Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1997 Volume VI: Global Change, Humans and the Coastal Ocean

Global Environmental Coastal Changes: Cause and Effect A “Hands-On” Approach Primary Style

Curriculum Unit 97.06.01
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Introduction

My curriculum unit is divided into eighteen basic sections. It is targeted at second grade “scientists”, but can be simplified for Kindergarten or extended to sixth grade. (This way my curriculum will be of more use to more teachers.)

It is also my hope that my second graders will “catch fire” with all the scientific knowledge available and will view themselves as “scientists”. This is something I was not able to do as a child . . . (I was taught early on that I was a “lousy scientist” by several teachers . . .)

Since children learn far faster with the “hands-on” approach, I intend to make these eighteen sections into “hands-on” projects and/or activities. At the same time these activities will run the gamut of the curriculum.

In other words, this curriculum will be integrated into mathematics, reading, language arts, social studies, music, physical education and art. Extension activities will be included in the appendix. This curriculum unit will be presented over an eighteen week period.

My main objectives are:

1. To write the finest curriculum unit of which I am able.
2. To “light a fire” in my little scientists so they view themselves as “real scientists”.
3. To convey knowledge in a “hands-on” manner.
4. To share my curriculum with other innovative teachers who can also “light a fire”, too, in their classrooms.
5. To make my curriculum unit user friendly.

PART I: ENTRANCE INTO THE CURRICULUM UNIT

Section A: Taken from *A House for Hermit Crab* by Eric Carle

Read *A House for Hermit Crab* to the children. Discuss the story. Use prediction strategies while reading. (I have a hermit crab puppet with which I will introduce the story.)

KEY WORDS:	hermit crab, sea anemones, starfish, corals, snails, sea urchins, lantern fish, algae, sponges, barnacles, clown fish, sand dollars, electric eels
Sea Anemones	may look like flowers, but they are soft animals (polyps) without bony skeletons. They come in many shapes and colors. With their many arms (tentacles) they catch their prey. Some specialize in attaching themselves to the shell of the hermit crab. Then they protect and camouflage the hermit crab, and, in turn, may share the hermits crab's meals. This arrangement is called symbiosis, meaning that both animals benefit from each other.
Starfish	There are many kinds of starfish. Most have five arms growing from a central disk. The mouth of a starfish is on the underside of this disk, and it has a single, simple eye on the end of each arm. With its powerful arms it can open an oyster, or hold onto a rock during a storm when the waves lash.
Corals	are somewhat similar to tiny sea anemones that build hard skeletons around themselves. Then hundreds and hundreds of them stick together, forming whole colonies. Some look like branches; others are round or disk-like. Millions upon millions fuse themselves together to build miles long coral reefs. Some, however, live by themselves.
Snails	There are approximately 80,000 species of snails and slugs. Some live on land, others live in the sea or in lakes. Some carry a shell—their "house"—on their backs; others have none. The shells come in many colors and shapes.
Sea Urchins	Some are fat and round, others are thin and spindly. Many have long spines (sometimes poisonous) with which they move around and dig into the mud or rocks or other places. Their mouths, with five pointed teeth, are on the underside.
Lanternfish	like fireflies, have luminous, or light-producing, spots on their bodies that light up their dark surroundings. Some lanternfish have a lantern-like organ that dangles in front of their mouths, attracting other fish which become their prey.

Discuss what the key words mean. Encourage full class participation. Ask them what these excerpts are about? Where are these words going to lead us?

WHY IT IS GOING TO TAKE US TO THE SEASHORE, OF COURSE!!

PART II: MAKE A K-W-L CHART.

Make a K-W-L chart which will pool a knowledge base from the children. The K-W-L chart is as follows. (Actually it is three separate charts):

1. K—What We Know—List all children's knowledge of global environment change. (Section A)
2. W—What We Would Like To Know—List all the knowledge the children would like to know about this topic. (Section B)
3. L—What We Have Learned—At the conclusion of the unit list all the knowledge the children

have gained.

PART III: INTRODUCE THE FOLLOWING FOUND AT THE SEASHORE IN CONNECTICUT

Section A	Hermit Crab Fish Game—Pictures were duplicated so there would be four of each so a “fish” card game could be played with them.
	Hermit Crab Concentration Game—Pictures from *A House for Hermit Crab* are used here, too. Match the picture with the definition. Picture and definition cards are: Sea Anemones, Starfish, Corals, Snails, Sea Urchins and Lanternfish.
Section B	Seashore Concentration Game—Similar to Hermit Crab Concentration. (Pictures can be purchased through the AIMS Education Foundation newsletter May/June 1892.) I do not use all the cards at once with the primary grades since there are too many. Vocabulary cards follow.
	Seaweed Bingo—I have fashioned many eight-block bingo cards for the children from the same pictures. The bingo games can be one horizontal line, four corners at the end or in a block or a cover-all. Just specify which one you are playing.

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ACTIVITY—CUT UP THE WORLD

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DIRECTIONS:

1. Cut a pizza into quarters.
2. Put aside three of the quarters. What do these represent? The oceans of our world, the Blue Planet!
3. The fraction left is 1/4. Slice it in half. Set aside one of the halves. This is the part that people can’t live or work on. The poles, deserts, swamps, high mountains, etc.
4. What’s left? What is left is 1/8. This is where the humans live, but not necessarily where they grow their food.

5. Slice 1/8 piece into four sections. Put aside three of them. What's left? (1/32)
6. The three pieces you set aside represent the places where the soil is too poor to farm—where it's too rocky, wet, cold or steep to produce food. They also represent the cities, houses, highways, shopping malls, schools, parks, factories, parking lots and miniature golf courses where people live, play and work—but CANNOT grow any food.
7. Take your 1/32 piece that's left. Look at this scrap of pizza. It represents the farmable surface topsoil of our planet, the thin skin of the of the Earth's crust upon which humankind totally depends.

IT IS LESS THAN 5 FEET DEEP AND IT IS QUITE A FIXED AMOUNT OF FOOD-PRODUCING LAND.

Now we are going to eat the rest of the pizza, but we are going to save this tiny piece of pizza.

WE WILL TREAT IT AS IF OUR LIFE DEPENDED ON IT!!!

