

Ocean Literacy - The Essential Principles and Fundamental Concepts of Ocean Sciences and Excellence in Environmental Education – Guidelines for Learners (K-12)

Crosswalk for Twelfth Grades

Ocean Literacy – The Essential Principles and Fundamental Concepts of Ocean Sciences		Excellence in Environmental Education Guidelines for Learning (K-12) (2010)	
OL CODE	1. The Earth has one big ocean with many features.	EE Code	Twelfth Grade
1.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.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
1.B	An ocean basin’s size, shape and features (such as 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.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
1.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.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
1.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.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
1.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	2.1A 2.1B	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to

	comes from eroding land, volcanic emissions, reactions at the seafloor, and atmospheric deposition.		characteristics of the Earth. B) Changes in matter —Learners apply their understanding of chemical reactions to round out their explanations of environmental characteristics and everyday phenomena.
1.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.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth —Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
1.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.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth —Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
1.H	Although the ocean is large, it is finite and resources are limited.	2.1A 2.4C	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth —Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth. STRAND 2.4: Environment & Society C) Resources —Learners understand that the importance and use of resources change over time and vary under different economic and technological systems.
OL Code	The ocean and life in the ocean shape the features of the Earth.	EE Code	Twelfth Grade
2.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.	2.1A 2.1B	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth —Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth. B) Changes in matter —Learners apply their understanding of chemical reactions to round out their explanations of environmental characteristics and everyday phenomena.
2.B	Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and shaped the surface of land.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth —Learners understand the major physical processes that shape the Earth. They can

			relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
2.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.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
2.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.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
2.E	Tectonic activity, sea level changes, and force of waves influence the physical structure and landforms of the coast.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
OL Code	3. The ocean is a major influence on weather and climate.	EE Code	Twelfth Grade
3.A	The ocean controls weather and climate by dominating the Earth’s energy, water and carbon systems.	2.1A 2.1B 2.1C	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth. B) Changes in matter— Learners apply their understanding of chemical reactions to round out their explanations of environmental characteristics and everyday phenomena. C) Energy— Learners apply their knowledge of energy and matter to understand phenomena in the world around them.
3.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.	2.1C	STRAND 2.1—The Earth as a Physical System C) Energy— Learners apply their knowledge of energy and matter to understand phenomena in the world around them.

3.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.	2.1A 2.1C	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth. C) Energy— Learners apply their knowledge of energy and matter to understand phenomena in the world around them.
3.D	Most rain that falls on land originally evaporated from the tropical ocean.	2.1A	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
3.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.	2.1B 2.2A 2.2C	STRAND 2.1—The Earth as a Physical System B) Changes in matter— Learners apply their understanding of chemical reactions to round out their explanations of environmental characteristics and everyday phenomena. STRAND 2.2—The Living Environment A) Organisms, populations, and communities— Learners understand basic population dynamics and the importance of diversity in living systems. C) Systems and connections— Learners understand the living environment to be comprised of interrelated, dynamic systems.
3.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.	2.1A 2.1B 2.1C	STRAND 2.1—The Earth as a Physical System A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth. B) Changes in matter— Learners apply their understanding of chemical reactions to round out their explanations of environmental characteristics and everyday phenomena. C) Energy— Learners apply their knowledge of energy and matter to understand phenomena in the world around them.
3.G	Changes in the ocean’s circulation have produced large, abrupt changes in	2.1A	STRAND 2.1—The Earth as a Physical System

	climate during the last 50,000 years.		A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.
OL Code	4. The ocean makes Earth habitable.	EE Code	Twelfth Grade
4.A	Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean.	2.1B 2.2D	STRAND 2.1—The Earth as a Physical System B) Changes in matter— Learners apply their understanding of chemical reactions to round out their explanations of environmental characteristics and everyday phenomena. STRAND 2.2—The Living Environment D) Flow of matter and energy— Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems.
4.B	The first life is thought to have started in the ocean. The earliest evidence of life is found in the ocean.	2.2A 2.2B	STRAND 2.2—The Living Environment A) Organisms, populations, and communities— Learners understand basic population dynamics and the importance of diversity in living systems. B) Heredity and evolution – Learners understand the basic ideas and genetic mechanisms behind biological evolution.
OL Code	5. The ocean supports a great diversity of life and ecosystems.	EE Code	Twelfth Grade
5.A	Ocean life ranges in size from the smallest virus to the largest animal that has lived on Earth, the blue whale.	2.2A	STRAND 2.2—The Living Environment A) Organisms, populations, and communities— Learners understand basic population dynamics and the importance of diversity in living systems.
5.B	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.	2.2A	STRAND 2.2—The Living Environment A) Organisms, populations, and communities— Learners understand basic population dynamics and the importance of diversity in living systems.
5.C	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.	2.2A	STRAND 2.2—The Living Environment A) Organisms, populations, and communities— Learners understand basic population dynamics and the importance of diversity in living systems.
5.D	Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (such as symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.	2.2A 2.2B 2.2C 2.2D	STRAND 2.2—The Living Environment A) Organisms, populations, and communities— Learners understand basic population dynamics and the importance of diversity in living systems. B) Heredity and evolution – Learners

