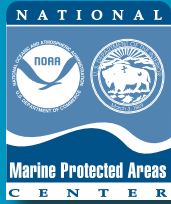


MARINE PROTECTED AREA RESOURCES AND CONCEPTS FOR TEACHING OCEAN LITERACY



Introduction

“Ocean Literacy is an understanding of the ocean’s influence on you and your influence on the ocean.”

This document melds the “Ocean Literacy: Essential Principles and Fundamental Concepts of Ocean Sciences for Learners of All Ages” (version 2: March 2013) with resources from the National Marine Protected Areas Center (MPA Center) that illustrate those principles. The information is intended to help educators improve ocean literacy by highlighting MPA Center resources on marine protected areas and conservation. The seven Essential Principles are a practical resource that outlines the knowledge required to be ocean literate, and are aligned with the Next Generation Science Standards (NGSS). For more information on how these principles map to educational standards and to view the Ocean Literacy document, see this link:

<http://oceanservice.noaa.gov/education/literacy.html>



How to use this document

The seven Essential Principles of Ocean Literacy are listed in this document with those concepts that most relate to MPA Center resources highlighted in blue. Resource boxes showcase the MPA resources that illustrate each concept. For more information, contact: Lauren.Wenzel@noaa.gov

General MPA Resources for Educators

- Conserving Our Oceans
http://marineprotectedareas.noaa.gov/pdf/fac/mpas_of_united_states_conserving_oceans_1113.pdf
- MPA Education Page
<http://marineprotectedareas.noaa.gov/resources/education/>
- National Estuarine Research Reserves Education Page
<http://www.nerrs.noaa.gov/Education.aspx>
- National Marine Sanctuaries Education Page
<http://sanctuaries.noaa.gov/education/welcome.html>

The Nation’s Hub for Building Innovative Partnerships and Tools to Protect Special Ocean Places
marineprotectedareas.noaa.gov

Ocean Literacy: Essential Principles And Fundamental Concepts

I. The Earth Has One Big Ocean With Many Features

- The ocean is the defining physical feature on our planet Earth—covering approximately 70% of the planet’s surface. There is one ocean with many ocean basins, such as the North Pacific, South Pacific, North Atlantic, South Atlantic, Indian, Southern, and Arctic.
- Ocean basins are composed of the seafloor and all of its geological features (such as islands, trenches, mid-ocean ridges, and rift valleys) and vary in size, shape and features due to the movement of Earth’s crust (lithosphere), Earth’s highest peaks, deepest valleys and flattest plains are all in the ocean.
- Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth’s rotation (Coriolis effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation. This “global conveyor belt” moves water throughout all of the ocean basins, transporting energy (heat), matter, and organisms around the ocean. Changes in ocean circulation have a large impact on the climate and cause changes in ecosystems.
- Sea level is the average height of the ocean relative to the land, taking into account the differences caused by tides. Sea level changes as plate tectonics cause the volume of ocean basins and the height of the land to change. It changes as ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools.
- Most of Earth’s water (97%) is in the ocean. Seawater has unique properties. It is salty, its freezing point is slightly lower than fresh water, its density is slightly higher, its electrical conductivity is much higher, and it is slightly basic. Balance of pH is vital for the health of marine ecosystems, and important in controlling the rate at which the ocean will absorb and buffer changes in atmospheric carbon dioxide.
- The ocean is an integral part of the water cycle and is connected to all of the earth’s water reservoirs via evaporation and precipitation processes.
- The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments and pollutants from watersheds to estuaries and to the ocean.
- Although the ocean is large, it is finite and resources are limited.

