State of Wisconsin
Department of Health and Family Services
Division of Public Health

Cyanobacteria and Human Health

As summer approaches and the weather gets warmer, conditions become more favorable for the growth of cyanobacteria in Wisconsin lakes, ponds and streams. Already this year, algal blooms have resulted in beach closings out of concern for human health. In response to inquiries from local health department officials, the Department of Health and Family Services and the Department of Natural Resources have reviewed the available literature on health risks associated with blue-green algae, and have developed the following guidance for local health departments faced with concerns from the public about water conditions in their local lakes or ponds and deciding when closing a beach or taking other action is warranted.

It is important to remember that all natural surface waters contain bacteria, algae, viruses and other pathogens that, if consumed, may pose health risks to humans, pets and livestock. No one should ingest untreated lake or pond water at any time.

Sampling of Wisconsin water bodies

While blue-green algae are not new to Wisconsin, the Wisconsin Department of Natural Resources has increased its sampling efforts in selected state lakes in the past year to determine the prevalence of cyanobacterial species such as *Anabaena, Microcystis*, and *Cylindrospermopsis* in Wisconsin. The Wisconsin State Laboratory of Hygiene can analyze water samples for the presence of blue-green algal species.

Health officials, natural resources specialists and others need to understand the public health significance of cyanobacteria in order to interpret sampling results and take appropriate action. This guidance will assist local health officials and natural resources specialists in using cyanobacterial sampling results to make appropriate decisions regarding recreational use of lakes in Wisconsin.

Background on Cyanobacteria

Cyanobacteria are photosynthetic single-celled aquatic organisms that tend to be found living near the surface of lakes or ponds. Their relative abundance in a lake is dependent on a range of factors including water temperature and the availability of nutrients. Many types of cyanobacteria will form visible scums, or large floating mats, on lake surfaces during a algal bloom. Some species of cyanobacteria can be present in appreciable numbers without forming surface scums, however.

Health Concerns Associated with Cyanobacteria

There are health concerns associated with contact with the cyanobacterial organisms themselves, as well as with the toxins produced by some species and some strains of cyanobacteria. When present in high numbers in recreational waters, cyanobacteria have been found to contribute to eye, ear and skin irritation, as well as gastrointestinal symptoms such as vomiting and diarrhea in bathers. Animals eating dried scum may also exhibit symptoms.

Cyanobacterial toxins can be classified into two different types: neurotoxins and hepatotoxins. Neurotoxins include anatoxin-a, anatoxin-a(s) and saxitoxin, and are commonly produced by the *Anabaena* and *Oscillatoria* species. Consumption of large amounts of these toxins by animals or humans can result in muscle cramps, twitching, paralysis and cardiac or respiratory failure. Symptoms can appear within a few hours of exposure, but may take up to 36 hours to manifest themselves.

Hepatotoxins include microcystin and cylindrospermopsin, and are produced by the *Microcystis* and *Cylindrospermopsis* species. These toxins produce symptoms including nausea, vomiting and acute liver failure. In general these symptoms will appear rapidly, but may occur as late as several days following exposure to high amounts of hepatotoxins.

Summary table of toxins.

Type of Toxin	**Species Producing These Toxins**	**Toxins Produced**	**Symptoms**
Neurotoxins	Anabaena Oscillatoria	anatoxin-a anatoxin-a(s) saxitoxin	Muscle cramps, twitching, paralysis, cardiac or respiratory failure, death in animals
Hepatotoxins	Microcystis Cylindrospermopsis	microcystin cylindrospermopsin	Nausea, vomiting, acute liver failure

Existing Guidance Regarding Cyanobacteria

No guidance is available on safe levels of cyanobacteria and/or their toxins in recreational waters or in drinking water from either the U.S. Environmental Protection Agency or the federal Centers for Disease Control and Prevention (CDC). The World Health Organization (WHO) has established guideline levels for low and moderate probability of adverse health outcomes related to *non-toxin* cyanobacterial effects (effects of exposure to the cyanobacterial organisms themselves).

Results from water sampling are generally reported in units of cells per milliliter. For filamentous cyanobacteria such as *Cylindrospermopsis*, results are commonly reported as filaments per milliliter.

WHO guidelines state:

- **Low probability** of adverse health effects: **20,000 cyanobacterial cells per milliliter**. At this level, the WHO states that providing information to bathers is considered sufficient.

- **Moderate probability** of adverse health effects: **100,000 cyanobacterial cells per milliliter**. The WHO states that interventions such as restricting bathing at beaches and public education campaigns may be appropriate when cyanobacterial counts are at this level.

- **High risk** of adverse health effects: **presence of cyanobacterial scums at bathing areas**. The WHO reports that animal poisonings and human illnesses related to cyanobacteria are usually accompanied by the presence of scum material at the water

surface, and that ongoing observation of bathing beaches is necessary to assess the existence of high-risk exposures.

Summary Table of WHO Guidelines for Cyanobacteria Levels in Water:

Risk Category	Cell Density (cells/mL)	Action Recommended
Low Risk	20,000 – 100,000	None
Moderate Risk	>100,000	Advisory & Possible Closure
High Risk	Visible Scum Layer	Closure

Limitations of Guidelines and Testing

Many blue-green algal species of concern form clumps, spheres, and/or coils of intertwined cells. Therefore, it is often problematic to quantify cell counts using routine laboratory protocols. As such, it may not be possible in some cases to compare cell densities from any particular lake or pond sample to the guidelines provided by the WHO regarding human risk from exposure to blue-green algae.

Because certain species such as Cylindrospermopsis are not prone to form surface scums when cell counts are high, the WHO guidance for defining high levels of risk is less informative for this species than for others. It is also likely that there is some variation in the degree to which different species of cyanobacteria contribute to allergenic and irritative effects.

Existing Guidance for Exposure to Cyanobacterial Toxins

Some guidance has been established by the World Health Organization for exposure to microcystin-LR, a particular hepatotoxin produced by several cyanobacterial species, including *Microcystis* and *Anabaena*. The WHO has developed a limit of 1 μg/L for microcystin-LR, and considers water with a toxin concentration below this level as safe for long-term consumption. According to the WHO, data are insufficient for the derivation of guidance values for other cyanobacterial toxins.

Posting Health Advisories and/or Beach Closures

> The department or a local health department shall close or restrict swimming, diving and recreational bathing if a human health hazard exists in any area used for those purposes on a body of water and on associated land and shall require the posting of the area.
>
> (s. 254.46, Wisconsin Statutes)

A health officer may close beaches and post signs indicating a beach closure if sampling reveals an exceedance of the WHO 100,000 cell count “moderate risk” level or a scum layer indicative of an exposure hazard is present. Sampling should be conducted to assure that cell counts are below applicable health guidelines before a beach is reopened.

Communication with the Public

The Department of Health and Family Services has developed a fact sheet for the general public on cyanobacteria, the toxins they produce, and their health effects. Local health department officials are encouraged to use this fact sheet as part of their education and outreach efforts to the community. The fact sheet can be found online at: http://dhfs.wisconsin.gov/eh/Water/.

Fish Consumption from High Cyanobacterial Count Areas

Some studies have shown that microcystin and saxitoxin can accumulate in fish to some degree in natural waters with high toxin levels. Data from crayfish and rainbow fish suggest that there is some potential for bioaccumulation of cylindrospermopsin in farm-raised freshwater aquatic foods. While there have been no confirmed reports of cyanotoxin-related human health effects related to fish consumption, there are few data on cyanotoxins in lakes, fish or shellfish on which to base judgments about health risk.

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