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# Practical ocean literacy for all: ecology and exploration

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The oceans cover over 70% of the surface of our planet. Try these activities to learn more about Earth's largest habitat and how it affects our lives.

The ocean literacy (OL) principles were created to explain and underline the mutual influence between the ocean and humans.

## The OL principles

1. **Earth has one big ocean with many features.**
2. **The ocean and life in the ocean shape the features of Earth.**
3. **The ocean is a major influence on weather and climate.**
4. **The ocean makes Earth habitable.**
5. **The ocean supports a great diversity of life and ecosystems.**
6. **The ocean and humans are inextricably interconnected.**
7. **The ocean is largely unexplored.**

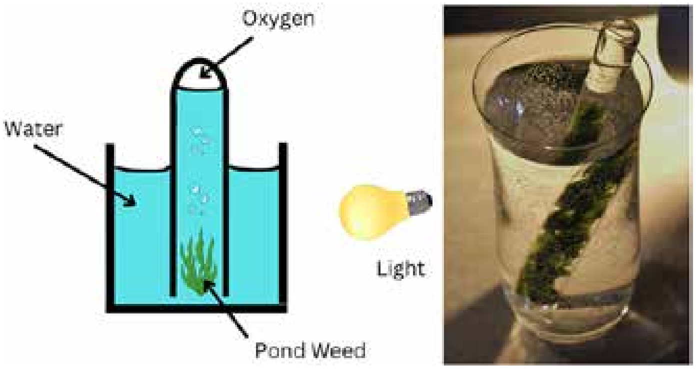
This influence may be hard to grasp when living far from coastal areas, but you can use the simple classroom activities presented in this article (OL principles 4–7) and in the previous one (OL principles 1–3) to help students understand the importance of the ocean.

*Image: Hiroko Yoshii/Unsplash*

# Activity 1: A habitable Earth

**OL principle 4 – The ocean makes Earth habitable**
The primordial atmosphere did not contain oxygen until the appearance of photosynthesis in marine microorganisms, which first began to produce oxygen that later diffused into the atmosphere. The subsequent formation of the ozone layer, through the action of UV rays on atmospheric oxygen, made it possible for the living organisms to colonize land. Since then, nearly half of the atmosphere's oxygen has come from the ocean. A simple experiment on photosynthesis and oxygen production allows us to visualize the production of this gas by aquatic plants.

This activity takes about 25 minutes: 15 minutes to set up the apparatus plus another 10 minutes for observation.




Left: Diagram of the setup for visualizing oxygen production by photosynthesis in water. Right: A photograph of the setup.
*Diagram: adapted from sciencequiz.net, Picture courtesy of Giulia Realdon, CC BY NC*

## Materials

- One long test tube (bacteriology type)
- A glass or beaker
- Tap water
- Sodium bicarbonate (baking soda)
- A teaspoon or spatula
- A sprig of *Elodea canadensis* or other aquarium plant
- A fluorescent or LED desk lamp

## Procedure

1. Ask a student to 3/4 fill the glass with tap water (or bottled still water if tap water is heavily chlorinated).
2. Add a spoon tip of baking soda to the water and mix the solution.
3. Fill the test tube with tap water.
4. Insert the plant sprig into the test tube.
5. Turn the test tube upside down, plugging it with a finger so that no air bubbles can enter the tube, and position it vertically in the glass.
6. Expose the plant to direct sunlight or, even better, to a fluorescent or LED lamp.
7. After some time, you will see gas bubbles forming on the leaves and merging into a larger bubble on top.

Usually, the amount of produced gas is not enough to test for oxygen. If you use more plant sprigs under a funnel feeding into a test tube, you can collect more gas and test it by re-moving the test tube and thrusting a glowing splint into it: it will burst into flame due to the produced oxygen (this should be done by the teacher!).

## Discussion

Ask the students which other photosynthesizing marine or-ganisms they know in addition to aquatic plants (e.g., phy-toplankton and algae), and challenge them to discover the role of these plants and marine organisms in the removal of atmospheric $CO_2$ dissolved in the ocean.

As the saying goes: *"every second breath, thank the ocean!"*.

# Activity 2: Mediterranean food webs

**OL principle 5 – The ocean supports a great diversity of life and ecosystems**
Extending over 71% of Earth's surface with an average depth of nearly 3.7 km, the ocean is the largest living space on our planet, ranging from warm water to cold water (and ice!); from shallow to deep; from sunlit to eternally dark environments. It houses incredibly diverse communities of living organ-isms, from those as small as nanoplankton to those as enormous as a blue whale (the largest animal ever to have lived on Earth).

