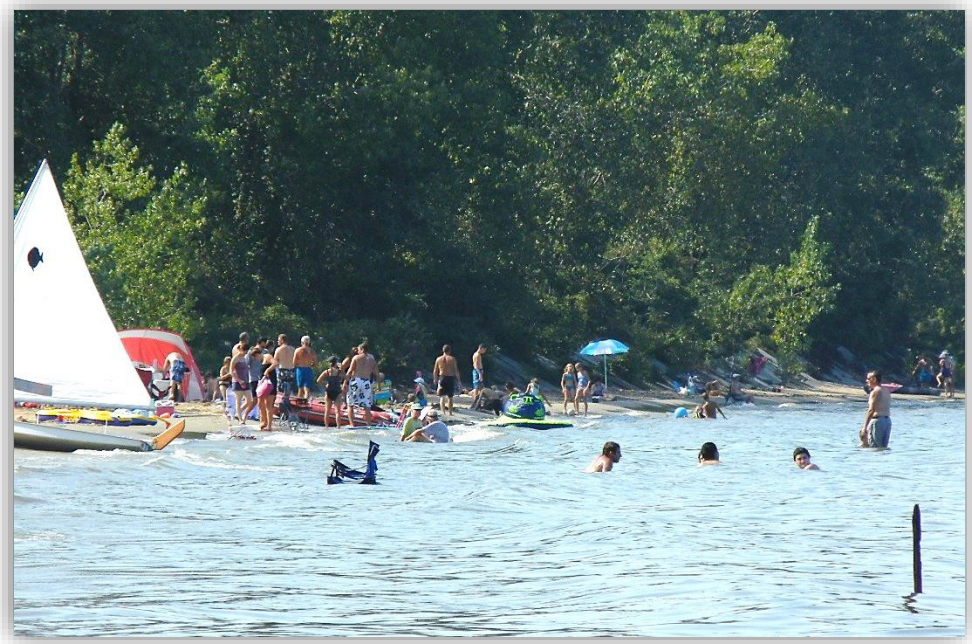
Ohio | Department of Health
Environmental Protection Agency
Department of Natural Resources

State of Ohio
Harmful Algal Bloom Response Strategy for Recreational Waters



August 2020

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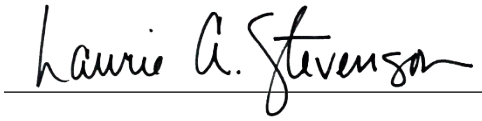
Ohio Harmful Algal Bloom Response Strategy for Recreational Waters 2020

By signature, the undersigned certify that they have provided comments on, or reviewed the 2020 Ohio Harmful Algal Bloom Response Strategy for Recreational Waters:



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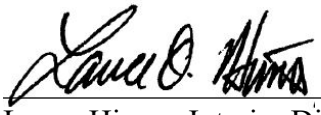

Lance Himes, Interim Director, Ohio Department of Health

Acknowledgements

We acknowledge the close working relationship between the Ohio Environmental Protection Agency, the Ohio Department of Natural Resources, and the Ohio Department of Health in addressing Harmful Algal Bloom (HAB) issues in Ohio and in developing this unified state response strategy for recreational waters.

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1. Introduction

1.1 Purpose

The purpose of the *Ohio Harmful Algal Bloom Response Strategy for Recreational Waters* is to provide a unified statewide approach to addressing harmful algal blooms (HABs) in Ohio recreational waters and to protect people from cyanotoxins produced by cyanobacteria. The Strategy identifies numeric thresholds to be used in making advisory decisions. Sampling will target those cyanotoxins that may be present at or above the threshold criteria established by the State of Ohio.

The focus of the Ohio Harmful Algal Bloom Response Strategy for Recreational Waters is on publicly owned, recreational lakes with public beaches and boat ramps, although these practices can apply to any recreational water body. The State of Ohio will post advisories at state park lake beaches and signage at boat ramps. On state park lakes jointly managed by the Ohio Department of Natural Resources (ODNR) and the U.S. Army Corps of Engineers (USACE), sampling and public notification will be coordinated according to the interagency agreement (see Appendix I). Local agencies and entities responsible for other recreational waters are encouraged to follow the State Strategy for posting advisories for consistency in communicating risk to the public. To assist local beach managers and public health departments, a Local HAB Response Guide was developed this year and is included with this state response strategy as Appendix A.

The State will conduct sampling at state park beaches in response to the presence of cyanobacterial blooms. Harmful algal blooms can also impact recreational activities that occur in the open waters of lakes and rivers (such as boating and jet skiing). However, the potential exposure to cyanotoxins at much greater at beaches (e.g., full emersion swimming, larger number of children), therefore the State is focusing on monitoring and advisories on those higher risk waters. Increased education and outreach will be conducted to address and minimize the public's exposure to harmful algal blooms in the open waters. This includes posting of caution signage at boat ramps in conjunction with posting advisories at beaches.

A separate procedure for responding to harmful algal blooms on sources of drinking water, the Ohio Environmental Protection Agency's (Ohio EPA) *Public Water System Harmful Algal Bloom Response Strategy*, is available online at: ***epa.ohio.gov/ddagw/HAB***. Guidance on the health effects of exposure to cyanotoxins and testing private drinking water sources for the presence of cyanotoxins and treatment options is available from the Ohio Department of Health (ODH) at ***https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/private-water-systems-program/Resources-and-Education/***.

1.2 Agency Roles and Responsibilities

The following are the responsibilities of each of the three state agencies that developed this Strategy:

Ohio Department of Natural Resources (ODNR):

- Monitor state park lakes for HAB development.
- Visually inspect state park beaches in response to bloom reports.
- Sample state park beaches for cyanotoxins if a bloom is visually evident at or near the beach.
- Post advisories and caution signs when necessary at state park beaches and boat ramps.
- Provide outreach to the public about HABs.
- Coordinate with the U.S. Army Corps of Engineers on jointly managed lakes.
- Create advisory signage templates in PDF format.

Ohio Department of Health (ODH):

- Evaluate illness reports, support local health district investigations, classify reports according to existing case definitions and report case results to the One Health Harmful Algal Bloom System (OHHABS).
- Determine advisory thresholds in consultation with ODNR and Ohio EPA.
- Advise the public about private lake HAB issues.
- Provide information to the public about HAB safety and health effects.
- Provide one website for posting recreational HAB advisories to the public through the BeachGuard application.
- Forward information on bloom reports and NOAA satellite imagery to local health districts.
- Coordinate with local health districts when responding to a potential HAB and post advisories when necessary, including sampling on public beaches not located at state parks.
- Communicate with Ohio EPA and ODNR as described in the communication protocol when advisories will be posted by local health districts.
- Review National Oceanic and Atmospheric Administration (NOAA) satellite imagery to evaluate HAB risks in open waters.

Ohio Environmental Protection Agency (Ohio EPA):

- Monitor NOAA satellite imagery and other information to identify bloom formation and share with ODH and ODNR.
- Use various screening tools to assist in determining the presence of a cyanobacteria and cyanotoxins.
- Collect and review Algal Bloom Reports, maintain in a database, and forward as appropriate for response.
- Maintain a database of state-reported HAB data.
- Maintain the ***ohioalgaeinfo.com*** website.
- Provide HAB sample collection guidance for private lakes and other private water bodies and refer them to the Ohio State University (OSU) Extension, local health districts or ODH for additional assistance.
- Assist with sampling at public lakes as needed.
- Assist in determining the presence of a cyanobacteria bloom by microscopic review to determine genera.
- Sample for cyanotoxins and phytoplankton as part of the Inland Lakes Monitoring Program.
- Provide HAB sampling protocols and train others in sample collection.
- Provide outreach to the public about HABs.

The following table outlines the roles and responsibilities for sampling and posting advisories at various recreational water bodies.

Table 1 — State and Local Agency Roles and Responsibilities.

	Type of Waterbody	Sampling or Observations of Blooms	Post Advisories
Beaches and Primary Contact Recreation Areas	State Park	ODNR, Local Health Districts	ODNR
	Other Public Beaches and Recreation Areas	Local Beach Manager or Local Health District*	Local Beach Manager or Local Health Districts
	Private Beaches and Recreation Areas	Property Owner	Property Owner
	US Army Corps of Engineers (USACE) lake	USACE coordinates with ODNR, Local Beach Manager*	USACE coordinates with ODNR, Local Beach Manager
Rivers with Primary Contact Recreation Activities	Rivers- Private access	Property Owner	Property Owner
	Ohio River	ORSANCO*	Local govt./Ohio EPA
	Rivers – public access	Local Health Districts/ Ohio EPA	Local Health Districts

*Ohio EPA may be able to provide sampling assistance if the local health district or Ohio River Valley Sanitation Commission (ORSANCO) is unable to respond.

HABs reported in non-public (private) waters may be referred to the Ohio State University Extension Office or local health departments for assistance. Owners and managers of private beaches, lakes, and ponds can use the sampling guidance provided in Appendix A to collect samples. Samples can be sent to labs listed in Appendix E for cyanotoxin analysis.

1.3. Cyanobacteria

Cyanobacteria are organisms that are found in all bodies of water. Under favorable conditions (nutrient availability, light, and heat) cyanobacteria can multiply and create an algal bloom becoming visible to the naked eye. These algal blooms generally occur in eutrophic or hypereutrophic water bodies. Eutrophication is most often the result of an elevated supply of nutrients, particularly nitrogen and phosphorus, to surface waters that results in enhanced production of primary producers, particularly phytoplankton and aquatic plants (Prepas and Charette 2003).

