

Harmful Algal Blooms (HABs) Dashboard User Guide

Bureau of Epidemiology,
Division of Environmental
Health Epidemiology

July 2023



pennsylvania
DEPARTMENT OF HEALTH

Table of Contents

Table of Contents	1
Glossary	3
Background	4
Methods	5
Dashboard Components	7
Using the Dashboard	17
Citations	23

Glossary

CDC: Centers for Disease Control and Prevention

DCNR: Department of Conservation and Natural Resources

DEHE: Division of Environmental Health Epidemiology (PA DOH)

DEP: Department of Environmental Protection

EHC: Environmental Health Capacity grant

HAB: Harmful algal bloom

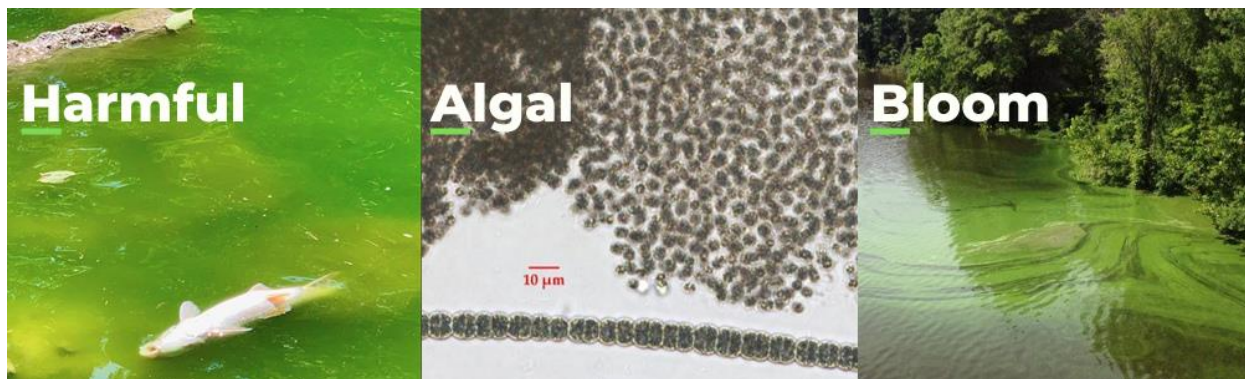
PA DOH: Pennsylvania Department of Health

US EPA: United States Environmental Protection Agency

WHO: World Health Organization

Background

The Division of Environmental Health Epidemiology (DEHE) at the Pennsylvania Department of Health (PA DOH) has developed an interactive dashboard providing the latest available information on harmful algal blooms (HABs) in PA. With funding from the Centers for Disease Control and Prevention's (CDC) Environmental Health Capacity (EHC) grant, DEHE strives to make environmental health-related data more publicly accessible. Intended to be updated in (near) real time, the HAB dashboard will be used by DEHE, its partners, and the public to increase awareness of harmful conditions posed by HABs at state-managed waterbodies and private beaches. The dashboard will also facilitate information exchange between government agencies and non-governmental organizations to support and assist in designing evidence-based interventions to mitigate human and animal health risks posed by HABs.



Harmful: HABs **produce toxins**, known as cyanotoxins, and other chemical compounds that can harm people and animals.

Algal: HABs are made up of **microscopic organisms known as cyanobacteria** or “blue-green algae.”

Bloom: HABs occur when cyanobacteria undergo a **period of rapid growth** in a waterbody or waterway, often associated with abundant nutrients, water temperatures, and calm water.

The HAB dashboard is an activity under the CDC-funded grant: Strengthening environmental health capacity to detect, prevent, and control environmental health hazards through data-driven, evidence-based approaches. Contributing to the EHC grant's overarching objective, the HAB dashboard aims to offer a publicly accessible, comprehensive, and interactive display of information on the location of HABs, microbe/toxin levels, and advised response levels to support decision-making by those using Pennsylvania waterbodies and HABs stakeholders.

