FACT SHEET

HARMFUL ALGAL BLOOMS AND SHELLFISH IN MARINE ENVIRONMENTS
IN CONNECTICUT

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SEPTEMBER 2023

Microscopic algae or phytoplankton form the base of the marine food web and provide food for filter-feeding shellfish. There are thousands of species of photosynthesizing single-celled organisms, which are a naturally occurring and beneficial part of the marine environment. However, several species of phytoplankton, as well as some other types of algae, produce toxic substances that may harm people, fish, shellfish, marine mammals and birds.

What are harmful algal blooms (HABs) and what causes them in marine environments?

Harmful algal blooms (HABs) occur when microscopic algae, or phytoplankton, proliferate in response to environmental factors such as light, water temperature, salinity, pH, and nutrient levels. Under some circumstances, it is difficult to tell if a HAB is present simply by looking in the water, as HABs are not always visible to the naked eye. However, high cell concentrations can also cause waters to appear red, brown, green or various other colors due to the pigments that the cells produce. HABs occur around the globe and the human, animal and environmental health impacts have significant economic consequences.

Do seaweeds cause harmful algal blooms?

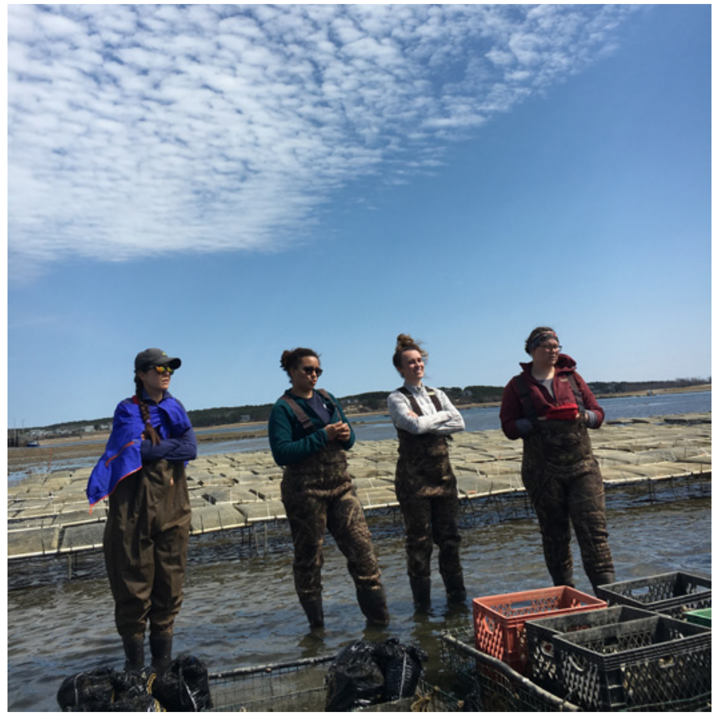
The most common HABs in the marine environment are caused by microalgae, however, some species of larger "macroalgae" or seaweeds, can be problematic. Sometimes currents and tides can move large quantities of seaweed that pile up on the beach, and under normal circumstances this poses no health concerns. But an example of a seaweed that can pose a risk is the non-native red seaweed *Dasysiphonia japonica*, which, when decaying, releases gasses that can cause respiratory irritation or harm, and has been associated with young fish and shellfish mortality in Great South Bay.

Are HABs the same as "red tide?"

The term "red tide" has been used in the past to refer to any HAB, but it is a misnomer. While certain phytoplankton blooms contain reddish pigments that can discolor the water, not all HABs are visible and not all blooms that are visible are harmful. Additionally, HABs are not always associated with tides and can occur far from shore.

How do HABs impact humans?

Some algal species produce toxins that are harmful to humans as well as wildlife. Shellfish such as oysters, clams and mussels are filter feeders, constantly pumping large volumes of water through their gills to extract food particles, including phytoplankton. While not lethal to the shellfish themselves, HAB toxins can accumulate in the flesh of shellfish through this process. Under some conditions, the toxins in the shellfish meat can reach levels that are dangerous or even lethal to humans and other animals that consume them. According to the Centers for Disease Control, shellfish poisoning syndromes can cause gastrointestinal and neurological problems, from nausea, vomiting and incapacitating diarrhea to dizziness, disorientation, amnesia and permanent memory loss and paralysis.



Work crew members at an oyster and quahog farm.

PHOTOGRAPH BY STEPHANIE MURPHY, WHOI SEA GRANT

How do HABs impact shellfish?

Some phytoplankton are not harmful to humans but can harm shellfish through toxins and other compounds they produce, through their physical characteristics (e.g., spines that lodge in gill tissues), or by dominating the food supply and stunting growth. Also, HABs, even those that do not produce toxins, can have ecosystem impacts that harm shellfish. For example, bacteria that eat dead and dying algae can deplete the surrounding waters of oxygen, causing die-offs of animals unable to move out of the anoxic zone. Algae blooms can also shade submerged aquatic vegetation, smothering habitat and starving animals of oxygen.

