

Earth: The Ocean Planet Teacher's Guide



This Teacher's Guide is designed to help you, the teacher, better prepare your class for their upcoming visit to the Northern Stars Planetarium when it visits your school. The presentation that you have chosen for your class takes a close look at the most dynamic aspect of the planet Earth--its oceans. We will begin by examining how people have explored the ocean's depths throughout history, from using sounding equipment to submersibles. The students will learn of the unique environment that is the ocean's floor. The oceans will be shown to be a dynamic place with continual motion from evaporation, heating, cooling, currents, and tides. We will also examine the web of life found in the oceans from plankton to great whales, with a special emphasis on the strange creatures found in the deepest abyss.

PRESENTATION OUTLINE: or what you can expect will be covered in the show

- I. Overview: Earth, the water planet.
 - A. Is all water the same?
 - B. Where is all the water?
 - C. The water cycle.
- II. What would Earth look like without water?
 - A. World Map without water.
 - B. Depths of the world oceans and contours of the ocean's floor
- III. Human exploration of the seas.
 - A. *Challenger* expedition
 - B. Diving
 - C. Submersibles
 - D. Sonar
 - E. Satellite
- IV. How and Why the Oceans Move
 - A. Waves
 1. Waves caused by winds
 2. Tsunamis-waves caused by earthquakes and volcanoes
 - B. Tides and the Moon
 - C. Ocean Currents
 1. Wind
 2. Coriolis Effect
- V. Strange Creatures of the Deep
 - A. Food cycles--The Food chain, eat and be eaten.
 - B. The deep sea creatures



Glossary

Abyssal Plain The vast relatively flat area on the sea floor that spreads from the mid-ocean ridge to the edge of the continents.

Algae A simple form of plant life.



Antarctic The very cold southern regions of the Earth surrounding the south pole.

Arctic The very cold northern regions of the Earth surrounding the north pole. The Arctic is covered by the Arctic Ocean. Since water retains heat better than land, it is slightly warmer than the Antarctic which is covered with the land mass of Antarctica.

Bathysphere A spherical shaped submersible vessel that scientists used in the 1930's for studying deep sea life.

Bioluminescence Some sea creatures have special organs in their bodies that make them glow in different ways. This is most commonly found in deep sea creatures such as *Angler Fish* and *Lantern Fish*, but is also produced by some forms of plankton that live on the ocean's surface.

Continental Shelf A flat shelf of submerged land that projects out into the sea from the shore.

Continental Slope The slope that drops off from the continental shelf to the abyssal plain.

Coriolus Effect The apparent curving motion of wind and ocean currents due to the Earth's rotation. In the northern hemisphere currents tend to move to the right, in the southern hemisphere currents tend to move to the left.

Ocean Currents A "Rivers of Water" that flow in the oceans. There are two types of ocean currents: 1) warm surface currents that are usually caused and directed by prevailing winds. 2) cold submerged currents which are caused by temperature and density variations.

Gyre A large circular or spiral motion of moving water in the ocean. There are five great *gyres* in the world's oceans. They are driven by winds. In the northern hemisphere they move clockwise, while in they southern hemisphere they move counter-clockwise.

Mid-Oceanic Ridge A mountain range that runs for 40,000 miles on the bottom of the world's oceans. In the Atlantic it is called the Mid-Atlantic Ridge, but it actually encircles the entire globe.

Glossary Continued



Navigation The science of directing the course of a ship across the sea.

Oceanographer A person who studies the oceans.

Oceanography The science of the structure and workings of the oceans.

Plankton Small, often microscopic drifting creatures. There are two types: **Phytoplankton** small drifting plants, **Zooplankton** small drifting animals.

Prevailing Winds Winds that generally blow in the same direction. They create most of the world's surface currents. **Trade winds** are the prevailing winds of the tropics, while **westerlies** are the prevailing winds for mid latitudes like we have here in Maine.

Salinity The total amount of salt and dissolved minerals in the water. The higher the salinity, the saltier the water.

