Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1994 Volume V: The Atmosphere and the Ocean

Learning About The Water Around Us

Curriculum Unit 94.05.02
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Without water, we have no future. We simply cannot survive. Water is something we all take for granted as long as it tastes and looks good and there is enough of it. But it is a limited resource. It is imperative that we involve our students in their education concerning this precious resource and teach them methods of scientific inquiry and problem solving. We must teach this as if our lives depend upon it. They do!

Students in New Haven have the benefit of living on Long Island Sound. Long Island Sound is a viable and valuable habitat; it is home to hundreds of species of fin fish, shellfish, birds, and mammals—it should be used as a classroom for New Haven's students. Their own place to learn about one of New England's largest and most important natural resources.

I have written this unit to help teachers find appropriate classroom activities and information to share with students in grades 3-8. The unit was written because I believe New Haven's students should have a great understanding and respect for water. I have included lessons which are easy to implement with few materials. I have tried to include basic information in the text to help teachers who may not feel comfortable teaching science. The text of this unit which is intended to give general information is just a beginning, I have included a bibliography which includes resources and information appropriate for both teacher and student use. I have only begun to discuss the basics—you and your students can choose any topics and pursue further studies.

I don't think students should have to be bogged down with all the details, but should have a basic understanding of the principles discussed. I have chosen areas which will hopefully pique young curiosity and encourage further study and consideration. There is a wealth of material available about water and Long Island Sound. My goal is to help students take maximum advantage of their resources and be comfortable and knowledgeable enough to make good decisions as they enter their adult lives. Long Island Sound is an estuary, a place where salt water from the ocean mixes with fresh water from rivers and the land. Like other estuaries, Long Island Sound (the Sound) abounds in fish, shellfish, and waterfowl. It provides feeding, breeding, nesting, and nursery areas for diverse animal and plant life. But the Sound is unique in the degree to which it provides recreational and commercial value to the region. Since it was formed more than 8,000 years ago with the retreat of glacial ice and a rise in sea level, the Sound has been an important resource for people living along its shores. Native Americans were sustained by its abundant resources. Its embeyments were natural harbors for European Colonists seeking refuge after their long journeys across the Atlantic Ocean. Today, it lies in the midst of the most densely populated region of the United States. More than 8 million people live in the Long Island Sound watershed and millions more flock yearly to the Sound for recreation. About $5 billion is generated annually in the regional economy from boating commercial and sport fishing, swimming, and beach going. The ability of the Sound to support these uses is dependent on the quality of its waters, living resources and habitats. The regional economy also benefits from many other valuable uses of the Sound, such as cargo shipping, ferry transportation, and power generation. With the uses it serves and the recreational opportunities it provides, Long Island Sound is among the most important estuaries in the nation.

The current value and quality of the Sound are partly the result of the investments in water pollution control programs made in the two decades since the passage of the Clean Water Act. These programs have led to measurable improvements in pollution control and water quality, in spite of ever-increasing numbers of people and activities on the Sound and within its watershed. Obvious sources of pollution are now regulated and controlled through permit programs, tidal wetlands are protected, and major efforts in the states of Connecticut and New York to build sewage treatment plants and control industrial discharges have helped restore degraded waters. More recently, with programs focusing on the ecosystem as a whole, the approach has become more comprehensive to include increased efforts in storm water and non point source pollution control.

In spite of these efforts, problems remain. The quality of Long Island Sound is still far from what it should or can be. Many of the uses or values of the Sound are still impaired from old abuses. Other uses or values face new threats. Residential, commercial, and recreational development have increased pollution, altered land surfaces, reduced open spaces, and restricted access to the Sound. Development has dramatically increased the use of the Sound as a place to dispose of human and other wastes. The paving over of the land has increased runoff and has reduced the filtration and processing functions of natural landscapes. Habitat destruction and alteration throughout the watershed have harmed native wildlife populations and reduced the breeding grounds and nursery areas for a variety of species.

Long Island Sound in Perspective

Long Island Sound lies in the midst of the highly urbanized and suburbanized northeast seaboard, one of the most densely populated regions in the nation. It is characterized by a nearly unbroken chain of urban centers, including the country’s largest city, New York City.

The watershed of the Sound drains an area of more than 16,000 square miles. It encompasses virtually the entire state of Connecticut, portions of Massachusetts, New Hampshire, and Vermont, a small area in Canada at the source of the Connecticut River, and portions of New York City, and Westchester, Nassau, and Suffolk Counties in New York state.

Unlike a typical estuary, the Sound has no major direct source of fresh water at its head. Instead, the lower salinity waters enter the western Sound from the Upper Bay of New York Harbor through the East River and Harlem River tidal straits. Higher salinity waters of the Atlantic Ocean enter at its eastern end, through Block Island Sound. The largest source of freshwater is the Connecticut River, discharging into the eastern Sound. These unusual characteristics contribute to the Sound’s complex circulation and mixing patterns. Furthermore, waters from outside the Sound’s drainage basin that enter the Sound through it’s boundaries are significant sources of pollutants.

Ecological Importance

Estuaries are highly productive ecosystems. While the Sound has problems, it is important to note that it remains highly productive, with a great abundance and diversity of aquatic organisms and wildlife inhabiting it for part or all of their lives. Improving and maintaining water quality is critical to their continued presence and health. In addition, Long Island Sound is not an ecologically isolated estuary; it is part of the East Coast migration route, providing nesting or resting habitat for waterfowl. Fisheries of the Sound, other estuaries and the open ocean are also linked together. As such, the Sound serves as vital habitat for fish passage and as spawning grounds and nurseries. Pollution, physical or chemical obstacles, or loss of viable habitat in this water body can affect not only the Sound, but also the productivity of the entire system.

