



Principle 6 Graphic (Kaleigh Ballantine, Oregon State University for NOAA Education)

PRINCIPLE 6:

The ocean and humans are inextricably interconnected (7 concepts)

Maria Cheimonopoulou, Hydrobiologist, Hydrobiological Station of Pella, Greek Ministry of Rural Development and Agriculture

Google Dictionary, Oxford Languages

“inextricably” an adverb that means “in a way that is impossible to separate”

Is it impossible to separate the Ocean and humans?

Yes it is!



PRINCIPLE 6

The ocean supplies freshwater (most rain comes from the ocean) (concept 6a)



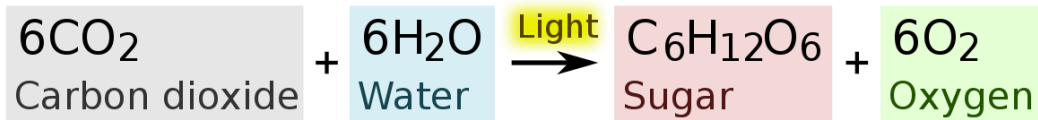
Canva.com

PRINCIPLE 6

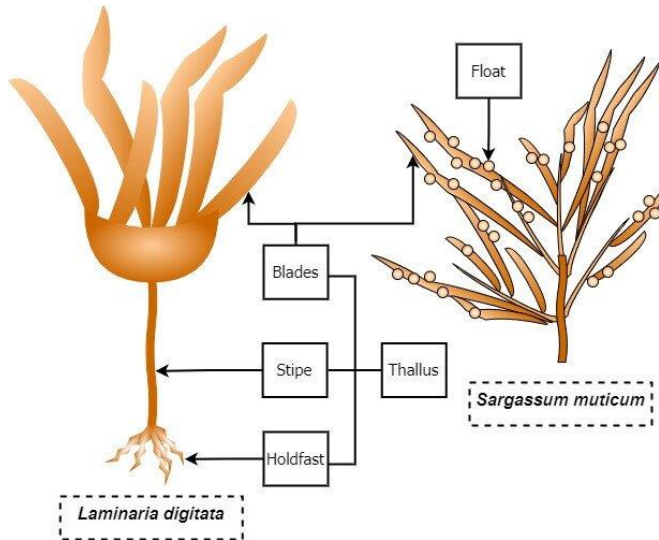
- About half of Earth's oxygen comes from the ocean via photosynthesis. About the same amount is consumed by marine life.

Seagrass, *Posidonia oceanica*

Photosynthesis



https://en.wikipedia.org/wiki/File:Photosynthesis_equation.svg#globalusage



Phytoplankton

Prochlorococcus marinus

By Luke Thompson from Chisholm Lab and Nikki Watson from Whitehead, MIT - flickr, CC0, <https://commons.wikimedia.org/w/index.php?curid=79705118>

Morphology of Brown seaweed, Zhao et al. 2022.

https://www.researchgate.net/publication/360221899_Bioriel_Production_from_Seaweeds_A_Comprehensive_Review Available via license: CC BY 4.0



Seagrass meadow of *Posidonia oceanica* in the Mediterranean Sea,

Photo by Monica Prevati, Informare

PRINCIPLE 6

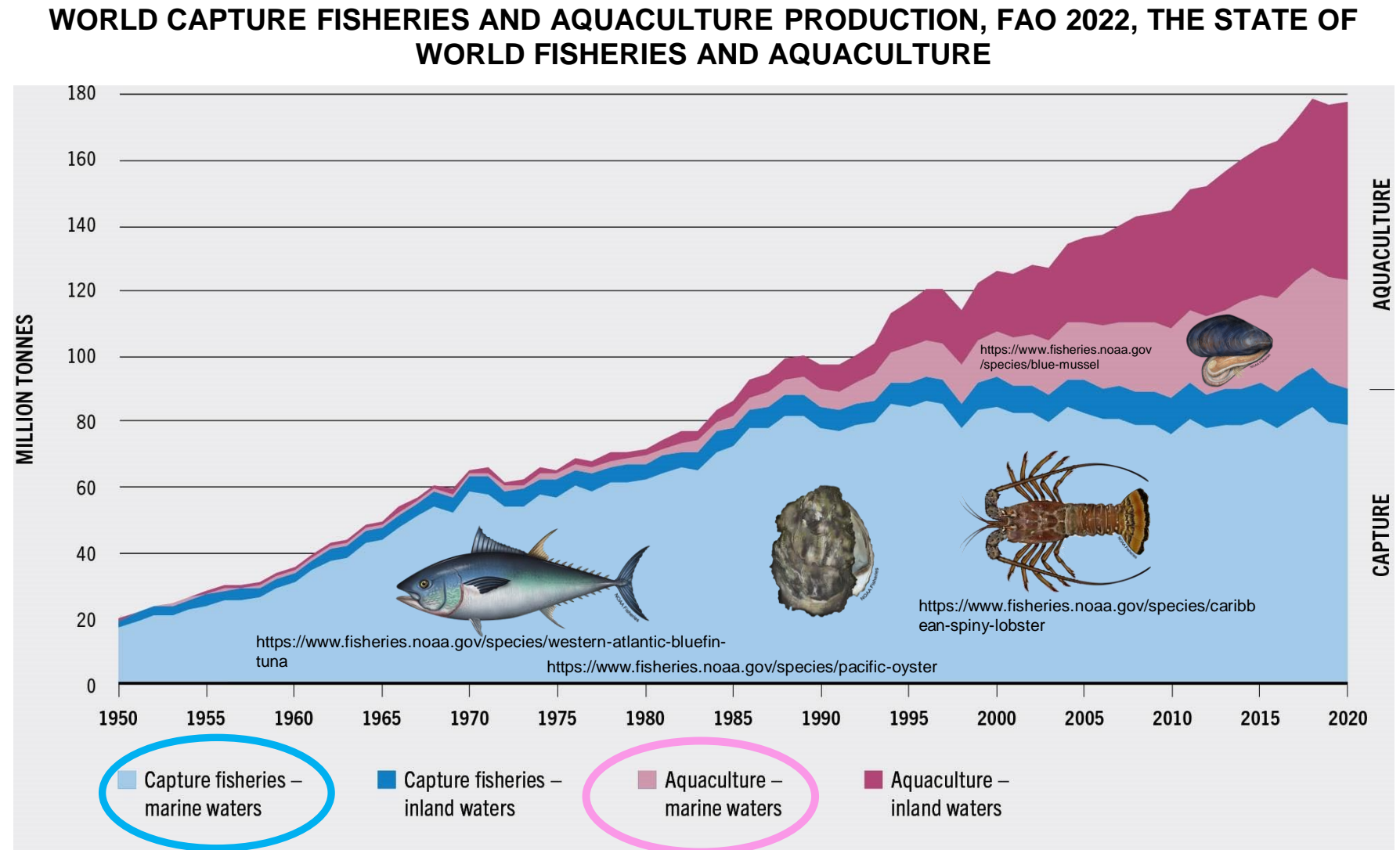
Inspiration for a blue
school project/OL
activity: European
Maritime Day Activity
2021

- “Exploring a drop of sea water and not only...”
 - Elementary school of Rahi-Tripotamos, Greece
 - Students 10-12 years of age,
 - School subjects:
Language, Geography,
Biology, Arts



PRINCIPLE 6

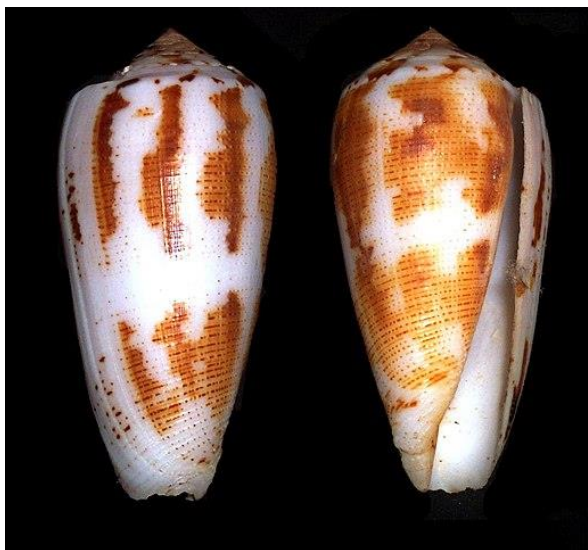
- The ocean provides **food** (**concept 6b**)
- In **2020**,
- **80 million tones** of marine animals were **captured**
- **33 million tones** were raised in **aquaculture**
- **36 million tones** of **algae** (mostly marine aquaculture were produced (FAO 2022)



FAO. 2022. In Brief to The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO. <https://doi.org/10.4060/cc0463en>

PRINCIPLE 6

- The ocean provides **medicines** (concept 6b)
- **Anti-inflammatory, anti-cancer, anti-microbial agents** (e.g. sponges, algae),
- **Painkillers**



By Richard Parker - Conus magus 56mm Uploaded by JoJan, CC BY 2.0, <https://commons.wikimedia.org/w/index.php?curid=9831177>

Approved Marine drugs

Ziconotide is a chemical compound derived from the *Conus magus* toxin that acts as a **painkiller**. It is much stronger than morphine without producing tolerance.