Resources

- Marine Protected Areas: Conserving Our Oceans One Place At A Time
http://marineprotectedareas.noaa.gov/pdf/fac/mpas_of_united_states_conserving_oceans_1113.pdf
- Current: The Journal of Marine Education - Special Issue on MPA Networks and Systems
<http://marineprotectedareas.noaa.gov/resources/education/current/welcome.html>
- Frequently Asked Questions about MPAs
<http://marineprotectedareas.noaa.gov/resources/faqs/>
- Video: The National System of MPAs: An Introduction
<http://marineprotectedareas.noaa.gov/resources/multimedia/>
- Video: Protecting our Planet
<http://marineprotectedareas.noaa.gov/resources/multimedia/>
- Fact Sheet: Marine Reserves
http://marineprotectedareas.noaa.gov/pdf/helpful-resources/factsheets/us_marinereserves.pdf



Supporting Concepts

- Marine Protected Areas, or MPAs, are defined areas where natural and/or cultural resources are given greater protection than the surrounding waters.
- In the U.S., MPAs span a range of habitats including the open ocean, coastal areas, inter-tidal zones, estuaries, and the Great Lakes.
- MPAs vary widely in purpose, legal authorities, agencies, management approaches, level of protection, and restrictions on human uses.
- Almost all of our nation’s MPAs are multiple-use sites that allow a variety of human activities, including fishing and other extractive uses.
- “No take” MPAs which prohibit the extraction or significant destruction of natural or cultural resources, occupy only about 3% of U.S. waters.
- Sometimes a single MPA is not sufficient in size or scope to protect all of the resources that reside within its boundaries. Therefore, a network of MPAs – a grouping of smaller MPAs protecting different habitats at various locations within the larger ecosystem - may be more effective.
- Many marine species like crabs live in various habitats throughout their lifecycle, and some species, like whales, migrate huge distances. For a single MPA to protect all of those habitats it would have to be very large, which often isn’t practical. Networks of MPAs can be used to help protect species like these.

2. The Ocean And Life In The Ocean Shape The Features Of The Earth

- a. Many earth materials and biogeochemical cycles originate in the ocean. Many of the sedimentary rocks now exposed on land were formed in the ocean. Ocean life laid down the vast volume of siliceous and carbonate rocks.
- b. Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and shaped the surface of land.
- c. Erosion – the wearing away of rock, soil and other biotic and abiotic earth materials – occurs in coastal areas as wind, waves and currents in rivers and the ocean, and the processes associated with plate tectonics move sediments. Most beach sand (tiny bits of animals, plants, rocks, and minerals) is eroded from land sources and carried to the coast by rivers; sand is also eroded from coastal sources by surf. Sand is redistributed seasonally by waves and coastal currents.
- d. The ocean is the largest reservoir of rapidly cycling carbon on Earth. Many organisms use carbon dissolved in the ocean to form shells, other skeletal parts, and coral reefs.
- e. Tectonic activity, sea level changes, and force of waves influence the physical structure and landforms of the coast.

Resources

- MPA Inventory
<http://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/>
- Interactive MPA Mapping Tool
<http://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/mpaviewer/>
- Sea Level Rise in East Coast MPAs
http://marineprotectedareas.noaa.gov/pdf/helpful-resources/sea_level_rise_march_2013.pdf

Supporting Concepts

- The MPA Inventory is a comprehensive geospatial database that contains information on over 1,700 MPAs in the U.S.



3. The Ocean Is A Major Influence On Weather And Climate

- a. The interaction of oceanic and atmospheric processes controls weather and climate by dominating the Earth's energy, water, and carbon systems.
- b. The ocean moderates global weather and climate by absorbing most of the solar radiation reaching Earth. Heat exchange between the ocean and atmosphere drives the water cycle and oceanic and atmospheric circulation.
- c. Heat exchange between the ocean and atmosphere can result in dramatic global and regional weather phenomena, impacting patterns of rain and drought. Significant examples include the El Niño Southern Oscillation and La Niña, which cause important changes in global weather patterns because they alter the sea surface temperature patterns in the Pacific.
- d. Condensation of water that evaporated from warm seas provides the energy for hurricanes and cyclones. Most rain that falls on land originally evaporated from the tropical ocean.
- e. The ocean dominates the Earth's carbon cycle. Half the primary productivity on Earth takes place in the sunlit layers of the ocean and the ocean absorbs roughly half of all carbon dioxide added to the atmosphere.
- f. The ocean has had, and will continue to have, a significant influence on climate change by absorbing, storing, and moving heat, carbon and water. Changes in the ocean's circulation have produced large, abrupt changes in climate during the last 50,000 years.
- g. Changes in the ocean-atmosphere system can result in changes to the climate that in turn, cause further changes to the ocean and atmosphere. These interactions have dramatic physical, chemical, biological, economic, and social consequences.