Cyanobacteria can cause problems in recreational waters. Large algal blooms can cause decreased dissolved oxygen concentrations resulting in fish kills. Many cyanobacteria also produce taste and odor compounds that affect the taste of fish. The foul smell produced by some cyanobacteria is a nuisance to those living around or recreating on the water.

1.4 Cyanobacterial Blooms

Cyanobacterial blooms vary in species composition and cyanotoxin production over time and within a water body. The distributions of cyanobacteria populations are affected by weather and lake conditions, hydrology, lake morphology, and the type of cyanobacteria. The cyanobacteria can be distributed evenly throughout a lake, or irregularly distributed because of currents and/or prevailing winds. Hydrologic changes because of heavy rains, or the discharge from a stream resulting in currents, can significantly affect cyanobacteria population distributions. Areas like shallow bays, coves, sites directly affected by nutrient-rich inflows, or structures that affect flow (e.g. dikes, piers, or intake towers) can significantly affect population growth rates and cyanobacteria distribution.

Cyanobacteria can be found at the water surface (scums), at a particular depth (e.g. *Planktothrix rubescens*), or can occur throughout the water column (e.g. *Planktothrix spp*., *Cylindospermopsis spp*.). Strong winds, rainfall, currents, and lake turnover can all mix a surface algal bloom throughout the water column. Winds can also concentrate a surface algal bloom in calm leeward (downwind) areas such as a bay, cove, beach, or inlet. Some cyanobacteria are also capable of buoyancy regulation, and during calm non-mixed conditions can move vertically throughout the water column based on light and nutrient availability. These various factors, that can move a visible surface algal bloom below the surface or to a different portion of the lake, are important to understand because the absence of a surface algal bloom does not necessarily indicate an algal bloom is not present. If it is noticed that a surface algal bloom has dissipated, the bloom may not have senesced (died), but could have just moved to another area of the lake or mixed below the lake surface within the water column. In addition, some cyanobacteria cannot form surface scums, so surface accumulations should not be relied on as the only indicator that an algal bloom is present.

Color is not necessarily a good way to distinguish cyanobacteria from green algae or suspended sediment. Cyanobacteria can appear in many colors that include brown and green. *Cylindrospermopsis spp*. blooms are generally brown and appear like suspended sediment. Other blooms are green and are mistaken for green algae. It is important for lake managers to be familiar with their lake so they can notice changes in the normal appearance outside bloom season. The best way to know for sure if cyanobacteria are present is through processed satellite imagery, microscopic examination, or use of other cyanobacteria screening tools (e.g. molecular methods, cyanotoxin field test kits).

1.5 Cyanotoxins

Cyanobacteria can produce a variety of cyanotoxins which can cause illness and death in humans and animals. These cyanotoxins include liver toxins, nerve toxins, and skin toxins. Some of the more common cyanotoxins detected in Ohio waters include microcystins and saxitoxin. Cylindrospermopsin and anatoxin-a have also been detected, but much less frequently. Cyanotoxins can be found within cyanobacteria cells or released from the dying cells into the water. Sudden die-off of an algal bloom can release cyanotoxins to the water all at once in great concentration (when using an algaecide) or gradually when some cells die while others grow during the lifecycle of a bloom. Cyanotoxin production is strain-specific, and many of these organisms can produce one or several different types of cyanotoxins. These cyanotoxins are colorless, odorless, and tasteless, and persist in the water after an algal bloom is gone. Cyanotoxins may be degraded by bacterial action and sunlight over time.

2. Cyanotoxin Toxicity Thresholds

2.1 Introduction

This section provides guidelines for public recreational water managers responding to HABs and their potential to adversely impact human health. Included in this strategy are cyanotoxin thresholds protective of human health by incidental ingestion in recreational waters; a framework to be used in issuing HAB advisories; and language for signage to use when posting affected water bodies.

These guidelines were recommended by a committee that included representatives from Ohio EPA, ODH and ODNR and were adopted by the Directors of those state departments. These guidelines are reviewed and updated annually. This strategy supersedes previous versions of this document. The science of HABs and their related cyanotoxins is evolving, and this strategy may require updating with the issuance of new toxicity information or national HAB guidance or policy.

2.2 Health Impacts from Exposure to Cyanotoxins

Many of the health symptoms associated with exposure to cyanotoxins can mimic other illnesses and diseases and therefore may not be readily recognized by the medical community or the public. Some of these symptoms include nausea, skin rashes, gastrointestinal distress, disorientation, numbness and fatigue. These symptoms can occur more quickly and severely in dogs and other animals. Increasing the level of awareness through education within the medical and veterinary community, general public and government agencies is strongly recommended in order to determine the public health impact of these cyanotoxins. ODH has developed information for physicians, known as "Screen for Green" that provides a diagnostic flowchart to assess probable patient exposure to cyanotoxins and treatment options. Similar information is available for veterinarians including diagnosis and treatment actions when an animal illness is suspected. Information for physicians, veterinarians and health effects of exposure to cyanotoxins can be found at ***odh.ohio.gov/wps/portal/gov/odh/know-our-programs/harmful-algal-blooms/welcome/***.

Cyanotoxins can affect liver and brain function. Many of the cyanobacteria produce toxins that can cause skin irritation. Due to the potency of these toxins and no known antidote, the State of Ohio is taking a conservative approach with human exposure to these toxins when setting recreational water thresholds.

Reports of suspected human or animal illnesses should be reported to the local health district of residence. Local health districts will collect illness report information and work with ODH on reviewing these reports and next steps. Should ODH determine that an outbreak has occurred, then a Recreational Public Health Advisory, as described in Section 4.4, may be posted even when toxin levels are below advisory thresholds.

2.3 Cyanotoxin Thresholds for Recreational Waters

Numerous risk assessment frameworks, exposure assumptions, and toxicity values from state, national, and primary literature sources were considered prior to developing the cyanotoxin thresholds. The following thresholds were established based on the best scientific information, guidance, and public policy available at the time, and are based on incidental ingestion only (Table 2).

While protective of human exposures based on current information, the thresholds given here may or may not be protective of animals such as dogs or livestock. The United States Environmental Protection Agency (U.S. EPA) issued final recommended recreational swimming advisories for two cyanotoxins, microcystins and cylindrospermopsin in June 2019 which were subsequently adopted by the State of Ohio in this document.

For a toxicity review of various cyanotoxins, exposure assumptions and threshold calculations, see Appendix D.

Table 2 — Numeric Thresholds for Cyanotoxins in Recreational Water.

Threshold (µg/L)	Microcystins*	Anatoxin-a	Cylindrospermopsin	Saxitoxins*
Recreational Public Health Advisory	8	8	15	0.8

*Microcystins and saxitoxin thresholds are intended to be applied to total concentrations of all reported congeners, variants, or analogs of those cyanotoxins.

3. HAB Identification and Reporting

This section describes how to recognize a potential HAB, how to report a HAB, what to sample for, and how information is shared.

3.1 Observation

The initial observation of a possible HAB involves identifying the presence of color and/or scum in surface water. Frequent, close monitoring of the algal bloom's location(s) is recommended, especially in recreational waters. The color can vary from brown (looks like suspended sediment), green, blue-green, white, black, purple or red. (See Photo Gallery of Ohio HABs at ***ohioalgaeinfo.com***).

The State will use remotely sensed imagery collected and processed by the National Oceanic and Atmospheric Administration (NOAA) or the National Aeronautical and Space Administration (NASA) to assist in identifying the location of HABs in Lake Erie, inland state park lakes, and portions of the Ohio River. For state recreation managers, the imagery is used as a tool to assist in visual confirmation of algal bloom presence. These remote sensing tools can provide information on lakes or rivers that are at least 300 meters wide. A processed image can detect HABs approximately 1-2 feet below the surface when the human eye cannot. It can also detect algal blooms in turbid waters when the blooms can be difficult to visually identify. Hyperspectral imaging by airplane may also be used during times of increased cloud cover to supplement the satellite images. NOAA prepares a bi-weekly bulletin depicting satellite images of HABs, predicted algal bloom densities and wind directions for Lake Erie. More information on the NOAA HAB detection and monitoring program for Lake Erie can be found at the Great Lakes Environmental Research Lab website at ***glerl.noaa.gov***. Beginning in May 2017, a similar satellite product became available for inland lakes in Ohio. Ohio EPA reviews the near daily images for any cyanobacteria detections, generates maps of cyanobacteria detections for individual lakes, and shares a summary of current cyanobacteria detections and lake maps with ODNR and ODH. A multi-agency project, Cyanobacteria Assessment Network (CyAN), is responsible for using satellites to identify cyanobacteria blooms across the contiguous United States and will publicly share satellite data through an Android mobile application (in development) and EnviroAtlas. More information on the CyAN project can be found at the U.S. EPA website at ***epa.gov/water-research/cyanobacteria-assessment-network-cyan***.

Ohio EPA conducts ambient HAB sampling at inland lakes and Lake Erie as part of their inland lakes and nearshore Lake Erie monitoring programs. Public water systems routinely monitor for HABs on their source waters and provide that data to Ohio EPA. When HABs are detected on inland lakes or nearshore Lake Erie areas near public beaches, that data will be provided to ODNR and ODH for follow-up. USACE, Ohio Lake Management Society (OLMS), and other organizations also conduct HAB sampling and provide that information to Ohio EPA. When these data indicate a HAB may be present on a lake, the information will be forwarded to ODNR and ODH for potential follow-up.

