BLUE MINDS 4 TEACHERS

Melita Mokos

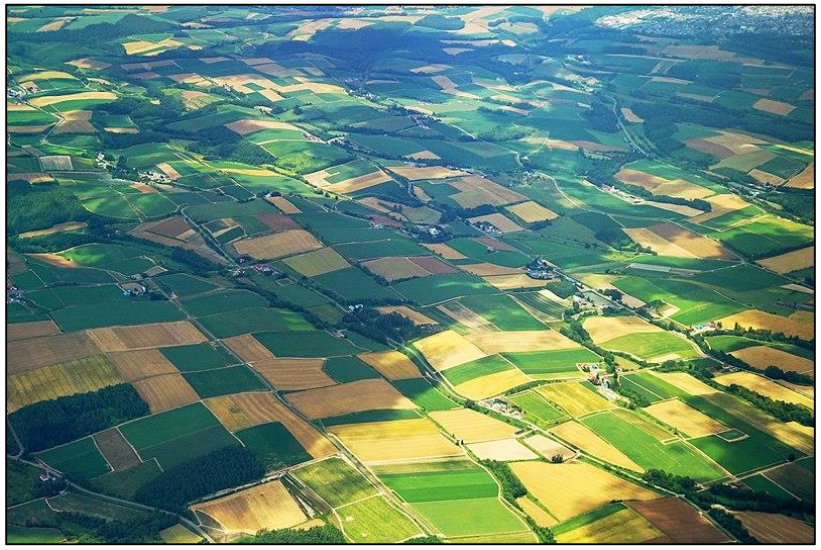
Department of Ecology, Agronomy and Aquaculture

University of Zadar

Zadar, Croatia

mmokos@unizd.hr

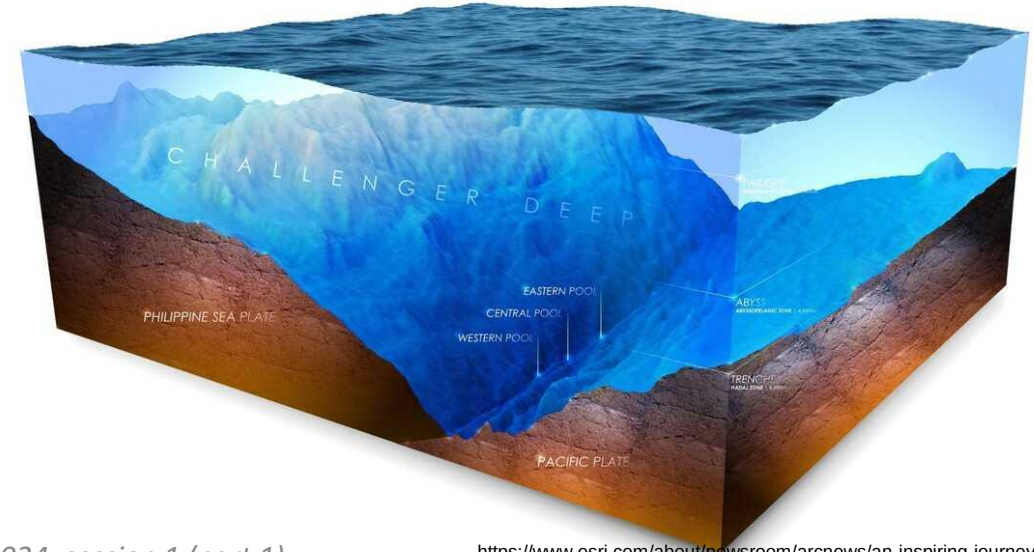
Principle 5: The ocean supports a great diversity of life and ecosystems.



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)



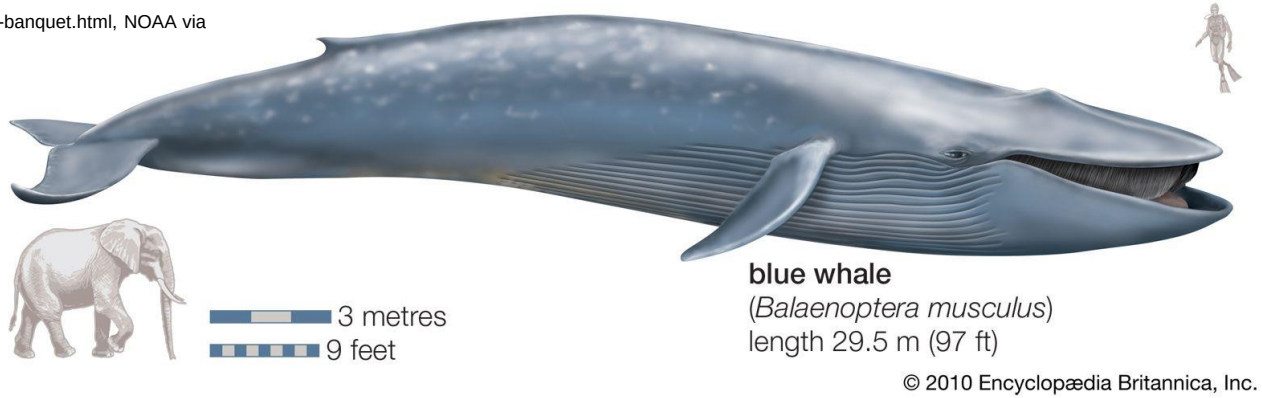
https://www.esri.com/about/newsroom/arcnews/an-inspiring-journey-to-map-the-deepest-part-of-the-ocean/ John Nelson, Esri.)

Principle 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.