The incidence of HABs is likely to increase with climate change as research has demonstrated increased cyanobacteria growth with warmer temperatures.^{1,2,3} As potentially more people use beaches as a source of outdoor recreation for a longer period of the year due to extended warmer weather, the environmental health hazard posed by HABs is expected to become more severe. Thus, the HAB dashboard provides a source of information on one aspect of waterbody quality by reporting harmful toxin levels to the public to assist in protecting their health and welfare.

Methods

The dashboard integrates field data and laboratory test data as soon as they become available (approximately within a week of testing).

Field data: HAB field data are entered using *Survey123* software in the ArcGIS online platform by field staff collecting water samples for HAB testing. Trained Commonwealth staff and other trained staff from volunteer groups are the only ones with access to the Survey123 software. Overseeing agencies are the Pennsylvania Department of Environmental Protection (DEP)'s Bureau of Clean Water and the Pennsylvania Department of Conservation and Natural Resources (DCNR). Field data presented in the dashboard include date and time of sample collection, sample collection location (latitude and longitude), and name of the waterbody.

Laboratory test data: HAB laboratory data are sent to DEP by the laboratories (DEP Bureau of Laboratories and GreenWater Laboratories [FL]) performing the cyanobacteria colony count and toxin tests. The laboratory test data are then merged with the field data to populate the HAB dashboard. HAB response levels (discussed in detail below) are based on cyanobacteria colony counts in natural units, and/or elevated toxin levels following the recommendations of the PA interagency HAB task force which follows guidelines set by the United States Environmental Protection Agency (US EPA), the state of Ohio, and the World Health Organization (WHO).^{4,5,6,7,8} Variables added to the dashboard from the lab data include the following: cyanobacteria natural units, and toxin levels for microcystin, saxitoxin, anatoxin-a, and cylindrospermopsin.

Response Levels:

Waterbody response levels based on cyanobacteria natural units and toxin thresholds established by the PA interagency HAB task force at the time of the creation of this dashboard are outlined below. These responses are specific to a sampling event. Due to the nature of what is currently known about HABs there is variability on what thresholds should be used. The HAB dashboard as well as this document will be updated if and when new thresholds are adopted. Users should note that the threshold guidelines are intended for advising risk mitigation in relation to swimming, which has higher water exposure than other activities.

Table 1. Public Health Advisories for Cyanobacteria Toxin Levels (in µg/L)

Response Level	Microcystin	Cylindrospermopsin	Anatoxin-a (provisional)	Saxitoxin (provisional)
Advisory (Yellow)	Detect - <8 µg/L ¹	Detect - <15 µg/L ¹	Detect - <15 µg/L ^{1,2}	Detect - <8 µg/L ^{1,3}
Avoid Contact (Red)	>=8 µg/L ¹	>=15 µg/L ¹	>=15 µg/L ^{1,2}	>=8 µg/L ^{1,3}

¹ EPA, 2019. Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin.

² Fawell et al. 1999. The toxicity of cyanobacterial toxins in the mouse: II anatoxin-a. *Hum Exp Toxicol.* 18(3):168-73.

³ EFSA, 2009. European Food Safety Authority (EFSA) Marine Biotoxins in Shellfish – Saxitoxin Group: Scientific Opinion of the Panel on Contaminants in the Food Chain.

Provisional values have been provided by the PA Harmful Algal Bloom Taskforce in the absence of federal guideline values. There is a limited number of toxicological studies on these cyanotoxins. Therefore, PA Harmful Algal Bloom Taskforce may update or revise the values as more research becomes available.

Table 2. Public Health Advisories for Cyanobacteria (in natural units/mL)

Response Level	Cyanobacteria Density
Advisory (Yellow)	300 Natural units per milliliter (mL) ^{1,4,5,6}
Avoid Contact (Red)	1,500 Natural units per milliliter (mL) ^{1,4,5,6}

⁴. [WHO] World Health Organization, 2003. Guidelines for safe recreational water environments. Volume 1 Coastal and Fresh Waters.

⁵. [WHO] World Health Organization, 2021. Guidelines on recreational water quality. Volume 1: coastal and fresh waters. Geneva: World Health Organization.

