
APPLES AND OCEANS

FOR THE TEACHER

Discipline

Earth Science

Themes

Energy; Systems and Interactions

Key Concept

Our earth is a water planet covered by one interconnected world ocean which circulates around all the continents.

Synopsis

Students use an apple and a pie chart to represent the planet. They slice the apple and draw the chart into sections illustrating the small amount of drinkable water on land, and the small portion of the ocean that is highly productive.

Science Process Skills

communicating, comparing, measuring, organizing

Social Skills

checking for understanding

Vocabulary

photic zone
productivity

photosynthesis
upwelling

neritic

MATERIALS

For INTO the Activities:

small and large ocean-related pictures and other visuals
brainstorming chart paper for class (*see pattern*)

(*Note: all charts can be made on chart paper, the chalkboard or an overhead projector*)

Optional:

Ocean sounds audiotape (e.g., *Gentle Ocean* from Nature Co.)
Ocean images videotape (e.g., *Worlds' Below* from Sea Studios)

For THROUGH the Activities:

poster "Our Human Body and Our Ocean Planet" (*see pattern*)
poster "The Planet as an Apple" (*see pattern*)
extra-large plastic blow-up globe (optional, available from TAP Plastics stores)
or large map of world

For each pair of students and one for teacher demo:

- one apple
- dull knife (plastic or butter)
- full-size paper plate (sturdy Chinette are best)
- colored markers, three or four colors
- paper towels

Optional:

- chart or butcher paper
- scissors
- 8.5" x 11" plain paper for mini-book

INTRODUCTION

Our world is a water planet with nearly three quarters of the earth's surface covered with ocean. Looking at a globe from the perspective of the vast Pacific Ocean, it appears obvious that our Planet Earth should more appropriately be named Planet Water. The Southern Hemisphere, with only one third of the land area on earth, could more realistically be called the Oceanic Hemisphere. The ocean is the one feature which distinguishes our planet from all others in the solar system. The ocean allows for life to exist, makes our climate habitable, provides much of our oxygen and food, and transports nutrients, cultures and pollution around the globe.

Sailing the seven seas is a statement often used throughout maritime history and literature. However, in our modern world the consequences of our actions are often global, so it is more important than ever to consider that there is essentially only one ocean. What is put into one "sea" may very well end up on the beach of another halfway around the world. Looking at a globe from a South Polar perspective, the marine environment can easily be seen as one interconnected ocean system. The Antarctic continent can be viewed as being surrounded by an "Antarctic Ocean" with three large "extensions," the Atlantic, Pacific and Indian oceans. Other smaller oceans and seas, such as the Arctic and the Mediterranean Sea, can be considered to be tributaries of these larger oceans. Although we may think of the ocean as separating continents, it really connects and links them.

Connected by surface and bottom currents, acting in many respects like the circulatory system of our human bodies, seawater and marine organisms are carried throughout the ocean. Trash from all over the west coast of North America washes up on the remote South Pacific island of Laysan; and cold, salty, nutrient super-rich water from Antarctica sinks and is pushed along the ocean floor all the way to Newfoundland, Canada where it finally upwells around the steep sides of the Grand Banks, creating one of the largest localized fishing areas in the world. The currents insure that the proportions of the major constituents in seawater (salts) remain constant throughout the world ocean, even though their total abundance may differ from place to place. Not only is the composition of seawater the same in any part of the one world ocean, but there is also a vital similarity between the chemical composition of seawater and that of the body fluids of all organisms. Most of the more abundant elements of seawater are also important components of all organisms.

The vast ocean may appear to be a limitless resource, but there are huge areas of open ocean that support very little life and are considered to be deserts. Only a small proportion of the entire ocean is actually considered to be highly productive. About 10%, over the continental shelves, supports large concentrations of phytoplankton, the base of the food web. Worldwide, over 90% of human fishing effort is concentrated in these coastal or neritic zones along the margins of the continents. Within the neritic zone are a small handful of intensely productive areas, where deep, cold, nutrient-rich waters are upwelled or brought up to the surface. Once at the surface, these nutrients act as fertilizer to stimulate blooms of drifting plants or phytoplankton living in the sun-lit surface waters. The depth to which light penetrates varies from less than one meter in turbid estuaries to over 100 meters in clear open ocean waters. This thin surface layer where photosynthesis occurs is called the photic zone.

