



## Marine Conservation Science & Policy: Ocean Zones

### Grade Level:

4<sup>th</sup> – 12<sup>th</sup>

### Subject Area

Science

Biology

### Duration

1.5 Hrs

### Benchmarks:

#### Body of Knowledge

Life Science

Nature of Science

Physical Science

#### Big Idea

The Practice of Science

Earth Structures

#### Standards

##### SC.K.N.1.4

Create a visual representation of an object which includes its major features.

##### SC.2.L.17.2

Recognize and explain that living things are found all over Earth, but that each is only able to live in habitats that meet its basic needs.

##### SC.912.E.6.5

Describe the geologic development of the present day oceans and identify commonly found features.

##### WL.K12.NM.1.4

Demonstrate understanding of information supported by visuals.

### Focus Question

What are the ocean zones and how do they differ? What kinds of animals live in each zone? Why is it important to learn more about the ocean?

### Objectives

Students will explore the different ocean zones and the variety of life found in them. Students will learn to:

- Identify the 5 ocean zones.
- Compare and contrast the conditions in the different zones.
- Demonstrate knowledge by drawing a scale diagram of the five ocean zones.

This will be a project-based activity in which students will work together to draw a scale diagram of the ocean zones.

### Background

An **ocean** is a major body of saline water, which covers 71% of the Earth's surface forms part of the hydrosphere, Earth's largest ecosystem, hosting an estimated 50-80% of all life on earth, though much is unknown as 95% of this underwater world remains unexplored.<sup>4</sup> Scientists estimate that life with the ocean evolved 3 billion years prior to life on land, from simple obligate anaerobes to the first photosynthesizing organisms to the blue whales and clown fish we recognize today.<sup>1</sup> Some 230,000 marine species are known so far, but an estimated 1-10 million species remain to be discovered.<sup>2</sup> These organisms have adapted to the varying conditions of the different ocean zones.

Ocean zones are layers within the oceans with diverse physical and biological conditions that support distinctive plant and animal life. The ocean is divided into two realms, the **benthic realm** (consisting of the seafloor) and the **pelagic realm** (consisting of the ocean waters), which are then subdivided into five different vertical zones depending on depth.

The benthic realm is the ecological region at the bottom of the ocean, and includes the sediment layer below which hosts crustaceans, snails, sea stars and other creatures. This realm begins at the shoreline and continues downward along the continental shelf, a slope that drops down to the abyssal plain at around 4,000 m. The ocean floor has submarine mountains, canyons, ridges and trenches, and the organisms that live in this realm vary as the pressure, salinity, temperature, nutrients and light change.<sup>3</sup>

The photic zone covers the oceans from surface level to 200 meters down, the only zone in which sufficient sunlight penetrates to permit photosynthesis. Because photosynthesis can take place, many plants and photosynthetic organisms live in this zone forming the first link in the food chain as primary producers. Some of these primary producers, microscopic free-floating plants called phytoplankton, are the most abundant organisms on earth and generate 50-90% of Earth's oxygen. Because of this abundant food source, this zone supports 90% of ocean life, though it is the smallest zone, featuring coral reefs, sea grass beds, and much more.<sup>4</sup>

## Vocabulary:

### Ocean Zones:

The divisions of the ocean from the surface to the ocean floor, which vary by depth, pressure, light, and nutrients.

### Benthic Realm:

This realm begins at the shore and extends along the continental shelf and the ocean floor, shaped by submarine mountains, ridges and trenches

### Pelagic Realm:

The open part of the ocean (or lakes) that is neither near the bottom nor the shore.

### Mesopelagic Zone:

The zone extending from 200 to 700-1000 m deep, only dimly lit but host to millions of microorganisms.

### Bathyal Zone:

This zone is cold, dark, and ranges from 1,000-4,000 m deep.

### Abyssal Zone:

Extending from 4,000 to 6,000 m deep, this zone is perpetually dark and cold but surprisingly hosts a wide array of organisms.

### Hadal Zone:

Diving from 6,000 m to the bottom of the deepest ocean trench, this zone is characterized by extreme cold and pressure, populated by extremophiles.

## Background

Most light remains in the sunny photic zone, with few rays penetrating the **mesopelagic**, or twilight **zone**, which extends from 200 to 700-1000 meters. This zone is significant in the diurnal (daily) vertical migration of numerous species of small organisms upwards to the photic zone at night, a movement often referred to as the greatest migration on earth in terms of biomass. This movement makes the ocean the world's largest carbon sink and essential to mitigating climate change.