⁶. There is limited evidence for specific cyanobacteria-based threshold; however, there is a low probability of adverse health effects at exposures in this advisory level.

Watch Status:

Note: Watch status is NOT currently displayed on the dashboard.

The following table provides the criteria for a ‘Watch’ status as currently recognized by the HAB task force. Please note that a watch is based on observation and/or historical HAB events. It is not based on current laboratory data. This information is not reflected in the HAB dashboard due to its current imprecise definition and information for earlier years being unavailable. The watch status definition is provided here for reference only. The HAB task force is currently revising, and refining definitions and this document will be updated as definitions are adopted.

Table 3. Criteria for Watch Status

Response Level	Criteria
Watch	Recommended for waterbodies that have experienced HAB events and/or conditions that favor HAB events. Can include visual observation that would prompt sample collection and laboratory testing. *

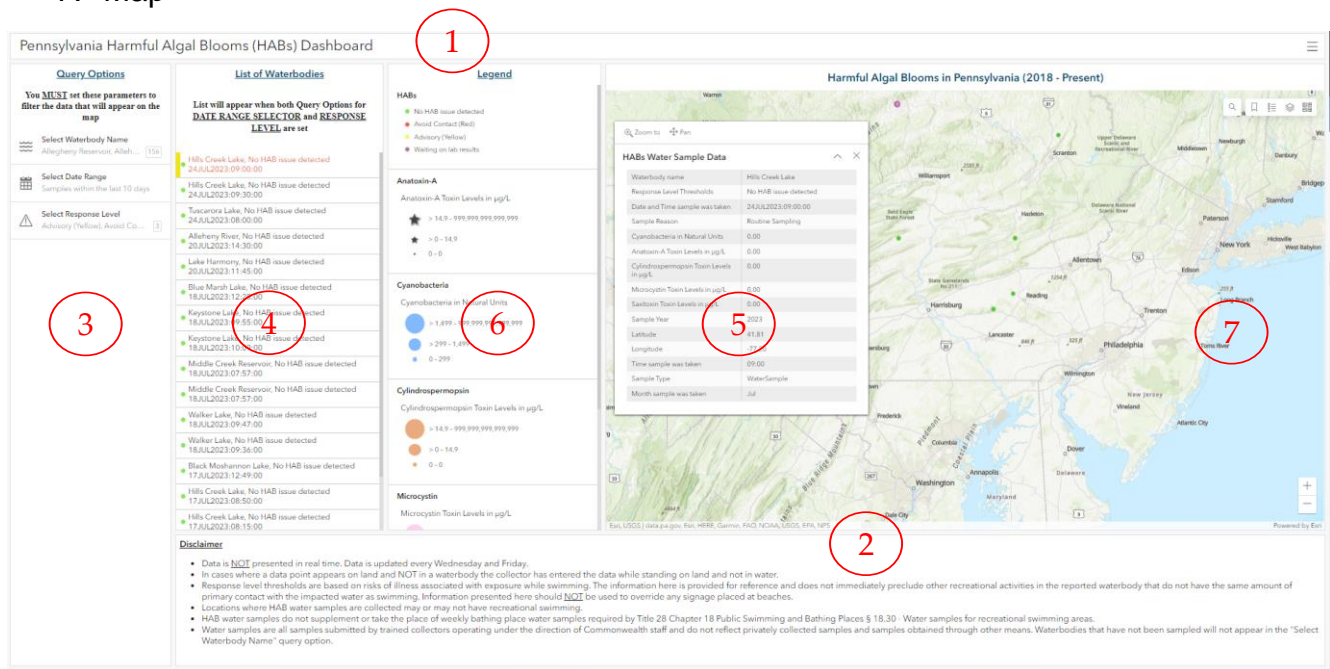
*Office of Water Programs, DEP

Dashboard Components

The following description provides details about each component in the HAB dashboard. Screenshots from the ArcGIS Online dashboard web application are included. Please direct questions to dehe@pa.gov.

The dashboard contains the following seven components which are covered in more detail below.