Screening marine organism for medicinal agents is very important to humans

Approved marine drugs

Cytarabine (Ara-C) – cytotoxic arabinonucleoside from the Caribbean sponge *Cryptotethya crypta*



Cytarabine
Inhibits DNA biosynthesis
Used in leukemia treatment



Focus project,
https://www.youtube.com/watch?v=wtXP5Z2j9YE&ab_channel=FocusProject

CC BY-SA

Bolton, et al. "PubChem3D: a new resource for scientists." J Cheminform. 2011 Sep 20;3(1):32.

PRINCIPLE 6

- The ocean provides **mineral and energy resources** (concept 6b)
- **Sand, gravel, oil and gas**



By Divulgação Petrobras / ABr - Agência Brasil [1], CC BY 3.0 br, <https://commons.wikimedia.org/w/index.php?curid=5621984>



<https://www.nrel.gov/news/program/2022/marine-hydrokinetic-toolkit-update.html>

- **Minerals that are carried out by rivers to the sea (e.g. diamonds, tin, titanium, gold), other minerals:**
Manganese nodules, cobalt crusts, massive sulphides
- **Renewable Ocean Energy**, Devices that turn the energy from moving water and wind into electricity



PRINCIPLE 6

- The ocean supports jobs and national economies (**concept 6b**). **More than three billion people rely on the ocean for their livelihoods.**
- **Tourism and fisheries** are key **resources** (income, foreign exchange and jobs)



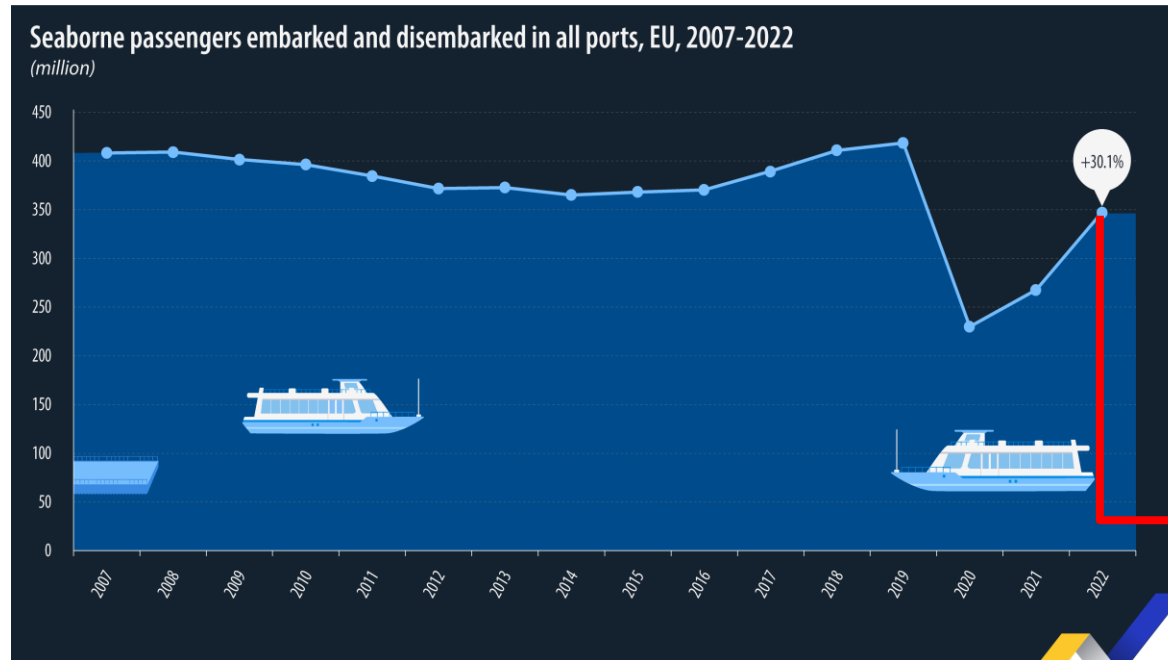
Taverna Mylos. Olympos, Island of Karpathos, Greece



Ponta Delgada, Azores, Fish Market, Maria Cheimonopoulou

PRINCIPLE 6

- The ocean serves as a highway for transportation of goods and people, and plays a role in national security (**concept 6b**)
- **Maritime transport accounts for roughly 80% of international trade,**



<https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231214-1>



By kees torn - FAIRPLAY I & MSC ZOE, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?curid=51782110>

- **In 2022, maritime passenger transport reached 348.6 million passengers in EU ports.**

PRINCIPLE 6

- The ocean is a source of inspiration, recreation, rejuvenation and discovery (**concept 6c**)
- It is also an important element in the heritage of many cultures (**concept 6c**)
- Pavlopetri (Lakonia, Greece), the oldest submerged city in the world



Pavlopetri, Laconia, Greece, the oldest submersed city
<https://www.olympictours.gr/attractions/peloponnese/124-pavlopetri>

Inspiration for a blue school project:
**“OUR OCEAN -MARINE LEGENDS, FAIRY
TALES
and FOLKLORE”
IRELAND**



<https://oar.marine.ie/bitstream/handle/10793/1396/OUR%20OCEAN%20MARINE%20LEGENDS%20online.pdf?sequence=1&isAllowed=y>

- Artwork and poems around Ireland
- Students 10-11 years of age
- School subjects: English, Music, Art, History, ICT, etc.

PRINCIPLE 6

➤ **The Ocean is in trouble!**

➤ **Why?**

➤ **Because**
Humans affect
the Ocean in a
variety of ways
(Concept 6d)

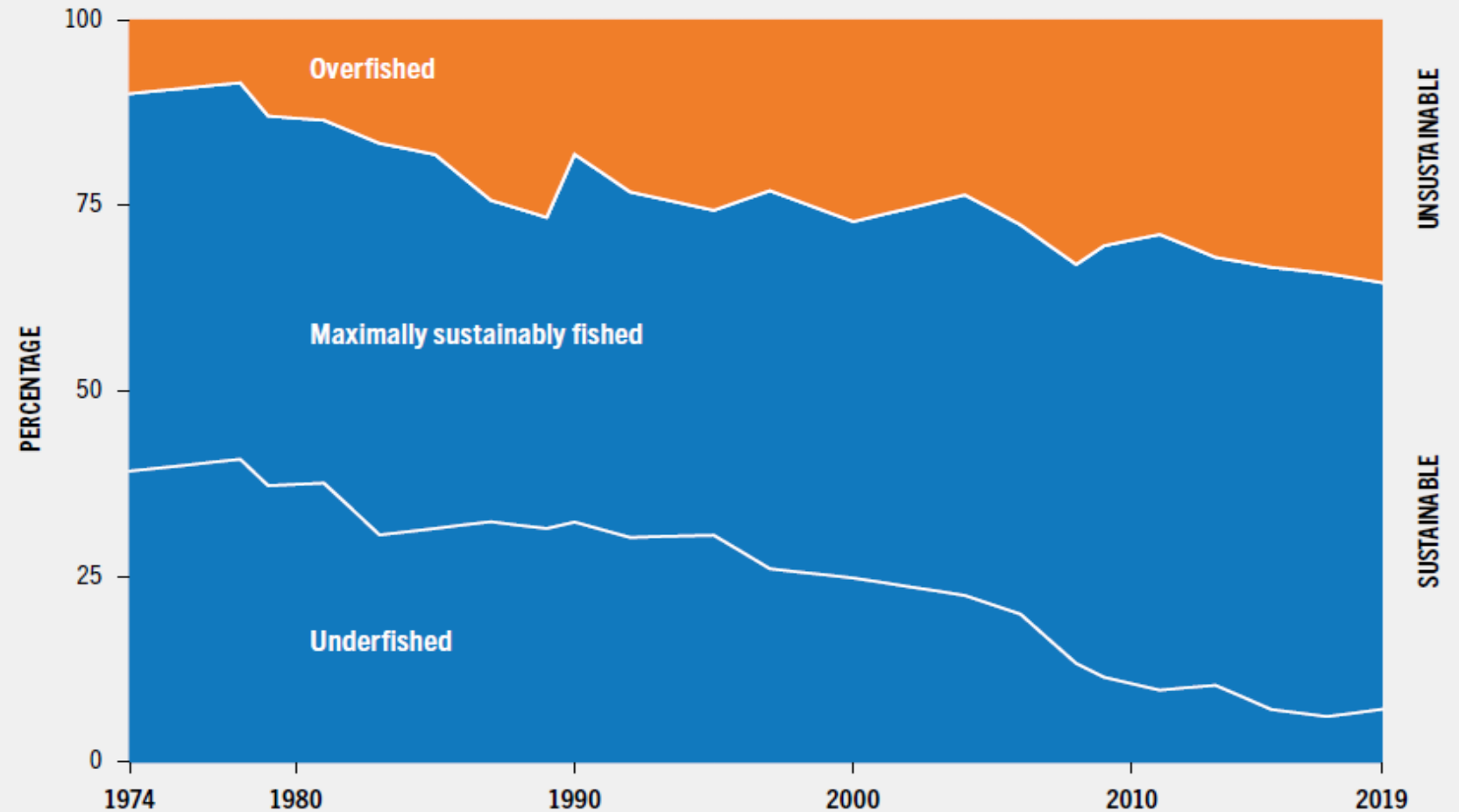
Ocean of trouble: human pressures on the marine ecosystem



PRINCIPLE 6

- **Overfishing** occurs when too many fish in a particular stock are caught and **there are not enough adults left to breed and sustain a healthy population.**
- The **collapse of fish stocks** will be **devastating for coastal communities** that rely on fishing

FIGURE 23 GLOBAL TRENDS IN THE STATE OF THE WORLD'S MARINE FISHERY STOCKS, 1974–2019



SOURCE: FAO.

