

Encyclopedic Entry

dead zone

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Dead zones are low-oxygen, or hypoxic, areas in the world's oceans and lakes. Because most organisms need **oxygen** to live, few organisms can survive in hypoxic conditions. That is why these areas are called dead zones.

Dead zones occur because of a process called **eutrophication**, which happens when a body of water gets too many **nutrients**, such as **phosphorus** and **nitrogen**. At normal levels, these nutrients feed the growth of an organism called **cyanobacteria**, or **blue-green algae**. With too many nutrients, however, cyanobacteria grows out of control, which can be harmful. Human activities are the main cause of these excess nutrients being washed into the ocean. For this reason, dead zones are often located near **inhabited coastlines**.

Understanding the eutrophication process provides the clearest picture of how and why dead zones develop.

Causes of Eutrophication

Eutrophic events have increased because of the rapid rise in intensive agricultural practices, industrial activities, and population growth. These three processes **emit** large amounts of nitrogen and phosphorous. These nutrients enter our air, soil, and water. Human activities have emitted nearly twice as much nitrogen and three times as much phosphorus as natural emissions.

Different regions of the world emit different levels of these nutrients. In developed countries, such as the United States and nations in the European Union, heavy use of animal **manure** and commercial **fertilizers** in **agriculture** are the main contributors to eutrophication. **Runoff** from large agricultural fields enters **creeks** and bays because of rain or **irrigation** practices.

In developing countries of Latin America, Asia, and Africa, untreated wastewater from **sewage** and **industry** mainly contribute to eutrophication. Factories and sewage facilities are less regulated than they are in developed countries, and sometimes wastewater is simply dumped into creeks, rivers, lakes, or the ocean.

Atmospheric sources of nitrogen also contribute to eutrophication in some areas of the world. **Fossil fuels** and fertilizers release nitrogen into the atmosphere. This atmospheric nitrogen is then redeposited on land and water through the **water cycle**—rain and snow.

The Chesapeake Bay, on the East Coast of the United States, has one of the first dead zones ever identified, in the 1970s. The Chesapeake's high levels of nitrogen are caused by two factors: urbanization and agriculture. The western part of the bay is full of factories and urban centers that emit nitrogen into the air. Atmospheric nitrogen accounts for about a third of the nitrogen that enters the bay. The eastern part of the bay is a center of **poultry** farming, which produces large amounts of manure.

Since 1967, the Chesapeake Bay Foundation has led a number of programs that aim to improve the bay's water quality and [curb](#) pollution runoff. The Chesapeake still has a dead zone, whose size varies with the season and weather.

Eutrophication and the Environment

The eutrophication process has severe environmental impacts. Dead zones result from these impacts, which include [algal blooms](#) and [hypoxia](#).

Algal Blooms

Phosphorous, nitrogen, and other nutrients increase the productivity or fertility of marine [ecosystems](#). Organisms such as [phytoplankton](#), [algae](#), and [seaweeds](#) will grow quickly and excessively on the water's surface. This rapid development of algae and phytoplankton is called an algal bloom. Algal blooms can create dead zones beneath them.

Algal blooms prevent light from penetrating the water's surface. They also prevent oxygen from being absorbed by organisms beneath them. Sunlight is necessary for plants and organisms like phytoplankton and algae, which manufacture their own nutrients from sunlight, water, and carbon dioxide. Oxygen is necessary for almost all [aquatic](#) life, from sea [grasses](#) to fish.

By depriving organisms of sunlight and oxygen, algal blooms negatively impact a variety of species that live below the water's surface. The number and diversity of [benthic](#), or bottom-dwelling, species are especially reduced.

Because algae dominates the aquatic ecosystem, algal blooms are sometimes referred to as "[red tides](#)" or "brown tides," depending on the color of the algae. Red tides actually have nothing to do with [tides](#). They also have nothing to do with algae. The organism that causes red tides is a [bacteria](#), called cyanobacteria.

Algal blooms also cause larger-scale problems, such as human illness. [Shellfish](#), such as oysters, are [filter feeders](#). As they filter water, they absorb [microbes](#) associated with algal blooms. Many of these microbes are [toxic](#) to people. People may become sick or even die from shellfish poisoning.

Algal blooms can also lead to the death of [marine mammals](#) and shore birds that rely on the marine ecosystem for food. [Wading birds](#), such as herons, and mammals, such as sea lions, depend on fish for survival. With fewer fish beneath algal blooms, these animals lose an important food source.

Algal blooms can also impact [aquaculture](#), or the farming of marine life. One red tide event wiped out 90 percent of the entire stock of Hong Kong's fish farms in 1998, resulting in an estimated economic loss of \$40 million.

Algal blooms usually die soon after they appear. The ecosystem simply cannot support the huge number of cyanobacteria. The organisms compete with one another for the remaining oxygen and nutrients.