3.2 Reporting

Individuals that observe HABs are encouraged to complete an Algal Bloom Report Form on the ***ohioalgaeinfo.com*** website that is accessible as a webform to directly locate the bloom location and include digital photos. Alternatively, a paper form is available (included in Appendix F) and may be submitted through e-mail along with digital photos to Ohio EPA's HAB mailbox (***HABMailbox@epa.ohio.gov***). All Algal Bloom Reports and HAB data (cyanotoxin and phytoplankton data, and photographs) will be entered into a repository maintained by Ohio EPA. Cyanotoxin data will be posted on ***ohioalgaeinfo.com***.

Algal bloom observers are encouraged to submit digital photographs with the Algal Bloom Report for algal bloom evaluation. Close-up (within 24 inches) and landscape photographs showing the extent and location of the algal bloom are helpful. Bloom reports at state park beaches will be forwarded to the state park beach manager for response. In response to reports of potential HABs on non-state park beaches, Ohio EPA will evaluate the report and share with local water managers and ODH, who will notify local health districts. Ohio EPA will provide sampling guidance to managers of private water bodies.

Coordination of response to blooms reported in non-state park beaches may be referred to the OSU Extension Office or local health districts for assistance. Owners of private beaches or ponds can use the sampling guidance provided in Appendix B to collect samples. Samples can be sent to labs listed in Appendix E for cyanotoxin analysis.

3.3 Screening and Cyanotoxin Analysis

Ohio EPA has developed a standard sampling protocol that can be used when sampling HABs (Appendix B). The protocol is used to collect samples at state park beaches during the primary recreational season from Memorial Day to Labor Day and as deemed necessary outside of the primary recreational season when conditions warrant the need for continued testing. At Ohio State Park beaches, if the park managers observe a potential HAB at the beach, the standard protocol is to collect a composite cyanotoxin sample and submit for microcystin analysis. The Ohio EPA protocol can be found in Appendix B. An instructional video (*HABs - A Guide to Collecting Grab and Composite Cyanotoxin Samples*) is available on online at ***https://youtu.be/B2yLi1Bp0CY***.

Cyanobacterial screening may include: phytoplankton identification (qualitative identification of genera and/or species present); cell quantification (cell counts or biovolume); phytopigment quantification (e.g. chlorophyll a or phycocyanin from sensors or analytical methods, reported in relative fluorescence units or cell density); molecular (qPCR) assessment of cyanobacteria genes or cyanotoxin-production genes; and rapid assessment field tests for cyanotoxins.

If screening is not conducted prior to cyanotoxin analysis, water managers are recommended to at least sample for microcystins, since they are the most commonly occurring cyanotoxin in Ohio. If phytoplankton identification or molecular screening shows an abundance of cyanobacteria capable of producing other cyanotoxins, additional analysis for those cyanotoxins (such as cylindrospermopsin, anatoxin-a, and saxitoxins) is recommended.

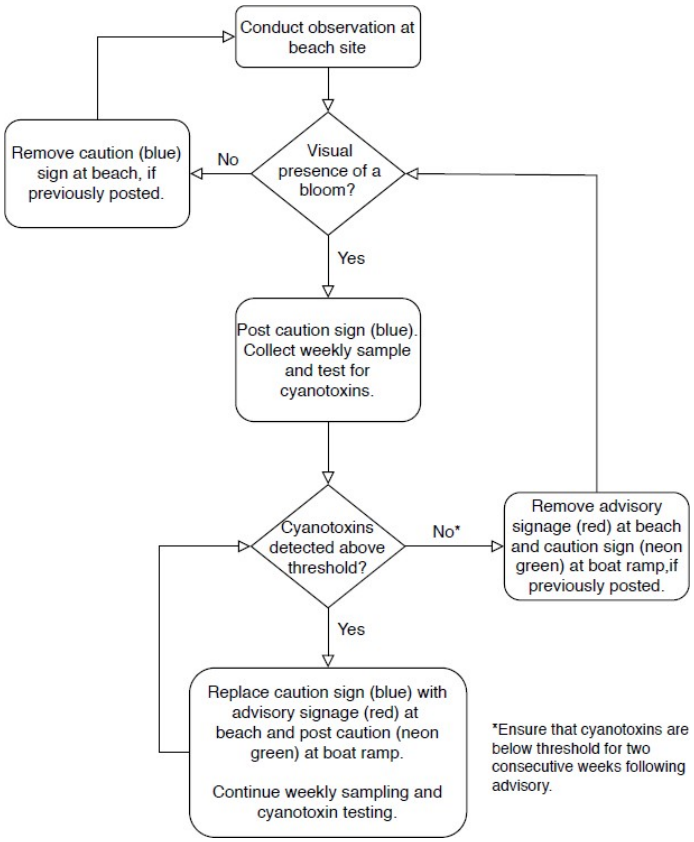
3.4 Information Sharing and Data Management

All recreational advisories occurring at state park beaches will be posted by ODNR on the BeachGuard website at ***odh.ohio.gov/healthybeaches***. If a water manager posts an advisory on a non-state park public beach or boat ramp, they are encouraged to share that information with their local health district, who should then post the advisory on the BeachGuard website. The ***ohioalgaeinfo.com*** website has been developed as the State's primary site for HAB information. The website includes access for advisory notifications, reported recreational water quality data and information, links to the NOAA bulletin and related satellite imagery, the ability to report algal blooms, factsheets and general HAB information.

4. Harmful Algal Bloom Advisories

4.1 Advisory Postings

Public advisories are necessary to inform the public of the health risks associated with exposure to water that contains cyanotoxins. The State of Ohio will issue a recreational caution and a recreational public health an advisory for recreational waters based upon the available evidence as described below. The State will only be responsible for posting advisories at state park beaches and caution signage at boat ramps. For state park beaches, advisory posting removal will be based upon two consecutive samples taken at least one week apart with cyanotoxin levels below threshold levels. Caution signage removal will depend on where the sign is posted, as detailed below. It is recommended that other public and private recreational water managers post (and remove) advisories at beaches and access points according to this strategy to ensure consistency in messaging (see Table 1). PDF versions of the sign templates are available at ***ohioalgaeinfo.com*** for use by local health districts, other managing agencies responsible for public beaches, and private beach managers to help ensure consistent messaging across the state. A flow-diagram outlining the posting strategy is provided below:



4.2 General Signage

The general informational sign has been posted for recreational waters at public state park beaches and boat ramps. For non-state park beaches with a history of HAB occurrence or upon visual confirmation of a HAB at a beach, posting of the informational sign is recommended:

Have fun on the water, but know that blue-green algae are in many Ohio lakes. Their toxins may be, too.

Be alert! Avoid water that:

- **looks like spilled paint**
- **has surface scums, mats, or films**
- **is discolored or has colored streaks**
- **has green globs floating below the surface**

Avoid swallowing lake water.
For more information go to *ohioalgaeinfo.com*
or call 1-866-644-6224

4.3 Recreational Caution

A Recreational Caution will be issued at a public state park beach when an algal bloom is visually confirmed. A Recreational Caution will be issued with an BLUE sign (with black lettering) posted with the following language:

CAUTION
A possible algal bloom may be at the beach.
<FACILITY NAME> has tested the water.
Lab results pending.

For more information go to *ohioalgaeinfo.com*
or call 1-866-644-6224

Once a Caution sign is posted, sampling for cyanotoxins occurs according to standard procedures (Appendix B). If cyanotoxins are detected above the recreational threshold; the Caution sign will be replaced with a Recreational Public Health Advisory. The Caution sign may be removed after algal bloom is gone.

4.4 Recreational Public Health Advisory

A Recreational Public Health Advisory will be issued at a public state park beach when cyanotoxin levels are equal to or exceed a recreational threshold. A Recreational Public Health Advisory will be issued with a RED sign (with white lettering) posted with the following language:

DANGER

Avoid all contact with the water.
Algal toxins have been found at unsafe levels.
Swimming and wading are not recommended.
Keep pets away.

For more information go to *ohioalgaeinfo.com*
or call 1-866-644-6224

A Recreational Public Health Advisory will remain until cyanotoxin levels have decreased to below recreational thresholds. The Advisory (and Boat Ramp Caution) may be removed after two consecutive samples taken at least one week apart indicate cyanotoxin concentrations are below recreational thresholds. If the bloom is still visually present, the Recreational Caution sign shall be reposted.

4.5 Boat Ramp Caution

A Boat Ramp Caution sign will be issued and removed at a public state park boat ramps in conjunction with a Recreational Public Health Advisory (4.4 above). A Boat Ramp Caution will be issued with a SAFETY GREEN sign (with black lettering) posted with the following language:

CAUTION
Harmful algae toxins have been found along the beach and may be present in other areas of the lake.
Avoid water that looks like spilled paint, is discolored, or has surface scums.
Avoid swallowing water and keep pets away from algae.

For more information go to *ohioalgaeinfo.com* or call 1-866-644-6224

5. Harmful Algal Bloom Public Awareness and Education

Ohio EPA, ODNR and ODH work together to educate the general public about harmful algal blooms in publicly owned recreational waters with public beaches and/or boat ramps. This education includes where harmful algal blooms have been detected, their type and water sample testing levels; potential health risks of coming into contact with them; and any public health advisories that have been issued for contaminated recreational waters (see Section 4 "Harmful Algal Bloom Advisories").