Sonar The use of sound to explore under the sea. Sound travels better through water than it does through air. By sending sound waves to the bottom, an echo comes back telling us the depth, as sound will take longer to come back from a greater depth than a shallower depth.

Tide The rising and falling of the ocean's levels, caused by the gravitational pulling of the Moon, and, to a lesser degree, the Sun.

Trenches Trenches are very deep valleys on the ocean's floor. They are the lowest spots on Earth. The deepest trench is the Mariana Trench in the Pacific (35,800 feet deep).

Tsunami A huge sea wave that is triggered by an undersea earthquake or volcano. A tsunami poses little danger to vessels at sea as it will be little more than a large swell. When the swell reaches shallow water, the wave will break as a huge wall of water resulting in great destruction when it reaches the shore.

Waves The movement of energy through the water. Most waves (except Tsunamis) are caused by wind. Waves do not physically move the water sideways. The wave moves through the water, but the water itself only rides up and down over the waves. The only time a wave will move water sideways is when it hits the shore.



Did you Know...

1. The oceans hold 48,000,000,000 (*that's 48 Billion!*) cubic feet of water? That's 1,358 cubic decimeters for you metric fans.
2. The deepest part of the ocean is the *Mariana Trench* in the western Pacific? It's depth is 35,620 feet (10,860 meters). If you dropped Mt. Everest into it, it would sink a mile beneath the surface before it hit the bottom!
3. The Gulf Stream carries 30 Billion gallons (135 billion liters) of water every second? That's over six times more water than all the rivers in the world combined.
4. That 98% of the sea's floor has yet to be explored?
5. If you dried all the salt out of the world's oceans there would be enough salt to cover the entire surface of the earth to a depth of nearly 150 feet?
6. The average depth of the world's oceans is 10,970 feet (3,344 meters), that's over 2 miles deep (over 3 kilometers)?
7. That some creatures in the sea can *Fall Up?* These creatures live under miles of water. The water pressure is so heavy that they are especially adapted to live in this environment in which we would be crushed. But they must also stay in the deep dark depths. If they venture too far up, their swimming bladders expand so fast that they cannot swim back down; instead, they *fall up!* Unfortunately they cannot survive in the low pressures found at the surface, so this is a deadly fall.
8. The total weight of the world's ocean water is approximately 1,450,000,000,000,000 tons? That's 1 Quintillion, 450 Quadrillion tons of water. Remember 1 ton = 2000 pounds.
9. That tsunamis or tidal waves can travel across the ocean at over 600 miles per hour? When they hit shore the wave can break with a height of over 100 feet.
10. That the largest wind wave ever measured and recorded was 112 feet high? It was recorded by the American Tanker *USS Ramapo* in the South Pacific in 1933.
11. That that largest creature to ever live on Earth (even bigger than the dinosaurs) is the *Blue Whale?* Yet this giant creature only eats krill and plankton, but it eats 4 million krill a day--that's 4 tons per day. Blue whales grow to be between 80 and 100 feet long, and can weigh up to 180 tons. Its tongue alone weighs as much as an elephant!

Study Questions

Use the *Vital Statistics of the World's Oceans* Table on page 8, and the *Glossary* found of page 2.