Hypoxia

Hypoxia occurs when algae and other organisms die from lack of oxygen and available nutrients. Hypoxia events often follow algal blooms. The cyanobacteria, algae, and phytoplankton sink to the seafloor, and are [decomposed](#) by bacteria. Even though oxygen can now flow freely through the aquatic ecosystem, the decomposition process uses up almost all of it. This lack of oxygen creates dead zones in which most aquatic species cannot survive.

The Gulf of Mexico has a seasonal hypoxic zone that forms every year in late summer. Its size varies from fewer than 5,000 square kilometers (1,931 square miles) to approximately 22,000 square kilometers (8,494 square miles, or the size of Massachusetts). Concern over its increasing size led to the formation of the Mississippi

River/Gulf of Mexico Watershed Nutrient Task Force in 1997. Its mission is to reduce the five-year running average of the Gulf of Mexico dead zone to less than 5,000 square kilometers.

The Baltic Sea is home to seven of the world's 10 largest marine dead zones. Increased runoff from agricultural fertilizers and sewage has sped up the eutrophication process. **Overfishing** of Baltic **cod** has intensified the problem. Cod eat **sprats**, a small, herring-like species that eat microscopic **zooplankton**, which in turn eat algae. Fewer cod and more sprats mean more algae and less oxygen. The spreading dead zones are starting to reach the cod's deep-water breeding grounds, further **endangering** the species.

The Baltic Sea has become the first "macro-region" targeted by the **European Union** to combat **pollution**, dead zones, overfishing, and regional disputes. The EU is coordinating the Baltic Sea Strategy with eight EU member countries that border the Baltic Sea: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, and Sweden.

Categorizing Eutrophic Systems

Scientists have identified 415 dead zones worldwide. Hypoxic areas have increased dramatically during the past 50 years, from about 10 documented cases in 1960 to at least 169 in 2007. The majority of the world's dead zones are located along the eastern coast of the United States, and the coastlines of the Baltic States, Japan, and the Korean Peninsula.

As a result of the dramatic increase in dead zones, scientists have categorized coastal systems experiencing any symptoms of eutrophication.

An **area of concern** is a coastal system that exhibits effects of eutrophication, such as elevated nutrient levels, harmful algal blooms, and negative changes in the benthic community. Areas of concern are at the most risk of developing hypoxia. Major concentrations of areas of concern are located along the western coast of Central and South America, and the coastlines of Great Britain and Australia. There are 233 areas of concern around the world.

A **system in recovery** is one that once exhibited low oxygen levels and hypoxia, but is now improving. For example, the Black Sea once experienced annual hypoxic events, but is now in a state of recovery. Others, like Boston Harbor in the United States and the Mersey Estuary in the United Kingdom, also have improved water quality. These are the results of better industrial and wastewater controls. There are only 13 coastal systems in recovery around the world.

VOCABULARY

Term	Part of Speech	Definition
agriculture	<i>noun</i>	the art and science of cultivating the land for growing crops (farming) or raising livestock (ranching).
algae	<i>plural noun</i>	(singular: alga) diverse group of aquatic organisms, the largest of which are seaweeds.
algal bloom	<i>noun</i>	the rapid increase of algae in an aquatic environment.
aquaculture	<i>noun</i>	the art and science of cultivating marine or freshwater life for food and industry.
aquatic	<i>adjective</i>	having to do with water.
area of concern	<i>noun</i>	aquatic ecosystem that exhibits effects of eutrophication, such as elevated nutrient levels, harmful algal blooms, and negative changes in the benthic community.

atmosphere	<i>noun</i>	layers of gases surrounding a planet or other celestial body.
bacteria	<i>plural noun</i>	(singular: bacterium) single-celled organisms found in every ecosystem on Earth.
benthic	<i>adjective</i>	having to do with the bottom of a deep body of water.
blue-green algae	<i>noun</i>	type of aquatic bacteria (not algae) that can photosynthesize light to create energy. Also called cyanobacteria and (in freshwater habitats) pond scum.
carbon dioxide	<i>noun</i>	greenhouse gas produced by animals during respiration and used by plants during photosynthesis. Carbon dioxide is also the byproduct of burning fossil fuels.
coastline	<i>noun</i>	outer boundary of a shore.
cod	<i>noun</i>	popular food fish native to the North Atlantic Ocean.
coral	<i>noun</i>	tiny ocean animal, some of which secrete calcium carbonate to form reefs.
coral reef	<i>noun</i>	rocky ocean features made up of millions of coral skeletons.
corridor	<i>noun</i>	hallway, or connecting passage of land.
creek	<i>noun</i>	flowing body of water that is smaller than a river.
curb	<i>verb</i>	to restrain or control.
cyanobacteria	<i>noun</i>	type of aquatic bacteria that can photosynthesize light to create energy. Also called blue-green algae (even though it is not algae) and (in freshwater habitats) pond scum.
dead zone	<i>noun</i>	area of low oxygen in a body of water.
decompose	<i>verb</i>	to decay or break down.
developed country	<i>noun</i>	a nation that has high levels of economic activity, health care, and education.
developing world	<i>noun</i>	nations with low per-capita income, little infrastructure, and a small middle class.
diversity	<i>noun</i>	difference.
dominate	<i>verb</i>	to overpower or control.
economic	<i>adjective</i>	having to do with money.
ecosystem	<i>noun</i>	community and interactions of living and nonliving things in an area.
emit	<i>verb</i>	to give off or send out.
endanger	<i>verb</i>	to put at risk.
estuary	<i>noun</i>	mouth of a river where the river's current meets the sea's tide.
European Union	<i>noun</i>	association of European nations promoting free trade, ease of transportation, and cultural and political links.
eutrophication	<i>noun</i>	build-up of sediment and organic matter in bodies of water, which may cause a change in the productivity of the ecosystem.
fertilizer	<i>noun</i>	nutrient-rich chemical substance (natural or manmade) applied to soil to encourage plant growth.
filter feeder	<i>noun</i>	aquatic animal that strains nutrients from water.

