What You Need to Know

Essential Standard: 8.E.1 Understand the hydrosphere and the impact of humans on local systems and the effects of the hydrosphere on humans.

Clarifying Objective: 8.E.1.2 Summarize evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms:

- Estuaries
- Marine ecosystems
- Upwelling
- Behavior of gases in the marine environment
- Value and sustainability of marine resources
- Deep ocean technology and understandings gained

Students need to know:

· **that the ocean is a dynamic system in which many chemical, biological, and physical changes are taking place.**

- The ocean is an important source of food and mineral resources as well as a venue for human recreation and transportation. Students know that the ocean is the largest reservoir of water on the surface of the Earth. They also know that the ocean is the single largest reservoir of heat at Earth's surface. The stored heat in the ocean drives much of Earth's weather and causes climate near the ocean to be milder than climate in the interior of continents. Many of the cycles that circulate materials between the atmosphere, lithosphere and hydrosphere originate in the ocean. Ocean currents are a source of large scale distribution of energy and resources on the Earth.

· **that estuaries are areas where fresh and salt water mix, producing variations in salinity and high biological activity.**

- Estuaries trap nutrients and sediment that are carried from the land by rivers and from the ocean by tides. In an estuary, these nutrients are constantly being mixed, due to tidal action and river flow. These conditions create a fertile repository of plant and animal life. Estuaries are one of the most productive ecosystems on earth.

- Because estuarine waters are shallow (in North Carolina, less than thirty feet deep), sunlight penetrates to the bottom. This promotes plant growth. The rivers that feed estuaries deposit sediments rich in nutrients, which settle onto the sand and mud of the estuary floor. These conditions create unique habitats for both plants and animals, and provide the basis for great biological diversity in species (of fish, shrimp, crabs, clams and oysters) that are able to adapt to the brackish conditions. Estuaries are also good nurseries as they provide a protected environment for species to hatch and grow in before they migrate to the sea to live out their adult lives.

- Estuaries are numerous in North Carolina. The largest North Carolina estuary is Pamlico Sound. Water drains into this system from eastern North Carolina and southeastern Virginia, from the Chowan, Roanoke, Pasquotank, Pamlico, and Neuse Rivers, from marshes, swamps, forests, and grasslands. Estuaries help control erosion and reduce flooding of the mainland. Sand bars buffer the impact of waves, while plants and shellfish beds anchor the shore against tides. Swamps and marshes take the initial impact of high winds moving in from the ocean, soak up heavy rain and storm surges, and release the extra water gradually into rivers and groundwater supplies.

- Estuaries are a type of environmental filter. Plants and animals in estuaries filter pollutants out of the water. For instance, salt marsh plants trap some of the chemicals and pathogens carried by rivers and move them into soils where they can be neutralized. Oysters filter impurities out of water as they eat, collecting the contaminants in their bodies. One oyster can filter twenty-five gallons of water per day. Bacteria eat organic matter found in the sediment and in turn release carbon dioxide, hydrogen sulfate and methane into the atmosphere preventing these gases from being excessively stored up in the estuary. However, toxins can accumulate in estuaries causing many environmental and health problems. Chemical pollution and sedimentation are great threats to the well-being of estuaries and oceans.

· **that from the seashore to the deepest depths, oceans are home to some of the most diverse life on Earth.**

- Oceanographers divide the ocean into zones according to how far down sunlight penetrates. Plants are found only in the sunlit zone where there is enough light for photosynthesis, however, animals are found at all depths of the oceans. As far as we know, nearly all life in the ocean is dependent on plants. Only plants have the ability to manufacture food out of inorganic substances. Algae in the ocean are an important food source as well as an important source of atmospheric oxygen. The most abundant plants in the ocean are known as phytoplankton. To grow, phytoplankton needs nutrients from sea water and an abundance of sunlight. Currents in the ocean recycle and circulate a variety of organic and inorganic materials. This makes nutrients, minerals, and gases available to organisms.

· that in the ocean there are innumerable individual food chains overlapping and intersecting to form complex food webs.