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

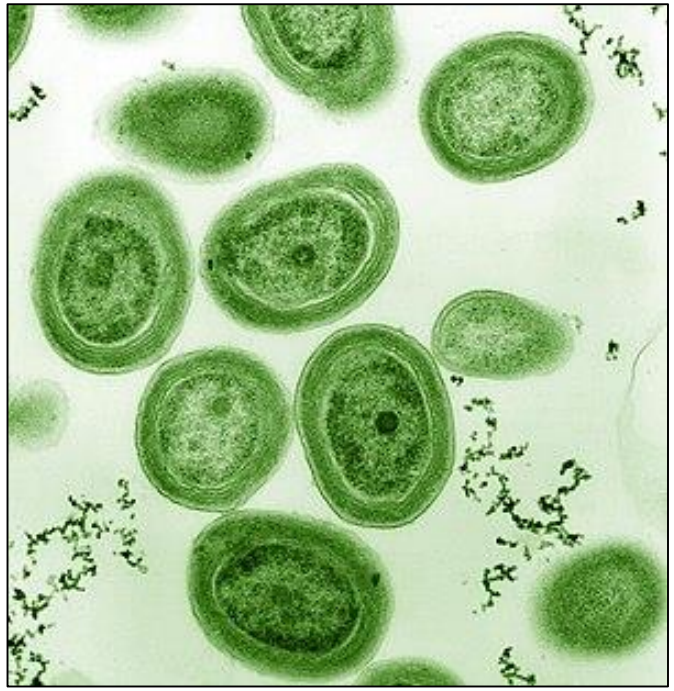


Principle 5: The ocean supports a great diversity of life and ecosystems.

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, cynobacteria - at the bottom of most of the ocean food webs
- Primary production - PHOTOSYNTHESIS

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



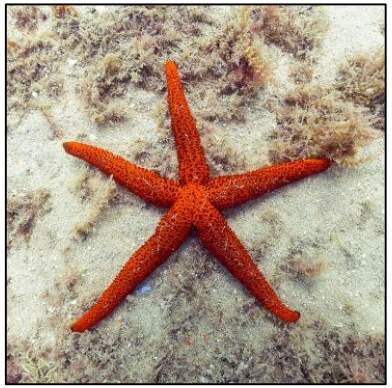
https://en.m.wikipedia.org/wiki/File:Prochlorococcus_marinus.jpg, Luke Thompson from Chisholm Lab and Nikki Watson from Whitehead, MIT

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_sepositus 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 *Diego Delso, delso.photo, License CC-BY-SA*

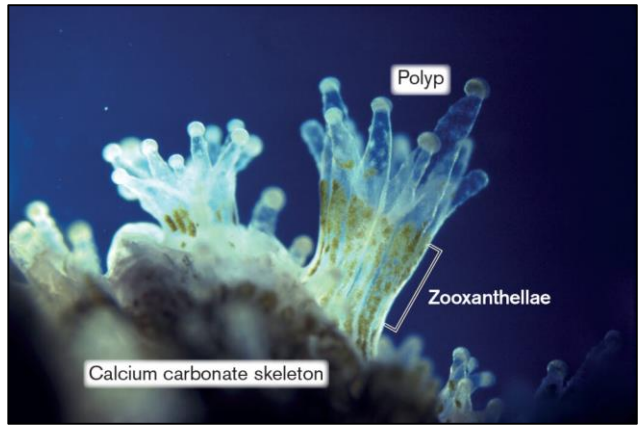
https://commons.wikimedia.org/wiki/File:Aplysina_aerophoba.jpg, credit: Yoruno

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

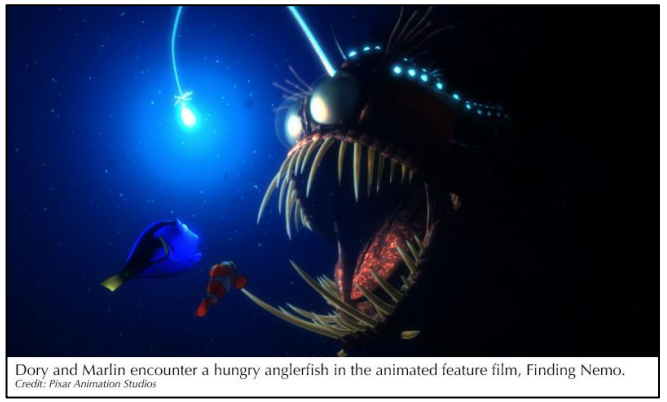
- **The diversity of ocean ecosystems allows many different and unique lifeforms and adaptations of ocean organisms.**

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)
- Bioluminiscence - angler fish (Finding Nemo)
- Buoyancy – oil droplets in phytoplankton – omega-3-fatty acids

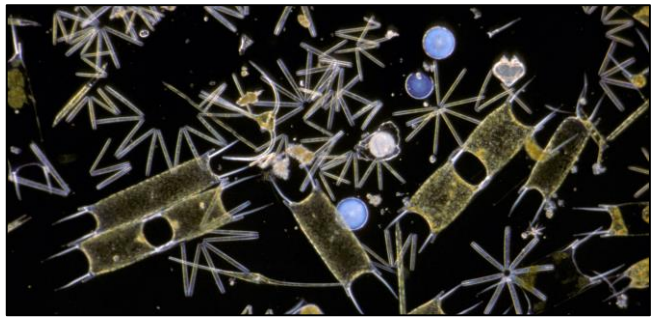


https://oceanus.org.mx/en/coral-reefs/



Dory and Marlin encounter a hungry anglerfish in the animated feature film, Finding Nemo.
Credit: Pixar Animation Studios

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



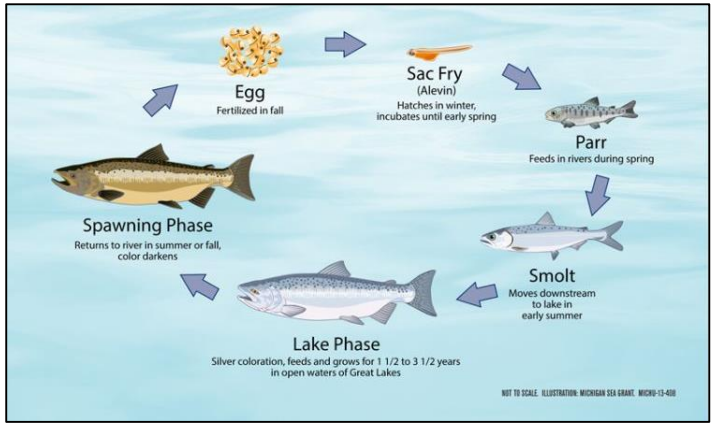
https://hakaimagazine.com/news/why-are-there-so-many-kinds-of-phytoplankton/ Photo by D. P. Wilson/FLPA/Minden Pictures

