



BLUE MINDS 4 TEACHERS

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Principle 5: The ocean supports a great diversity of life and ecosystems.

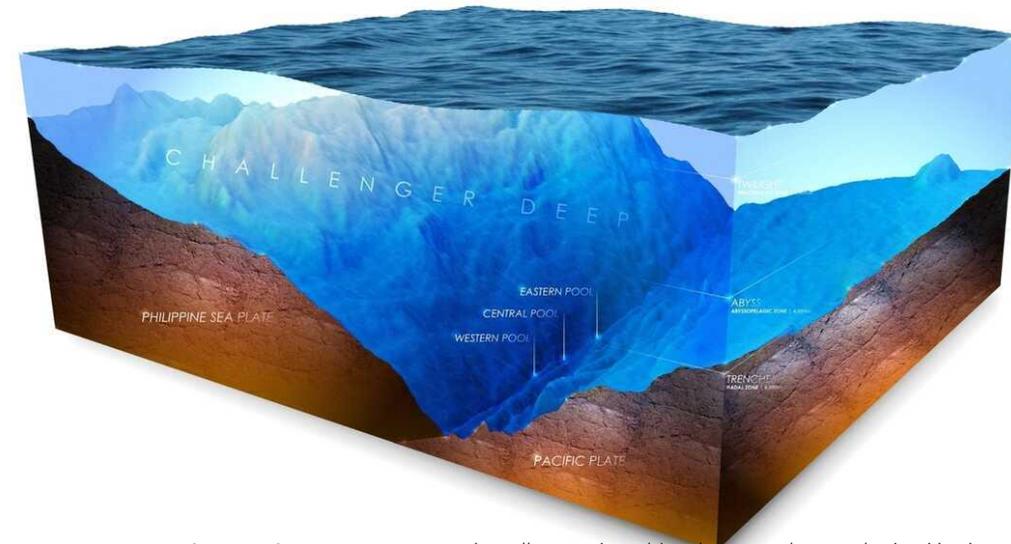


https://commons.wikimedia.org/wiki/File:140724_Biei_Hokkaido_Japan01s8.jpg
 Attribution: 663highland



<https://oceaninfo.com/ocean/properties/how-deep-is-the-ocean/>

- Very narrow living space on land
- Vast interconnected living space with diverse and unique ecosystems from the surface through the water column and down to the sea floor - 11 000 m (Mariana trench – Challenger Deep)

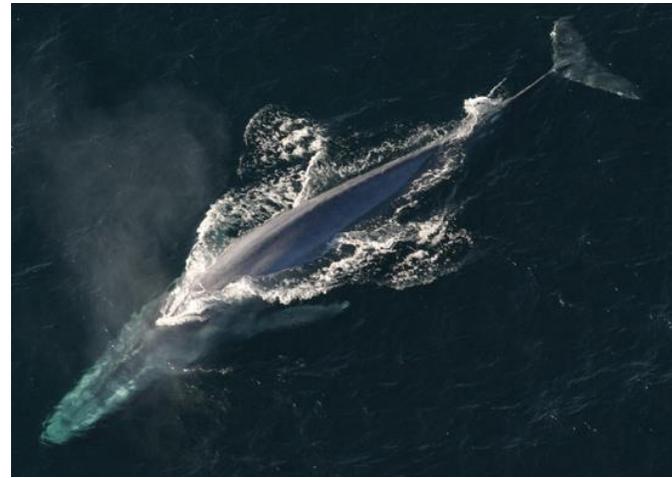


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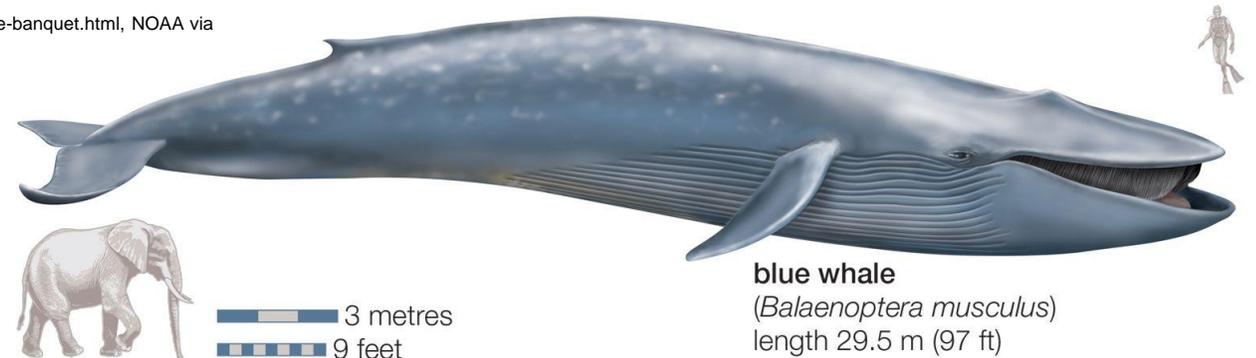
- a) Ocean life ranges in size from the smallest living things, microbes, to the largest animal on Earth, blue whales.



<https://www.nationalgeographic.com/science/article/these-microbes-drive-the-planets-breath-and-oceans-pulse> Credit: Ed Delong and Dave Karl, Soest, University of Hawaii at Manoa



<https://www.nhm.ac.uk/discover/a-blue-whale-banquet.html>, NOAA via Wikimedia Commons



blue whale
(*Balaenoptera musculus*)
length 29.5 m (97 ft)

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- 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.
- Phytoplankton, cyanobacteria - at the bottom of most of the ocean food webs
 - Primary production - PHOTOSYNTHESIS



<https://www.bbc.co.uk/newsround/67913636>, Elif Bayraktar



https://en.m.wikipedia.org/wiki/File:Prochlorococcus_marinus.jpg, Luke Thompson from Chisholm Lab and Nikki Watson from Whitehead, MIT

Principle 5: The ocean supports a great diversity of life and ecosystems.

- The diversity of ocean ecosystems allows many different and unique lifeforms and adaptations of ocean organisms.
- 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 (echinoderms, ctenophores, tunicates, and most sponges and cnidaria).