			<p>understand the basic ideas and genetic mechanisms behind biological evolution.</p> <p>C) Systems and connections—Learners understand the living environment to be comprised of interrelated, dynamic systems.</p> <p>D) Flow of matter and energy—Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems.</p>
5.E	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.	2.2A	<p>STRAND 2.2—The Living Environment</p> <p>A) Organisms, populations, and communities—Learners understand basic population dynamics and the importance of diversity in living systems.</p>
5.F	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.	2.2A	<p>STRAND 2.2—The Living Environment</p> <p>A) Organisms, populations, and communities—Learners understand basic population dynamics and the importance of diversity in living systems.</p>
5.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.	2.2A 2.2C 2.2D	<p>STRAND 2.2—The Living Environment</p> <p>A) Organisms, populations, and communities—Learners understand basic population dynamics and the importance of diversity in living systems.</p> <p>C) Systems and connections—Learners understand the living environment to be comprised of interrelated, dynamic systems.</p> <p>D) Flow of matter and energy—Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems.</p>
5.H	Tides, waves and predation cause vertical zonation patterns along the shore, influencing the distribution and diversity of organisms.	2.2A	<p>STRAND 2.2—The Living Environment</p> <p>A) Organisms, populations, and communities—Learners understand basic population dynamics and the importance of diversity in living systems.</p>
5.I	Estuaries provide important and productive nursery areas for many marine and aquatic species.	2.2A 2.2C	<p>STRAND 2.2—The Living Environment</p> <p>A) Organisms, populations, and communities—Learners understand basic population dynamics and the importance of diversity in living systems.</p> <p>C) Systems and connections—Learners understand the living environment to be comprised of interrelated, dynamic systems.</p>

OL Code	6. The ocean and humans are inextricably interconnected.	EE Code	Twelfth Grade
6.A	6.A)	2.3D 2.4A	<p>STRAND 2.3—Humans and Their Societies D) Global connections—Learners are able to analyze global, social, cultural, political, economic, and environmental linkages.</p> <p>STRAND 2.4—Environment and Society A) Human/environment interactions—Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.</p>
6.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.	2.4C	<p>STRAND 2.4—Environment and Society C) Resources—Learners understand the basic concepts of resource and resource distribution.</p>
6.C	The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.	2.4B	<p>STRAND 2.4—Environment and Society B) Places—Learners understand that places differ in their physical and human characteristics.</p>
6.D	Much of the world’s population lives in coastal areas.	2.4A	<p>STRAND 2.4—Environment and Society A) Human/environment interactions—Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.</p>
6.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 (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.	2.3C 2.4A	<p>STRAND 2.3—Humans and Their Societies C) Political and economic systems—Learners understand how different political and economic systems account for, manage, and affect natural resources and environmental quality.</p> <p>STRAND 2.4—Environment and Society A) Human/environment interactions—Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.</p>
6.F	Coastal regions are susceptible to natural hazards (such as tsunamis,	2.1A 2.4A	<p>STRAND 2.1—The Earth as a Physical System</p>

	hurricanes, cyclones, sea level change, and storm surges).		<p>A) Processes that shape the Earth— Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.</p> <p>STRAND 2.4—Environment and Society</p> <p>A) Human/environment interactions— Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.</p>
6.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.	4A 4B 4C 4D	<p>STRAND 4—Personal and Civic Responsibility</p> <p>A) Understanding societal values and principles—Learners know how to analyze the influence of shared and conflicting societal values.</p> <p>B) Recognizing citizens’ rights and responsibilities—Learners understand the importance of exercising the rights and responsibilities of citizenship.</p> <p>C) Recognizing efficacy—Learners possess a realistic self-confidence in their effectiveness as citizens.</p> <p>D) Accepting personal responsibility— Learners understand that their actions can have broad consequences and accept responsibility for recognizing those effects and changing their actions when necessary.</p>
OL Code	7. The ocean is largely unexplored.	EE Code	Twelfth Grade
7.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.	1A	<p>STRAND 1 – Questioning, Analysis, and Interpretation Skills</p> <p>A) Questioning—Learners are able to develop, modify, clarify, and explain questions that guide environmental investigations of various types. They understand factors that influence the questions they pose.</p>
7.B	Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.	1A 1B	<p>STRAND 1 – Questioning, Analysis, and Interpretation Skills</p> <p>A) Questioning—Learners are able to develop, modify, clarify, and explain questions that guide environmental investigations of various types. They understand factors that influence the questions they pose.</p> <p>B) Designing investigations—Learners know how to design investigations to answer particular questions about the environment. They are able to develop</p>

			approaches for investigating unfamiliar types of problems and phenomena.
7.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.		
7.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.		
7.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.	1F	STRAND 1—Questioning, Analysis and Interpretation Skills F) Working with models and simulations – Learners are able to create, use, and evaluate models to understand environmental phenomena.
7.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.		