
4. Plan a trip to Whitney Water Works.
5. Plan a trip to clean up a beach.

Activity

Purpose:	To help students observe winds effect on water(making waves), and the waves effect on the shore.(erosion)
Materials:	A rectangular shaped aquarium
	A ruler
	A fan
	A crayon to write on glass of aquarium
	Sand (preferably beach sand)
Procedure:	1. Add water to the aquarium until it is a little bit over half full.
	2. Have a student draw a line with the crayon to show where the water level is.
	3.Tape a ruler to the side of the aquarium and have the students measure the water depth in inches. Record on a sheet of paper.
	4. Add the beach sand to the aquarium. As you do this add the sand to one end of the aquarium sloping it down with your hand to form a beach.(this is used to simulate a shoreline) It is important that you have the sand level above the water level at the one end, if not the experiment will not work.
	5. Have the students again measure the water depth in inches and record on a sheet of paper.
	6. Have a student with a crayon draw the outline of the sand on the aquarium glass. Make sure to do this when the water in the aquarium is calm. It is important to draw the outline carefully so you can observe changes later.
	7. Set up a fan facing down on the water in the aquarium. The fan must be set up at the opposite end of the aquarium from the higher elevation of sand.
	8. Have the students predict what will happen when you turn on the fan? Will it matter if you turn the fan on different speeds? You can have them write these predictions or have an oral class discussion.
	9. Turn on the fan. You may use the different speeds. Observe the aquarium and what happens when the fan is on. Observe the waves and their shape. Leave fan on for a few minutes to allow the waves to take affect.
	10. Turn the fan off. Have the students look at the original outline of the sand that formed a shoreline. Have the students note the difference in the outline after the fan caused the waves to erode the sand somewhat.

Results: As the fan is turned on it has the affect of creating waves. The fan at different speeds causes smaller and larger waves. This is designed to show how wind effects water. The waves created should crash, or break, against the shoreline you created with the sand. As the waves crash they should reform the outline of the sand. This is designed to represent the erosive effect waves have on the shore. It is important that you explain to the students that the erosion process takes a long time so as not to confuse them into thinking this is a quick process.

Questions:

1. What was the depth of the water(in inches) before the sand was put in?
2. What was the depth of the water(in inches) after the sand was put in?
3. What is the difference in depth(in inches)? Why is there a difference?
4. What part of nature did the fan represent in the experiment?
5. Was your prediction right about what effects the fan would have on the water?
6. Did you notice a difference when the fan was on different speeds?
7. What happened as the waves hit the sand?
8. Was the outline of the sand different after the fan was turned off? How?

Evaluation: The experiment is successful in giving the students a visual representation of the erosion process. The students should have an understanding of the direct correlation of wind, and its rate, to this process. The students should understand the effects wind has on water. They should also understand how the waves created effect the shaping of our coastlines(erosion). If they can explain the basics of this process in words, either orally or in written form, then the activity was a success.

Activity

Purpose: To demonstrate to the students how folded mountains and block mountains are created and how they differ.

Materials:

Sand

Old doormat

Two pieces of straight edged wood

Background: Folded mountains are smooth. As the earth pushes and pulls apart, it “skin” gets a little too big for the shrinking earth, so the earth’s crust folds, producing mountain ranges. Block mountains are jagged(until weathering and erosion take over). As the earth moves, cracks sometimes appear in the crust. The cracks are called faults. Pressures that would cause a fold produce a different result where there are faults. Instead of folding, the two sides of the crack move separately. When one side pushes towards the other, one side goes up more than the other and a jagged mountain range is formed.

Procedure:

Folded Mountains

1. Place an old doormat on a table or ground over some sand.
2. Cover the doormat with more sand.
3. Have two students push the opposite ends of the doormat toward each other. This will simulate the creation of a folded mountain.

Block Mountains

1. Place two pieces of wood facing each others edges on top of sand.
2. Cover the wood with more sand.
3. Wiggle both boards causing the boards to separate a little and simulating the creation of a fault.
4. Tilt one board up slightly

5. Push boards towards each other. As you do this sand should be pushed under the tilted board causing it to rise and simulate the creating of a block mountain.