Resources

- MPAs in a Changing Climate
<http://marineprotectedareas.noaa.gov/sciencestewardship/climatechangeimpacts/>
- MPA Connections: Special Issue Focused on Climate Change
http://marineprotectedareas.noaa.gov/resources/publications/newsletters/mpa_connections/
- MPA Federal Advisory Committee Primer on MPAs and Climate Change
<http://marineprotectedareas.noaa.gov/sciencestewardship/climatechangeimpacts/>
- Marine Protected Areas: Building Resilience To Climate Change Impacts
http://marineprotectedareas.noaa.gov/pdf/helpful-resources/mpas_climate_change_march_2013.pdf



Supporting Concepts

- Climate change is altering the physical dynamics and functioning of the ocean and marine ecosystems through increased ocean temperatures, sea level rise, altered weather patterns, changes in ocean currents, melting sea ice, and the effects of ocean acidification.
- Degraded ecosystems are less likely to be resilient to the effects of climate change than healthy, fully functional ecosystems.
- MPAs have the potential to play an important role in maintaining and restoring ecosystem resilience, protecting biodiversity and creating places safe from climate change impacts.

4. The Ocean Makes Earth Habitable

- a. Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean. This accumulation of oxygen in Earth's atmosphere was necessary for life to develop and be sustained on land.
- b. The ocean is the cradle of life; the earliest evidence of life is found in the ocean. The millions of different species of organisms on Earth today are related by descent from common ancestors that evolved in the ocean and continue to evolve today.
- c. The ocean provided and continues to provide water, oxygen, and nutrients, and moderates the climate needed for life to exist on Earth (Essential Principles 1, 3 and 5).

Resources

- Video: Discovering The Ocean's Secrets
<http://marineprotectedareas.noaa.gov/resources/multimedia/>
- Video: Protecting our Planet
<http://marineprotectedareas.noaa.gov/resources/multimedia/>
- MPA Effectiveness - Achieving Conservation
<http://marineprotectedareas.noaa.gov/nationalsystem/effectiveness/>



Supporting Concepts

- The ocean is a vital resource that makes Earth habitable by providing food, water, commerce, recreation, medicine and the air we breathe.
- Ocean plants produce half of the world's oxygen, which is more than all forests combined.
- Beyond making the Earth habitable by regulating our weather and climate, the ocean also forms clouds that produce fresh water to drink.
- The ocean is connected to our food in more ways than seafood. Marine algae and kelp are used in making peanut butter, soymilk and frozen foods. Ocean ingredients are also found in our shampoos, makeup, and medicines that help to fight cancer, heart disease and viruses.