FAO. 2022. In Brief to The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO.
<https://doi.org/10.4060/cc0463en>

PRINCIPLE 6

- As fisheries, tourism have expanded without sufficient consideration for environmental and social sustainability



Environmental degradation



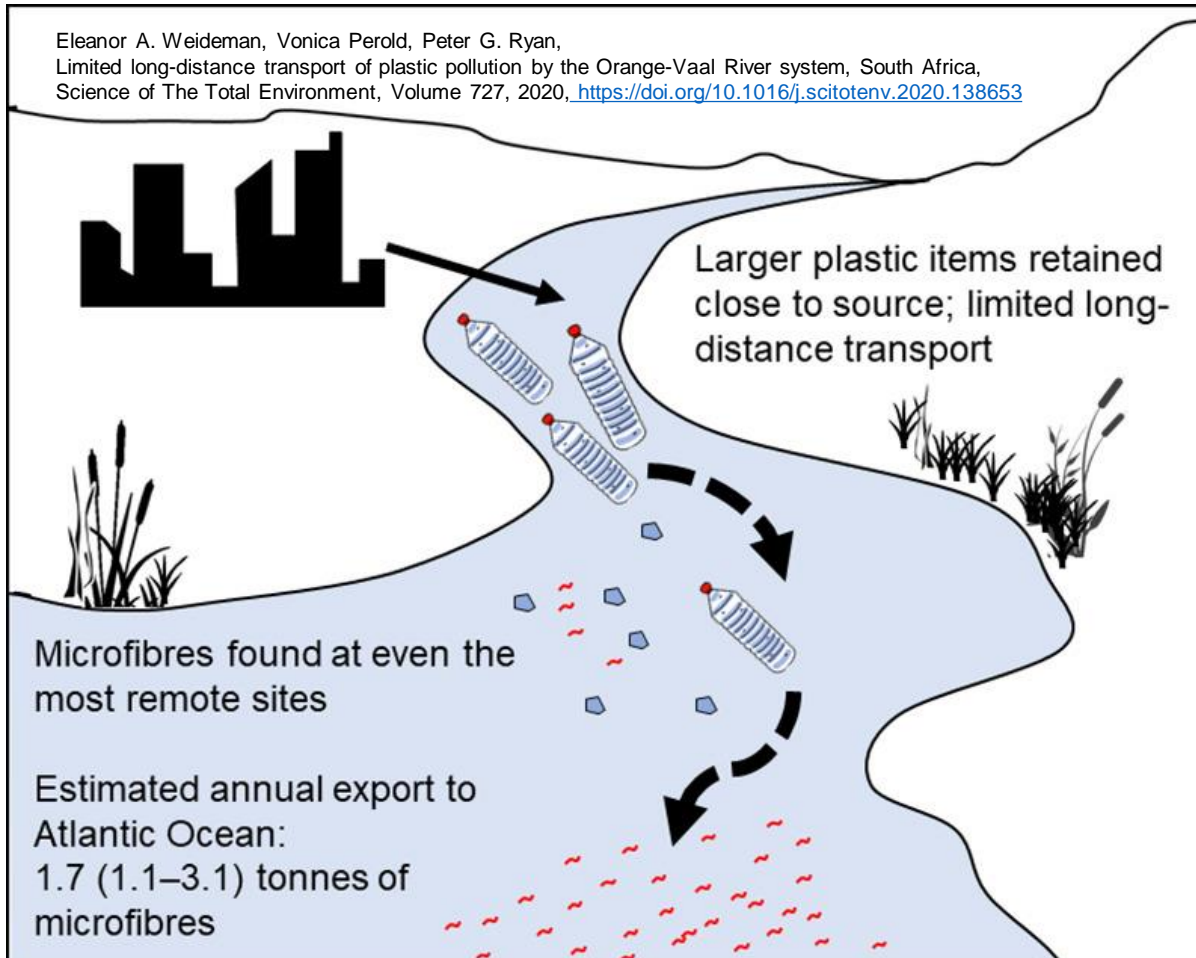
Imagine: ResponSEable.eu

PRINCIPLE 6

- **Human development and activity leads to pollution (e.g. point source, non-point source) (Concept 6d)**
- **Marine and coastal pollution can be linked to the presence of litter, nutrients, organic matter, oil and other pollutants (e.g. PCBs).**
- **Each year billions of pounds of litter and other pollutants, that originate from human activities along the coastlines and far inland, enter the ocean.**

PRINCIPLE 6

- Human development and activity leads to pollution
(e.g. **plastic pollution**) (**Concept 6d**)



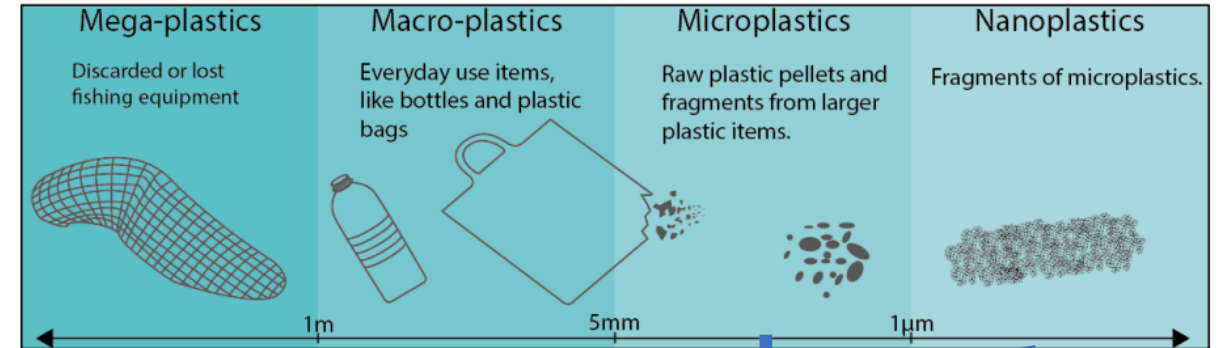
- **Ghost gear:** lost and abandoned fishing gear, is responsible for “large plastic pollution”
- **Entanglement of marine life** (e.g. turtles, whales, birds) and **consequent death**



Photo: Monica Prevati, informare

PRINCIPLE 6

- **Size ranges of plastic debris defined in (Ryan et al., 2019) from Stürzinger V., 2020)**
- Plastic degrades into smaller particles but it does not biodegrade!!!)
- Micro and nanoplastics have been detected in various marine organisms from plankton to whales, in commercial seafood, and even in drinking water.
- Indications suggest that micro and nanoplastics carry toxic substances and microorganisms.
- Aquatic life and birds can mistake plastics for their food which has detrimental effects on their life



PRINCIPLE 6

➤ Inspiration for Blue school project about plastics

➤ Plastic Pirates – Go Europe!

A joint citizen science project that promotes knowledge and research on the distribution and abundance of plastic waste in European freshwater ecosystems

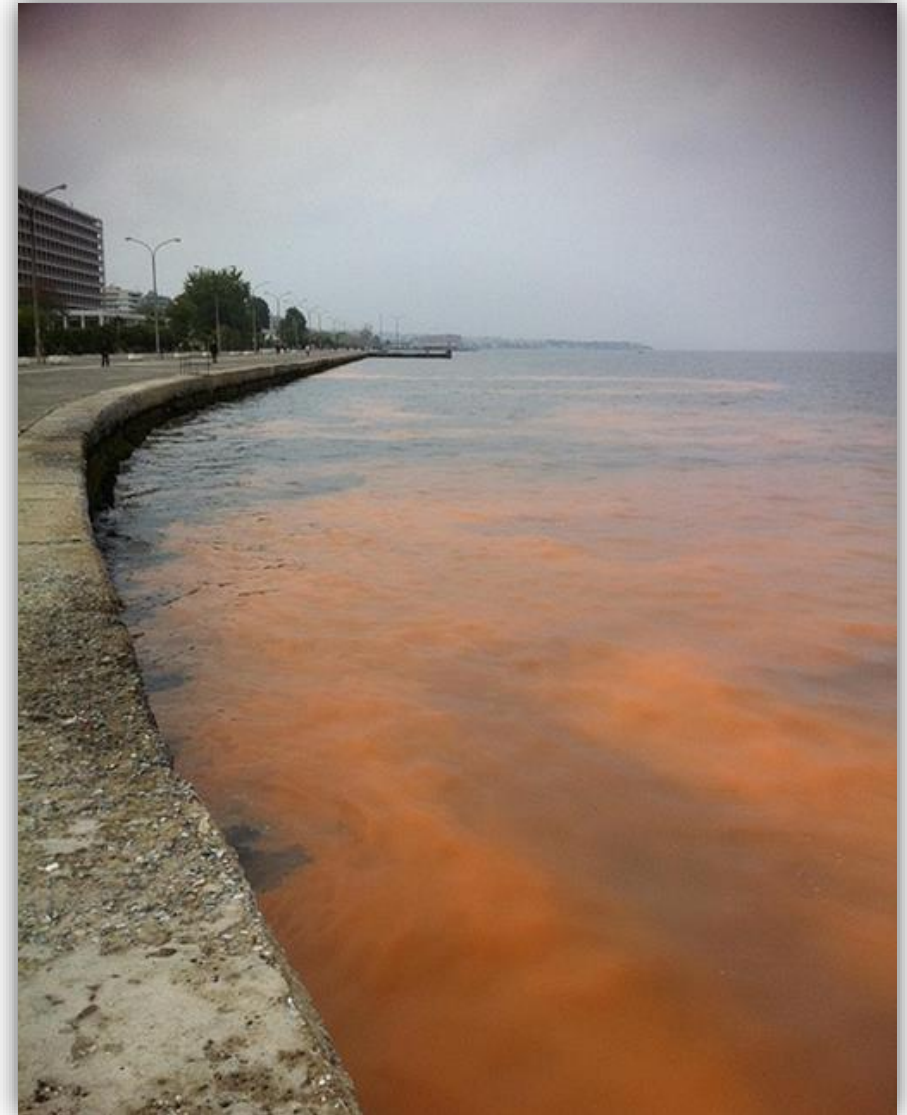
(Germany, Portugal, Slovenia)



