

# 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” developed by the National Geographic Society, NOAA and partners for K-12 curricula 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 National Science Education Standards (NSES). For more information on how these principles map to educational standards and to view the original Ocean Literacy document, click here: <http://oceanservice.noaa.gov/education/literacy.html>.



## HOW TO USE THIS DOCUMENT

The original seven Essential Principles of Ocean Literacy and Fundamental Concepts are shown below with those concepts that most relate to MPA Center resources highlighted in blue. Resource boxes on the right hand side of each Essential Principle showcase the MPA resources that illustrate each concept. For more information on these resources contact [Kara.Yeager@noaa.gov](mailto:Kara.Yeager@noaa.gov).

## GENERAL MPA RESOURCES FOR EDUCATORS

- **Introductory Lesson: Working Together With Sherman**  
[http://www.mpa.gov/pdf/helpful-resources/education/sherman\\_lagoon\\_lp\\_May2010.pdf](http://www.mpa.gov/pdf/helpful-resources/education/sherman_lagoon_lp_May2010.pdf)
- **Current: The Journal of Marine Education, Special Edition focused on Networks and Systems of MPAs**  
[http://www.mpa.gov/pdf/helpful-resources/education/current/current\\_jun\\_2010.pdf](http://www.mpa.gov/pdf/helpful-resources/education/current/current_jun_2010.pdf)
- **MPA Education Page**  
<http://www.mpa.gov/resources/education/>
- **MPA Virtual Library**  
[http://www3.mpa.gov/mpa\\_lib/virtual\\_library.aspx](http://www3.mpa.gov/mpa_lib/virtual_library.aspx)
- **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>

NOAA's National Marine Protected Areas (MPA) Center's mission is to facilitate the effective use of science, technology, training, and information in the planning, management, and evaluation of the nation's system of marine protected areas. The MPA Center works in partnership with federal, state, tribal, and local governments and stakeholders to develop a science-based, comprehensive national system of MPAs. These collaborative efforts will lead to a more efficient, effective use of MPAs now and in the future to conserve and sustain the nation's vital marine resources.



## OCEAN LITERACY: ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

### 1. THE EARTH HAS ONE BIG OCEAN WITH MANY FEATURES

- a. The ocean is the dominant 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 and Arctic.
- b. An ocean basin’s size, shape and features (islands, trenches, mid-ocean ridges, rift valleys) vary due to the movement of Earth’s lithospheric plates. Earth’s highest peaks, deepest valleys and flattest vast plains are all in the ocean.
- c. 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.
- d. 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.
- e. Most of Earth’s water (97%) is in the ocean. Seawater has unique properties: it is saline, 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. The salt in seawater comes from eroding land, volcanic emissions, reactions at the seafloor, and atmospheric deposition.
- f. 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.
- g. 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.
- h. Although the ocean is large, it is finite and resources are limited.

### Resources

- Snapshot of United States MPAs  
[http://www.mpa.gov/pdf/helpful-resources/us\\_mpas\\_snapshot.pdf](http://www.mpa.gov/pdf/helpful-resources/us_mpas_snapshot.pdf)
- Current: The Journal of Marine Education - Special Issue on MPA Networks and Systems  
[http://www.mpa.gov/pdf/helpful-resources/education/current/current\\_jun\\_2010.pdf](http://www.mpa.gov/pdf/helpful-resources/education/current/current_jun_2010.pdf)
- Frequently Asked Questions about MPAs  
<http://www.mpa.gov/resources/faqs/>
- Video: The National System of MPAs: An Introduction  
<http://www.mpa.gov/resources/multimedia>
- Video: Protecting our Planet  
<http://www.mpa.gov/resources/multimedia>
- Fact Sheet: Marine Reserves  
[http://www.mpa.gov/pdf/helpful-resources/factsheets/us\\_marinereserves.pdf](http://www.mpa.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.
- Less than 8% of the area of MPAs in the U.S. is “no take,” prohibiting the extraction or significant destruction of natural or cultural resources.
- 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 required.
- 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 geochemical 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 move sediments.
- d. Sand consists of tiny bits of animals, plants, rocks and minerals. Most beach sand is eroded from land sources and carried to the coast by rivers, but sand is also eroded from coastal sources by surf. Sand is redistributed by waves and coastal currents seasonally.
- e. Tectonic activity, sea level changes, and force of waves influence the physical structure and landforms of the coast.

### Resources

- MPA Inventory  
<http://www.mpa.gov/dataanalysis/mpainventory/>
- Interactive MPA Mapping Tool  
<http://www.mpa.gov/dataanalysis/mpainventory/mpaviewer/>

### Supporting Concepts

- The MPA Inventory is a comprehensive geospatial database that contains information on over 1,600 MPAs in the U.S.



## 3. THE OCEAN IS A MAJOR INFLUENCE ON WEATHER AND CLIMATE

- a. The ocean controls weather and climate by dominating the Earth's energy, water and carbon systems.
- b. The ocean absorbs much of the solar radiation reaching Earth. The ocean loses heat by evaporation. This heat loss drives atmospheric circulation when, after it is released into the atmosphere as water vapor, it condenses and forms rain. Condensation of water evaporated from warm seas provides the energy for hurricanes and cyclones.
- c. The El Niño Southern Oscillation causes important changes in global weather patterns because it changes the way heat is released to the atmosphere in the Pacific.
- d. 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.
- g. Changes in the ocean's circulation have produced large, abrupt changes in climate during the last 50,000 years.

