Cyanobacteria are a growing One Health challenge

Cyanobacteria are among the oldest organisms on Earth. They are believed to be responsible for the planet's oxygenation and the development of photosynthesis in plants.[1] Today, cyanobacteria are ubiquitous and perform many ecosystem services.[2]

The concept of One Health is the understanding that the health of animals, the environment, and humans are interdependent. Cyanobacteria can become a One Health challenge when they negatively impact the health of humans, animals, and ecosystems. In freshwater lakes, cyanobacteria can pose a threat when they produce dangerous cyanotoxins[3] or multiply rapidly, forming blooms[4,5] **[Figure 1]**. Such blooms can cause hypoxic water conditions, which sometimes result in wildlife mortality and plant die-off due to ultraviolet radiation blocking.[6] Blooms have substantial economic consequences when they impact fisheries, tourism, or livestock. Cyanotoxins are also a significant challenge for drinking water, because toxins may persist after conventional treatment (e.g., chlorination, filtration), different toxins require different treatments, and certain treatments can increase the release of toxins.[7]

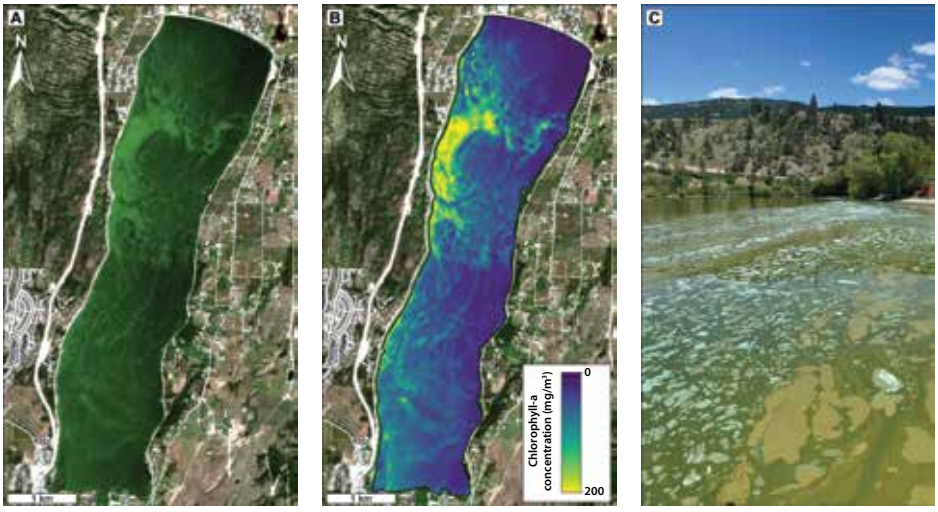

FIGURE 1. ***Anabaena flos-aquae*** **bloom in a BC lake in May 2021, shown via (A) a satellite true-color image, (B) satellite-derived chlorophyll-*a* estimates[4] indicating the concentration of cyanobacteria or algae, and (C) a field photo of the bloom die-off.[5]**

Human health

There are approximately 2000 known species of cyanobacteria, and less than 5% are recognized to produce cyanotoxins, which have hepatotoxic, neurotoxic, dermatoxic, and cytotoxic effects.[8,9] Exposure can occur via ingestion (e.g., drinking contaminated water), dermal contact (e.g., swimming), and inhalation of aerosolized water droplets. Acute health impacts range from mild self-limiting symptoms, such as diarrhea, headaches, and skin irritation, to paralysis and death.[3] There is evidence of chronic effects, such as liver damage and cancer, and impacts of repeat low-dose exposures, but these effects are less understood.[3]

Changing cyanobacteria risks

Cyanobacteria multiply in freshwater lakes under specific environmental conditions, which are often driven by anthropogenic nutrient loading from industry, agriculture, sewage, urban runoff, and waste facilities.[9,10] These sources of nutrients are likely to increase as the population continues to grow. At the same time, favorable environmental conditions, such as higher water temperatures, are being enhanced by climate change. For example, wildfires interact with higher rainfall to increase nutrient runoff from burned areas. Flooding may inundate nutrient-rich farms or septic systems. Wildfire smoke mobilizes and deposits nutrients in lakes, which has been linked to downwind blooms. Wind may transport nutrients in smoke long distances, increasing the risk of nutrient loading in lakes previously unaffected by blooms. Finally, human-mediated transport (e.g., via boat) and changing environmental conditions are allowing new cyanobacteria species to thrive in new regions.

