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Water Will, Water Way

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by Laura Pringleton

Webster defines diversity as unlikeness, variety and difference; bio as life. Biodiversity then would be the contrasts existing among the different and various kinds of life surrounding us. Pharmaceuticals are the preparations of drugs.

My plan is to explore relations between biodiversity and pharmaceuticals. I believe that because of biodiversity, the universe is shrinking and with it, perhaps, many potential benefits of water and its inhabitants. Some of the benefits may still exist and with modern technology, be found again. New ones may even present themselves. I would like to pursue these benefits, lost and found, through aquaculture, the farming of the sea.

My rationale for writing this unit is threefold. 1) I am working on a grant that deals with water and marine animals. 2) I am interested in marine life that is pharmaceutically beneficial to mankind. 3) Because of biodiversity, some potential cures for many now incurable diseases may have been lost. Perhaps the emphasis should be on finding beneficial pharmaceuticals because many of the marine animals extant today have existed for millions of years. The water that we use today is the water that has been there too, since the beginning of oceans.

The first third of the unit will deal with ocean (sea) water, its salinity and the other 3% fresh water. Long Island Sound and its watershed is covered in the curriculum for K-4 grades. The length of the unit can take anywhere from a month through the first quarter. The students will learn about and how to test for: chlorine, iron, copper, magnesium, etc., and the pH level of purity. They will learn just how much of our water is drinkable, and how the government does and does not regulate our drinking water. Long Island Sound and its watershed should provide ample science experiments for the group.

In the second third of the unit my students will be learning about biodiversity and its pharmaceutical effects on marine life. Students will explore certain sea animals with known benefits to mankind; such as shellfish: clams ,oysters, mussels, and scallops; sharks, whales, lobsters, sponges, and coral reefs. Inherent in these yet unclassified sea creatures may be the cures for HIV, Alzheimer's, Cancer, etc.

The last third of the unit is devoted to a summary of our findings rather than the future speculation on pharmaceutical gains. I will include the research of BBSR's techniques and their use of "Genomics," genetic engineering technology in "cloning."

I. Salt, Fresh, and Tap Water

Long Island Sound is an estuary (a place where fresh river water mixes with salty ocean water). It is extremely productive in that it abounds with plant life, finfish, shellfish and waterfowl. It provides feeding breeding, nesting and nursery areas for many animals.

According to Living Treasures: The Plants and Animals of Long Island Sound, the Sound is 110 miles long from end to end, from East River to the “Race.” At its widest point, it is 21 miles and ranges from 60 - 300 feet at its deepest points; average depth - 65 feet. While most estuaries orient from North to South, the Sound orients from East to West. Its watershed, which is a place that receives the run-off and drainage of other bodies of water, reaches into five states and part of Canada.

Some rivers that drain into Long Island Sound are the Thames, Connecticut, Quinnipiac, and the Housatonic. There are more than 1,200 species of invertebrates and 170 species of fish. It is an essential food stop for dozens of species of migratory birds. There are salt marshes and tidal wetlands that provide sheltered nursery areas for many species of fish. In the tidal flats, sandy, muddy areas, we find gastropods and bivalve mollusks, horseshoe crabs and others. In the subtidal zone, there are benthic (of the sea floor) and pelagic (open water) communities. Included in the benthic animals are sponges, cnidarians like sea anemones, and coral. There are channeled whelks (conchs) and lobsters, which molt, often; and the blue crab, fiddler crabs, spider crabs, sea stars and sea urchins; skates, which lay eggs in purse-like pouches called a “Mermaid’s Purse.” In the pelagic zone or open water areas, things bloom bountifully; perhaps too bountifully because even algae blooms, which are not toxic, can cause havoc. The algae blooms result from excess nutrients in the form of Nitrogen discharged to Long Island Sound from treated sewage. The blooms multiply and die, using up tremendous amounts of Oxygen. This causes drops in Oxygen to dangerous levels for the other animals. There has been some attention given to this problem.

There are many groups protecting the watershed. In the Resource Directory of Agencies and Organizations focused on Long Island Sound and its watershed, organizations are listed by Environmental Organization: Connecticut National Region, New York etc.; Land Conservation Trust, Local Government; Museum/Nature Center; Regional Planning Organizations; and State and United States Government. Each also lists a mission statement, contact telephone numbers, E-mail; web sites, available resources and fees.

According to *The Sound Book* , these organizations, recognizing the need for watershed protection, have identified significant issues and devised a plan to address them, involving local, state, and federal resources. The task is a difficult one because of these danger signs to watershed health: 1) Erosion from development sites of stream banks that carry nutrients and sediments, clog rivers and wetlands, and damage fish habitats. 2) Landscape trash ends up in the *Sound.* 3) Fallen trees block streams, causing flooding. 4) Algal blooms cause nutrient problems in natural waters. 5) Dead fish and wild life indicate low oxygen levels or polluted water. 6) Pipes (illegal pollution sources) spill into natural waters. 7) Failed septic systems. 8) Intrusion on watershed wetlands needed to purify storm water runoff. 9) Closed beaches and shellfish beds indicate pathogen contamination.

There are also many Living Resources and Habitats of the Lower Connecticut River listed in the Connecticut College Arboretum, bulletin #37. One can find information on the geology, hydrology and Ecology of the lower Connecticut River. The bulletin lists birds, fisheries, and human uses of Aquatic Resources. Students would find this book useful for doing research, but on an upper grade level.

Aquaculture Depends on the Health of the Ocean

Aquaculture (the farming of the sea) depends on the health of the ocean. According to Dr. Hank Trapido-Rosenthal of the Bermuda Biological Station for Research, Incorporated (BBSR); and his key partners: Dr. Stephen Giovannoni of Oregon State University; and Dr. Craig Carlson of the University of California, Santa Barbara (Partnership with Diversa); “This diversity has existed for three billion years and less than 1% of these marine animals have been classified and domesticated.” The staggering potential of extracting beneficial chemicals pharmaceutically is today greatly enhanced by such advanced technology as “cloning.” However, pollution has always been a threat to the health of the sea and to our fresh water.

There is always the threat of pollution. Our ground water, which is fresh water is very easily contaminated by pesticides, while other water lends itself to microbes, heavy metal in anti-fouling paints, waterborne diseases and chemical contamination.

As long as scientists have been studying the ocean, and because of biodiversity, they have only been able to identify, classify and domesticate less than one percent of the ocean’s many inhabitants. Little is known today about the pharmaceutical value of these plants and animals. My source for the following sections is DiscoveryWorks.

