

Cyanobacteria Harmful Algal Blooms (HABs) and Cyanotoxins: Recreational Exposure, Health Effects and Guidance Levels

What are Cyanobacteria and Cyanotoxins?

Cyanobacteria are a type of bacteria capable of photosynthesis. Although they are not true algae, they are often referred to as “blue-green algae”. A cyanobacterial Harmful Algal Bloom (CyanoHAB) is an excessive growth, or “bloom”, of cyanobacteria, some of which can produce one or more types of potentially harmful toxins (cyanotoxins). HABs can occur under suitable environmental conditions of light, temperature, nutrients, and calm water. These “blooms” often result in a thick coating or “mat” on the surface of a waterbody, often in late-summer or early fall. People, pets, livestock and/or wildlife can be exposed to CyanoHABs by coming in contact with or ingesting water that is experiencing a CyanoHAB bloom. If a waterbody is suspected of having a CyanoHAB, people, pets and livestock should avoid contact with and not consume the water, and fish caught in the affected waterbody should not be consumed. A separate fact sheet providing general information about CyanoHABs is available at: www.state.nj.us/dep/wms/bfbm/CyanoHABHome.html. The fact sheet here provides detailed information on CyanoHAB Recreational Exposures, Health Effects, and the NJ recreational advisory guidance levels.

What are the potential human health impacts from recreational exposure to cyanobacteria and related toxins?

During recreational activities (e.g. swimming, wading, and watersport activities including jet skiing, kayaking, wind surfing, and paddleboarding), exposure to cyanobacteria and the toxic chemicals (cyanotoxins) produced by these organisms can occur. Recreational exposure can occur from accidental or deliberate ingestion of water, direct skin contact, or inhalation of water droplets.

Adverse health effects of cyanotoxins include allergic-like reactions (e.g., rhinitis, asthma, eczema, and conjunctivitis), flu-like symptoms, gastroenteritis, respiratory irritation, skin rashes, and eye irritation. More serious adverse health effects may include liver toxicity and neurological effects. Studies in laboratory animals suggest the possible involvement of some cyanotoxins in tumor formation.

The table below summarizes the health effects caused by the most common cyanotoxins and the species of cyanobacteria that are capable of producing them.



The Primary Cyanotoxins and their Health Effects (Based on USEPA’s table located at their website on HABS: <https://www.epa.gov/nutrient-policy-data/cyano-habs>)

Cyanotoxin	Health Effects in Humans	Cyanobacteria that can produce the toxin
Microcystin-LR	Abdominal pain, headache, sore throat, nausea and vomiting, dry cough, diarrhea, blistering around the mouth, pneumonia, liver toxicity.	<i>Microcystis, Anabaena, Nodularia, Planktothrix, Fischerella, Nostoc, Oscillatoria, and Gloeotrichia</i>
Cylindrospermopsin	Fever, headache, vomiting, bloody diarrhea, liver and kidney toxicity	<i>Cylindrospermopsis raciborskii, Aphanizomenon flos-aquae, Aphanizomenon gracile, Aphanizomenon ovalisporum, Umezakia natans, Anabaena bergii, Anabaena lapponica, Anabaena planctonica, Lyngbya wollei, Raphidiopsis curvata, and Raphidiopsis mediterranea</i>
Anatoxin-a group	Tingling, burning, numbness, drowsiness, incoherent speech, salivation, respiratory paralysis leading to death, neurotoxin.	<i>Chrysochloris (Aphanizomenon) ovalisporum, Cuspidothrix, Cylindrospermopsis, Cylindrospermum, Dolichospermum, Microcystis, Oscillatoria, Planktothrix, Phormidium, Anabaena flos-aquae, A. lemmermannii Raphidiopsis mediterranea (strain of Cylindrospermopsis raciborskii), Tychonema and Woronichinia</i>

What recreational HAB guidance levels are available?

EPA is currently developing recreational threshold values for one or more of these cyanotoxins, while a number of states, as well as the World Health Organization (WHO), have derived their own “action levels” or health advisory guidelines based on cyanobacteria cell counts and/or concentrations of the more toxic, commonly-occurring cyanotoxins.

The Bureau of Freshwater and Biological Monitoring of the NJ Department of Environmental Protection (NJDEP) has developed the laboratory capability to measure levels of three of the most toxic, commonly observed cyanobacterial toxins in NJ’s freshwaters, namely microcystins (suite of microcystin congeners), cylindrospermopsin, and anatoxin-a.

NJDEP’s Division of Science, Research and Environmental Health (DSREH) has reviewed the cyanotoxin guidance values developed by WHO and various states, as well as relevant scientific publications, and has developed guidance values for these three toxins (see below) which are applicable to recreational exposure. These values will be used by NJ to provide advice on recreational activities in response to HABs.