Important ecological components of the Sound are its diverse and distinctive habitats including tidal wetlands and flats, beaches, dunes, bluffs, rocky inter tidal areas, submerged aquatic vegetation (particularly eel grass and kelp), natural and artificial reefs, the water itself and the sediment floor of the Sound. These habitats provide feeding, nesting, and nursery areas and shelter for fin fish, shellfish, plankton, birds, and other organisms inhabiting or visiting its waters. Each habitat not only supports its own community of plants and animals but contributes to the productivity of the whole Sound. All of the habitats that make up the Sound are interconnected through the food web and are integral parts of the whole.

Economic Importance

Long Island Sound strengthens the region's economy through the many valuable uses that it supports. Some of the uses, such as shipping, ferry transportation, electric power generation, industrial use, and waste disposal, are indirectly dependent on water quality. Others, such as tourism, fishing, boating, and beach going clearly depend on good water quality. A few of the resources that are economically important in terms of commercial or recreational fisheries are oysters, clams, bluefish, flounder, fluke, striped bass, weak fish, and lobster.

Population and Land Use

The rich estuarine and woodland resources of the Long Island Sound coastal areas once supported some of the largest concentrations of Native Americans found in North America. The abundant natural resources of the are made it attractive to European settlers as well. Though both Connecticut and New York state (including Long Island) were almost entirely forested at the time of the explorer Giovanni Verrazano's arrival in the 16th century, growth in agriculture resulted in widespread deforestation of the basin by the late 1700's. By 1774, Connecticut was one of the most densely settled of any of the American colonies, with much of its population living in the shore communities and relying on agriculture and coastal trade.

During the Industrial Revolution, the regional economy shifted from agricultural to small manufacturing and maritime trades. Factory towns sprouted along the shorelines of Connecticut and New York, reflecting the reliance on water for transportation and commerce. The mid-19th and early 20th centuries saw southwestern Connecticut coastal communities and Long Island increasingly oriented towards New York City as the center of commerce. The arrival of the railroads, first on Long Island and then along the Connecticut coast, enhanced the ability of many Long Island and Connecticut cities to flourish as industrial centers. The railroads also changed many of the communities into suburbs of New York City.

The railroads both encouraged, and were encouraged by, the growth of tourism. As coastal towns and villages became accessible to residents of New York City, extensive resorts were developed along both the Connecticut and Long Island shores of the Sound. The desire to enjoy the natural beauty and recreational assets of the Sound spurred the development of summer cottages and vacation houses for the middle class.

The post World War II era brought dramatic changes to the region. The decade immediately following the war were characterized by rapid increases in population and in suburbanization. The urgent need for inexpensive land, suitable for development, resulted in the conversion of agricultural lands and the filling of wetlands for suburban housing. As agriculture diminished, forest regrowth occurred, particularly in Connecticut.

The present distribution of human population within the Long Island Sound basin is very uneven, reflecting the distribution of manufacturing centers as they developed in the 1800's and early 1900's. Of the approximately 8.4 million people living in the basin, New York City, which makes up only about 0.4 percent of the land area, has about 42 percent of the population. Westchester, Nassau, and Suffolk Counties, with 2.1 percent of the land are contribute 8.3 percent of the population and Connecticut with 33 percent of the basin, has 37 percent of the population. Vermont, New Hampshire, and Massachusetts comprise the remaining 12.7 percent of the population in the drainage basin.

The population growth rate in the Connecticut and New York state portions of the Long Island Sound basin has declined significantly in recent decades. After rapidly expanding by 78 percent between 1940 and 1970, population growth has slowed to an increase of 1 percent between 1970 and 1990. Future population growth is expected to be about 4.1 percent (300,000 people) between 1990 and 2101 and 6.4 percent (500,000 people) over the period from 1990 to 2030.

Water Quality

In the two decades since the passage of the Clean Water Act, water pollution control programs have resulted in measurable improvements in water quality. The current value and quality of the Sound are partly the result of investments in water pollution control programs since the passage of the Clean quality, in spite of ever increasing numbers of people and activities on the Sound and within its watershed. Obvious sources of pollution are now regulated and controlled through permit programs, tidal wetlands are protected, and major efforts in the states of Connecticut and New York to build sewage treatment plants and control industrial discharges have helped to restore degraded waters.

These efforts have taken place because of increased awareness and concern among citizens and the responsiveness of public officials. Without the substantial investment already made in environmental protection, the value of the Sound would be far less than it is today.

Despite the significant progress made in solving many water quality problems, much work remains before the goals of the Clean Water Act to *restore and maintain the chemical, physical, and biological integrity of the nation's waters, so they are fishable and swimmable* are met in all of the Sound. The quality of Long Island Sound is still far from what it should or can be. Many of the uses or values of the Sound are still impaired from old abuses. Other uses or values face new threats. Residential, commercial, and recreational development have altered land surfaces, reduced open spaces, and restricted access to the Sound. The density of people living within the Sound's watershed increases with proximity to the coastline. This development has dramatically increased the use of the Sound as a place to dispose of human and other wastes. More than 60 public waste water treatment plants discharge more than one billion gallons of treated effluent into the Sound each day. The paving over of the land has increased runoff and reduced the filtration and processing functions of natural landscapes. Habitat destruction and alteration throughout the watershed have harmed native wildlife populations and reduced the breeding grounds and nursery areas for a variety of species.

These and other problems require new approaches to protect and preserve Long Island Sound and to provide access for the public use and enjoyment.

Learning Activities

Visit Long Island Sound with your students. Allow then to collect shells on Lighthouse Park Beach or enjoy a nature walk along the beach observing how we (New Haven area residents) use the area. Visit Sound School! Explain to your class how they can pursue an interest in oceanology or oceanography as early as high school in New Haven.