[Handbook European Blue Schools 2022 \(europa.eu\)](https://europa.eu)

PRINCIPLE 6

- Human development and activity leads to pollution)
(Concept 6d) (e.g. nutrients (dissolved nitrogen and phosphorus derived mainly from agricultural run off and sewage) carried out by rivers to the ocean cause eutrophication and harmful algal blooms (HABs) e.g. red tides)



Thermaikos Gulf, Greece, Maria Cheimonopoulou

PRINCIPLE 6

- Human development and activity leads to pollution (e.g. **oil pollution**) (**Concept 6d**)



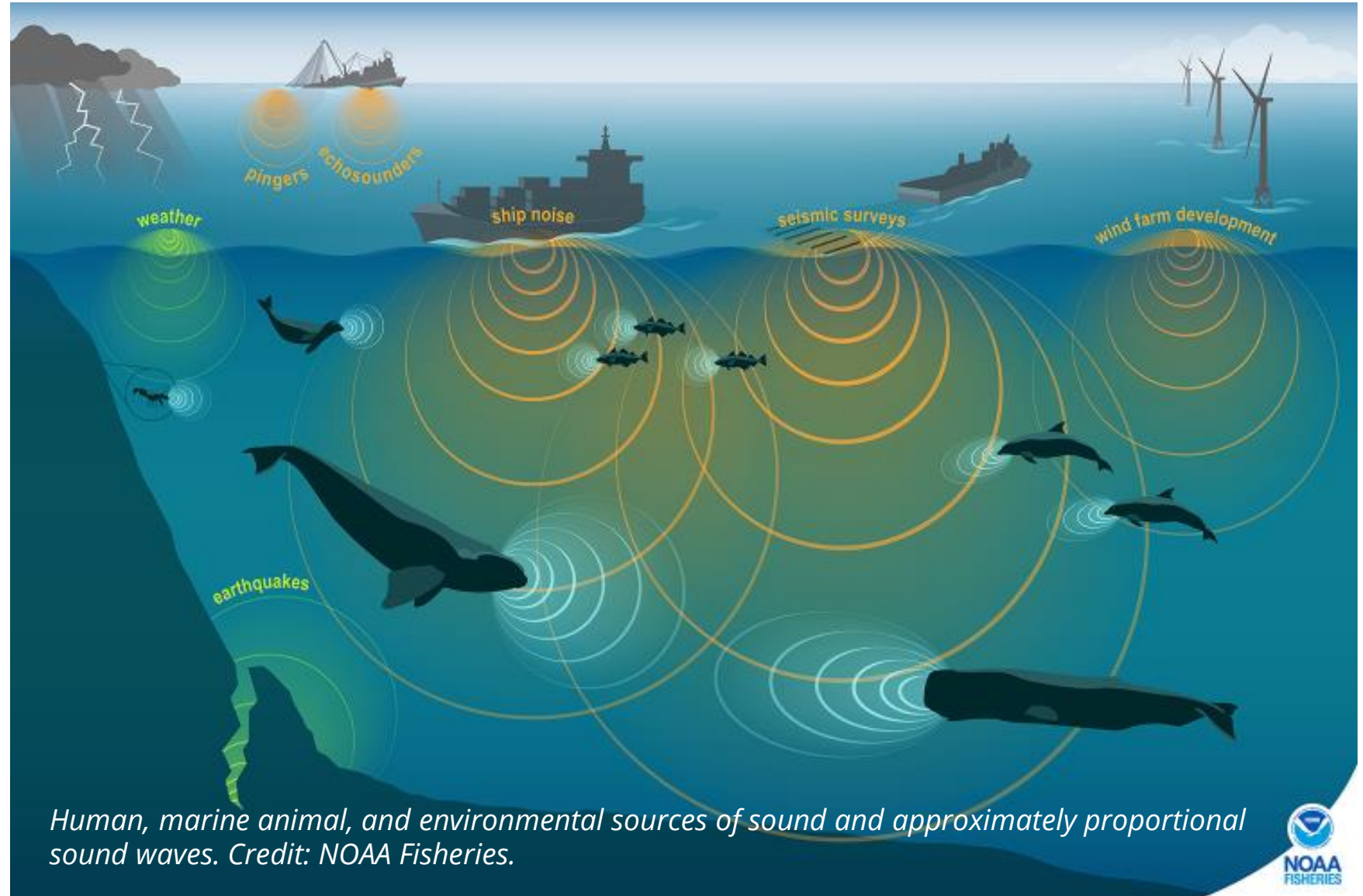
Brown pelicans lathered in oil captured at Grand Isle, Louisiana, after the BP oil spill in the Gulf of Mexico.



Ullapool Sea Savers, Scotland,
<https://www.scubaverse.com/scubaverse-meet-the-ullapool-sea-savers/>

PRINCIPLE 6

- Human development and activity leads to pollution (e.g. **noise pollution**) (Concept 6d)
- Sources:
Marine traffic, marine renewable energy projects, oil platforms, seismic surveys



PRINCIPLE 6

Inspiration for a blue
school project/OL activity:
European Maritime Day
Activity 2023

“Echolocation and Ocean noise”

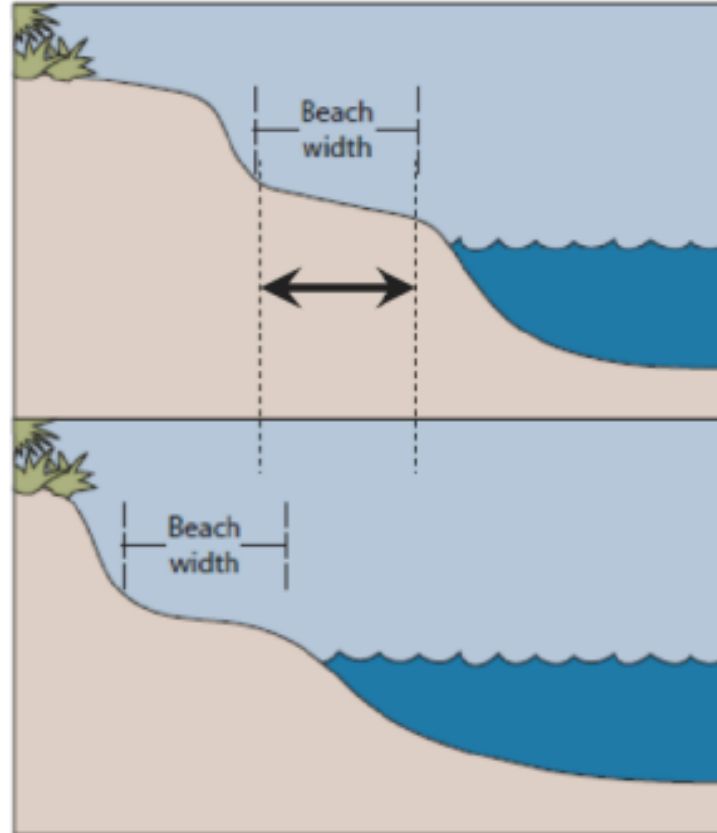
Elementary school of Rahi-
Tripotamos, Greece,
students 10-12 years of age
school subjects:



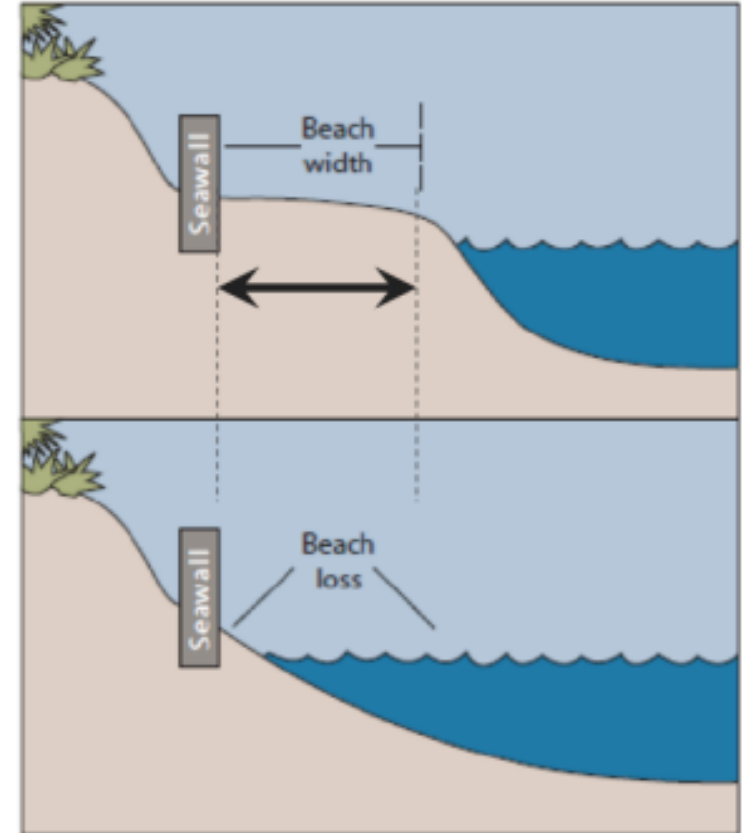
PRINCIPLE 6

- Human development and activity leads to physical modifications (changes to beaches, shores and rivers) (Concept 6b)
- **Shoreline Armoring**, is the process of building robust structures in the shoreline to **prevent erosion**
- It **protects man-made structures**
- But over time it can speed up the **loss of coastal habitats**

