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Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Ocean Literacy

Ocean Heroes – Minecraft Educational Game

Lesson Plan Series on

Ocean Literacy & Marine Ecosystems



Ocean Literacy

A global effort to foster an ocean-literate society — through education, collaboration, and action.

Ocean Literacy is the understanding of how the ocean affects us — and how we affect the ocean. It's a scientific, social, and ethical awareness that helps individuals grasp the vital role the ocean plays in Earth's systems, climate, and all life—including human life. Recognizing that the ocean provides oxygen, food, energy, jobs, and climate regulation, Ocean Literacy equips learners with the knowledge needed to appreciate the ocean not just as a distant body of water, but as an integral part of their everyday lives.

Promoted globally through the UNESCO-IOC Ocean Literacy programme, this educational approach empowers people to make informed and responsible decisions about the ocean's future. By engaging with themes like marine biodiversity, sustainable use of resources, climate resilience, and pollution, Ocean Literacy helps bridge the gap between scientific understanding and community action. It emphasizes that everyone, no matter where they live, has a role in ocean protection—because human actions on land impact the sea, and changes in the ocean influence life on land.

In the classroom, Ocean Literacy offers educators a powerful tool to teach systems thinking, sustainability, and civic responsibility. Through inquiry-based learning, real-world case studies, and interactive tools like the Ocean Heroes: Minecraft Education Game, students can explore ocean challenges in meaningful, hands-on ways. Most importantly, Ocean Literacy fosters a sense of connection and responsibility, preparing young people not only to understand the ocean but to become active stewards of its future.

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THE SEVEN PRINCIPLES

The Ocean Literacy Framework is built on seven essential principles that explain our relationship with the ocean. These principles highlight how the ocean influences life on Earth — and how human actions, in turn, affect ocean health. Together, they serve as a foundation for education, stewardship, and sustainable decision-making.



Earth has one big ocean with many features
despite the division into distinct basins (Atlantic, Pacific, Indian, Arctic, and Southern), the global ocean is interconnected, forming a single, massive body of water.



The ocean and life in the ocean shape the features of Earth
the ocean's role in shaping landforms, including coastlines, and influencing the distribution of sediments and other geological features.



The ocean is a major influence on weather and climate
The ocean absorbs and releases vast amounts of heat, impacting global weather patterns and climate. Ocean currents distribute heat around the world, influencing regional temperatures and precipitation.



The ocean makes Earth habitable
The ocean provides crucial resources like oxygen, regulates the planet's temperature, and supports a vast diversity of life, making Earth a habitable planet.



The ocean supports a great diversity of life and ecosystems
The ocean is home to an incredible array of life, from microscopic organisms to the largest animals on Earth. These ecosystems play vital roles in maintaining the health of the planet.



The ocean and humans are inextricably interconnected
Humans rely on the ocean for food, transportation, recreation, and other essential resources. Our actions, in turn, have a significant impact on the ocean's healt



The ocean is largely unexplored
Despite its importance, a vast portion of the ocean remains a mystery, with much of the deep sea and its inhabitants still unknown.

Click the link to dive deeper into the subject: **Ocean Literacy Principles**



Minecraft Education

Ocean Heroes

Ocean Heroes is an immersive Minecraft Education experience designed to bring marine science to life in your classroom. Through this series of lesson plans, your students will take on the role of young environmental investigators, exploring three vital marine ecosystems—mangrove forests, coral reefs, and kelp forests—each facing real-world environmental threats.

Guided by a team of engaging in-game scientists, students will dive into investigative missions rooted in authentic conservation challenges. As they interact with each ecosystem, they'll not only learn key scientific concepts such as biodiversity, food webs, and ecosystem interconnectivity, but also participate in hands-on restoration efforts:

- In the **mangrove forest**, students will discover how mangroves prevent coastal erosion and actively contribute by planting new saplings to protect vulnerable shorelines.
- Within the **coral reef**, students will tackle the threat of invasive starfish by removing them and replanting coral, witnessing firsthand the delicate balance required for reef recovery.
- In the **kelp forest**, students will confront habitat loss by restoring predator-prey balance—reintroducing sea otters to control overpopulated sea urchins and help the kelp thrive again.

Throughout these missions, students will develop essential skills in observation, critical thinking, and environmental stewardship. Ocean Heroes is more than a game—it's a powerful tool to spark curiosity, connect classroom learning with global ecological issues, and inspire the next generation of ocean advocates.

This introduction will set the stage for your lesson plans, equipping you with the context and objectives needed to guide your students through meaningful, game-based exploration of our planet's most important marine ecosystems.



One Ocean

Introduction

The surface of our planet is covered by one vast ocean, which connects all the world's continents and covers more than 70% of Earth's surface. Most of this ocean is saltwater, while a much smaller portion consists of freshwater found in seas, estuaries, and polar ice. Though it is a single continuous body, the ocean features a remarkable variety of physical, chemical, and biological characteristics that create diverse habitats and ecosystems. Beyond its incredible biodiversity, the ocean plays a crucial role in regulating the planet's climate by absorbing heat and carbon dioxide, influencing weather patterns, and driving global ocean currents. It also provides vital ecosystem services such as oxygen production through marine plants, food resources for billions of people, livelihoods for coastal communities through fishing and tourism, and important materials for medicine and industry. In fact, over three billion people worldwide depend directly on the ocean for their food, work, and way of life.

In this lesson, students will explore the foundational characteristics of the ocean, learning about its physical properties like temperature, salinity, and currents; its chemical makeup; and the incredible biodiversity that thrives beneath the waves. Understanding these basics helps us appreciate the ocean's importance and the challenges it faces.

Key words: *One ocean, Ocean services, Biodiversity, Climate & weather.*

Lesson plan: One Ocean

- **Subject Areas:** Gepgraphy, Envionmental Sciences, Earth Science, Biology

- **Lesson duration:** Approx. 60min

- **Ocean Literacy Principle Connection:**

Principle 1 : "*Earth has one big ocean with many features.*" The activity helps students understand how salinity, as a physical force, varies across ocean basins and affects marine life and ecosystems.

Principle 3 : "*The ocean is a major influence on weather and climate.*" By understanding how density differences due to temperature and salinity drive ocean currents, students gain insights into how these currents help regulate the Earth's climate.