Project Soundwise by Dana Mcardle and Laura Norwitz is an excellent guide for activities to heighten student awareness of Long Island Sound. There is the original book which is geared to kindergarten through fourth grade and a supplement for grades five through 8. It was sent to all public schools in New Haven and is also available for $5.00 from Schooner, Inc. 60 South Water Street, New Haven, CT 06519. (203)865-1737.

Discussing and Demonstrating the Ecosystems of and Human Impacts on Long Island Sound

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Water Wonders

If you just look at the chemical formula for water (H_2O), it seems that water is a simple enough compound consisting of two parts of hydrogen and one part of oxygen. However, the structure of this small, light weight molecule gives it several unique characteristics that have contributed significantly to the patterns of life on this planet. Consider first of all, that water is one of only three naturally occurring liquids under normal atmospheric conditions and that the other two liquids are petroleum and mercury, then try to imagine an ecological system based on mercury! Other important characteristics of water include:

> -an uncommon tendency for water molecules to cling together due to a form of attraction between the hydrogen and oxygen atoms in different water molecules.
> -an ability to absorb or release large amounts of heat/energy before changing temperature.
> -a uniquely temperature dependent density pattern: water is most dense at 4 degrees Centigrade or 39 degrees Fahrenheit and becomes less dense at above and below this key temperature.
> transparency, or the ability to allow light to pass through the substance of water.

-the ability to dissolve many different substances or compounds.

There are many other molecules of similar size and weight we can compare to water, such as ammonia (NH_3), methane (CH_4), and carbon dioxide (CO_2), but none of these substances exhibit any of the properties of water.

Molecular Structure

The secret of water's unique characteristics lies in the arrangement of the atoms within the molecular structure of water. Both hydrogen atoms are arranged to one side of the oxygen atom. Hydrogen atoms carry a positive charge (like an electrical charge) and oxygen atoms carry a negative charge. Because of this arrangement of atoms, a water molecule ends up acting like a very tiny magnet, with a "positive" side and a "negative" side, and like magnets, the oppositely charged ends of different molecules are attracted to each other. A molecule with this arrangement is referred to as "polar", because while the total charge of the molecule is zero, the asymmetrical distribution of the charges creates "magnetic poles" within the molecule.

Water absorbs heat

The attractive force between water molecules is known as a "hydrogen bond". It is not as strong as the bonds that join the hydrogen to the oxygen within the water molecule, but breaking this bond to separate the water molecules does require energy. It is the hydrogen bonds formed between water molecules that keep water in liquid form at room temperature.

To move from a liquid to a gaseous form (evaporation), each gram of water must absorb 540 calories of energy. When the water reverts to its liquid form (condensation) all that energy is released to the air around the water molecules. The release of energy through the condensation process provides the energy that powers hurricanes and thunderstorms (this is where Lightning comes from). Energy is also released when water goes from a solid to a liquid form, and energy is required for ice to melt back to a liquid, but the quantity of energy for these events is significantly smaller than is used in the processes of evaporation and condensation. The large amounts of energy absorbed and released through the heating and cooling of water help moderate the atmospheric temperature (climate) (which explains why it always seems 1 0 degrees cooler near the water in the summer, warmer in the winter), and also helps living organisms maintain a constant body temperature.

Learning activities

Molecular Tag

Materials:

*tags or arm bands in two colors

*a large cleared area or an outside location

Divide the group into groups of three, preferably with one child being somewhat larger than the other two. Give each small group three tags, two representing hydrogen and one representing oxygen. Have the groups arrange themselves in a triangle, clasping hands in the middle with the identifying mark on their outside arm.

Mark boundaries for the "container" and tell the kids that they are liquid water and have them start moving around within the "container", forming and breaking hydrogen bonds as they pass near other groups. Tell them the temperature is getting colder and they are moving slower and the hydrogen bonds are getting harder to break (and colder and slower and colder and slower . . .) until you reach zero and the water freezes. At zero have everyone grab hold where their hydrogen bonds are formed and see if they can successfully create the crystalline structure of ice.

Once they've seen how they look, reverse the process by telling them the temperature is rising and the ice is melting, etc. As the "water temperature" rises, the groups should be moving around faster and faster until some groups are accidentally moving outside the "container" boundaries. Groups that fall out of the boundaries have broken all their bonds and evaporated. You can try getting the "water" all the way to boiling, but only if the children don't appear to be in danger of hurting themselves. End by "cooling" down the water again.

Ask where they think the energy came from to heat up the water and where it went when the water cooled down .

Water Molecules Stick Together

Materials:

*construction paper

*markers or pencils

*scissors

*waxed paper

*toothpicks

*squeeze bottles of colored water

*student worksheet "Water Drops"

*pennies

*eyedroppers

Make models of water molecules out of construction paper, with one large circle for the oxygen and two smaller circles for the hydrogen. Put several of the molecules together, keeping the opposite charges next to each other, to show how the attractive forces between the molecules make them stick together. To illustrate, give everyone a square of waxed paper and some toothpicks, then have them sprinkle drops of different colors of water onto the waxed paper. Each person can experiment with the drops, following the ideas on the worksheet.

Pass out one penny, a container of water and an eyedropper to small groups of two or three. Ask each group to guess how many drops they think they can put on a penny before the water runs off. Then have them try to it, writing down their guess and the actual number of drops. You'll be surprised!

Density

Water is densest at 4 degrees Centigrade and less dense at higher and lower temperatures. This unique density pattern is due to the polar configuration of water molecules. While in its liquid form, water molecules move around each other randomly and hydrogen bonds are continually forming and breaking between different molecules depending on the energy available. Decreasing water temperatures indicate a decreasing availability of energy. When the water temperatures reach 4 degrees Centigrade, there is not enough energy available to break hydrogen bonds once they have formed. As the temperature decreases further, the continual formation of hydrogen bonds force water molecules to start lining up in crystalline formation, which becomes visible to us when the temperature reaches 0 degrees Centigrade and ice forms. The rigidity of these crystalline structure forces the water molecules to take up more room than while they were moving together randomly in their liquid form, so ice, the solid form of water, is actually less dense than the liquid form. This is why ice floats and why the most dense water, at 4 degrees Centigrade, is found at the bottom of lakes and ponds. When the water gets colder than this temperature, it rises to the surface and freezes, allowing life to persist in the deeper water throughout the winter months. (You might want to consider what life would be like if water sank when it froze instead of floating.)