Normal Beach Retreat



Blocked Beach Retreat

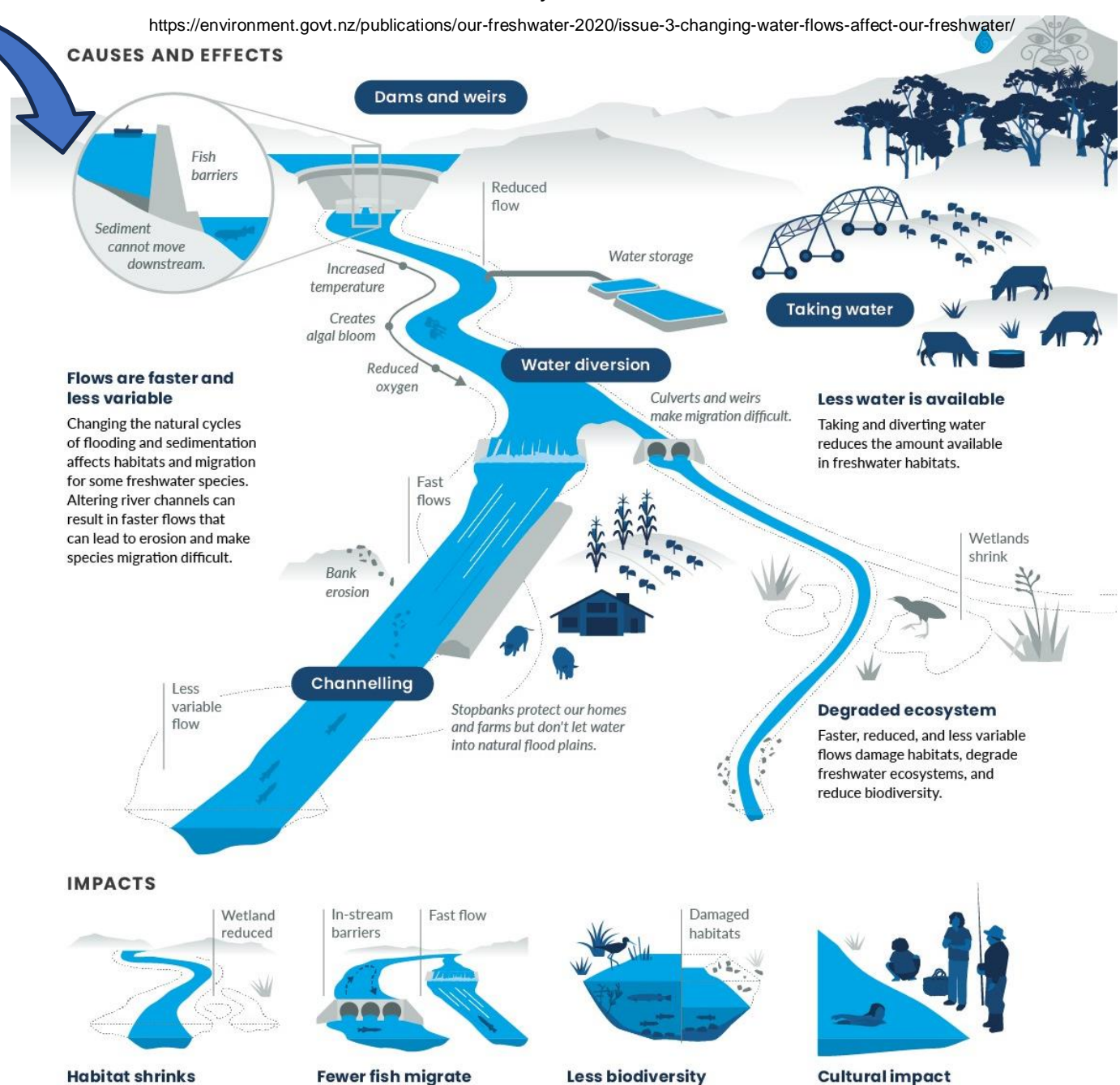


<https://pme.ubc.ca/learn/educator-resources/human-impacts-on-the-ocean/>

Course:EOSC270/2021/Impacts of Shoreline Armoring on Marine Ecosystems, The University of British Columbia

PRINCIPLE 6

- Dams in rivers
- Cause:
 - reduction of sediments at river deltas, leading to degradation of deltaic ecosystems (e.g. delta erosion, reduction of biodiversity and abundance of e.g. fish)
 - fragmentation in rivers blocking the way on migratory fish as salmon and eel and not only...
 - emission of methane (organic matter decomposition in artificial lakes), a green house gas...

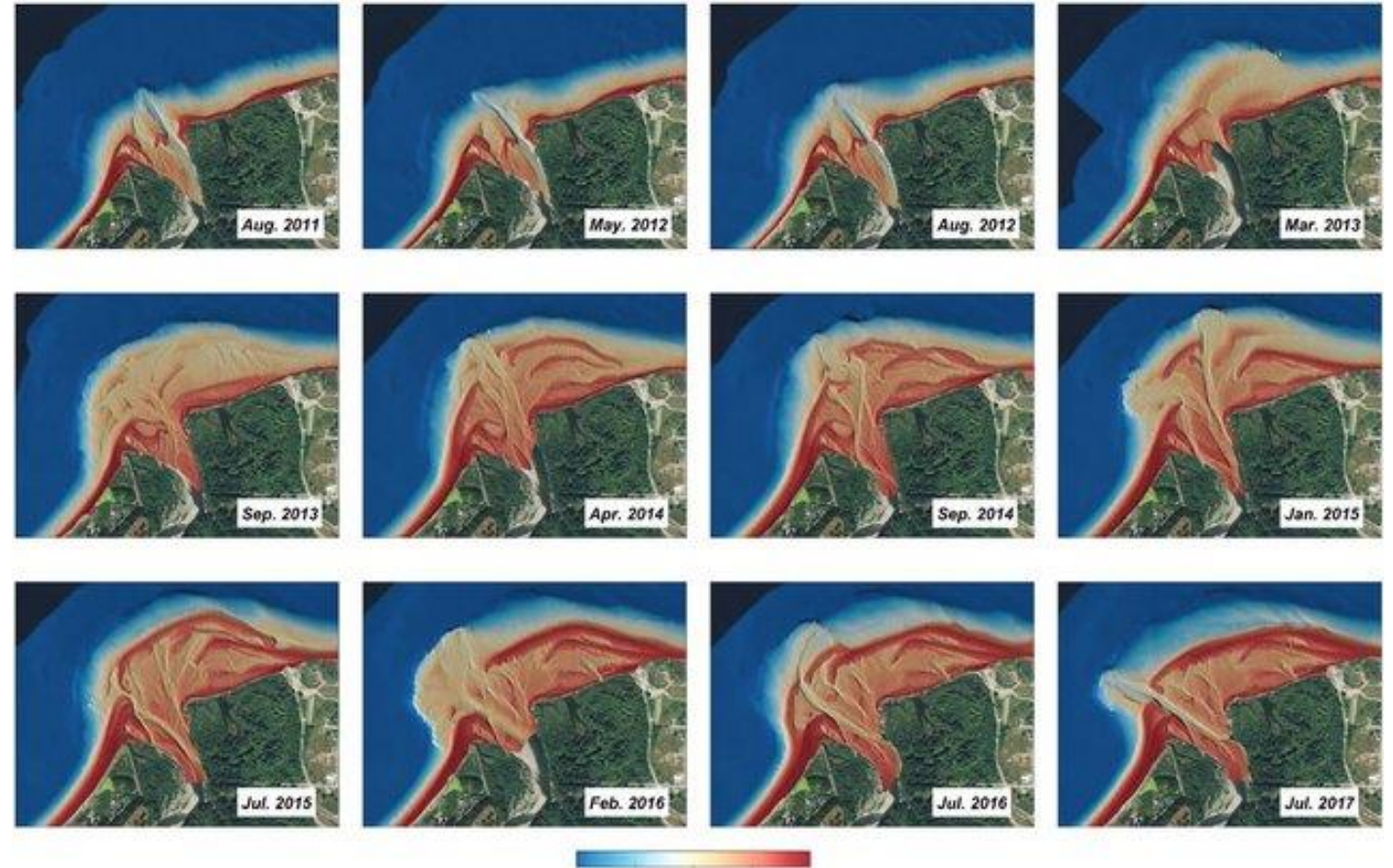


PRINCIPLE 6

- Human development and activity leads to physical modifications (**changes to rivers**) (**Concept 6b**).



Aliakmon river dam, Greece



Evolution of the Elwha River delta topography and bathymetry before, during and after dam removal, 2011-2017.