CONTINENTS

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A continent is one of the earth's principal divisions of land. The term comes from a Latin word that means "continuous mass of land". There are seven continents.

From largest to smallest, they are Asia, Africa, North America, South America, Antarctica, Europe, and Australia. When geographers identify the land areas they consider part of a continent, they usual include all the islands associated with the landmass.

All together the continents add up to a great deal of land, totaling about 148 million square kilometers (57 million sq. mi.). Even so, the surface area of the ocean is more than twice that of the continents combined. The areas of blue that usually represent water are far more extensive than the areas of brown and green that often represent land and vegetation.

The ocean which covers almost 3/4 of the earth is divided by the continents. Its various sections have been given different names. You can find each continent of the map which follows. On this map, as on most others, the coastlines do not indicate the actual boundaries of the continents. There are gently sloping areas called continental shelves that extend outward under the water, often stretching far into the ocean. If the underwater shelves were included in the total land area, the continents would make up more than 1/3 of the earth's surface.

PANGAEA, LAURASIA AND GONDWANA

Earth's plates have been moving around and pulling apart and bumping into each other for a long time. It' s no wonder the world has gone through a lot of changes.

Take our continents, for instance . . . You may have looked at a globe or map of the world and thought that the continents look like puzzle pieces. If you moved them around, some of them would fit together. Look at South America and Africa—if you pushed them towards each other, they'd match up perfectly side by side! Maybe they were connected once, and then floated apart . . .

Floated apart? The continents? Millions of tons of rock? Can you believe it? Until recently that was pretty much how most scientists reacted when anyone suggested that maybe the continents had been connected long ago and then somehow moved apart.

A German scientist, Alfred Wegener, was the first to study the idea and say that it might be true. He came up with some pretty convincing evidence, too. He discover that the same types of rock and fossils of the same kinds of creatures could be found in places where the continental "puzzle pieces" fit, even though those places were separated by hundreds of miles of oceans.

But it wasn't until 50 years after Alfred Wegener's death that geologists realized he was right . . . The continents and ocean floors really do "float" on moving rock plates and have been for millions of years.

They're floating right now. If a child who is now ten years old—North America and Europe are about one foot farther apart today than they were on the day this child was born. In some places the continents are moving about 2.54 cm (1 inch) a year. In other places, they're drifting as much as 10 cm (4 inches) a year. Over time continents drifting a few inches a year can make a BIG difference.

About 250 million years ago all the continents on Earth were connected in a single land mass near the equator. Alfred Wegener called it Pangaea which means "all earth". Around 200 million years ago, Pangaea split into two super-continents that gradually drifted apart. Laurasia, in the north, included the land that would become North America, Europe and Asia. Gondwana, in the south, included South America, Africa, India, Antarctica and Australia.

Over the next 100 million years the land that was to become India drifted northward and eventually crashed into Asia, creating a huge pileup of rock we call the Himalayas. (See Experiment 7B) A split opened between South America and Africa and also between North America and what would be Europe and Asia. The narrow strip of seawater in the middle was a baby ocean. We now call it the Atlantic.

With the help of computers, geologists are using their knowledge of how and where plates move to figure out what our world might look like in the future. Some predict that the Mediterranean Sea will disappear, that the

Red Sea will become a new ocean, and that Australia will float to the equator. These changes are expected to take about 75 million years to happen!

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EXPERIMENT: PANGAEA, LAURASIA AND GONDWANA

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This experiment show how heat moves water and also how a material floating on a moving liquid moves with it. Imagine that the water is the slowly moving bottom layer of the Earth’s crust.

MATERIALS NEEDED:

1. 1.9 liter (2 quarts) cooking pot, full of water

2. stove

3. some dried herbs, such as rosemary, basil or oregano—or some dry sawdust

4. notebook

5. pencil

DIRECTIONS:

> 1. AN ADULT HAS TO HELP CHILDREN WITH THIS EXPERIMENT!!! This is necessary because of the stove and boiling water. Place the pot half on and half off one of the burners. (You are trying to make one part of the pot hotter than the other.)
> 2. Turn on the stove burner to high. As the water begins to boil (you’ll see tiny bubbles forming on the bottom of the pot), sprinkle a thin layer of dried herbs or sawdust on top of the water. Watch what happens. Think of the dry particles as the earth’s crust plates riding on the liquid mantle of the earth.
> 3. Notice where the herbs or sawdust go. Where do the particles gather? Do they gather over the hotter or the cooler part of the pot? Why? What does the movement of the herbs or sawdust tell you about the movement of the water? The dry particles gather where the cooler current sinks and moves away from the spot where the hotter water rises. Why does this happen? Make notes of your observations.

EXPERIMENTS: MOUNTAIN BUILDING

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These three experiments demonstrate the process by which many mountain ranges were created. Of course, it takes hundreds and hundreds of years for a mountain range to develop, but these simple experiments will let you imagine how great slabs of the earth's crust moving toward each other could push up mountains.

MATERIALS NEEDED:

1. 2 large chunks of clay (either ceramic clay or plasticine), each twice as big as your fist
2. rolling pin
3. dull table knife
4. 2 pieces of aluminum foil, each about 13 cm (5 inches) long
5. fat dowel or a piece of an old broomstick

DIRECTIONS:

1. Work the lumps of clay with your hands until they are soft and easy to bend and shape.
2. Roll each chunk out until it is about 20 cm (8 inches long), 10 cm (4 inches) wide and 5 cm (2 inches) high. Trim the chunks with the knife so that they look like bricks.
3. Place each clay brick onto the edge of a piece of aluminum foil. Each brick will represent a land mass.
4. Place the two land masses—each riding on its aluminum foil plate—about 30 cm (1 2 inches) apart on a smooth table or countertop.