1. Title
2. Disclaimer
3. Query Options
4. List of Waterbodies
5. Water Sample Data Pop-Up
6. Legend
7. Map



1. Title: Provides description of the dashboard.

2. Disclaimer: Describes nuances about the data source and how samples were collected.

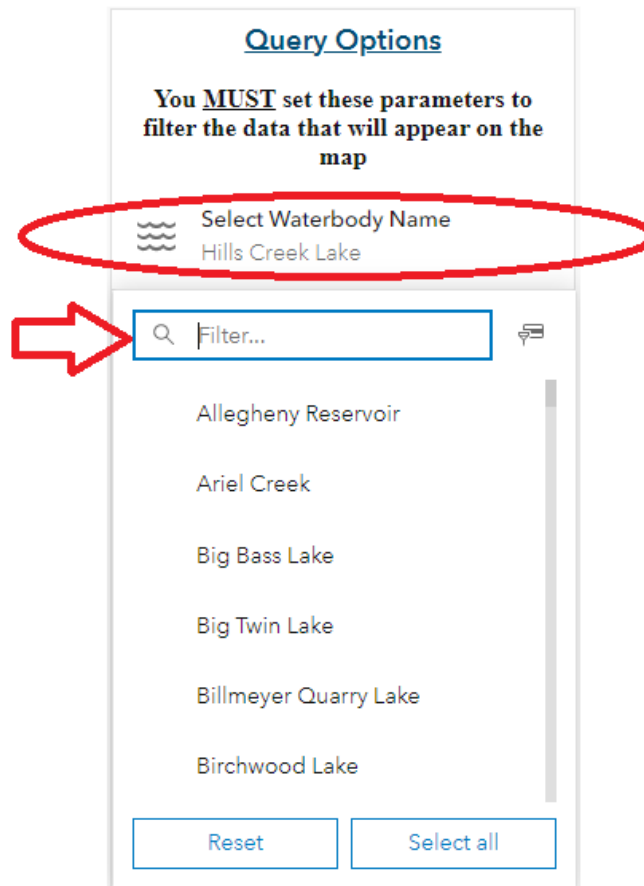
3. Query Options: All query options **MUST** be set for points to appear on the map. There are the following three query options:

- Select Waterbody Name
- Select Date Range
- Select Response Level

Note that all query options need to have values selected to render points on the map. The query options filter the data so that only points corresponding to the parameters set by query options appear on the map.

The **Select Waterbody Name** query option lets the user search for the name of a waterbody to filter records according to waterbody name.

Click on the “Select Waterbody Name” option and filter your selection by scrolling down on the list and clicking on the desired entry or entries, or by typing in the text box next to the magnifying glass icon.



The **Select Date Range** allows the user to select the time range of HAB samples to view on the map and waterbody list. There are two date options, “Predefined” and “Select Other Dates.” To view the predefined options, click on the “Predefined” option under the Select Date Range tool and select from the following date ranges: Samples within the last 10 days, Samples within the last year, Samples within the last month, or All samples recorded before now. “Samples within the last 10 days” is selected by default.

The image shows a 'Query Options' panel with the following content:

- Query Options**
- You MUST set these parameters to filter the data that will appear on the map**
- Select Waterbody Name**
Hills Creek Lake
- Select Date Range**
Samples within the last 10 days
- Predefined** | Select Other Dates
- Samples within the last 10 days
- Samples within the last year
- Samples within the last month
- All Samples recorded before now
- Reset

Red annotations highlight the 'Predefined' tab and the 'Samples within the last 10 days' option, with a red arrow pointing to the 'Select Date Range' label.

To view other dates, click on the “Select Other Dates” option within the tool and select or type the desired date range. Displayed in the screenshots below is a selection for the entire month of August 2021. The selection is obtained by entering August 1, 2021, through August 31, 2021, in the “Select Other Dates” tab.