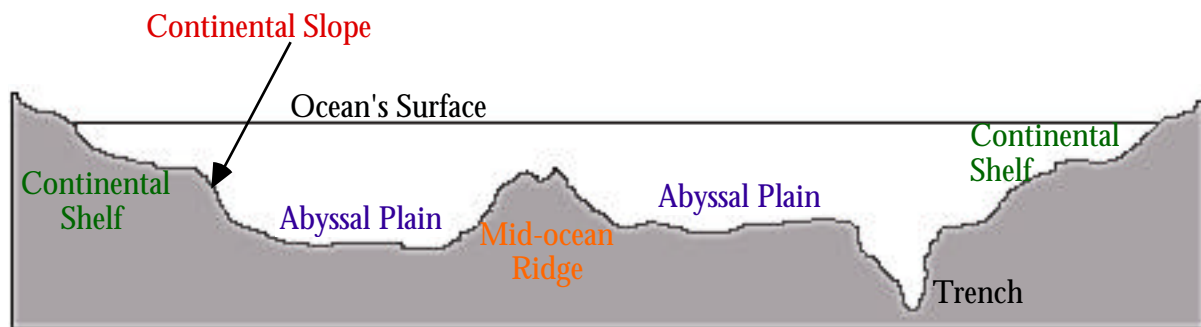
1. If you dried all the salt out of the world's oceans there would be enough salt to cover the entire surface of the Earth to a depth of: a) 5 feet b) 20 feet c) 50 feet d) 150 feet e) 500 feet
2. Which ocean is the largest? a) Atlantic b) Pacific c) Indian d) Arctic
3. Which ocean is the smallest? a) Atlantic b) Pacific c) Indian d) Arctic
4. SCUBA (Self Contained Underwater Breathing Apparatus) diving equipment was developed in 1943 by what famous French undersea explorer? a) Napoleon Bonaparte b) Jacques Cartier c) Jacques-Yves Cousteau d) Christopher Columbus
5. Tides are the rising and falling of the ocean's surface due to the pull of: a) Sun b) Jupiter c) Moon d) Moon and Sun combined e) Moon and Sun and Jupiter combined. f) a black hole
6. Which ocean has the deepest spot? a) Atlantic b) Pacific c) Indian d) Arctic
7. Which ocean is the shallowest? a) Atlantic b) Pacific c) Indian d) Arctic
8. True or False Tsunami's or tidal waves are caused by storm winds.
9. True or False The Gulf Stream is the world's largest ocean current.
10. What are the most common fish in the world? a) tuna b) cyclostomes c) haddock d) sharks e) cod
11. True or False Water from the Atlantic Ocean will never naturally go to the Pacific Ocean.
12. True or False Spring tides only happen in the spring of the year.
13. Ocean currents move in ocean-sized circular motions called gyres. In the northern hemisphere these circles move: a) clockwise b) counter-clockwise



Answers: 1. d 2. b 3. d 4. c 5. d 6. b 7. d 8. False (they are caused by undersea earthquakes or volcanoes) 9. True 10. b
11. False 12. False 13. a

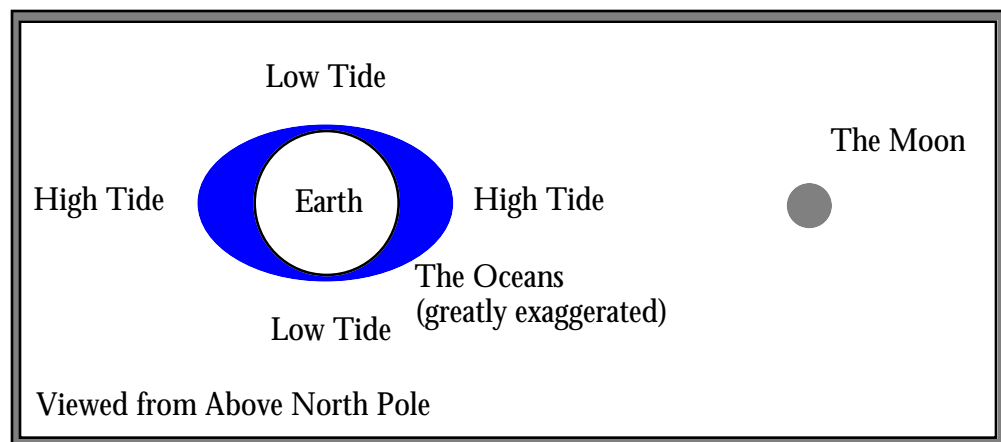
The Ocean Floor

The ocean floor has several different parts. We have only explored about 3% of the oceans floors. Much of what we do know comes from the use of *sonar*. Ships on the surface send sound waves down towards the bottom. By timing the echoes that come back, they can tell the depth and contours found there. The floor of the ocean might look like this in cross-section:



The Pull of the Tides

The rising and falling of the ocean's surface every six hours or so is called the tides. The tides are caused by the gravitational pulling of the Moon and, to a

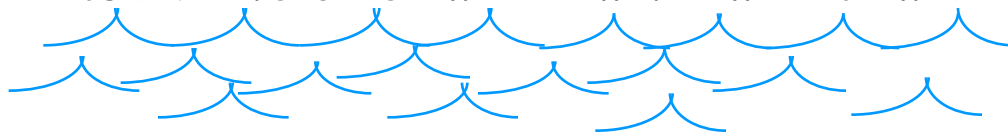


lesser degree, the Sun. There are always two high tides and two low tides. The high tides are on the sides of Earth facing the Moon and opposite the Moon. This opposite tide is caused by the centrifugal force away from the Moon. Low tides are found on the sides at 90° angles from the Moon. When the Sun is in line with the Moon, the tides are more extreme, the high tides are higher and the low tides are lower. These extreme tides are called "*Spring Tides*". Spring tides have nothing to do with the season. When the Sun is at 90° angles to the Moon, the tides are slightly moderated so that the highs aren't so high and the lows aren't so low. These tides are called a "*Neap Tides*".


Oceans Word Search

Try to find the words listed below hidden in the puzzle.
 Words will be found horizontally, vertically, and diagonally. Good Luck!

ABYSS AIR ARCTIC ~~ATLANTIC~~ CONTINENTAL SHELF CURRENT CYCLE
 DEEP DIVER FISH GULF STREAM GYRE HEAT ICE INDIAN LEE
 MOON NEAP OCEANOGRAPHY PACIFIC PLANKTON RIDGE SALT
 SCUBA SEA SHIP SONAR SUBMARINE SUN TIDE TRENCH
 TSUNAMI VOLCANO WATER WAVE WHALES WIND



	A			T				O			P				
	S	E	A		R	V	D		A	I	R		L	E	E
C	D	I	V	E	R	K	A	B	Y	S	S	R	T	G	A
K	O	R	C	T	Q	S	R	S	K	T	A	I	S	U	C
P	C	N	L	S	U	O	C	J	C	I	G	D	U	L	X
S	E	A	T	L	A	N	T	I	C	U	Z	G	N	F	P
Z	A	U	I	I	Q	A	I	W	L	K	B	E	A	S	V
M	N	L	D	P	N	R	C	M	H	R	V	A	M	T	O
B	O	P	E	L	W	E	W	U	H	A	H	J	I	R	L
H	G	O	Y	A	X	W	N	L	R	U	L	R	G	E	C
O	R	F	N	N	S	A	L	T	P	R	D	E	H	A	A
W	A	V	E	K	B	T	T	H	A	W	E	T	S	M	N
J	P	M	A	T	H	E	A	T	C	L	Z	N	S	R	O
S	H	I	P	O	S	R	Z	N	I	C	S	O	T	D	V
G	Y	R	E	N	U	O	M	Y	F	I	S	H	V	Z	E
Y	X	T	R	E	N	C	H	O	I	D	W	K	E	U	D
I	N	D	I	A	N	G	J	E	C	B	E	P	J	L	X
C	Y	C	L	E	O	W	I	N	D	X	B	E	M	Z	F
E	B	S	U	B	M	A	R	I	N	E	N	G	P	K	D

 Vital Statistics of the World's Oceans Source: Compton's Interactive Encyclopedia V.2.02 ©1994					
Oceans:	Pacific:	Atlantic:	Indian:	Arctic:	OCEAN TOTAL:
Volume in Cubic Miles	169,749,500	77,609,600	69,821,000	4,073,700	321,253,800
Volume in Cubic Kilometers	707,549,900	323,492,300	291,027,900	16,980,000	1,339,050,100
Area in Square Miles	63,801,600	31,830,700	28,356,200	5,440,200	129,428,700
Area in Square Kilometers	165,245,400	82,441,100	73,442,200	14,090,100	335,218,800
Average Depth in feet	14,052	12,874	13,000	3,954	10,970
Average Depth in meters	4,283	3,924	3,963	1,205	3,344
Maximum Depth in Feet	35,800	27,498	26,400	17,899	35,800
Maximum Depth in Meters	10,900	8,381	8,050	5,456	10,900