The major upwelling areas supporting intense, seasonal blooms of phytoplankton occur off the west coasts of North America, Peru, Africa and Australia. Phytoplankton form the base of the food pyramid and are grazed by zooplankton that are eaten by fish that are eaten further up the food pyramid by hundreds of thousands of seabirds, pinnipeds, whales, sharks and other predators. It is also these productive zones where the greatest fisheries in the world are located. These rich upwelling areas represent only about 1/1000 of the ocean or 3/4000 of the earth.

It is not too strong of a statement to say that the intense upwelling along the California coast was the most compelling reason for the establishment of four National Marine Sanctuaries: Cordell Banks, Gulf of the Farallones, Monterey Bay and Channel Islands. Northern and central California are visited each summer by feeding blue, humpback and other whales that take advantage of the huge blooms of fish and zooplankton.

INTO THE ACTIVITIES

Ocean Sounds Audiotape and Ocean Images Videotape

Use audiotapes of ocean sounds and videotapes of ocean images without narration to create an ocean mood.

Partner Parade or Silent Mingle

Partner Parade: Use ocean-related visuals (posters, video scenes or pictures of animals, seascapes, waves, people using or enjoying the ocean) one at a time as prompts for students to discuss what they know about each image.

Silent Mingle: Have students "mingle" around ocean-related visuals such as posters on walls and pictures, books or models on the tables. Have students travel from item to item until you give the signal to stop. Students then quickly pair-up with someone nearby and discuss the closest item.

After the Partner Parade or Silent Mingle, have each student jot down in words or pictures all s/he can recall from the discussions. Have students check each others "notes" for common understanding.

Small Group Brainstorming/Clustering

Provide each group of four students with a variety of ocean-related pictures and have them use the visuals as prompts to brainstorm and record some of the things they already know about the ocean.

Have students organize and sort the ideas they have recorded to create an ocean cluster diagram. Possible categories include *human uses, animals, plants, geography, physical features, aesthetics, etc.*

Have student groups share their cluster diagrams, holding up pictures as they describe their clusters. Record these ideas on the class brainstorming chart (see pattern below) or on the board.

Poster: Class Brainstorming

Portfolio Assessment

Teacher observation or student self-assessment of participation in each task. Written (pictures or words) individual and group record from each task.

- Group Cluster Diagrams
- Teacher observation of "Checking For Understanding"

THROUGH THE ACTIVITIES

Part 1: One World Ocean

Use an extra-large plastic blow-up globe, regular globe or large wall map to show the relationship between the planet's land masses and ocean from different perspectives; e.g., show the world from the Pacific Ocean and then from the South Pole.

Begin to talk about **Planet Ocean** rather than **Planet Earth**. Point out that although we usually think of many oceans, there is really just one huge ocean. Also, point out that the ocean does not separate the continents, it really connects and links them.

Use the prepared poster (see pattern below) to begin to draw a comparison between the planet and our own human bodies. Add the corresponding information about the planet and human body to the poster as each is discussed as follows:

- Approximately 3/4 of the planet is covered by water; approximately 3/4 of the human body is water.
- Approximately 1/4 of the planet is covered by land or continents;
- Approximately 1/4 of the human body is muscle, bone, and other hard tissue. The hard parts of our body are made up of the same minerals as are the continents. Our blood and all our other bodily fluids are close to the same salinity as ocean water.

The ocean can be compared to our circulatory system. Whatever we put into our bloodstream, no matter whether it enters through a vein in our arm or an artery in our neck, is almost immediately distributed equally throughout our entire body. We can feed our body quickly with intravenous glucose or we can poison it just as fast with drugs or alcohol. Similarly, whatever we dump in the ocean, whether it is nutrient from sewage or oil from a wrecked tanker, will eventually be distributed equally throughout the entire ocean system. Wind and density-driven currents are the forces that globally mix ocean water from top to bottom and from hemisphere to hemisphere. Now add a circulatory system to the human body and currents to the ocean on the poster.

Poster: Our Human Body and Our Ocean Planet

Part 2: The Planet as an Apple

Have students sit side by side with a partner. All materials should be cleared off their table except an apple, a knife, a paper plate, a paper towel and a number of colored markers. One of the partners will be the **land** and cut the

apple first. The other partner will be the **ocean** and will draw and label the plate first. Partners will switch jobs in the second part of the activity.