Query Options

You **MUST** set these parameters to filter the data that will appear on the map

Select Waterbody Name
No category selected

Select Date Range
8/1/2021 - 8/31/2021

Predefined **Select Other Dates**

From
08/01/2021

Until
08/31/2021

<< < August 2021 > >>

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

Reset Today

The **Select Response Level** query option has three categories the user can filter by:

- “No HAB issue detected” (in green)
- “Advisory (Yellow)” (in yellow)
- “Avoid Contact (Red)” (in red)

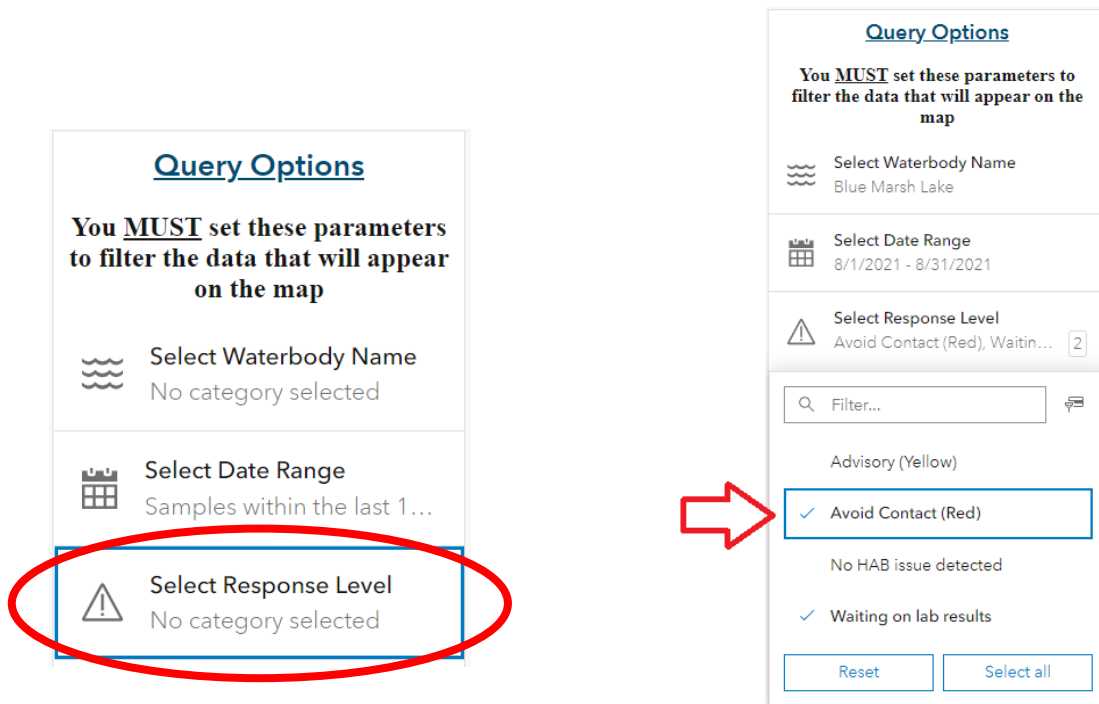
“Avoid Contact (Red)” denotes tested water samples that designate cyanobacteria natural units or toxin levels that are potentially harmful as defined above. At the Avoid Contact Red level the water should not be touched, pets should not be allowed in the water and people should avoid boating or other activities in discolored or scummy water.

“Advisory (Yellow)” indicates that cyanobacteria that could potentially create toxins was detected but a potentially harmful level of toxin was not found. Humans and animals should not drink the water and any activity in the water including but not limited to boating and swimming should be done with caution. Contact with discolored water or scum should be avoided.

“No HAB issue detected” indicates that no laboratory data conducted on the sample for the species of cyanobacteria surpassed a threshold value requiring a response. Humans and pets should not drink the water and areas with the following appearance should be avoided: paint-like streaks of algae in the water, scum or areas with green, blue, brown, gold or red colors in, on or near the water’s edge.

“Waiting on lab results” indicates that lab results are not currently available for a record, but it is anticipated that the record will have lab results, typically within the next week or two.

Click on the desired response level categories to filter observations on the map and waterbody list by response level.