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

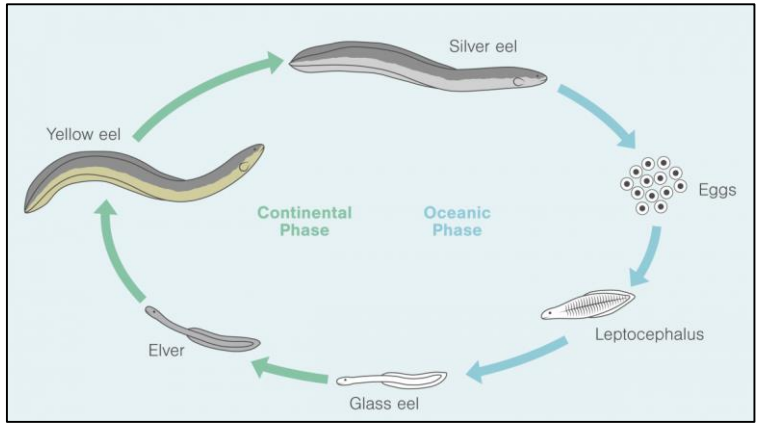
- **The diversity of ocean ecosystems allows many different and unique lifeforms and adaptations of ocean organisms.**

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.

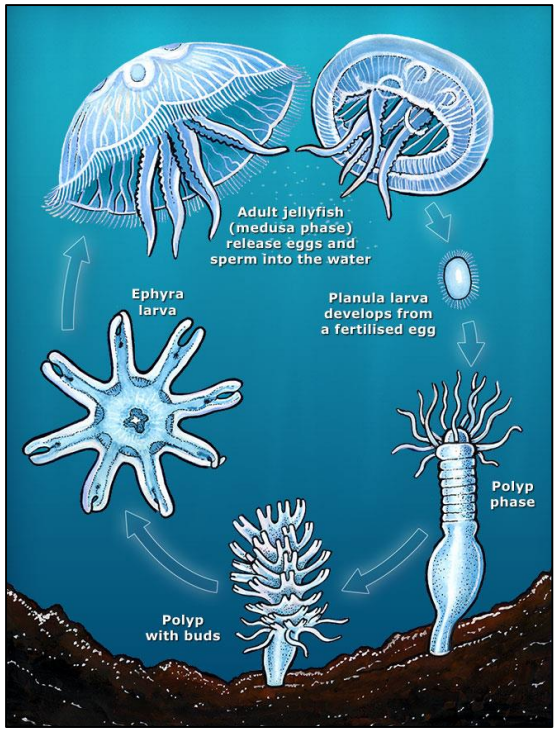
- Complex life cycles with:
  - freshwater and marine life phases – salmon and eel
  - plankton and benthos life phases – jellyfish



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

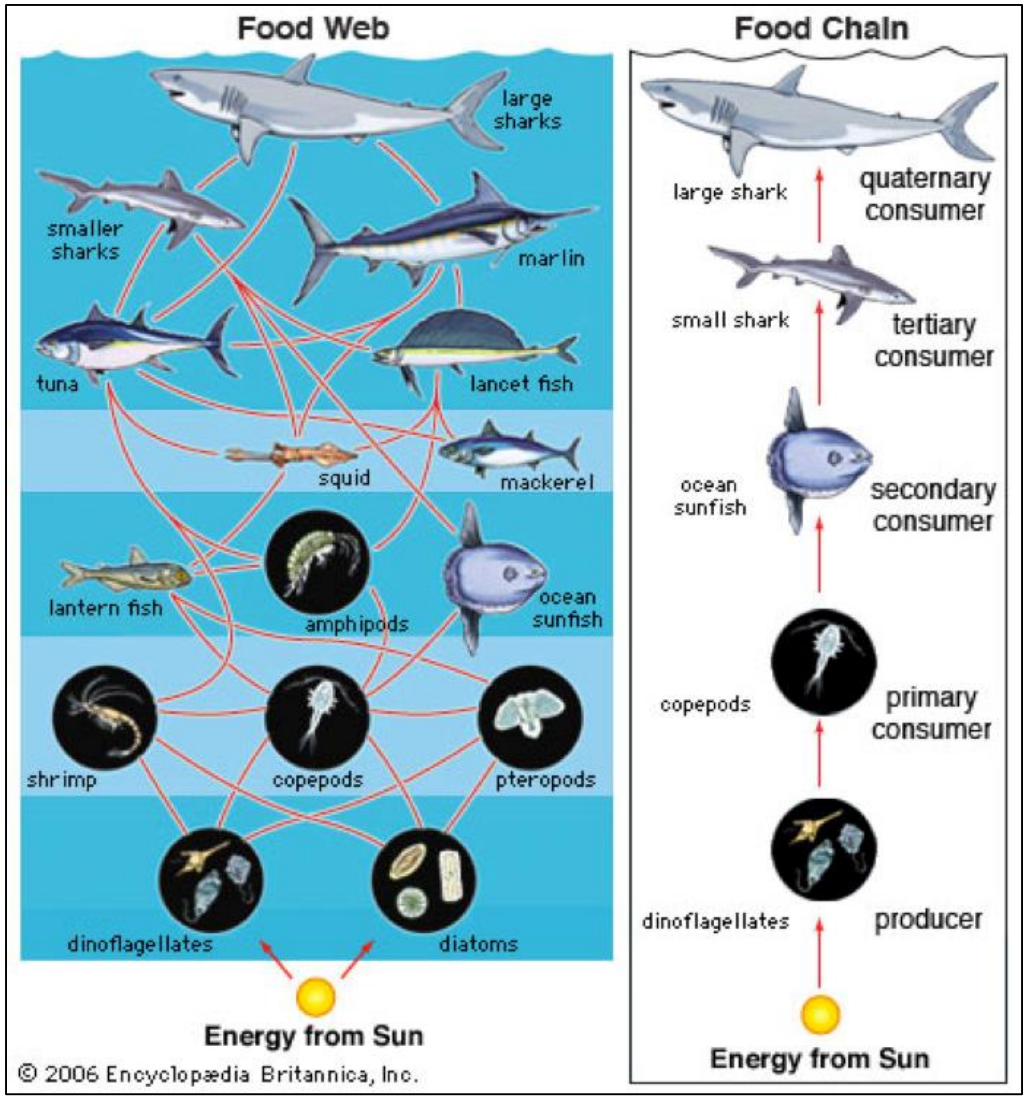


https://teara.govt.nz/en/diagram/5355/jellyfish-life-cycle

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

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.

