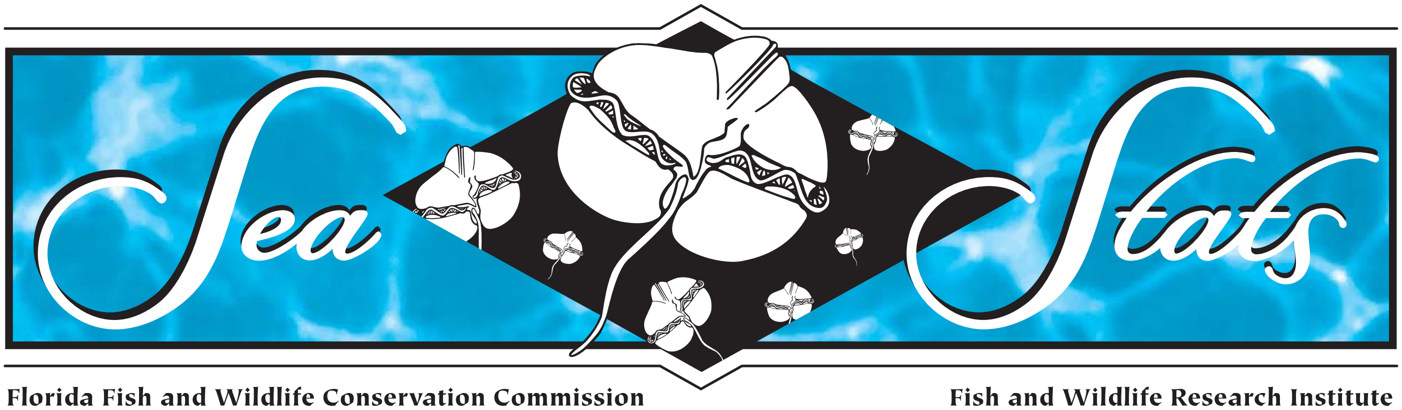


Florida Fish and Wildlife Conservation Commission | Fish and Wildlife Research Institute

RED TIDE

Florida's Unwelcome Visitor

The Florida red tide is a naturally occurring phenomenon that continues to challenge researchers seeking clues to its origin and cause. It has been documented along Florida's Gulf Coast since the 1840s and probably occurred much earlier. Fish kills around Tampa Bay were mentioned in the logs of Spanish explorers. The source of these red tides—a group of tiny, plant-like organisms called dinoflagellates—was not discovered until the massive red tide of 1946–47 in southwest Florida.

Description

Red tides with various characteristics have been documented worldwide for thousands of years in cold temperate to tropical waters. Dinoflagellates, the organisms that cause most red tides, are microscopic, single-celled organisms characterized by two whiplike structures, each called a flagellum. One flagellum spins the cell around and the other propels it through the water at about three feet per hour. Dinoflagellates and other types of microscopic algae, collectively called "phytoplankton," are commonly referred to as the "grass of the sea" because they are so plentiful and have plant-like nutritional characteristics. They use the sun's energy to produce their own food and, in turn, are eaten by many other kinds of marine life. In this way, they serve as a foundation for the marine food web.

Dinoflagellates can produce some of the most powerful poisons in nature. When certain dinoflagellates are present in higher-than-normal concentrations, a "bloom" is created that releases poison, or toxin, into the water. This toxin can cause various effects; for example, it may paralyze fish, causing them to stop breathing. Sometimes, a bloom discolors the surrounding water. The color may be red, but a bloom may also be yellow, orange, brown, or reddish-brown.That's why scientists prefer the term Harmful Algal Bloom (HAB).

fast FACT

Scientists prefer to call red tides Harmful Algal Blooms, or HABs.

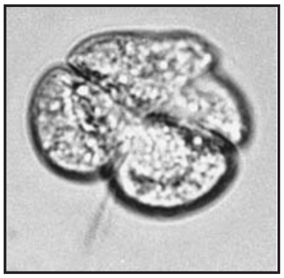
In Florida, the most common cause of red tides is a toxic marine dinoflagellate named *Karenia brevis* (frequently abbreviated to *K. brevis*), which is a yellow-green dinoflagellate measuring only about 1/1000 of an inch long. A stingray-shaped single cell, it contains one flagellum encircling a groove around the middle of the cell and a second flagellum trailing behind like a ship's rudder. The cell's forward motion resembles a gently falling leaf, turning over and over in the water as it swims, but *K.*