Let us consider two water ecosystems: freshwater and saltwater. Only 3% of the water on earth is freshwater. Our streams, ponds, lakes, rivers, swamps, bogs, marshes are considered to be freshwater even though they too, have some dissolved salts. Two percent of this total is locked in polar ice. The rest of the “freshwater” is in the ground or surface water.

Biomes are ecosystems that cover large areas of land. The major biomes are: the deciduous forest, desert, grassland, taiga, tropical rain forest, and tundra. Have students create a model of the biome in which they live and how it may have changed. Then have them create one that might have been before people inhabited it.

Living things in the freshwater community owe their survival to some abiotic factors such as: Is the water still or flowing?; Is it slow-moving or flowing rapidly?; What is the water temperature?; Is the water clear or cloudy?; and How much oxygen does the water contain? This is important because cold water holds more oxygen than warm water and fast-moving water holds more oxygen than slow-moving water. A river can be defined as running water. Rivers empty into lakes, oceans and other rivers. Rivers support freshwater fish, plants, birds and other forms of life. Lakes on the other hand are large standing bodies of water. Lakes provide many habitats for perch, bass, frogs, insects etc.

A wetland is an area where land and water meet. The soil of a wetland is watery and the oxygen is less than in a river or lake. Wetlands include marshes, which have mostly grasses and cattails; swamps, which mostly have trees and shrubs; and bogs, which consist mostly of mosses.

Ninety-seven percent of earth’s water is salty. One could consider the ocean as one continuous body of water. Its vastness makes it easy to support many forms of life, such as tiny, one-celled organisms to the highest mammals. Different organisms are found at different depths. Ocean water contains about 3 1/2 % salt, but this amount can vary. One of the projects, I plan for my students is to find out what % the “Sound” around us is salt? Ocean organisms are affected by water pressure, temperature and light.

The shoreline, where the ocean meets the land, has tides and waves that affect the organisms as well as rocks, sand and pebbles. Coastal ocean is home to kelp, jellyfish, whales. It also includes sponges, coral crabs,

starfish. Coastal Ocean is shallow enough to allow sunlight to shine all the way to the coastal floor. Here is where Plankton, the basis of our food chain is plentiful.

Layers of the Open (Pelagic) Ocean

The pelagic (open) ocean covers most of the globe. Plankton abound in the upper layer while others swim in the next layer. Some live on the ocean floor without light or they make their own. Mid-water organisms include sharks, whales, manta rays, sunfish, and squid. Bottom dwellers are angelfish, viperfish and lantern fish.

There are other dissolved substances in ocean water besides salts. Six substances make up about 99% of these dissolved substances. Large amounts of dissolved gases, such as Nitrogen, Carbon Dioxide and Oxygen are also found in ocean water. The dissolved Oxygen is in addition to the Oxygen in the water molecule itself. Amounts of the Oxygen vary according to water depth and temperature. Near the surface, sunlight helps plantlike organisms grow. They release Oxygen into the water. So, surface water has more Oxygen. Gases dissolve easily in cold water so cold water areas in the world have more plants and animals. Plankton drifts with the current near the surface of the water. Phytoplankton, plant-like plankton, can only survive if there is Oxygen, Carbon Dioxide and other dissolved gases. Zooplankton, animal-like plankton, feed on phytoplankton. If the water cannot support phytoplankton, the zooplankton cannot survive either.

Sediments containing sand particles, bits of shells and decaying organisms pollute the other because they do not dissolve in water. Pollution caused by humans wreaks havoc in our oceans, especially when wastes from coastal communities are carried out to sea and dumped. These affect the quality of the water. Ocean water is a carefully balanced mixture that provides oxygen and food and support for living things in the ocean, which in turn support organisms on land - including us.

The Ocean- Resource for Life

The oceans of the world are a vast resource for life. Yet the exploration has barely begun. There is a CD-ROM (“Hello Down There”) which will allow students to take an imaginary trip 4,000 meters down. As they descend, they measure water pressure and temperature. They enter this data on a spreadsheet. Students identify the thermocline and click to learn about deep ocean organisms in the thermal vent. In (“Final Frontier”), students consider why oceans are an important resource. They “probe” to measure the ocean’s surface area, and try to determine the benefits to the marine life found there. They write their findings in a spreadsheet and analyze the data.

What is in the Water?

What is in the water? Salt! However, when the oceans formed billions of years ago, they were not salty. The two most common elements in salt are sodium and chlorine. In nature, sodium chloride, potassium chloride and magnesium chloride are present in rocks and soils. Rainwater flowing over these lands carries away traces of this salt as well as other elements and compounds. Rainwater drains into rivers and streams that let out into the ocean. The ocean keeps some of them. Those that come out of solutions form sediments and settle on the ocean floor. Even freshwater rivers and streams deposit dissolved salts in the oceans. On the average, 1 kilogram of ocean water contains 35 grams of salt. So, 3.5% of ocean water is made up of dissolved salts. My students will determine the percent of salinity in the “Sound” around us.

One suggestion is that students follow a drop of rainwater as it falls into a river and flows toward the ocean. They can also estimate the distance it would travel from the beginning of the river system to the ocean.

Another mathematics challenge would be, to have students compare the amounts of water available from these sources: oceans, glaciers, granddaughter, lakes, rivers and the atmosphere. Oceans contain 97% of Earth's water, glaciers - 2%, granddaughter - 0.6 %, lakes and rivers - 0.02%, atmosphere - 0.001%. If l mL = 1% and 5 drops of water =1 mL, ask students to calculate how many mL or drops of water they would have to put in jars representing each source? Results: Oceans - 97 mL, glaciers - 2 mL, granddaughter - 5 drops, lakes/rivers - 0.1 drop and atmosphere - 0.005 drop.

Pollution Threats

As we know, pollution (the contamination of the environment by waste), is a great threat to water. There are freshwater pollutants as well as ocean water pollutants. The lesson in *Science Horizons- Grade 5* , suggests a warm-up exercise. Water may not be as safe to drink today as it was 100 years ago. Ask students why. Divide students into groups and give each group a set of eight cards labeled: lake water, ocean water, pond water, tap water, water from the sink drain, melted snow, river water and melted icicles. Have each group classify these as suitable or unsuitable for drinking. Students can also identify the key contaminants of fresh water and their sources. Discuss the answers.