The density of water is also affected by whether or not it contains other dissolved materials. Salt water is denser than fresh water because of the quantities of salt and other minerals it contains. Water from the open ocean has a salinity of 35 parts per thousand (ppt) which means that 35 grams of salts have been dissolve in 1 000 grams of water. Density can be a complicated concept to explain. I generally think about a bucket of feathers and a bucket of sand: which one is heavier and which one is bigger. Since a bucket of sand is heavier than one full of feathers but takes up the same amount of room, sand is denser than feathers.

Water is transparent

Because water is transparent, light can travel deep below it surface. The availability of light enables plants of all sizes to grow under water. Phytoplankton, tiny one celled plants that float in waters of our lakes and oceans, are responsible for about one half of all the photosynthetic activity that occurs on our planet, thus providing the material for the base of many food chains. When water is clear it will appear blue in color. Other colors are caused by small particles suspended in the water. Oceanographers and limnologists (scientists who study our oceans and lakes) can often determine what sort of particles are in the water by looking at the apparent color of the water. A brown color is often caused by suspended sediments or silts or clays, although some phytoplankton can cause the water to look green or yellow or red.

Water as a universal solvent

The polar structure of water enables it to dissolve all polar compounds (like salts that are composed of one positive and one negatively charged particle) and many non polar compounds (like sugars which have no charges within their structure). Water also dissolves gases like oxygen, nitrogen and carbon dioxide. This ability to dissolve almost anything (given enough time) make water ideal for transporting substances through living bodies or around the planet. Water, in the form of blood, carries nourishment around your body and removes wastes. It carries nutrients into plants and salts from eroding rocks into our oceans.

There is a difference between materials that are dissolved in water and materials that are suspended in water. When a substance has dissolved in water (making a solution), it has generally been divided to a size where it actually fits between the water molecules. It is very difficult to remove dissolved materials from water without some energy intensive procedure like evaporation or reverse osmosis. If a substance is suspended in water, it will eventually settle out of still water with smaller particles settling at a much slower rate than larger particles. Somewhere in between dissolved substances and suspended substances comes a group of substances that when mixed with water, create a “colloidal suspension”. The materials involved are not dissolved in the water but they also will not settle out of the water. Milk is an excellent example of a colloidal suspension. One way to differentiate between a solution and a suspension is to determine whether you can see through the liquid. Solutions are generally fairly transparent while suspensions are generally opaque.

Learning Activities

Water Dissolves Many Things Materials:
*student worksheet “Water Dissolves Things”

*transparent containers

*measuring spoons

*cold water

*salt

*baking soda

*vegetable oil

*sand

Following the procedure on the student worksheet, introduce the activity. Depending on the group size and time available, you may want to divide the group into mini groups and have each group experiment with one substance, or have each group test each substance for its ability to dissolve. You should expect that one cup of cold water will dissolve five to seven teaspoons of salt. Baking soda dissolves less readily than salt, oil will form a suspension but not really dissolve, and the sand will not dissolve at all. You should explain with the sand that if the sand was in the water for a very long time it would eventually dissolve. This activity can be varied by comparing the dissolving powers of cold and hot water.

Ask what they think caused the different substances to dissolve differently .

The Water Cycle

Scientists aren’t sure exactly when liquid water first appeared on our planet, but they estimate it was over one billion years ago. After the planet was formed it was too hot for most substances to exist in other than a gaseous form, but as the temperature decreased many of the chemicals that are now a part of the earth were formed from these gases. Water formed from the gases of hydrogen and oxygen. This newly formed water fell as showers of hot water until enough rain had fallen that water covered most of the planet and made our first oceans. These first rains also carried many other compounds out of the atmosphere into the oceans just as today’s rain washes pollution out of the sky. The first rain started the water cycle and it has been running ever since.

The hydrological (water) cycle can be divided into four parts or phases. All the water in the world is somewhere within this cycle, although some of it can be shunted temporarily out of the main pathways for a time. The four phases of the major cycle include: precipitation, earth water, evaporation, and air water. Water that has been taken up and made a part of a living organism (be it a plant or an animal) is temporarily pulled out of this cycle, but after helping the organism grow, transport food or eliminate wastes, water reenters the cycle. Water that moves into the ground water system, into the deep ocean, or is frozen into a glacier can take thousands of years to move into the next phase of the water cycle because it is effectively isolated from the rest of the cycle but eventually it will come back into the process.

Water is never really standing still, even when we see it in a lake or in the ocean. Rain falls out of the sky and is either absorbed into the ground to become part of the ground water or it runs over the surface of the ground until it enters a small stream or brook and becomes part of the surface water system. Streams run together and form rivers which empty into lakes or oceans. From these places, water evaporates and moves back to the clouds. The fog visible over lakes or the ocean early in the morning is the evaporation process made visible. Rain water trapped in puddles also evaporates right back to the clouds. Evaporation is the reason the oceans don't overflow. Water also returns to the clouds through the processes of living organisms. When animals breathe, or when they perspire, they give off water vapor. Plants have a similar mechanism called transpiration. Water taken up by the roots is pulled up through the plant in tiny tubes, known as xylem, all the way to the leaves where it leaves the plant by evaporating through tiny pores. The evaporation of water through the leaves is what provides the force to move the water up the plant and, while it doesn't seem like a big deal, it involves a lot of energy. It's been estimated that the energy required to move water from the roots to the leaves of a redwood would be great enough to boost a can of soda into low planetary orbit!