Let's dive in and explore an example of a food web in the Mediterranean Sea, with its complexity and a final surprise! This activity requires about 30 minutes, plus the time needed to prepare the badges and the ribbons.

## Materials

- Diagram of the food web to be studied (e.g., the one above)
- A badge for each student, prepared in advance with the photos and names of the members of the food web (see the food webs worksheet), plus an extra sea walnut badge
- Strings or pins for wearing the badges
- 25–30 pieces of gift-wrapping ribbons, about 3 m long, to represent the biomass flows in the food web

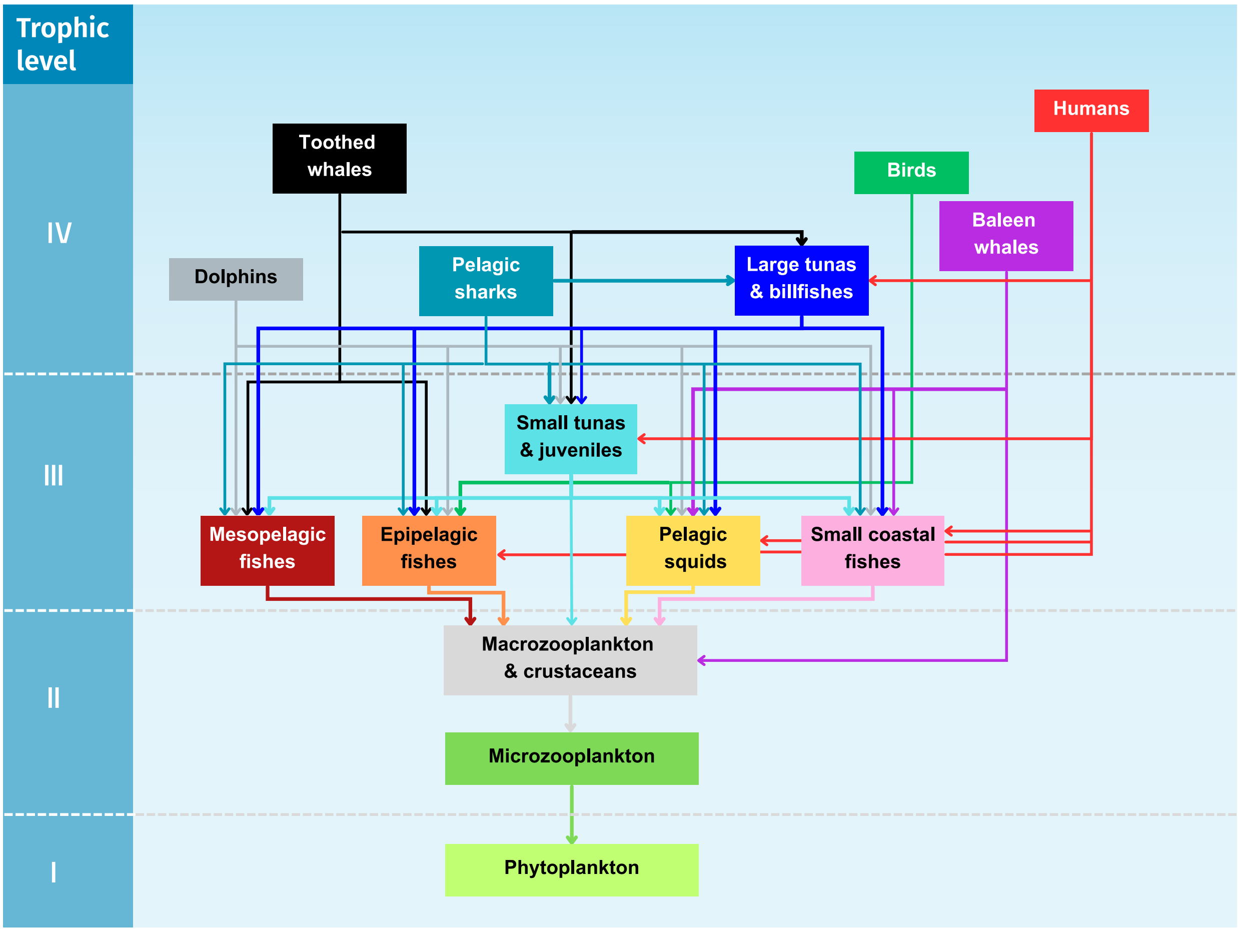



*Image: Adapted from FAO*

## Procedure

1. Explain the structure of a marine food web to the students.
2. Give each student a badge except one and keep the sea walnut badge aside; you will give it to the remaining student later. If necessary, you can print more badges.
3. Get the students, wearing their badges, to stand in a circle in a large enough space. The student without a badge stands outside the circle at this point.
4. Explain to the students how to connect who eats to who is eaten by using the ribbons (e.g., zooplankton will be linked to phytoplankton; whales to macroplankton and pelagic squids; dolphins to small coastal fish, pelagic fish, and squids).
5. Once the network is complete, introduce an external factor that alters it, for example, the addition of an alien species, as symbolized by the sea walnut (the student with that badge comes in).
6. Explain that sea walnuts are voracious consumers of zooplankton (the sea walnut student removes all ribbons connected to zooplankton, causing a visible impact on the food web).