Warrick, Jonathan & Stevens, Andrew & Miller, Ian & Harrison, Shawn & Ritchie, Andrew & Gelfenbaum, Guy. (2019). World's largest dam removal reverses coastal erosion. Scientific Reports. 9. 1-12. 10.1038/s41598-019-50387-7.

PRINCIPLE 6

Inspiration for a Blue school
project/OL activity:

“Hydroelectric power. How much
environmentally friendly is it?”



European eel

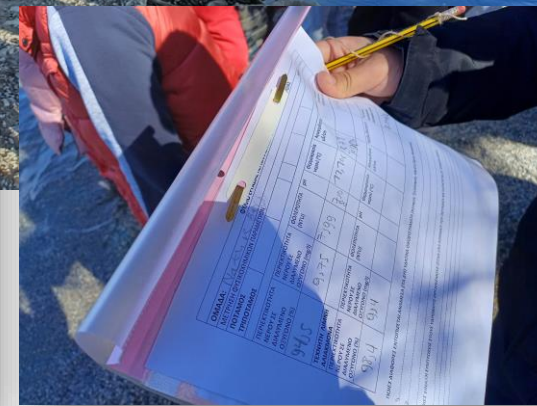
By Felice Supino - Supino, Felice (1916) Pesci
d&A039;Acqua Dolce d&A039;Italia, Milan: Ulrico Hoepli,
Editore Librai della Reali Cassi. Public Domain,
<https://commons.wikimedia.org/w/index.php?curid=42866149>



- **Fish Migration Day 2024**, (World
Fish Migration Foundation)

6th Gymnasium of Veria, Greece

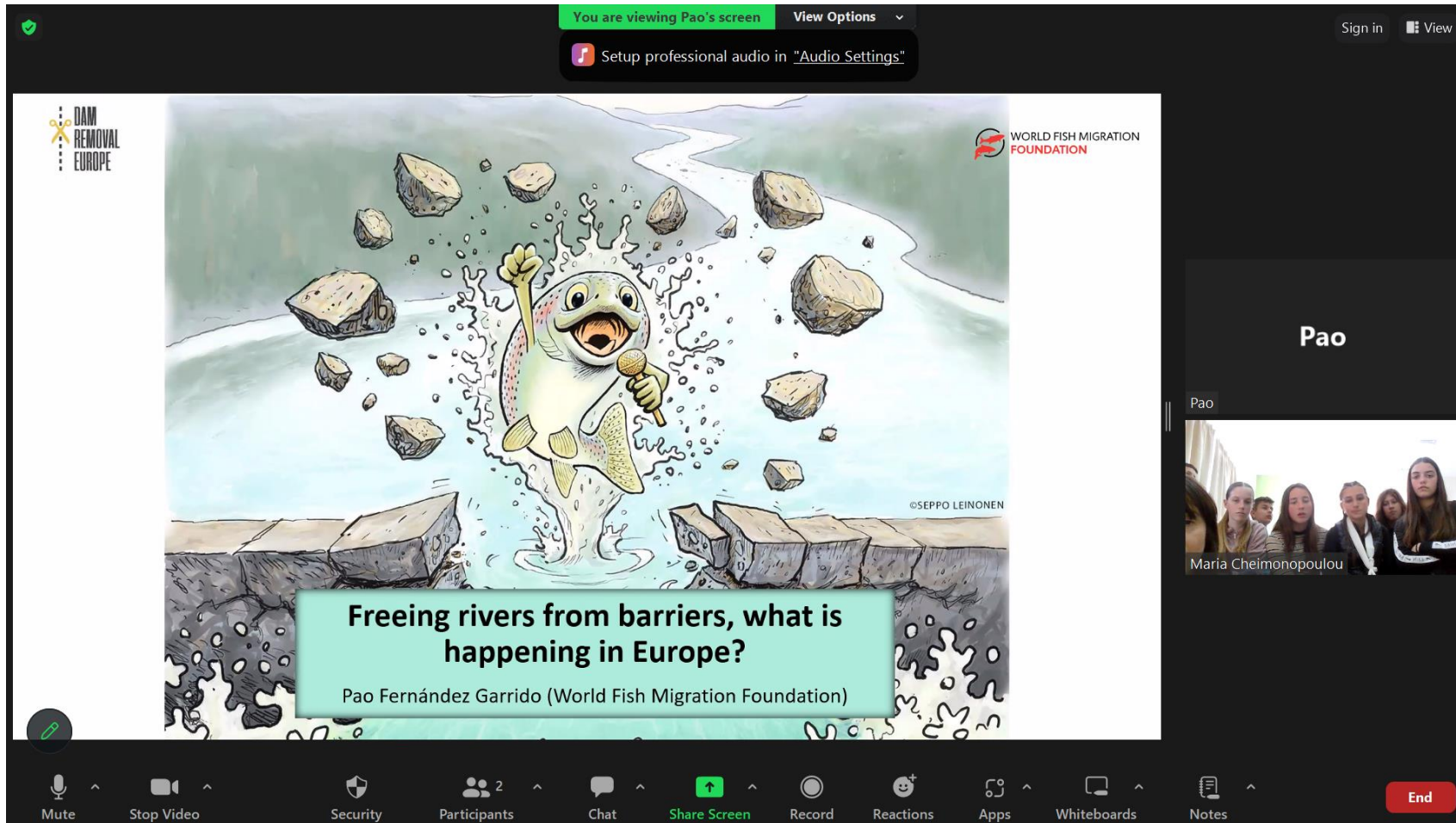
- Students 14 years of age
- School subjects: Biology, chemistry,
mathematics, geography, ICT



PRINCIPLE 6

Inspiration for a Blue school project

“Hydroelectric power. How much environmentally friendly is it?”



The screenshot shows a Zoom meeting interface. The main window displays a presentation slide titled "Freeing rivers from barriers, what is happening in Europe?" by Pao Fernández Garrido (World Fish Migration Foundation). The slide features a cartoon illustration of a fish jumping over a dam, surrounded by falling rocks. Logos for "DAM REMOVAL EUROPE" and "WORLD FISH MIGRATION FOUNDATION" are visible. The Zoom interface includes a top bar with "You are viewing Pao's screen", "View Options", "Sign in", and "View". A bottom bar contains icons for Mute, Stop Video, Security, Participants (2), Chat, Share Screen, Record, Reactions, Apps, Whiteboards, Notes, and an End button. A small video window on the right shows a group of participants, with the name "Pao" above them and "Maria Cheimonopoulou" below them.

STRUCTURE

- PPT presentation (operation of hydroelectric power plants, advantages, impacts of dams on freshwater and marine ecosystems),
- Life cycle of migratory fish (eels)
- Hands on lab (measuring physicochemical parameters in a river and in an artificial lake)
- A hydropower plant visit
- Talking to a dam removal expert and watched a movie

PRINCIPLE 6

By Kurzon - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=1618794>

- Humans have removed most of the large vertebrates (e.g. whales, large fish, sharks) from the ocean

(concept 6d).