Here are the primary ways the agencies educate the general public about harmful algal blooms:

- All three agencies offer extensive harmful algal blooms information and resources on their websites, which can be accessed at
  - ***ohioalgaeinfo.com***
  - ***https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/harmful-algal-blooms/welcome-to-habs***
  - ***ohiodnr.gov/wps/portal/gov/odnr-core/divisions/parks-wc/div-parks/div-parks-wc***
- Posting of signage on state park beaches and boat ramps (see Section 4 - Harmful Algal Bloom Advisories).
- When ODNR issues a "Recreational Public Health Advisory" or a "Recreational Caution" for state park beaches signage is posted and the information is listed on the ***odh.ohio.gov/healthybeaches*** website's HAB Advisory Map.
- For state park beaches under a "Recreational Public Health Advisory" updated water sample test results are posted periodically on the ***odh.ohio.gov/healthybeaches*** website's HAB Advisory Map.

6. Glossary and Acronyms

Algal toxin (cyanotoxin): A toxin produced by cyanobacteria.

Anatoxin-a: A nerve toxin produced by a number of cyanobacteria.

Beach: Area along the shore that is a designated swimming area and is managed for public use.

BeachGuard: Website (***odh.ohio.gov/healthybeaches***) on which water quality data and recreational advisories for public beaches are listed and mapped. Bacterial advisories for recreational waters (E. coli and HAB) are listed and mapped on this site.

Biovolume: Measured and derived by associating the phytoplankton with similar geometric forms and determining the volume of these by measuring the linear dimensions required for its calculation under the microscope (Vadrucci et al. 2007).

Blue-green algae (cyanobacteria): Photosynthesizing bacteria, (see definition below).

Cyanobacteria (blue-green algae): Photosynthesizing bacteria which may produce cyanotoxins that can cause sickness and possibly death in exposed populations of humans and animals. Cyanobacteria can be present as unicellular, colonial, or filamentous organisms. Some have the ability to fix nitrogen and/or regulate their buoyancy.

Cyanotoxin (algal toxin): Toxin produced by cyanobacteria. These cyanotoxins include liver toxins, nerve toxins and skin toxins.

Cylindrospermopsin: A liver toxin produced by a number of cyanobacteria.

ELISA (Enzyme Linked Immunoassay): A rapid assessment method commonly used to detect microcystins, cylindrospermopsin, and saxitoxin.

Eutrophic: A body of water rich in mineral and organic nutrients that promote a proliferation of algae and aquatic plants, resulting in a reduction of dissolved oxygen.

HAB (Harmful Algal Bloom): A visually identified concentration of cyanobacteria that discolors the water, or a cell count greater than 4,000 cells/ml of cyanobacteria genera capable of cyanotoxin production (Shambaugh and Brines, 2003) Accumulations of cyanobacteria cells may be present at the water surface, at a defined depth, or throughout the water column.

Hypereutrophic: A body of water extremely rich in nutrients and minerals.

Microcystins: A common type of cyanotoxin that is toxic to the liver. There are more than 80 congeners (forms) of this cyanotoxin. Microcystin-LR is one of the most toxic congener.

Photic zone: The uppermost layer in a body of water into which light penetrates in sufficient amounts to influence living organisms, especially those organisms like cyanobacteria that require light for photosynthesis.

Primary recreational contact: Waters that, during the recreation season, are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking, and scuba diving.

Public lake: A lake managed by a political subdivision of the State of Ohio.

Recreational area: Water area where swimming, wading, diving, jet skiing, water skiing, tubing, wakeboarding, windsurfing, kite boarding or any other in-water activity may occur that is likely to result in immersion or ingestion of water.

Saxitoxin: A nerve toxin produced by a number of cyanobacteria.

Scum: A cyanobacteria algal bloom that has a dense surface accumulation of cyanobacteria cells.

Water column: A vertical expanse of water from the surface of a river or lake to the bottom sediments.

Acronyms

DES: Division of Environmental Services, Ohio EPA Laboratory

NASA: National Aeronautics and Space Administration

NOAA: National Oceanic and Atmospheric Administration

ODH: Ohio Department of Health

ODNR: Ohio Department of Natural Resources

Ohio EPA: Ohio Environmental Protection Agency

ORSANCO: Ohio River Valley Water Sanitation Commission

USACE: United States Army Corps of Engineers

U.S. EPA: United States Environmental Protection Agency

Appendix A –
Local HAB Response Guide

Since 2011, the State of Ohio has maintained the Harmful Algal Blooms Response Strategy for Recreational Waters. As Ohio's HAB response continues to evolve, the role and responsibility of local beach managers and local health districts has increased due to greater awareness of HABs, increased monitoring by public water systems. Additionally, the role and responsibility of local heath districts was clarified in a recent opinion by Ohio Attorney Mike DeWine, Opinion 2017-009. Pursuant to R.C. 3709.11, the health commissioner of a general health district shall inform the public of the presence of a harmful algal bloom in a river when the HAB constitutes a public health matter and has implied authority to test, or obtain testing, for HABs within or abutting the boundaries of the general health district that is accessible by the public and may inform the public of the results when it is necessary to protect the public health from a public nuisance.

The state of Ohio recommends that local health districts and beach managers follow the HAB identification and posting steps described in Section 3 and the posting of HAB advisories as described in Section 4 to help ensure consistency with messaging posting and advisory language to the public statewide. This response guide summarizes key pieces of the State's Response Strategy relevant for local HAB response and provides a quick reference tool.

How to identify a harmful algal bloom?

Potential HABs may be reported directly to local health districts or beach managers by the public or park staff, submitted as a bloom report to Ohio EPA, observed on satellite imagery and reported by Ohio EPA, ODH or another entity. Upon notification of a bloom it is important to get a visual observation to confirm the report and determine if additional monitoring steps are needed. Some types of algae are often mistaken as cyanobacteria and not all cyanobacteria produce toxins. During the site visit, it is helpful to take photos, collect an initial water sample for algae identification, and potentially grab a water sample for toxin analysis if the bloom appears to be a HAB.

How to determine if a bloom is toxic and post advisories?

If a bloom is suspected to be cyanobacteria, it is recommended to collect a water sample at the beach or recreational water and either conduct a phytoplankton identification to determine the type of cyanobacterial present, or analyze for the water sample for the most common toxins, including microcystin, cylindrospermsopsin, anatoxin-a and saxitoxin. See the Sampling and Safety Materials in Appendix B. If the phytoplankton identification determines that cyanobacteria are present that produce certain toxins (see Table 1), then ask the laboratory to test for those specific toxins. Post the blue sign while sampling results are pending. Consider posting recreational health advisories and caution signs on the state beach advisory webpage, BeachGuard.

How many samples should be collected and what is the process?

It depends on the size or type of recreational area, sampler access or resources. If it is a large beach and the bloom is only impacting a small portion, it may be helpful to sample multiple areas. Multiple grab samples from several locations can be collected and mixed together for a single composite sample. The transect procedure described in the Strategy, Appendix B provides a way to representatively sample the beach recreation zone and is preferred. However, if only a single grab sample can be collected from the bloom that is also acceptable. Regardless, it is important to document when, where and how the sample was collected. Photos of current conditions during sample collection are also very helpful.

How to interpret the results?

Cyanotoxin results should be compared to Numeric Thresholds for Cyanotoxins in the 2020 Harmful Algal Blooms Response Strategy for Recreational Waters (Section 2.3, Table 2). If the results exceed the Recreational Health Advisory level, it is recommended to post the recreational advisory (red) sign immediately and plan to conduct weekly samples until the levels drop below the threshold for two consecutive weeks and the bloom is gone. If cyanotoxins are detected but below the threshold, you should continue to conduct visual inspections of the water and if conditions worsen collect additional samples. If a bloom is visually observed it is recommended that the caution (blue) sign be posted and remain until the bloom is gone, as long as toxins are not detected at or above a recreational threshold.

When can the Recreational Health Advisory be removed?

Once you have posted a Recreational Health Advisory, weekly monitoring is recommended until the levels drop below the Recreational Health Advisory level for two consecutive weeks and the bloom is gone. If cyanotoxin concentrations drop below the Recreational Health Advisory level for two weeks and the bloom is gone, you can remove the recreational advisory (red) sign. If a bloom reappears, repost the blue Caution sign and resample for cyanotoxins. If at anytime during the weekly testing of a visually confirmed bloom shows cyanotoxin results above the Recreational Health Advisory level, the recreational advisory (red) sign should be reposted.

Reports of Illness

Individuals who are concerned that they may be experiencing HABs illness symptoms after exposure to contaminated water should contact their healthcare provider and their local health district. Healthcare providers may follow the "screen for green" tool and obtain more information on diagnosing a HAB illness at ***odh.ohio.gov/wps/portal/gov/odh/know-our-programs/harmful-algal-blooms/Information-for-Physicians/***. Healthcare providers who rule out other potential causes of the symptoms and suspect or confirm a HABs illness are advised to contact their local health district. Local health districts should complete forms for reports of human illnesses associated with either recreational or public water supply exposure to HABs toxins, and then fax completed forms to the ODH Bureau of Environmental Health and Radiation Protection secure fax: (614) 466-4556.

Pet and livestock owners who are concerned that their animal may be experiencing HABs illness symptoms after exposure to contaminated water should contact their veterinarian and the local health district. Veterinarians can use the diagnostic and treatment tools provided at ***odh.ohio.gov/wps/portal/gov/odh/know-our-programs/harmful-algal-blooms/Information-for-Veterinarians/***. Veterinarians who rule out other potential causes of the symptoms and suspect or confirm a HABs illness, should complete an animal illness report form and fax it to the ODH Bureau of Environmental Health and Radiation Protection secure fax: (614) 466-4556.

