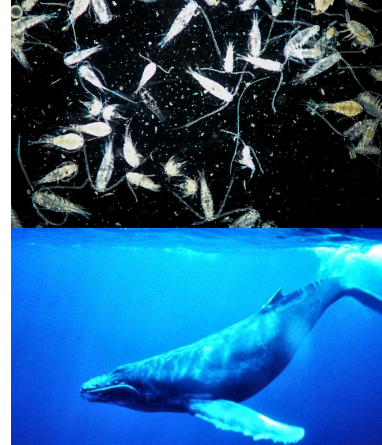


Ecosystem Biodiversity

Reflect

When you think of the ocean, you may picture the many fascinating creatures that live in its depths. The ocean is home to the world's largest animal, the blue whale, and perhaps its fiercest predator, the great white shark, which share the ocean with tiny **photosynthetic** algae. These algae, called phytoplankton, produce up to 90% of the world's oxygen. More than one million species live in the ocean, making it a habitat rich in **biodiversity**.



Top: Phytoplankton
Bottom: Blue whale

biodiversity – number of different species living in an ecosystem

photosynthetic – organisms that use carbon dioxide and sunlight to produce oxygen and glucose (food)



A model of green fluorescent protein

The biodiversity of ocean life is important and beneficial to human populations in a variety of ways. For example, in 2008, the Nobel Prize in Chemistry was awarded to three scientists who had investigated a chemical isolated from the jellyfish *Aequorea victoria*. This chemical, named GFP, emits a fluorescent green glow. Scientists attached GFP to other molecules within living cells and tissues, and for the first time, they could “see” the inner workings of living cells under a microscope. GFP has revolutionized molecular and medical science.

Imagine if the *Aequorea victoria* had become **extinct** before the discovery of GFP. How many new medicines, technical breakthroughs, and unexpected discoveries might we have missed out on because of the thousands of species that have disappeared from our world? Human activities such as overhunting, commercial fishing, and deforestation have caused the extinction of many species, including the Bali tiger, the dodo bird, and the West African black rhino (pictured below). How else might human activities harm the ocean and other ecosystems? Why is it critical that we protect all the diverse species in our ecosystems?

extinct – describes a species that has completely died out



The Bali tiger, dodo bird, and West African rhino are extinct.

Ecosystem Biodiversity

What is biodiversity?

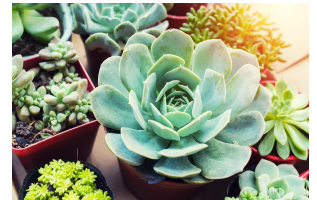
Biodiversity is a contraction of *biological diversity* and is used to describe the variety of species in an ecosystem. Areas with greater biodiversity will have a greater number of native species living in the ecosystem. Biodiversity is often used to measure the health of ecosystems. An ecosystem with greater biodiversity will be more resilient to harmful events, such as disease outbreaks, forest fires, droughts, etc. The more diverse species are present, the more likely some of them will find a way to survive the disaster. If an ecosystem has very little biodiversity, it has likely already experienced some catastrophe and is not well equipped to survive any further stress.



Every species in an ecosystem relies on the others to survive. If too many species are lost, the ecosystem may collapse. If a habitat suddenly begins to lose its animal and plant types, ecologists become worried and search for causes such as pollution. Alternatively, an increase in the biodiversity of an area may mean that corrective measures have been effective.

Look Out!

Some habitats are naturally stressful, so few organisms are adapted for life there; those that are adapted may well be unique or rare. For example, only certain plants can live in the desert, because water is so limited. Such ecosystems are still very important, even though they have less biodiversity.



Reflect

How do healthy ecosystems benefit or “service” people where you live?

Services	Type of Service Included
Provisioning services	Food, water, raw materials, genetic resources, medical resources, ornamental resources
Regulating services	Air quality regulation, climate regulation, disturbance moderation, regulation of water flows, waste treatment, erosion prevention, nutrient cycling, pollination, biological control
Habitat services	Nursery service, genetic diversity
Cultural services	Esthetic information, recreation, inspiration, spiritual experience, cognitive development



People rely on ecosystems.

Oceans, or marine ecosystems, are indispensable resources for life on Earth. Oceans cover more than 70% of the planet's surface. Algae in the oceans consume carbon dioxide and produce oxygen. People rely on Earth's oceans for a wide variety of purposes, such as the following:

- Most goods and products are transported between countries via shipping routes throughout the ocean.
- Useful minerals and resources, such as gold, silver, metal ores, and oil, are retrieved through mining the ocean floor.
- Humans enjoy recreational activities in the ocean, such as swimming, diving, sailing, and snorkeling among coral reefs.
- Most cultures of the world consume a great deal of ocean life as food. Many of these food sources are harvested from ocean systems such as estuaries and kelp forests.

What Do You Think?



