

UNIT 10: OCEAN DECADE

Ocean Literacy Essential Principle of #4:

“The ocean makes the Earth habitable”

3 Fundamental Concepts that explain Principle #4:

4A. Most of the **oxygen** in the atmosphere originally came from the activities of photosynthetic organisms in the ocean. This accumulation of oxygen in Earth’s atmosphere was necessary for life to develop and be sustained on land.

4B. The ocean is the **cradle of life**; the earliest evidence of life is found in the ocean. The millions of different species of organisms on Earth today are related by descent from common ancestors that evolved in the ocean and continue to evolve today.

4C. The ocean provided and continues to provide water, oxygen, and nutrients, and moderates the climate needed for **life to exist** on Earth.

[Scope & Sequence: Adjust for your Grade Level—](#)

<u>K - 2</u>	<u>3 - 5</u>	<u>6 - 8</u>	<u>9 - 12</u>
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SUGGESTED ACTIVITIES

ACTIVITY 10.1— The Ocean Decade

The United Nations are serious about achieving the Sustainability Goals, especially **Goal #14: Life Below Water**. In fact, the United Nations has declared this decade, from 2021-2030, the *Ocean Decade*.

Review and Discuss the Meaning of each of the *The 7 Outcomes for the Ocean Decade* described as [“The Science We Need for the Ocean We Want”](#)

- A **clean ocean** where sources of pollution are identified and reduced or removed.
- A **healthy and resilient ocean** where marine ecosystems are understood, protected, restored and managed.
- A **productive ocean** supporting sustainable food supply and a sustainable ocean economy.
- A **predicted ocean** where society understands and can respond to changing ocean conditions.
- A **safe ocean** where life and livelihoods are protected from ocean-related hazards.
- An **accessible ocean** with open and equitable access to data, information and technology and innovation.
- An **inspiring and engaging ocean** where society understands and values the ocean in relation to human wellbeing and sustainable development.

Critical Thinking:

- Do you believe these are realistic outcomes for the current decade?
- What roll can you, your school, your city, your country have in achieving these outcomes?



Resource:

- [The Ocean Decade: The Science We Need for the Oceans We Want](#)
- [NOAA and the Ocean Decade](#)
- [UNESCO : The United Nations Decade of Ocean Science](#)

ACTIVITY 10.2— Habitable Earth

Ocean Literacy Essential Principle #4:

“The Ocean makes the Earth Habitable”

Discuss:

How does the ocean make the Earth habitable? Could humans live on Earth without the oceans? Could anything?

Why is NASA so intent on finding water on other planets?

Preview these 3 Fundamental Concepts:

4A. Most of the **oxygen** in the atmosphere originally came from the activities of photosynthetic organisms in the ocean.

4B. The ocean is the **cradle of life**; the earliest evidence of life is found in the ocean. The millions of different species of organisms on Earth today are related by descent from common ancestors that evolved in the ocean and continue to evolve today.

4C. The ocean provided and continues to provide water, oxygen, and nutrients, and moderates the climate needed for **life to exist** on Earth.



Resource:

NASA: [Water: Life’s Elixir in the Solar System](#)

ACTIVITY 10.3— The Air We Breathe

4A. Most of the **oxygen** in the atmosphere originally came from the activities of photosynthetic organisms in the ocean. This accumulation of oxygen in Earth’s atmosphere was necessary for life to develop and be sustained on land.

“The surface layer of the ocean is teeming with photosynthetic plankton. Though they're invisible to the naked eye, they produce more oxygen than the largest redwoods.” --National Oceanographic and Atmospheric Administration

Explain Photosynthesis and how it works on land and in the ocean. Construct an experiment that would demonstrate photosynthesis—*without* using words.



Resource:

- Khan Academy- [Intro to Photosynthesis](#)
- Smithsonian Science Education Center- [What is Photosynthesis](#)
- NOAA: [How Much Oxygen Comes From the Ocean](#)

ACTIVITY 10.4— Cradle of Life and Livelihoods

4B. The ocean is the **cradle of life**; the earliest evidence of life is found in the ocean. The millions of different species of organisms on Earth today are related by descent from common ancestors that evolved in the ocean and continue to evolve today.