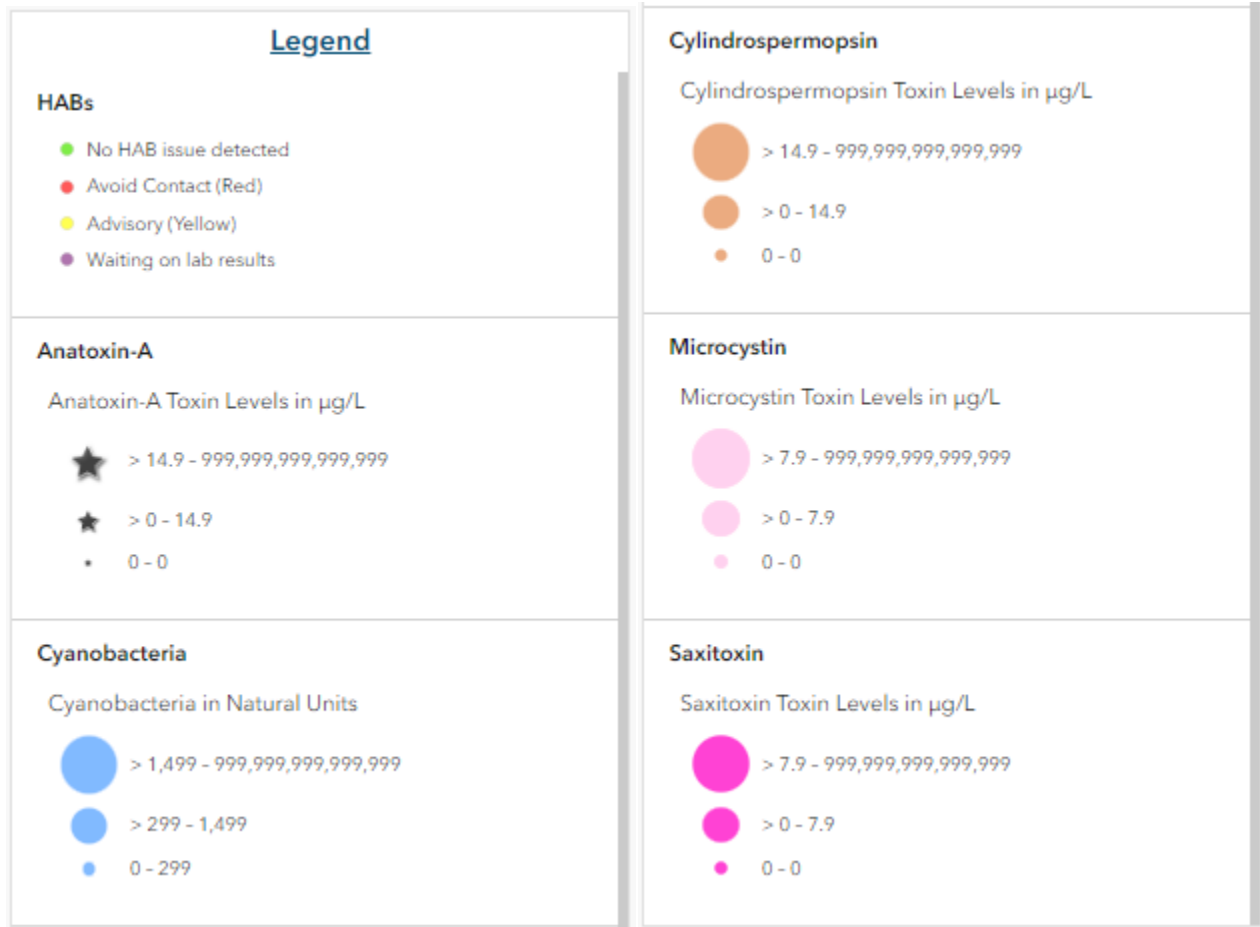
4. List of Waterbodies: This section only populates when query options for the “Select Date Range” and “Select Response Level” are selected. When populated, entries in the list display the waterbody name, response level category, and the date and time the sample was taken. Users can click on multiple records in the list to highlight select records. Here the first three entries are highlighted for the waterbody Hills Creek Lake. On the map a pop-up summary window will appear and the point on the map will flash briefly. If multiple entries are selected, an arrow will appear in the top right-hand corner of the pop-up window to allow the user to scroll through the records.