- **Lesson objectives:**

By the end of this lesson, students will be able to:

1. Define what is meant by "One Ocean" and explain how the world's ocean is interconnected.
2. Identify and describe key physical and chemical properties of the ocean.
3. Understand the concepts of ocean services, biodiversity, climate, and weather in relation to the ocean.
4. Explain why the ocean is vital to life on Earth and how it supports global systems.
5. Participate in a collaborative activity to reinforce learning through critical thinking and creativity.

- **Key words definitions:**

1. **One Ocean** – Refers to the idea that all the Earth's ocean basins (Atlantic, Pacific, Indian, Arctic, and Southern) are interconnected, forming one global, continuous body of saltwater that circulates around the planet.
2. **Ocean Service**s – The benefits humans receive from the ocean, such as food, oxygen production, climate regulation, tourism, medicine, and transportation.
3. **Biodiversity** – The variety of living organisms in a particular environment. The ocean is home to millions of species, many of which are not yet discovered.
4. **Climate & Weather** – Climate is the long-term pattern of temperature, humidity, and precipitation in an area. Weather is the day-to-day state of the atmosphere. The ocean helps regulate both through heat absorption and global circulation patterns.

Core Content

1. Present the following topics (via slideshow, handout, or teacher-led discussion):
2. **Physical properties:** temperature, salinity, currents, depth.
3. **Chemical composition:** saltwater, dissolved gases (e.g., oxygen, carbon dioxide).
4. **Biological diversity:** marine ecosystems from coral reefs to the deep sea.
5. **Ocean's influence on climate:** heat absorption, current-driven weather changes, carbon sink role.

Introduction

- **Start with an engaging question:** Ask students, "How many oceans are there?" Use this to spark curiosity and challenge prior assumptions.
- **Display a world map or globe:** Highlight the five traditionally named oceans (Pacific, Atlantic, Indian, Southern, Arctic), then introduce the One Ocean concept using the Spilhaus Projection to show how all oceans are connected as one global system.
- Explain the ocean's global role: Briefly describe how the ocean influences climate, supports biodiversity, and provides essential resources and services to people and the planet.
- **Introduce and define key vocabulary**: Review important terms such as One Ocean, ocean services, biodiversity, climate, and weather. Use visual aids or real-world examples to deepen understanding.
- **Facilitate a personal connection:** Use open-ended questions to prompt discussion, such as:

    1. ***Have you ever been to the ocean? What did you notice?***
    2. ***Can you name a product, food, or activity in your life that depends on the ocean?***
    3. ***Why do you think the ocean matters even to people who live far from the coast?***

Class investigation activity:

Friendly Floatees Spill

Recommend exploring a rubber duck spill in the Pacific Ocean (1992) to help students understand how ocean currents move floating objects across vast distances. This real-world event offers a fun and memorable way to visualize the power and interconnectedness of ocean circulation.



Illustration by: UNESCO, Esteban Gottfried B. 2025

Indoor Class Activity:

- **Activity Title:** One Ocean – Mapping a Connected Ocean

- **Objective:**

To help students visualize the ocean as a single, continuous system through the lens of the Spilhaus Projection, and understand how different ocean basins contribute unique physical, chemical, and biological characteristics to the global ocean.

- **Materials Needed:**

  - A large printed or projected Spilhaus Projection map (showing the world's ocean as one continuous body of water)
  - Pre-cut puzzle pieces of the major ocean basins (e.g., Pacific, Atlantic, Indian, Southern, Arctic)
  - Worksheet templates for each group to fill in information about their basin
  - Markers, colored pencils, glue/tape, wall or board space

- **Instructions:**

1. **Group Assignment:**
Divide the class into 5–6 small groups. Assign each group one ocean basin:

  - Pacific
  - Atlantic
  - Indian
  - Southern
  - Arctic

2. Research & Fill-In (Worksheet or Chart):
Each group investigates or is given data on their ocean basin and records:

  - **Physical Characteristics**: Average depth, temperature range, major currents, notable features (e.g., trenches, ridges).
  - **Chemical Characteristics:** Salinity, dissolved oxygen, nutrient levels.
  - **Biological Characteristics:** Types of ecosystems or iconic species found (e.g., coral reefs, polar marine life).
  - **One Global Circulation:** How water, heat, or species move from their basin to another (e.g., via currents like the Gulf Stream or the Thermohaline circulation).

- **Instructions:**

3. Design & Decorate Puzzle Piece:
Students add visuals and keywords to their puzzle piece representing their basin's features and its role in the greater ocean system.

4. Puzzle Assembly & Discussion:
As groups complete their pieces, assemble the One Ocean Puzzle on a classroom wall or board using the layout of the Spilhaus Projection.

Each group gives a short explanation of:

- What makes their basin unique
- How it connects and interacts with others
- Why it's essential to view the ocean as one system rather than many separate ones

- **Learning Outcomes:**

- Students understand the ocean is one interconnected body of water with distinct but connected regions.
- They gain familiarity with the Spilhaus Projection and how it shifts our perspective of the ocean's true scale and unity.
- They explore how physical, chemical, and biological features vary across basins but still contribute to global ocean processes like climate regulation and nutrient cycling.

- **Additional Lesson Support:**

To deepen understanding of ocean connectivity, two specific lesson plans have also been added on:

- **Ocean Salinity** – exploring how salt concentration varies across ocean basins and its role in global circulation.
- **Ocean Currents** – investigating surface and deep-water currents, including how they transport heat, nutrients, and pollution across the One Ocean system.



Exploring Salinity Across the Ocean

Introduction

Salinity—the concentration of dissolved salts in seawater, measured in parts per thousand (ppt)—varies widely across different parts of the ocean. These variations are driven by environmental factors such as evaporation, precipitation, river runoff, and ice melt, making some regions saltier than others. For example, enclosed seas like the Dead Sea or Red Sea tend to have much higher salinity levels due to high evaporation and limited freshwater input, while regions like the Baltic Sea are significantly less salty.

Salinity is not just a number—it plays a key role in ocean dynamics. It influences water density, helping to drive thermohaline circulation, which in turn affects climate, nutrient transport, and the distribution of marine life.

In this lab activity, students will simulate the average salinity of selected ocean basins and seas using water, salt, and a hydrometer. By adjusting salt levels to match real-world values, students will gain a tangible understanding of how salinity is measured and why it matters. This activity builds critical thinking skills and supports ocean literacy by connecting physical ocean properties to global environmental processes and marine ecosystems.