Math problems for older students:

Use the Table above to answer the following questions:

1. A mile is 5280 feet. How many miles deep is the deepest part of the Pacific Ocean? The Atlantic? The Arctic? The Indian?
2. The Pacific Ocean contains the largest volume of water of any ocean. If you added the other three oceans together, which would have more water--the Pacific or the total volume of all the other oceans combined?
3. The Pacific Ocean covers the largest area of any ocean. If you combined the areas of the other three oceans, which would cover the greatest area--the Pacific or the total area of the others combined?
4. The Marianas Trench is the deepest spot in the Pacific. How much deeper is it than the average depth of the Pacific?
5. If the Indian Ocean has a deeper average depth than the Atlantic, then how can the Atlantic have a greater volume?



Water on Earth

Where is it?

Imagine if *all the Earth's water* were represented by a 55 gallon drum.
Ask your students how much of that water would be divided up in these different categories:

1. The oceans
2. Freshwater Lakes
3. Rivers
4. Salt water lakes and inland seas
5. The Atmosphere
6. Ground water
7. Ice caps & Glaciers
8. Vadose--or moisture in the soil above ground water.

Rank which categories have the most water to the least.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

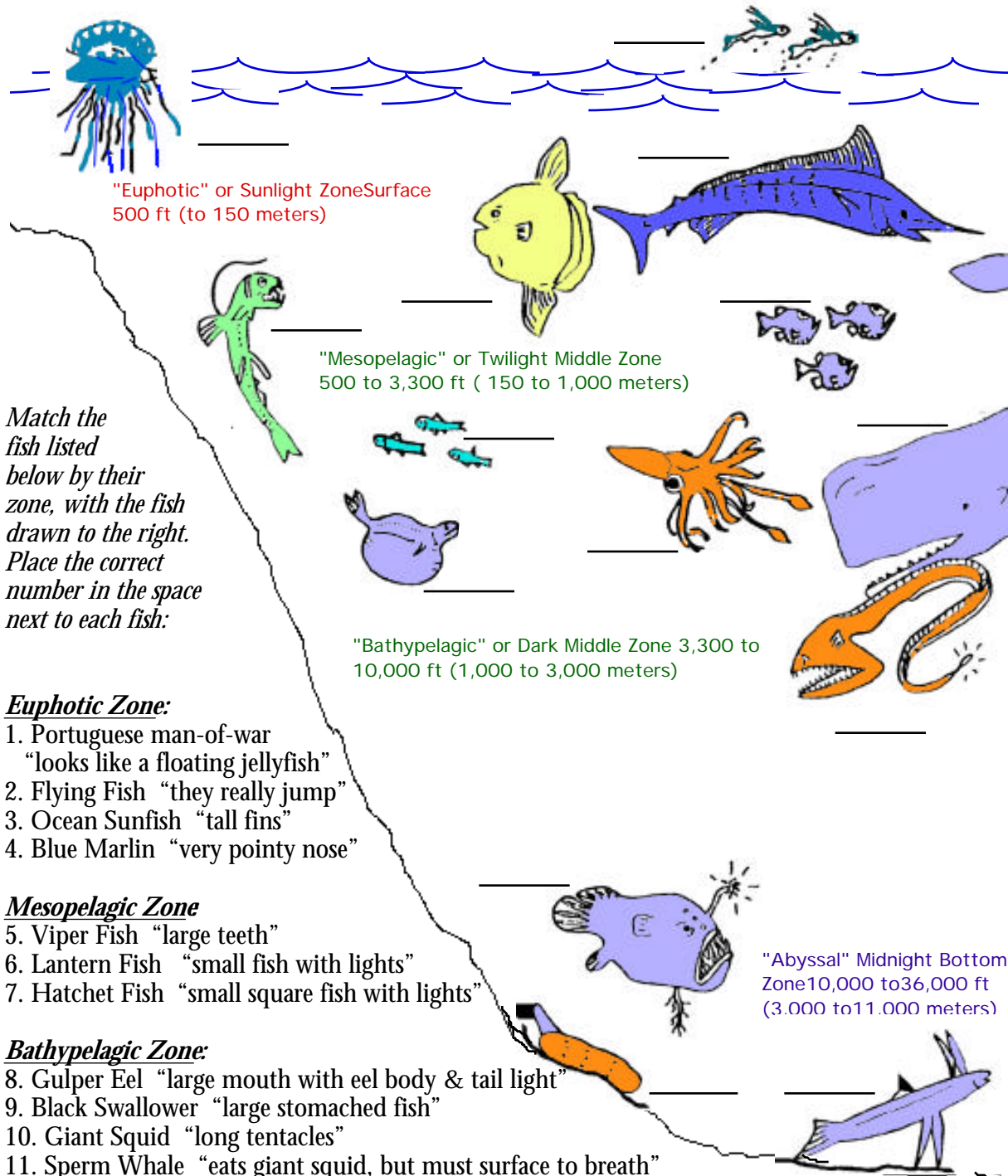


Measure out these different amounts of water in various containers to help your students understand the contrast in the various amounts.

Answers: Of 55 gallons of water=earth's water,
Oceans= 53 gallons + 1 quart + 1 pint + 12 ounces
Ice caps & Glaciers= 1 gallon + 12 ounces
Ground water= 1 quart + 11.4 ounces
Atmosphere= 1 pint + 4.5 ounces
Freshwater Lakes= 1/2 ounces
Saline Lakes & Inland Seas= 1/3 ounce
Vadose (soil moisture)= 1/4 ounces
Rivers = 1/100th ounce or < 1/millionth of earth's water supply

Diving to the Bottom of the Sea!