There are some things that determine in which section of the liquid phase precipitation ends up. Topography is an important factor. Tall mountain ranges create a "rain shadow". When the moisture laden air hits the mountain, the air is forced up to higher elevations where it cools, causing all the condensation and precipitation to occur on that side of the mountain. Thus in Washington state, there is a temperate rain forest on the western side of the Cascades and a desert on the eastern side.

Learning Activities

The Adventures of Drip Drop—a story to read out loud.
Once upon a gloomy day, far above a town similar to yours, and excited raindrop sat in his cloud waiting to fall to Earth. He continued to gather water until he was so heavy he began to fall. This was Drip Drop's favorite part of the water cycle. He knew when he landed, it could be in one of several exciting places around the world. At the thought of this, Drip began dancing around the world. At the thought of this, Drip began dancing and twirling in a playful manner. His thoughts wandered on his destination:

He'd once landed in the savannas of Brazil

Where his fine mist helped water the plants.

One time he landed on a great plateau

Where Indians rejoiced with a dance.

Maybe he'd land in China this time,

Where he'd water the fields of rice.

He's always wanted to fall near Alaska

And become part of the glacier ice.

He could splash into a German country pond

To make a home for frogs and fish.

He may even land in an English King's fountain

Where Children throw coins for a wish.

How much fun it would be to land in the alps

Where he'd turn to mountain snow.

And if he fell in the Nile in Egypt,

Down the world's longest river he'd flow.

Drip's thoughts were broken by the warmth of the sun above and a strange feeling came over him. As the sun's rays passed through Drip's body, beautiful colors began to appear: violet, indigo, blue, green, yellow, orange, and red. Drip noticed the same thing happening to all of the other raindrops around him. Together, they had formed a spectacular rainbow that stretched across the sky.

There was a great celebration among the drops with all of them splashing and singing. Then suddenly, the colors began to fade, and Drip was close enough to see the ground below him.

He heard the voices of children laughing and playing. Then PLOP! Drip Drop was surrounded by old raindrop friends. He could feel salt mixing through his body and the tide pulling him toward a sandy beach. Then, CRASH! He was being pulled out toward the sea again. Drip Drop had landed in the Mediterranean Sea!

He was ecstatic over his destination and spent many sunny days in the sea until he evaporated and became part of the water cycle again.

The Changing Forms of Water

a. Wet Rocks and Blackboards

Materials:

*sponges

*hot and cold water

*several small flat rocks, different colors if available

*stopwatch

Using sponges, make streaks with hot and cold water on the blackboard.

Ask which one will disappear faster .

Time and record the results. Make more streaks with water at the same temperature and have someone fan on streak to see what happens.

Ask why one streak disappeared faster than the other.

If the blackboard is portable, arrange it so one side is in direct sunlight and the other side is shaded and make two more streaks.

Ask where all the water is going .

You can perform similar experiments with different colors of flat rocks (dipped in hot or cold water, placed in sun or shade, waived or kept still).

b. Tea Kettle Rainstorm

Materials:

*hot plate or water heating instrument

*tea kettle

*2 tea cups or a cup and bowl

*hot water

*oven mitt or winter glove

Half fill the kettle with water and heat it over a hot plate or stove. When water starts to boil, steam will come out the spout in a stream. Hold one tea cup upside down where the steam stream will hit it. *Wear a glove or be very careful of your fingers!* Place the other cup or a bowl under the upside down cup. As the steam hits the first cup it should condense and drip into the second cup.

Ask which part of the demonstration represent the rain, a lake, the sun and other parts of the water cycle .

C. Hot Water Bottles and Ice Cubes

Materials:

*narrow neck bottle or thermos

*hot water

*ice cubes

*dark background

By holding an ice cube over the mouth of a thermos or a narrow necked bottle full of hot water, you can create a fog cloud. The cloud will show up best in indirect light against a dark background.

d. Water Cycle Microcosm

Materials:

*clear glass or plastic container

*plastic wrap

*water

*small weight

*cup that fits completely inside container

Place water in the bottom of the clear container and set the cup in the center of the container. The cup should not float, but rest steady on the bottom. Cover the container loosely with a piece of plastic wrap but make sure the edges are sealed. Place the small weight in the middle of the plastic wrap so that it lines up with the cup in the container. Place the whole thing in direct sunlight where it can absorb heat. After a short time, water should start condensing on the underside of the plastic wrap, roiling to the point under the weight and dripping off into the cup, forming a water cycle. If you have enough materials, you can have several small groups make different microcosms and place them in different areas to see how fast the cycle can be started. Note: If you start this with hot water, it works much faster.

Making Observations About the Weather and Sea State

Wind, air pressure, temperature, precipitation (rain, snow), humidity, clouds, and other phenomena make up what we call weather. Created by complex interactions of solar energy, water, air, and the motions of the earth, weather has a profound effect on our lives. It disrupts our plans, determines the abundance of our crops, influences the way we feel and act, and often changes the course of history. For these reasons and many more the forecasts of the weather are needed.

The Oceans play a major role in creating weather. Water evaporates from the surface of the sea, forms clouds and returns to the earth as precipitation. Warm water currents, such as the Gulf Stream, result in warmer climates wherever they come close to land. The temperature of the sea changes slowly, which moderates the seasonal temperature swings of coastal communities and gives them warmer winters and cooler summers than their inland neighbors. The difference in temperature between the sea and the land creates winds that blow toward the land in the daytime and toward the ocean at night. Warm, moist air blown over the cool surface of the sea can create low clouds, which we call fog.