Experiment #1—Hold each land mass at its far end and slam them together as hard as you can. Try this several times. Describe what happens. Describe how the clay after the collision is like the edge of a continent that has had a collision with another continent. Experiment #2—Separate the clay and form it into bricks again. Place the long side of each brick along an edge of its aluminum foil. Push the two bricks so that they brush against each other as they travel past each other. Describe what happens. How is the edge of the clay like an edge of a continent that has had another land mass slide alongside it? Often one land mass is heavier than the other, and it sinks under the lighter land mass as the two collide. Experiment #3—Here you will use a dowl to lift one clay brick over the other. First make the clay into two bricks again. Sit one of them on a piece of aluminum foil. Place the other brick facing the first brick, but with one of its short ends tilted up so that it rests on the dowl. Slide the two bricks toward each other and jam them together. What happens as they hit each other? How is this collision different from the first or second one that you tried. What kind of land forms would be the result of a collision like that?

THE GEOGRAPHY OF THE EARTH

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The earth is a huge sphere of rock covered by water and soil, and surrounded by air. About 70% of the Earth's surface is covered with water, most of it in the oceans. Land makes up about 30%.

Earth's crust has a very interesting and varied landscape made up of mountains, valleys, plains, deserts, oceans, lakes, rivers and icecaps.

1. Mountains are large landforms that rise above the surrounding land.
2. Valleys are depressions on the Earth's surface.
3. Plains are areas of relatively level, treeless land.
4. Deserts are areas with very little water available.
5. Oceans are huge bodies of water that cover most of our Earth.
6. Lakes are bodies of water that form in hollows or basins.
7. Rivers are streams of water moving across the land.
8. Icecaps are huge areas of ice found at the North and South Poles.

Geologists investigate materials of Earth's crust such as soil, sand, and rocks.

Pictures can be purchased through the AIMS Education Foundation in their *Primary Earth* book. many geography activities can be found there.

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THE EARTH HAS A HYDROSPHERE

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The study of water is a very important part of Earth Science. Water is a major architect of our landscape; it is an agent of erosion and essential to weathering both as a solvent and as a transport agent.

Water is vital to all life on Earth. Even the hardiest plants and animals of the desert need some water. Water is a colorless, odorless, tasteless liquid. It is naturally found in three different states: liquid, gas, and solid. The state depends on the water's temperature.

When water is cooled below its freezing point, it becomes solid. When water is heated, it can evaporate into the air as a gas. When it is above the freezing point and below the boiling point, it is liquid.

Earth is known as the water planet. There is water all around you in the air above you, in the ground below you, and in the oceans. While we speak of four different oceans, they are actually one vast body of water. The oceans contain 97% of the water on our planet.

Water deposits, small and large, are found in the following:

1. Oceans

2. Lakes

3. Icebergs

4. Ponds

5. Streams

6. Rivers

Pictures can be purchased through AIMS Educational Foundation in their *Primarily Earth* book.

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WINDS

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Wind is the movement of air caused by the uneven heating of the earth by the uneven heating of the earth by the sun. It does not have much substance—you cannot see it or hold it but you can feel its force. It can dry your clothes in summer and chill you to the bone in winter. It can be strong enough to carry sailing ships across the ocean and rip huge trees from the ground. It is the great equalizer of the atmosphere, transporting heat, moisture, pollutants, and dust great distances around the globe.

Air moves from area of high atmospheric pressure to areas of lower pressure. In an area of high pressure, the air molecules are closer together than they are in an area of lower pressure.

Air molecules tend to move from high to low pressure, and it is this movement of air that we feel as wind. The greater the difference between the two pressures, the stronger the wind will be. The earth's rotation adds a curve to this flow from high to low pressure, creating a gentle spiral that twists inward.

EXPERIMENT: FLOWING WIND

(figure available in print form)

Air flows from a high-pressure area to a low pressure area, much as water flows from a higher to a lower level. This is demonstrated in this experiment. ADULT SUPERVISION IS NEEDED FOR THIS EXPERIMENT.

MATERIALS NEEDED:

1. scissors

2. food coloring

3. modeling clay

4. tape

5. 2 plastic bottles

6. a plastic tube

7. a hand drill and bit

8. water

DIRECTIONS:

1. An adult drills a small hole near the bottom of each bottle (in the same position each time) and then cuts off the top of each bottle.
2. The adult seals the bottle edges with tape. Stick strips of tape at equal intervals on both bottles to make a rough scale.
3. Connect the two bottles by placing the ends of the plastic tube in the holes. Use some modeling clay to seal the joints.
4. Fill one bottle with colored water to the level of the tube, and fill the other completely. What happens to the water levels?

MEASURING THE WIND

Many people need to find out what the wind conditions are each day. Aircraft crews need to know the strength and direction of the wind on takeoff and landing. Winds make waves at sea, so sailors need to know what conditions to expect.

The direction from which the wind blows is measured with a wind vane. Speed is measured with an instrument called an anemometer. In weather forecasts, wind speed is usually reported in miles or kilometers per hour, or—for ships and aircraft—in knots. One knot is equal to 1.85 km/h (1.15 mph). The Beaufort Wind Scale gives wind speed as a “force”.

The Beaufort Wind Scale originally described the type and amount of sail a ship should carry in particular winds. Today the scale describes the effects seen on land and relates these to wind speeds. Look for the signs it describes and you can estimate the wind speed. The Beaufort Wind Scale is as follows:

Force 0	Smoke rises vertically, and the air feels still.
Force 1	Rising smoke drifts, but wind vanes and flags do not move.
Force 2	Smoke shows the wind direction.
Force 3	Flags, leaves, and twigs move gently.
Force 4	Loose pieces of paper blow about.
Force 5	Small leafy trees sway in the wind.
Force 6	Umbrellas are difficult to use.
Force 7	Pressure is felt when walking into the wind.
Force 8	Twigs are torn from trees.
Force 9	Slates and chimneys are blown away.
Force 10	Trees are broken or uprooted.
Force 11	Cars overturned. Trees blown a distance.
Force 12	Widespread devastation. Many trees uprooted. Buildings destroyed.

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HURRICANES

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Hurricanes are the biggest and most powerful of all storms. They are circular and vary in size many of them are roughly 650 km (400 miles) in diameter, and wind speeds can reach 200 km/h (125 mph) or more.

Hurricanes form over warm, tropical seas when the water temperature is above 80 degrees Fahrenheit. They do not form on the equator or beneath jet streams.

Once formed, they follow a path away from the equator, usually growing in intensity while they remain over warm water. They dissipate over cool water or over land. Such storms are called hurricanes if they form in the Atlantic, cyclones around India and Australia and typhoons in the western Pacific.