https://fish-commercial-names.ec.europa.eu/fish-names/species/thunnus-thynnus_en

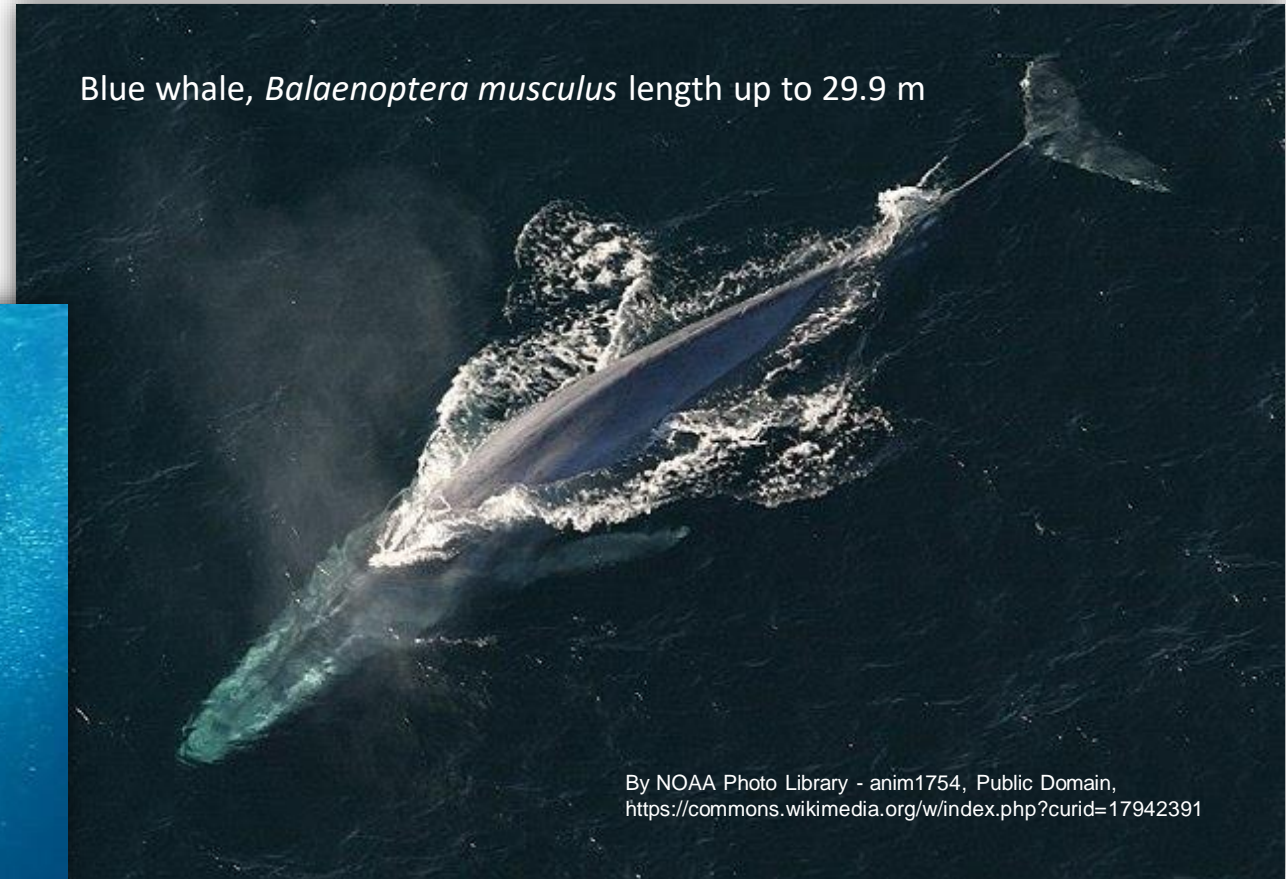


Blue fin tuna, *Thunnus thymus*, length up to 4,58 m



Whale shark, *Rhincodon typus*, length up to 18.8 m

By Abe Khao Lak - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=37306146>



Blue whale, *Balaenoptera musculus* length up to 29.9 m

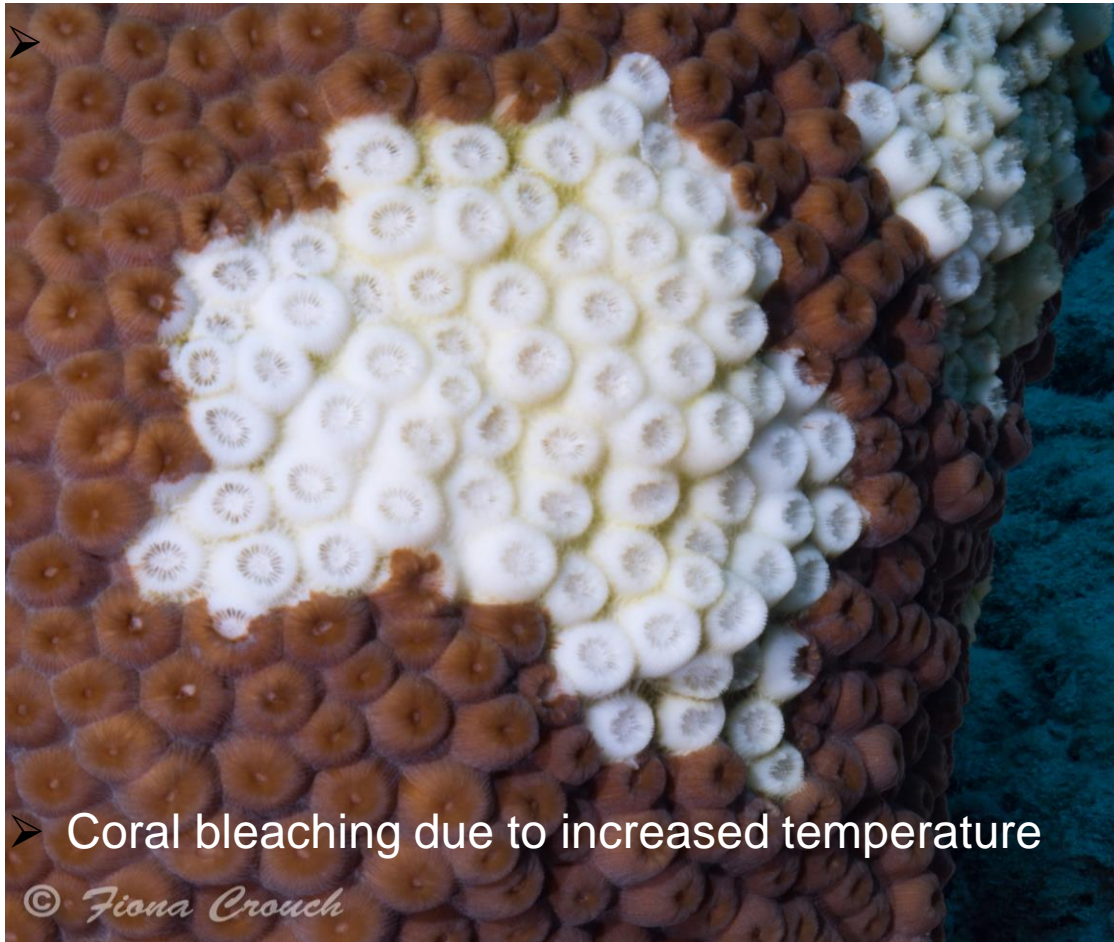
By NOAA Photo Library - anim1754, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=17942391>

PRINCIPLE 6

- **Human development and activity leads to changes to ocean chemistry and temperature (Concept 6e)**
- **Atmospheric levels of CO₂ are 50 % above** pre-industrial levels
- **The ocean absorbs around 23 % of annual CO₂ emissions** generated by human activity and helps mitigate the impacts of climate change (SDG14).
- **This leads to the pH reduction of sea-water and increase of its acidity**
- **The ocean has also absorbed more than 90% of the excess heat in the climate system.**

PRINCIPLE 6

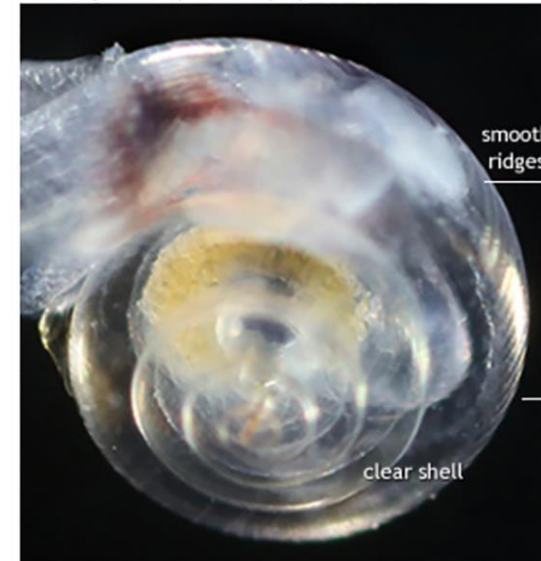
- **Changes in ocean temperature and pH due to human activities can affect the survival of many organisms and impact biological diversity**



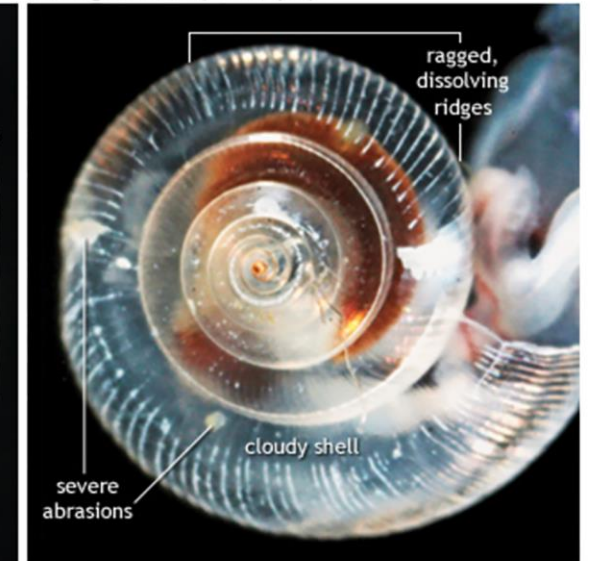
Inhibition of shell formation due to ocean acidification.

Photo © National Oceanic and Atmospheric Administration, <https://reefresilience.org/stressors/ocean-acidification/>

Healthy shell (normal pH)