Three fourths of the earth is covered with salty water, which is unsuitable for drinking, industry and farming. Less than one percent of fresh water is usable and most of that is locked up in the polar caps and glaciers. This small percent of usable freshwater, found in lakes and rivers can easily be polluted by sewage (raw and treated), chemicals and heat. This sewage, material that passes down drains in sinks and is flushed down toilets has microbes in it that cause disease in humans and animals. It is therefore unsafe to drink. Chemicals such as pesticides, (including fungicides, hubicides, rodenticides, algaecides, and all biocides) can also pollute water supplies. Fertilizers are chemicals that add minerals to the soil, but are often carried away by runoff. The runoff carries fertilizers to streams and lakes. Laundry detergents can also pollute water. It is a substance used for cleaning, but contains phosphorous, which can help some living things to grow and others to die.

Simple algae plants may grow quickly in water containing phosphorus. When the algae die, microbes break down their remains, which uses up great amounts of Oxygen needed by fish. Heat can also pollute water. Heat from nuclear power plants raises the temperature of the ponds and rivers near these plants. Warm water holds less Oxygen than the same amount of cool water. Adding heat reduces the amount of Oxygen available to the living things in water. If the fish are very active, they will need more Oxygen, which is already scarce. However, wastewater can be purified by filtering it through several tanks of sludge and charcoal (which removes color from water). The sludge may also be burned or used as landfill. Chemicals are added to kill bacteria. The clean water is then tested for purity before being released into a river or lake.

Ocean pollution is caused by natural means and humans. People dump waste materials into the ocean and eventually, it washes up on the beach. It often consists of non-biodegradables (substances that do not decay) such as plastics. It is dangerous for sea life. Sea life and birds strangle, choke and suffocate on plastic. Cans, bottles, and wood are other harmful pollutants that should be recycled. Oil is another pollutant. Most spills leave an oil slick. The Exxon Valdez oil spill in Prince William Sound in 1989 was one that spilled 10 million gallons of oil into the bay. The oil slick covered everything. It killed many sea otters, birds, and even deer that fed near the shore. However, there are several ways to clean up an oil spill: it can be soaked up by absorbent materials, sprayed with detergents (a process called emulsifying) that break up the oil into droplets; skimmers can be used to remove the oil from the water's surface; it can be burned by spraying it with laser beams from helicopters; add bacteria that digests oil, to the water and to the beach.

Water polluted with industrial waste can cause cancer in humans. Cancer is a condition in which some cells

grow faster than others and gobble up good, healthy cells. They can form lumps and tumors. Cancerous cells can spread throughout the body.

Tap Water

An extension of the water pollution lesson would be to have each student measure the amount of water used from one tap in his/her home for a period of time. They should record whether each use was a legitimate use or a wasteful use of clean water. One more activity would be to make a charcoal filter to show how it helps to purify water.

In exploring our tap water, there is a kit that each student can use. It prepares the students, by having them work in groups. There is a vocabulary list that students will learn as they tour the “tap water route.” Distilled, “hard water,” and indicator are a few which are defined as we tour. Each group will do some record keeping, testing and cleanup. Students will test for iron, pH levels of purity, copper etc. Each should be made to understand, however, that failed experiments can also be a learning experience. For instance, if a student with an orange stain in the bathtub tests negative for iron, he needs to know that iron is unstable in solution and that it probably settled out of solution before testing began. Tests can also be done on pool water, puddles, fish tanks and rainwater.

In the kit, there is a list of water words, all defined: acid, algae, bacteria, base, calcium, Carbon Dioxide, chlorine, corrosion, disinfect, magnesium, monitoring, pH, scale and water conditioners. As an introduction, students will bring in a tap water sample in an appropriate container. The students will know that 3/4 of the earth is covered with water and less then 0.4% is fit for consumption; and that the average family uses 300 gallons of water per day.

Unit 1 - pH Testing

The kit comes with all the testing materials. For pH testing, there are pH tablets, sample bags, baking soda, aspirin, vinegar, tap water, straws, 4 quarts of distilled water, 3-quart containers, a data sheet, a prepared poster for class results and, color chart paper. A pH scale is used. The definition of pH is a scale that tests for the acidity or baseness of water. The scale ranges from 0 - 14, with 7.0 (middle of the scale) being neutral. Students will discover that lemon juice, cola, and vinegar are highly acidic, while household bleach is very basic. Each will use his/her 3 water samples to test for color and pH. Put in a tablet, close the bag and shake so that the tablet dissolves. Do this with Carbon Dioxide and baking soda. Compare the resulting color with the chart. Ask students to journal about what they learned.

Students will also want to know how our water is purified. A trip to the Water Purification Plant is in order. Some students may use well water. That being the case, they will need to know that rocks and soil act as filters for our drinking water. The same rocks and soil that septic tanks drain into help to purify our drinking water. There is a Water Pipe Diagram which shows how corrosive water with a low pH of 5.0 can be to pipes, virtually destroying them. Water with a neutral pH of 7.0 will not harm pipes. Water with a high pH will “clog” pipes.

Unit 2 - The Chlorine Test

The chlorine test follows the same procedure. Using DPD #4 tablets, students will test each sample and chart the results. Chlorine will kill bacteria and control algae. It is added to city water supplies. When this activity is completed, charts are filled in and students will be asked to journal about the results. Students should know

that chlorine bleach has some residual effects and lasts beyond its first use.

Unit 3 - Testing for Iron

Testing for “iron” follows the same procedure. In the five steps of sample #1, we fill a quart container with distilled water, and leave one empty. One supplement tablet is put in a cup to which 3 teaspoons of distilled water is added. Swirl to dissolve the tablet coating because the coating will interfere with the color development. Mix the uncoated tablet in one quart of distilled water for 30 seconds. Put the water into the empty container. What happened to the tablet? It probably will look the same. Some forms of iron do not react with the tablet. Iron bacteria causes rust and has a foul odor, but will not give a positive test. In sample #2, measure out 1/2 cup of sample #1 and put it in an empty, clean, one-quart container. Fill the container with distilled water. Avoid handling the iron tablets with wet hands. It is a skin irritant.

During the iron activity, group students and have someone on the team fill a bag to line “C” with sample #1 and sample #2. Add a LR iron tablet to each. Close the bag and shake. Compare the resulting color with the color chart and record the data on the data sheet. Compare the two tests. Which one is darker? (#1) because it has more iron. Then have the students test their tap water samples for iron. Ask the question, “Do you have iron? How concentrated is it?” Compare the color to the reaction with the color chart poster. Record the answer on the data sheet. The data sheets are a good tool for the students to use. The activity engages them and keeps them focused on the task.