- Most marine creatures eat a variety of foods. If one link in a chain is depleted, the other consumers in the chain have alternate food sources. Ocean organisms generally belong to several different food chains that are linked to form a food web. Ocean food chains and webs are also connected to land-dwelling organisms.

· **how winds have a powerful effect on the oceans and are an important force in creating ocean currents.**

- From global circulation to microscopic patterns of turbulence, winds move water and its resident animals and plants. Under certain conditions, a special kind of ocean event known as upwelling can occur. Upwelling happens when warm surface water near coastal areas is blown offshore by winds. This creates a condition in which the cold water along the bottom of the ocean near the shore rises, carrying sediment and organic material to the surface. Phytoplankton uses these nutrients to grow and reproduce at a rapid rate. This attracts organisms that rely on the phytoplankton as food and their consumers in turn. As a result, areas of upwelling tend to become areas of rich biological activity, providing resources to a great diversity of ocean organisms. Approximately half of the fish caught in the world come from areas where there is upwelling.

· **that seawater has many different gases dissolved in it, especially nitrogen, oxygen and carbon dioxide.**

- The action of ocean wind and waves agitates the ocean surface, stimulating the exchange of these gases between the ocean and the atmosphere. Marine plants depend on dissolved carbon dioxide in order to perform photosynthesis. Photosynthesis releases oxygen into ocean water which is in turn used by ocean organisms for respiration. Respiration releases energy from stored carbohydrates and produces carbon dioxide and water as byproducts. Some properties of seawater affect how much gas can be dissolved in it:

    - Cold water holds more gas than warm water.
    - Seawater with low salinity holds more gas than high salinity water.
    - Deep water, which has a high pressure, holds more gas than shallow water.

· **that carbon dioxide is one of the most important gases that dissolve in the ocean.**

- Some of it remains as dissolved gas, but most reacts with the water to form carbonic acid or reacts with carbonates already in the water to form bicarbonates. This reaction removes dissolved carbon dioxide from the water. Many marine organisms use the bicarbonate to form calcium carbonate shells. When these organisms die, some of the bicarbonate is returned to the water, but a lot of it settles down to the sea bed. This process locks up, for long periods of time, carbon that originated in carbon dioxide in the atmosphere. As atmospheric levels of gases rise, so do the levels of the same gases dissolved in ocean water rise.

· **that the ocean is one of Earth's most valuable natural resources.**

- Marine resources include biotic, mineral and energy resources. The ocean provides food. It is used for travel and shipping. It provides a source of recreation for humans. It is mined for minerals and drilled for crude oil.

- The ocean plays a critical role in removing carbon from the atmosphere and providing oxygen. It regulates Earth's climate. The ocean is an increasingly important source of biomedical organisms with potential for fighting disease. The ocean is very important to life on land.

- The oceans have been fished for thousands of years and are an integral part of human society. Fish have been important to the world economy for a very long time. Fisheries today provide about 16% of the total world's protein with higher percentages occurring in developing nations.

- The word *shipping* refers to the activity of moving cargo with ships in between seaports. Wind-powered ships exist, but more often ships are powered by steam turbine plants or diesel engines. The various types of ships include container ships, tankers, crude oil ships, chemical ships, bulk carriers, cable layers, general cargo ships, ferries, gas and car carriers, tugboats, barges and dredgers.

- Tourism is the fastest growing division of the world economy and is responsible for more than 200 million jobs all over the world. The tourism industry is based on natural resources present in each country and tourism often has a negative impact on coastal and ocean ecosystems. However, sustainable tourism can actually promote conservation of the environment. The negative effects of tourism originate with the over development of coastal habitats and the annihilation of entire ecosystems. Garbage and sewage generated by natives and visitors can add to an already existing solid waste and garbage disposal issue. Often visitors produce more waste than locals, and much of it ends up as untreated sewage dumped in the ocean. This causes eutrophication because it results in excessive algal bloom. It can also lead to disease epidemics. Ecotourism and cultural tourism are a new trend that favors low impact tourism and fosters a respect for local cultures and ecosystems.