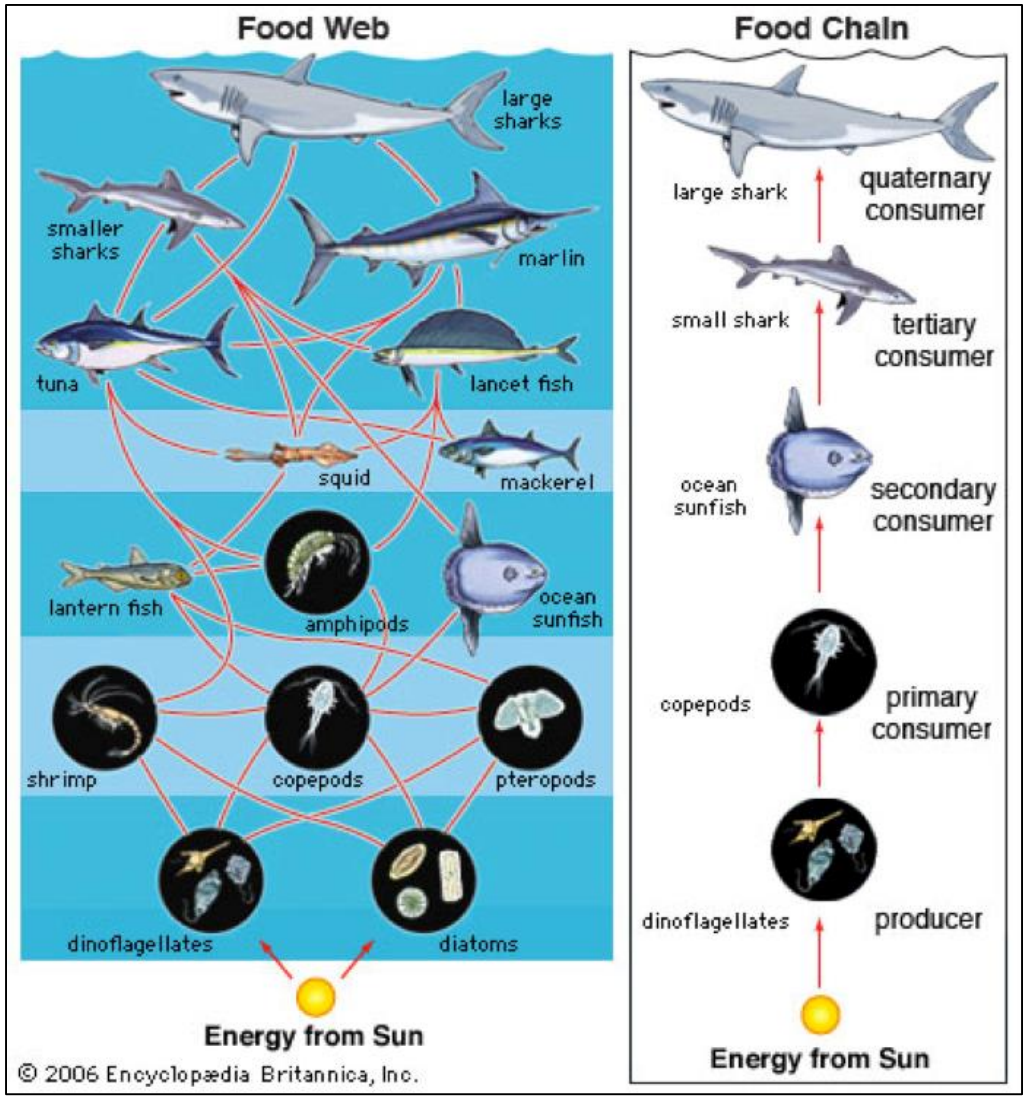
f) Ocean ecosystems are defined by environmental factors and the community of organisms living there. Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation. A few 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

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

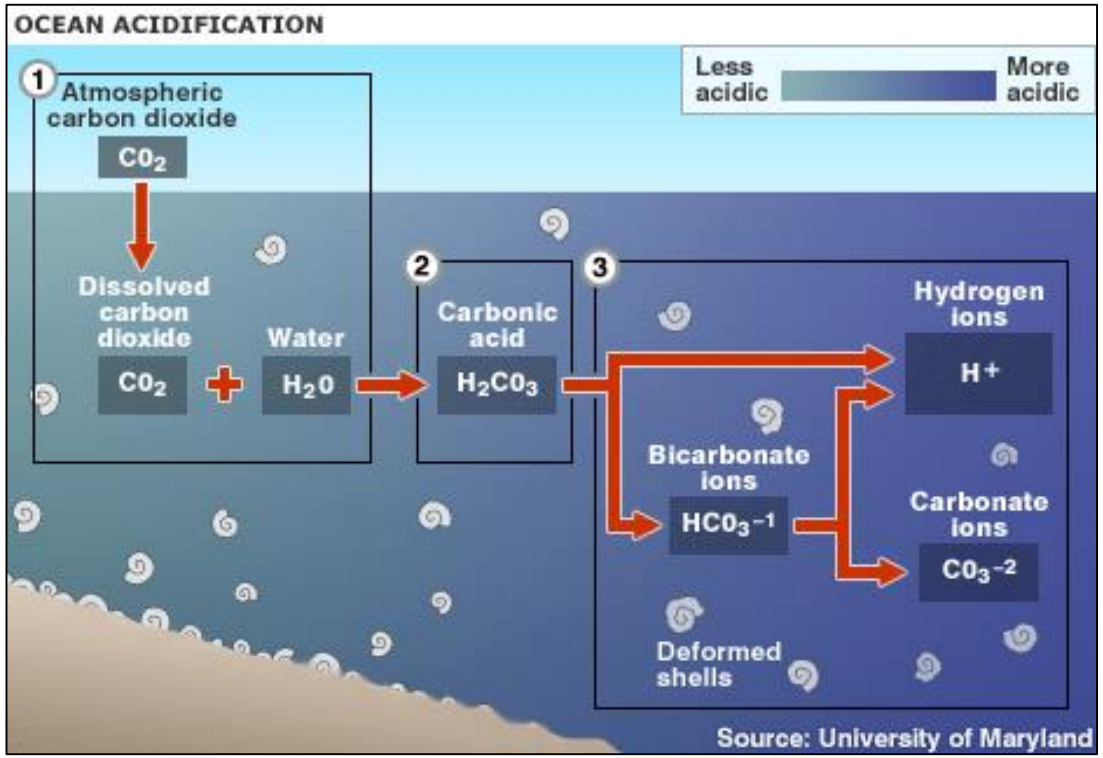
- Organisms and ecosystems are connected to each other in a macro food web. Over time, organisms move from one ecosystem to another as they grow, migrate, and die.
- Changes in an ecosystem or an organism may have unpredictable effects on other ecosystems (nutrients, organic matter, oxygen use, energy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