### Resources

- Current: The Journal of Marine Education - Special Issue on MPA Networks and Systems  
[http://www.mpa.gov/pdf/helpful-resources/education/current/current\\_jun\\_2010.pdf](http://www.mpa.gov/pdf/helpful-resources/education/current/current_jun_2010.pdf)
- Video: "What are MPAs?" - Featured at the Smithsonian Museum of Natural History  
<http://www.mpa.gov/resources/multimedia>
- MPA Connections: Special Issue Focused on Climate Change  
[http://www.mpa.gov/pdf/helpful-resources/connections/connections\\_dec10.pdf](http://www.mpa.gov/pdf/helpful-resources/connections/connections_dec10.pdf)
- MPA Federal Advisory Committee Primer on MPAs and Climate Change  
[http://www.mpa.gov/pdf/helpful-resources/climatechange\\_impacts4\\_10.pdf](http://www.mpa.gov/pdf/helpful-resources/climatechange_impacts4_10.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.
- b. The first life is thought to have started in the ocean. The earliest evidence of life is found in the ocean.

##### Resources

- Video: The National System of MPAs: An Introduction  
<http://www.mpa.gov/resources/multimedia>
- Video: Protecting our Planet  
<http://www.mpa.gov/resources/multimedia>
- MPA Effectiveness - Achieving Conservation  
<http://www.mpa.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

- Ocean life ranges in size from the smallest virus to the largest animal that has lived on Earth, the blue whale.
- Most life in the ocean exists as microbes. Microbes are the most important primary producers in the ocean. Not only are they the most abundant life form in the ocean, they have extremely fast growth rates and life cycles.
- Some major groups are found exclusively in the ocean. The diversity of major groups of organisms is much greater in the ocean than on land.
- 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.
- The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.
- Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is “patchy”. Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.
- Tides, waves and predation cause vertical zonation patterns along the shore, influencing the distribution and diversity of organisms.
- Estuaries provide important and productive nursery areas for many marine and aquatic species.

### Resources

- MPA Mapping Tool  
<http://www.mpa.gov/dataanalysis/mpainventory/mpaviewer/>
- Video: Protecting Natural Heritage Resources  
<http://www.mpa.gov/resources/multimedia>
- Science Brief: Do Fish Swim out of MPAs?  
[http://www.mpa.gov/pdf/helpful-resources/sciencebriefs/mpasciencebrief\\_fishswimin\\_andoutmpas.pdf](http://www.mpa.gov/pdf/helpful-resources/sciencebriefs/mpasciencebrief_fishswimin_andoutmpas.pdf)
- Fact Sheet: Definition and Classification of U.S. MPAs  
[http://www.mpa.gov/pdf/helpful-resources/factsheets/mpa\\_classification\\_may2011.pdf](http://www.mpa.gov/pdf/helpful-resources/factsheets/mpa_classification_may2011.pdf)

### Supporting Concepts

- There are over 1,600 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 MPA 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. It moderates the Earth's climate, influences our weather, and affects human health.
- b. From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, 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. Much of the world's population lives in coastal areas.
- e. 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) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
- f. 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://www.mpa.gov/resources/multimedia/>
- CA Atlas Viewer (Heat Map showing intensity of uses along the coast)  
[http://www.mpa.gov/dataanalysis/atlas\\_ca/](http://www.mpa.gov/dataanalysis/atlas_ca/)
- NOAA's State of the Coast Website  
<http://stateofthecoast.noaa.gov/>
- Cultural Heritage MPAs link  
<http://www.mpa.gov/nationalsystem/culturalheritage/>
- MPA Virtual Library – MPA Websites: Legislation and Regulations  
[http://www3.mpa.gov/mpa\\_lib/websites.aspx](http://www3.mpa.gov/mpa_lib/websites.aspx)
- Video: Protecting Sustainable Resources  
<http://www.mpa.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, shellfish, plants, birds, or mammals) that live within the MPA, or that are exploited elsewhere but depend upon the protected area's habitat for essential 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.
- One in six jobs in the United States is ocean related.
- 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.
- Tourism and recreation is the largest sector of the ocean economy, contributing to 75 percent of employment and 51 percent of GDP.
- More than 160 million people live in the coastal watershed counties of the United States and the five U.S. territories, representing just over half the U.S population in 2010.

## 7. THE OCEAN IS LARGELY UNEXPLORED

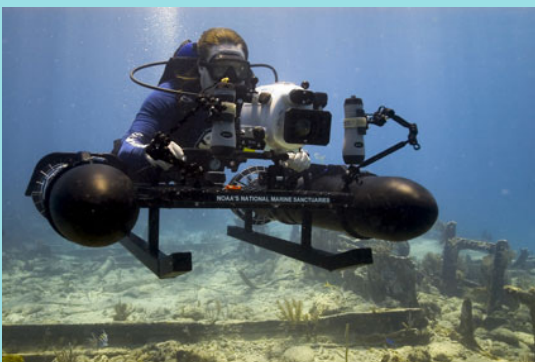
- a. The ocean is the last and largest unexplored place on Earth— less than 5% of it has been explored. This is the great frontier for the next generation’s explorers and researchers, where they will find great opportunities for inquiry and investigation.
- b. Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.
- 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 now an essential part of ocean sciences. Models help us understand the complexity of the ocean and of its interaction with Earth’s climate. They process observations and help describe the interactions among systems.
- f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.

### 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](http://www.youtube.com/watch?v=Wyvc_r_0HgA)
- Biographies of MPA Federal Advisory Committee Members  
<http://www.mpa.gov/fac/bios/>

### 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

Read the MPA Federal Advisory Committee member bios to explore a range of careers related to the ocean and read about individuals who are heavily involved in underwater exploration. Watch FAC member Michelle Ridgway describe her experience of exploring the world’s largest undersea canyon.

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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