Hurricanes are an example of a particularly severe weather condition that forms on the ocean. They usually begin over the tropical Atlantic when an area of low air pressure becomes encircled by a ring of extremely strong winds, often reaching speeds of over 160 kilometers per hour. The low pressure area and its surrounding winds move northward at about 45 to 90 kilometers per hour (25 to 50 knots). Since the path of a hurricane is primarily over water, there is little resistance to slow it down or moderate its winds.

The ocean responds quickly and dramatically to weather conditions. The wind creates waves and currents which mix oxygen into the water and stir up the bottom sediments. Wind and changing barometric pressure can raise the sea level and cause the flooding of shore areas.

Precipitation and evaporation can change the salt concentration of the water. Changes in temperature can generate vertical movements of water and are one of the most important factors affecting marine life.

Man’s relationship with the ocean is also influenced by the weather. High seas can sink ships, destroy waterfront property, and kill many people. Fisherman, waterfront resorts, and beaches may have good or bad seasons depending on the weather. Boat operators may get lost if they get caught in the fog. Strong winds may cause sailboats to tip over, and no wind at all can ruin a sailboat race.

Knowledge about the weather can make the difference between life and death to anyone on a boat. Weather also has many major effects on the marine environment.

Learning Activities

Make Your Own Barometer

Materials:

*tape

*scissors

*glue

*balloon

*small glass jar

*2 straws

*marker

*heavy rubber band

Stretch the balloon so that it covers the mouth of the jar and is flat on top. Wrap a rubber band around the mouth of the jar to hold the balloon in place.

Cut of the end of one straw at an angle so that it looks pointed. With the pointed end sticking out glue the other end of the straw to the center of the balloon piece.

Place the jar on one end of a heavy cardboard base and tape it down. Take the other straw and tape it in a standing-up position to a spot on the cardboard about a half inch from the pointer.

With a marker, draw a line on the straw where the pointer is pointing. You can label this with the date if you have room. This will be your starting point. As the air pressure changes, the straw will move up and down Watch you barometer from day to day. When the air pressure is high, it will press hard on the air in the bottle, and the other end of the straw will point higher. When the air pressure lowers, the air pressure in the bottle will push up, and the point of the straw will go down. If the pointer is higher on one day than the day before, the weather will be getting better. If the pointer is lower, the weather will be turning stormy.

Make Your Own Anemometer

Materials:

*3 straws

*2 or 3 twist ties

*4 foil mini-cupcake holders, 3 in one color and 1 in a different color

*tape

Cross 2 of the straws like a “+” sign. Wrap one twist tie around the middle to hold them together.

Tape the foil holders as close to the ends of the straws as possible. Make sure that the open ends are all facing the same direction.

Loop another twist-tie around the center of the four straws, leaving as long a tail as possible. Try to make the tail as skinny as you can.

Place the twist tie tail inside the unused straw. You should be able to blow near the foil holders and see your anemometer spin.

Take your anemometer outside with a friend. You can stick the straw in the ground or hold it in your hand. As it starts to spin, count the number of times the odd colored foil holder passes you in one minute. The number of turns tells how fast the wind is blowing.

How People Use Water

Water is a resource without which nothing can live. Water has an endless number of uses, and some of these uses are not compatible, but we seem to assume that clean water will always be available to us. In fact, less than one percent of the water of the world is available as fresh, drinkable water. Problems with pollution and major droughts around the country have started to change our thinking about the availability of water, but we still have a long way to go as a society before we truly appreciate the value of water.

When America was being settled, and water had to be carried to the house by hand, the average pioneering family would use about a bucket (five to 1 0 gallons) of water in a day. These days, experts estimate that the average person uses a minimum of 100 gallons of water a day and the figure may be more along the lines of two or three hundred gallons of water per person per day. Some of the differences have to do with our many changes in lifestyle since those earlier days. Pioneering families had enough water for cooking and drinking, and chores such as washing clothes and scrubbing floors required the extra effort of hauling more water, so they weren’t done very often. Innovations such as indoor plumbing and washing machines, while making life easier, greatly increased society’s demand for water.

The water used within our homes is only a small part of the water we use each day. Most industrial processes require the use of water to make or clean the products we consume. Then there are the swimming pools, skating rinks, gymnasiums, water fountains in public parks, car washes, the concrete in foundations of our buildings, the heating and cooling systems and refrigeration units, and fire fighting equipment, that all use millions of gallons of water each day. Think of what would change in your community if the water supply was suddenly disrupted for some reason.

Water supplies for our communities come from two places: From water diverted from rivers and stored in reservoirs, or pumped from the ground by huge municipal wells. Modern technology has allowed us to store and transport massive amounts of water over great distances and to remove various impurities before the water is delivered to the consumer.

In recent years, there have been major droughts in many sections of our country and throughout the world that have reduced the water available in these areas. In other sections of the world, such as Africa, drought has devastated entire countries where the water supply had virtually disappeared. Hundreds of thousands of people have died as a result of drought in Africa and many more were only saved by international famine relief efforts. Other problems may make such situations more difficult (civil war or government corruption) but the lack of water was responsible for much of the devastation.

Similar droughts have affected sections of our country over the years (think of the Kansas/Oklahoma Dust Bowl and the mass migration of farmers to California in the 1930's), but we do not have similar problems now because of our technology. Most of the water used in southern California, for example, is piped in from northern California. Water used in Manhattan is piped to the city from as far upstate as Poughkeepsie. Water for New Haven comes from reservoirs in Madison.

Many different uses of water already touched on (industry, home consumption, municipal uses) have not included public recreation, fisheries resources, and waste disposal, uses that are of growing importance in this country, and are also in direct conflict with each other. Waters that receive the effluent from sewage treatment plants and industrial manufacturing are not esthetically pleasing and are generally ecologically degraded to some degree. Over one billion gallons of sewage effluent is released directly into the Long Island Sound and the rivers near the Sound every day, and the number will only get larger. At the same time, it is estimated that the value of Long Island Sound to the economy of its surrounding states is on the order of billions of dollars every year generated from the fisheries, the recreational industry and support services. Decisions need to be made about how to balance all the demands on the Sound.

