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*Background and Monitoring Program for Florida*

# RED TIDE

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**Overview:**



***Safeguarding the public and supporting Florida's agricultural economy.***

## Red Tide Facts

- *Red tide* (Karenia brevis) *has been observed in Florida for hundreds of years.*
- *Commonly occurs fall to spring along the southwest Florida coast.*
- *Red tide associated toxins can kill fish, birds, marine mammals and shellfish.*
- *Shellfish harvesting areas are closed when red tide cell counts exceed 5,000 cells per liter.*
- *Filter feeding shellfish (clams, oysters and mussels) concentrate toxins associated with red tide, and can cause neurotoxic shellfish poisoning in humans if consumed.*
- *Once red tide diminishes, shellfish require approximately two to six weeks to purge toxins from their tissues.*
- *Cooking contaminated shellfish* ***does not*** *reduce the toxicity of* Karenia brevis *cells, as they remain toxic even after cell death.*

## History and Regulatory Program

Red tides are harmful algal blooms (HABs) that occur when toxic microscopic algae in seawater grow to higher than normal concentrations, called a "bloom", often discoloring the water red, brown, green or yellow. More than 40 species of toxic microalgae live in the Gulf of America.

*Karenia brevis* is the most prevalent toxic species in the Gulf of America and is primarily responsible for red tide in Florida. *K. brevis* was identified in 1947, but anecdotal reports of red tide effects in the Gulf of America date back to the 1530s. Red tides bloom in the Gulf of America almost every year, generally in the late summer or early fall. They are most common off the central and southwest coasts of Florida but may occur anywhere along the Gulf and southeastern Atlantic coasts from Texas to North Carolina, depending on environmental conditions such as ocean currents and wind direction. Most blooms last three to five months and may affect hundreds of square miles. Occasionally, blooms continue sporadically for prolonged periods and may affect thousands of square miles.

*Large fish kill caused by red tide along the west coast of Florida*

During red tide events, filter-feeding bivalves like clams and oysters accumulate toxins from red tide (called brevetoxins) and can cause neurotoxic shellfish poisoning in humans if consumed. When brevetoxins become airborne in sea spray, eye and respiratory irritation can occur.

The goal of the Division's Shellfish Harvesting Area Classification program is to provide maximum utilization of shellfish resources, while minimizing the risk of shellfish borne illness. To achieve this goal, and be able to ship shellfish nationally and internationally, Florida is a member of the Interstate Shellfish Sanitation Conference (ISSC).

The ISSC is an association of states, U.S. Food and Drug Administration (FDA), NOAA National Marine Fisheries Service, U.S. Environmental Protection Agency and shellfish industry. Together, the ISSC members create and amend the National Shellfish Sanitation Program's (NSSP) model ordinance. The model ordinance outlines standards and requirements that Florida must adopt to ensure that shellfish are grown, harvested and processed in a safe and sanitary manner. The Division is responsible for the monitoring of over 1,200 water quality monitoring stations in 38 shellfish harvesting areas (SHAs), encompassing over 1.3 million acres of coastal waters.

**For more information visit Shellfish Harvesting Area Information.**

# Neurotoxic Shellfish Poisoning (NSP)

⇒ ***Cause***
- Brevetoxin exposure via consumption of toxic shellfish.

⇒ ***Symptoms***
- Tingling and numbness of tongue, lips and throat.
- Muscular aches
- Gastrointestinal distress
- Dizziness
- Symptoms appear within hours and disappear within a few days.
- No fatalities have occurred from NSP.

⇒ ***Seafood Associated with NSP***
- Clams, oysters, scallops and mussels
- Commercial seafood available in restaurants and grocery stores is safe because it comes from monitored shellfish harvesting areas.

⇒ ***Cases in the Gulf of America***
- All Florida NSP cases have been associated with illegal recreational shellfish harvesting.

*Large red tide* (K. brevis) *bloom*

# Florida's Marine Biotoxin Management Plan

The NSSP model ordinance requires that the Division develop and implement a marine biotoxin management plan. The goal of this plan is to achieve maximum public health protection against *K. brevis* and other marine HAB species.

## Early Warning

Offshore blooms are generally concentrated enough to yield a red to brownish discoloration of surface waters and cause fish kills. Such offshore events are reported by the Florida Fish and Wildlife Conservation Commission (FWC), U.S. Coast Guard, or commercial, recreational and charter boat fishers. Seasonal current patterns and meteorological events are continuously monitored to predict possible offshore bloom movement. For more information on offshore monitoring visit Coastalscience.NOAA.gov/science-areas/habs/hab-forecasts/gulf-of-america/.

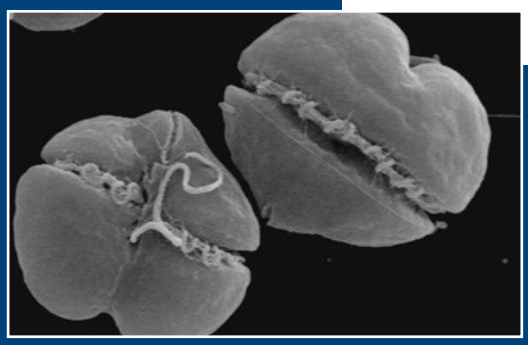
Monitoring of inshore waters is accomplished by an extensive water sampling network. Division staff collect water samples monthly and will increase sampling frequency when cell counts are elevated above background levels (>1,000 cells per liter) or if there are other indicators of a bloom, such as fish kills, water discoloration or respiratory irritation.