Read: [“The Ocean – Cradle of Life and Livelihoods”](#)

Critical Reading:

- What themes are consistent with other readings and Activities that you have encountered in this curriculum?
- The article says: “In many cases the industries and jobs that rely on the ocean have contributed to environmental degradation and pollution of our marine life.” What examples does it provide to back up this claim? What solutions does it propose?
- Find some additional articles that address the same themes about the Blue Economy and the importance of protecting the “cradle of life”.

Review: [The Distribution of Life on Earth](#), from Biocyclopedia. There are some excellent explanations and diagrams of the various ocean layers and which creatures live there.

Create your own diagram of the Marine Zones. What surprises you the most about this distribution?

ACTIVITY 10.5— The Ocean Provides

4C. The ocean provided and continues to provide water, oxygen, and nutrients, and moderates the climate needed for **life to exist** on Earth.

Critical Thinking:

- How could you utilize these 3 Fundamental Concepts, in your efforts to convince others to become more aware and more active in the Ocean Decade?
- What actions can you take that will contribute to sustainability of our oceans?

You're the Teacher:

Prepare a lesson for a group of 5th graders in which you present these three Fundamental Concepts.

- What would be the main objectives that you would want every student to understand?
- Use lots of examples and media.
- Make it engaging.
- How can you determine whether your students understood your presentation?
- Create an activity that enables them to internalize the overall message: “The Ocean makes the Earth habitable!”

ACTIVITY 10.6— Activists and Advocates

In Unit 7 we learned that “*The ocean and humans are inextricably connected.*” Specifically, in Fundamental Concept 6G, that

6G. 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.

Review Activity 7.7

Everyone is responsible for caring for the ocean! Including you and me. We can all wait for someone else to act, or for our political leaders to make the oceans a priority, or for all big companies to put sustainability over profits—but we haven't seen any widespread evidence that that is going to happen.

So... find non-profits and other organizations that have mission statements you passionately agree with... and join the cause.

For example:

Read about professional surfer Rob Machado and his efforts to reduce plastic pollution in San Diego: [Machado Foundation](#)

Here are some other organizations and individuals who have taken direct and courageous action to inform others about climate change, to confront politicians who are reluctant to address the issue, to advocate for environmental and social justice for others, to act to create viable solutions, to act up to dramatize the urgency of the moment:

Compare and contrast the organizational missions of:

The Ocean Conservancy, Pure Ocean, Greenpeace, The Ocean Clean-up, Clear Blue Sea, and the Surfrider Foundation.

Create a chart for these and other organizations working on environmental issues. List their location, mission statement, goals or priorities, major action or activities, education initiatives, funding sources, membership or volunteer opportunities, etc.

Research:

- Who are Greta Thunberg, Boyan Slat, and the Standing Rock Sioux Tribe?
- What other Environmental Activists can we add to this list?
- As an activist, what issues are most important to you?

Be an Influencer:

Explore the research findings presented by The Ocean Foundation in the document: [“Ocean Literacy and Conservation Behavior Change.”](#)

What does the research say about educating, influencing, and [changing the behavior of others](#).

CREATE YOUR OWN PERSONAL ACTION PLAN:

It's your generation that will most benefit from today's actions. Speak up and Speak out! What's *your* action plan?