How are toxins cleared out of shellfish?

Once an algal bloom has dissipated, shellfish can naturally eliminate toxins from their tissues by constantly pumping water through their bodies. This process can take a few days to several weeks, depending on the toxin and the metabolism of the shellfish species. During severe HAB events, shellfish and other seafood can remain unsafe to eat for an extended period of time.

How can I be sure the shellfish are safe to eat?

Humans rarely fall ill from eating commercial seafood because state regulators monitor fisheries for HABs and act quickly to close them during blooms. All U.S. shellfish programs are required to meet the same monitoring and reporting requirements and are annually evaluated by the U.S. Food and Drug Administration. This requires significant effort, but it is successful. To ensure shellfish are safe to consume, state and federal agencies regularly collect phytoplankton samples to monitor for the HAB organisms, and test samples of shellfish tissue for the toxins they produce. All U.S. shellfish programs are required to close shellfish beds when toxin concentrations in shellfish tissue reach the established regulatory limits. Monitoring agencies can also close shellfish beds precautionarily if there are high concentrations of HAB organisms in the water or if toxin concentrations are increasing but have not reached the regulatory limit in shellfish tissue to protect public health. Prior to harvesting shellfish, every individual must hold the applicable permits, check if the area is open, and follow all state guidelines such as properly storing shellfish. The state shellfish programs institute closures for a variety of reasons, including unsafe toxin levels, but all are relevant to public health and must be followed. It is important to note that cooking shellfish does not destroy any toxin present, so abiding closure notices is the best way to avoid risk of illness. See state-specific monitoring and closure information on page 4.

What's the difference between dinoflagellates and diatoms?

Dinoflagellates and diatoms are two primary groups of phytoplankton. Both types photosynthesize and produce oxygen, contributing to the overall health of the ocean; but they have some interesting differences.

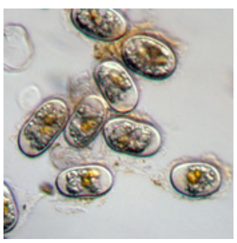
- Dinoflagellates have two whip-like tails called flagella, which help them move around in the water. Their thin, flexible covering doesn't offer them much protection.
- Diatoms are shaped like little boxes or glass jars and have a tough protective armor made of silica. They cannot propel themselves the way dinoflagellates can; rather, they drift on currents.

Blue mussels collected for toxin testing.

PHOTOGRAPH COURTESY CONNECTICUT SEA GRANT

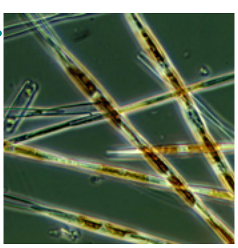
What phytoplankton are of concern in New England?

In New England waters, there are three primary phytoplankton of concern that can harm humans.



Alexandrium

The most well-known harmful algal bloom issue in New England is caused by the dinoflagellate *Alexandrium*. Blooming annually in the Gulf of Maine, *Alexandrium* is well monitored throughout the region. It produces saxitoxin, which causes life-threatening Paralytic Shellfish Poisoning (PSP) in humans when they consume contaminated shellfish (mussels, oysters, scallops or clams)—either raw or cooked. The symptoms are neurological and can include numbness or paralysis, respiratory difficulty, speech incoherence or loss of speech, which may begin anywhere from 10 minutes to three hours following consumption of contaminated food. In non-lethal cases, symptoms generally last a few days



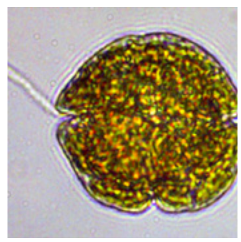
Pseudo-nitzschia

Pseudo-nitzschia, a diatom that produces the neurotoxin domoic acid, has long been present in the Gulf of Maine. However, domoic acid in shellfish tissue did not exceed the regulatory limit in New England until 2016, which caused a shellfish recall and fishery closures over much of Eastern Maine as well as Massachusetts and Rhode Island. Since then, areas of Maine, Massachusetts and Rhode Island have seen closures due to domoic acid. Domoic acid can cause amnesic shellfish poisoning (ASP). ASP symptoms include short-term memory loss, headaches, gastrointestinal distress, confusion, weakness and seizures. While there is no known antidote or cure for ASP, recovery is possible; however, some of the effects of domoic acid on humans can be permanent.