Unit 4 - The Copper Test

Next is the copper test. Small amounts of copper are found in natural water. Sometimes people put copper in water to control algae. Copper can also dissolve in your water from copper pipes and fittings. Only acidic water dissolves copper from inside the surface of pipes. Students should be reminded of the pipe diagram on the pH section. They will learn that people use copper solutions to treat fish with bacterial disease. The copper kills bacteria. They should answer question like, “Was your water acidic?, Do you have copper in your water?” Bathtubs and sinks have a blue-green stain if copper is present. Students should use the data sheets. Teams will fill a clean bag to line “C” with tap water and add a Copper HR tablet. Close the bag and shake. Compare the color with the color reaction chart. Record the copper concentration on the data sheet.

Another experiment is to have students place a penny in vinegar. The acidic vinegar will dissolve some of the copper. If enough of it is dissolved, the solution will become blue. Try to get the students to see the connection that acidic waters can dissolve metals out of pipes. There is a Word Search to go with these activities. The students will keep their data sheets and Science Journals.

Unit 5 - Checking for Hardness

There is an activity to check for hardness. Not all liquid hand soaps will produce bubbles. Students will use a liquid hand soap in deionized water to attempt to get bubbles. It probably will not work with soaps that have a lot of additives. These tend to overcome the affects of calcium and magnesium. They might also try the soap in the classroom. One drop of ideal soap in deionized water should give a rich lather. Several drops of this soap in hard water should give no bubbles, and make cloudy, bathtub water. Hard water has a lot of calcium and magnesium minerals dissolved in it. It is responsible for the spots on your drinking glasses, the white crusty scale on the showerhead, and even the ring in your bathtub.

One experiment that dealt, not specifically with hard water, but with the detergent that gave more bubbles or

washed the most dishes for the money, is one that could be used here as well. Use one cup of water, add one drop of glycerin and 1/2 ounce of detergent. After mixing the solution, spill one teaspoon on a smooth counter or one covered with a taped down garbage bag. Have each student blow through a straw at counter level until a bubble starts. Blow the bubble as large as you can. When it pops, measure the footprint and chart the information.

In the hardness activity, a clean bag is filled to line “A” with tap water; add a T hardness tablet; close the bag and shake. Compare the results to the color chart. The ring in your bathtub is formed when your soap reacts with the calcium and magnesium in the water. In doing so, it gets all used up and cannot remove dirt. So, in washing clothes, dishes, cars, and pets, you should use more soap if you have hard water.

Do the bubble test. Use 2 bags, filling one with a hard water sample and one with distilled water. Ask, “Which one has more calcium and magnesium?” The hard water does, of course, because the distilled water is pure.

The activity includes using a cardboard strip to add one drop of soap at a time to your water. Keep adding until you get bubbles. Record which sample needed more soap to bubble. There is a bubble gram game for this activity.

At the end of all of these activities, is a summary. The tour can be summarized. The Water Quality Report is a wrap-up in itself. The report should generate discussions on actual results. Water Quality Reports and Crossword Puzzles are handed out. Some summary topics that we should be concerned about are (the presence of); pH, corrosion, scale; chlorine, taste, smell, bacteria; iron, stains; copper, taste, stains; hardness, crusty deposits, uses too much soap.

There is a concept map on Ocean Water found in a grade 6 Houghton Mifflin *Discovery Works* , which I think will benefit my students. A discussion starter might be to ask what a marine biologist would use to monitor whether or not a pollution problem is getting better or worse. Some things would include the amount of garbage in the water; cloudy water, fewer living things and changes in their behavior or health. These chapters abound in vocabulary words. Some could be made into a puzzle: plankton, zooplankton, salinity, photosynthesis benthos, phytoplankton, and nekton.

II. Biodiversity and Pharmaceuticals

Because of biodiversity, many potential cures of currently “incurable” diseases have perhaps been lost in the sea and in marine life. According to Dr. Hank Trapido-Rosenthal of the Bermuda Biological Station for Research, Incorporated (BBSR) and his key partners: Dr. Stephen Giovannoni of Oregon State University, and Dr. Craig Carlson of the University of California, Santa Barbara (Partnership with Diversa), “this diversity has existed for 3 billion years.” The staggering potential of extracting beneficial chemicals pharmaceutically is today greatly enhanced by such advanced technology as “cloning.”

The health of the ocean itself and the health of marine organisms is important and even though only a fraction of one percent of these sea organisms have been tapped, the medical and economic value of these have been vast. So, the remaining 99%, yet to be classified, gives new hope. Perhaps pharmaceutical benefits can be found among the yet, unclassified marine life.

Sea creatures have survived for three million years despite temperatures above boiling and below freezing. They have been unclassified for the most part. They have also survived salt concentrations from almost “0” to 10 times the salinity of seawater. They have endured pressures from 20,000 feet below sea level to 20,000 feet above. They have lived through energy sources: sunlight, sulfur and petroleum. Consider that this may be a vast source of pharmaceuticals.

Aquaculture (the Farming of the Sea) may lead to pharmaceutical benefits as well. Many sea creatures are known to be beneficial as well. Many sea creatures are known to be beneficial to man. Shellfish like clams, oysters, mussels and scallops offer much, as does the horseshoe crab. Sharks and whales give so much that laws protect these animals from being hunted to extinction.

Because new diseases and human activity worldwide threaten coral reefs, research programs are essential to identify stresses and develop techniques for the better management of these ecosystems. Dr. Richard Owens of the BBSR faculty received his Ph.D. for using stable isotopes in molluscan shells to establish seawater temperature records and productivity cycles. He is currently working on projects to assess the pesticide contamination of granddaughter and the coastal zone, the distribution and impact of heavy metal constituents in anti-fouling paints on inshore marine communities and the development of biomarkers for the assessment of marine pollution. Research is also being done in “Genomics” on benthic organisms such as sponges found in Bermuda’s shallower inshore waters.

My source, *Food- Drugs from the Sea Proceedings* (1969) tells of a “Drugs from the Sea” symposium in 1967. It generated a lot of interest in searching the sea for bioactive substances. For my purposes, I will cite some examples of already known pharmaceuticals extracted from marine animals, listed in this report.

All toxins have potential as drugs because of their action on cells. These molecules, as useful compounds, can reverse disease and increase the efficiency of the normal cell. Developing a new drug can be costly because its efficacy and lack of toxicity have to be proven before acceptance. The Federal Drug Administration (FDA) must clear the drug for safety and the product must be better than an existing one on the market for it to be useful. Listings are taxonomical. Several Classification lessons will be given.