<https://www.snorkeling-report.com/species/arbacia-lixula/>, © thecoralnerd



https://en.wikipedia.org/wiki/Echinaster_positus Diego Delso, delso.photo, License CC-BY-SA



https://commons.wikimedia.org/wiki/File:Holothuria_tubulosa.jpg, Frédéric Ducarme



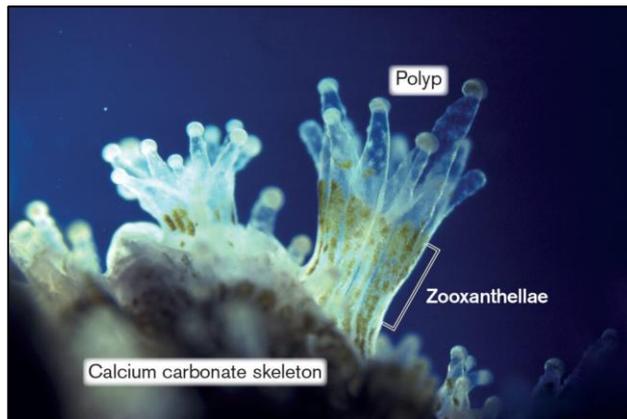
[https://commons.wikimedia.org/wiki/File:Pi%C3%B1a_de_mar_\(Phallusia_mammillata\),_Parque_natural_de_la_Arr%C3%A1bida,_Portugal,_2020-07-31,_DD_72.jpg](https://commons.wikimedia.org/wiki/File:Pi%C3%B1a_de_mar_(Phallusia_mammillata),_Parque_natural_de_la_Arr%C3%A1bida,_Portugal,_2020-07-31,_DD_72.jpg) Diego Delso, delso.photo, License CC-BY-SA



https://commons.wikimedia.org/wiki/File:Aplysina_aerophoba.jpg, credit: Yoruno

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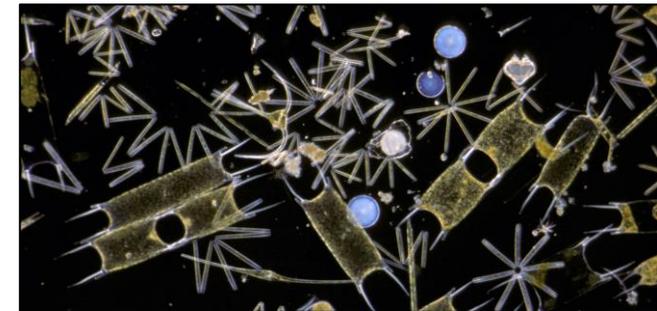
- The diversity of ocean ecosystems allows many different and unique lifeforms and adaptations of ocean organisms.
- d) Ocean biology provides many unique examples of life cycles, adaptations, and important relationships among organisms (symbiosis, predator-prey dynamics, and energy transfer) that do not occur on land.
- Symbiosis – corals and zooxanthellae (algae)
- Bioluminescence - angler fish (Finding Nemo)
- Buoyancy – oil droplets in phytoplankton – omega-3-fatty acids



<https://oceanus.org.mx/en/coral-reefs/>



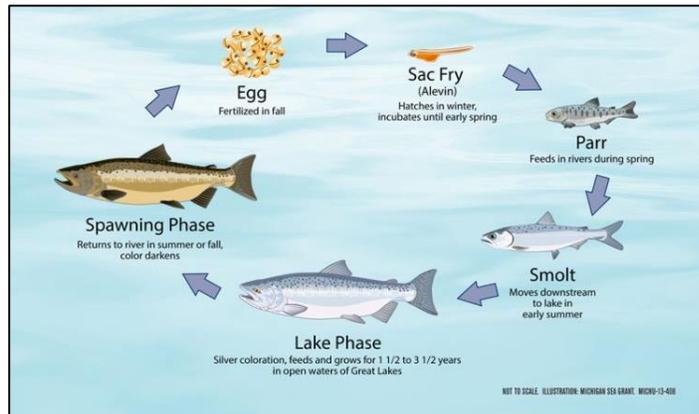
<https://www.shapeoflife.org/news/featured-creature/2021/01/19/anglerfish>



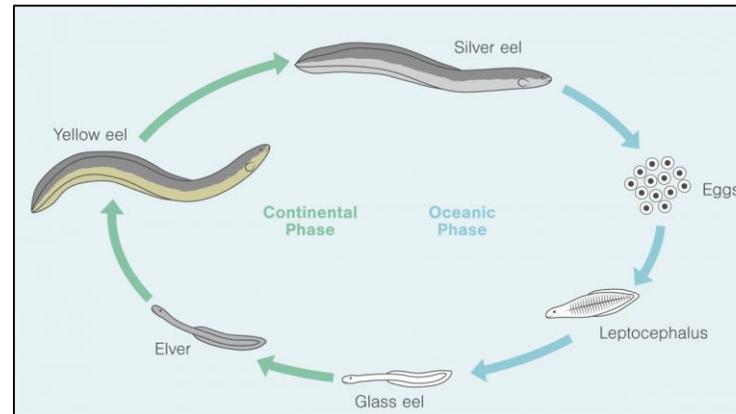
<https://hakimagazine.com/news/why-are-there-so-many-kinds-of-phytoplankton/> Photo by D. P. Wilson/FLPA/Minden Pictures

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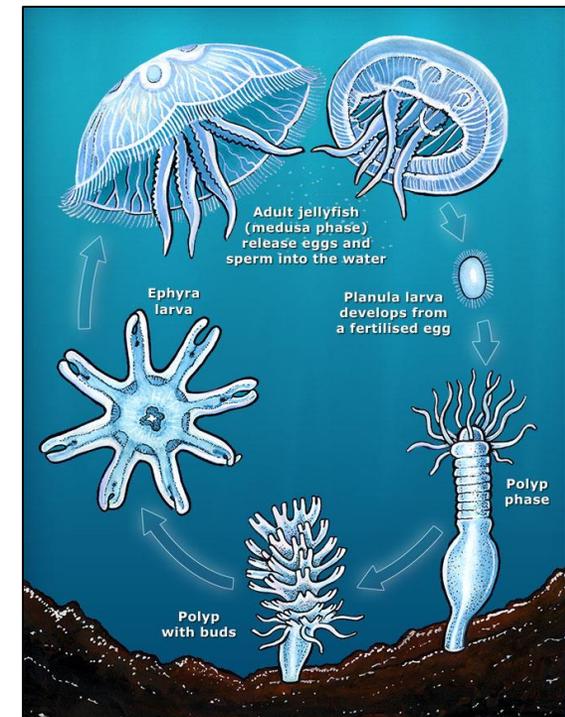
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- Complex life cycles with:
 - freshwater and marine life phases – salmon and eel
 - plankton and benthos life phases – jellyfish



https://www.canr.msu.edu/news/great_lakes_migrants_more_than_just_salmon, Todd Marsee | Michigan Sea Grant