Key words: *Ocean Basins, Density, Salinity, Hydrometer*

Lesson plan: Exploring Salinity Across Ocean Basins

- **Subject Areas:** Geography, Earth Science, Chemistry

- **Lesson duration:** Approx. 60min

- **General Objective:**

Students will explore how salinity varies across different marine regions by replicating the salinity of major ocean basins and seas using a hydrometer. They will also investigate the environmental factors that affect salinity and reflect on its impact on marine life.

- **Learning Outcomes:**

  - **Measure and Replicate Ocean Salinity:** Students measure salinity using a hydrometer and replicate the salinity levels of different ocean basins and seas.
  - **Understand Salinity Variation Across Oceans**: Students recognize how salinity varies between ocean basins - seas and the factors that influence these variations.
  - **Develop Practical Lab Skills:** Students gain experience in measuring, calculating, and adjusting salinity levels in a controlled environment.
  - **Connect to Ocean Literacy:** Students connect the concept of salinity to ocean processes, understanding its impact on marine ecosystems and biodiversity.
  - **Collaborate and Analyze Data:** Students collaborate in groups, analyze their results, and compare salinity levels across different ocean basins, enhancing teamwork and critical thinking skills.

- **Material:**

  - Clear container (beaker or jar) with 500 mL of freshwater
  - Hydrometer or salinity refractometer
  - Measuring spoon or digital scale
  - Table salt (non-iodized preferred)
  - Stirring stick or spoon
  - Worksheet to record salinity measurements and calculations

- **Procedure:**

1. **Group Assignment:** Divide students into five groups. Assign each group one ocean basin or sea from the list below. Provide each group with a fact sheet or slide with the average salinity of their assigned region.
2. **Target Salinity Setting:** Explain that ocean salinity is usually measured in parts per thousand (ppt). Give each group a target ppt value based on their assigned region.
3. **Preparing the Water Sample:** Each group receives a container of 500 mL freshwater. They must calculate how much salt to add to reach their assigned salinity level. Example: For 500 mL water and a target salinity of 35 ppt: 35 grams of salt per 1,000 mL → use 17.5 grams of salt for 500 mL.
4. **Salinity Testing:** Students add the estimated amount of salt, mix thoroughly, and measure with the hydrometer. If the salinity is too low, they add more salt incrementally and re-test until the target is reached.
5. **Observation & Comparison:** Once all groups reach their target salinities, have them line up their containers. Students observe and compare salinity levels across regions. Optionally, use food coloring to help visually differentiate the samples.
6. **Class Discussion:** Lead a discussion using guiding questions:
   - ***Why does the Dead Sea have such high salinity compared to the Baltic Sea?***
   - ***What factors affect the salinity of a body of water? (e.g., evaporation, river input, temperature, depth)***
   - ***How might different salinity levels impact marine life in these regions?***
   - ***How do organisms adapt to extremes in salinity?***

Recommended Ocean Basins & Seas:

1. ***Dead Sea –*** *~340 ppt (extremely high salinity)*
2. ***Red Sea –*** *~40 ppt (very salty due to high evaporation)*
3. ***Mediterranean Sea –*** *~38 ppt (salty, enclosed, high evaporation)*
4. ***Pacific Ocean (central basin) –*** *~34.5 ppt (moderate, average salinity)*
5. ***Baltic Sea*** *– ~7–15 ppt (low salinity due to large freshwater input)*

- **Additional Resources:**

- https://www.noaa.gov/jetstream/ocean/sea-water
- https://www.sciencelearn.org.nz/resources/686-ocean-salinity
- https://mynasadata.larc.nasa.gov/mini-lessonactivity/energy-and-matter-exploring-ocean-salinity





Exploring Global Currents

Introduction

Ocean water density is a key driver of deep-sea circulation and one of the most important forces regulating Earth's climate. The density of seawater is influenced primarily by two factors: temperature and salinity. Cold, salty water is denser and tends to sink, while warm or fresh water is less dense and remains closer to the surface. These differences in density set ocean waters in motion, creating a global conveyor belt known as thermohaline circulation ("thermo" for heat, "haline" for salt).

This circulation pattern helps move heat, oxygen, and nutrients around the world's oceans, linking surface and deep-water systems. For example, when warm surface currents like the Gulf Stream travel northward, they gradually cool and become saltier due to evaporation. As a result, the water becomes denser and sinks, forming the start of a deep current that travels across entire ocean basins.

In this lab activity, students will simulate this process by layering warm, fresh red-colored water and cold, salty blue-colored water in a clear container. By observing how the two water masses interact based on density, students will gain a visual and practical understanding of how temperature and salinity combine to power deep ocean currents. This experiment provides an engaging entry point to understanding climate regulation, marine ecosystems, and the interconnected nature of Earth's systems.

Key words: *Thermohaline Circulation, Density, Salinity, Temperature*

Lesson plan: Exploring Ocean Currents

- **Subject Areas:** Geography, Earth Science, Chemistry, Physics

- **Lesson duration:** Approx. 60min

- **General Objective:**

Students will explore how temperature and salinity influence the density of seawater, and how these factors drive thermohaline circulation—the deep ocean current system that helps regulate Earth's climate. Using a hands-on demonstration, students will visualize how warm, freshwater and cold, salty water form distinct layers based on their density differences.

- **Learning Outcomes:**

  - **Understand Ocean Density:** Students understand how differences in water temperature and salinity affect the density of seawater.
  - **Observe and Simulate Ocean Currents:** Students observe how warm, fresh water and cold, salty water create layers based on their different densities and learn the process of thermohaline circulation, understanding how surface water moves, cools, increases in salinity, and sinks to form deep ocean currents.
  - **Apply Ocean Literacy Principles:** Students connect the concept of ocean currents to the Earth's climate system and recognize how currents influence global weather patterns.
  - **Develop Critical Observation Skills:** Students develop their observational and analytical skills by documenting the behavior of the different water layers and understanding the dynamics at play.