Dinophysis

The first *Dinophysis*-driven fishery closure in New England was in Massachusetts in 2015 followed by one in Maine in 2016. Subsequent closures in Massachusetts occurred in 2017 and again in 2022. The dinoflagellate *Dinophysis* produces the toxin okadaic acid, which causes Diarrhetic Shellfish Poisoning (DSP). DSP symptoms, which usually begin 30 minutes to a few hours after consuming toxic shellfish, include nausea, vomiting, abdominal pain and incapacitating diarrhea. Individuals with DSP typically recover within three days, however those with other medical conditions may need to be treated with IV fluids.

There are two phytoplankton species in New England waters that are not toxic to humans but threaten the fish and shellfish industries.



Karenia mikimotoi

Blooms of this dinoflagellate species can cause large-scale mortality events of shellfish, crustaceans and fish, and therefore have the potential to be damaging to fisheries and the aquaculture industry. *Karenia mikimotoi* can be found around the world but first bloomed in New England waters from Maine to Massachusetts in 2017. There have been limited harmful impacts caused by *Karenia mikimotoi* in New England. There is evidence that the effect of the harmful compounds they produce may be enhanced when the cells come into direct contact with fish gills. When *K. mikimotoi* cells die in large numbers and are eaten by bacteria, oxygen depletion can occur in the surrounding waters, contributing to die-offs of animals unable to move out of the anoxic zone. Dense blooms of *K. mikimotoi* were associated with hypoxia that caused lobster and scallop mortality events in 2019 and 2020 in Cape Cod Bay.

Margalefidinium polykrikoides

Formerly known as *Cochlodinium*, *Margalefidinium polykrikoides* is responsible for brown-colored blooms known as "rust tides." Blooms can occur over a broad range of temperatures and salinities but are typically associated with warm summer waters and high nutrient (eutrophic) conditions in estuaries. Blooms in the Northeast have increased in recent years due to warming surface temperatures and increased nutrient inputs. While not harmful to humans, *M. polykrikoides* can kill other marine organisms and is especially of concern due to the gill damage it can cause to shellfish and caged fish that cannot swim away from the bloom. Blooms of *M. polykrikoides* do not result in closures to the harvest of shellfish, as there is no human health risk, but they do impact the growth of animals and have negative economic impacts on related businesses. Blooms of *M. polykrikoides* were first recorded in the Northeast in Narragansett Bay in the 1980s and it occurs regularly in Narragansett Bay. Massachusetts saw its first bloom in Buzzards Bay in 2005 and every year since. Blooms have occurred in Narragansett Bay (RI), Buzzards Bay (MA), Nantucket (MA), Vineyard Sound (MA), coastal Massachusetts and Long Island Sound. *M. polykrikoides* has sporadically been reported in Connecticut waters since 2008, but no die-off events have concretely been associated with blooms of this species.

Shellfish and HABs monitoring in Connecticut

The Connecticut Department of Agriculture Bureau of Aquaculture (DoAG) is the lead state agency responsible for regulating the shellfish industry, managing shellfish beds and monitoring and responding to HABs. The DoAG conducts routine statewide HABs monitoring using phytoplankton samples collected throughout all shellfish growing areas from a minimum of March-October, and leverages the HABs monitoring program as an early warning system to trigger additional phytoplankton and shellfish toxin testing. The DoAG has maintained the phytoplankton and toxin monitoring programs since 1997 and 1985, respectively. In CT, the only area impacted by shellfish bed closures is the Town of Groton, which has a sporadic history of Paralytic Shellfish Poisoning (PSP) closures. The DoAG annually monitors the Town of Groton shellfish beds for the presence of *Alexandrium* in the phytoplankton and saxitoxin in blue mussels. No other areas have been closed due to PSP, and no areas in CT have been closed due to ASP or DSP. The DoAG also maintains a Biotoxin Management and Contingency Plan, which outlines the monitoring strategies and how the DoAG would respond to a HABs event.

Sea Grant-funded research by City College of New York (investigator: Maria Tzortziou) and Columbia University (investigator: Joaquim Goes) will apply observations from space to characterize the impacts of key climate stressors—hypoxia, eutrophication, acidification— on HAB development and water quality in Long Island Sound and NY coastal waters. Satellite images will be combined with in-situ measurements conducted by local and state monitoring programs (e.g., CT-DEEP, CT-DABA, NYS-DEC, NYC-DEP) to provide early indicators of HAB outbreaks useful for water quality and shellfisheries management and decision making. The team will integrate resulting datasets into NOAA's CoastWatch Program for open, free, easy and wide distribution of information as needed for inclusive water quality and shellfisheries management. Contact: Emily Marquis, CT DOAG: Emily.marquis@ct.gov

A Massachusetts Division of Marine Fisheries staff member collects a water sample that will later be viewed under a microscope to determine presence or absence of plankton species that can produce toxins.

PHOTOGRAPH COURTESY OF EASTHAM DEPT. OF NATURAL RESOURCES

Resources:

CT DOAG website: Harmful Algal Blooms (ct.gov)

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Publication number: CTSG-23-09