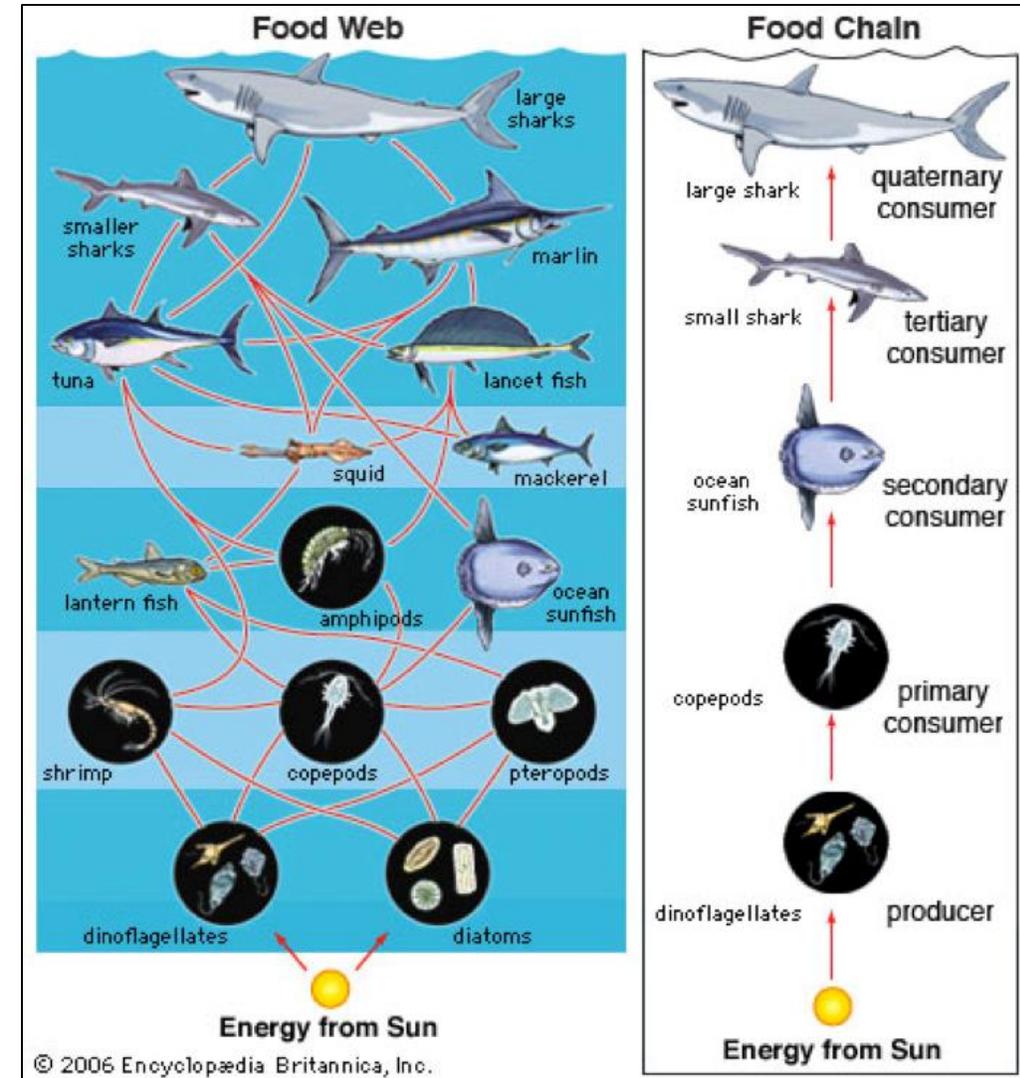
<https://hakaimagazine.com/features/eel-of-fortune/>, Illustration by Mark Garrison



<https://teara.govt.nz/en/diagram/5355/jellyfish-life-cycle>

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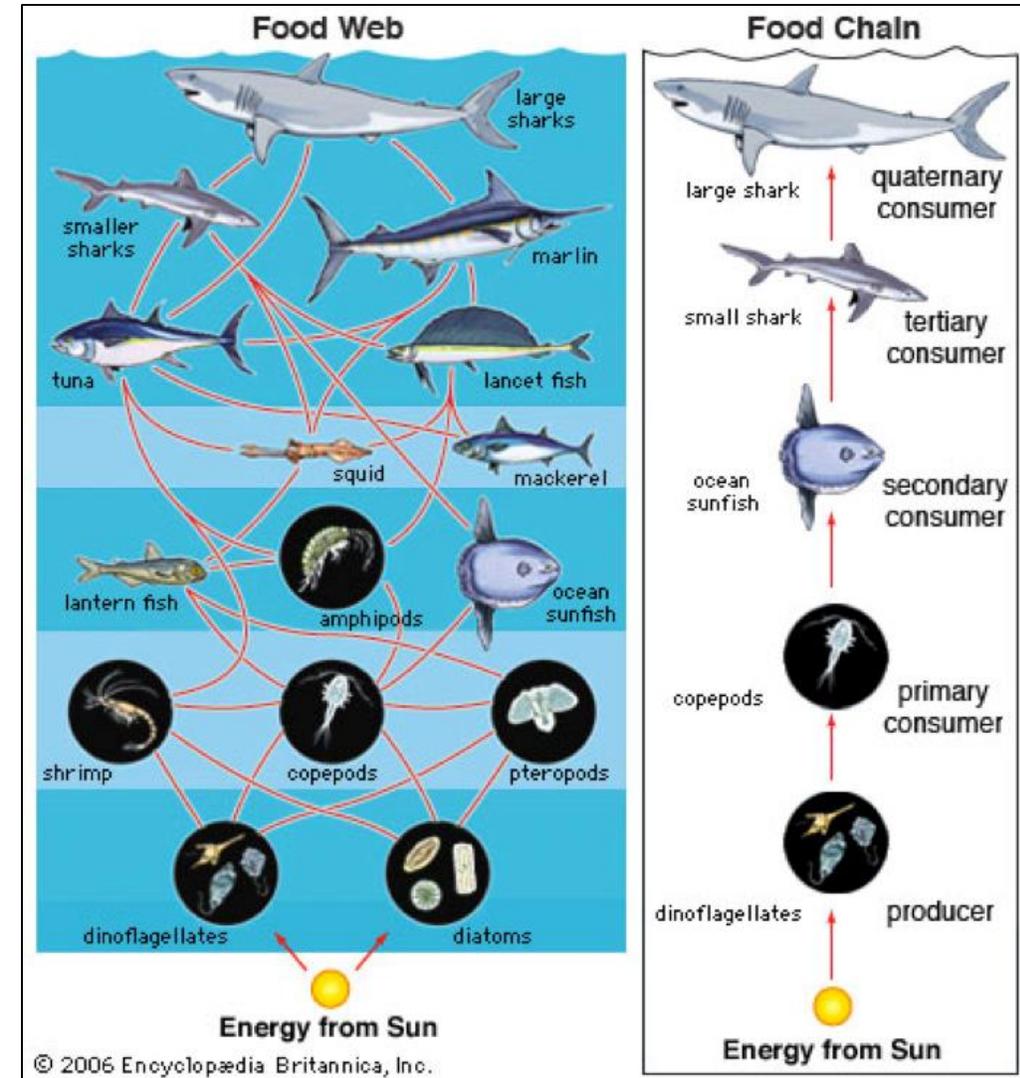
- e) The ocean provides a vast living space with diverse and unique ecosystems from the surface through the water column and down to, and below, the seafloor. Most of the living space on Earth is in the ocean.
- f) Ocean ecosystems are defined by environmental factors and the community of organisms living 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.