EXPERIMENT: MODEL HURRICANE

(figure available in print form)

The clouds around a hurricane form spiral bands. In them water vapor condenses in the warm, rising air. This releases latent heat, helping the air to continue rising.

At high altitude the air enters the region of high pressure, adding to the pressure difference between the top and the bottom of the storm.

Some of the energy in the cloud is then transferred to the clear air next to each spiral band and increases the wind speed. You can make a ”hurricane” vortex in water showing that spiraling water also forms bands.

MATERIALS NEEDED:

1. eye dropper

2. food coloring

3. plastic hand mixer

4. bowl—preferably a clear plastic one

5. water

DIRECTIONS:

> 1. Fill the bowl with lukewarm water. The bigger the bowl, the better. Stir the water gently until it is all moving slowly in a circle around the bowl.
> 2. Release a few drops of food coloring into the center of the bowl. Watch the color move out and form bands—just as clouds in a hurricane do.

(figure available in print form)

EXPERIMENT: STORM SURGE

(figure available in print form)

A hurricane is seen in clouds and winds. Its winds affect the ocean surface. Much of the damage caused by a hurricane is due to the oceans lapping on the shore with great intensity.

Rainfall is heavy and winds produce waves up to 15 m (50 ft.) high. This effect is widespread and waves are often much larger than normal as much as 1,500 km (900 miles) from the eye of the storm. Fiercely pounding waves ahead of the storm can be 3 m (10 ft.) high.

When the hurricane approaches a coastline, strong onshore winds cause water to pile up in a “storm surge”. If the surge coincides with a high tide, sea water may sweep inland. This experiment shows you how to make a storm surge at home. ADULT SUPERVISION IS REQUIRED FOR THIS EXPERIMENT.

MATERIALS NEEDED:

1. electric fan

2. paper

3. grease pencil

4. scissors

5. tape

6. water

7. dishpan

DIRECTIONS:

1. Make a funnel out of paper and tape its wide end to fit over the fan. This will concentrate the wind.
2. Fill the dishpan with water to within about 5 c (2 in.) of the brim. Mark the water level at one end of the pan with the grease pencil. Position the fan so that it will blow towards the mark.
3. Have an adult switch on the fan so that the wind blows across the surface of the water. How much does the water rise above the mark at the far end? (This is a “storm surge”.)
4. Now repeat step 3, but tilt the dishpan a little to raise the water level near the mark, creating a high tide. See how much difference the tide make to the “storm surge”.

OCEAN CURRENTS

(figure available in print form)

Warm and cold ocean currents can change the climate of coastal regions, but only when prevailing local winds blow from the sea to the land. Warm currents bring higher temperatures and more precipitation, while cold currents can lower temperatures and shorten growing seasons.

Most ocean currents are driven by prevailing winds, but the earth’s rotation deflects them into roughly circular paths, clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere.

These circular currents, called gyres, are strongest in the largest oceans—the North and South Atlantic and the Pacific. The North Atlantic gyre moves from the warm north coast of South America toward Florida, then east across the ocean, and south off Portugal.

The following picture details the main ocean currents. Western currents such as the Gulf Stream and the Kuroshio flows faster than those on the eastern sides of oceans. Off the coast of Florida the Gulf Stream is 50-75 km (31-47 miles) wide and flows at 4-11 km/h (2.5-7 mph).

The Kuroshio is about 80 km (50 miles) wide and flows at a speed of about 11 km/h (7 mph). The Benguela current, flowing northward along the west coast of Africa, flows at about 1.0 km/h (0.6 mph). The most constant current is the Antarctic Circumpolar current, which flows through the southern oceans.

EXPERIMENT: DEEP-WATER CURRENTS

(figure available in print form)

The general circulation of water in the Atlantic and Pacific is driven by deep, slow-moving currents of cold water that flow from the poles toward the equator. When sea water freezes, its salt separates from it.

Sea ice is fresh, but the water close to it is saltier than other water because it contains the salt that was removed during freezing. This makes the water denser. Water close to the ice is also cold, and this dense water sinks all the way to the ocean floor, flows away from the ice and is replaced by warmer surface water which then cools and sinks.

These deep water currents move only 1.5-2.2 m (2-3 yards) a day. This experiment shows you how to make a deep-water current in a dish.

MATERIALS NEEDED:

1. ice

2. food coloring

3. eye dropper

4. water

5. glass dish

6. aluminum foil

DIRECTIONS:

1. Fill the glass dish with warm water, and leave it until the water has become quite still. This represents a warm ocean such as the mid-Pacific.
2. Wrap some ice cubes carefully in foil, making sure no melted water will be able to leak out. Put the foil package in one end of the glass dish and leave it until the water is still once again. The ice will start to cool the warm water.
3. Place a few drops of food coloring over the foil so the color trickles into the water. What happens to the color as it sinks to the bottom of the dish? This is how deep-water currents carry

water toward the equator from the poles.

TIDEWATER BASINS

(figure available in print form)

North and south of the tropics, saltwater swamps give way to tidal marshes. These wetlands form a grassy fringe near river mouths, in bays, and along coastlines protected from the open ocean. They are dominated by grasses and are alternately flooded and exposed by the movement of the tides. Tidal creeks carrying fish and tiny plants crisscross them.

Of the ecosystems available for human use, tidewater basins are among the richest in plant and animal life. The grasses provide food and shelter for shellfish, fish, amphibians, and other animals. Wading birds and other animals feed on the vegetation and abundant insects. Tidal salt marshes make ideal nurseries for the young of many animals that live in the ocean as adults.

ACTIVITY

For children living near the sea coast, a small marine aquarium may be the best capstone to a trip to a beach or tidal flats. In the interest of conservation, no more than one or two small specimens of the common species, such as clams, hermit crabs, sea anemones, starfish, scallops, and some salt-water fish, should be collected to stock the aquarium.

The salt-water tank should be clean, leak-free, and located in a cool place. Cover the bottom with sea sand and a few barnacled rocks. Water may be brought from the ocean or be synthetic brine. Sea salts in cloth bags (available from scientific supply houses) should be dissolved according to directions. Avoid contact between brine and brass, copper or zinc.