Learning Activities

Water Use Decisions

Materials:

*five or ten gallon bucket with water

*several one gallon containers like milk jugs

*dishpan

*dipper or ladle

*plastic sheeting or waterproof floor area

Gather the group around the material and start with a story along these lines. Feel free to embroider or expand any way you want. You may want to involve the children in the story by having different kids act out characters in the story and do the scooping of the water for you. This might also speed up the activity.

"Imagine yourself as a pioneer on the wild frontier around 1850. You and your family (mother, father and two or three children) live in a log cabin built on a hill at the edge of a field your father cleared. At the bottom of the hill is a stream that provides all the water used by you family and all your animals. The animals are walked down to the stream twice a day to get their water, but you have to carry the buckets of water up the hill for your family to use. (Have some of the children pick up the bucket of water and carry it a short distance.) Every morning after you bring the water up the hill, your mother uses some to make corn meal and hot tea for breakfast (scoop about a half gallon out of the water and put it in the dishpan). After breakfast, your father fills his jug so he and your brothers can take water to the field with them (fill one of the one gallon jugs). Mother fills the kettle again to wash the dishes (scoop out another gallon of water). Today is baking day so some of the water gets used as Mother makes the bread dough and stews up some fruit to make a pie (add a few more scoops to the dishpan). After lunch you help weed the garden and need another drink (more water in the dishpan). For supper, Mother makes stew (more water) and then washes the dishes from the day (fill another gallon jug). Before bed, you pour water into the wash basin and wash your hands and face, and leave the water for your brothers and sisters (whatever water is left). Tomorrow is washing day and that means you'll have to bring two extra bucket of water up the hill! Just thinking about it makes your arms ache.

Be fairly liberal when pouring out the water, and if you run out in the middle of the day, adjust the story to have the child carry another bucket up the hill (groaning all the way).

After you get through the story, start a discussion about how much water gets used in a modern household in the course of a day. Make sure showers, washing machines, lawn sprinklers, swimming pools/hot tubs, and all the other water amenities of modern society are included. Make a list on a flip chart or blackboard of all the ways water is used in a modern home.

Re-designing Long Island Sound

Materials:

*charts of Connecticut and Long Island Sound (with rivers) on legal size paper

*sheets of water use and pollution symbols (included at the end of this unit)

*scissors

*tape or glue

You can either do this exercise as a group or in small teams. It will be more work for you but be less time consuming during the activity if you have already cut up the symbols. Have the group place the water recreation symbols (boating, fishing, picnicking) where they think these activities might occur. Then, for every four recreation symbols on the picture, they must also put on one gas pump, one garbage can and one car. For every six recreation symbols, they must add one farm and one factory. Make sure the children understand what the different pollution symbols will do to the water. It's best not to attach any of the symbols immediately, as the groups may want to relocate some after some thought. You can make the activity more true to life by announcing a population boom of people who want to use the water and giving them another 10-12 symbols to place when they think they have completed their task.

Ask what has been learned by trying to fit all the symbols together on the picture . (There's too many people; pollution and recreation don't mix; people who pollute are ruining their own recreational places.)

Water Use Scavenger Hunt

Materials:

*student worksheet (sample included at the end of this unit)

*master list of water uses at school or camp

*pens or pencils

For this activity, you may also need the cooperation of other people, or you can place some materials yourself first thing in the morning. You will need to do some legwork beforehand to count the listed water uses for yourself.

Either have everyone work individually or in groups of two or three, no larger. Give each group a copy of the list and give them fifteen minutes (more or less depending on how widespread the area is) to get the answers and return to the meeting place. The group with the most right answers should get some sort of recognition.

Ground water and Pollution

Ground water is water found beneath the surface of the earth. It may be flowing in between the particles of soil or through cracks in rocks. Most ground water comes from precipitation that has soaked into the ground through the surface soil. All ground water eventually reappears as surface water either in the form of springs, or by feeding directly into streams or lakes or the ocean.

Many regions of the country rely on ground water for their water supply. Wells get their water by being drilled into the ground water supply. Ground water supplies water to nearly half the households in our country and is the primary source of irrigation water for agriculture in the United States. This dependence on ground water is causing problems in some sections of the country where the demand for water is exceeding the supply of ground water. In some areas in Texas and Oklahoma, so much ground water has been removed from the system that the landscape has actually sunk and changed shape. In other areas, ground water is threatened when the surface is covered so that the ground water supply cannot be recharged. On Long Island, where ground water is there only source of fresh water, the governments have had to create ground water recharge basins that are designed to direct rainwater into the ground water because so much of the ground of Long Island is covered with houses and asphalt that the natural recharging process cannot keep up with the demand for water.

Most people picture well water or spring water as being exceptionally pure and good to drink because it has been filtered and protected by the earth and is far away from any sources of contamination. Unfortunately, we have shown that humans can pollute even waters in the depths of the earth and that ground water is quite vulnerable to contamination. Soil is simply not a good enough filter to protect ground water from some of the contaminants that we have dumped on the ground over the years. There are many activities that can lead to ground water contamination, including: Industrial and agricultural waste disposal, poorly designed landfills, leaking underground storage tanks, failing septic systems, improperly applied agricultural fertilizers and pesticides, and the list goes on. Once these substances are released on the ground, they move down through the soil and into the ground water. Some of these chemicals, such as phosphates or the bacteria from septic systems, are filtered by the soil before they reach ground water unless the ground water is very close to the surface. Other chemicals, more soluble in water, are not likely to be absorbed by soil particles and are more likely to move to contaminate the ground water. The type of soil and quantity of chemical involved also affect the possibility of ground water contamination.