<https://oceantracks.org/sites/oceansofdata.org/files/foodwebchain.png>

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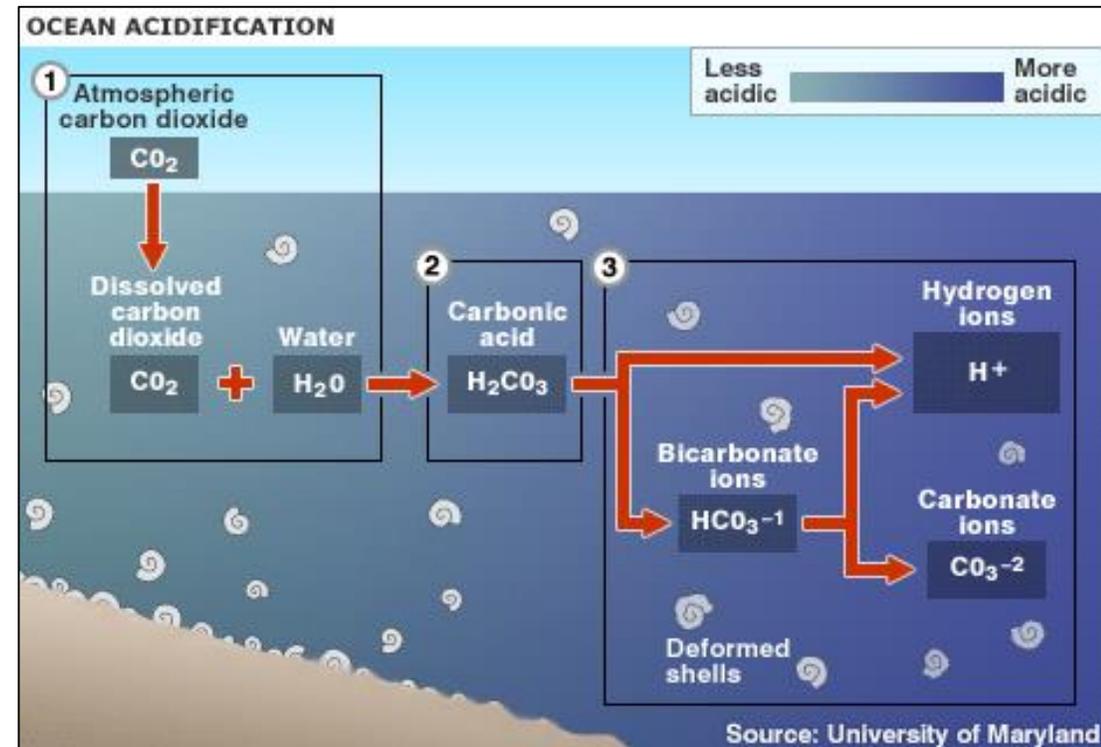
- Organisms and ecosystems are connected to each other in a macro food web. Over time, organisms move from one ecosystem to another as they grow, migrate, and die.
- Changes in an ecosystem or an organism may have unpredictable effects on other ecosystems (nutrients, organic matter, oxygen use, energy transfer)



<https://oceantracks.org/sites/oceansofdata.org/files/foodwebchain.png>

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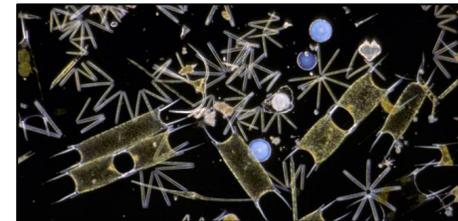
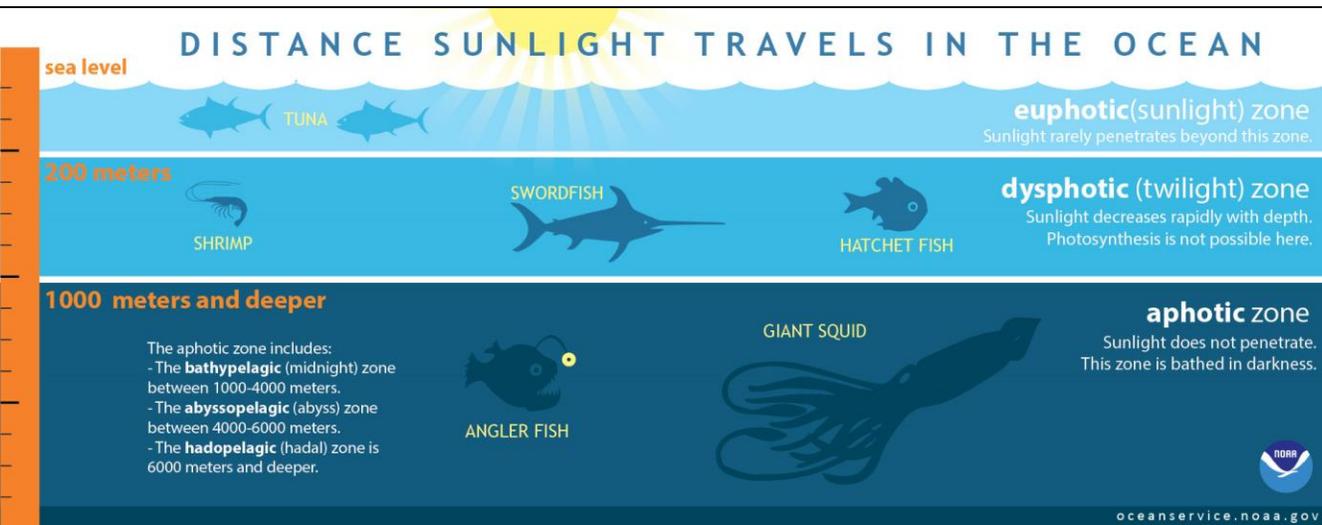
- Ocean acidification (OA) is an increase in the acidity of the ocean over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide (CO_2) from the atmosphere.
- Acidity is the concentration of hydrogen ions (H^+) in a liquid, and pH is the logarithmic scale on which this concentration is measured. It is important to note that acidity increases as the pH decreases.
- OA is changing seawater carbonate chemistry. The concentrations of dissolved CO_2 , hydrogen ions, and bicarbonate ions are increasing, and the concentration of carbonate ions (which provide chemical building blocks for marine organisms' shells and skeletons) is decreasing (corals, molluscs, urchins, gastropods, algae ...)