- **Material:**

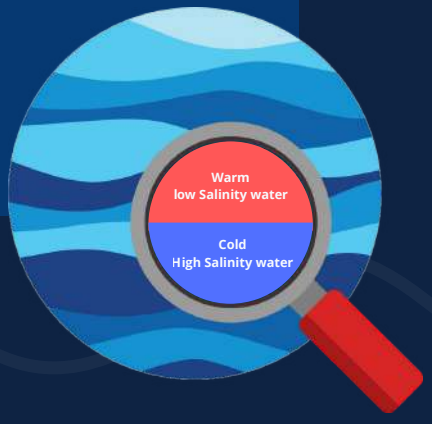
  - Large clear container or aquarium
  - Room temperature water (for base)
  - Warm water (colored red with food coloring)
  - Cold water (colored blue with food coloring)
  - Salt
  - Ice cubes
  - Thermometer
  - Measuring cup
  - Spoon or stirrer
  - Optional: Lab worksheet for observations

- **Procedure:**

1. **Prepare the Water Solutions:** (a) Warm Red Freshwater: Heat a small amount of water (not boiling) and color it red using food coloring. (b) Cold Blue Saltwater: Mix cold water with a high amount of salt to simulate seawater (about 35 grams per liter). Color it blue. Add ice cubes to keep it cold while preparing the rest.
2. **Set Up the Aquarium:** Fill the aquarium about ¾ full with room temperature water to serve as a neutral base layer. Let the water settle for a minute before adding colored solutions.
3. **Measure & Compare Temperatures:** Use a thermometer to record the temperature of both the warm red water and the cold blue salty water. Note the difference and hypothesize which one is denser and why.
4. **Add the Waters (Slowly!):** Carefully pour the warm red freshwater down one side of the tank. Slowly add the cold blue saltwater from the opposite side. Pour both gently to prevent immediate mixing—using a spoon or slide can help **reduce turbulence.**
5. **Observe the Density Differences:** Watch how the two colored waters behave. Typically, the warm freshwater floats near the top while the cold salty water sinks and spreads along the bottom. Have students record their observations: color layering, movement patterns, and any mixing.
6. **Class Discussion**: Lead a discussion using guiding questions:
   - ***Which water was denser? How could you tell?***
   - ***Why do salt and temperature both affect density?***
   - ***What might happen in the real ocean when warm water travels toward the poles?***
   - ***How do these density differences help power thermohaline circulation?***

- **Additional Resources:**

- https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-currents
- https://marine.copernicus.eu/explainers/why-ocean-important/ocean-currents
- https://education.nationalgeographic.org/resource/resource-library-ocean-currents/





Coral Reefs

Introduction

Coral reefs are some of the most vibrant and diverse ecosystems on Earth, built over thousands of years by tiny coral polyps. Although they cover less than 1% of the ocean floor, they support nearly 25% of all marine life, providing habitat for fish, sea turtles, invertebrates, and more. These reefs also offer essential benefits to people, including food, coastal protection, tourism, and even potential medicines. Often called the "rainforests of the sea," coral reefs are vital to both ocean health and human well-being.

However, coral reefs face growing threats from rising ocean temperatures, pollution, overfishing, and outbreaks of crown-of-thorns starfish—natural predators that can devastate reefs when their populations go unchecked. In this lesson, students will explore how coral reefs form, the services they provide, and the challenges they face. They'll also learn about ongoing restoration efforts, such as coral farming and predator management, to understand how we can help protect these critical underwater ecosystems.

Key words: *Biodiversity, Polyps, Crown-of-thorns starfish, Coral bleaching*

Lesson plan: Coral Reef

- **Subject Areas:** Biology, Environmental Science, Geography, Earth Science

- **Lesson duration:** Approx. 60min

- **Lesson objectives:**

By the end of this lesson, students will be able to:

- Describe what coral reefs are and how they are formed.
- Explain the importance of coral reefs in terms of biodiversity and ocean services.
- Identify major threats to coral reefs, including coral bleaching and crown-of-thorns starfish.
- Understand the connection between environmental changes (e.g., salinity, temperature) and reef health.
- Participate in a collaborative simulation to reinforce learning through creative thinking and teamwork.

- **Key words definitions:**

1. **Polyps –** Small, soft-bodied marine animals that live in colonies and build hard skeletons of calcium carbonate, forming the foundation of coral reefs over time.
2. **Biodiversity –** The variety and abundance of different species living within an ecosystem; coral reefs support one of the highest levels of biodiversity on Earth.
3. **Crown-of-thorns starfish –** A spiny, coral-eating predator that, when overpopulated, can cause severe damage to coral reefs by consuming large amounts of living coral.
4. **Coral bleaching –** A process where stressed corals (often due to increased water temperatures) expel the algae that give them color and energy, making them vulnerable to disease and death.

- **Core Content**

1. Reef Formation: How polyps build coral skeletons over time.
2. Marine Biodiversity: Coral reefs support fish, invertebrates, turtles, and sharks.
3. Ecosystem Services: Food, medicine, tourism, coastal protection.
4. Reef Stressors: Warming temperatures (bleaching), pollution, overfishing, invasive species like crown-of-thorns starfish.
5. Connection to Ocean Chemistry: Changes in salinity and acidity can weaken coral structures.

- **Introduction**

  - Begin with the question: “What do you think lives in a coral reef?”
  - Show images or short videos of vibrant coral reefs and marine life.
  - Explain that coral reefs are living structures made by tiny animals called polyps, and they form some of the most biologically rich ecosystems on Earth. Though they cover less than 1% of the ocean floor, they support nearly one-quarter of all marine species and provide essential services to humans, such as food, storm protection, and tourism.
  - Ask discussion prompts:
    1. ***Why might coral reefs be compared to rainforests?***
    2. ***What do you think happens if a coral reef dies?***
    3. ***Have you seen news about coral bleaching or reef restoration?***

- **Class investigation activity:**

The Legacy of Coral Mining in Southeast Asia

Recommend investigating the historical practice of coral mining in Southeast Asia, particularly in regions like the Philippines and Indonesia. For centuries, coral was extracted for use in construction, lime production, and even decorative arts. This practice offers a compelling lens to examine how human dependence on coral reefs has evolved—and how unsustainable use has led to long-term ecological damage.

Indoor Class Activity:

- **Activity Title:** Reefs Through Time: How People Have Lived With Coral Ecosystems

- **Objective:**

To explore the historical and cultural importance of coral reefs, and investigate how human societies have benefited from, impacted, and now work to protect coral ecosystems.