5. The Ocean Supports A Great Diversity Of Life And Ecosystems

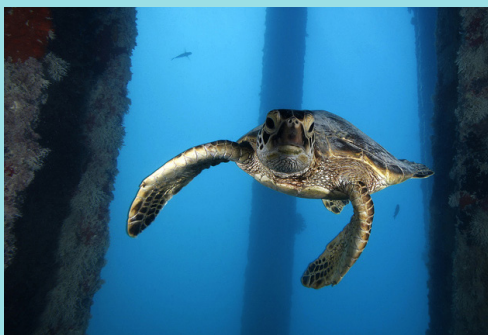
- a. Ocean life ranges in size from the smallest living things, microbes, to the largest animal on Earth, blue whales.
- b. Most of the organisms and biomass in the ocean are microbes, which are the basis of all ocean food webs. Microbes are the most important primary producers in the ocean. They have extremely fast growth rates and life cycles, and produce a huge amount of the carbon and oxygen on Earth.
- c. Most of the major groups that exist on Earth are found exclusively in the ocean and the diversity of major groups of organisms is much greater in the ocean than on land.
- d. Ocean biology provides many unique examples of life cycles, adaptations, and important relationships among organisms (symbiosis, predator-prey dynamics, and energy transfer) that do not occur on land.
- e. The ocean provides a vast living space with diverse and unique ecosystems from the surface through the water column and down to, and below, the seafloor. Most of the living space on Earth is in the ocean.
- f. Ocean ecosystems are defined by environmental factors and the community of organisms living there. Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation. A few regions of the ocean support the most abundant life on Earth, while most of the ocean does not support much life.
- g. There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs, and methane cold seeps, rely only on chemical energy and chemosynthetic organisms to support life.
- h. Tides, waves, predation, substrate, and/or other factors cause vertical zonation patterns along the coast; density, pressure, and light levels cause vertical zonation patterns in the open ocean. Zonation patterns influence organisms' distribution and diversity.
- i. Estuaries provide important and productive nursery areas for many marine and aquatic species.

Resources

- MPA Mapping Tool
<http://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/mpaviewer/>
- Video: Protecting Natural Heritage Resources
<http://marineprotectedareas.noaa.gov/resources/multimedia/>
- Science Brief: Do Fish Swim out of MPAs?
http://marineprotectedareas.noaa.gov/pdf/helpful-resources/sciencebriefs/mpasciencebrief_fishswimin_andoutmpas.pdf
- Fact Sheet: Definition and Classification of U.S. MPAs
<http://marineprotectedareas.noaa.gov/aboutmpas/classification/>

Supporting Concepts

- There are over 1,700 MPAs in the U.S. These MPAs are used to conserve natural and cultural heritage, and/or to support sustainable production of our marine resources.
- Most U.S. MPAs were created to conserve natural heritage values such as biodiversity, ecosystems, or protected species.
- MPAs can protect special habitats that help maintain ecosystem integrity. For example, salt marshes export nutrients and biomass that are used by organisms occurring offshore; coral reefs provide mangroves and seagrasses with protection from wave erosion; and mangroves buffer coral reefs and seagrasses from siltation.



Connections

Type "Tortugas" into the search field in the MA Mapping Tool to learn more about the Dry Tortugas National Park in Florida. The word "Tortuga" means "turtle" in Spanish, which is very fitting for this MPA whose coral and sea grass communities are among the most vibrant in the Florida Keys. Large sea turtles lumber onto the park's protected beaches each summer to bury their clutches of eggs. These and other wonders make this park a truly one-of-a-kind place.

6. The Ocean And Humans Are Inextricably Interconnected

- a. The ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and nearly all Earth's oxygen. The ocean moderates the Earth's climate, influences our weather, and affects human health.
- b. The ocean provides food, medicines, and mineral and energy resources. It supports jobs and national economies, serves as a highway for transportation of goods and people, and plays a role in national security.
- c. The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.
- d. Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution), changes to ocean chemistry (ocean acidification), and physical modifications (changes to beaches, shores, and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
- e. Changes in ocean temperature and pH due to human activities can affect the survival of some organisms and impact biological diversity (coral bleaching due to increased temperature and inhibition of shell formation due to ocean acidification).
- f. Much of the world's population lives in coastal areas. Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges).
- g. Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Resources

- Video: Protecting Cultural Heritage Resources
<http://marineprotectedareas.noaa.gov/resources/multimedia/>
- CA Atlas Viewer (Heat Map showing intensity of uses along the coast)
http://marineprotectedareas.noaa.gov/dataanalysis/atlas_ca/viewer/
- NOAA's State of the Coast Website
<http://stateofthecoast.noaa.gov/>
- Cultural Heritage MPAs
<http://marineprotectedareas.noaa.gov/nationalsystem/culturalheritage/>
- Video: Protecting Sustainable Resources
<http://marineprotectedareas.noaa.gov/resources/multimedia/>