The **bathyal**, or midnight, zone is a chill 4° C (39° F) extending in inky darkness from 1,000 to 4,000 meters. This zone marks the beginning of the aphotic, or no light, zone, and it is so dark that some species don't even have eyes, while others have adapted transparent skin, slimy bodies or even bioluminescence to survive. This zone is the feeding ground of many whales, squid, and octopuses, as well as many unusual creatures.

From 4,000 to 6,000 meters deep, the **abyssal** zone is characterized by perpetual darkness, with temperatures an almost freezing 2-3° C (35° F). Fissures in the ocean floor create hydrothermal vents with boiling temperatures, lethal levels of hydrogen sulfides and pressures that would crush a human instantly. Creatures in this zone are mostly scavengers that depend upon marine snow for nutrients, sinking organic matter that includes dead or dying plants and animals. Though conditions were thought to be too hostile to support life, scientists using the minisubmarine Alvin in 1977, discovered an extraordinary abundance of creatures in these depths, ranging from the ten-foot long tube worms, clams over a foot wide, wriggling spaghetti worms, and even Giant squid. This extraordinary exuberance actually stems from the deep sea vents, where tiny, unassuming bacteria are converting the toxic compounds into sustenance and thereby providing the means to support a food chain independent of light, oxygen or anything else normally associated with life. This system is supported by chemosynthesis rather than photosynthesis, and could help us understand the possibilities on life on other planets.

The **hadal** zone, named after the underworld realm of Hades, is found in the deepest trenches of the ocean from depths of 6,000 meters to bottom of the ocean. Food is sparse and the pressure can reach 11,000 p.s.i., the equivalent of a human trying to hold 50 jumbo jets. Because of the extreme pressure, low nutrient availability and lack of light, this zone is only sparsely populated by creatures adapted to withstand the harsh conditions, including jellyfish, viperfish, sea cucumbers and tube worms.

Though these zones are distinguished by their differences, they are all interconnected by currents and each is an important habitat for a variety of organisms. Likewise, the oceans provide the air we breathe, the food we eat, life-saving medicines, jobs, recreation and many other necessities. Over 95% of the ocean remains unexplored, and we must preserve this wondrous world for the untold discoveries of future generations.<sup>4</sup>

## Supplemental Resources

- 1- "History of Life on Earth." BBC Nature. [http://www.bbc.co.uk/nature/history\\_of\\_the\\_earth](http://www.bbc.co.uk/nature/history_of_the_earth)
- 2- "The Census of Marine Life." Smithsonian National Museum of Natural History. <http://ocean.si.edu/census-marine-life>
- 3- "The Deep Sea." MarineBio. <http://marinebio.org/oceans/deep/>
- 4- "Name that Zone!" National Oceanic and Atmospheric Administration (NOAA). <https://coast.noaa.gov/data/SEAMedia/Presentations/PDFs/Grade%203%20Unit%20%20Less%20on%201%20The%20Open%20Ocean.pdf>

## Marine Conservation Science & Policy: Ocean Zones

### Vocabulary Continued:

#### Ocean Zones:

The divisions of the ocean from the surface to the ocean floor, which vary by depth, pressure, light, and nutrients.

#### Benthic Realm:

This realm begins at the shore and extends along the continental shelf and the ocean floor, shaped by submarine mountains, ridges and trenches

#### Pelagic Realm:

The open part of the ocean (or lakes) that is neither near the bottom nor the shore.

### Extension Activity:

Students will investigate the history and limitations of ocean exploration, and justify future explorations by summarizing and analyzing an article. The objective is for students to understand how deep the ocean is and why organisms are limited to certain depths. Why is the ocean mostly unexplored and what prevents humans from diving using SCUBA to explore the deep ocean? What technologies are being developed to push the limits of ocean exploration?

### Assessment:

Students will complete the ocean zones worksheet after class, and should write a science journal entry answering the following prompt:

*If you could visit any ocean zone, which would it be and why? How would you get there and what would do you think you'll discover? Remember to use the five senses when describing your trip.*

### Activity: Illustrating the Ocean Zones

#### Materials

- Four large butcher or poster paper sheets
- Multicolor markers, crayons or colored pencils
- Large meter stick or ruler
- Pictures of marine life from different depths (can be pre-glued onto index cards to strengthen)
- Glue or double-sided tape
- Tape for hanging the diagram

#### Procedure

1. Have students divide into four groups and lay their paper on the floor.
2. Using the meter scale on either side of the diagram, have students label from 0 m at the ocean surface to 6,000 m and deeper and draw some of the geological structures of the ocean basin (i.e. continental shelf, slope, rise and continental plain).
3. At the top of the diagram, have students draw the surface of the ocean and structures found at this level (i.e. coral reefs, a sailboat, a leaping dolphin).
4. At the bottom of the diagram, have students draw some features of the benthic realm, (i.e. trench, hydrothermal vent).