The badges and the use of ribbons to simulate the flux of biomass

*Images courtesy of Giulia Realdon, CC BY-SA*

## Discussion

Discuss with the students the effects of perturbation on the network studied, encouraging them to propose solutions to the problems that have emerged from the discussion. You can also think of other pressures on marine food webs (over-fishing, pollution, etc.) and simulate their impact.

# Activity 3: Mutual interconnection

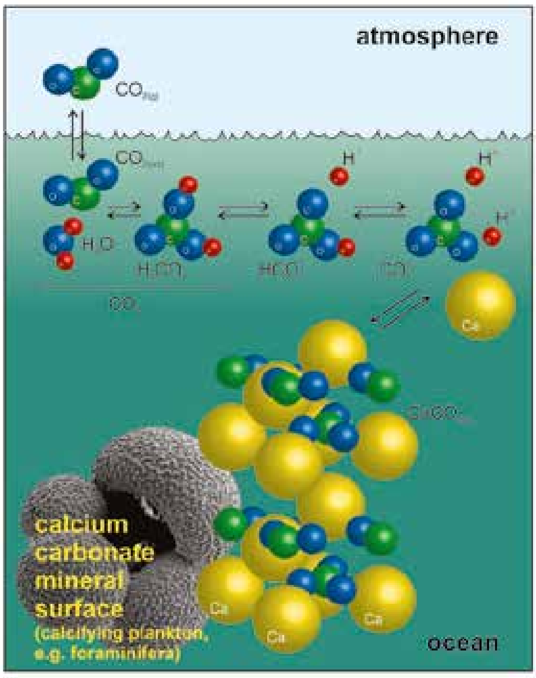
**OL principle 6 – The ocean and humans are inextricably interconnected**

This is probably the most important of the OL principles, as it deals with the complex effects of an ever-growing human population (more than 8 billion in 2022) drawing biological and nonbiological resources from the ocean and spilling waste and pollution into it. The problem of microplastic pollution, which can come from some surprising sources, in the ocean is a well-known example.

An inspiring set of activities on one of the main anthropogenic impacts on the ocean can be found in a previous issue of *Science in School*, An ocean in the school lab: carbon dioxide at sea recently proposed by Carla Isabel Ribeiro and Ole Ahlgren.

A related activity presents the dangerous action of ocean acidification on marine calcifying organisms, which are organisms that have body parts made of calcium carbonate ($CaCO_3$), such as molluscs, corals, and some algae. In fact, $CO_2$ dissolved in seawater produces $H_2CO_3$, which generates $H^+$ ions that, in turn, react with the dissolved $CO_3$ used by calcifying organisms to build shells and skeletons, thus making this process more difficult.

This activity takes about 15 minutes, plus the time for discussion.