The world's oceans have an average depth of two miles and creatures are found at every level. Here's how the ocean's depths are divided up with a sampling of what lives where.



Match the fish listed below by their zone, with the fish drawn to the right. Place the correct number in the space next to each fish:

Euphotic Zone:

1. Portuguese man-of-war "looks like a floating jellyfish"
2. Flying Fish "they really jump"
3. Ocean Sunfish "tall fins"
4. Blue Marlin "very pointy nose"

Mesopelagic Zone

5. Viper Fish "large teeth"
6. Lantern Fish "small fish with lights"
7. Hatchet Fish "small square fish with lights"

Bathypelagic Zone:

8. Gulper Eel "large mouth with eel body & tail light"
9. Black Swallower "large stomached fish"
10. Giant Squid "long tentacles"
11. Sperm Whale "eats giant squid, but must surface to breath"

Abyssal Zone:

12. Angler Fish "uses a light on the end of a stalk to attract food"
13. Tripod Fish "has long stiff fins to stand on bottom"
14. Deep Sea Cucumbers "not plants at all, but an animal with a cucumber shaped body"

Bibliography

Books marked with an asterisk () are aimed at elementary age children.

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Ocean Related Web Sites

****Websites designed for students to use.***

***Journey to a Black Smoker/American Museum of Natural History:**

<http://www.amnh.org/nationalcenter/expeditions/>

***Extreme 2002: Mission to the Abyss:** <http://www.ocean.udel.edu/extreme2002/>

New England Aquarium: <http://www.neaq.org/index.flash4.html>

***NOAA Kids Corner:** <http://www.nmfs.noaa.gov/kids.htm>

NOAA List of Resources for Oceanography:

http://www.esdim.noaa.gov/ocean_page.html

Ocean Adventure: <http://www.oceanadventure.org>

***The Ocean Channel:** <http://www.ocean.com/learn/>

***The Ocean Planet/Smithsonian:**

http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/ocean_planet_ocean_science.html

Planet Ocean/Discovery School:

<http://school.discovery.com/schooladventures/planetoccean/ocean.html>

Woods Hole Oceanographic Institute: <http://www.whoi.edu/>