Tidepool animals will not survive overnight without an aerator. Common aerators for fresh-water tanks are suitable if more than one per tank (usually two) is used. Specimens will survive for a considerable period in a cool, aerated tank.

Even a superficial consideration of sea life will suggest comparisons with life in a pond—that is, communities within a community.

Life in a tidepool is very different from the plant and animal life on a sandy beach or life along a muddy shore or tidal estuary. The offshore shallow also represent a different community. Children should be led to see that transitions between saltwater communities are sharper than those between freshwater life zones.

Because of the rigorous conditions, animal forms, being more adaptable, predominate over plant forms in marine zones. Observation of this phenomenon can lead to discussion and research into the world’s population explosion and food problems. With respect to the latter problem, the sea is achieving great prominence as a source of protein. The production of fish protein is less costly because of the extensiveness of the sea and its countless beds of algae and animal plankton which need no cultivation or irrigation.

EL NINO

(figure available in print form)

The trade winds drive the South Pacific equatorial current which carries surface water west and leaves relatively cool water off South America and a much deeper layer off Indonesia. Every few years, however, this normal pattern changes.

The trade winds weaken and the temperature and rainfall patterns change over a huge area stretching from the Pacific coast of South America to the Indian ocean. This is called Southern Oscillation, and when it happens the equatorial current in the Pacific reverses. The oscillation is between the two states.

Warm water flows east and then south along the coast of Peru. This current is call El Nino. The two changes together are call an El Nino—Southern Oscillation (ENSO) event. This affects weather and climate over other parts of the world as well as the Pacific area.

An ENSO event raises the sea temperature off South America by 18 degrees Fahrenheit. Cold water, rich in nutrients, cannot penetrate the deeper layer of warm water. This reduces the amount of phytoplankton (tiny plants) in the surface water. The number of animals and fish that feed on the plants also dwindles, affecting the Peruvian fishing industry.

ENSO events usually happen in December. The strongest one in recent history occurred in 1982-1983. It generated a series of changes in the oceans that moved farther and farther from the equator, producing climatic changes that were still being felt in 1994. Another ENSO event lasted two years, in 1991-1993. El Nino brings rainstorms to Peru, unusual weather to North America and may affect crops in Zambia and elsewhere.

El Nino and the monsoons are driven by the same process.

EXPERIMENT: MAKING YOUR OWN EL NINO

(figure available in print form)

The trade winds blow warm surface water across the ocean, so it forms a pool on one side and only a thin layer on the other. During an El Nino, the flow reverses. This happens on a huge scale right across the Pacific, but the principle is simple. With the help of a friend you can easily see how it works.

MATERIALS NEEDED:

1. food coloring

2. water

3. ruler

4. wide, clear-sided container

DIRECTIONS:

1. Fill the container with cold water to within about 10 cm (4 in.) of the brim. When the water is quite still, trickle colored, hot tap water into the container to form a surface layer.
2. Use the ruler to measure the thickness of the warm, colored layer of water at either end of the container. This should be the same at both ends.
3. Ask your friend to blow the water to make a “trade wind” that moves the colored water toward one end. To make your El Nino, ask your friend to stop blowing so that warm water flows to the other end. (Compare the depth of the colored layer to the level before you started to blow.)

MONSOONS

(figure available in print form)

Monsoons are land and sea breezes on a very large scale. They are produced by changes in pressure systems. The Asian monsoon is the best known.

In winter dry, sinking air forms a large high pressure area over Asia. The weather is dry and winter monsoon winds blow away from the coasts.

In summer the land heats faster than the sea. The high-pressure systems weakens, and the winds reverse direction, bringing moist air from over the sea into the dry continent. The onset of the summer monsoon is usually sudden and dramatic, bringing heavy rains.

The following pictures show monsoons in Asia. In summer the land warms faster than the sea. Air pressure falls over central Asia and rises over the Indian Ocean. Moist air blows inland, rising as it reaches high ground and bringing heavy rains to India. This is the summer monsoon.

In winter the land cools rapidly, and sinking air forms a large but shallow area of high pressure over the continent. Air pressure is now higher over the land than over the sea, and northerly winds bring dry air to India. This is the winter monsoon. As mentioned previously, monsoons and El Nino are driven by the same process.

EXPERIMENT: MONSOON MUD MADNESS

(figure available in print form)

Monsoon rains increase the amounts of water flowing in rivers. In the lowlands, rivers flood surrounding farms. When the floods recede, tiny particles of silt that were in the water remain. Silt makes soil fertile, and farmers rely on the monsoons for this seasonal flooding. You can see how this flooding happens. TAKE CARE. THIS EXPERIMENT IS VERY MESSY, SO DO IT OUTSIDE TO KEEP YOUR SPACE CLEAN.

MATERIALS NEEDED:

1. large board

2. bricks

3. soil

4. water

5. spoon

DIRECTIONS:

1. Raise one end of the board and support it with bricks at one end. Cover the board with about 5 c (2 in.) of soil and pack the soil down well.
2. Use the spoon to make a hollow “lake” at the top of the board and a “river” channel down the board from the lake. About halfway from the bottom, make the channel meander gently from side to side.
3. Pour water into the lake. When the river is flowing, pour faster until it breaks its banks, then stop. When it dries, where has the silt settled?

HEAT AND TEMPERATURE

(figure available in print form)

You can feel the sun’s warmth on your skin. Sunshine also warms rocks and walls that are directly exposed to it and they feel warm when touched. In hot climates the packed earth, sand or concrete at midday may be too hot to walk on in bare feet. On the hottest day, though, you can walk barefoot on grass.

Heat is what we feel when the energy radiated by the sun strikes an object. This energy is like light, but it cannot be seen. When heat strikes an object, some of that energy is transferred to molecules in the object.

When touched, these energized molecules transfer some of their energy to molecules in your skin, so the temperature of your skin rises—this is why the object feels warmer. Warmed objects lose energy. They may radiate it, like a fire; pass it to another object by conduction; or warm a gas or liquid, which carries heat away by convection. All these different sorts of heat help to produce our weather.