## Occurrence Severity

Sampling is conducted at set stations to monitor changes in cell concentrations. Sampling results, field reports and hydrographic and meteorological data are evaluated to determine the severity and extent of the bloom. When cell concentrations exceed 5,000 cells per liter in an SHA, the SHA is temporarily closed to harvesting at sunset on the same day of the test results. Factors such as currents and tides are evaluated to predict the transport direction and distribution of a bloom. If it is determined that additional SHAs will be impacted, those areas are temporarily closed for the harvesting of shellfish. Harvesting closures do not apply to crabs, shrimp, lobsters or fish, which are safe to eat even during red tide blooms because brevetoxins do not accumulate in the meat consumed by humans.

## Reopening Closed Harvesting Areas

When red tide cell counts fall below 5,000 per liter and shellfish meat sample results are below closure thresholds, the temporarily-closed SHAs are reopened beginning at sunrise the following day (see page 3 for more details on meat testing). As part of the reopening process of a closed area, the Division notifies shellfish harvesters and processors, health agencies, FWC Division of Law Enforcement and the public. If red tide persists in a region or a new bloom appears, the process of monitoring, sampling and testing is repeated in the affected SHAs.



*Scanning electron micrograph of red tide cells*

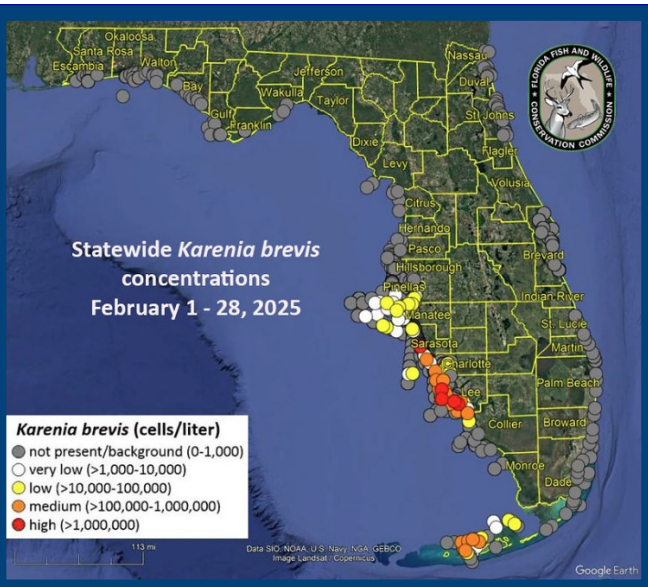
## Biology of *Karenia brevis*

*Karenia brevis* is a common photosynthetic, marine microscopic algae called dinoflagellate. It is found year-round throughout the Gulf at concentrations of 1,000 cells per liter or less. Each cell is typically 20 to 50 µm long and 10 to 15 µm deep. It has two whip-like appendages, or "flagella," that propel and direct it through the water at a speed of three feet per hour. In Florida, *K. brevis* thrives in warm salty waters, but it can tolerate a wide range of temperatures and salinities. The species is able to outcompete or exclude other phytoplankton and form blooms composed entirely of *K. brevis.*

## Collection and Testing

Collection of water samples relies on an extensive collaboration of state agencies, institutions and volunteer monitoring programs. The Division is responsible for the monitoring and management of HABs in harvesting areas in conjunction with the FWC Fish and Wildlife Research Institute (FWRI). However, red tide cell counts and toxicity analysis are completed by FWRI personnel to ensure the validity and accuracy of the results.

Live and preserved water samples are sent to the FWRI lab for microscopic evaluation to determine the amount of cells per liter. Shellfish meats are also sent to FWRI to determine toxicity using a mouse bioassay or ELISA (see the column to the right for more details).




*Current red tide condition map example produced by FWC. These maps are available online at: MyFWC.com/research/redtide/statewide/*

**For additional information on red tide in Florida please visit:**
MyFWC.com/research/RedTide/

## Economic Impacts of Red Tide

There are direct and indirect economic losses from each red tide event that occurs in Florida. Direct costs to the state's economy are primarily from health care for affected residents, decreased tourism revenue, beach cleanup activities and lost revenue from various marine-related businesses, such as shellfish aquaculture and fishing. Indirect costs can be much more difficult to accurately estimate and are often more costly than direct impacts. Indirect impacts to the aquaculture industry include disruptions in hatchery supply, processing facilities, seafood dealers and markets, distribution and supply chains and the local restaurant industry. These reverberating economic impacts are often estimated at two to three times the direct costs of each red tide event.


*Permanent water quality monitoring station*

*Offshore water quality sampling*

## Shellfish Meat Testing

The mouse bioassay is the approved method recognized by the NSSP for determining brevetoxin concentration.

The test is based upon the time it takes for a mouse to die when injected with a dose of toxin extracted from shellfish meat. A specific type and weight of mouse is used and the test is repeated to ensure accuracy of results.

Relative toxicity is expressed in mouse units. One mouse unit is equal to the amount of toxin that kills 50% of test mice in 930 minutes (15.5 hours). A shellfish meat sample result of less than 20 mouse units is considered safe for human consumption.

Enzyme-linked immunosorbent assay (ELISA) was adopted as a limited use method for testing brevetoxin concentration by the ISSC in 2017. This method uses antibodies to measure brevetoxin in samples.

A clam meat sample result of less than or equal 1.6 part per million and an oyster meat sample result of less than or equal to 1.8 ppm is considered safe for human consumption.