<u>List of Waterbodies</u>	
List will appear when both Query Options for <u>DATE RANGE SELECTOR</u> and <u>RESPONSE LEVEL</u> are set	
●	Hills Creek Lake, No HAB issue detected 24JUL2023:09:00:00
●	Hills Creek Lake, No HAB issue detected 24JUL2023:09:30:00
●	Tuscarora Lake, No HAB issue detected 24JUL2023:08:00:00
●	Alleheny River, No HAB issue detected 20JUL2023:14:30:00
●	Lake Harmony, No HAB issue detected 20JUL2023:11:45:00
●	Blue Marsh Lake, No HAB issue detected 18JUL2023:12:28:00
●	Keystone Lake, No HAB issue detected 18JUL2023:09:55:00
●	Keystone Lake, No HAB issue detected 18JUL2023:10:09:00
●	Middle Creek Reservoir, No HAB issue detected 18JUL2023:07:57:00
●	Middle Creek Reservoir, No HAB issue detected 18JUL2023:07:57:00
●	Walker Lake, No HAB issue detected 18JUL2023:09:47:00
●	Walker Lake, No HAB issue detected 18JUL2023:09:36:00
●	Black Moshannon Lake, No HAB issue detected 17JUL2023:12:49:00
●	Hills Creek Lake, No HAB issue detected 17JUL2023:08:50:00
●	Hills Creek Lake, No HAB issue detected 17JUL2023:08:15:00

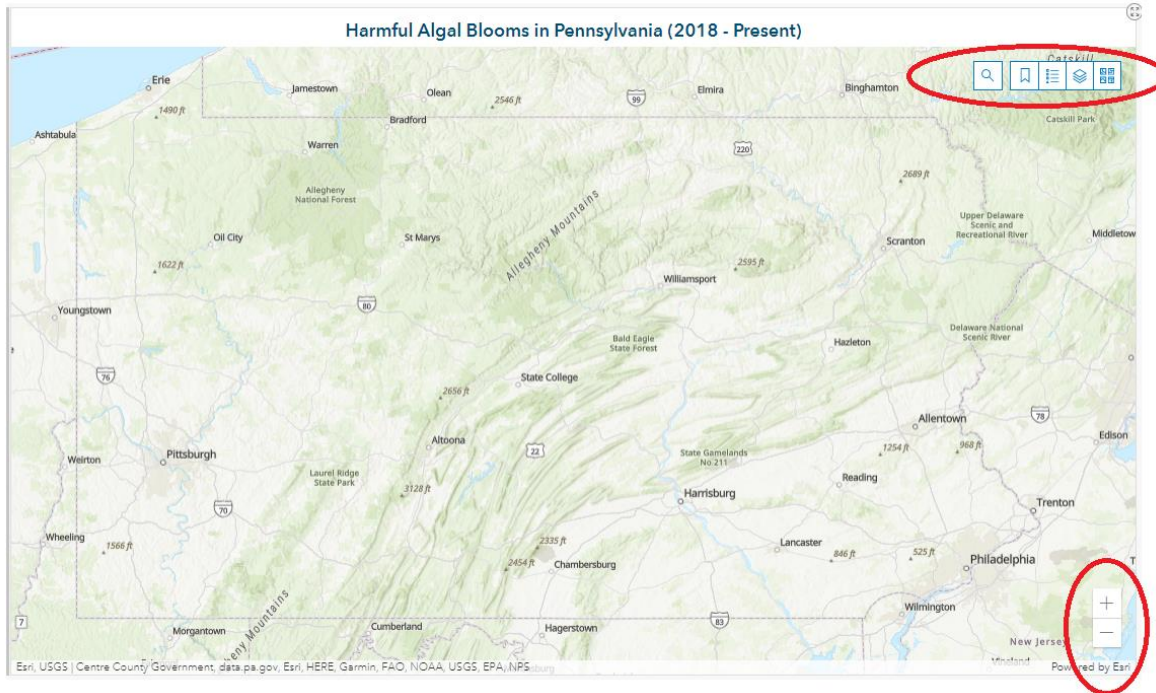
5. Water Sample Data Pop-Up: A pop-up will appear if a user clicks on an individual water sample point on the map or from the list. This pop-up provides information on the specific water sample, including: waterbody where the sample was collected, if the sample exceeded any response level thresholds, the date and time when the sample was collected, the reason for the sampling, and specific laboratory data for each of the toxins available. There are two entries highlighted in yellow in the List of Waterbodies for ‘Hills Creek Lake’ in the image below.