<https://www.otago.ac.nz/future-ocean/about/ocean-acidification>

Principle 5: The ocean supports a great diversity of life and ecosystems.

- Most of ocean biomass is in the euphotic zone – up to 200 meters, where there is enough sunlight for the photosynthesis



PHYTOPLANKTON

<https://hakaimagazine.com/news/why-are-there-so-many-kinds-of-phytoplankton/> Photo by D. P. Wilson/FLPA/Minden Pictures

SEAWEED/MACRO ALGAE



<https://more.slobodnadalmacija.hr/om/vijesti/ova-alga-prekriva-cijelo-dno-na-mnogim-mjestima-oko-komize-1198867> SHUTTERSTOCK



SEAGRASS

[https://en.wikipedia.org/wiki/File:Posidonia_oceanica_\(L\).jpg](https://en.wikipedia.org/wiki/File:Posidonia_oceanica_(L).jpg)

Principle 5: The ocean supports a great diversity of life and ecosystems.

- Some of the most diverse ecosystems are coral reefs and seagrass meadows
- *Posidonia oceanica* – Mediterranean endemic species, “lungs of the Mediterranean”



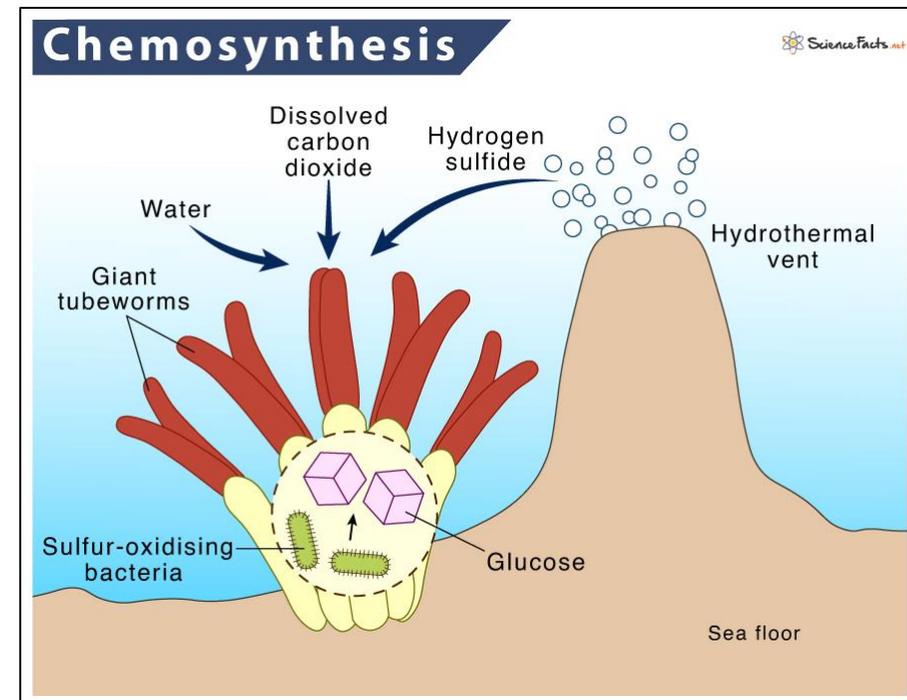
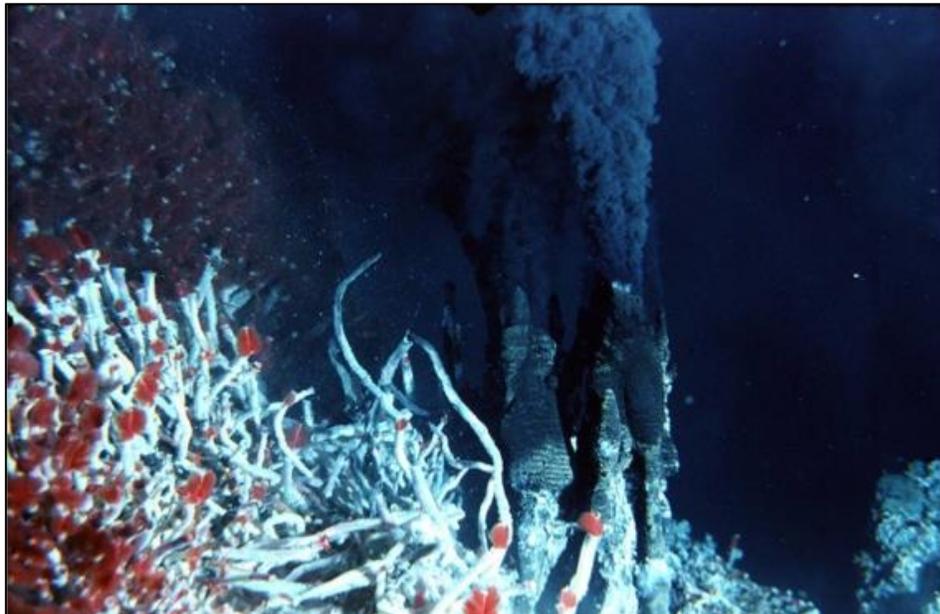
<https://www.nationalgeographic.com/science/article/scientists-work-to-save-coral-reefs-climate-change-marine-parks> PHOTOGRAPH BY GREG LECOEUR, NAT GEO IMAGE COLLECTION



[https://en.wikipedia.org/wiki/File:Posidonia_oceanica_\(L\).jpg](https://en.wikipedia.org/wiki/File:Posidonia_oceanica_(L).jpg)