Demonstrate each step before students proceed. Have students hold up their apple slices and plates so that you and their partner can check them for understanding.

Use the poster: "The Planet as an Apple" as a visual record of the information you present (see pattern below). As you and the students make each slice in the apple and on the plate, add the corresponding fractions to the poster.

Poster: The Planet as an Apple

The Land

Cut the apple into four equal pieces from top to bottom. Three of the pieces represent the three quarters of the world that is covered by ocean. Set these 3 pieces aside for the ocean part of the activity. The remaining quarter represents the land, or area not covered by ocean.

After the land partner cuts the apple, the ocean partner follows the teacher demonstration of how to divide the paper plate (using a colored marker to draw a cross through the center of the plate) into four equal quarters, labeling three of them "ocean" and one "land".

Now cut the one quarter of the apple representing the land into two equal pieces. Hold up one piece ($\frac{1}{8}$ of the world). This piece represents the land that is too dry, too wet, too cold, or too hot for people to live there. This is uninhabitable land (mountaintops, river basins, deserts, etc.). Set this piece aside, and hold up the other piece that represents the habitable land.

Draw a line dividing the $\frac{1}{4}$ piece representing the land on the paper plate in half. Label one of the resulting $\frac{1}{8}$ pieces " $\frac{1}{8}$ Uninhabitable" and the other " $\frac{1}{8}$ Habitable". Or draw a picture of a person in one piece and a person with an **X** through it in the other.

Cut the $\frac{1}{8}$ piece representing the habitable land into four equal pieces. Set aside three of these pieces. Hold up the remaining piece. It represents the portion of the habitable land on which we are able to grow food.

Divide the $\frac{1}{8}$ piece on the paper plate representing the habitable portion into four slices. Color one of the resulting $\frac{1}{32}$ pieces to represent the habitable land on which we can grow food. Label this with an arrow pointing to the colored in slice " $\frac{1}{32}$ All Our Farm Land"

Take this $1/32$ piece and cut off the thinnest slice possible and hold it up. This tiny slice (which is still too big) represents $3/100$ of 1% ($3/10,000$) of the earth's surface. This area supplies all of our drinkable water.

Show the drinkable water on the plate as a dot in the section colored in to represent the area on which we can grow food. Label this dot "3/100 of 1% Drinkable Water". All life on land, including human life depends on fresh water for survival, and look how little of it there is. Discuss conservation issues with students such as: drought, pollution, water diversions, water use and waste, etc.

The Ocean

Set aside the land (save the drinkable water!) and return to the three quarters of the apple representing the ocean. Have the partners switch jobs so that the ocean partner is now cutting the apple and the land partner is drawing on the paper plate.

Take one of the three pieces representing the ocean and cut it in half. Take one of the halves and cut it in half again. Hold up one of these small pieces. This piece, a sixteenth of the world's surface (or 9.9% of the ocean), approximately represents the productive coastal or neritic zones of the ocean. Over 90% of the world's fisheries occur in this slice. Though we think of the ocean as a vast, infinite resource, most regions of the world's ocean are not very productive; there is little life in these areas, and we consider them deserts. Only this small slice is considered even moderately productive. This area of concentrated ocean productivity is found over the shallow continental shelves.

Draw a line that divides one of the quarters on the plate marked "ocean" in half. Then draw another line dividing one of these eighths in half. Color in and/or label one of the halves "1/16 Productive Coastal (or neritic) Zone" or draw a fish in it.

Take one of these $1/16$ pieces and cut off a thin slice. This tiny slice represents $3/4000$ of the world's surface (or $1/1000$ of the ocean). Hold up this tiny slice. It represents the tremendously productive upwelling areas found within the coastal zone. Explain that upwelling is a process that brings nutrient-rich water from deep down up to the surface during some seasons on the west coasts of four continents. The highest concentrations of productivity are found in upwelling areas--these are by far the richest areas of the world ocean, the destinations for migrating birds, pinnipeds and whales. One of these upwelling areas is found along the Pacific Coast of North America, one of the richest regions of the ocean. This means that roughly $1/4$ of the entire world's upwelling zones lie off our coast between Alaska and Baja California. We are responsible for caretaking and sharing this huge and vital world resource.