AT A glance

Scientific name	*Karenia brevis* (pronounced Kah-REN-ee-uh BREV-is, often abbreviated to *K. brevis*). Formerly known as *Gymnodinium breve* and *Ptychodiscus brevis*.
Size	About 1/1000 of an inch long
Range	Documented throughout the Gulf of Mexico and along the Atlantic coastline to North Carolina
Effects	Red tides can kill fish and other marine animals and contaminate shellfish such as clams and oysters. People can become ill by eating shellfish tainted with red tide toxins; additionally, toxic particles in sea spray at the shore can cause respiratory discomfort.

brevis is a weak swimmer and progresses mostly by drifting along with currents.

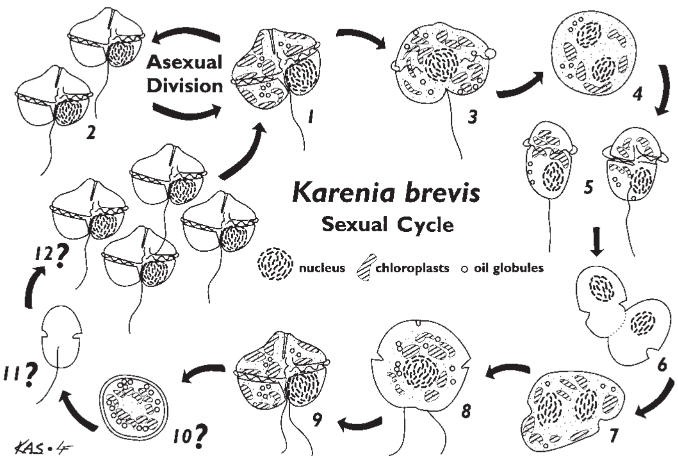
Like other dinoflagellates, *K. brevis* reproduces by cell division, with a single cell splitting into two about every 48 to 120 hours. In addition to a dividing cycle, *K. brevis* has a sexual cycle that may include "resting" stages whereby it could remain inactive during non-bloom periods.



Karenia brevis, *magnified 1,160 times.*

Karenia brevis is probably always present in Florida marine waters at very low levels of less than or equal to 1,000 cells per liter (approximately equal to one quart) of water. Periodically, due to a combination of environmental or biological conditions, *K. brevis* can accumulate in concentrations of up to millions of cells per liter. Water samples collected during a red tide that plagued southwest Florida in 1995 and 1996 contained over 20 million cells per liter. Counts exceeding 100 million cells per liter have been recorded.

Scientific research shows that the growth of *K. brevis* is influenced by a variety of factors, including sunlight, temperature, salinity, and the amount and types of nutrients available in the water. Winds and currents also play a role in determining when and where blooms will occur. Studies indicate that *K. brevis* probably blooms annually in offshore waters as part of its normal growth cycle. It becomes a problem for people only when winds and currents drive the blooms close to shore, where they can be concentrated.



The life cycle of Karenia brevis. *The dominant cell can reproduce in two ways: by dividing into two cells (asexual division) and by merging with another cell (sexual cycle). Stages 1 through 9 are known, but stages 10 through 12 are still in question.*

Because Florida red tides caused by *K. brevis* start offshore, one theory is that pulses of warm water from the Caribbean moving into the deeper waters of the Gulf of Mexico may "awaken" *K. brevis* and spark a red tide bloom. Another theory is that another phytoplankton organism precedes *K. brevis* and conditions the water for red tide growth.

People frequently ask whether red tides are a result of increasing pollution of coastal waters. Although excess nutrients associated with human activities have been linked to red tides caused by other species in enclosed areas in Japan, Europe, and elsewhere, there is no evidence to suggest a similar connection between pollution and Florida's offshore *K. brevis* blooms. *K. brevis* red tides begin offshore and have occurred in the Gulf of Mexico for hundreds of years, long before man-made pollution became prevalent. However, pollution can cause other types of algal blooms in Florida's coastal waters and estuaries, and researchers are investigating the possibility that pollution or nutrient enrichment may influence *K. brevis* blooms after the blooms are transported and concentrated inshore.

Distribution

Karenia brevis red tides have been observed at least once along almost the entire coastline of Florida. They have also occurred at least once in the coastal waters of the other Gulf states (most frequently in Texas) and in Mexico. On the Atlantic coast, *K. brevis* has been transported as far north as the Carolinas. Blooms occur most frequently from August through February but have been documented in every month of the year. Offshore surveys have shown that Florida red tides generally begin 10 to 40 miles from the coast in the Gulf of Mexico on the mid-continental shelf. Winds and currents may push the patches of red tide onshore or along the shore to other areas.