- Humans began to mine the ocean floor for diamonds, gold, silver, metal ores like manganese nodules and gravel in the 1950's. Sands and gravels are often mined for in the United States and are used to protect beaches and reduce the effects of erosion. Mining the ocean can be devastating to natural ecosystems. Dredging of any kind pulls up the ocean floor and a cloud of sediment rises up in the water, interfering with photosynthetic processes of phytoplankton and other marine life. Dredging also introduces previously benign heavy metals into the ocean food chain.

- Drilling for oil is another activity that extracts resources from the ocean. Before an offshore oil well can be drilled, it must first be located. Geologists locate potential oil wells beneath the ocean floor through the use of magnetic and seismic surveys. This surveying does not indicate for certain whether a site contains oil until exploratory drilling takes place. In order to drill exploratory wells, government permission must first be obtained. An environmental impact assessment may be carried out at this stage. Then,

using an exploratory drilling rig, geologists drill temporary wells to find out if there's a source of oil. If they think they've found a good source of oil, then more drilling takes place to substantiate the findings. Once oil or gas is discovered, then a production well is drilled and a production oil rig is built to replace the exploratory drilling rig. An average well will last from ten to twenty years, and even after it has run dry an oil rig may still be used for processing or storage of petroleum from other wells, so the production oil rig is built to last. The platforms are normally made of steel and are secured to the seabed using concrete or metal foundations. Initially the pressure from the reservoir is enough to pump the oil or gas, but as the pressure decreases various techniques are used to increase the pressure in the reservoir. These techniques include pumping in gas, water, compressed air or steam. The crude oil obtained from the well is then refined at oil refineries onshore.

- Drilling for oil under the ocean has many different environmental impacts. The rigs themselves impact living creatures, the actions and processes of drilling affect the oceans and ocean life, and the danger of accidental release of petroleum into the oceans is constant. Conservation of ocean resources and thoughtful long term cost/benefit analyses with regard to the use of the ocean's many natural resources are an integral part of sustaining our oceans well into the future.

· **that the deep ocean has long been of interest to scientists.**

- In order to understand the ocean, scientists must gain access for themselves or their instruments to very specific parts of it. Traditionally, scientists have used ships to photograph the depths, to drop floats and drifters into the currents, and to collect samples of water, rock, and marine life. In recent years, the spectrum of available observing tools has grown to include human-occupied submersibles, remote-controlled vehicles, and autonomous robots.

- At one time, scientists thought that life could not exist on the deep ocean floor. In 1977, scientists diving in Alvin to the Galápagos Rift discovered a new community of organisms. These organisms can withstand tremendous pressure, high temperatures, utter darkness, and toxic chemicals. These organisms are called extremophiles because of the extreme nature of their living conditions.

- The discovery of life at vents and seeps revolutionized what scientists understand about how and where life can exist on Earth. The organisms that thrive at deep-sea vents and seeps have to survive freezing cold, perpetual darkness, high-pressure, and toxic chemicals. Hydrothermal vents and cold seeps are places where chemical-rich fluids emanate from the seafloor, often providing the energy to sustain lush communities of life in some very harsh environments. Studying the organisms at hydrothermal vents and cold seeps expands our understanding of how life first took hold and slowly evolved on

our planet as well as where it might exist elsewhere in the solar system and beyond.

- On land and near the ocean surface, sunlight provides the energy that allows photosynthetic plants to convert carbon dioxide and water into the organic carbon, the fundamental source of nutrients for animals higher up the food chain. Below the photic zone (the sunlit, upper reaches of the ocean) many microbes have evolved chemosynthetic (instead of photosynthetic) processes that create organic matter by using oxygen in seawater to oxidize hydrogen sulfide, methane, and other chemicals present in vent and seep fluids.

- Animals such as clams, mussels, snails, and shrimp feed on the microbes, and in turn, provide food for fish and other predators. Some vent and seep animals, such as tubeworms and shrimp, also host chemosynthetic microbes on or within their bodies, providing a place for the microbes to live in exchange for nutrients produced by the microbes.