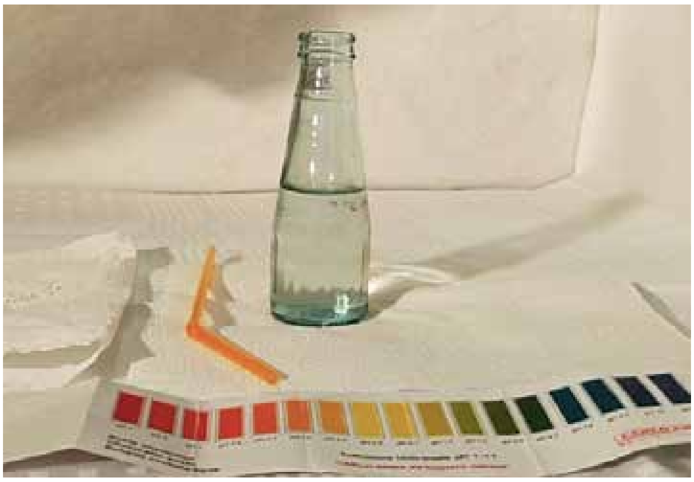



Chemical reactions following the dissolution of $CO_2$ in sea water

*© 2012 Stephen Barker and Andy Ridgwell, used with kind permission*

## Materials (for every group of students)

- A small glass bottle or beaker (approx. 100–150 ml)
- A drinking straw
- Distilled (= demineralized) water
- Universal liquid pH indicator
- Indicator colour scale
- A few shells (or eggshell) reduced to powder
- A teaspoon



Materials used in this activity

*Image courtesy of Giulia Realdon, CC BY-NC*

## Procedure

1. Ask students to fill the bottle/beaker up to 2/3 with distilled water.
2. Next, 10–12 drops of indicator are added and mixed by rotating the bottle.
3. Ask students to observe the colour and compare it with the colour scale (it is expected to be around pH 7).
4. One student uses the straw to blow into the solution for 30 seconds.
5. Students then observe the colour change and estimate the pH value.
6. Next, the students add one to two teaspoons of shell powder and stir the solution by swirling.
7. Ask students to observe the new colour change.

Ask students to explain this colour change (it is due to the chemical reaction between $H^+$ ions and $CaCO_3$ of crushed seashells, which produces an increase in pH, as visualized with the pH indicator).

Finally, ask students to imagine how living calcifying organisms (molluscs, corals, etc.) can be affected by ocean acidification.

## Activity 4: Seafloor mapping

**OL principle 7 – The ocean is largely unexplored**
Surprisingly, more details are known about the surfaces of the Moon and Mars than the seafloor. But understanding the ocean is more than a matter of curiosity: ocean conservation and sustainable use require in-depth knowledge of this enormous and still mysterious space.

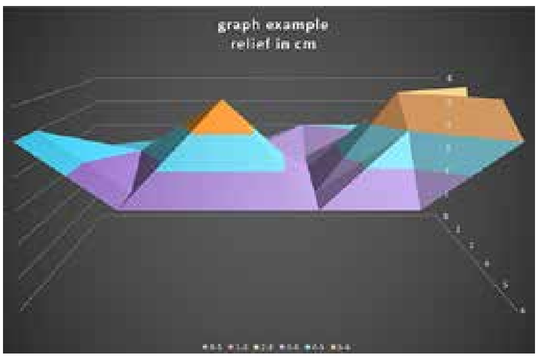
Let's address the topic of ocean exploration by means of a classroom activity on seafloor mapping by simulating the echosounder study of seafloor topography;[1] this technology promises to provide a high-resolution map of the whole seabed by 2030 (see more on the Seabed 2030 Project).

This activity takes about 30 minutes, plus the time needed to prepare the box with the mock seafloor.

Left: The lid of the sounding box with a skewer probing the depth in a cell of the grid. Right: The mock seafloor in the sounding box
*Image courtesy of Giulia Realdon, CC BY NC*

### Materials (for every group of students)

- A sounding box: a cardboard shoebox prepared in advance by the teacher, with a printed grid glued on the box lid, holes punched in the centre of each grid square using a steel skewer and a mock seafloor on the bottom made of Lego bricks
- Several 20 cm wooden skewers (the probes; remember to cut off the pointed tip) marked with a felt tip pen every cm
- A printed table to record the measurements
- A computer with spreadsheet software to enter the data table and draw a 3D graph of the relief (to be completed by the students, see Excel sheet in the supporting materials)
- A short video about seafloor topography mapping




Example of a 3D graph obtained in this activity

1. Print a table with the same number of cells as the grid on the box lid for recording the measured depths.
2. Prepare a spreadsheet table with the same number of cells as the printed table and a second one similar to the first one, but with a pre-set formula to calculate the measured seafloor relief:
   seafloor relief = box depth – measured depth.
3. Show students the video to visualize the technique that will be simulated.
4. Give each group a sounding box, 2–3 probes, and a printed table.
5. Explain to the students that the model aims to simulate exploration of the seafloor by means of echo sounding.
6. To draw the topography of the surface, students will probe the bottom of the box with the skewers by successively inserting the stick in all the holes of the grid on the box lid.
7. Students record the measured depths in the printed table.
8. Students then copy the table data into the spreadsheet table and use it to plot a 3D graph that will allow them to (roughly) visualize the topography of the simulated seafloor. The graph can also be rotated for a better view.