What are the recommended recreational action levels and health advisory guidance levels for New Jersey waters?

Action level based on cyanobacterial cell counts

Low concentrations of cyanobacteria may cause allergenic and/or irritant effects to a portion of an exposed population. These effects are caused by endotoxins (mainly the lipopolysaccharide component of the cyanobacterial cell wall) rather than cyanotoxins. Therefore, county or local authorities may wish to post precautionary advisories for freshwater lakes or ponds in which cyanobacterial blooms are suspected through visual or other screenings, until confirmation analysis is performed.



It is recommended that if the cyanobacterial cell count equals or exceeds 20,000 cells/ml in an area where primary recreational contact is likely to occur, county or local authorities should post advisory signs. When cell counts exceed this level, or other visual or screening assessments indicate a suspected bloom, monitoring for cyanotoxins should be initiated. This recommendation is based on the WHO (2003a) guidance (i.e. $\geq 20,000 - 100,000$ cells/ml is categorized as moderate risk) described in detail in the full DSREH document: Recommended NJ Action Level and Health Advisory Guidelines for Recreational Exposure to Microcystin-LR, Cylindrospermopsin, and Anatoxin-A.

Health advisory guidance levels for individual cyanotoxins

The following guidance values are recommended for recreational exposure to individual cyanotoxins or, in the case of microcystins, toxin groups. The bases for these values is provided in the NJ Action Level document within the overall Response Strategy which can be located at:

www.state.nj.us/dep/wms/bfbm/CyanoHABHome.html

- Microcystins (as total including –LR and other detectable congeners): 3 $\mu\text{g/L}$
- Cylindrospermopsin: 8 $\mu\text{g/L}$
- Anatoxin-a: 27 $\mu\text{g/L}$

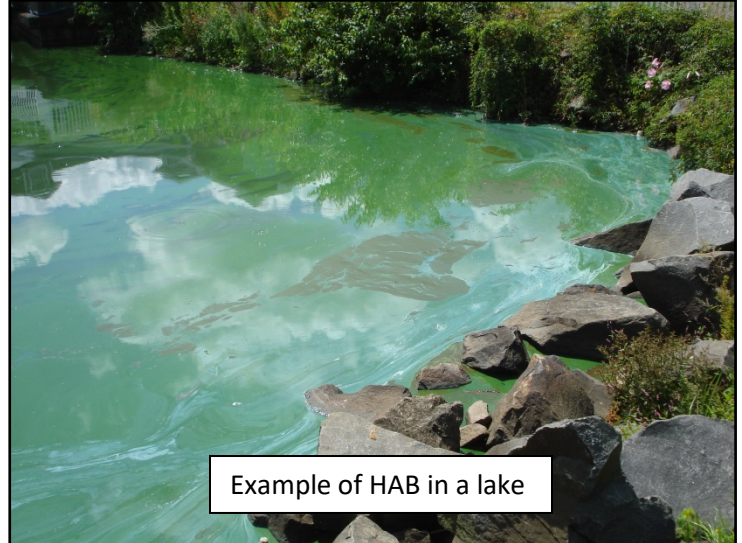
These concentrations are intended to be protective during short-term exposures, such as multiple days of swimming during the swimming season, for the more sensitive sub-population of children. The values are probably highly conservative (i.e., protective) for the degree of exposure most likely to occur. The uncertainties in the risk estimates underlying the development of these values, as well as the inherent uncertainty in the time course and location of the toxins in any given waterbody, should be considered when providing advice to the public regarding recreation in affected waterbodies.

What other conditions besides threshold level exceedances could result in advisories or warnings?

Upon initial reporting of a suspected HAB, one or more of the following field screenings will be performed by a qualified organization to verify whether or not a potential HAB is present. If field screenings verify that a HAB may be present, a sample will be collected for further confirmatory analysis.

Visual Assessment

This approach is used to provide visual assessment of lake conditions and land use as well as HAB presence. This assessment is available in the Cyanobacterial Harmful Algal Blooms (HABs) Freshwater Recreational Response Strategy



(www.state.nj.us/dep/wms/bfbm/CyanoHABHome.html) and is modified from a USEPA method as part of the National Lake Assessment (NLA). Procedures are outlined in: *USEPA. 2012 National Lakes Assessment: Field Operations Manual, Version 1.0, May 15, 2012. EPA 841-B-11-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC.*

Cyanobacteria Presence

If visual assessment confirms a potential HAB, the presence of cyanobacteria species can be confirmed in two ways, if equipment is available: 1. a broad identification of individual cyanobacteria may be performed using microscope equipment; or 2. the presence of phycocyanin pigment (unique to cyanobacteria) may be determined using a handheld field fluorometer.