- **Materials Needed:**

- Printed case studies (provided or prepared by teacher)
- Internet access (optional, for research-based version)
- "Investigation Sheet" with guiding questions
- Projector or map for location reference
- Colored pencils/markers

- **Instructions:**

Step 1: Case Study Exploration
Assign student groups one of the following real-world cultural or historical connections to coral reefs:

1. The Pacific Island Navigators – How traditional Polynesian and Micronesian communities used coral reefs for navigation, food, and coastal protection.
2. The Coral Trade in the Red Sea – How coral skeletons were used in jewelry and religious artifacts, traded across Asia, Africa, and Europe for centuries.
3. The Great Barrier Reef & Aboriginal Lore – How Indigenous Australian groups tell stories about the reef in their Dreamtime traditions and used reef species in rituals and daily life.
4. Tourism and the Maldives – How coral reefs now support modern tourism economies—and how tourism has both helped and harmed reefs.
5. Coral Mining in the Philippines & Indonesia – Historic and ongoing practices of coral extraction for construction and lime production, and their ecological costs.

Step 2: Guided Investigation Questions
Each group uses a worksheet to answer:

- Where is this coral reef region located?
- How have people historically used or depended on the reef?
- What cultural beliefs or traditions were connected to the reef?
- How has human activity affected the reef over time (positively or negatively)?
- What is being done today to protect or restore it?

Instructions

Step 3: Group Sharing & Discussion
Each group presents a 2-minute summary of their findings. As a class, discuss:

- Are coral reefs more than just ecosystems?
- How does culture shape the way people interact with nature?
- Should traditional knowledge play a role in reef conservation today?

Learning Outcomes:

- Students understand coral reef structure, function, and the effects of human and environmental stressors. They apply systems thinking to assess the interconnected impacts of biodiversity loss.





Indoor Class Activity 2:

- **Activity Title:** Crown of Thorns: Predator or Problem?

- **Objective:**

Students will investigate the Crown-of-Thorns starfish (Acanthaster planci), understanding its role in coral reef ecosystems, the ecological impacts of its population blooms, and the importance of balanced predator-prey relationships.

- **Materials Needed:**

  - Printed sheets (or digital slides) on Crown-of-Thorns starfish (CoTS)
  - World map (physical or digital)
  - Colored pencils or markers
  - Short video (optional) showing CoTS in coral reefs
  - Worksheets with guiding questions

- **Learning Outcomes:**

  - Understand the biological characteristics and life cycle of the Crown-of-Thorns starfish.
  - Identify its ecological role and threats to coral reefs.
  - Recognize human impact (pollution, overfishing) on predator-prey balance.
  - Develop critical thinking on conservation interventions.

- **Instructions:**

1. **Introduction:** Briefly introduce coral reef ecosystems and the role of balance in marine life. Ask: What happens when one species grows too much?
2. **Exploration** : Present facts about CoTS: where they are found (Indo-Pacific region), their diet (coral polyps), predators (e.g. giant triton, pufferfish), and how blooms occur (nutrient runoff, overfishing of predators).
3. **Group Activity:** Divide students into small groups
    - Group 1: Research and map CoTS distribution globally.
    - Group 2: Explore their lifecycle and fill in a blank diagram.
    - Group 3: Label the anatomy of the starfish and explain each part's function.
4. **Discussion:** Groups present their findings. Discuss real-world efforts to manage CoTS outbreaks (e.g., diver removal programs).
5. **Wrap-up Reflection:** Ask: *Should we remove Crown-of-Thorns from coral reefs? Why or why not?*