If conditions are right, a bloom may remain in an area for several weeks or may move up and down along the coast for months at a time. One red tide that first appeared near Naples in November 1946 spread as far north as Sanibel Island and Englewood by January 1947. Red tide surfaced again in the spring of 1947 in outer Florida Bay and a few months later as far north as Tarpon Springs. It was during this event, characterized as one of the worst red tide episodes on record, that scientists first identified *K. brevis* as the toxic organism responsible for Florida red tides.

How Red Tides Affect Marine Life

Karenia brevis toxins, called "brevetoxins," primarily affect the nervous system of fishes, causing death by paralyzing the nerves and effectively suffocating the fish. *Karenia brevis* can become lethal to fish at concentrations greater than 100,000 cells per liter. This organism has been implicated in the mortality of marine mammals, birds, and invertebrates during red tides such as the one that occurred in 1996.

Although *K. brevis* red tides can kill thousands or even millions of fish, there is no evidence that they cause permanent damage to marine fish and invertebrate populations. The impact of a red tide often appears to be short-lived, and fishermen have reported better catches of some species, such as crabs, in the months following an outbreak. This may occur because the red tide organism has killed specific predators, allowing certain prey species to survive in greater numbers, or because red tides introduce more food into the system. Thus, although large numbers of fish may be killed by a bloom, other species may benefit. Indeed, the ecosystem currently in the Gulf of Mexico is composed of populations that are the product of an environment that has included red tides, storms, and other disturbances for probably thousands of years.

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The red tide bloom of 1946–47 is estimated to have killed 500 million fish.

Slow-moving fish, unable to flee from the path of red tides, are usually the first to die, along with territorial or bottom-dwelling fish. Nearly all fish are susceptible, especially if the bloom is dense or prolonged. Invertebrates are usually not killed by red tide toxins, although a greater variety of animals, including snails and crabs, may be killed if the bloom is severe enough.

Bivalve shellfish such as clams and oysters, which feed by filtering plant matter from the water, may ingest *K. brevis* and, consequently, become toxic to consumers. Even when *K. brevis* concentrations are only slightly above normal, these filter-feeders may become toxic if they are exposed to low levels of toxin long enough.

In southwest Florida in 1996, an unprecedented event of 149 manatee deaths was finally linked to a red tide bloom that had extended into winter. As a result, both the bloom and the manatees were present at the same time in one of the manatee wintering areas. Red tide toxin was found in the organs and stomach contents of manatee carcasses. Given the results of detailed examination of the carcasses, scientists hypothesized that these animals died quickly after being exposed to large quantities of toxin. Additional manatees died in the winter of 1982 and in recent years during red tide events; these animals also showed signs of exposure to red tide toxin.

How Red Tides Affect People

The greatest threat to humans posed by *K. brevis* red tides is through consumption of bivalve shellfish that have been contaminated with the red tide toxin. At present, no humans have died from eating tainted clams, mussels, oysters, or coquinas, but some people have become seriously ill with an ailment called Neurotoxic Shellfish Poisoning (NSP). Symptoms include nausea, diarrhea, tingling of fingers and toes, and sometimes a reversal of sensations—hot seems cold and cold seems hot. Illness occurs within a few minutes to several hours after consumption of the shellfish. NSP is often confused with a more dangerous and commonly known shellfish poisoning called Paralytic Shellfish Poisoning (PSP). PSP is caused by other dinoflagellates that produce an entirely different set of symptoms in humans.

As part of a routine shellfish management plan, the Florida Department of Agriculture and Consumer Services closes harvesting areas when shellfish beds are threatened by a bloom. The harvesting ban is lifted only after meat from shellfish passes a laboratory test for the toxin. Generally, most bivalves can purge the toxin from their systems within two to six weeks after the red tide dissipates. The shellfish harvesting bans do not apply to shrimp, crabs, or lobsters because the edible parts of these and other crustacean shellfish do not become toxic when the animals are exposed to Florida red tides.

Fish caught during *K. brevis* red tides are safe to eat if they are filleted. However, at any time, experts advise against eating a fish that appears sick or lethargic.