Results: As the students follow the steps in the creations of the different mountains, they should become aware of the differences. The differences they should notice should be in how each mountain was formed. They should also notice the difference in shape. The folded mountain should be a smooth shape and the block mountain should have a more jagged shape. Have them notice the concept of the creation of a fault with the block mountains.

Questions: 1. What did you notice in the shape of the folded mountain?

2. What did you notice in the shape of the block mountain?

3. What is the difference in these shapes?

4. What was created when you wiggled the boards when making the block mountain?

5. Explain the difference in how these two types of mountains are formed in nature?

Evaluation: The activity grants the students a visual representation of how these mountains are formed and the differences between them. The students should be able to explain the concepts behind these two mountains and their shape. They should be able to do this orally or in written form. They should also be able to understand the significance in the creation of a fault with the block mountains.

Activity

Purpose: To demonstrate and create a water filtration system

Materials: Empty 2-liter soda bottle

fish tank filter charcoal-rinse before using

pebbles

sand

scissors

Nylon stockings cut into small squares

Rubber bands

2 Large clear plastic cups

one cup measuring cup

Substances to filter EX. Food coloring, cooking oil, dish soap,

dirt etc.

Procedure: Making filters

1. Cut bottoms of soda bottles with scissors.

2. Wrap piece of nylon stocking over pour opening of bottle and secure with a rubber band.

3. Measure and pour into bottle one cup of pebbles, sand and charcoal in that order. Put in cut open side.

4. Place bottle upside down in empty plastic cup to stand.

Filtering

Note* Have materials to be filtered mixed ahead of time. Mix them in equal proportions.

1. Have students choose a mixture to filter and record.

2. Measure a one cup amount of the mixture to be filtered and record observations on what the mixture looks like before.

3. Carefully pour the measure mixture into the cut opening of the filter. Be sure the empty cup is under to catch the filtered liquid.

4. Allow the liquid to pass throught he filter. Record the observations of what the liquid looks like after passing through the filtration system.

5. Measure the amount of liquid that passed through the filtration system and ended up in the plastic cup.

Results: The mixture that passed through the filtration system created should have been cleaned somewhat. This allows the students to have a basic understanding of the filtration process. They should understand the connection with our water pollution problem of our coastlines.

Questions: 1. Do you think the filtration system you created did a good jobcleaning out the polluted water mixture?

2. What might make the filter more effective?

3. Was any liquid lost in the filtering process?(was the liquid less coming out than going in the filter.

4. In a water treatment plant, the filtering process is only one part of the treatment process. Before water is filtered, it is mixed with coagulant, a sort of jello, which attracts impurities in the water. The water is then run through the filters, much like the ones you made. How do you think the coagulant helps the filtration process? *The coagulant forms clumps which make it easier to filter out.

Note Make sure to then tell the students that the filtered water is then treated with chemical to kill bacteria. The bacteria seeps through the filter so it is important to treat the filtered water with chemical to make it safe.

Evaluation: The students should be able to explain how a filter is created. They should also have a basic understanding on how the material help filter the polluted water. The students should also understand that filtering is only part of the treatment process. The also should make the connection to cleaning up our coastlines from pollution.

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* **Denotes Books Appropriate For Student Use.**

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Figure 1

A visual representation of the differing layers of the Earth’s structure. Good to use as a model for the clay experiment.

(figure available in print form)

Figure 2

A clear representation of the layers of the Earth and their dimensions.

(figure available in print form)

Figure 3

Shows the Continental Drift over the past 200 million years.

(figure available in print form)

Figure 4

Explanation of the steps and processes of how the continents move.

(figure available in print form)

Figure 5

Sea-floor spreading and the creation of a subduction zone. These processes are directly related to volcanic activity.

(figure available in print form)

Figure 6

The physical make-up of a wave.

(figure available in print form)

Figure 7

The differing ways a wave breaks.

(figure available in print form)