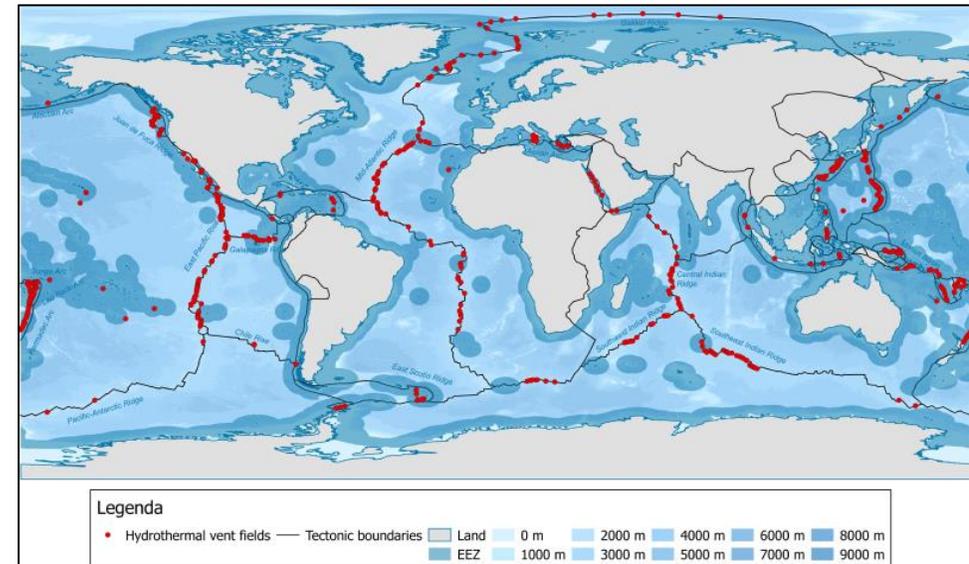
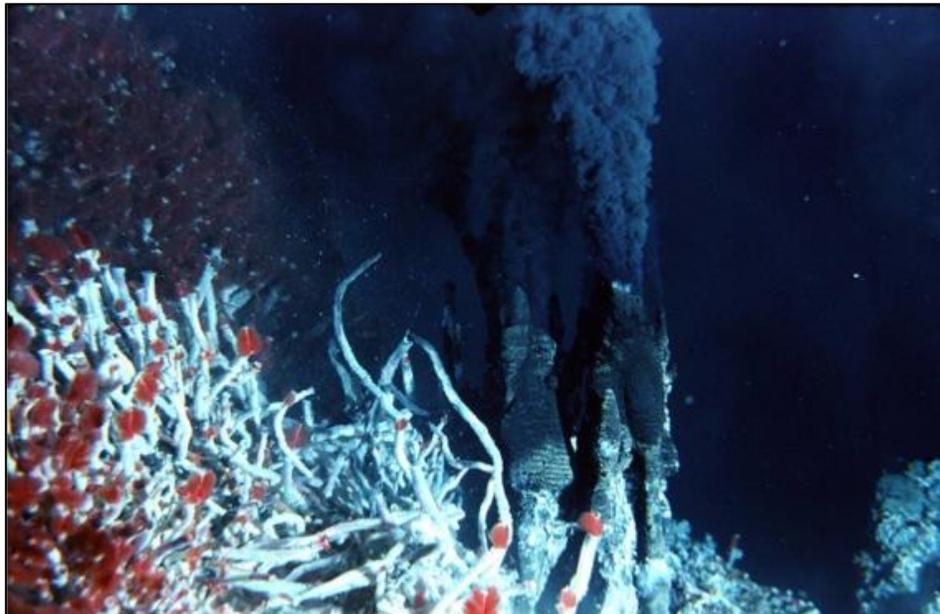
Principle 5: The ocean supports a great diversity of life and ecosystems.

- 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.
- First hydrothermal vents discovered in 1977, and before that it was believed that life couldn't exist without the sun
- They are present in all world oceans



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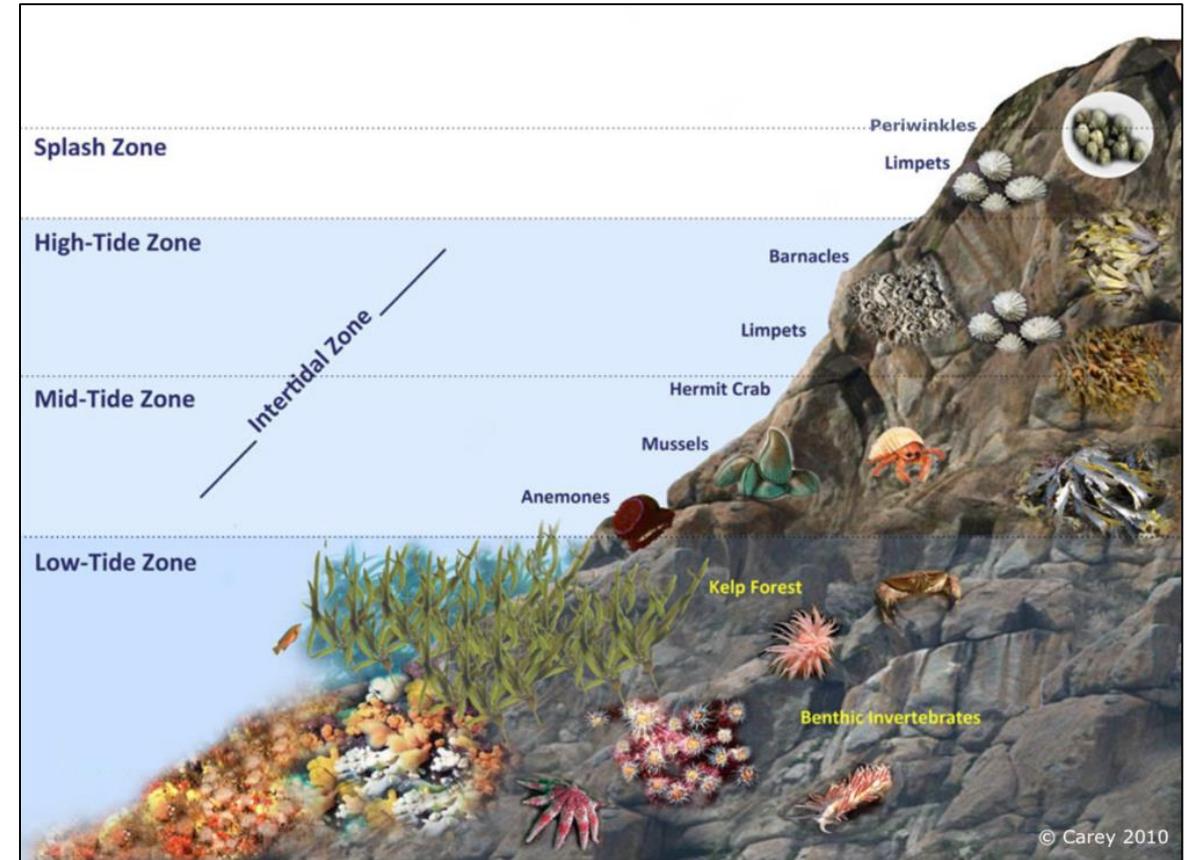


https://commons.wikimedia.org/wiki/File:Distribution_of_hydrothermal_vent_fields.png, Photo by: DeDuijn