Toxin Presence Screening

A microcystins field-kit test strip reading can be used to identify the presence of microcystins (other toxin test strips are now available; NJDEP is investigating the feasibility of use).

What are appropriate responses if the NJ recreational water advisory guidance levels are exceeded?

NJ thresholds are developed for human exposures only. They do not apply to pets, livestock, or other animals, and they do not apply to fish consumption. Contact should be avoided by livestock and pets when evidence of HABs or their toxins are present.

Example Advisories:

Warning - Avoid Contact and Ingestion (Humans and Animals)

A suspected Cyanobacteria bloom is present which can produce toxins harmful to humans and animals. People, pets, and livestock should avoid contact and ingestion. Exposure can include swimming, wading, and watersports. Fish caught in this waterbody should not be eaten

Danger/ High Risk - No Contact and Ingestion (Humans and Animals)

A confirmed Harmful Algal Bloom is present with levels quantified at or above the NJ Health Advisory Guidance. There should be no contact with the water including, but not limited to, swimming, wading, and watersports. Fish caught in this waterbody should not be eaten. Pets and livestock should not contact or ingest the water.

What effects can HABs and cyanotoxins have on pets, livestock and aquatic organisms, such a fish?

Livestock, pets, and other wildlife can become ill or die after drinking water contaminated by HAB toxins. Algal blooms may cause off-flavor and objectionable odors in fish, and lead to fish kills and decrease fish production because of oxygen depletion.

How are people or animals treated that have been exposed to cyanobacterial blooms?

The Center for Disease Control (CDC) states that if you or your pet comes in contact with a cyanobacteria, wash yourself and your pet thoroughly with fresh water. If you or your pet swallow water from where there is a harmful algae bloom, call your doctor, a Poison Center, or a veterinarian. Call a veterinarian if your animal shows any of the following symptoms of cyanobacteria poisoning: loss of appetite, loss of energy, vomiting, stumbling and falling, foaming at the mouth, diarrhea, convulsions, excessive drooling, tremors and seizures, or any other unexplained sickness after being in contact with water. CDC website: <http://www.cdc.gov/habs/materials/factsheets.html>.

You can help!

If you observe what you think might be a HAB in a pond, lake, or stream, to report a suspected Harmful Algal Bloom, a call should be placed to the DEP Hotline at 1-877-WARNDEP (927-6337) or submitted through the WARN NJDEP mobile app (available via iTunes, Google Play or Windows Phone). In addition to contacting the DEP Hotline, please complete the HAB Reporting Form at: www.state.nj.us/dep/wms/bfbm/CyanoHABHome.html . You can also contact your local or county Health Department (see website below). Please note the exact location of the suspected HAB along with any details (e.g., date/time, bloom appearance and color, whether a swimming beach is nearby).

Contacts

NJDEP Hotline: 1-877-WARNDEP (1-877-927-6337)

<http://www.nj.gov/dep/warndep.htm>

NJDEP Bureau of Freshwater & Biological Monitoring (609-292-0427)

njcyanoHabs@dep.nj.gov

www.state.nj.us/dep/wms/bfbm/CyanoHABHome.html

<http://www.state.nj.us/dep/wms/bfbm>

NJDOH Public Health Sanitation and Safety Program (609-826-4941)

<http://www.nj.gov/health/ceohs/sanitation-safety/environmental/>

Local and county Health Departments in New Jersey

<http://www.state.nj.us/health/lh/directory/lhdselectcounty.shtml>

For questions regarding drinking water, please contact your local water supplier or NJDEP Division of Water Supply and Geoscience (609-292-7219)

<http://www.nj.gov/dep/watersupply>

Additional Resources:

NJDEP Division of Water Monitoring and Standards Harmful Algal Bloom Website:

www.state.nj.us/dep/wms/bfbm/CyanoHABHome.html

USEPA's website on HABS, including Draft Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin: <https://www.epa.gov/nutrient-policy-data/cyanoHabs>.

Harmful Algal Blooms and Hypoxia Comprehensive Research Plan and Action Strategy: An Interagency Report, National Science and Technology Council, Feb. 2016. <https://www.epa.gov/nutrient-policy-data/guidelines-and-recommendations>

USGS. Graham, J.L., Dubrovsky, N.M., and Eberts, S.M., 2016, Cyanobacterial harmful algal blooms and U.S. Geological Survey science capabilities: U.S. Geological Survey Open-File Report 2016–1174, 12 p., <https://pubs.er.usgs.gov/publication/ofr20161174>.