Once ground water is contaminated it takes a very long time, if it is even possible, for it to purify itself. In surface waters, there are a variety of chemical and biological reactions that help to speed the purification of contaminated water. These reactions include evaporation to the atmosphere, biological uptake, and breakdown by sunlight or microorganisms. Since none of these processes are available to ground water, purification is almost impossible. Slow movement of ground water and the colder temperatures within the earth also slow down the purification process. Even when a contamination source is very small, such as a leak from a home heating oil tank, the expense of cleaning up the ground water can be astronomical.

The best way to ensure a constant supply of clean ground water is to protect the water now rather than trying to clean it up later. Connecticut has state laws created under and "Aquifer Protection Act", that are designed to keep activities using potentially contaminating substances out of areas where ground water is used or could be used as a source for drinking water.

Learning Activities

Making a Ground water Model

Materials:

*large glass or clear plastic container

*mixture of sand and gravel

*water

Pour the sand and gravel mixture into the container, making a layer several inches thick that slopes toward one side of the container. Add water until you can see the level of the water within the soil in the container. Explain that the visible line of water is the "water table" or the upper limit of the ground water. Below the water the pores between the grains of sand and gravel are filled with water and this water is the ground water.

Continue adding water to the container until there is standing water visible over the lowest side of the sand and gravel mixture and the water table is visible in the mixture on the other side of the container. *Ask the group to compare the level of the water on both sides of the container* . Explain that swamps, streams and ponds are actually areas where the water table is higher than the surface of the ground because of uneven topography. *Ask the group what would happen if more water was added to the container* . ("pond" would get larger as water table got higher) *or if a well was placed in the dry land area* ("pond" will get smaller if too much water is removed and the water table is lowered). Emphasize the tie between precipitation, ground water and surface water.

Soil As A Filter

Materials:

for each group you will need:

*3 jars, 1 with a lid

*2 coffee filters

*2 funnels

*sand

*potting soil

*measuring spoons

*student worksheets (included at the end of this unit)

*sugar

*vegetable oil

*food coloring

*water

*large container for waste water

Divide the groups into groups of four or five. Have the groups set up their soil filters as described on their worksheet and place the funnels over two of the jars. The experimental solutions are mixed in the third jar as described on the worksheet. The soil should be a more effective filter than the sand because soil has smaller particles, making it easier for substances to absorb into soil. The vegetable oil should be filtered out by the soil, but the sugar and food coloring should pass through both filters.

Water Use Scavenger Hunt Sheet

(Sample)

How many toilets are there in the camp? ______ How many beds are there in the camp? ______ If each toilet uses 7 gallons of water every time it's flushed, and the person in each bed uses the toilet three time a day, how much water is going down the toilet every day? ______ How many sinks are there in the camp? ______ How many showers? ______ Where does the camp's water come from? ______ How are dishes washed in the camp? ______ How much water gets used? ______ What is the biggest body of water in the camp? ______ Where does the water go when it goes down the drain? ______ How much water do the animals use every day? ______ How many people go swimming at camp each day? ______ How many people go boating? ______ How many kinds of water recreation are there at camp? ______

SOIL AS A FILTER

1. Set up your soil filters as follows: Put the filter papers inside the funnels. In one funnel, place several tablespoons of sand into the filter paper. In the second funnel, place several tablespoons of potting soil into the filter paper.
2. Place the two soil filters over two of the jars.
3. Fill the third jar half full of water and add one teaspoon of sugar. Shake the mixture well. Describe the results in the "Before" column on the worksheet.
4. Pour half of the mixture into each of the funnels. Describe the results in the "After" column on the worksheet.
5. Empty the two jars and repeat the experiment three times with the following mixtures:
    - 3 drops food coloring in a half jar of water
    - 1 teaspoon vegetable oil in a half jar of water
    - a half jar of plain water

Record all your observations on the worksheet.

What is a more effective filter: sand or soil? ______

What substances were easy to filter out? ______

What substances were hard to filter out? ______

Was the plain water cleaner or dirtier after being filtered? ______

What do you think happened? ______

Soil as a Filter Worksheet

(figure available in print form)

Water Dissolves Things

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1. Fill your cups with cold water and label them. Into cup 1, stir one teaspoon of salt at a time until the salt no longer dissolves. How many teaspoons of salt could you dissolve in the water?
2. Test the baking soda, oil, and sand for their ability to dissolve in water. Before you start the testing, predict whether the water will be able to dissolve more or less of the substance than of the salt. Circle your prediction below.

baking soda: more less same _____
oil: more less same _____
sand: more less same _____

Now perform the tests. Stir the different substances into the water one teaspoon at a time. Record your results in the blanks above. How well did your predictions match your results?

When you are done, empty your all your samples EXCEPT the sand sample into a sink. Drain the water off the sand sample and throw the sand into a trash can.

Water Drops

Procedure:

1. Squeeze several drops of water out onto your square of waxed paper. Be careful not to let the drops get too near the edge of the paper.
2. Use your toothpick to examine the drops: touch and move the drops and observe their behavior. Be careful not to poke your toothpick through the waxed paper or this won’t work.
3. Draw a side view and a bird’s eye view of a drop. Describe its shape.

Side view Bird’s eye view

4. Make two drops touch each other. What happens? Try to take the drops apart again. Can you do it?
5. Do different sizes of drops act differently?
6. Mix different color drops together and see what colors you can make. Can you get the colors apart again once they have been mixed?
7. Tape another piece of waxed paper over the water maze race course and see how fast you can move a drop through the maze. Then see how far you can make a drop stretch across the scale. If one inch equals 2.54 centimeters (cm) how many inches could you stretch your water?

When you are done, mop up the water drops with a paper towel or sponge, then throw your waxed paper and toothpick in a trash can.

(figure available in print form)

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