

Harmful Algal Blooms, Unwelcome Visitors to Our Coast

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Fall can be a beautiful time of year in the Northern Gulf of Mexico; the heat of summer has largely dissipated yet it remains warm enough to enjoy the beach and all that the Gulf has to offer. However, these days of failing light are also when harmful algal blooms (HABs), particularly red tides, have historically made their way to our coasts. HAB events can close fisheries and deter tourists, impacting local businesses. They can also make people sick. This means that laws and regulations are in place to protect human health.

Just What Are Harmful Algae?

Algae are plant-like organisms that mostly live in water, both fresh and marine waters. They can range in size from microscopic to macroscopic (e.g., seaweed or giant kelp). Algae species are incredibly diverse and are found all over the planet. Like plants in land-based environments, algae are the base of marine and freshwater food chains and produce much of the world's oxygen supplies. While algae are valuable and necessary members of our coastal ecosystems, some algae can be harmful. "Harmful algae" can cause negative impacts on humans and wildlife, including noxious beach conditions, low oxygen conditions in the water (hypoxia), fish kills, and foodborne illness.¹ When algae populations grow to very large numbers, they form a "bloom." Harmful algal blooms (HABs) are caused by phytoplankton, a diverse group of mostly algae which includes diatoms, dinoflagellates, and cyanobacteria (sometimes called blue-green algae).

In the Gulf of Mexico, one of the most common HABs comes from the dinoflagellate species *Karenia brevis*, or *K. brevis* for short. These blooms, and others around the world caused by different species, are often known as 'red tide' because of the reddish color the water turns when algae concentrations are very high. When a *K. brevis* bloom occurs off the coast of Florida it is called Florida red tide.²

Blooms of Algae Are Natural in Many Aquatic Systems

Less than one percent of algal blooms are considered harmful, in fact, annual algae blooms are periods of great productivity in most of the world's oceans. These blooms

can attract huge schools of algae-feeding fish, which in-turn attract larger fish and even migrating whales.³ When blooms of algae die, they sink to the ocean floor. If they are not buried rapidly they may be decomposed by bacteria. But the blooms can cause harm other than toxic events. During very large blooms the decomposition by bacteria uses massive quantities of oxygen, causing low oxygen conditions called hypoxia. The annual "dead zone" in the Gulf of Mexico is created in just this way.⁴

The Causes of HABs Are Complex

Algae, like plants, need sunlight and nutrients such as nitrogen and phosphorus to grow. While the reasons for individual HAB events vary across years and locations, nutrients from lawns, sewage, and agricultural operations can run off into nearby waterways and travel to the coast. Some algae can use these abundant nutrients to grow rapidly. Under normal conditions, it is unlikely that algae will bloom in marine waters solely as a result of nutrients from inland sources. For example, scientists believe marine HAB events in Florida begin offshore in deep water⁵ and only meet nutrients from runoff if the tides, currents, and winds carry the algae toward shore.

In freshwater environments like lakes and streams, nutrient pollution can cause cyanobacteria blooms.⁶ Although cyanobacteria blooms are rare in marine waters, after extreme rain events, large amounts of stormwater may flow downstream into bays and estuaries making them less salty. This can allow cyanobacteria to bloom, as happened in the Mississippi Sound this past summer.

Sea surface temperature and underwater mixing can also contribute to HAB events. Multiple studies have found that the position of the Loop Current within the Gulf of Mexico plays a role in the occurrence and severity of red tide events along Florida's west coast.⁷ For example, more major red tides (those with *K. brevis* cell concentrations at one million cells per liter of seawater) occur when the Loop Current extends further to the north (Figure 1). Some scientists hypothesize that this may be because when the Loop Current is further south, upwelling of cold, nutrient-rich, deep ocean waters favor competing types of algae over *K. brevis*.⁸ Scientists hope

to use the location of the Loop Current to help predict the occurrence of major blooms in the future.

Currently, NOAA’s HAB Operational Forecast System gives advanced warning of potential red tides to officials in Texas and Florida, two states that regularly experience HABs. New tools are being developed to help researchers forecast HABs in places where they are less common and to understand additional risks they may pose.⁹