Show the rich upwelling zone on the paper plate as a dot within the coastal zone. Label it with an arrow. Note that about 1/4 of the upwelling areas are along the west coast of North America.

Now take a larger slice of apple still representing part of the ocean. Peel off a piece of the apple skin and hold it up. This piece of skin, though it is too thick to be truly accurate, represents the photic zone, the top 100 meters or 330 feet through which light can penetrate and support photosynthesis. All seaweed and plant or phytoplankton live and grow in the photic zone. Since they form the base of the ocean food pyramid, all life in the ocean depends on the photic zone. Almost all of the life in the ocean is concentrated in this narrow region below the surface of the sea, and while there is photosynthesis going on across the entire ocean, it is occurring at a much more prodigious rate in the coastal zone.

Show the photic zone on the paper plate as a dot or two in each of the sections of the ocean. Label these dots "Photic Zone".

Now look at your tiny slices in relation to the rest of your apple. One represents our drinkable water, the resource necessary for all life on land; one represents all of the upwelling zones, the most productive places on Earth; and the peel of the apple represents the all important photic zone, where all of the ocean's primary productivity takes place. These three minute and fragile pieces of our planet support most of its life. They also represent the parts of the land and ocean that humans impact the most.

Part 3. Text Reconstruction

Class Planet Brainstorm

Have each pair of students join another pair to discuss the results of the demonstration/activity. Have each group brainstorm five new things they learned about the planet, the land, or the ocean in the lesson. Have the groups share their ideas with the class as you write them on a class brainstorm chart. Compare the results with the class chart you made before beginning to cut the apples. Have each student write a narrative description of what is represented on their pie chart.

Student Posters

Have each group select one of the following topics or one of their own to discuss and to represent graphically on a poster. Have the groups share their posters with the whole class. Topics:

Why don't many animals and plants live below the photic zone? What do you think they eat if they do live there?

What are some ways we depend on the small amount of drinkable water that is available to us? How many different ways do we use this water?

What are some ways we depend on the narrow photic zone of the sea? How do we use this zone?

What are some ways we can take care of these important resources?

Mini-Book on the Ocean

Have individual students create a mini-book which includes words and graphic information about what they learned. Have students fold an 8.5" x 11" sheet of plain paper lengthwise and then into thirds. Open it up again so that it is only folded in half lengthwise with the fold at the top. On one half only, cut along the two small folds, to form three flaps that open vertically.

Fold the right third to the center, and the left third on top of it. With the book folded shut and only the "cover" showing, have students write a name for their book on the cover and illustrate it. Open the cover (from right to left) and on the first "page" write the author's name. Turn the title page (from left to right) and label one section or chapter "The Planet", one "The Land", and one "The Ocean". Now flip up each chapter and draw a picture in one subsection and write text in the other.

Have students share their book with a partner and check each other for accuracy and understanding.

Portfolio Assessment

Teacher observation of participation in brainstorming and small group work

Paper plate pie graph with narrative interpretation

Student Posters

Individual Mini-Book

Audio/videotapes of student retelling and discussion

Group/Individual Rating Sheets for "Checking for Understanding"

BEYOND THE ACTIVITIES

Extended Experiments/Activities

Have students work in cooperative groups to complete one of the following activities. Have each group present the results of its work to the entire class.

(a) List and discuss all the ways you can conserve drinkable water at school and at home.

(b) Look at a rainfall map of the world in an atlas and a regular map or globe showing rivers and lakes. What regions have the most drinkable water? The least? How does this affect people's lifestyles?

(c) Do some research on upwelling. What causes it? Where does it occur? What animals are associated with upwelling areas? What happens during an El Niño year?

(d) Research and discuss the myths and stories about the open ocean which exist in several cultures. What do different cultures believe about the ocean? What do these say about the importance of and relationship between the ocean and their culture?

(e) Write to a National Marine Sanctuary office to obtain information about the Sanctuary system. Where are all the sanctuaries? When and why were they designated? What special plants and animals occur in each?

Debriefing

Have cooperative groups discuss what helped them accomplish their tasks successfully and what were road blocks to their progress. Did Checking for Understanding help?

Have students make a class list or chart with visual representations of "helpers" and "road blocks".