Supporting Concepts

- Humans use the ocean for a wide range of activities, including fishing boating, kayaking, SCUBA diving, snorkeling, whale-watching and other consumptive and non-consumptive activities.
- Sustainable production refers to the nation's renewable living resources and their habitats (including, but not limited to, spawning, mating, and nursery grounds and areas established to minimize by catch of species) and the social, cultural and economic values and services they provide to humans.
- Sustainable production MPAs can be created to support the continued extraction of renewable living resources (such as fish shellfishplants, birds, or mammals) that live within the MPA, or that are exploited elsewhere but depend upon the protected area's habitat foressential aspects of their ecology.
- Maintaining healthy coastal and marine ecosystems requires an understanding of the relationships between people and the environment.
- Cultural heritage, which belongs to all people, emphasizes these connections, and can include artifacts (such as shipwrecks), natural resources (such as marine species and habitats), and sacred places.
- Fifty-eight percent of our nation's gross domestic product, or GDP, is generated in the coastal watershed counties along the oceans and Great Lakes.
- More than 160 million people live in the coastal watershed counties of the United States and the fi e U.S. territories, representing just over half the U.S population in 2010.

7. The Ocean Is Largely Unexplored

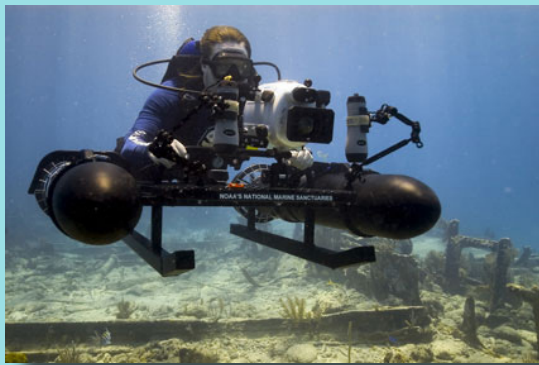
- a. The ocean is the last and largest unexplored place on Earth— less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.
- b. Understanding the ocean is more than a matter of curiosity. Exploration, experimentation, and discovery are required to better understand ocean systems and processes. Our very survival hinges upon it.
- c. Over the last 40 years, use of ocean resources has increased significantly, therefore the future sustainability of ocean resources depends on our understanding of those resources and their potential and limitations.
- d. New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.
- e. Use of mathematical models is an essential part of understanding the ocean system. Models help us understand the complexity of the ocean and of its interactions with Earth's interior, atmosphere, climate, and land masses.
- f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, physicists, animators, and illustrators. And these interactions foster new ideas and new perspectives for inquiries.

Resources

- NOAA's Ocean Explorer Website
<http://oceanexplorer.noaa.gov/>
- Video: Into the Abyss: Submarine Exploration of the World's Largest Undersea Canyon (Michelle Ridgway)
<http://www.youtube.com/watch?v=CvEGfvtZleE>
- Video: Life on the edge: Is ocean acidification a threat to deep-sea life? (MBARI Researchers)
http://www.youtube.com/watch?v=Wyvc_r_0HgA

Supporting Concepts

- Dozens of deep submarine canyons are perhaps the most striking feature of the continental margin of the eastern United States. Most of these canyons are relatively minor features, but several are incredibly extensive and cut quite deeply into the seafloor.



Connections

Listen to Monterey Bay Aquarium Research Institute Postdoctoral Fellow Josi Taylor describe some of the experiments she and other MBARI researchers are doing to study the impact of ocean acidification on deep-sea animals. Track MBARI scientists on their website as they go on expeditions and read more about the use of underwater vehicles used for deep sea exploration.

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