ACTIVITY 10.7— The Innovators: Keep Your Eye on the Seaweed

I asked **Chap GPT** if seaweed was a valuable resource. Here was the response:

Yes, seaweed is considered a valuable resource due to its numerous beneficial properties and potential applications:

1. **Food and Nutrition:** Seaweed is a nutritious food source and has been consumed for centuries in various cultures. It is rich in vitamins, minerals, antioxidants, and dietary fiber. Seaweed is used in a variety of dishes, including sushi, salads, soups, and snacks.
2. **Environmental Benefits:** Seaweed plays a crucial role in marine ecosystems as it provides habitat and food for many marine organisms. It also contributes to ocean biodiversity and can help mitigate the effects of climate change. Seaweed absorbs carbon dioxide and nutrients from the water, helping to reduce ocean acidification and eutrophication.
3. **Agriculture and Fertilizers:** Seaweed is used as a natural fertilizer and soil conditioner in agriculture. It contains essential nutrients that can enhance soil fertility, improve crop growth, and increase yield. Seaweed extracts are also used in plant growth-promoting products and bio-stimulants.
4. **Biofuels and Energy:** Seaweed has the potential to be used as a renewable source of biofuels and energy. It can be converted into bioethanol, biodiesel, and biogas through various processes, offering an alternative to fossil fuels. Seaweed cultivation for bioenergy production also provides opportunities for coastal communities and contributes to sustainable energy solutions.

5. **Pharmaceuticals and Biomedical Applications:** Seaweed contains bioactive compounds with potential pharmaceutical and biomedical applications. These compounds have antimicrobial, antioxidant, anti-inflammatory, and anticancer properties. Seaweed-based extracts and compounds are being studied for their potential in drug development, wound healing, and biomedical research.
6. **Cosmetics and Personal Care:** Seaweed is used in the formulation of various cosmetics and personal care products. It can moisturize and nourish the skin, enhance hair health, and provide natural exfoliation. Seaweed extracts are often used in skincare products, shampoos, conditioners, and spa treatments.
7. **Sustainable Aquaculture and Bioremediation:** Seaweed cultivation can be part of sustainable aquaculture practices. Seaweed absorbs excess nutrients and can help mitigate the negative environmental impacts of fish farming by reducing nutrient pollution and improving water quality. Additionally, seaweed can be used in bioremediation efforts to absorb heavy metals and contaminants from polluted waters.

Seaweed's versatility, sustainability, and potential in various industries make it a valuable resource with multiple benefits. Ongoing research and innovation continue to explore new applications and further unlock the potential of this marine resource.

Now it's your turn:

Utilize A.I. to investigate the latest innovations in aquaculture and how seaweed is rapidly becoming a valuable resource for addressing the UN Sustainability Goals.



Resource:

Aquaculture:

- [NOAA: National Marine Sanctuaries-- Kelp Forest](#)
- [Sinking Into Seaweed: Japan SDGS Innovation Challenge](#)
- [Why Earth's Giant Kelp Forests are worth \\$500 billion a Year](#)
- [Revealing the Secrets of Seaweeds](#)
- [San Diego's Regenerative Seaweed Farm](#)
- [Seaweed is the Key To A Sustainable Future](#)
- [A Groundbreaking Insight Into Global seaweed Production](#)
- [Seaweed Innovation Trends 2022](#)
- [New Aquaculture Technology Can Ease the Global Food Crisis](#)

ACTIVITY 10.8— The Innovators: Plastic

I asked **Chap GPT** about the management of plastic. Here was the response:

As of my last knowledge update in September 2021, several innovative strategies have been developed and implemented to manage plastics more effectively. Here are some of the most notable strategies:

1. [Circular Economy](#): The circular economy approach aims to minimize waste and maximize resource efficiency. It promotes strategies such as recycling, reusing, and repurposing plastics to keep them within the economy for as long as possible. By adopting circular economy principles, the emphasis shifts from a linear "take-make-dispose" model to one that focuses on reducing, recycling, and redesigning plastics.
2. Extended Producer Responsibility (EPR): EPR is a policy approach where producers are held responsible for managing their products throughout their lifecycle, including the end-of-life stage. It encourages manufacturers to take responsibility for the proper disposal and recycling of their plastic products. EPR programs often involve collecting fees from producers to fund recycling and waste management initiatives.
3. Plastic Waste Collection and Sorting Technologies: Advanced technologies are being developed to improve plastic waste collection and sorting processes. These include automated sorting systems that use artificial intelligence and machine learning to identify and sort different types of plastics accurately. These technologies help increase recycling rates and reduce contamination in recycling streams.
4. Biodegradable and Compostable Plastics: Innovative research is focused on developing biodegradable and compostable plastics that can break down more easily in natural environments without causing harm. These alternative materials can potentially reduce the environmental impact of plastics and provide more sustainable options for certain applications.
5. Plastic-to-Fuel Conversion: Several technologies have been developed to convert plastic waste into fuels, such as diesel, gasoline, and synthetic crude oil. These processes, including pyrolysis and depolymerization, can help reduce the volume of plastic waste and provide an alternative energy source.
6. Plastic Alternatives and Redesign: Many companies are exploring alternative materials that can replace traditional plastics. This includes the use of bioplastics made from renewable sources, such as plant-based polymers. Additionally,

redesigning products to use less plastic or to be more easily recyclable is an effective strategy to reduce plastic waste.

7. Public Awareness and Education: Raising public awareness about the environmental impacts of plastic waste and promoting responsible plastic use is crucial. Education campaigns and initiatives help change consumer behavior, encourage recycling, and promote sustainable alternatives.

It's important to note that the field of plastic management is continuously evolving, and new innovative strategies may have emerged since my last update.

Now it's your turn:

Utilize A.I. to investigate the latest innovations in plastics and how remediating plastic pollution is effectively addressing the UN Sustainability Goals.



Resource:

Plastics:

- [8 Inspiring Innovations Tackling Plastic Pollution](#)
- [Innovation on Plastics](#)
- [15 Innovations in Plastics](#)
- [Top 10 Innovations Fighting Plastic Waste](#)
- [Innovations to Solve the Planet's Plastic Problem](#)

ACTIVITY 10.9— The Innovators: Fresh Water for a Thirsty World

I asked **Chap GPT** about the prospects of converting water in the ocean to fresh, potable drinking water.

“What are the most promising strategies to convert sea water into fresh water? 75% of the Earth is water... we should be able to achieve the UN Sustainability Goals on making fresh water available for every human.”

Here was the response:

You are correct that converting seawater into fresh water can play a crucial role in addressing global water scarcity and achieving the UN Sustainable Development Goal of ensuring access to clean water for all. Several strategies for desalination, the process of removing salt and other impurities from seawater, show promise. Here are some of the most promising strategies:

1. **Reverse Osmosis (RO):** Reverse osmosis is currently the most widely used desalination technology. It involves pushing seawater through a semi-permeable membrane that allows water molecules to pass through while trapping salts and other impurities. RO has become more efficient and cost-effective over the years, making it a popular choice for large-scale desalination plants.
2. **Multi-Stage Flash (MSF) Distillation:** MSF distillation is an established desalination technique that uses heat to evaporate seawater, condensing the resulting steam to produce fresh water. The process involves multiple stages of evaporation and condensation, utilizing the heat from previous stages to reduce energy requirements. Although MSF has been widely used, it is gradually being replaced by RO due to its higher energy consumption.
3. **Multi-Effect Distillation (MED):** MED is another thermal desalination process that operates on a similar principle as MSF. It involves multiple evaporators, or effects, operating at decreasing pressures and temperatures. Each effect utilizes the heat from the previous stage, resulting in improved energy efficiency compared to MSF.
4. **Electrodialysis (ED):** Electrodialysis uses an electric field to separate ions from seawater through ion-exchange membranes. The process involves alternating positive and negative electrodes, which attract and repel ions, allowing the separation of salts from the water. ED has potential for smaller-scale applications or in combination with other desalination technologies.
5. **Forward Osmosis (FO):** Forward osmosis utilizes a semi-permeable membrane to draw water from a feed solution with a higher osmotic pressure to a more concentrated draw solution. The process does not require high-pressure pumps like RO, resulting in potential energy savings. FO is still under development and holds promise for the future.
6. **Solar Desalination:** Utilizing solar energy for desalination can help reduce the environmental impact and operational costs. Solar desalination systems, such as solar stills and solar-powered RO, use sunlight to produce heat or electricity, which can then be used in desalination processes. Research and development in this area are ongoing to improve efficiency and cost-effectiveness.