<https://www.youtube.com/watch?v=xFAu8CqCtR8>

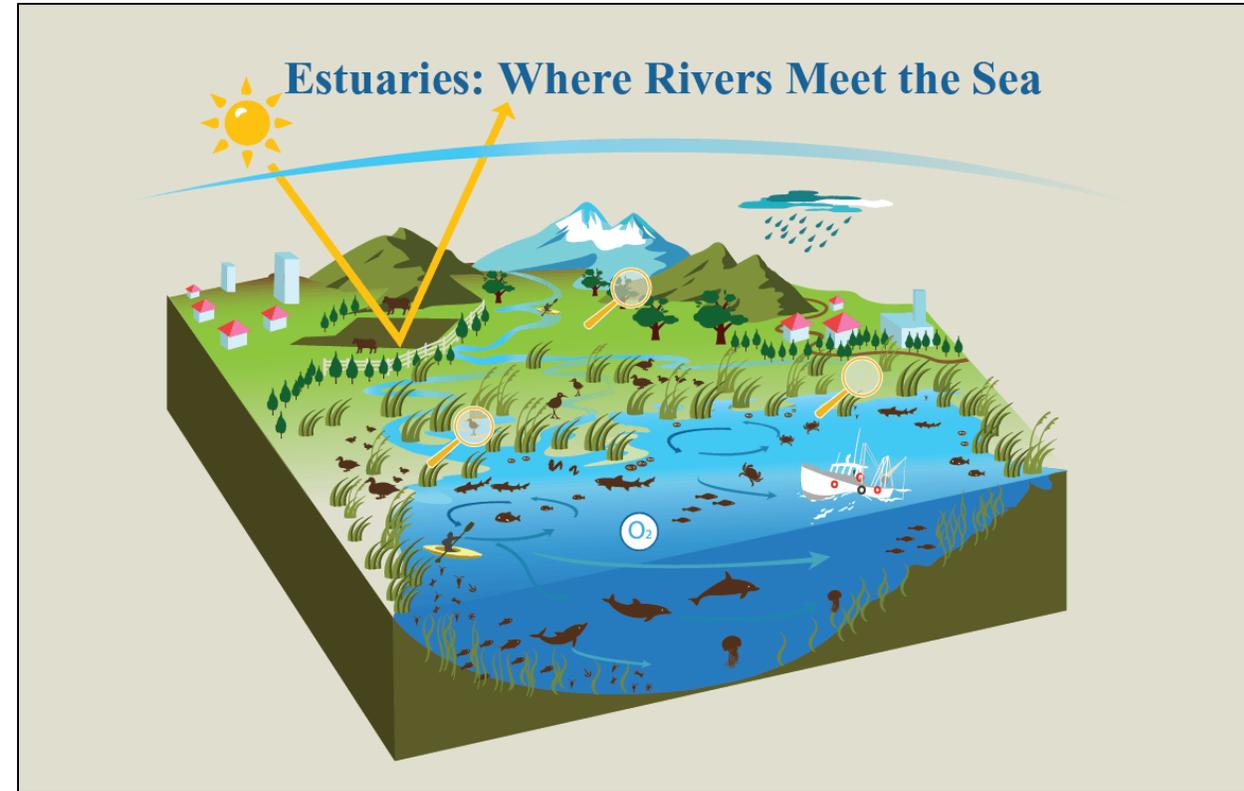
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- h) Tides, waves, predation, substrate, and/or other factors cause vertical zonation patterns along the coast; density, pressure, and light levels cause vertical zonation patterns in the open ocean. Zonation patterns influence organisms' distribution and diversity.
- Intertidal zone – bordering the land and the sea, zone between the high tide and the low tide, extreme habitat due to extreme life conditions (moisture, temperature, wave action, etc.), distribution of organisms here is defined by the sea level and the impact of the waves



Principle 5: The ocean supports a great diversity of life and ecosystems.

- i) Estuaries provide important and productive nursery areas for many marine and aquatic species.
 - A place where river meets the sea
 - They support a great diversity and number of organisms - nutrients flowing into the ocean from rivers which boost primary production.
 - Great place for juvenile organisms to be as they can feed with plankton
 - Mixture of freshwater and saltwater – salinity gradient
 - Diverse habitats
 - Under anthropogenic pressure (coastal development, eutrophication)



<https://coast.noaa.gov/estuaries/curriculum/climate-extension.html>

Scope and Sequence conceptual flow diagram

GRADES 9 THROUGH 12

Principle 5, Part 1



**Principle 5:
The ocean supports a great diversity of life and ecosystems.**

The ocean provides a vast, interconnected living space with diverse and unique ecosystems from the surface through the water column and down to the sea floor.

Primary Productivity

Ecosystem Diversity

A. Microbes, such as cyanobacteria and phytoplankton, are the most abundant lifeforms, and the most important primary producers in the ocean. They are the base of most of the food webs in the ocean.

B. Ocean ecosystems are defined by environmental factors and the community of organisms living there.

A.1. Primary production is the net gain in organic matter that occurs when producers make more organic matter than they use in respiration.

A.7. Chlorophyll, the green pigment found in microbes, algae, and other photosynthetic organisms, absorbs energy from sunlight; and together with carbon dioxide (inorganic carbon) and water, converts and stores chemical energy in the form of glucose (organic carbon).

B.1. 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 the vast majority of the ocean does not support much life.

B.6. Ocean ecosystems are often composed of habitats and microhabitats that exist in distinct, vertically distributed zones. Vertical zonation exists as distinct horizontal layers or bands on the coastline and throughout the water column.

A.2. Nutrients, such as minerals and vitamins, are needed to convert glucose into other organic material used to grow and reproduce. Some of the most important nutrients for producers in the ocean include: nitrogen (especially nitrate), phosphate, silicate, and iron. Nitrogen is often the nutrient in shortest supply.

A.6. Organisms that do not make their own food (heterotrophs) are dependent on the primary producers (autotrophs) to get the energy and matter they need to survive.

B.2. Ocean ecosystems with the greatest abundance of life occur where environmental conditions and/or adaptations allow for high levels of productivity.

B.7. Zonation patterns occur in part because ocean organisms are adapted to live within specific environmental conditions.

B.10. Ocean ecosystems are connected to each other in a macro food web. Over time, organisms move from one ecosystem to another as they grow, migrate, and die. Changes in an ecosystem or an organism may have unpredictable effects on other ecosystems.

B.11. Ocean ecosystems support a large number of niches—the range of environmental conditions, including physical (e.g., temperature, depth) and biological (e.g., competitors, predators) under which an organism can live, and its role in the ecosystem (e.g., what it does and what it eats).

A.3. Most of the nutrients needed for primary productivity come from nutrient recycling. Nitrogen, phosphorous, and other nutrients in organic molecules, such as proteins and nucleic acids, are released when organisms die and are decomposed by bacteria.

A.4. Some of the organic matter produced by primary producers sinks below the sunlit surface zone, carrying nutrients to the deep.

B.3. Coastal habitats, such as estuaries and kelp forests, support a great diversity of organisms, which is due in part to: abundant sunlight and current patterns (e.g., upwelling, which brings nutrients to the surface, and nutrients flowing into the ocean from rivers).

B.4. 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.