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Coral Reef Biodiversity

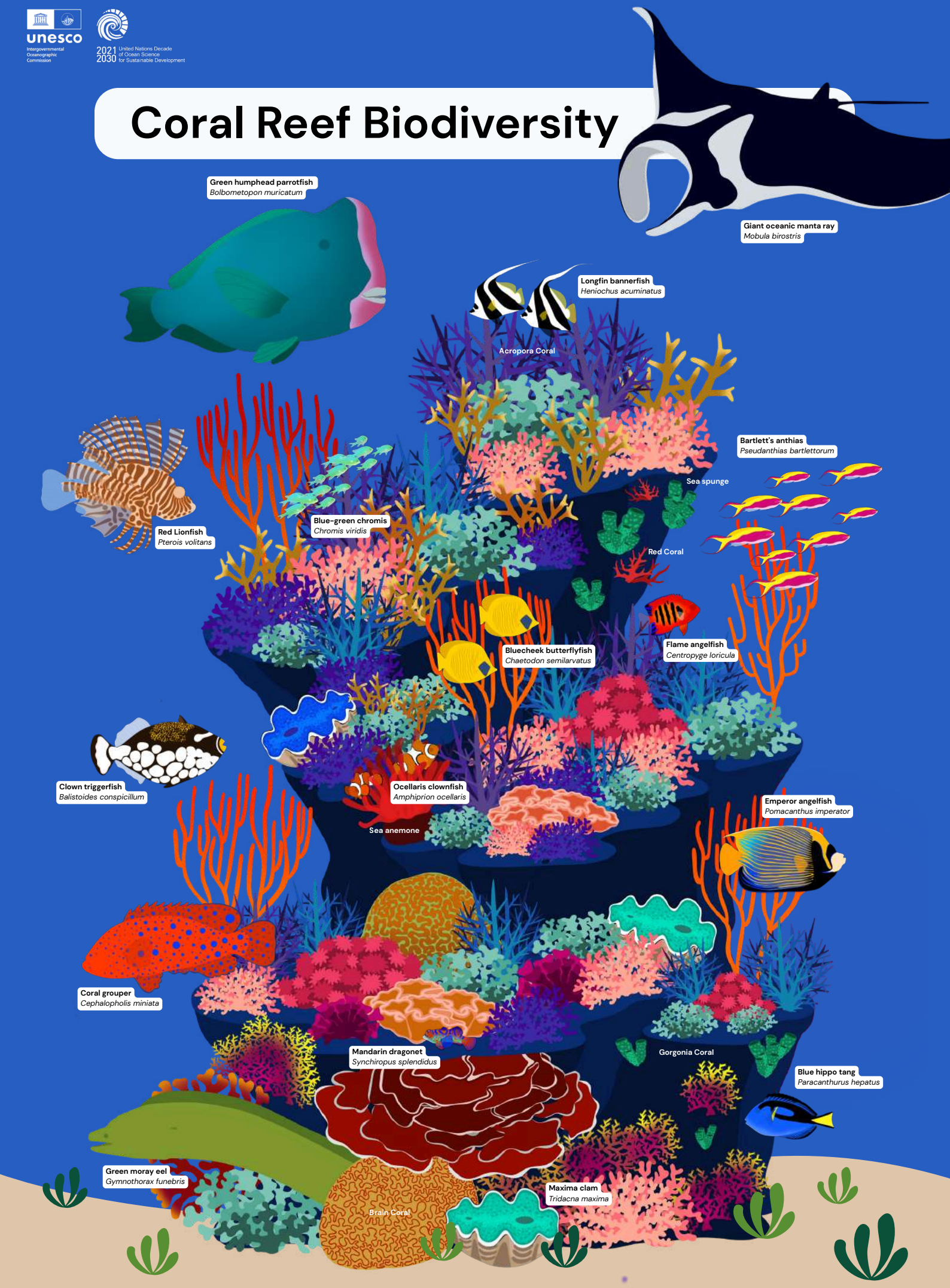


Illustration by: UNESCO, Esteban Gottfried B. 2025



Mangrove Forests

Introduction

Mangrove forests grow along tropical and subtropical coastlines where saltwater and freshwater meet, forming dense root systems that rise above the water. These unique trees protect shorelines from erosion, filter pollutants, and provide crucial nursery habitats for fish, crabs, and shrimp. Mangroves also store large amounts of carbon in their roots and soil, helping regulate the climate, while supporting millions of people through fishing, tourism, and farming.

However, mangrove ecosystems are increasingly threatened by coastal development, pollution, and climate change. Deforestation, plastic waste, and nutrient runoff weaken their resilience, while rising sea levels and stronger storms accelerate erosion and habitat loss.

In this lesson, students will explore how mangroves function and why they are vital to both marine life and human communities. They will also investigate global efforts to restore mangrove habitats through replanting and nature-based shoreline protection.

Key words: *Mangrove, Root System, Blue Carbon, Erosion*

Lesson plan: Mangrove Forests

- **Subject Areas:** Biology, Environmental Science, Geography, Earth Science

- **Lesson duration:** Approx. 60min

- **Lesson objectives:**

By the end of this lesson, students will be able to:

1. Define what a mangrove forest is and describe its main features.
2. Understand how mangroves protect coastlines and store carbon.
3. Identify the ecosystem services provided by mangroves, including biodiversity support and climate regulation.
4. Recognize the human impacts that lead to mangrove degradation.
5. Participate in a creative simulation to reinforce learning through teamwork and systems thinking.

- **Key words definitions:**

1. **Mangroves** – Salt-tolerant trees that grow in intertidal zones, with roots adapted to brackish or salty water.
2. **Root systems** – The exposed and tangled roots of mangrove trees that anchor them in soft, shifting sediments, reduce erosion, trap pollutants, and provide shelter for aquatic species.
3. **Blue carbon** – Carbon stored in coastal ecosystems like mangroves, seagrasses, and salt marshes, which helps reduce greenhouse gases and mitigate climate change.
4. **Erosion** – The natural process of soil and land being worn away by water, wind, or waves; mangrove roots help prevent this by stabilizing shorelines.

- **Core Content**

1. **Mangrove Adaptations:** Salt filtration, aerial roots, viviparous seeds.
2. **Ecosystem Services:** Coastal protection, fisheries, carbon storage.
3. **Human Impacts**: Deforestation, aquaculture, pollution, rising seas.
4. **Restoration Efforts**: Replanting mangroves, building living shorelines, community-based projects.

Introduction

- Start with the question: *What kind of forest grows in the sea?*
- Introduce mangrove forests as coastal wetlands found in tropical and subtropical regions. Discuss how they grow where freshwater meets saltwater and explain their role in preventing erosion, supporting wildlife, and fighting climate change through blue carbon storage.
- Ask students open-ended questions:
  1. ***Why do you think mangroves grow above water with exposed roots?***
  2. ***What animals might rely on these tangled roots for shelter?***
  3. ***How do you think mangroves help protect coastlines during storms?***

Class investigation activity:

The legend of Bonbibi from the Sundarbans mangrove forest.
a guardian spirit revered by local communities in India and Bangladesh. Worshipped by honey collectors and fishers, Bonbibi is believed to protect people from tigers and the dangers of the mangroves. This powerful cultural story highlights how human relationships with mangrove forests go beyond resources, weaving spiritual and ecological connections that continue to shape conservation efforts today.



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Indoor Class Activity:

- **Activity Title:** Mangroves Through Culture – Nature's Defenders in Human Stories

- **Objective:**

To explore cultural and historical connections to mangroves and how different societies have used or revered them.

- **Materials Needed:**

  - Printed case studies (provided or prepared by teacher)
  - Internet access (optional, for student-led research)
  - "Investigation Sheet" with guiding questions
  - Projector or map for global kelp forest regions
  - Colored pencils/markers (for optional map work)

- **Instructions:**

Step 1: Case Study Exploration
Assign groups one of the following case studies

1. Sundarbans (India & Bangladesh) – Mangroves as tiger habitat and spiritual barrier in folklore.
2. Philippines & Indonesia – Community-led mangrove planting and food sources.
3. West Africa (Senegal & Gambia) – Mangrove rice farming and sustainable livelihoods.
4. Florida, USA – Legal protections and restoration after hurricane damage.
5. Myanmar & Thailand – Mangrove ecotourism and coastal defense strategies.

Step 2: Guided Investigation Questions
Students answer on an investigation sheet:

- *Where is this region?*
- *How have people used mangroves historically?*
- *Are there traditional beliefs or practices connected to mangroves?*
- *What threats do mangroves face in this area?*
- *What is being done to protect or restore them?*

Step 3: Group Sharing
Each group presents a summary of their region. Wrap up with a discussion:

- *Can ecosystems be part of culture and identity?*
- *Should restoration include the communities who live alongside mangroves?*

- **Learning Outcomes:**

  - Students will understand that mangrove forests are vital ecosystems deeply connected to both nature and culture. Through simulation and case studies, they'll gain insight into why preserving mangroves is crucial for both people and the planet.





Indoor Class Activity 2:

- **Activity Title:** Plastic in the Roots: Trapped but Not Forgotten

- **Objective:**

Students will learn how plastic pollution affects mangrove ecosystems, focusing on how plastic waste becomes trapped in mangrove roots and impacts marine life.