These strategies have shown promise in making seawater desalination more efficient, cost-effective, and environmentally friendly. However, it's important to consider the energy requirements, environmental impact, and long-term sustainability of desalination processes. Integration with renewable energy sources, such as solar or wind power, and the development of innovative technologies will be crucial to achieving widespread access to fresh water while minimizing the impact on the environment.

Now it's your turn:

Utilize A.I. to investigate the latest innovations in desalination and our progress to date toward making potable drinking water available to all.



Resource:

Desalination:

- [New Technology Could Tap Into a Virtually Limited Supply of Fresh Water](#)
- [Seawater Desalination: A Method for Combating Scarcity?](#)
- [Changing the Future of Water](#)
- [Innovation in Desalination – The Path Forward](#)
- [Breakthrough in Reverse Osmosis May Lead to Most Energy-Efficient Seawater Desalination Ever](#)
- [Innovations in Desalination](#)
- [Desalination Innovation Could Make Water Filtration More Cost Effective](#)

ACTIVITY 10.10— Shark Tank

UN Sustainability Goal #14 is Life Below Water. The Goal states:

“Healthy oceans and seas are essential to our existence. They cover 70 percent of our planet and we rely on them for food, energy and water. Yet, we have managed to do tremendous damage to these precious resources. We must protect them by eliminating pollution and overfishing and immediately start to responsibly manage and protect all marine life around the world.”

We just explored three innovation themes that represent new ways of thinking about sustainability:

- **Activity 10.7**- Seaweed
- **Activity 10.8**- Plastics
- **Activity 10.9**- Desalination

There are, of course many, many more innovative ideas and efforts needed to create and maintain sustainable oceans. For example:

[Seven Sustainable Innovation to Watch](#), from NESTE

[These 5 Technologies are Helping Save Our Ocean](#), from The National Oceanic and Atmospheric Administration (NOAA)

[11 Innovative and Surprising Solutions for Saving Our Seas](#), from the World Economic Forum

In this final activity... reflect on your own interests, skills, and ideas. What is your vision? Based on all of the ideas you have learned about for managing our oceans, what is your solution?

Your innovation should be bold...

- It should be disruptive
- It might be controversial
- It could be expensive

Don't worry about any of those things.

- What is your idea?
- If you were going to be a guest on *Shark Tank*, what would you say to convince them to invest in your idea?
- What makes you think your idea is going to be a game-changer?

ACTIVITY 10.11— The Capstone: *Building Vida Azul*

CULMINATING PROJECT: Designing an Underwater City (3 Weeks)

Sooner or later, human communities will be built in the oceans. There are a lot of challenges associated with maritime construction, and a lot of innovative strategies needed to build a safe and sustainable city in the sea. But the oceans offer plenty of space, great projects in aquaculture, opportunities for developing alternative energy sources, and lots and lots of water.

THE PROJECT:

Design a buildable, inhabitable, safe, and sustainable city in pristine waters off the coast of San Diego and below the surface of the Pacific Ocean.

Vida Azul means “Blue World”. Here are some questions to consider:

- How could an underwater city be designed to be completely safe and self-sustaining?
- What would high school students need to know and be able to do to actually build an underwater city?
- If a project-based school actually launched this program, how should the curriculum change in order to support students?
- What are the STEM topics that would be good to research for this project?
- What questions do we need to ask about maritime construction?
- How deep could an underwater city be safely built?
- The project specifically requires that the city be built **in pristine waters**. How will we find ocean waters that are pristine, i.e., free from plastics, toxins, poisons, trash and chemicals?
- What efforts would have to go into returning our oceans to their once-pristine state?
- Are humans capable of building in the ocean (or anywhere else for that matter) in such a way that protects the environment—and ensures that our natural resources are available “seven generations” from now?