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

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

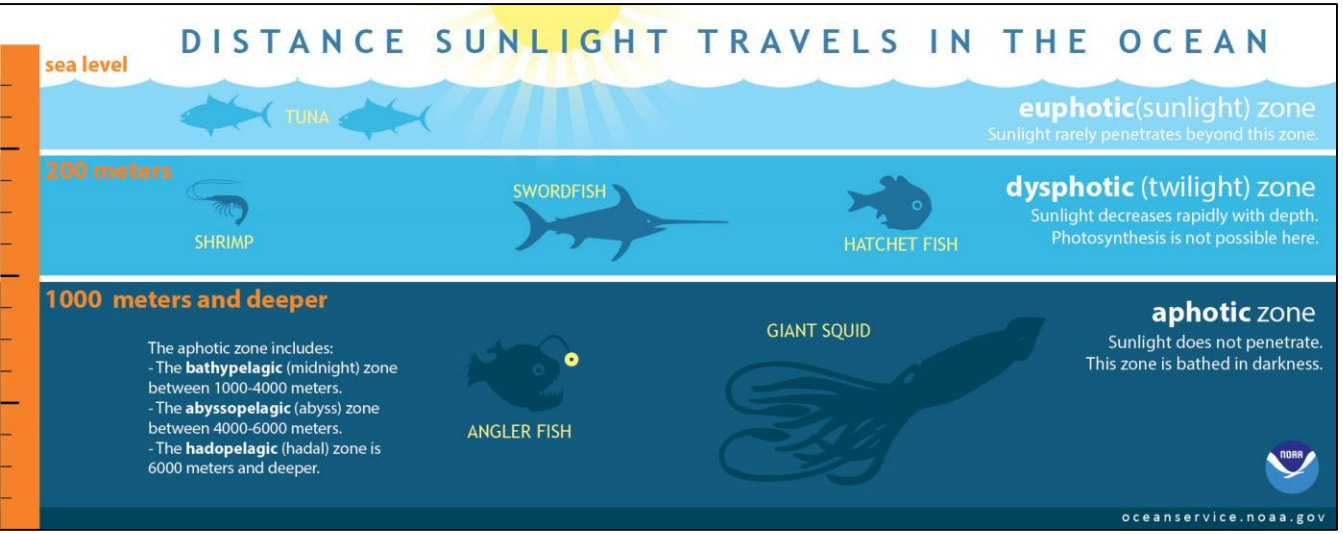
- Ocean acidification (OA) is an increase in the acidity of the ocean over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide (CO_2) from the atmosphere.
- Acidity is the concentration of hydrogen ions (H+) in a liquid, and pH is the logarithmic scale 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 CO2, 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 …)



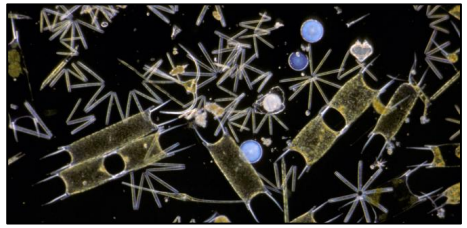
https://www.otago.ac.nz/future-ocean/about/ocean-acidification

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

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”

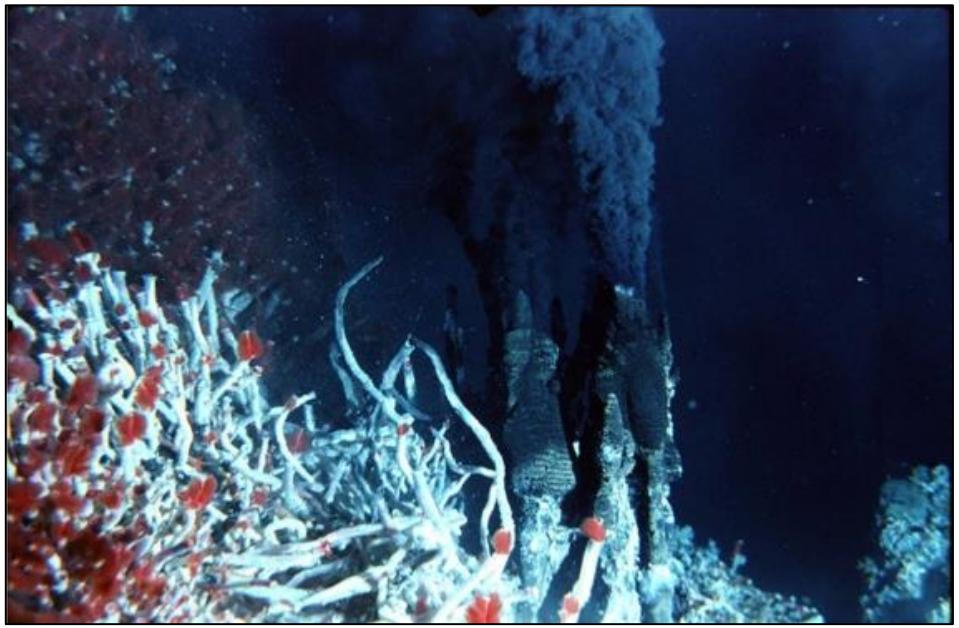
https://www.nationalgeographic.com/science/article/scientists-work-to-save-coral-reefs-climate-change-marine-parks PHOTOGRAPH BY GREG LECOEUR, NAT GEO IMAGE COLLECTION