- **Materials Needed:**

  - Plastic samples (cleaned or simulated with paper)
  - Photos/videos of plastic in mangroves
  - Mini-mangrove model or diagram of root structure
  - Fact sheet on mangrove ecosystem services

- **Learning Outcomes:**

  - Understand the structure and ecological function of mangroves.
  - Identify how plastic pollution becomes trapped in root systems.
  - Evaluate the impact of plastic on marine life and coastal ecosystems.
  - Propose community-based and systemic solutions to reduce plastic waste

- **Instructions:**

1. **Introduction:** Introduce mangroves: where they grow, their root structure, and their ecological importance (coastal protection, nursery grounds, carbon storage).
2. **Visual Impact:** Show video/photos of plastic trapped in mangrove roots. Ask: What do you think happens to the animals living here?
3. **Hands-on Activity:** Students work in small groups
    - Groups are given a diagram or physical model of mangrove roots.
    - Using “plastic” pieces, they simulate how debris becomes trapped.
    - Read species impact cards and match them to plastic types (e.g., ghost nets, bottles).
4. **Creative Reflection:** Groups design a poster campaign titled “Keep Plastics Out of Our Mangroves” focusing on one solution (e.g., cleanups, recycling, education).
5. **Wrap-Up Discussion:** Link to the game: How does your avatar help clean mangroves, and why is that important?

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Mangrove Forest Biodiversity

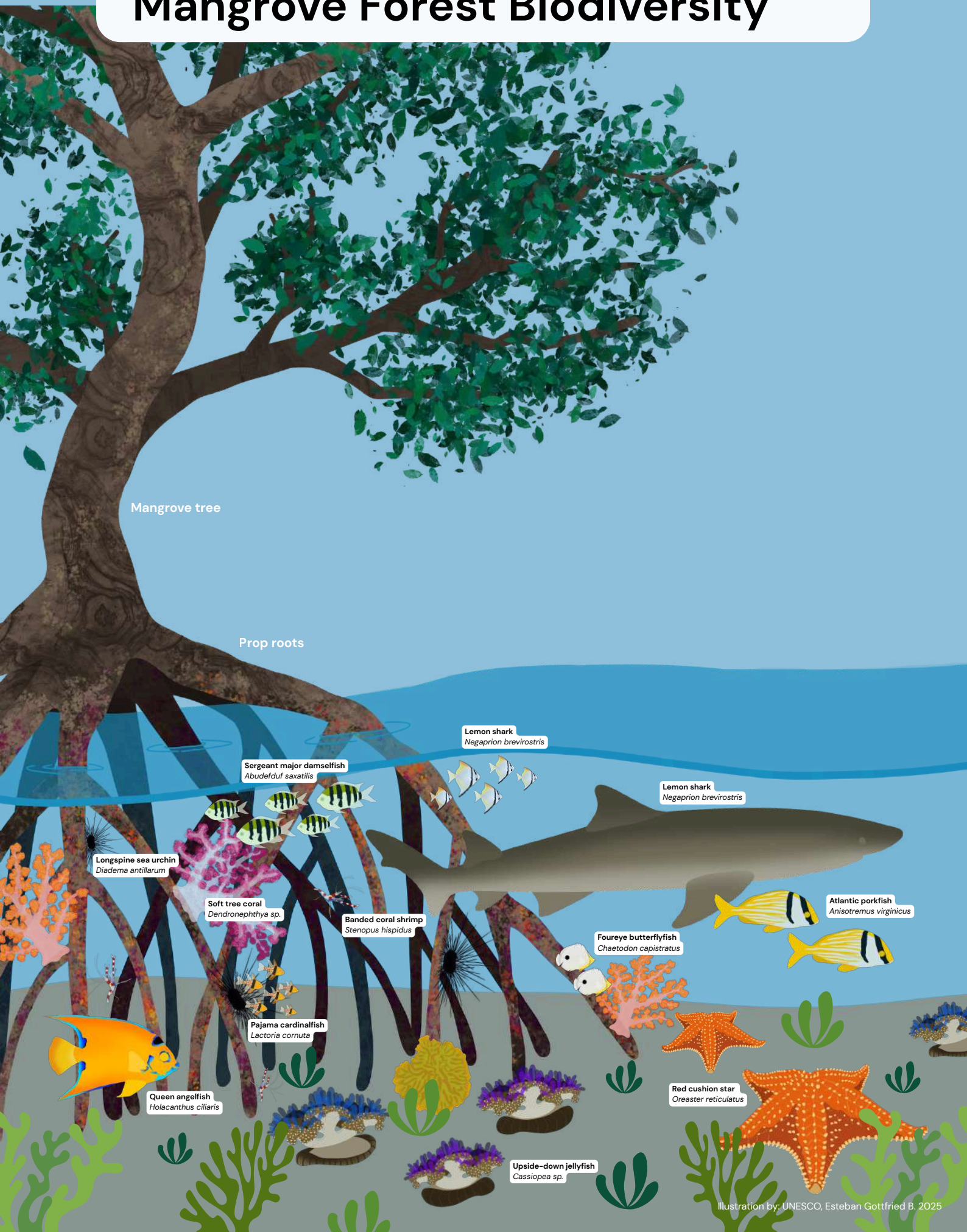


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Kelp Forests

Introduction

Kelp forests are rich, fast-growing underwater ecosystems found in cold, nutrient-rich waters, where giant brown algae form dense, towering canopies. These forests provide shelter, food, and nursery grounds for a variety of marine life, including sea otters, fish, and crabs. Beyond supporting biodiversity, kelp forests help stabilize shorelines, absorb carbon dioxide, and store "blue carbon," making them important allies in the fight against climate change.

Yet many kelp forests are in rapid decline due to the overpopulation of sea urchins, which feed aggressively on kelp when their natural predators—like sea otters and sunflower sea stars—are removed by hunting, disease, or environmental shifts.

This imbalance can turn vibrant forests into barren seascapes, threatening marine life and coastal ecosystems. In this lesson, students will explore how kelp forests function, what happens when ecological balance is disrupted, and how restoration efforts—such as reintroducing predators or removing urchins—are helping to protect these critical marine habitats.

Key words: *Algae, Sea urchin, Canopy, Predatory-prey balance*

Lesson plan: Kelp Forests

- **Subject Areas:** Biology, Environmental Science, Geography, Earth Science

- **Lesson duration:** Approx. 60min

- **Lesson objectives:**

By the end of this lesson, students will be able to:

1. Define what a kelp forest is and describe its main features.
2. Understand the role of predator-prey relationships in maintaining ecosystem balance.
3. Identify the ecosystem services provided by kelp forests, including blue carbon storage.
4. Recognize the human impacts that lead to kelp forest decline.
5. Participate in a creative simulation to reinforce learning through teamwork and systems thinking.