B.5. Coral reefs, one of the most diverse ecosystems on Earth, thrive in nutrient-poor, warm waters because of a symbiotic relationship between corals and zooxanthellae, a type of dinoflagellate. This relationship enables corals to grow, forming substrates that are the foundation of complex reef ecosystems.

B.8. Many intertidal organisms are adapted to survive in zones defined by tidal cycles (amount of time exposed to air), crashing waves, predation, or substrate.

B.9. Many open ocean organisms are adapted to live only within distinct density layers or in zones defined by pressure or light levels.

B.12. Niches in the ocean are in a very dynamic environment, contributing to the high diversity seen in this ecosystem, e.g., sudden upwelling events create an environment conducive to the survival of a different set of organisms than were present prior to the influx of nutrient-rich water.

See Principle 2: B1

See Principle 1: C5

See Principle 2: B4

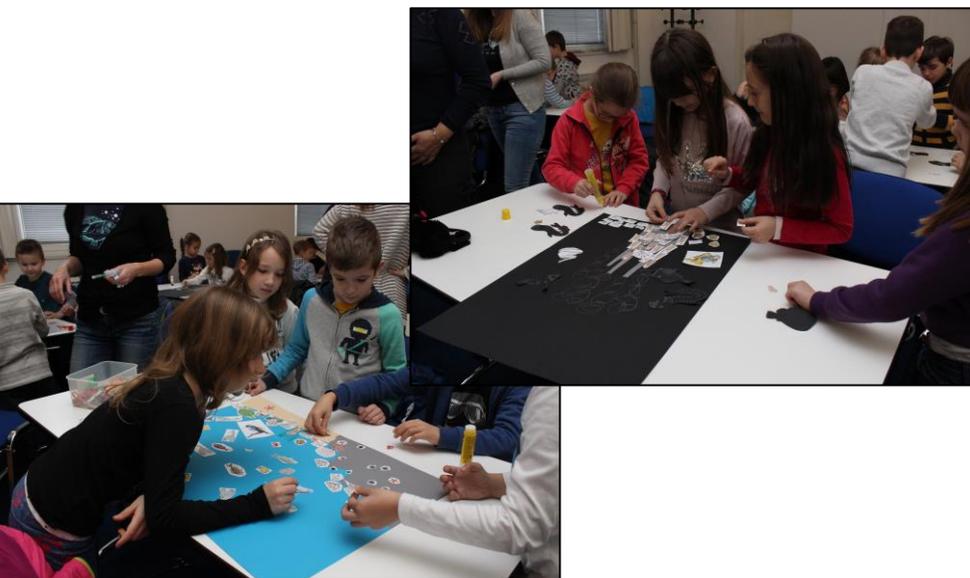
See Principle 1: C12
See Principle 2: B1

See Principle 1: C17

<https://www.marine-ed.org/ocean-literacy/scope-and-sequence>

Examples of projects and activities

- *The sea of light, the sea of the dark* – comparison of life conditions in the photic and aphotic zone, hydrothermal vents, research methods
- *Living on the edge* – life in the intertidal zone (bioblitz)
- A wave of European Blue Schools. Handbook for teachers https://maritime-forum.ec.europa.eu/system/files/2021-02/handbook_european_blue_schools_220221.pdf



Principle 5: The ocean supports a great diversity of life and ecosystems.

- Natural resources are at the baseline of sustainability
- As the ocean covers 71% of Earth, marine resources and ecosystems are at the baseline of Earth (human) sustainability
- Preserving biodiversity and stable marine ecosystems are crucial for sustaining both, **NATURE AND SOCIETY**

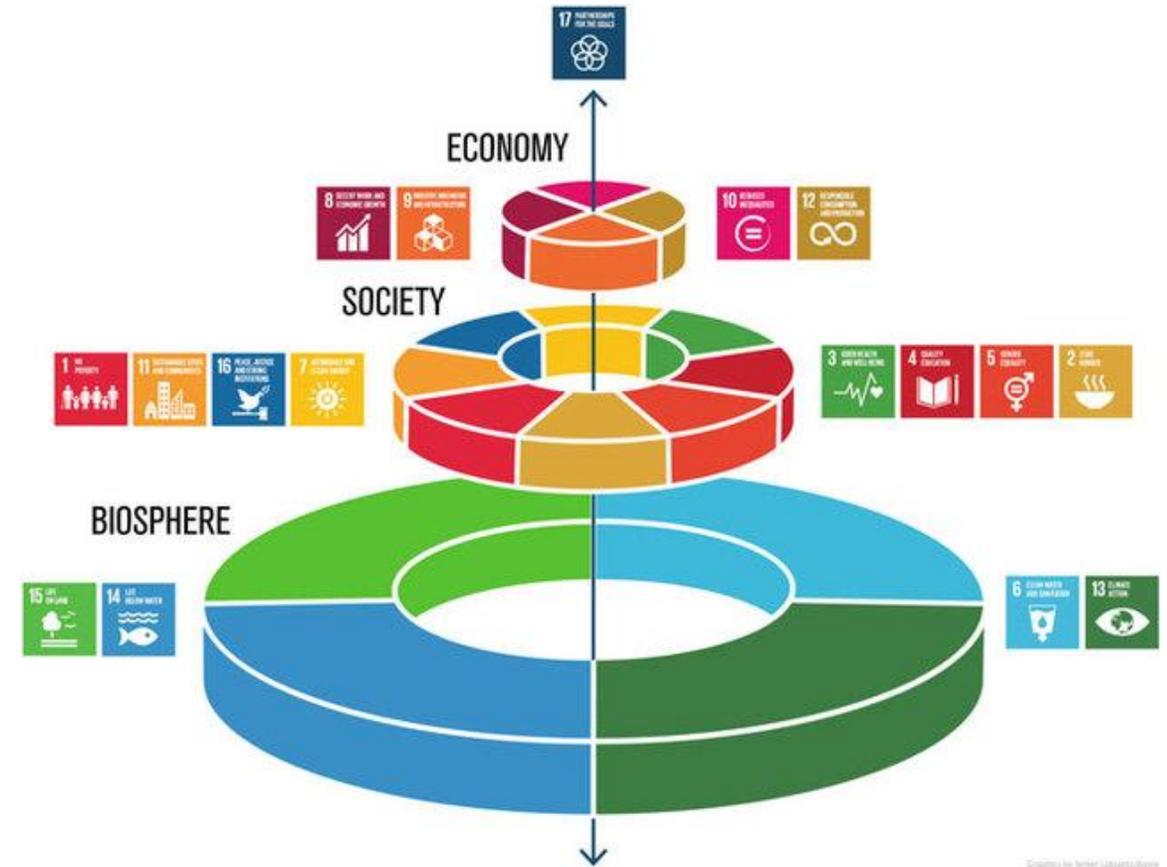


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