- Cold seeps and hydrothermal vents differ from one another in the underlying conditions that form and drive them. This has implications for the kinds of animals that are able to survive at each.

- Hydrothermal vents are driven by heat from volcanism beneath the seafloor. In this environment, chemical reactions take place as seawater percolates through cracks in the seafloor to produce hot (more than 400°C or 750°C), acidic fluids that eventually rise back to the seafloor. Vents, and the ecosystems they support, are created and destroyed as underlying volcanic activity waxes and wanes over tens or hundreds of years. On land and near the ocean surface, sunlight provides the energy that allows photosynthetic plants to convert carbon dioxide and water into a fundamental source of nutrients for organisms in proximal food chains and webs. Below the photic zone many microbes have evolved chemosynthetic (instead of photosynthetic) processes that create organic matter by using oxygen in seawater to oxidize hydrogen sulfide, methane, and other chemicals present in vent and seep fluids. Animals such as clams, mussels, snails, and shrimp feed on the microbes, and in turn, provide food for fish and other predators.

- Cold seeps are a little bit different. They produce a diffuse flow of lower-temperature fluids, often composed of natural gas and a mixture of hydrocarbons, at slower rates for longer periods. The methane seeping from the seafloor sustains microbes that serve as the base of the food chain for communities of animals which thrive in the sunless depths. Far more natural gas is sequestered on the seafloor (or leaking from it) than can be drilled from all the existing wells on Earth. Some seeps may be thousands of years old.

BOTTOMLINE: *The oceans of the earth are one continuous body of water covering the majority of our planet. The ocean is an integral part of the water cycle and is connected to all of*

the earth's water reservoirs via evaporation and precipitation processes. The salinity of the open sea is fairly constant, but the ocean consists of several zones with different properties due to variations in temperature, pressure and penetration of light. Many earth materials and geochemical cycles originate in the ocean. Productivity is greatest in the surface layers of the ocean, where sunlight penetrates and photosynthesis occurs. Currents and recycling processes make nutrients, minerals, and gases available to marine life. Upwelling is a type of ocean current in which cold nutrient-rich water rises to the surface from the ocean depths. Microscopic algae serve as the base of open ocean food webs and provide the majority of the world's oxygen. Terrestrial and aquatic food webs are often interconnected and affected by the level of nutrients. Estuaries are places where fresh and salt waters meet. They are partially enclosed bodies where seawater is diluted by fresh water that drains from the land. Estuaries serve as an important habitat for many marine species, buffer zones for pollutants and breeding grounds of many organisms. They also act as a filtering system to remove some chemical elements and compounds from land run off. They provide important and productive nursery areas for many marine and aquatic species. Marine resources are used to provide many important products to humans in addition to food. Although the ocean is large, it is finite and resources are limited. The salt in seawater comes from eroding land, volcanic emissions, reactions at the sea floor, and atmospheric deposition. There are three different marine ecosystems: shore, open ocean and deep ocean. There are many deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs, and methane cold seeps rely only on chemical energy and chemosynthetic organisms to support life. Deep ocean exploration and technology continues to provide information about new life forms, Earth resources, and geologic processes. Tides, waves and predation cause vertical zonation patterns along the shore, influencing the distribution, diversity and availability of organisms. Use of ocean resources has increased significantly; therefore the future sustainability of ocean resources depends on our understanding of those resources and their potential and limitations. The ocean affects every human life. Most rain comes from the ocean and over half of Earth's oxygen. From the ocean we get foods, medicines, minerals, and energy resources. Many organisms spend parts of their life cycle in aquatic and terrestrial surroundings. Most of life in the ocean exists as microbes. Microbes are the most important primary producers in the ocean. Not only are they the most abundant life form in the ocean, they have extremely fast growth rates and life cycles.

Reference: North Carolina Department of Public Instruction, Essential Standards: Grade 8 Science, Unpacked Content, September 2012 Revision, http://scnces.ncdpi.wikispaces.net/file/view/Unpacked_Content_Grade8Science_RevisedSeptember2012.docx.pdf/368725266/Unpacked_Content_Grade8Science_RevisedSeptember2012.docx.pdf