Monerans (one-celled organisms with no clearly defined nucleus):

Marine bacteria - antibiotic, antifungal and antiyeast properties; growth stimulant, antitumor, inactivates viruses; Vitamin “B;” a bromine derivative which can be synthesized and may have survival significance

Blue-green algae - studies being done on fatty acids, human food source

Protistans (one-celled organism with a clearly defined nucleus):

Algae - food protein, growth stimulant, anticoagulant, includes sugars, sterols, lipids, nitrogen compounds, inhibitors of antibiotics, fatty acids, minerals, sodium alginate to be used for contamination removal of Sr 90, vaccine adjutant, dental impression substrates, treatment of esophagitis, immunologic responses, treatment of rheumatic diseases, anti-viral, mucilage

Invertebrates (animals having no backbone):

Porifera (sponges - most primitive of all multicellular animals) - antibiotics, growth regulators, better understanding of complex nervous systems, fights bacterial infections, phospholipids, combats microbial pollution from fecal contamination in estuaries.

Coelenterata (Cnidaria -sea animals that attach themselves to rock surfaces, pilings and shellfish) - immunity

Echinodermata (having the surface of the body covered with spines) - possible anti-tumor activity, tissue regeneration, sperm inactivation and egg maturation studies

Sea Stars - converting the crown of starfish into edible protein

Sea Cucumber - antifungal steroid

Mollusca (clams, oysters - animals with soft insides and hard shells) - studies on antineoplastic activity of clam liver extract; also prolongs the mean survival time of mice with leukemia

Annelida (worms) - insecticide

Arthropoda (joint-footed animals - crustaceans) - serotonin and crustacean diabetogenic hormone

Barnacles - cement, gluefilling for teeth

Vertebrates (animals having a backbone):

Fish - Vitamin “A” and”D,” viz. cod liver oil; viz. Shark liver oil; catfish - follicle stimulating hormone

Cold blooded vertebrates produce interferon. There are also the pharmacological effects of eptratretin, in support of the failing heart. Fish are alsoused in mosquito control. They ingest them.

Amphibians (frogs, toads, newts - live on land and in the water) - perhaps these studies will lead to cell regeneration; peptides are active on smooth muscles.

Reptiles (snakes, lizards, turtles - creep and crawl):

Sea Snakes - Southeast Asian studies related to immunization are being pursued.

Snake venom is being studied because of it anticancerous enzymes; anticoagulant and coagulant activity.

Drugs and foreign compounds are similar in both the advanced and primitive water dwelling species.

III. Aquaculture and Pharmaceuticals

A lot of work is going on at the BBSR to extract pharmaceutical information from certain marine life. Dr. Richard Owen is concerned about the pollution threats to marine life and to the ocean itself.

In the case of pharmaceutical development, the concept at BBSR is this, medical advances means identifying new ways of attacking diseases by finding where a desired process in nature is promoted or inhibited. Genomics gives BBSR scientists access to the entire genome of an organism thus providing them with new

biological targets as well as potential promoters and inhibitors to aim at those targets. Genomics is the study of the genomes, a complete set of genetic blueprints of organisms.

Scientists are studying the biodiversity of the microbial community found in the pelagic ocean and in association with the benthic (ocean floor) organisms, such as sponges and corals. Corals are found here in Florida and in Bermuda. They are found in shallow waters where they can stay at the ocean floor and still receive sunlight. Corals are formed by millions of tiny sea animals called polyps. Polyps take calcium from the sea water and convert into limestone (calcium carbonate), with which they make “houses” around the lower halves of their bodies. When they die, the limestone “skeleton” remains. As more and more polyps grow on top of each other, they form a coral reef. Corals thrive in warm, shallow water (60? F) and no deeper than 45 meters. The algae that grows there need the sunlight to do photosynthesis and provide food and Oxygen for the coral animals to eat and breathe. Some reefs are thousands of feet thick because they have grown as the sea floor sank. Reefs are found off the coast of Australia, in the Caribbean Sea, off the eastern coast of the Florida, in Bermuda, Japan, Hawaii, and other places.

In the past, marine chemists did their bioprospecting by homogenizing large quantities of an organism like the sponge. When they found a valuable chemical they would then have to harvest large quantities. This process would be too damaging to the coral reefs. Now scientists can collect a small sample of sponge, extract DNA and clone it into a domestic strain. The cloned DNA contains all the blueprints necessary for biological synthesis of whatever chemical it was capable of producing. It is now possible to train the genetically engineered organism to produce large quantities of the sought after drug or chemical.

The sea is a vast natural farm that can produce great quantities of nutritious protein food, forever, if managed wisely. According to National Marine Fisheries, an arm of the United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), scientific knowledge allows us to increase the yield of food from the sea, to a limited extent with oysters. There are ideas as to how other fishery yields can also be improved. This can be done by: 1) adding nutrients (fertilizer) 2) transplanting marine animals from one place to another 3) breeding fish and shellfish for desirable characteristics. Fast growth, disease resistance and desirable flavor are some of the qualities that might be developed in this way. However, scientists need to know how to make their improvements while at the same time reducing the cost of catching fish and bringing them to market. (Jefress)

Fish are the main source of protein, needed as an important body builder. Fish and shellfish provide valuable vitamins; A, B, and D, oysters and shrimp are excellent sources of iron and copper (needed by our bodies in building blood), and they supply us with five times the magnesium and more phosphorus than is in milk. Seafood has 50-200 times as much iodine (needed to keep our thyroid glands functioning properly). (Jefress)

These nutrients have pharmaceutical value. They came to be in fish and shellfish by the “food chain” (the passing of nutrients from one animal or plant to another), the chain progressing from the simplest to the most complex organism. These nutrients, elements, minerals and organic compounds such as carbon, oxygen, nitrogen, phosphorus, chlorine, iodine, boron, magnesium, calcium, silicon, protein, and carbohydrates have been recycling in the sea for eons. Floating sea animals and plants (plankton) use these nutrients to build their bodies. Juvenile fish, plankton-feeding fishes and many other sea animals live on plankton. These in turn, are fed on by larger carnivores such as tuna, halibut, sharks, and squids. It is important to realize that when sea animals die, the nutrients return to the sea (or remain, as in the case of coral) to be used by subsequent generations. We, being at the end of the food chain take these nutrients into our bodies. (Jefress)

Another valuable resource coming from the sea is our marine mammals: sea otters and fur seals - furs; gray

whale and sea elephant - oil; walrus - ivory tusks; California sea-lion - entertainment. There are thousands of kinds of sponges. However, approximately one dozen is all that have commercial value. Two and one half tons were harvested in 1938, but this has fallen off because of disease among the sponges and the introduction of the synthetic sponge. Sponges contain unique chemicals that may have industrial or medical value some day. (Jefress)