Links to forms and other public health information is available online at ***odh.ohio.gov/wps/portal/gov/odh/know-our-programs/harmful-algal-blooms/welcome-to-habs***.

Media and Outreach Materials

Communicating to the public during a HAB event can be challenging and it is important to provide consistent advice and messaging. ODH and Ohio EPA can provide technical and outreach assistance and encourage development of draft materials prior to an event. Informational brochures and other materials are available at ***ohioalgaeinfo.com.*** Information on health effects of exposure to cyanotoxins, and information for healthcare providers and veterinarians can be found at ***odh.ohio.gov/wps/portal/gov/odh/know-our-programs/harmful-algal-blooms/welcome/***

Pre-season Recommendations

- Determine staff responsible for responding to HABs.
- Review the State Response Strategy and contact Ohio EPA's Emerging Contaminants Section ifyou have any questions or would like to set up a HAB response training event.
- Contact a laboratory that provides phytoplankton identification and/or algal toxin analysis and verify prices, hours of operation, sample containers, sample preservation procedures. Be sure to inquire about weekend availability. Prepare a "grab and go" sampling kit (cooler, gloves, containers, lab paperwork and contact information) and make sure responding staff are aware of safety and sampling procedures.
- If there are waters with previous HAB problems or recreational advisories, consider posting white information signs at the start of the recreational season.
- Contact the ODH Recreation Program to set up an account to post HAB advisories on BeachGuard.

Who do I contact for assistance?

For information on health effects of HABs and reporting HAB human and animal illnesses, please contact ODH at (614) 728-9452. For information on posting advisories on BeachGuard, please contact ODH at (614) 644-7464 or toll free at 1-866-OHIO BCH (1-866-644-6224). For guidance on monitoring and general HAB questions, please contact Ohio EPA Emerging Contaminants Section at (614) 644-2752. A detailed list of contacts is provided in Appendix H of the Strategy.

Appendix B –
Sampling and Safety Materials

This sampling protocol is designed to be responsive to Algal Bloom Reports in recreational waters so that public health may be protected. It is applicable to collections by anyone who wishes to characterize phytoplankton and cyanotoxins in Ohio waters.

Safety Precautions

Safety must come first when sampling for cyanotoxins. Gloves should be worn when sampling HABs (shoulder length if collecting samples at depth). Chest waders should also be worn if collecting a cyanotoxin sample when wading off the shore to protect skin from contact with cyanotoxins. A personal floatation device should be worn if entering the water to collect a sample or sampling from a boat. Avoid inhaling spray or getting spray in eyes from boats, wind, or irrigation water from areas with harmful algal blooms. Consider wearing an N95 mask to prevent inhalation of spray if conditions promote formation of water droplets (high wind, fast moving boat).

Do not ingest or allow the water to come in contact with the skin. Always wash hands with clean, fresh water after sampling and do not touch hands to mouth, eyes, open cuts or other exposed areas of the body before washing. All equipment, gloves, and waders should be rinsed with clean (tap or bottled) water (not lake water) after a sampling event.

Sample Collection at Beaches

The following materials are needed for collecting samples at beaches: Clean PETG (polyethylene terephthalate) plastic or glass sample container(s), clean bucket, long handled spoon or stir rod, waders, floatation device, and shoulder length waterproof gloves.

The goal of beach sampling is to determine the average, representative, total microcystins concentration at the beach and determine if an advisory is necessary to help protect public health. To determine the average total microcystins concentration, samples will be collected along three beach transects, equally spaced along the beach, at ankle, knee, and hip depths (adapted from USGS, 2008). A composite sample should be collected using the following approach:

1. Label a clean sample container with the official beach name (includes lake name), current date and time.

2. Divide beach into three equally spaced transects. Try to use the same transect locations each time you sample that beach.

3. Go to first transect location and slowly wade into the water, perpendicular to the shoreline, to ankle depth. Samplers should walk slowly as not to stir bottom sediments and avoid collecting suspended sediment that may be kicked up. At ankle depth, lower the clean sample container to wrist depth (approximately 15 cm below water surface), fill the container with water, and then dump the container into a clean sampling bucket. Next, slowly wade to knee depth water, lower the same sample container to elbow depth (approximately 30 centimeters below water surface), fill the container with water, and dump the water in the bucket (combine with the previously collected sample). Slowly walk to hip depth, lower the same sample container to elbow depth and fill with water, and dump that sample into the bucket (combine with previously collected sample). Wade back to shore.

4. Repeat step 3 at the second and third transects, using the same sample container and bucket, taking care not to slosh the water collected along previously transects out of the sample bucket.

5. Mix the water in the bucket using a clean spoon or rod, fill the sample container with the mixed sample (3/4 full), and tightly cap the sample container. This is the composite sample you will submit to the laboratory for total microcystins analysis (see Appendix E for list of labs certified in Ohio EPA Method 701.0). This sample represents average conditions at the beach. If the ODNR HAB coordinator instructs you to also collect a sample for saxitoxins analysis, fill a pre-preserved 40 ml glass vial to the top of the vial (do not overfill or underfill). If the ODNR HAB coordinator also instructs you to collect a sample for phytoplankton identification, fill a third sample container and follow the preservation instructions provided by the HAB coordinator.

6. Immediately transfer the sample(s) to a dark cooler on wet ice or ice packs after sample collection. The sample(s) must be kept in the dark and on ice to preserve any cyanotoxin that may be present. If a microcystins sample will not arrive for processing at the laboratory within 5 days, the sample must be frozen in a standard freezer until it is analyzed by the lab. Ensure enough head space in the container to allow for expansion of the water when frozen to avoid breaking the bottle (3/4 full is typically fine). If a saxitoxins vial must be frozen, invert the vial three times, uncap and discard 1/3 of the sample volume, recap, and freeze the vial laying down to avoid container breakage during freezing. If a phytoplankton identification sample is collected, it should not be frozen.

7. If samples are being shipped to a lab, they must be shipped overnight (next day morning delivery) on ice to ensure the sample arrives chilled at the lab. If samples arrive to the lab warm, the lab must qualify the sample results as estimated, and may refuse to analyze the sample.

To clean sampling equipment between sampling sites (if sampling multiple beaches in one day), rinse equipment (waders, bucket, stir spoon) at least three times in water from the beach you are currently sampling, at a location away from any of your sampling transects.

The procedure for collecting both discrete grab and composite beach samples is demonstrated in an Ohio EPA training video, available on Ohio EPA's HAB website: *https://youtu.be/B2yLi1Bp0CY.*

Local beach managers may not have the supplies available to conduct composite sampling. In that case, a single grab sample from the densest part of the bloom will typically provide a worst case cyanotoxin concentration. If a scum is present, a scum sample can be collected from the scum-water surface interface. If the cause of the bloom is not known, the beach manager may collect a phytoplankton identification or molecular sample first or may sample for cyanotoxins directly. General sample collection and preservation instructions for each type of sample collection are provided below. The state recommends contacting the lab that will be analyzing the samples for further instructions.

Phytoplankton Sample Collection. Phytoplankton samples can be collected to determine the cause of the bloom. If cyanobacteria are present, the manager should use Table A1 at the end of this Appendix to determine if the bloom is capable of producing cyanotoxins, and which cyanotoxins should be analyzed.

The sampler should contact the lab that will be analyzing the samples for further instructions on containers, sample volume, and preservation guidance. Ideally, samples should be preserved at the time of collection with Lugol's iodine solution at a ratio of 1:100. To achieve a 1:100 ratio add approximately 1 ml of Lugol's solution per 100 ml of sample. Final preserved sample color should be similar to that of weak tea. Samples should be kept on wet ice and in the dark during transport. Ship for overnight delivery to the laboratory. If samples are shipped immediately after collection on wet ice, sample preservation with Lugol's iodine may not be necessary (consult lab conducting analysis). Do not freeze the phytoplankton sample - doing so will make identification difficult.

If the location of the bloom is evident (i.e. at the surface or just below the surface), collect a grab sample from the densest part of a bloom. If collecting a scum, collect a grab sample from the scum-water surface interface. Do not collect the portion of the scum that is above the water surface, as these are often dead cells that may no longer be readily identified. If the bloom is not at a distinct location, but diffuse throughout the water column, consider using a composite sampler that includes a collection for a range of depths. If you suspect the presence of benthic cyanobacteria, you can collect a sample near the lake bottom.

Molecular (qPCR) HAB Testing. Molecular testing methods are emerging as a new screening tool for HAB identification. Molecular testing can identify the presence of cyanobacteria in a water sample (16S gene) and the presence of toxin-production genes (microcystins- mcyE gene, cylindrospermopsin- cyrA gene, and saxitoxin- sxtA gene). These methods continue to evolve, with additional analysis options becoming available. These methods are unique in that they can distinguish between strains of cyanobacteria that are capable of toxin-production from those that are not (this is not possible with microscopic phytoplankton identification). However, this method cannot distinguish between live and dead cells, nor does the presence of a cyanotoxin gene equate to cyanotoxin being present in the water. The manager should contact the lab for sample collection guidance, but generally only 50 ml of water is needed and a preservative is not necessary. Samples must be shipped overnight on ice. The lab conducting the analysis will be able to provide further sampling instructions. A list of Ohio EPA certified cyanotoxin screening (qPCR) labs is included in Appendix E.