EXPERIMENT: CONVECTION: WARMING FLUIDS

When a fluid a gas or a liquid is warmed, its molecules move apart. The fluid takes up more space, but the number of molecules remain the same, so it becomes less dense than its cooler surroundings. This means it weights less, so it rises through the fluid surrounding it until it reaches a level where the substance above such as the air above a liquid is less dense than it is. The fluid then cools and sinks. You can demonstrate convection with hot and cold water.

MATERIALS NEEDED:

1. a large jar

2. water

3. a small cup

4. food coloring

5. a rubber band

6. plastic wrap

7. a small stick

DIRECTIONS:

> 1. Fill a cup with colored hot water. Cover it with plastic wrap, secured with a rubber band. Put the cup in the jar.
> 2. Now fill the jar with cold water so that the water goes over the level of the cup and nearly to the top of the jar.
> 3. Poke a hole in the plastic wrap with the stick, and watch the warm colored water rise. What happens next?

EXPERIMENT: HEAT CONDUCTION

(figure available in print form)

The molecules that make up a solid object are touching. If one molecule vibrates faster because it has absorbed energy, it vibration make its neighboring molecules vibrate so the energy spreads. This is conduction.

Different materials have different structures, and this affects how their molecules pass energy. Materials also vary in the amount of heat they can absorb before their temperature rises. This is called their specific heat capacity. Grass feels cooler than stone because grass contains water which has a high specific heat capacity.

MATERIALS NEEDED.:

1. a metal tray

2. a wooden board

3. a piece of plastic

DIRECTIONS:

1. Put the metal tray, a wooden board and a piece of plastic on a table.
2. Leave them there for an hour so that they equalize in temperature. Now feel them. Which object feels warmest?

VOLCANOES

(figure available in print form)

Volcanoes are a source of fascination and fear. Cultures from around the world have created stories to explain the causes of volcanic eruptions. The word “volcano” comes from Vulcano, an island near Sicily that was thought to be the home of Vulcan, the ancient Roman god of fire.

Magma is a mass of melted rock that originated in the Earth’s lower crust and upper mantle where temperatures may reach more than 700 degrees Centigrade. The magma tends to rise because it is less dense than the surrounding rock. Basaltic magma forms at about 1200 degrees Centigrade.

The magma, which is under a great deal of pressure, escapes through the weakest area in the surface. These weak areas could be places where the crust is thin or cracked or along boundaries of Earth’s plates. Magma that has reached Earth’s surface is called “lava”.

A “volcano” is an opening in the Earth’s crust through which hot molten rock, gases, solid rock fragments, ashes, etc. from inside the Earth make their way to the surface. A volcano can take on different forms, but the one we usually think of is that of a mountain in the shape of a cone.

There are about 500 active volcanoes on Earth. Volcanoes are often located over areas where crustal plates meet, separate, or subduct (one plate is forced beneath another). Volcanoes that erupt where the plates are separating tend to be much gentler than those where the plates collide and these are all under water. As the plates pull apart, magma wells up to seal the gap between the plates.

There are or have been volcanoes in almost every part of the world. Although volcanoes may seem quite destructive, they are also considered quite beneficial. Volcanic ash is full of nutrients that enrich the soil. In many parts of the world, people risk living near volcanoes so they can tend farms on the fertile volcanic slopes. Steam and hot water from volcanoes are used for heating houses and for generating electricity in many parts of the world.

EXPERIMENT: VOLCANO MODEL

(figure available in print form)

Before attempting this experiment collect newspapers to cover the work area. Put the baking soda in a small jar. (If desired, add small pieces of styrofoam to represent rocks.)

Mix the vinegar, soap, and food coloring in a jar. Make a cardboard tube (or use a toilet paper roll) and fit it around the jar. Cut holes in the tube for drinking straws or small plastic tubing which represents vents.

The reaction of vinegar and baking soda is used in the simulation of a volcanic eruption. When vinegar and soda are mixed together, a chemical reaction will occur. This chemical reaction will produce carbon dioxide gas bubbles. These bubbles will rise to the top of the volcano and spill over the sides. The soap is added for a more frothy volcano.

MATERIALS NEEDED:

1. dirt

2. sand

3. water

4. straws

5. baking soda

6. vinegar

7. food coloring

8. cardboard

9. small jar

10. pan

DIRECTIONS:

1. Put sand in a pan or small box.
2. Make a cardboard tube and fit it around the top of a small jar.
3. Cut 2 or 3 holes in the tube. Put plastic straws or small tubes in the holes.
4. Mix sand, dirt and water. Mold it around the jar on the tube to make a mountain.
5. Put baking soda in the jar. Mix vinegar, food coloring and dishwashing liquid in a cup.
6. Eruption Time! Pour the vinegar mixture into the jar and tube. Stand back and observe.

WHAT HAPPENED?

EROSION

(figure available in print form)

Erosion is the movement of weathered materials—rock fragments and particles of soil broken down by water, ice and temperature changes. Water, ice, wind, and gravity are the agents of erosion. They move these materials and change the shape of the land.

As rivers flow, they carve their own valleys. Where masses of moving ice called glaciers are present, they widen and deepen the valleys. Wind hurls sand against rocks, sculpturing them into different shapes. The pull of gravity and heavy rains and snow cause landslides and avalanches.

Where any slope exists, surface material is moving slowly down it. Water, wind, and ice deposit rocks and similar debris, forming deltas, dunes or piles or rocky material called moraines.

The combined actions of weathering and erosion would eventually wear the surface of the earth into a smooth, low plain if it were not for the movement of the earth's plates. The plates are constantly shifting. building mountains and raising the land's surface in other ways.

EXPERIMENT: EROSION

(figure available in print form)

This experiment will show you the effects of rocks, plants and contouring on the way water erodes land.

MATERIALS NEEDED:
1. Something to use as a container. A paint roller pan is perfect, or try a dishpan, long wallpaper pan, baby bathtub, long plastic windowsill planter or planter trays, or old lasagna pan.
2. Piece of wood, 5 by 10 cm (2 by 4 inches) or a brick (if you are NOT using a paint roller pan)
3. Bucket of soil or sand; sandy soil works best
4. Trowel
5. Plastic knife, putty knife, or a flat stick for shaping the soil
6. Large nail
7. 2 paper cups
8. Water
9. Rocks, small blocks of wood, small clumps of moss, twigs from short-needled evergreen trees, lichens, pebbles, model railroad trees or any other objects that you can use to imitate plant growth

DIRECTIONS:.