Seaweed is another valuable resource found growing along our seacoasts. Japanese cook with it, but Americans do not use it much in their natural state. Americans, however, derive chemical and industrial products from seaweed, such as algin, agar, and carrageenin; which are used in foods such as ice cream, candies, and cake icings. In drugs: aspirin and antacid tablets and calamine lotions; in manufacturing processes: producing rubber textiles, acoustic tiles, and more commercial items. Mannitol, a seaweed derivative, is used in explosives and medicinal drugs. Along the coasts, over the Continental Shelves are the world's most valuable fisheries. It behooves us to control and manage well, the industrialization of, the disposal of wastes from our cities and ships and, the dumping of nuclear waste into the sea. (Jefress)

Minerals have been accumulating in the sea for a billion or more years. Volcanic ash sifting into the rivers carries with it to the sea, chlorine, and sulfur. Undersea volcanoes supply boron, iodine, sulfur, and chlorine. Soil-laden waters carry calcium and silicon from weathering rock and eroding land, down to the sea. The sea holds 99% of the world's bromine. Formerly, iodine came entirely from seaweed; now it is mined from brine deposits left when the great inland seas receded or obtained from underground water with oil-bearing rocks. Ancient seas, as their waters withdrew, left behind great salt beds, New York to Michigan; borax (SW), gypsum, magnesium, potash and magnesium, petroleum. (Jefress)

The question - Why is the sea salty? Most rivers drain into the sea and they have small amounts of dissolved salts. When the seawater evaporates, leaving salts behind, it falls on the land as rain or snow and returns to sea with more salt. Students will calculate the percent of salt in the "Sound" around us.

The BBSR is focusing some scientific work on the Bermuda scallop (Pecten Ziczac) and calico scallop (Argopecten gibbus). Constraints are the lack of an adequate sea water system and facilities for the culture of larval and post-larval stages of marine organisms. The scallop is a familiar bivalve with a fluted shell, two ear-like or wing-like projections and many vivid, blue eyes. It is a mollusk that is pretty to look at and good to eat. Its color varies with warmth of the water. The scallop sold in markets has a brown shell with gray and white markings; calico scallop is mottled; Pacific pink scallop ranges from pink to green; giant scallop of the Pacific has a purple-red upper shell and a white lower shell. Scallops swim in a jet-propelled fashion, by opening its valves to let water in and snapping shut the valves to propel itself forward.

The horseshoe crab's ancestors evolved hundreds of million of years before the appearance of land plants, fish, insects, mammal, and man. They are not crustaceans, but thought to be closer relatives of the spiders. They breed in late spring. The "piggy-back" crab (Limulus Polyphemus) has a dark brown, rounded, shield-like shell which resembles a tank as it swims along. It has ten legs for walking, ten book gills behind the legs, a sharp telson tail without barb or stinger, used in locomotion and to right itself when flipped over. It has two "fake" eyes that cannot form images, but may be able to detect movement; two smaller centrally located eyes with a group of light sensitive cells under the shell, which help the crab to see and may be functional during the larval stage of development. Underneath its mouth are two short pincers and pairs of strong legs. It must move to eat. The first four pairs of legs lift the body and the flaps on the modified fifth pair open and push. They eat small mollusks (clams and snails), crustaceans (crabs and shrimp), polychaetes (worms), and other small bottom animals.

The crabs mate in spring. Males are smaller but have large pincers on the front legs by which to hold on to the female. The female spawns long stings of thousands of greenish eggs, which are 1/8 of an inch in diameter. The male fertilizes the eggs as they are laid. The eggs hatch in approximately five weeks. The larvae are 1/3 of an inch in diameter. They are still in the case, which inflates with water and looks like a bubble. It has no tail at this stage. It waves its legs upside down because it is top-heavy in the bubble. The crab lives off the yolk in the bubble while it grows. The bubbles are ruptured by sand grains and small, pale horseshoe crabs emerge. After the yolk is exhausted, the larva sheds its shell and acquires a tail. Only two of the book gills are present. After shedding many times, the rest of the book gills appear and the tail lengthens. Horseshoe crabs are bottom dwellers and are usually safe from heavy dredges during hibernation. (Jefress)

People are the principal enemy of the adult crab, but loggerhead turtles are known to prey on the crabs as well as gulls. Horseshoe crabs have been used for fertilizer and the egg-laden female used as eel bait. Some farmers have fed them to chickens and hogs even though both flesh and eggs have a fish flavor. “Crab” remains were used as the main ingredient in a boiled, summer dish. The telson tail was used as a fish spear. Its blood, however, contains several biochemical substances that have proven very useful in science and medicine. Lysate, from the blood is used in cancer research and to aid in diagnosing spinal meningitis. Other parts of the blood are valuable for other medical tests. Knowledge gained from the animal’s eyes have given new insights and vital information about human eye disorders that can cause tunnel vision, which can lead to total blindness. The horseshoe crab is not an endangered species, but its survival may be threatened by man. (Jefress)

The shark is another mammal that has some pharmaceutical value. Shark liver oil has been investigated for its effects on plasma cholesterol and lipoprotein in man . The shark has been part of the oceans’ life cycle for four hundred fifteen million years. There are over 350 shark species. One shark that is described in Amazing Sharks by Mel Berger is the Great White: it is 19’ long, weighs over 7 tons, and has rows of sharp teeth to catch and eat large sea animals. Mentioned are the hammerhead, gray reef which sometimes have remora (suckerfish) attached to it. More than on half the world’s sharks grow to less than 3 feet. The blue shark often has pilot fish swimming along with it. The giant-sized Carcharodon megalodon may have 20 rows of teeth. No 2 species have the same kind of teeth. Whale sharks feed on plankton, krill and small fish because its teeth are very small. Sand tiger sharks, like most sharks, can replace their teeth. A shark may lose as many as 30,000 teeth in its lifetime, but can replace a tooth within 24 hours. The cookie cutter shark is one of the smallest. It attaches itself to tuna, whales, dolphins and other sharks, cutting out its food with its large teeth. A shark must keep its mouth open to breathe and stay afloat. Nurse sharks can rest because they have muscles that help pump water over their gills like other fish. A shark’s shape is torpedo-like. That and 5 types of fins, help them swim efficiently in the water. Most fish have hard bone skeletons but sharks have cartilage like we have in our noses and ears.

