Climate change could make toxic algal blooms in our oceans more deadly

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Toxins from blooms of microscopic marine algae can make animals like these sea lions gravely ill. Climate change could worsen the toxicity of these blooms, harming more marine life and threatening our food supplies. Credit: WikiCommons/Calibas

Late spring and early summer in California bring thousands of marine

mammals to the state's beaches, as groups of California sea lions, elephant seals and harbor seals give birth along the shore. Visitors to places such as the Carpinteria Harbor Seal Preserve can observe portly cubs lounging in sand, awaiting the return of their mothers from fishing expeditions in the Pacific Ocean.

Not all of the seals and sea lions are surviving, however. Toxic algal blooms are increasingly poisoning these marine mammals.

In the ocean, microscopic algae called phytoplankton provide energy at the base of marine food webs. However, some phytoplankton can produce potent toxins that adversely affect organisms that consume them.

Smaller marine life, such as plankton and smaller fish, absorb the toxins, which are then spread up the food web to larger fish and marine animals that feed on them. Coastal California has a history of harmful blooms that produce dangerous neurotoxins like saxitoxins and domoic acid, the latter of which has been found to cause severe brain damage in sea lions.

As our planet continues to warm, harmful blooms of microscopic algae may become even more toxic, indicates a new report from the USC Sea Grant program, headquartered at USC Dornsife College of Letters, Arts and Sciences. The report summarizes research they funded on harmful algal blooms conducted between 2012 and 2018.

Part of a national network of 34 university-based research programs funded by the National Oceanic and Atmosphere Administration, USC Sea Grant is working to solve the problems of the urban ocean in greater Los Angeles.

Oceans abloom

Algal blooms occur when oceanic conditions enable phytoplankton to rapidly reproduce, packing waters so densely that the blooms can sometimes be seen from space.

A number of environmental factors can stimulate an algal bloom. Algal blooms can be caused by naturally-occurring ocean nutrients like nitrogen, so blooms can happen when ocean upwelling bring these nutrients from deeper, colder waters to the surface. However, human sources of nutrients from sewage outflows, fertilizers and storm water runoff can also trigger blooms at the coast.

"The San Francisco Bay drains most of the agricultural land in California, so that's where a lot of the nutrients end up. In Southern California, our treated sewage from some 24 million people goes right into the ocean. Both of these sources are an issue," says David Hutchins, professor of biology, who contributed research to the report.

Thousands of seabirds and seals have died during coastal algal blooms. Humans who consume contaminated seafood are at risk of serious illness. Fishing industries hit with a bloom can sustain financial losses in the millions of dollars when seafood becomes contaminated.

Toxicity uptick

Harmful algal blooms will likely worsen as Earth's climate changes. Findings from studies funded by USC Sea Grant indicate that warmer, more acidic ocean waters (due to higher carbon dioxide levels) may increase both the frequency and toxicity of these events.

Findings included in the USC Sea Grant report indicate that toxicity can also be increased when multiple environmental conditions interact in specific ways. Warmer temperatures, higher CO_2 levels, ultraviolet light exposure, and changing nutrient availability can interact to boost both

the toxicity and abundance of domoic-acid producing species in the genus Pseudo-nitzschia. Domoic acid is the toxin responsible for shellfish poisoning in humans.

Hutchins has been working with graduate students at USC Dornsife to study climate change's impact on Pseudo-nitzschia.

"Unfortunately, it seems like this group of toxic algae is really going to be one of the biggest beneficiaries of a changing ocean. They really like warmer water, they grow faster in it and they also make more toxin per cell. They also make more toxins and grow faster when you put a lot of carbon dioxide in the water, which is ocean acidification."

From land to sea

Data from the report also indicate that atmospheric warming increases toxin-producing harmful algal blooms in freshwater environments, which can then be transported into coastal waters.

Algal toxins produced by blue-green algae were detected in lakes, lagoons, creeks and estuaries with direct connections to the Pacific Ocean, and were also found in coastal shellfish tissues.

Monitoring of algal blooms in marine and freshwater, and at the land-water interface, is crucial for water quality, public health, and recreation, according to the report.

Controlling the bloom

Hutchins reminds us that the vast size of these algal blooms makes them difficult to tackle once they appear. "There are ways to treat water and kill algae, like in a reservoir, but these blooms cover hundreds of square

miles of open ocean. Who knows what kind of unintended consequences could occur," he explains. "The best thing to do is to stop aggravating them by warming up the water and acidifying it."

His lab continues to experiment with Pseudo-nitzschia, to see how they react to warming water and increased CO_2. This provides more robust data for modeling what to expect from algal blooms as our oceans change.

Ongoing projects funded by the Ocean Protection Council and USC Sea Grant are aiming to advance technologies for rapid detection of marine blooms using genetic tools. Improved detection methods and better data will help make predictive modeling more reliable, and improve management of and response to these events, protecting humans and the diverse marine life of California alike.

Provided by University of Southern California