NO PREP

Harmful Algal Blooms

Red Tides, Toxins, and Ecological Consequences

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Harmful Algal Blooms: Red Tides, Toxins, and Ecological Consequences

The ocean is home to countless microscopic organisms, many of which are beneficial and essential for life on Earth. However, when conditions change, some of these organisms can grow excessively and create problems for ecosystems and humans. These events are known as harmful algal blooms (HABs). While not all algal blooms are dangerous, those that involve toxin-producing species or occur in overwhelming numbers can damage marine ecosystems, kill wildlife, and threaten human health and economies. One of the most familiar types of harmful algal bloom is the red tide, which occurs when populations of certain dinoflagellates multiply rapidly, coloring the water red or brown. These blooms often release toxins that poison fish and shellfish, leading to massive die-offs. For humans, consuming contaminated seafood can cause illnesses

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Causes of Harmful Algal Blooms

HABs are influenced by a combination of natural and human factors. Naturally, blooms occur when nutrient levels are high and environmental conditions are stable, such as during warm, calm waters. Dinoflagellates, diatoms, and cyanobacteria are common culprits. Human activity has greatly intensified HAB frequency and severity. Nutrient pollution from agriculture, sewage, and urban runoff often adds nitrogen and phosphorus to coastal waters. These nutrients act like fertilizer, fueling explosive growth. Climate change also plays a role. Rising sea surface temperatures create conditions that favor bloom-forming species, while changes in currents can spread blooms over larger regions. As human impacts on the ocean grow, HABs are becoming more frequent, longer-lasting, and more severe.

Toxins and Human Health Impacts

One of the most concerning aspects of HABs is their ability to produce toxins. Different species produce different harmful compounds. For example, the dinoflagellate Karenia brevis, responsible for red tides in the Gulf of Mexico, produces brevetoxins, which can kill fish and accumulate in shellfish. When humans eat contaminated shellfish, they can experience neurotoxic shellfish poisoning, which causes dizziness, nausea, and in severe cases, paralysis. Another dangerous toxin is saxitoxin, produced by certain dinoflagellates, which causes paralytic shellfish poisoning (PSP). Even tiny amounts can be lethal to humans. Cyanobacteria in freshwater can produce microcystins, which damage the liver and have caused major drinking water crises in some cities. The variety of toxins underscores the health risks of HABs and the need for monitoring programs to protect fisheries and public safety.

Ecological Consequences of HABs

The impacts of HABs go far beyond human health. Marine food webs are disrupted when fish and shellfish die in large numbers. Predators such as birds and marine mammals may also ingest toxins by eating contaminated prey, leading to illness and death. HABs can reduce biodiversity and alter the balance of ecosystems, sometimes allowing non-toxic species to dominate after toxic blooms fade. HABs also reduce oxygen in the water as the massive amount of algae eventually die and decompose. This decomposition process consumes oxygen, creating dead zones where marine life cannot survive. These zones can devastate fisheries and take years to recover. The cascading effects of HABs demonstrate how fragile marine ecosystems can be when nutrient cycles are disrupted.

Global Spread and Management

Harmful algal blooms are not confined to Florida or even the United States. They occur worldwide, from Asia to Europe to South America. As globalization has increased, ballast water from ships has transported harmful species across oceans, introducing them into new environments. For example, Alexandrium, a dinoflagellate responsible for PSP, has spread far beyond its native ranges. To manage HABs, governments use monitoring programs that test water samples and track toxin levels in shellfish. Some regions temporarily close fisheries during blooms to protect public

health. Long-term strategies focus on reducing nutrient pollution and addressing climate change. While HABs may never be eliminated entirely, reducing their severity and frequency is possible through responsible environmental management.

Key Information: Table: Examples of Harmful Algal Blooms

Organism	Toxin Produced	Impact
Karenia brevis	Brevetoxins	Fish kills, neurotoxic shellfish poisoning
Alexandrium spp.	Saxitoxin	Paralytic shellfish poisoning (PSP)
Cyanobacteria	Microcystins	Liver damage, drinking water contamination

Case Study: Florida's Red Tides

Along the Gulf Coast of Florida, harmful algal blooms caused by the dinoflagellate Karenia brevis are a recurring problem. Known locally as "red tides," these blooms can last for months and devastate marine life. Fish kills numbering in the millions have been reported, and manatees, dolphins, and sea turtles often die after exposure to brevetoxins. In addition to harming wildlife, the toxins can become airborne in sea spray, irritating the eyes and lungs of people onshore. The economic impact is equally significant. Florida's coastal communities rely heavily on tourism, yet during severe blooms, beaches are often deserted due to the stench of decaying fish and the health risks of airborne toxins. Fishing industries also suffer, as shellfish beds are closed to prevent poisoning. Scientists note that while red tides are natural events, human-driven nutrient pollution appears to make them more intense and frequent. This case highlights the wide-ranging ecological and social effects of HABs.

1. How do red tides caused by Karenia brevis affect Florida's coastal communities?

_____

_____

2. What role does human activity play in intensifying red tides?

_____

_____

Multiple Choice

1. What toxin is associated with Florida red tides?
    a) Microcystin
    b) Chlorotoxin
    c) Saxitoxin
    d) Brevetoxin

2. Which factor has increased the frequency and intensity of HABs?
    a) Declines in phytoplankton
    b) Decreased water temperatures
    c) Nutrient pollution
    d) Reduced shipping traffic

3. What health condition is caused by saxitoxin?
    a) Asthma attacks
    b) Paralytic shellfish poisoning
    c) Liver cancer
    d) Neurotoxic shellfish poisoning

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Karenia brevis	A) Causes paralytic shellfish poisoning
2. ___ Alexandrium	B) Liver-damaging toxins in freshwater
3. ___ Cyanobacteria	C) Creates oxygen-depleted dead zones
4. ___ Ballast water	D) Produces brevetoxins and red tides
5. ___ Decomposition of blooms	E) Transport of harmful species between oceans

Fill-in-the-Blank

1. HABs that cause reddish water discoloration are commonly called _____.

2. Florida red tides are caused by the dinoflagellate _____ brevis.

3. Decomposing algae from HABs can create _____ zones.

Short Answer

Answer each question in 2-4 complete sentences.

1. Explain how harmful algal blooms disrupt marine food webs.

_____

_____

_____

2. Why do governments often close shellfish beds during HABs?

_____

_____

_____

3. What global actions contribute to the spread of harmful algal bloom species?