Sharks, unlike most fish have denticles, not scales. Denticles are sharp and prickly, and made of the same materials as shark teeth. They point back toward the tail so the water flows smoothly over the shark’s skin. The shark’s skin is usually gray, blue, or brown and lighter on the underside. This camouflages the shark in the water. The lemon shark, Pacific angel shark, and carpet shark have spots, stripes or unusual patterns to help them blend with their surroundings. Some sharks reproduce pups inside their bodies. Others deposit mermaids’ purses, a thick leathery egg case on the bottom of the sea. Sharks’ senses of sight, hearing and smell are very sharp. So sharp is the sense of smell that they can detect a drop of blood a mile away. These keen senses help them hunt for food. Sharks locate their prey by electroreception (electrical impulses given off by the prey). They swallow their prey whole - no chewing. They eat about 2% of their body weight.

About 100 million sharks are killed each year for their body parts. Shark jaws are collectors' items. Fins also bring a high price and are used to make a rare and expensive soup. Fishermen catch sharks in gill nets. The shark drowns because it cannot get out. It has to keep moving in order to live. Sharks eat sick, diseased and dying fish. This probably slows the spread of disease among ocean animals. Scientists believe that we can benefit from studying why and how the shark can survive injury, disease and pollution.

Whales, Orcas are a part of the dolphin family. They are not the largest of whales. They can grow to 33' and weigh 13 tons. Orcas are black and white, but each has different markings. Even though they are able to stay submerged for long periods of time, they are mammals and must breathe air. The Orca's tail is horizontal to the water's surface, unlike fishtails. It can swim as fast as 24 miles per hour. Whales have blubber, which is why many of them are killed. This layer of fat lies below the whale's outer skin and keeps it warm in the icy waters. According to Encyclopedia Britannica, whale oil taken from blubber includes many uses: Lubricant for heavy machinery, fuel, lamp burning, soap making, and the making of fatty alcohols and separating them from fatty acids, which are not edible. Orcas live together in family groups called pods, which sometimes has as many as 20 individual whales in it, and at times even up to 55 members. (Jefress)

Orcas are flesh eaters. They gather the shoals (large groups) of fish together and eat until they are full. Orcas also talk to one another. They make a variety of different noises: chirps, high-pitched whistles, buzzes and clicks. They use sound to locate their prey. They make a stream of signs that bounces back to them off of their prey, as echoes (echolocation). They mate at different times depending on their location. North Atlantic- October, November; North Pacific- spring/summer months. When babies are born, they first are taken to the surface for air, then mother feeds them milk. Calves are about 7' and weigh 400 pounds. Orcas are playful. They sleep as they swim in half-hour dozes for six hours a day. No one knows why whales beach themselves (called stranding). Some Orcas are believed to be able to live for 50 - 60 years. Present dangers to Orcas are people, fishing nets and the careless dumping of toxic wastes in the sea. (Encyclopedia Brittannica)

Lesson Plan 1

Objectives: Students will learn how to test tap water for the presence of iron, pH level of purity, copper, chlorine and hardness.

Unit proceeds for several weeks

Materials:

(table available in print form)

Procedures/Activities:

1. pH - Prepare samples #1) baking soda #2) vinegar #3) aspirin. Fill a bag to line "C." Close bag and shake each. Compare the color reaction to the color chart.

2. Chlorine - Prepare sample #1 - (5mL) of chlorine bleach with 3 teaspoons of water. Use 10 drops of this diluted bleach for sample #2. Fill a bag to line "C" with samples #1 and #2. Compare the 2 tests. Then test the tap water sample.

3. Iron - Prepare samples #1 and #2. Add one iron LR tablet to 3 teaspoons of distilled water and swirl to dissolve the coating. Use the uncoated tablet in 1 quart of distilled water. Mix for 30 seconds. Pour into an empty container. Measure 1/2 cup of sample #1. Pour into a clean, empty quart container with distilled water. Compare the two tests. Chart the results.

4. Copper - Fill a bag to line “C.” Add copper HR tablet. Close the bag and shake. Compare the reaction to the color chart. Record the copper concentration on the data sheet.

5. Hardness - Fill a bag to line “A” with tap water. Add “T” tablet; close the bag and shake. Compare the color with the color chart and record results on the data sheet. Add 1 drop of soap to each bag and shake. Keep adding soap until you get bubbles. Test your soap before doing the experiment.

Assignments/Evaluations:

1. pH - Have students tell why we test pH levels. Compare well water with city water etc. Define vocabulary. Study pipe diagram. Explain.

2. Chlorine - Students should determine why chlorine is added to city water. Why is too much, bad? Could different concentrations kill algae or visible bacteria? Do the scramble game.

3. Iron - Students analyze data sheet. Answer questions.

4. Copper - Students should be able to tell why copper can be harmful. Do the Word Search.

5. Hardness - Do the bubble test. Tell why the ring in the bathtub exists. Answer: Where else would you use more soap, if you had hard water? Do the bubblegram game.

Vocabulary List

Acid

Carbon Dioxide (CO)

Distilled

Magnesium

Algae

Chlorine

Evaporation

Monitoring

Bacteria

Corrosion

Hard Water

pH

Base

Disinfect

Indicator

Scale

Calcium

Water Conditioners

Lesson Plan 2

Objectives:

- Students will learn how water cycles through the environment.
- Students will learn how clouds form.
- Students will learn how water is purified.

Unit proceeds for two weeks

Materials:

jar

water

kettle

heat

chalk dust

gravel

fish tank

Student Activity Sheet (SAS) puzzle (water cycle)

plants

2-liter clear bottles

soil

styrofoam pieces

cutter (knife)

charcoal

sand

Procedure/Activities/Presentation:

Explain that the sun heats the rivers, streams, lakes, ponds etc. and causes surface water to evaporate and rise. As it rises, it cools and condenses. It condenses and rests on particles of dirt and dust in the atmosphere. Clouds form. The altitude at which the droplets condense, forms the different kinds of clouds. Cirrus clouds are the highest in the sky and are formed of ice. Stratus are the lowest; fog being included in these. Cumulus are the middle clouds. These sometimes have a very dark undercover, called Nimbus. Nimbus clouds are water carriers.

Water vapor also comes from plants (transpiration) and animals (respiration). It continues down through the earth, until it hits bed rock. Plants take in water through infiltration. As it filters through bed rock, it is purified. Only clean water evaporates. All the salts etc. are left behind.

Assignments/Evaluations:

Put rocks in the tank and cover with soil. Place Ivy plants in the soil, water and close the tank top. Repeat the steps for the clear, 2-liter, soda bottles terrariums. Each student plants his/her own ivy plant. Students will define all vocabulary words.