Cyanotoxin Sample Collection. The sampler should contact the lab conducting the analysis prior to sample collection, for guidance on proper sampling container, sample volume, and any required sample preservation. If a microcystins sample will be analyzed using the Ohio EPA Microcystins-ADDA ELISA method, collect at least 100 ml of sample in a glass or PETG plastic container. No sample preservative is required with this method. If the laboratory is using an alternate analysis method, the required sample volume, container type, and preservation may be different. Saxitoxins sampling may require the use of a pre-preserved sample vial.

Immediately after sample collection, transfer the sample to a dark cooler on wet ice or ice packs. The sample must be kept in the dark and cool to preserve any cyanotoxins that may be present. If a sample will not arrive for processing at the laboratory within 5 days, the sample must be frozen in a standard freezer until it is processed. Ensure enough head space in the container to allow for expansion of the water when frozen to avoid breaking the bottle.

Total cyanotoxins should be determined for recreational water sample analysis. Total cyanotoxins include both extracellular cyanotoxins, which are located outside the cyanobacteria cell wall, and intracellular cyanotoxins, which are located inside the cell wall.

If there are multiple beaches on a single lake with cyanobacteria blooms, consider sampling all beaches in the same manner as stated above, differentiating each sample location by an alternate location name. When you move to a new beach location to set up new transects, rinse the collection bucket and stirring rod three times with lake water at each location. Rinse away from the transect sampling points so as not to cross contaminate or mix the water where samples will be collected. Use a new, glass, PETG plastic, or other laboratory approved container for each different beach sampled. Make sure each sample location is identified by latitude/longitude or at least marked on a map and provided to the laboratory and kept for your records.

Table B1. Cyanobacteria and Their Associated Cyanotoxins

Cyanobacterial Genera	Hepatotoxins		Neurotoxins	
	CYLINDROSPERMOPSIN	MICROCYSTINS	ANATOXIN	SAXITOXINS
Anabaena (Dolichospermum)	x	x	x	x
Anabaenopsis		x		
Aphanizomenon (Cuspidothrix)	x	x	x	x
Aphanocapsa		x		
Arthrospira		x	x	
Chrysosporum	x			
Cylindrospermum	x		x	x
Fischerella		x		
Gloeotrichia		x		
Leptolyngbya (Plectonema)		x		
Limnothirix		x		
Lyngbya (Microseira)	x	x		x
Merismopedia		x		
Microcystis		x		
Nostoc		x		x
Oscillatoria (Planktothrix)	x	x	x	x
Phormidium (Anagnostidinema, Geitlerinema, Microcoleus)		x	x	x
Pseudanabaena		x		
Raphidiopsis (Cylindrospermopsis)	x		x	x
Scytonema		x		
Snowella		x		
Synechococcus		x		
Synechocystis		x		
Umezakia	x			
Woronichinia		x	x	

Information adapted from Jennifer Graham (USGS) with cyanotoxin production documented by Bernard et al., 2017; Chapman and Foss, 2019; Huang and Zimba, 2019.

Appendix C –
Events Shaping Ohio's HAB Strategy

Formal lake monitoring in Ohio ceased in the mid-1990s when federal funding for the Clean Lakes Program ended. In 2007, Ohio EPA participated in the National Lakes Survey which included sampling for the cyanotoxin, microcystins. This initiated the new Ohio EPA Inland Lakes Sampling Program which formally commenced in 2008.

In 2008, because of developing awareness of cyanotoxins reported in other states, Ohio EPA Division of Surface Water formed a Harmful Algal Bloom Focus Group consisting of representatives from state and federal agencies and universities. The purpose of this group was to develop a network to benchmark on HAB issues and to develop an initiative to address HABs in Ohio.

In April 2009, the results of the 2007 National Lake Survey were released, showing that more than 36% of the randomly selected 19 Ohio lakes sampled had detectable levels of microcystins. This percentage was higher than the national average. The highest concentration of microcystins detected in Ohio was at Grand Lake St. Marys. Ohio EPA sampled the water at Grand Lake St. Marys during May 2009 and determined that the microcystins level was four times higher than the World Health Organization's criterion established for recreational exposure. A water quality advisory was posted. That advisory remained in place for the entire 2009 recreational season due to persistent, high concentrations of microcystins.

In 2010, Ohio EPA, ODNR and ODH developed a three-tiered advisory system. The highest level of advisory was posted at Grand Lake St. Marys and at Cutler Lake in Blue Rock State Park where swimming, boating and fishing were discouraged. The City of Celina has continued to test their finished water. There has not been a single detection of microcystins in their finished waters since testing began in May 2009.

Also, in 2010, Ohio EPA conducted limited testing of finished water supplies along the Lake Erie Western Basin and in several inland lakes. Akron had low levels of microcystins detected in their finished water. Ohio EPA followed up with additional testing to ensure that the water supply was safe. Western Basin Lake Erie beaches were also tested; the Maumee Bay State Park Beach had microcystins levels over 25 times higher than the World Health Organization's benchmark criterion for recreational waters.

Multiple meetings were held in 2010 between Ohio EPA, ODNR and ODH and with numerous groups around Grand Lake St. Marys. A consultant hired by U.S. EPA developed recommendations for addressing nutrient cycling in the lake and nutrient input from the watershed, which was recognized as causing the HABs. Two in-lake pilot projects were conducted in the fall of 2010 to collect data and address HAB issues. The State initiated in-lake treatment in the summer of 2011 to immediately address HAB growth. In addition, ODNR designated the watershed as "distressed," and adopted rules to mitigate nutrient loading in that watershed.

Based on the State's experiences in 2009-2010, a formal Strategy was developed in June 2011 that:

- Established commonly accepted terminology;
- Developed consistent sampling methodology;
- Reviewed cyanotoxin thresholds; and
- Revised the advisory protocol.

The 2012 revisions to the Strategy include:

- Addition of a beach managers guide which is intended to be a pull-out quick reference that outlines the sample collection and advisory posting process;
- Removal of the public water supply guidance so this document can focus only on recreational waters;
- Discussion of the use of satellite imagery for tracking HABs;
- Clarification of agency roles; and
- Streamlining of the Strategy document by placing some of the details in the appendices.

The 2014 revisions to the Strategy include:

- Updates to agency administrators and contacts;
- Clarification of the protocol for posting the white general information sign;
- Removal of the Fish Consumption and Cyanotoxins Section;
- Revisions to the satellite discussion;
- Removal of guidance for in-lake sampling;
- Updates to the Ohio State Parks beach list;
- Updates to contact information; and
- Addition of an agreement between Ohio and the U.S. Army Corps of Engineers for HAB coordination and response on jointly managed lakes.

The 2015 revisions to the Strategy include:

- Updates to the contact names and phone numbers-ODH, DDAGW;
- Changes to collection containers;
- Changes to cyanotoxin processing; and
- Changes to cyanotoxin holding times.

The 2016 revisions to the Strategy include:

- Revisions to the state agency roles and responsibilities;
- Modification of the advisory terminology and signage;
- Movement of the sampling protocol and safety precautions to an appendix;
- Movement of the Beach Manager's Guide, the outreach protocols, illness report protocols and case definitions to standard operating procedures; and
- General updates to the technical content of the document.

The Strategy was not revised in 2017, 2018, and 2019.

The 2020 revisions to the Strategy include:

- Revised cyanotoxin thresholds based on new U.S. EPA guidance;
- Updated Section 4 to reflect new signage and posting strategy;
- Added new Appendix A that summarizes local response;
- Updated Appendix B to simplify sampling procedures; and
- General updates to the technical content of the document.

Appendix D –
Toxicity Review, Exposure Assumptions, and Threshold Calculations

Toxicity Review

Toxicity values for microcystins, anatoxin-a, cylindrospermopsin, and saxitoxins were selected by an interagency committee for the establishment of cyanotoxin thresholds in recreational waters. The toxicity values for the specific cyanotoxins are referred to as reference doses (RfDs), which are intended to represent a "safe" dose for humans, below which no toxic effect is to be expected. The values are expressed in milligrams per kilogram body weight per day (mg/kg-day). Safety factors are included between 3 and 1000, depending on the number, variety, and quality of the available studies. The values are derived to account for varying lengths of exposure to the cyanotoxins, including an acute exposure, which can be as short as one day, a short-term exposure, a subchronic exposure, and a chronic (or lifetime) exposure. Not all cyanotoxins have all four exposure lengths assessed, depending on the cyanotoxin-specific data available specific to the cyanotoxin.

The other exposure factors used in the calculations of the threshold concentrations in recreational waters has been updated according to the U.S. EPA's *Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermospsin* (2019). The updated incidental ingestion rate (IR) used to establish the threshold values was calculated using a combined distribution analysis of available data on liters of ingestion per hour and number of hours spent in the water per day. The 90th percentile for children six to 10 years old is 0.21 L/day incidental ingestion while recreating in fresh water (U.S. EPA, 2019) and is a conservative estimate of incidental ingestion for the most sensitive population. The updated mean body weight (BW) for a child ages 6 – 10 was also used for the BW exposure facture and is 31.8 kg. The calculation used in developing all thresholds is:

$$\text{Recrational Water Threshold } (\mu g/L) = \frac{\text{RfD x BW}}{\text{IR}} \text{ x CF}$$

Where:

RfD = cyanotoxin-specific Reference Dose (mg/kg-day)
BW = Body Weight = 31.8 kg
IR = Incidental Ingestion Rate = 0.21 L/day
CF = Conversion Factor = 1000 µg/mg

Anatoxin-a

U.S. EPA's *Health Effects Support Document for the Cyanobacteria Toxin Anatoxin-A* from 2015 was used as the basis for the anatoxin-a thresholds presented here. In summary, 7-week drinking water study in rats reported the no observed adverse effect level (NOAEL) in the study was 0.05 mg/kg-day and the lowest observed adverse effect level (LOAEL) was 0.5 mg/kg-day based on an increase in white blood cell counts over the first 5 weeks of the study. However, U.S. EPA noted that the toxicological significance of this effect is not clear. A second short term oral toxicity study reported mortality end points at two dose levels, 0.5 and 2.5 mg/kg-day, that were unexplained by the authors. Therefore; the uncertainty in the biological significance of these effects and the deficiencies in the database for anatoxin-a, U.S. EPA concluded it was not appropriate to establish a toxicity value based on these studies.