1. If you are not using a paint roller pan, place the brick or piece of wood under one end of your container so that it will have a slope and water can drain away from the landform you will build.
2. Build a hillside at the high end of the container. Fill the entire end of the container, and build the hill at least 13 cm (5 inches) high.
3. Use the nail to poke four or five holes in the bottom of one of the paper cups. Space the holes evenly so that the bottom of the cup looks like a watering can spout. Fill the other paper cup with water.
4. For your first experiment, hold the holey paper cup about 30 cm (12 inches) over the hill, and put water into it from the other cup. Move your hand around so that the rain falls evenly on the hilltop. Watch to see what happens to the hill as rain falls on it. Draw a picture of the before and after.
5. Let the water drain to the low end of the container, then carefully pour only the water out. The soil should stay at the other end of the container. Now put the container back on its brick or piece of wood, and rebuild the fill. This time, add some rocks to the hill. Create another rain shower and watch what happens to the hill. Make notes or drawings.
6. Keep emptying water and rebuilding the hill each time you change the experiment. Try planting trees mad of moss or evergreen twigs; try contouring the hillside in different ways, much as farmers do when they plant crops on hillsides. Each time, build the hill as much as possible as it was built at first, and note what happens when it rains. Try placing some small blocks of wood (house) on the hillside in different places and watch what happens to them when it rains. What does this experiment show about the effect of plants, rocks and different kinds of contouring on erosion?

GLOBAL POLLUTION

(figure available in print form)

Heat energy radiated from the sun warms the earth’s surface. The earth radiates heat back into the atmosphere and into space, but at much longer wavelengths. Some of this heat is absorbed by molecules of polluting gases such as water vapor, carbon dioxide, methane, chloroflourocarbons and nitrous oxide.

This process warms the air and is called the greenhouse effect. Many scientists feel that by releasing more gases, we may change world climates. There are many uncertainties, and evidence of global warming is interpreted differently by scientists.

EXPERIMENT: DROWNING IN MELTWATER

(figure available in print form)

If global climates become very much warmer because of pollution, the ice at the poles could begin to melt. It is unlikely that this will happen on a large scale, but if it did sea levels would rise as they did at the end of the ice ages. This experiment will allow you to see what the result would be for low-lying islands and coasts.

MATERIALS NEEDED:

1. baking dish

2. water

3. ice

4. modeling clay

Directions:

> 1. Use some modeling clay to make a “continent” at one end of the dish, almost to the rim. Then make an “island“ in the middle of the dish, about half as high as the dish.
> 2. Pour water into the dish to make a “sea”. It should be high enough to leave only the top of the island above water. The continent remains dry, well above the water.
> 3. Pack as many ice cubes as you can on top of the continent, out of the water. Leave them to melt. The ice represents landlocked ice sheets, such as those over Antarctica. What happens to the sea level when the ice melts? What happens to the island as the water level rises?

(figure available in print form)

(figure available in print form)

(figure available in print form)

(figure available in print form)

(figure available in print form)

(figure available in print form)

GLOSSARY

(figure available in print form)

advancing	growing—A glacier advances due to an increased amount of snow in the area of accumulation
air mass	a large body of air, covering much of a continent or an ocean, throughout which the temperature, surface pressure and humidity are fairly constant
alpine glacier	mountain glacier formed and advancing through a pre-existing valley
barometer	an instrument for measuring atmospheric pressure
blizzard	a wind storm in which large amounts of snow are blown into the air from the surface and carried at high speed
centimeter (cm)	metric measure: 1 inch = 2.54 cm
chemist	scientist who studies properties of substances, how they are put together, and how they react with each other
climatology	the scientific study of climate, which is the weather typical of a region or the entire earth over a long period
condensation	the change from gas to liquid
continental glacier	ice sheet that covers a large part of a continent and moves out in all directions from a central region of accumulation
convection	the transfer of heat within a gas or liquid by the movement of the gas or liquid
cyclone	a body of air in which the pressure is lower than that of the surrounding air; another name for a depression or low (The name cyclone is also given to hurricanes near India and Australia.)
data	measurements or other factual information used as a basis to develop scientific theories
debris	loose fragments or rock, earth and other materials
denser	more compact
depression	a region of low atmospheric pressure (also called a low or cyclone)
diameter	length of a straight line drawn from edge to edge through the center of a circle
El Nino	a warm current, occurring every few years, that flows eastward across the Pacific, just south of the equator (El Nino is associated with a weakening of the trade winds)
equilibrium	a state of balance between opposing forces
erode	wear away
evaporation	the change from liquid to gas
force of gravity	attraction of bodies toward the center of the earth
geologist	earth scientist; one who studies the earth and the rocks of which it is formed
glacier	mass of ice with limited width and direction of movement
Greenhouse effect	the retention and build-up of heat in the lower atmosphere due to the absorption of long-wave radiation from the earth’s surface by molecules of such gases as water, vapor, carbon dioxide, nitrous oxide, and ozone
habitat	living space that supplies the needs of an animal or plant
heat capacity	the ratio of the amount of heat supplied to a body and the change in the temperature of the body. The higher the heat capacity, the more heat must be applied to raise the temperature.
hurricane	a severe tropical storm in which winds with winds in excess of 73 mph (116 km/h) blow around an area of intensely low pressure

ice age	span of geologic time, usually 1-3 million years, when the earth has had alternating warm and cold climates and been alternately covered and uncovered by glaciers
iceberg	huge mass of ice broken from a glacier, often found floating in water
meltwater	any water melted from snow or ice
meteorology	the study of all the processes that take place in the atmosphere and their relationships with processes at the surface of the earth—in particular, the study of weather
meter	metric measure of distance or length—1 meter = 39.37 inches
molecule	a chemical combination of two or more atoms (Some molecules are composed of thousands of atoms.)
monsoon	a seasonal change in wind direction bringing dry air or heavy rain (Monsoons affect much of southern Asia, northern Australia and western Africa.)
precipitation	amount of water that has fallen in the form of rain, snow, fog, hail and sleet
receding	melting of a glacier which makes the glacier appear to pull back or recede, especially when an alpine glacier seems to move back up the valley down which it had traveled
sleet	a mixture of rain and snow that falls when the temperature is around the freezing point
storm surge	a build-up of water levels along a coastline caused by longlasting strong winds (A storm surge coinciding with a natural high tide can cause widespread flooding.)
tornado	a violently rotating column of air, usually less than 330 ft. (100 m) in diameter, surrounding a core of extremely low air pressure
typhoon	a hurricane that occurs in eastern Asia