fish farming	<i>noun</i>	art and science of raising and harvesting fish and other seafood, such as shrimp or crabs.
fossil fuel	<i>noun</i>	coal, oil, or natural gas. Fossil fuels formed from the remains of ancient plants and animals.
grass	<i>noun</i>	type of plant with narrow leaves.
harbor	<i>noun</i>	part of a body of water deep enough for ships to dock.
harmful algal bloom (HAB)	<i>noun</i>	rapid growth of algae that can threaten an aquatic environment by reducing the amount of oxygen in the water, blocking sunlight, or releasing toxic chemicals.
hypoxia	<i>noun</i>	condition of not having enough oxygen in a substance, such as water or blood.
industry	<i>noun</i>	activity that produces goods and services.
inhabit	<i>verb</i>	to live in a specific place.
irrigation	<i>noun</i>	watering land, usually for agriculture, by artificial means.
larva	<i>noun</i>	a new or immature insect or other type of invertebrate.
manure	<i>noun</i>	animal excrement or waste used to fertilize soil.
marine	<i>adjective</i>	having to do with the ocean.
marine mammal	<i>noun</i>	an animal that lives most of its life in the ocean but breathes air and gives birth to live young, such as whales and seals.
microbe	<i>noun</i>	tiny organism, usually a bacterium.
nitrogen	<i>noun</i>	chemical element with the symbol N, whose gas form is 78% of the Earth's atmosphere.
nutrient	<i>noun</i>	substance an organism needs for energy, growth, and life.
overfish	<i>verb</i>	to harvest aquatic life to the point where species become rare in the area.
oxygen	<i>noun</i>	chemical element with the symbol O, whose gas form is 21% of the Earth's atmosphere.
penetrate	<i>verb</i>	to push through.
peninsula	<i>noun</i>	piece of land jutting into a body of water.
phosphorus	<i>noun</i>	chemical element with the symbol P.
phytoplankton	<i>noun</i>	microscopic organism that lives in the ocean and can produce its own food through photosynthesis.
pollution	<i>noun</i>	introduction of harmful materials into the environment.
poultry	<i>noun</i>	domesticated birds, such as chickens.
red tide	<i>noun</i>	the rapid, dense accumulation of algae that contain red or brown pigments; also called algal bloom.
runoff	<i>noun</i>	overflow of fluid from a farm or industrial factory.
seaweed	<i>noun</i>	marine algae. Seaweed can be composed of brown, green, or red algae, as well as "blue-green algae," which is actually bacteria.
sewage	<i>noun</i>	liquid and solid waste material from homes and businesses.
shellfish	<i>noun</i>	any aquatic animal that has a shell.

sprat	<i>noun</i>	small fish related to herring.
system in recovery	<i>noun</i>	aquatic ecosystem that once exhibited low oxygen levels, but is now improving.
terrestrial	<i>adjective</i>	having to do with the Earth or dry land.
tide	<i>noun</i>	rise and fall of the ocean's waters, caused by the gravitational pull of the moon and sun.
toxic	<i>adjective</i>	poisonous.
wading bird	<i>noun</i>	bird with long, thin legs adapted for walking and feeding in shallow water.
water cycle	<i>noun</i>	movement of water between atmosphere, land, and ocean.
zooplankton	<i>noun, plural noun</i>	microscopic organism that lives in the ocean.

For Further Exploration

Articles & Profiles

- National Geographic News: World's Largest Dead Zone Suffocating Sea
- National Geographic News: Gulf of Mexico Dead Zone is Size of New Jersey
- NASA: Science Focus—Dead Zones
- NOAA: What is a Dead Zone?



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