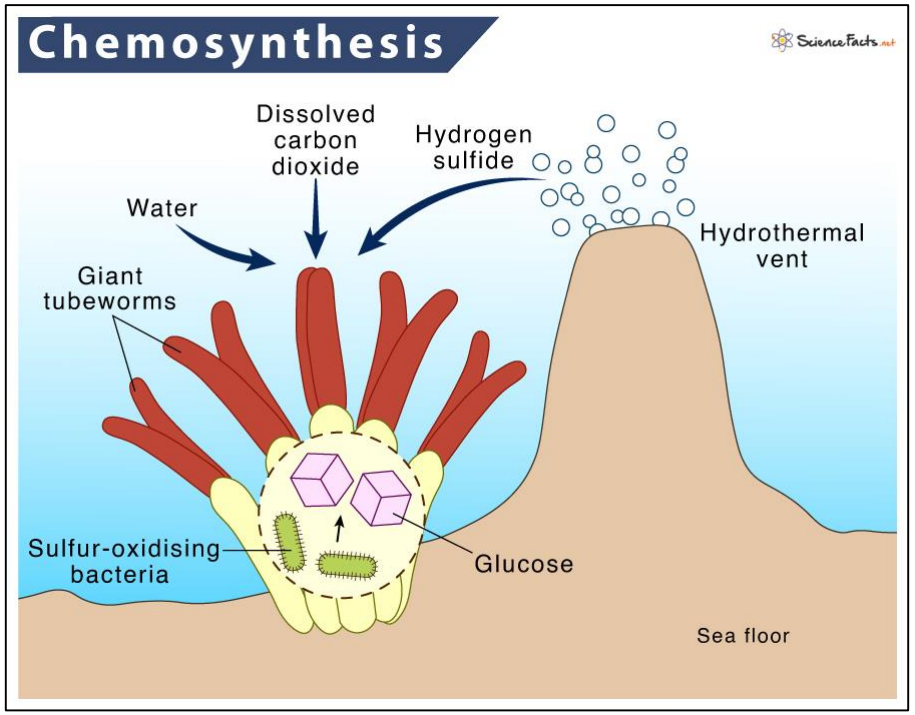
https://en.wikipedia.org/wiki/File:Posidonia_oceanica_(L).jpg

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

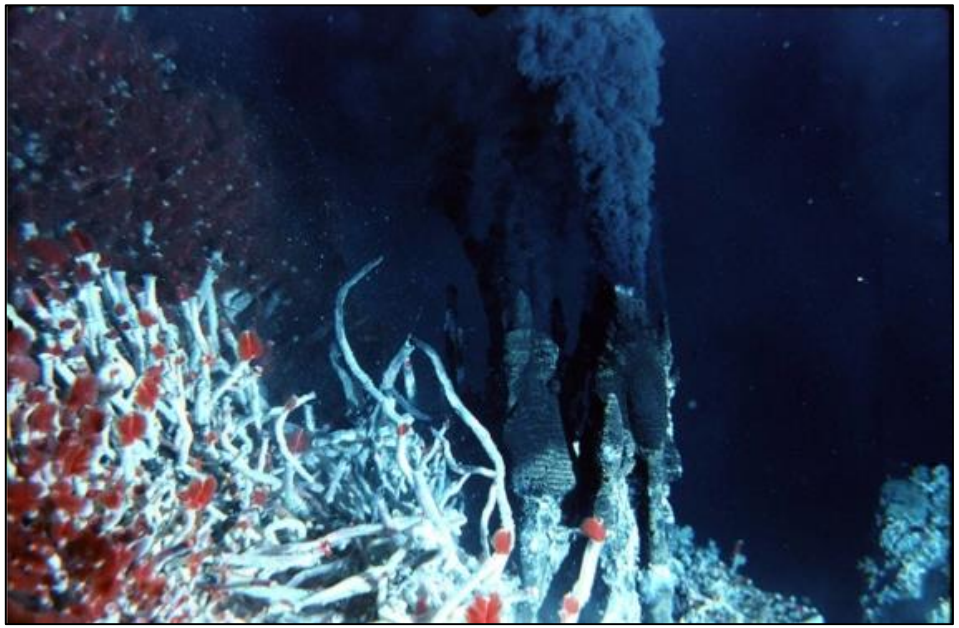


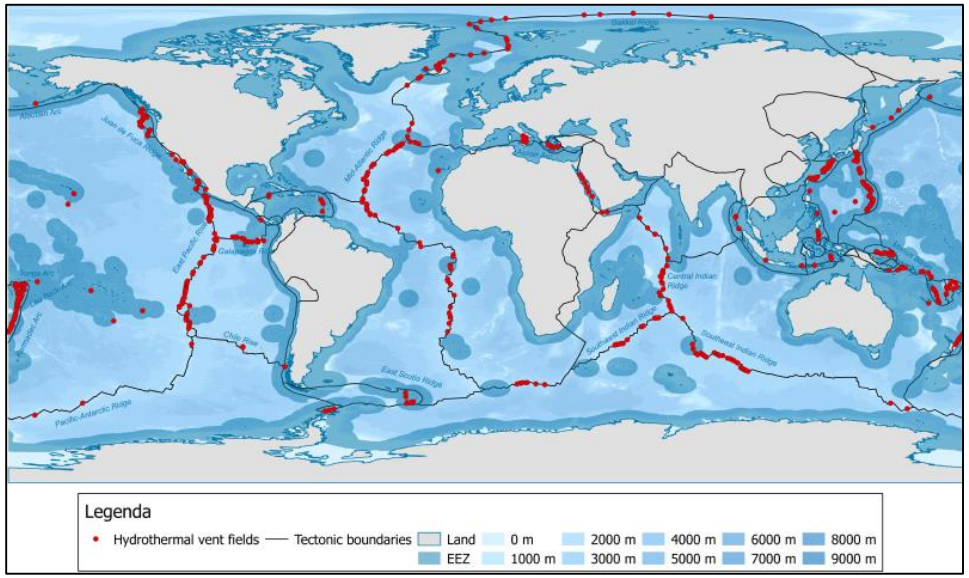


Principle 5: The ocean supports a great diversity of life and ecosystems.