Seafood Safety and Impacts to Human Health

Karenia brevis can produce a group of toxins called brevetoxins.¹⁰ Brevetoxins can cause respiratory irritation, contaminate some shellfish, and affect the central nervous system of fish, marine mammals, and birds, potentially causing fish kills and marine

mammal death.¹¹ Different types of HABs produce other types of toxins, each with their own characteristics and impacts on sea life and humans. Toxins produced during HABs can affect the quality and safety of many types of seafood if it is harvested from impacted areas. HAB events usually cause immediate effects when individuals are exposed to high concentrations of toxin, but toxins can also bioaccumulate in the flesh of fish and shellfish during periods of regular exposure. Consumption of HAB toxins from contaminated seafood—primarily oysters, clams, and mussels—can cause a variety of illnesses (Table 1). The type, duration, and severity of symptoms depends on the type of harmful algae and the toxins they produce, along with the overall health of the individual and how much contaminated seafood was consumed.

| Harmful Algae | Potential Health Impacts | Symptoms |
|---|---|---|
| <i>Karenia brevis</i> “Florida Red Tide” | Neurotoxic shellfish poisoning | Numbness, tingling in mouth/arms/hands, vomiting, diarrhea, loss of coordination, cold/heat sensitivity |
| | Brevetoxin exposure (not from eating seafood) | Throat irritation, watery eyes, respiratory distress |
| <i>Pseudo-nitzschia</i> | Amnesic shellfish poisoning | Nausea, vomiting, diarrhea, headaches, confusion, seizures, possibility of coma and death |
| <i>Dinophysis</i> and <i>Prorocentrum</i> | Diarrhetic shellfish poisoning | Nausea, vomiting, abdominal pain, diarrhea |
| <i>Gambierdiscus</i> | Ciguatera poisoning (reef fish consumption) | Nausea, vomiting, abdominal pain, diarrhea |
| | | Intestinal symptoms may be followed by numbness, dizziness, muscle pain, weakness, cold/heat sensitivity |
| <i>Gymnodinium</i> , <i>Alexandrium</i> , and <i>Pyrodinium</i> | Paralytic shellfish poisoning | Numbness, tingling in face/arms/legs, headache, dizziness, nausea, loss of coordination, sensation of floating, muscle paralysis and respiratory failure in severe cases only |

Table 1. Many harmful algae species that are found in marine waters of the United States are capable for causing illness in humans. Depending on the type of HAB, the toxins produced, and the route of exposure, people may experience a variety of symptoms. Source: Centers for Disease Control, <https://www.cdc.gov/habs/illness-symptoms-marine.html>.

Toxins from any type of HAB are odorless, tasteless, and cannot be destroyed by cooking, freezing, or washing seafood. To prevent these toxins from making their way into our food supplies, the U.S. Food and Drug Administration has set up seafood harvesting and testing guidelines.¹² In the Gulf of Mexico, government scientists regularly monitor shellfish growing waters for the presence of harmful algae species like *K. brevis* and *Pseudo-nitzschia*.

These species occur naturally in the environment, so closures only occur when concentrations are above certain levels. For example, shellfish growing waters are closed to harvest when *K. brevis* cells exceed 5,000 algal cells in one liter of sampled water (cells/L). Once closed, shellfish cannot be harvested until testing on shellfish meat is done to show concentrations of toxins are below recommended exposure levels.¹³

Influence of Storms and Hurricanes on HABs

Algae are readily transported by winds, currents, tides, and storms. Depending on the track of a storm, algae blooming in one area of the Gulf could be transported to another. For example, one Florida red tide event spread from the southwest coast of Florida to the Panhandle following Hurricane Katrina.¹⁴ However, even though wind and currents are capable of transporting algae that cause red tide to the Alabama and Mississippi coasts, it does not mean that a bloom will form here. A recent study of two historical events in the Mississippi Sound found that the bloom was only able to intensify during one of them, when water conditions were favorable (e.g. optimal nutrient input levels, relatively warmer winter months, currents that support HABs).¹⁵ Mobile Bay's normally low-salinity waters are not favorable to support a red tide event.



Figure 1. Graphical depiction of the Gulf of Mexico Loop Current in a (1) more southern position, (2) northern position, and (3) a typical Loop Current eddy. The retraction of the Loop Current into the southern position (1) is associated with a decrease in major HABs along Florida's west coast and was also responsible for a lack of oil on those same beaches following the Deepwater Horizon Oil Spill. (Modified by the National Academies Press from the original by UCAR.)

HABs Have Occurred throughout History but May Be Increasing in Frequency

Red tides have been occurring in the Gulf of Mexico for nearly 200 years. The first documented case of red tide off the coast of Florida was in 1844, according to the [Florida Fish and Wildlife Conservation Commission](#). Although these blooms have occurred naturally for centuries,

scientists believe that they could increase in frequency as the effects of climate change begin to be felt.¹⁶ Experiments are ongoing to help predict how sea level rise, increased rainfall, and warming ocean temperatures might affect algae growth in the future.¹⁷

Endnotes

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