Because of the need to take regulatory action, Ohio is setting a subchronic RfD based on the 7-week drinking water rat study discussed in the U.S. EPA Health Effects Support Document because it represents the best available toxicity information for anatoxin-a. The RfD is 0.00005 mg/kg-day, based on the NOAEL of 0.05 and an uncertainty factor of 1000. The uncertainty factor includes a factor of 10 for rat to human variability, 10 for variability among humans, and 10 for database deficiencies, including limitations within the study used as the basis for the RfD, lack of reproductive studies, and lack of toxicity testing in a second species. The resulting anatoxin-a threshold in recreational waters is 8 µg/L.

Cylindrospermopsin

U.S. EPA's *Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermospsin* (2019) was used as the basis for the cylindrospermospsin threshold presented here. The RfD is 0.0001 mg/kg-day based on a NOAEL of 0.03 mg/kg-day on increased kidney weight identified at the LOAEL of 0.06 mg/kg-day from an 11-week mouse study. The RfD incorporates an uncertainty factor of 300, including a factor of 10 for mouse to human variability, 10 for variability among humans, and 3 for database deficiencies. The resulting cylindrospermopsin threshold in recreational waters is 15 µg/L.

Microcystins

U.S. EPA's *Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermospsin* (2019) was used as the basis for the subchronic microcystins RfD of 0.00005 mg/kg-day. It was derived from a 13-week mouse study that identified a lowest-observed-adverse-effect-level (LOAEL) of 50 µg/kg/day based on liver pathology, and includes an uncertainty factor of 1000, which includes a factor of 10 for mouse to human variability, 10 for variability among humans, and 3 for LOAEL to no-observed-adverse-effect-level (NOAEL) extrapolation, and 3 for uncertainties in the database. The resulting microcystins threshold in recreational waters is 8 µg/L.

Saxitoxin

To develop a saxitoxin guideline, the committee reviewed various sources. Information in the *Report of the Joint FAO/IOC/WHO ad hoc Expert Consultation on Biotoxins in Bivalve Mollusks* (2004) was identified as a critical report for saxitoxin exposure. The expert consultant reviewed several case series for about 60 individuals, ages 3 to 72, and covering some 20 incidents of poisoning between 1970 and 1990. Based on these data, 2.0 µg STXeq/kg was established as a provisional LOAEL. By applying an uncertainty factor of 3 for the conversion of the LOAEL to an acute reference dose (ARfD) for saxitoxins of 0.0007 mg/kg-day was presented.

The *European Food Safety Authority (EFSA) Marine Biotoxins in Shellfish – Saxitoxin Group: Scientific Opinion of the Panel on Contaminants in the Food Chain* (2009) was also reviewed as a critical report for saxitoxin. This EFSA scientific panel calculated a LOAEL from 500 documented reports on exposure in humans to be in the region of 1.5 µg STXs/kg. They also incorporated an uncertainty factor of 3 to convert the LOAEL to a NOAEL of 0.5 ug STXs/kg. No additional uncertainty factor was included, and the resulting ARfD for saxitoxin was 0.0005 mg/kg-day. Both sources made the same conclusion that no additional uncertainty factor for variation among humans was necessary, because the data set covered a wide variety of affected consumers, including sensitive individuals (FAP/IOC/WHO, 2004; EFSA, 2009).

When discussing a saxitoxin threshold for recreational waters in Ohio, the committee decided to use 0.5 µg STXs/kg as an estimated NOAEL (EFSA, 2009) and further apply uncertainty factors to calculate an ARfD. The committee agreed to apply an uncertainty factor of 100 which includes 10 for a lack of chronic, developmental, and reproductive studies and 10 for variability among humans. The resulting ARfD for use in calculating a saxitoxin threshold is 0.000005 mg/kg-day. The resulting threshold for saxitoxin in recreational waters is 0.8 µg/L.

Appendix E –
Laboratories Used by the State of Ohio

The most up to date list of laboratories than are certified/accepted to perform analyses can be found at:
epa.ohio.gov/Portals/28/documents/labcert/Combined-Lab-List.pdf

There are other laboratories that may perform cyanotoxin and phytoplankton analysis. Any laboratory selected must use the protocol outlined in the Strategy or other method approved by Ohio EPA.

Appendix F – Forms*

Use the Algal Bloom Report Form to submit reports of an algal bloom and/or when submitting phytoplankton and/or cyanotoxin samples to a laboratory for analysis by e-mail to ***HABMailbox@epa.ohio.gov.***

The Algal Bloom Report Form and webform version are accessible at:

https://survey123.arcgis.com/share/ac459f1f0b344bfa93c0486b028fbba6

*Cyanotoxin sample submission should be coordinated with the laboratory where the samples will be submitted.

Algal Bloom Report Form

Please provide information about the potential blue-green algae bloom observed. Information can be entered into this electronic form and saved on your computer using Word or Adobe Reader (version 9+).
Please save and email a completed copy of this form to *HABmailbox@epa.ohio.gov*.
You are encouraged to include digital photographs as additional email attachments (close-up, and landscape showing extent and location of algal bloom).
If possible, consider including an image from an online mapping application such as Google, Bing or Yahoo Maps, with a marker at the bloom location. For more information go to the ***ohioalgaeinfo.com*** website.

Algal bloom Location:

Water body:	Date bloom observed: / /
County (optional):	Drinking water source? Yes ☐ No ☐ Unknown ☐
Publicly Owned Lake? Yes ☐ No ☐ Unknown ☐	Attached map with algal bloom location noted (e.g. Google Map image)? Yes ☐ No ☐ Digital photos attached? Yes ☐ No ☐

Report Completed By:

Name:	Organization:	
Title:	Phone: ( ) - ext.	Email:

Algal Bloom Description and Sampling Information:

Please describe the location of the algal bloom in the water body (e.g. center of lake, at the boat dock, at the beach):

Do you notice any colors in the water Yes ☐ No ☐

Please check any colors you see, or describe the color(s) below: Green ☐ Blue ☐ Red ☐ Rust ☐ Brown ☐ Milky White ☐ Purple ☐ Black ☐

Please estimate the size (sq. feet) or the extent of algal bloom:

Can you see a surface scum (an accumulation at the surface) or algae floating near the watersurface?
Algae floating at the surface can look like grass clippings, green cottage cheese curds, or spilled paint. Yes ☐ No ☐ Uncertain ☐

Is the algal bloom near a public beach? If yes, please specify the beach name or location below. Yes ☐ No ☐ Unknown ☐

Is the algal bloom near a drinking water intake? (Specify water system name if known) Yes ☐ No ☐ Unknown ☐

Were samples taken? Yes ☐ No ☐

If yes, what type of samples; when and where were they collected; and where were they sent for analysis?

Do you know if other water quality information is available? (Specify what data is available and where) Yes ☐ No ☐

Appendix G – Ohio State Park Beaches

OHIO STATE PARK BEACHES

LAKE ERIE BEACHES

County	State Park	Beach	Latitude	Longitude	Acres of Water
Ashtabula	Geneva State Park		41°51'25.58"N	80°58'39.85"W	
Lake	Headlands State Pk. (East)		41°45'24.38"N	81°17'24.35"W	
	Headlands State Pk. (West)				
Erie	Kelleys Island St. Pk.		41°36'55.32"N	82°42'17.15"W	
Ottawa	Catawba Island St. Pk.		41°34'25.45"N	82°51'27.09"W	
	East Harbor State Park		41°33'32.35"N	82°48'15.52"W	
	South Bass Island St. Pk.		41°38'31.97"N	82°50'14.05"W	
Toledo/Lucas	Maumee Bay St. Pk.	Erie	41°41'8.73"N	83°22'37.05"W	
		Inland	41°41'0.40"N	83°22'38.03"W	