Labels and features to include on the diagram:

Photic (sunlit) zone	Shoreline	Abyssal plain
Aphotic (no light) zone	Sea level	Rift valley
Benthic realm	Coral reef	Continental shelf
Pelagic realm	Mid-ocean ridge	Continental slope
Bathyal zone	Trench	Continental rise
Abyssal zone	Hydrothermal vent	Submarine canyon
Hadal zone	Subfloor sediment	

5. Have students place different organisms at their appropriate depths in the ocean.
6. Groups should present their work. Encourage discussion by asking which zones would they like to visit, which zone hosts the most interesting organisms, why ocean exploration is important, etc.

### Worksheet Answer Key

1. From shallow to deep: photic – mesopelagic – bathyal – abyssal – hadal
2. Oceanography, five
3. Photic, photosynthesis
4. Submarine trenches, anglerfish

# MSCP

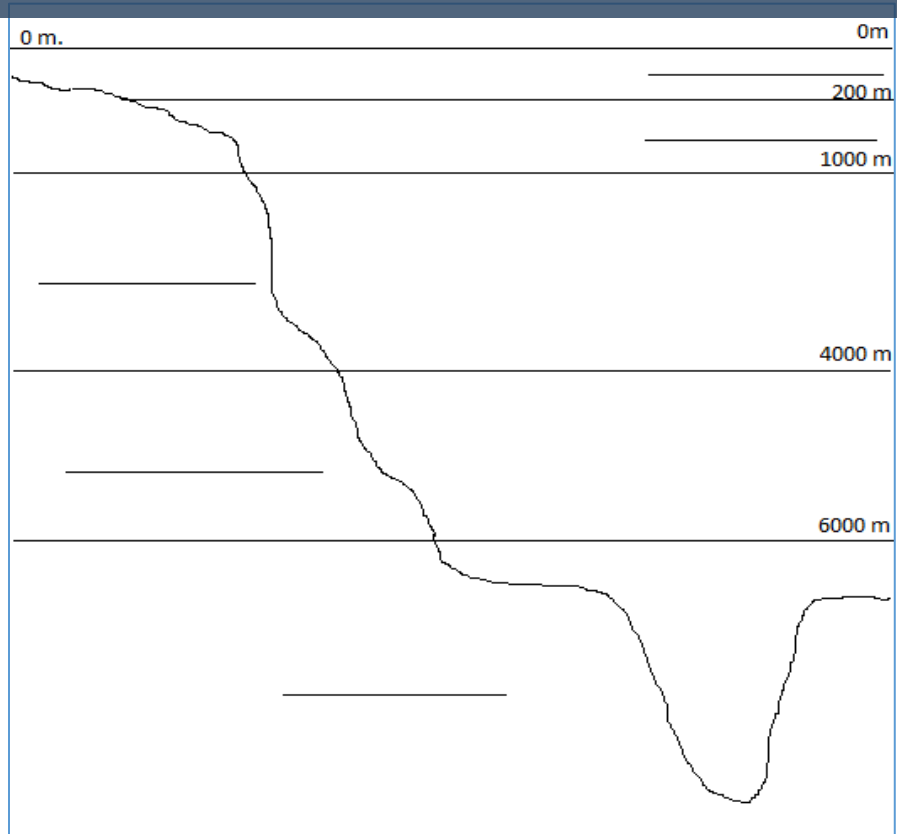


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## Ocean Zones:

The ocean is divided into five zones: the photic zone is the sunny top layer which supports photosynthesis and hosts most of the ocean's organisms; the mesopelagic zone begins 200 m deep and is home to many microorganisms; the bathyal zone is dark as midnight and is where many whales go to feed; the abyssal zone is almost freezing cold and many fantastic creatures live here; and finally the hadal zone delves into the deepest ocean trenches.

1. Please label the zones, color them according to light conditions, and draw some organisms in the zone that is their home.



2. The science of studying the ocean is called \_\_\_\_\_, and these scientists have divided the ocean into \_\_\_\_\_ zones.
3. The \_\_\_\_\_ zone hosts phytoplankton which produces most of the world's oxygen through \_\_\_\_\_.
4. In the \_\_\_\_\_ of the hadal zone, some species like the \_\_\_\_\_ use bioluminescence to lure in their prey.



Word Bank: anglerfish -photosynthesis - submarine trenches -oceanography - photic - five