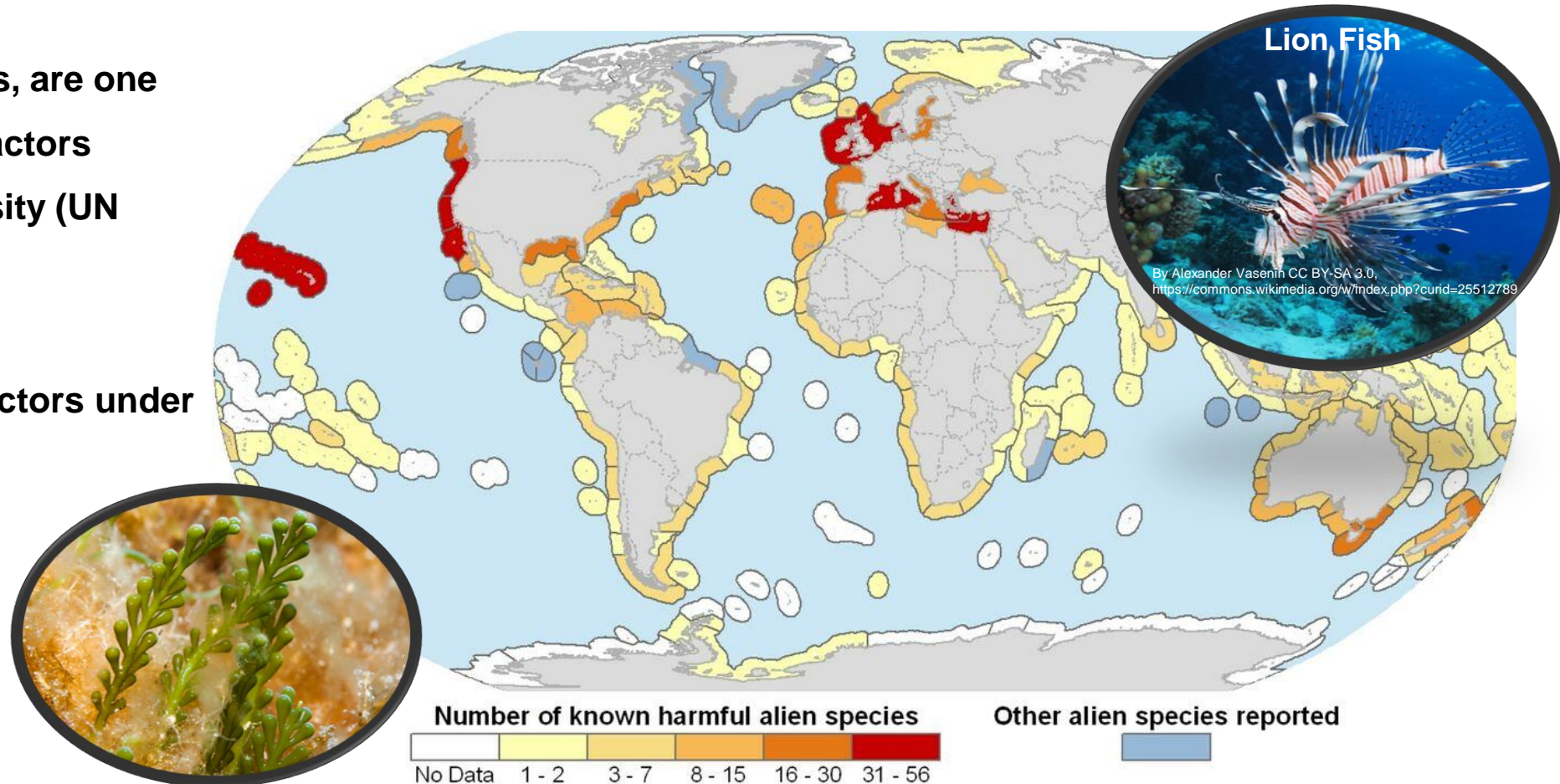
Damaged shell (lower pH)



PRINCIPLE 6

- Alien Species
- Invasions of alien species, are one of the five main driving factors affecting global biodiversity (UN 2019)
- Invasion methods and vectors under human interference
- Fisheries/ Aquaculture
- Ornamental species
- Ship Transportation
- Recreational boats
- Canals

Global map showing the number of harmful alien species by coastal ecoregions. **The darker red shades indicate a greater number of species with a high impact on the local ecology.** Molnar et al. 2008

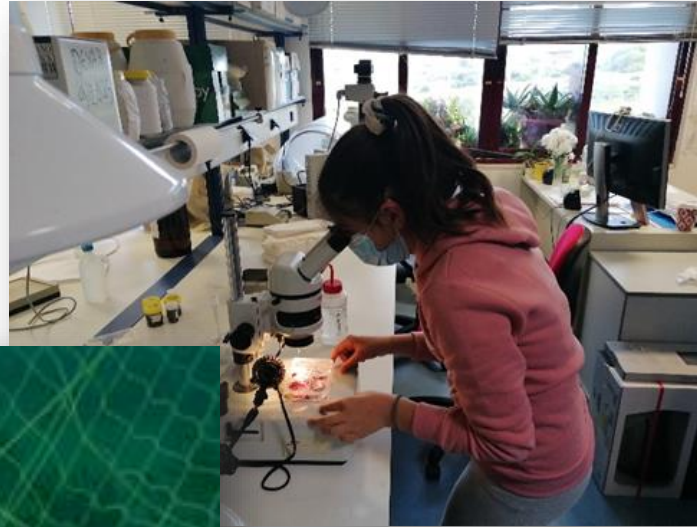


Caulerpa cylindracea, www.archipelago.gr

<https://pme.ubc.ca/learn/educator-resources/human-impacts-on-the-ocean/>

PRINCIPLE 6

- Alien species
- *Portunus segnis*



Inspiration for a blue school project
“Spot the non-indigenous blue crab
species *Portunus segnis* in the
Cretan Sea (Elounda bay)”

- Elementary School of Gournes
Pediados & HCMR
- Students 10-11, Heraklion, Crete,
Greece years old
- School subjects: Mathematics,
Physics, Language, Geography,
Social Education, Arts, STEM

PRINCIPLE 6

- Much of the world's population lives in coastal areas (**concept 6e**).
- Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges) (**concept 6e**).
- Hazard-resilient communities are a necessity.



<https://thecolumn.ahacentre.org/posts/insight-posts/vol-63-potential-coastal-hazards-in-the-region/>

PRINCIPLE 6

- 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. (concept 6g)

PRINCIPLE 6 & SDGs 6 & 14

- Principle 6 is inextricably connected to **SDGs 14 (Life below water)** and **SDG 6 (Clean Water & Sanitation)**

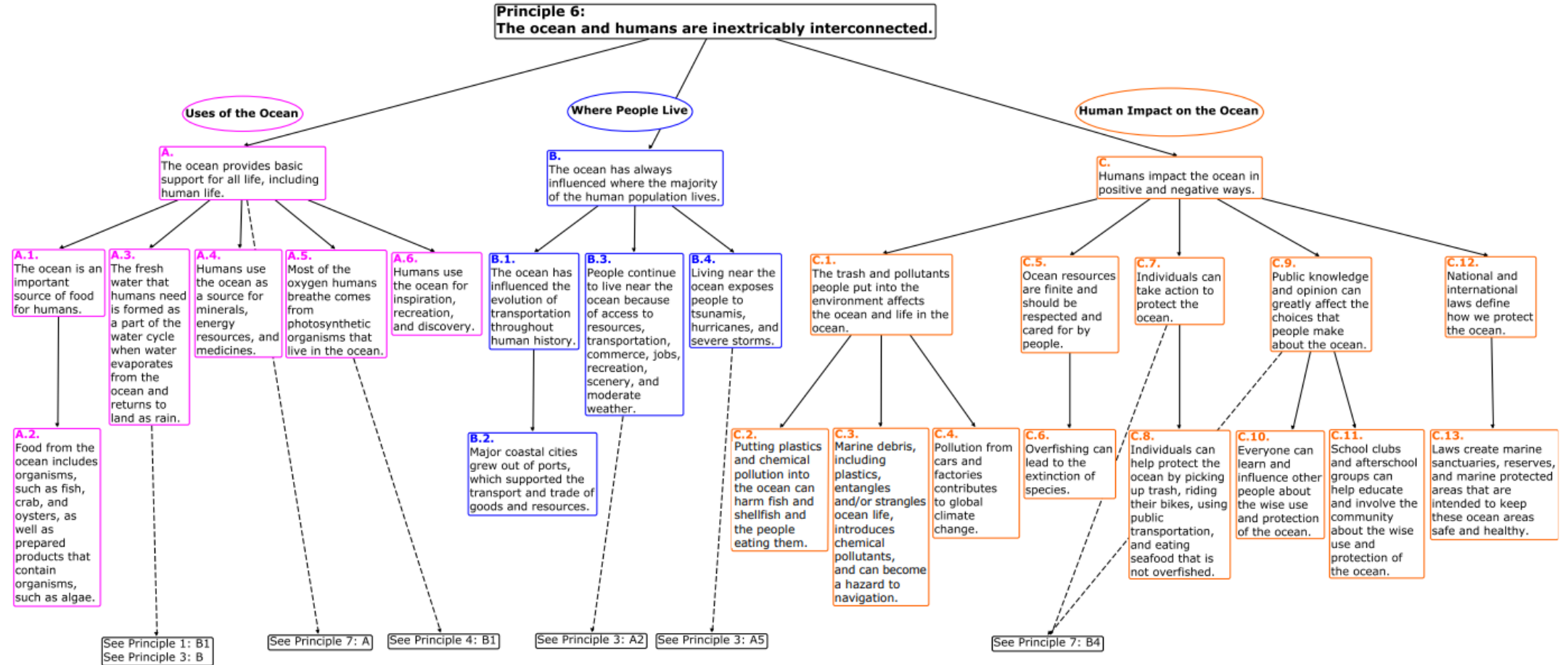
PRINCIPLE 6 & EU PRIORITIES FOR 2019-2024 & EU Mission

- EU Priority 1: A European Green Deal (Preservation of Europe's natural environment/Protecting the environment and oceans with the Green Deal) EU Mission: Restore our Ocean and Waters (with a 2030 target)

PRINCIPLE 6 & UN Decade 2021-2030

- UN Decade on Ecosystem Restoration (halt the degradation of ecosystems, and restore them to achieve healthy ecosystems)

PRINCIPLE 6, Conceptual Flow Diagram, Grades 3-5



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



Photo by: Kalliopi Lentaki, Island of Karpathos, Greece

We are indeed inextricably interconnected with the ocean!!!

Thank you so much!

Maria Cheimonopoulou, Hydrobiologist, Hydrobiological Station of Pella, Greek Ministry of Rural Development and Agriculture