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





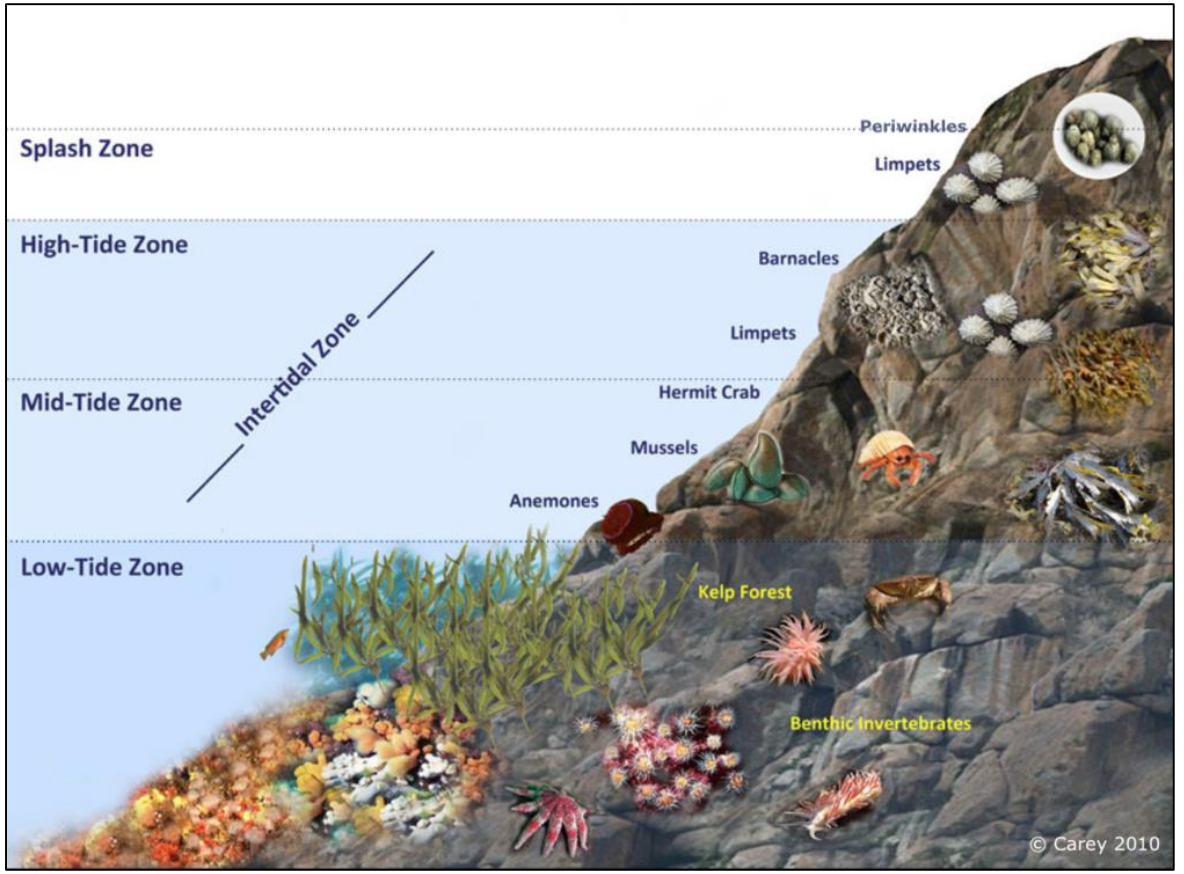
https://commons.wikimedia.org/wiki/File:Distribution_of_hydrothermal_vent_fields.png, Photo by: DeDuijn

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

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

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.

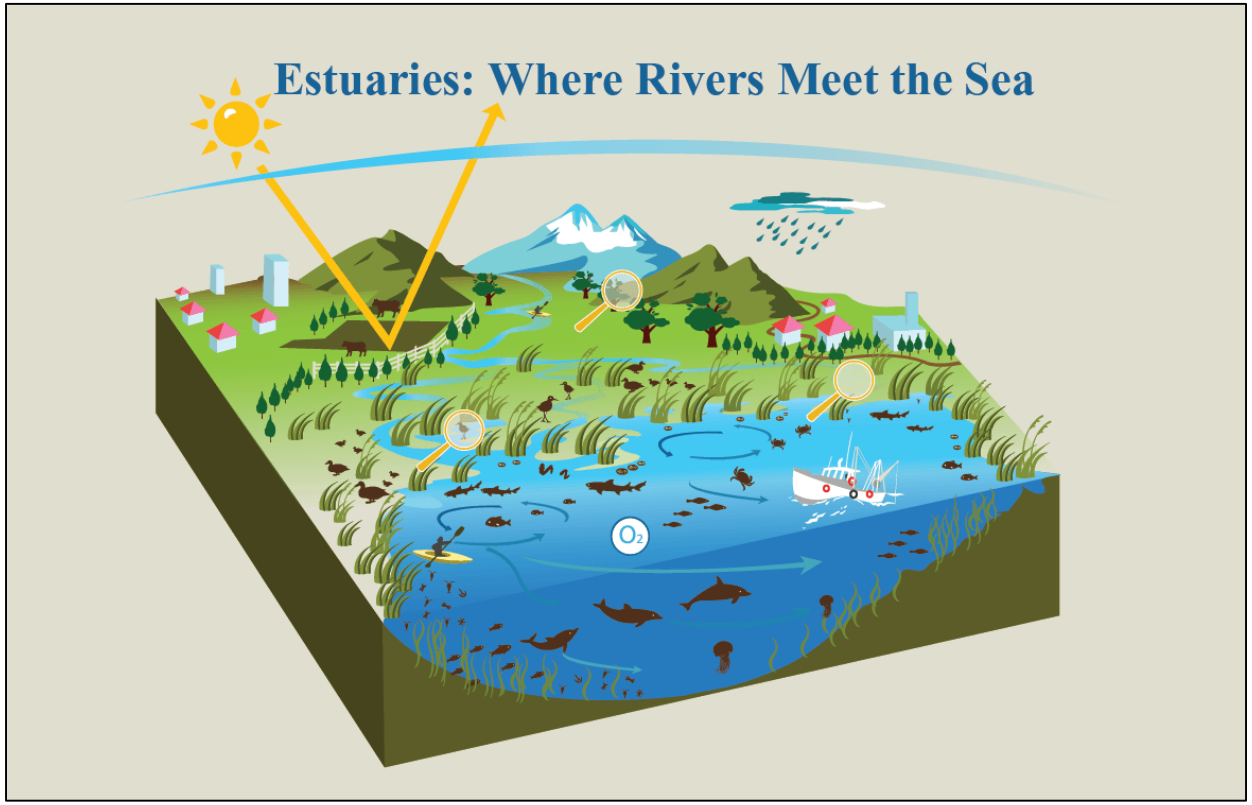
- Intertidal zone – bordering the land and the sea, zone between the high tide and the low tide, extreme habitat due to extreme life conditions (moisture, temperature, wave action, etc.), distribution of organisms here is defined by the sea level and the impact of the waves