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PACING CHART

(figure available in print form)

Week	Day	Activity
1	1	Introduce *A House for Hermit Crab*
	2	Review *A House for Hermit Crab* and review vocabulary
	3	Make a "What We Know" chart about the seashore
	4	Make a "What We Would Like to Know" chart about the seashore
	5	Introduce "A House for Hermit Crab" Fish Game
2	1	Introduce "A House for Hermit Crab" Concentration Game
	2	Introduce "A House for Hermit Crab" Old Crab (Old Maid) Card Game
	3	Introduce Seashore Concentration
	4	Introduce Seashore Bingo
	5	Introduce "Habitat" song
3	1	Review/ Time to Choose a Seashore Game
	2	Additional time for Seashore Games
	3	Make a "What We Have Learned" chart about the seashore
	4	Pizza "Cut Up The World" Activity
	5	Fraction Activity
4	1	Introduce continents
	2	Continental Twist
	3	Introduce Continental Concentration

	4	“Match the Word with the Continent” Worksheet
	5	“Locate the Continent on the Earth” Worksheet
5	1	Introduce Continental Shelf Map & Map Puzzle
	2	Introduce Pangaea, Laurasia & Gondwana Map Sequence/Sequence Worksheet
	3	Puzzle Worksheet
	4	Pangaea, Laurasia & Gondwana Experiment*
	5	Mountain Building Experiments*
6	1	Review/Add to (L) chart
	2	Choice Time of previous games/ activities taught
	3	Introduce the Earth as a Geosphere
	4	Matching words to landform
	5	Geosphere Worksheet
7	1	Picture Lotto
	2	Picture Word Match
	3	Word Picture Match
	4	Landform Concentration
	5	Landform “Fish” Card Game
8	1	Choice time on Geosphere games taught
	2	Ditto
	3	Ditto
	4	Layered Book of Earth’s Features
	5	Review & add to (L) chart
9	1	Introduce the earth has a hydrosphere
	2	Match words with areas of water
	3	Worksheet
	4	“Where is Water Found?” Worksheet
	5	Review & add to (L) chart
10	1	Introduce Wind & World Wind Map
	2	Introduce measuring the wind & Beaufort Wind Scale
	3	“Name That Force” Worksheet
	4	Flowing Wind Experiment*
	5	“The Wind Blows” Activity Sheet
11	1	Make a Pinwheel
	2	Review & add to (L) chart
	3	Introduce Hurricanes
	4	Model Hurricane Experiment*
	5	Storm Surge Experiment*
12	1	Review & add to (L) chart
	2	Introduce Ocean Currents & Map
	3	Deep-Water Currents Experiment*
	4	Review & add to (L) chart
	5	Choice time for previous games and/or activities
13	1	Introduce Tidewater Basins

	2	Tidewater Basin Activity
	3	Review & add to (L) chart
	4	Introduce El Nino & ENSO Event Map
	5	ENSO Diagram & Making Your Own El Nino Experiment*
14	1	Introduce Monsoons & Alternating Monsoon Winds Map
	2	Monsoon Mud Madness Experiment*
	3	Review & add to (L) chart
	4	Choice Time
	5	Choice Time
15	1	Introduce Heat & Temperature
	2	Convection: Warming Fluids Experiment
	3	Heat Conduction Experiment*
	4	Review & add to (L) chart
	5	Choice Time
16	1	Introduce volcanoes
	2	Volcano Model Experiment*
	3	Activity Sheet “Eruption”
	4	Review & add to (L) chart
	5	Choice Time
17	1	Introduce Erosion
	2	Erosion Experiment*
	3	Wind Erosion Experiment*
	4	Water Erosion Experiment*
	5	Ice and Glacier Erosion*
18	1	“Agent Erosion” Worksheet
	2	Review & add to (L) chart
	3	Introduce Global Pollution
	4	Drowning in Meltwater Experiment*
	5	Introduce”You Can’t Eat the Oysters” song
19	1	Review & add to (L) chart
	2	Choice Time
	3	Finale Jeopardy Game (Teams)
	4	Choice Time
	5	Jeopardy Game (Teams)

This is a tentative schedule in which some activities may be eliminated or some activities like proposed field trips may be added. In essence, it is just a working model.

*Ðexperiment

ADDITIONAL RESOURCES

The American Museum of Natural History, New York City, (212) 769-5100

The Maritime Center, IMAX Theater, Norwalk, CT, (203) 852-0700

The Peabody Museum, Whitney Avenue, New Haven, CT 06510, (203) 432-5050

SCHOONER, INC., 60 South Water Street, New Haven, CT 06519, (203) 865-1737

Mystic Aquarium, Mystic, CT 06355 9860) 572-5955

Save the Sound, Inc., 185 Magee Avenue, Stamford, CT 06902, (203) 327-9786

EPA Long Island Sound Office, Marine Science Research Center, SUNY, Stony Brook, NY 11794

Project SEARCH, Office of Environmental Education, CT Department of Environmental Protection, 79 Elm Street, Hartford, CT 06106

New England Guide to Environmental Educational Facilities and Resources , Roxbury Street, Keene, N.H. 03431

Directory of Natural Science Centers , 763 Silvermine Rd., New Canaan, CT 06840

Mr. & Mrs. Fish (marine educ. program), SMVTI Fort Rd., S. Portland, Me. 04106

A Way With Waste : A Waste Management Curr. for Schools, Washington State Dept. of Ecology, 4350 150th Ave. NE Richmond, WA 98052