### Discussion

You can stimulate discussion on the meaning of this kind of research by asking the students the following questions: Why, in your opinion, is it important to study seafloor topography? What other applications (good or bad) could this technique have? Possible answers include to produce better nautical maps; to explore the seafloor for oil, gas, and mineral extraction; to lay and repair undersea cables; and for military use.

### Extension activity

You can propose another activity on Marie Tharp, a scientist who, by plotting the seafloor by mapping sonar data on ocean maps in the 1950s and 1960s, paved the way to the development of the theory of plate tectonics.

At that time, female scientists were not allowed aboard research ships. Marie was not even mentioned in most of the published papers, thus becoming an unrecognized 'mother' of plate tectonics theory. Earthlearningidea has a fantastic teaching activity on this topic: Marie Tharp – a woman scientist in a man's world.[2] Other relevant materials can also be found in the Resources.

Marie Tharp: the scientist who made the seafloor visible without even boarding a research vessel

*Image: Lamont-Doherty Earth Observatory and the estate of Marie Tharp*

## What next?

After inspiring students' interest in the ocean, you can tell them about the Decade of Ocean Science for Sustainable Development 2021–2030, launched by the United Nations with the motto "the science we need for the ocean we want", which is aimed at promoting science but also connecting people with our ocean.

The Decade of Ocean Science for Sustainable Development represents a good opportunity to involve students in ocean-oriented environmental projects, taking advantage of an EU initiative called the Network of European Blue Schools. A Blue School is a school that develops a project addressing topics such as the ocean, climate, water, pollution, and the 2030 Agenda, and involves at least one class and a local partner. The school communicates the project to the local community and documents the process through the network website, thereby obtaining a European Blue School Certificate. Through the project, a school can also connect with other Blue Schools in Europe and beyond, making synergies with eTwinning and Erasmus+ networks. You can also apply to become a certified European Blue School.

More information and ideas can be found in *A wave of European Blue Schools: Handbook for teachers*[3] and in UNESCO's *Ocean literacy for all: a toolkit.*[4]


Call to become a European Network Blue School

*Image: Maritime Forum, European Commission*

## Acknowledgements

Activity 4 and the extension activity are based on activity worksheets from Earthlearningidea.[1,2]

## References

[1] Activity sheet for seafloor mapping: https://www.earthlearningidea.com/PDF/351_Sea_floor_mapping2.pdf

[2] Teaching resource on Marie Tharp: https://www.earthlearningidea.com/PDF/353_Sea_floor_mapping4.pdf

[3] Copejans E et al. (2020) A wave of European Blue Schools: Handbook for teachers. European Commission, Directorate-General Maritime Affairs and Fisheries, Brussels.

[4] Santoro F et al. (2017) Ocean literacy for all: a toolkit. IOC/UNESCO and UNESCO Venice (IOC Manuals and Guides), Paris.

## Resources

- Watch a video on seafloor topography mapping.
- Watch Girl Talk, a musical video on Marie Tharp by The Amoeba People.
- Discover a user-friendly, interactive-map-based educational tool on the ocean: Van Isacker N (2023) The European Atlas of the Seas: an interactive tool for ocean literacy. *Science in School* **61**.
- Try some classroom activities related to the thermal expansion of water: Ribeiro CI, Ahlgren O (2021) An ocean in the school lab: rising sea levels. *Science in School* **53**.
- Learn about the effect of carbon dioxide on ocean chemistry with some hands-on activities: Ribeiro CI, Ahlgren O (2021) An ocean in the school lab: carbon dioxide at sea. *Science in School* **55**.
- Explore the fascinating physiology of squid: Marra MV et al. (2023) Squid dissection: a hands-on activity to learn about cephalopod anatomy. *Science in School* **62**.
- Find out about the physics at work beneath the waves with these classroom experiments: Watt S (2012) Movers and shakers: physics in the oceans. *Science in School* **25**: 28–33.
- Learn about the role of the oceans in climate change: Harrison T, Khan A, Shallcross D (2017) Climate change: why the oceans matter. *Science in School* **39**: 12–15.

## AUTHOR BIOGRAPHY

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