Use the jars; one filled with sea or pond water. Filter the water through a bag of charcoal into a jar with sand and gravel.

Each student will compile a booklet of the 3/4 types of clouds, using text, pictures, drawings etc., and model each.

Vocabulary List

Bed rock

Cirrus

transpiration

Cumulus

ground water

Nimbus

evaporation

Stratus

condensation

atmosphere

respiration

cloud

precipitation

purify

water table

altitude

infiltration

Lesson Plan 3

Objectives:

- Students will learn how the seas became salty.
- Students will learn what percent of our sea, (Long Island Sound) is salty.

Unit Proceeds for one to two weeks

Materials:

2-liter soda bottles (clear or green)

sea water

window sill

Sun

large pans or bowls (to hold 4 liters of water)

Procedure/Activities/Presentation:

Why is the sea salty? Explain that the question has probably been asked as long as there have been seas (except that in the beginning, the seas were not salty). The chemical content of the heated and risen waters in the water cycle falling to earth again and again, encountering the atmospheric chemicals, and the pounding shore water running over the rocks and soils, multiplied by time, have made the seas salty! A better question

for my fourth, fifth, and sixth grade students, is the one above.

In order to do this, students are grouped in fours. Each group has two 2-liter soda bottles, which they will fill with sea water; a balance, pencil, and paper. Each group should choose a recorder, weigher, calibrator, pourer etc.

Students will calibrate the balances and carefully weigh the two full soda bottles, empty pans and then the empty soda bottles after the sea water has been poured into the empty pans. Weigh the filled pans. Place the pans on the window sill so that the water will evaporate. If the weather is warm, the water will evaporate fairly quickly. If this is done without sunshine, a burner can be used to speed the process. Only the water will evaporate, leaving the salt behind. Depending on the rate of evaporation, the experiment could take up to two weeks.

Students will record all of the weights on a chart. When the salted pans are weighed, students will apply the formula, “A” equals length (l) times width (w) times depth (d) times (4). l = 110 mi; w = 21 mi; d = 60 - 300 ft. The average depth is 65 feet.

Assignments/Evaluations:

Students will use their numbers; convert the percent to a fraction and then to a decimal. These numbers can be graphed, in mathematics (curriculum tie-in). All of the groups’ numbers will then be placed on one chart. The assignment for all will be to find the Range, Mean, Median, and Mode of all the numbers on the chart.

Vocabulary List

balances

pencils

paper

burner

Range

Mean

Median

Mode

percent

Lesson Plan 4

Objectives:

Students will learn about taxonomy.

Students will learn how to classify some marine plants and animals.

Students will learn how to match a pharmaceutical list to the classifieds.

Unit Proceeds for one month to first quarter

Materials:

Sea animals (2 of each if possible): sea stars, crabs, clams, shark eggs, worms, barnacles, killifish, algae, horseshoe crabs, etc.

20-gal. fish tank

Live rock or gravel

whisper pump/filter

charcoal

sea water

Vocabulary List

Plant

Porifera

Amphibians

Reptiles

Animal

Coelenterata (Cnidaria)

Monerans

Echinodermata

Protistans

Mollusca

Invertebrates

Annelida

Mollusca

Arthropoda

Vertebrates

Taxonomy

Kingdom

Phylum

Class

Order

Family

Genus

Species

Race

Students will learn how living things are classified. They will document the taxonomical properties of the animals in the tank as they study them, daily. As students progress, they will make a chart, listing the known pharmaceuticals.

Assignments/Evaluations:

Students, using their charts, will match as many of the pharmaceuticals as they can, to the classified animals **.**

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The adults are hairless except for whiskers. Walruses are huge, weighing up to 2400 lbs. Pinnipeds (web footed) mate once a year. They gather at ooglis and use their unbreakable tusks to find food, fight and avoid danger.

Green,Jen. *Dolphins - Nature's Children* . Danbury: Grolier 1999.

There are 37 different kinds of dolphins in the world. Some live in rivers and some in seas, They belong to the whale with teeth, family. They travel in schools, are smart and communicate with each other. They are playful and like people.

Miller, Geoff. Orcas. *Nature's Children* . Danbury: Grolier, 1999.

The author tells the reader about Orcas, the killer whales. He explains their habits, habitats, physical features, pods, herds, personalities, mating, beaching etc.

Puccio, Frank. *Sea Mammals - Nature's Children* . Danbury: Grolier 1997.

Sea mammals include dolphins, porpoises, whales, seals, sea lions and walruses. Humans depend on them for food, clothing, heat and light. They are mammals and must surface for air. They use echolocation for locate food, danger etc. Care must be taken in capturing these. They are smart and can easily be trained to do tricks. They communicate by making squawks, squeals, whistles,clicks and groans. They travel in groups. Some are movie stars.

Ruckman, Ivy. *Night of the Twisters* . Cromwell, 1984.

This is a fictional account of a series of tornadoes that hit Grand Island, Nebraska, in 1980. Sequoyah Childrens' Book Award.

Sauer, Julia L. *Fog Magic* . New York: Viking, 1943.

In this travel fantasy, a young girl is transported through the fog to a Nova Scotian village of long ago. Newbery Honor Book.

Shawner, Mark. *Sea Lions - Nature's Children* . Danbury: Grolier, 1986.

Their babies are called pups. The sea lions are fin-footed. They are called pinnipeds because "these feet"are effective swimming fins. Sea lions are cousins to fur seals, called eared seals. Eared and earless seals are related to the walrus. Seals have no visible ear flaps and crawl when they are on land. Sea lions and walruses have small ears on the side of its head and walk on all four flippers. Males are bulls. Sea lions hunt by themselves. They molt; eyes are protected by a layer and lids; uses its whiskers to hunt. Closes its nostrils under water. Sometimes called sea dogs because they bark as a way of communicating. They gather at rookeries to give birth and to mate. Harem - a group of females in a bull's territory. Pups bleat.

Tokuda, Wendy and Hall, Richard. Wakiyama, Hanako (Illustrator). *Humphrey, The Lost Whale - A True Story* . Torrance, CA: Heian International, Incorporated, 1986.

He is a humpback whale traveling south for the winter, He left his friends and got lost. He is in the San Francisco Bay, a body of fresh water. He trapped himself by squeezing under a tiny bridge. People saved him by banging pipes to get him to go back down river. They took away some of the bridge pilings. Humphrey was able to squeeze through and go home. This is a true story of a whale in San Francisco Bay for 26 days.