- **Key words definitions:**

1. **Algae –** Simple, plant-like organisms that live in water; in kelp forests, large brown algae (kelp) grow rapidly and create dense underwater habitats.
2. **Sea urchins –** Spiny marine animals that feed on kelp; if not kept in check by predators, they can overgraze and destroy entire kelp forests.
3. **Canopy –** The upper layer of a kelp forest formed by the long fronds of kelp reaching toward the surface, providing food and shelter for marine species.
4. **Predator-prey balance –** The natural relationship that keeps ecosystems stable; in kelp forests, predators like sea otters control sea urchin populations, maintaining healthy kelp growth.

- **Core Content**

1. Kelp Structure: Anchors (holdfasts), stems (stipes), and canopy (fronds).
2. Habitat Role: Nursery for fish, home for crabs, sea stars, and otters.
3. Predator-Prey Imbalance: Loss of predators → urchin explosion → kelp deforestation.
4. Human Impacts: Overfishing, pollution, and warming waters.
5. Restoration: Reintroducing otters, removing urchins, marine protected areas.

- **Instructions**

  - Start with the question: ***What does a forest look like underwater?***

  - Introduce the concept of kelp forests—cold-water, underwater ecosystems where giant brown algae grow like underwater trees, forming dense canopies that shelter and feed marine animals.

  - Explain their benefits: stabilizing shorelines, absorbing carbon dioxide, providing habitat, and storing "blue carbon" to fight climate change. Then share that kelp forests are now in trouble—being eaten away by out-of-control sea urchin populations when natural predators like otters disappear.

- **Class investigation activity:**

  Following the Kelp Highway – Migration Clues from the Forests Below

  Recommend exploring the theory of the "Kelp Highway Hypothesis," which suggests that early human populations may have migrated from Asia to the Americas by following a ribbon of kelp-rich coastlines along the Pacific Rim. These kelp forests offered food, shelter, and navigation clues to seafaring people.

Indoor Class Activity:

- **Activity Title:** Forests of the Sea: How People Have Lived With Kelp Ecosystems

- **Objective:**

To explore the historical, cultural, and economic roles of kelp forests in human societies, and investigate how people have both benefited from and worked to protect these unique underwater ecosystems.

- **Materials Needed:**

  - Printed case studies (provided or prepared by teacher)
  - Internet access (optional, for student-led research)
  - "Investigation Sheet" with guiding questions
  - Projector or map for global kelp forest regions
  - Colored pencils/markers (for optional map work)

- **Instructions:**

Step 1: Case Study Exploration
Divide students into small groups. Assign or let them choose from the following real-world connections between humans and kelp forests:

1. **Māori Seaweed Traditions in New Zealand** – Indigenous Māori communities have long harvested karengo (red algae) for food, medicine, and spiritual practices. Today, these traditional uses are being revived alongside modern efforts to sustainably manage coastal seaweed habitats.
2. **Traditional Uses in Japan & Korea** – Kelp (kombu) has long been harvested for food, medicine, and rituals in East Asian cultures.
3. **California's Sea Otter Recovery** – How protecting sea otters as a keystone species helped restore kelp forest health and sparked a conservation success story.
4. **Kelp Harvesting in Norway & Scotland** – Coastal communities harvested kelp for centuries to produce soda ash, fertilizer, and later biofuels and cosmetics.
5. **Modern Marine Permaculture Projects** – How kelp is being farmed today to absorb carbon and provide sustainable food, animal feed, and climate solutions.

Step 2: Guided Investigation Questions
Students work in their groups using an "Investigation Sheet" to answer:

- Where is this kelp forest region located?
- How have people historically used or relied on the kelp ecosystem?
- Are there any cultural beliefs, customs, or traditional knowledge linked to kelp?
- What challenges or threats has this kelp region faced?
- What conservation efforts or solutions are being implemented today?

- **Instructions:**

Step 3: Group Sharing & Discussion
Each group presents a 2-minute summary of their findings. Then, lead a class discussion around:

- How do kelp forests shape the identity or economy of coastal communities?
- Are kelp forests more than just "seaweed"? How do they support both ecosystems and people?
- What can we learn from traditional knowledge in preserving these ecosystems today?

- **Learning Outcomes:**

- Students will recognize that kelp forests are not just biological systems but are deeply tied to human history, culture, and innovation—and that protecting them is as much a social responsibility as an environmental one.





Indoor Class Activity 2:

- **Activity Title:** Sea Urchin Overload: Grazers Gone Wild

- **Objective:**

Students will explore how sea urchins can overgraze kelp forests in the absence of predators, understand trophic cascades, and discuss strategies to restore kelp ecosystems.

- **Materials Needed:**

  - Photos and videos of kelp forests before and after urchin overgrazing
  - Fact sheets on sea urchins and their predators (e.g., sea otters, lobsters)
  - Trophic cascade diagram template
  - Simulation worksheet: "Design a Balanced Food Web"
  - Poster paper, markers

- **Learning Outcomes:**

  - Understand the ecological importance of predator-prey dynamics in kelp forests.
  - Learn the causes and consequences of sea urchin overpopulation.
  - Explore food webs and trophic cascades.
  - Reflect on human impact and restoration practices.

- **Instructions:**

1. **Introduction:** Show images of healthy vs barren kelp forests. Ask: What could have caused this dramatic change?
2. **Learning Segment:** Explain the sea urchin's role in kelp forests, how overgrazing occurs when predators are removed (due to hunting or climate impacts). Introduce the concept of trophic cascades.
3. **Interactive Activity:** Students work in small groups
    - build a food web poster including kelp, sea urchins, predators, and other species.
    - Use color coding to show what happens when predators are removed (draw arrows of increase/decrease in population).
4. **Simulation Reflection:** Groups complete a worksheet simulating scenarios (e.g., "What if sea otters return?" or "What if fishing pressure continues?").
5. **Wrap-Up Discussion:** *Link this to the game challenge: Why does your avatar remove sea urchins in Ocean Heroes?*

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Ocean Literacy

Ocean Heroes – Minecraft Educational Game **Lesson Plan Series** on Ocean Literacy & Marine Ecosystems

oceanliteracy@unesco.org

oceanliteracy.unesco.org

@oceanliteracy_unescoioc
@ioc_unesco

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