How important do you think estuaries and kelp forests are to biodiversity? *Estuaries* (far left) are coastal water bodies that receive river flow and open into the ocean. *Kelp forests* (left) are open ocean ecosystems based around marine algae populations. Kelp forests contain a large diversity of ocean life, such as fish and shellfish.

Human activities have modified Earth's ocean systems.

Human activities impact ocean systems. One of the most concerning impacts of human activity is water pollution. Water pollution is the addition of harmful substances and chemicals to natural water. Water pollution occurs in many different ways. One source of water pollution is dumping wastes into sewers or rivers that empty into the ocean. Pollutants are sometimes dumped directly into the ocean. Contaminants such as fertilizers and pesticides from farms accumulate in the soil. When rain and other water move through the soil, the water dissolves and moves the pollutants. The *runoff* that results can eventually empty into oceans.



Ecosystem Biodiversity

Reflect

Pesticide runoff can poison marine organisms; fertilizer runoff can cause populations of bacterial and algal populations to explode, crowding out other organisms and reducing biodiversity. Spills from ships such as oil tankers also pollute the oceans. The 2010 oil spill in the Gulf of Mexico directly affected ocean, coastal, and estuary ecosystems.



Humans impact the oceans through *overharvesting*. This involves harvesting a resource at an unsustainable level. Marine life is sometimes fished until populations are nearly or completely wiped out. Changing the population sizes of different species also disturbs the balance of marine food webs. If prey animals die off, the predators that depend on them also die. On the other hand, if predators die off, prey animal populations may grow out of control.

Humans also modify ecosystems by introducing new species into non-native ecosystems from ships that carry aquatic organisms, insects in wood products, commercial plants, and pet trade. Such *invasive species* disrupt the biodiversity and food webs, competing with or harming species native to that ecosystem. The zebra mussel came to the United States from Eurasia in ship water released into the Great Lakes in 1988. Since then, they have spread everywhere and block water pipes, attach to hulls, and attach to other native mussels and crayfish.



Look Out!



This ship was intentionally sunk in Australian waters to form an artificial reef.

Humans can restore ecosystems. One way that humans attempt to compensate for overharvesting is to use artificial reefs. *Artificial reefs* are human-made underwater structures that promote marine life by providing surfaces for marine plants and animals to attach to on the ocean floor. These human-made ecosystems can support complex food webs. However, there are concerns with artificial reefs. Often they are made out of old objects, such as oil rigs, train cars, and boats. Such materials may release toxic chemicals into the ocean.

Reflect



Restoring ecosystem damage can also involve creating water-purification systems to filter pollutants, rebuilding coastal beaches, or adding sturdy ground cover to prevent erosion. Efforts to reduce, reuse, and recycle natural resources help in preventing a decrease in biodiversity. Sustainable agriculture is another eco-friendly process that promotes healthy ecosystems, such as through recycling nutrients and wastes and avoiding nonrenewable material.

Look Out!

Environmental changes cause some organisms to perish or move while others thrive.

Rapid changes to an environment are those that happen quickly. Some examples of rapid changes include hurricanes, floods, earthquakes, volcano eruptions, etc. Hurricanes bring high winds and huge amounts of water. When water from the ocean crashes onto land, the living organisms that typically survive in fresh water are threatened and may not survive. Living organisms have two outcomes that face them when they are hit by a rapid change to their ecosystem. First, if they are capable, they can migrate to escape the harmful conditions. If that is not an option for the organisms, they may die. Nature often finds a balance when environments change; some organisms may die while others find an opportunity to survive.



What Do You Think?

Nature overcomes some natural disasters, such as when a flooded mangrove forest or a burnt forest are reborn. Study the photos on the right and give examples of how an old ecosystem might be destroyed and make way for a different ecosystem.

Rapid environmental changes can bring destruction and new life.



Rebirth in a Flooded Mangrove



Rebirth in a Burnt Forest

Try Now

Humans rely on the ocean for a wide variety of resources. However, many human activities impact ocean ecosystems. Although some of these impacts have positive consequences, many lead to negative consequences. Below is a list of human activities and a list of some consequences of those activities. Match each activity with the consequences it can cause. Keep in mind that human activities may have several consequences.

Human Activities	Consequences
1. Overusing fertilizers and pesticides for agriculture	A. Bacterial or algal overgrowth B. Removal of oxygen from marine waters
2. Dumping trash into the ocean	C. Death of fish or other marine life D. Accumulation and spread of toxic chemicals in ocean habitats
3. Farming fish for commercial sales	E. Destruction of coastal land habitats F. Disruption of marine food webs
4. Emitting gases into the atmosphere that contribute to global warming	G. Endangerment or extinction of entire marine populations or species H. Reduction of the impact of overharvesting
5. Constructing artificial reefs	I. Spread of disease J. Rising sea levels
6. Overharvesting marine species	K. Toxic-chemical consumption by humans L. Acid precipitation over oceans
7. Introducing exotic marine species into new ecosystems	