INLAND BEACHES

County	State Park	Beach	Latitude	Longitude	Acres of Water
Delaware	Alum Creek	Main	40°11'25.21"N	82°58'14.43"W	3,387
		Camp	40°14'8.59"N	82°58'39.94"W	
Belmont	Barkcamp		40° 2'14.78"N	81° 0'37.98"W	117
Muskingum	Blue Rock		82°58'39.94"W	81°50'56.87"W	15
Clark	Buck Creek	Main	39°56'57.79"N	83°44'7.61"W	2,120
		Camp	39°58'1.20"N	83°43'47.55"W	
Fairfield	Buckeye Lake	Crystal Beach	39°55'56.71"N	82°28'37.68"W	3,173
		Fairfield	39°55'19.34"N	82°28'14.67"W	
		Lake Brooks	39°54'5.31"N	82°30'59.82"W	
Morgan	Burr Oak	Main	39°32'7.30"N	82° 2'11.11"W	664
		Lodge	39°31'49.79"N	82° 2'10.59"W	
Warren	Caesar Creek	North	39°32'13.27"N	83°59'8.52"W	2,830
		South	39°29'16.67"N	84° 3'25.91"W	
Clinton	Cowan Lake	Main (S)	39°22'54.20"N	83°53'58.69"W	700
		Camp (N)	39°23'23.90"N	83°53'59.40"W	
Fayette	Deer Creek		39°37'9.62"N	83°13'42.78"W	1,277
Delaware	Delaware		40°22'17.88"N	83° 3'29.47"W	1,330
Muskingum	Dillon	Boaters	40° 0'54.60"N	82° 7'8.84"W	1,560
		Swimmers	40° 0'59.25"N	82° 7'9.91"W	
Clermont	East Fork	Main	39° 1'10.38"N	84° 8'3.23"W	2,610
		Camp	39° 1'20.58"N	84° 5'39.47"W	
Lorraine	Findlay		41° 8'6.45"N	82°12'51.82"W	93
Meigs	Forked Run		39° 5'39.05"N	81°46'29.84"W	102

INLAND BEACHES					
County	State Park	Beach	Latitude	Longitude	Acres of Water
Auglaize	Grn Lk St. Marys	Main East	40°32'30.02"N	84°25'19.02"W	13,500
		Main West	40°32'33.62"N	84°25'34.44"W	
		Camp	40°32'42.00"N	84°26'25.53"W	
Columbiana	Guilford Lake	Main	40°48'10.70"N	80°52'58.49"W	396
		Camp	40°48'20.45"N	80°52'37.65"W	
Fulton	Harrison Lake		41°38'23.31"N	84°21'41.83"W	105
Preble	Hueston Woods		39°34'30.51"N	84°45'20.13"W	625
Logan	Indian Lake	Fox Island	40°28'34.79"N	83°52'54.61"W	5,800
		Camp	40°30'34.95"N	83°53'46.68"W	
		Oldfield	40°30'0.97"N	83°54'41.77"W	
Jackson	Jackson Lake		38°54'6.59"N	82°35'39.13"W	242
Jefferson	Jefferson Lake		40°27'48.54"N	80°48'0.31"W	17
Champaign	Kiser Lake		40°11'4.78"N	83°57'5.05"W	396
Vinton	Lake Alma	#1-West	39° 8'54.01"N	82°30'52.50"W	60
		#2-East	39° 8'54.46"N	82°30'45.62"W	
Vinton	Lake Hope		39°19'13.88"N	82°21'21.99"W	120
Athens	Lake Logan		39°32'30.25"N	82°28'15.66"W	400
Shelby	Lake Loramie		40°21'39.87"N	84°21'25.85"W	1,655
Trumbull	Lake Milton		41° 7'20.62"N	80°58'45.10"W	1,685
Pike	Lake White		39° 5'58.49"N	83° 1'9.89"W	337
Madison	Madison Lake	(Deer Creek)	39°52'10.39"N	83°22'27.45"W	106
Trumbull	Mosquito		41°18'10.67"N	80°45'44.16"W	7,850
Ross	Paint Creek		39°14'20.80"N	83°22'15.98"W	1,190
Pike	Pike Lake		39° 9'42.15"N	83°13'11.36"W	13
Summit	Portage Lakes	Main	40°58'9.32"N	81°32'45.53"W	2,034
		Camp	40°56'19.89"N	81°31'17.44"W	
Geauga	Punderson		41°27'18.14"N	81°12'33.80"W	150
Ashtabula	Pymatuning	Main	41°36'19.16"N	80°32'10.09"W	14,000
		Camp	41°32'50.72"N	80°31'35.98"W	
		Cabins	41°34'41.98"N	80°31'57.07"W	
Highland	Rocky Fork	North	39°11'32.19"N	83°28'35.12"W	2,080
		South	39°10'57.47"N	83°28'33.99"W	
Guernsey	Salt Fork	Main	40° 5'9.25"N	81°29'36.65"W	2,952
		Camp	40° 4'27.22"N	81°29'55.52"W	
		Cabins	40° 6'30.32"N	81°32'12.79"W	
Ross	Scioto Trail		39°13'48.59"N	82°57'13.29"W	30
Scioto	Shawnee	Turkey Crk-Lodge	38°44'17.62"N	83°11'52.24"W	68
		Roosevelt-Camp	38°43'37.62"N	83°10'39.45"W	
Clermont	Stonelick		39°13'16.51"N	84° 4'39.47"W	200
Athens	Strouds Run		39°20'58.37"N	82° 2'15.31"W	161
Vinton	Tar Hollow	Main	39°23'4.35"N	82°45'5.23"W	15
		Camp	39°23'18.34"N	82°45'0.88"W	
Portage	West Branch		41° 8'16.57"N	81° 6'13.70"W	2,650
Noble	Wolf Run		39°48'2.22"N	81°31'18.16"W	220

Appendix H – 2020 HAB Contacts

Report HABs – Ohio EPA

Ohio EPA - Division of Drinking and Ground Waters
Emerging Contaminants Section
HABmailbox@epa.ohio.gov

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Columbus, OH 43215
Office (614) 644-2752
Fax (614) 644-2909

Ohio EPA DES
Kristen Sowards, DES Sample Coordinator
8955 East Main Street
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Office (614) 644-4243

Report HABs - State Park Lakes

Natalie Pirvu ***natalie.pirvu@dnr.state.oh.us***
DNR HAB Coordinator
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Report HABs – Ohio River

Greg Youngstrom ***Gregy@orsanco.org***
ORSANCO
5735 Kellogg Ave.
Cincinnati, OH 45228
Office (513) 231-7719
Fax (513) 231-7761

Report HABs - Private Lakes

Local Health Districts
See Managing Harmful Algal Blooms in Private Ponds Fact Sheet
ohioalgaeinfo.com
Also see sampling methodology and laboratory information in this document.

Advisory Notifications on BeachGuard

ODH
Bureau of Environmental Health and Radiation Protection, Recreation Program
Mary Shaffer
Office (614) 466-1390 or (614) 466-6736
Mary.Shaffer@odh.ohio.gov

Gene Phillips
Chief, Bureau of Environmental Health and Radiation Protection
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Health Effects of HAB Exposures and Reporting of Human and Animal Illness Reports

ODH, Bureau of Environmental Health and Radiation Protection
Bryce Kerr (614) 728-4160
Danielle Kohan (614) 387-5703

A listing of local health departments can be found at: ***https://odh.ohio.gov/wps/portal/gov/odh/find-local-health-districts***

Appendix I – Ohio/U.S. Army Corps of Engineers Agreement and Points of Contact

Cooperation Between Ohio And The U.S. Army Corps of Engineers To Address HABs In Ohio

Introduction

Since 2009 three agencies for the State of Ohio have worked collaboratively to develop a Statewide Response Strategy for responding to Harmful Algal Blooms (HABs) observed in recreational lakes in Ohio. The response strategy is based on relative risk assessment for recreational users. Risk is high for recreational users in calm, shallow areas where prolonged, whole-body contact with water containing HABs and the cyanotoxins they can produce is found and where a high likelihood of ingestion is present. Open water recreation is a lower risk when compared with swimming at a beach.

The Ohio response strategy focuses on swimming beaches as the areas where the risk is the greatest for a threat to human health. The strategy includes monitoring for cyanotoxins and provides a framework for decision making about health advisory communication at beaches and at other locations around an affected lake.

Ohio is committed to the continued operation under the statewide strategy. Local, municipal and other agencies are all encouraged to follow this strategy when HABs are observed in recreational waters. In support of this effort to have all agencies follow the same protocol, the State of Ohio and the U.S. Army Corps of Engineers will work cooperatively as follows:

For USACE Projects Co-Located with ODNR

- If a bloom in the open lake is observed by USACE, that information will be communicated to the park staff and reported to the Ohio EPA
- If a HAB is observed, ODNR will sample and monitor according to the Ohio Statewide Response Strategy for HABs in Recreational Waters.
- When a cyanotoxin threshold is exceeded at a beach, the appropriate advisory will be posted only at beaches.
- White general information signs will remain posted at all major access points to the water according to the sign plan for each location.
- Any data from routine open water samples collected by USACE will be used to build the body of knowledge about HABs.

For USACE Projects Not Co-Located with ODNR

- If a HAB is observed and the USACE or other third party co-located at the project sample and monitor, they will do so in accordance with the Ohio Statewide Response Strategy for HABs in Recreational Waters.
- Analytical results will be shared with state and local agencies in order for those agencies to determine what action, if any, is called for in accordance with the statewide strategy.
- Samples may be submitted to Ohio EPA's lab for analysis and for long term data housing.

U.S. Army Corps of Engineers District POCs and Reservoir Park Managers at Projects Co-owned with ODNR

Louisville District POC:
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Louisville District Reservoir Park Managers:

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Huntington District Reservoir Park Managers:

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Deer Creek Lake
Bonnie Maki

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Dillon Lake
Will Rutter
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Tom Jenkins Dam (Burr Oak State Park)
Will Rutter
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Paint Creek Lake
T.J. Milnes
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Pittsburgh District POC:

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Pittsburgh District Reservoir Park Managers:

Mosquito Creek Lake
Bill Spring
(330) 637-1961

Michael J. Kirwan Lake (West Branch State Park
Doug Krider
(330) 358-2622

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