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

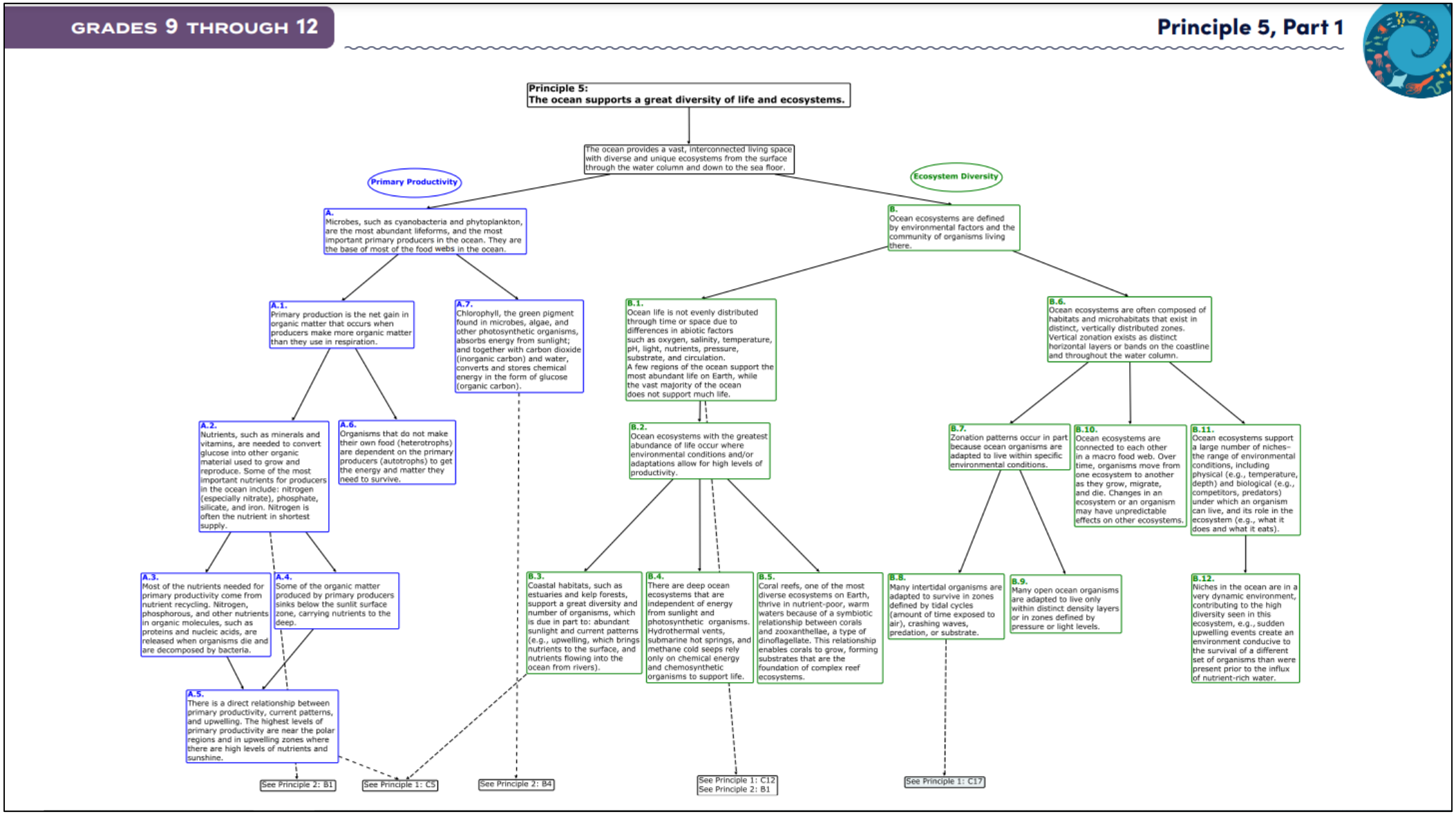
i) Estuaries provide important and productive nursery areas for many marine and aquatic species.

- 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

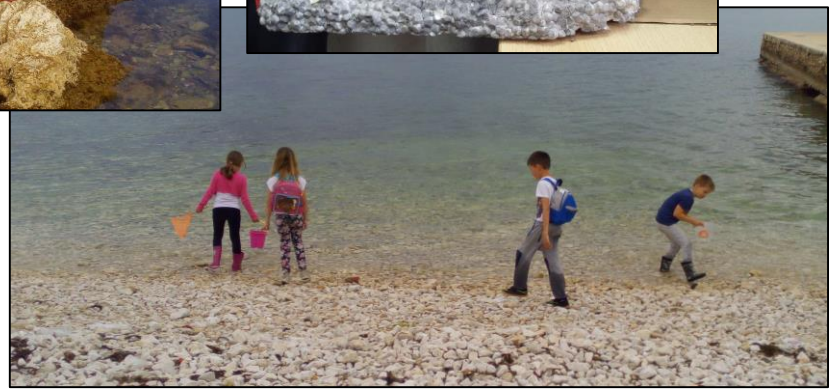
Scope and Sequence conceptual flow diagram



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_eueopean_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

Illustration Azote for Stockholm Resilience Centre, Stockholm University, Available via license: CC BY 4.0