Cyanobacteria in BC

In BC, there is a poor understanding of the burden of illness caused by cyanotoxin exposures. Illnesses are not reportable; there is no systematic surveillance; and cases are likely under-ascertained due to nonspecific, self-limiting symptoms.[9] Nevertheless, from 2012 to 2024, the BC Drug and Poison Information Centre recorded 34 calls about 43 individuals exposed to freshwater cyanobacteria, with more calls in recent years **[Figure 2]**. Most (88%) of these calls were about individuals who were exposed when swimming or recreating around fresh water, including food contact with contaminated water. The remainder

This article is the opinion of the BC Centre for Disease Control and has not been peer reviewed by the BCMJ *Editorial Board.*

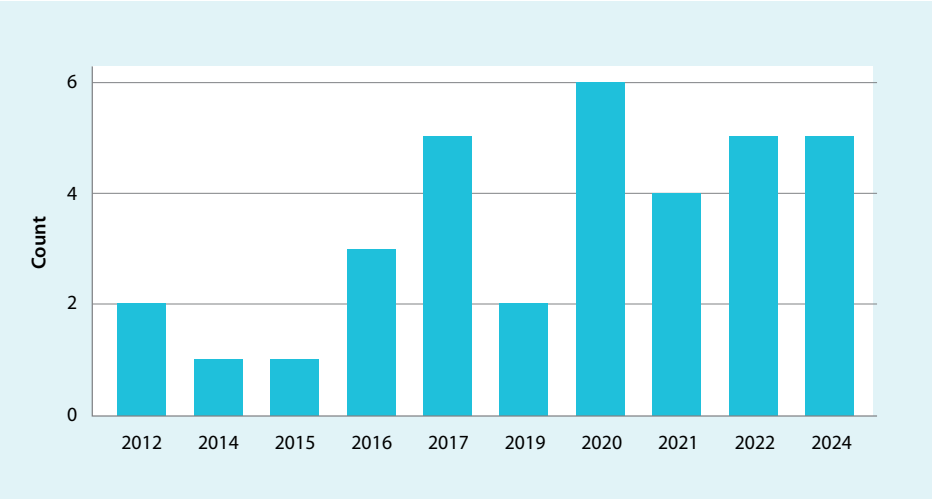

FIGURE 2. The number of annual calls made to the BC Drug and Poison Information Centre about exposure to cyanobacteria, 2012–2024. There were no cases of cyanobacteria in 2013, 2018, and 2023.

included work-related or unknown exposure sources. Two-thirds (68%) reported symptoms including abdominal pain, diarrhea, vomiting, fever, headache, respiratory distress, rash, itchiness, dizziness, fatigue, and conjunctivitis. The remaining callers were seeking preemptive advice about known exposures. Thirty-one calls were made in response to visible blooms and/or posted blue-green algae warnings, highlighting the importance of raising awareness.

Little is known about the provincial distribution of cyanobacteria and cyanotoxins or changes over time, because there is no comprehensive program of environmental surveillance. Data are collected for a small fraction of the more than 20 000 lakes in BC, and they are often disparate, time limited, and held by many different agencies.[11] There are programs that collect information on cyanobacteria specifically or blooms in general, such as the BC Lake Monitoring Network, which collects taxonomy samples twice a year for the more than 50 lakes it monitors across the province, and Algae Watch, where the public can submit photos of blooms.[5,12] Both programs indicate that blooms occur annually across BC. Routine monitoring for cyanotoxins by drinking water operators is primarily limited to a single group of toxins (microcystins), the only cyanotoxin with a Health Canada guideline limit for drinking and recreational waters. Monitoring for microcystins varies from no monitoring in many lakes to regular monitoring in some large drinking-water reservoirs.[7]

Although there is limited surveillance, cyanobacteria exposures are occurring in BC. Beyond Drug and Poison Information Centre data, there are periodic media reports demonstrating blooms and their wider impacts, including mortality among fish, pets, and cattle.[13,14] Building a robust surveillance system would support provincial adaptation and resiliency to the potential impacts of a growing population and climate change. Examples are available from other jurisdictions, such as the One Health Harmful Algal Bloom System, which collects data on blooms and related human and animal illnesses across the US. In BC, such a system would provide the foundation for a comprehensive and coordinated approach to cyanobacteria, enabling evidence-informed decision making about how and where to develop interventions and commit resources. ■

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COHP

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PREMISE

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