People can also be affected by airborne toxins. Wave action breaks apart the red tide cells, and the toxins, associated with particles in the sea spray, cause sneezing, coughing, and general respiratory irritation.

In addition, red tide can cause aesthetic problems in coastal areas; it often dumps smelly, dead fish—sometimes hundreds or thousands of them—on area beaches. Most local communities dispose of the rotting fish quickly, but these cleanups can be costly.

fast FACT

***K. brevis** is one of only a relatively few red tide organisms known or suspected to produce noxious, airborne toxic particles that can irritate human respiratory systems.*

Should Humans Seek to Eliminate Red Tides?

Although it has long been debated whether research should strive to find ways of eliminating or otherwise controlling red tide, many scientists believe that there is no practical way to totally eradicate Florida red tides. Getting rid of red tide would be extremely difficult and costly because red tide blooms often occur over hundreds to thousands of square miles of water, are distributed throughout the water column, can be moved great distances along the coast, and fluctuate daily with the tides. The use of chemical or biological control agents to disperse the red tide blooms or neutralize the toxins may adversely affect other forms of marine life. Yet, the possibility of controlling the bloom at a local level, by mitigating either its effects or its distribution, has recently gained popularity. Researchers are pursuing the possibility of applying techniques that have been used for limiting localized blooms of other species elsewhere. Overall, scientists and managers agree that we must be careful about introducing control agents into our coastal system. Indeed, there is speculation that the red tide phenomenon may serve an important, although currently unverified, role in making the marine ecosystem off Florida's coast more productive.

If red tides and their paths could be predicted, alerted communities might have time to mobilize cleanup crews and establish warning systems before the bloom arrives. With prediction as one of their goals, scientists from the Florida Fish and Wildlife Conservation Commission (FWC), the University of South Florida College of Marine Science, and Mote Marine Laboratory are collaborating on a federally funded project to develop and deploy new technology to monitor Florida's coastal waters for red tide. Additionally, FWC and Mote are collaborating on a state-funded program to identify specific nutrient sources that support red tides and to assess potential links between coastal nutrient pollution and the nearshore stages of red tides. The use of satellites in detecting ocean currents and blooms also holds promise for tracking the movement of red tide and possibly predicting its occurrence.

The FWC and a number of other agencies and research entities are acquiring scientific knowledge about the Florida red tide organism in order to manage its effects on humans and natural resources. Because of FWC's long-term experience with this organism and others, FWC scientists have made valuable contributions to investigations of harmful algal blooms.

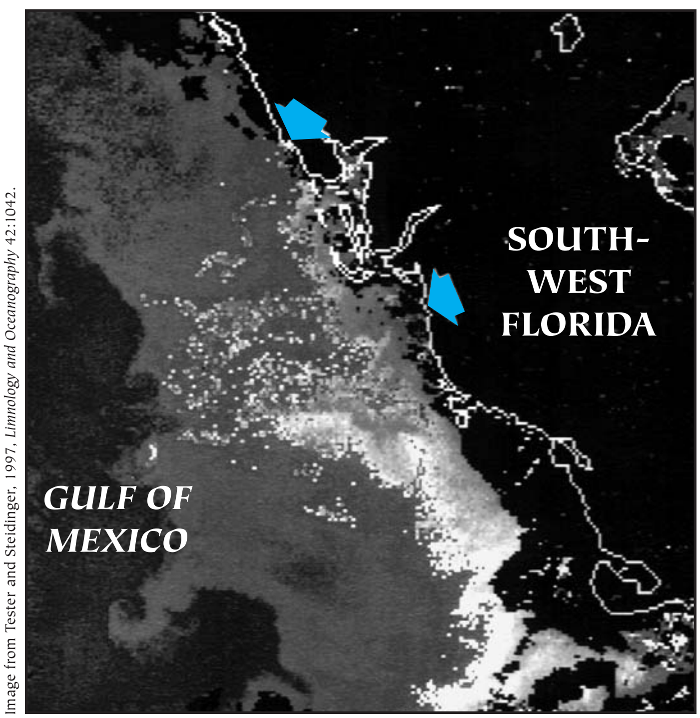

Image from Tester and Steidinger, 1997, *Limnology and Oceanography* 42:1042.

This satellite image, showing a bloom (light gray) in the Gulf of Mexico off the southwest coast of Florida, is an example of how satellites are used to detect and track red tides. The original image uses colors to show different concentrations of red tide. These blue arrows point to areas of greatest concentration.