The resulting pop-up of this selection has a scroll function at the top right-hand corner. On the pop-up users can click on the arrows to scroll through these selected entries and review detailed data for each sample. Any number of samples can be selected on the List of Waterbodies or by clicking points on the map to render these pop-ups.

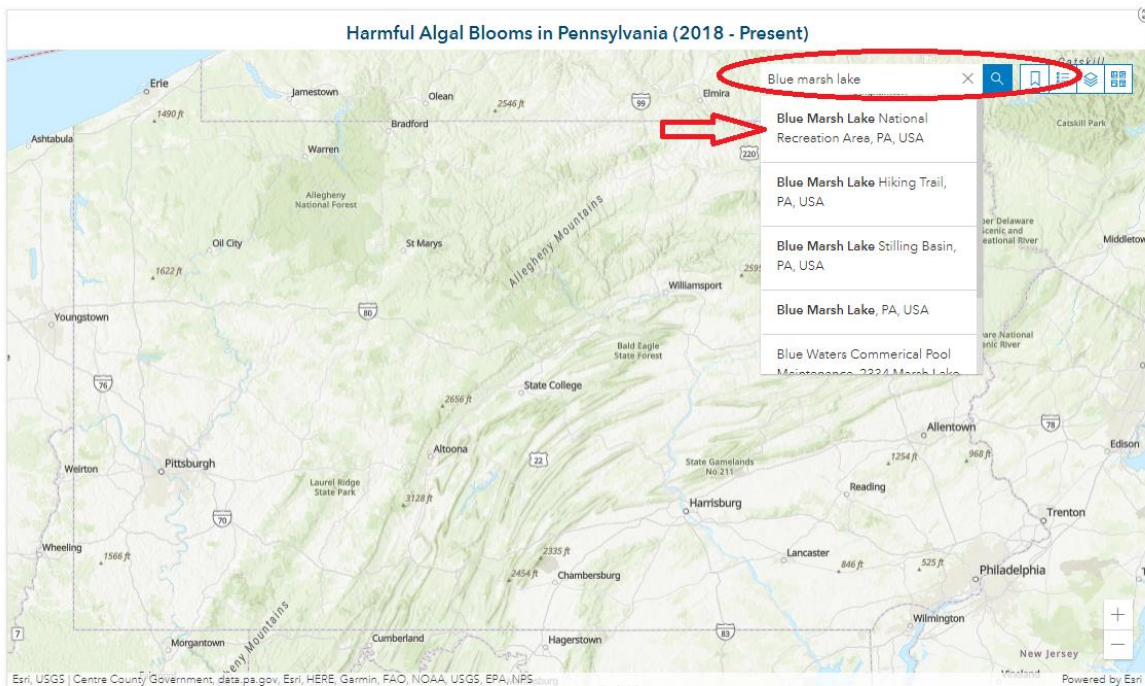
6. Legend: Provides a visual overview of how the data is displayed on the map. Response levels are categorized by color. For the cyanobacteria natural units and toxin levels the size of the symbol corresponds to magnitude, i.e., larger points indicate greater amounts of bacteria colonies/(natural units) or toxin level.



7. Map: The map contains 5 tools at the top right-hand corner of the map and the zoom tool at the bottom right-hand corner of the map. These tools are described below.



Search: Click on the search icon to search for a specific waterbody by typing the waterbody name into the text box and click on the desired entry in the drop-down list that appears.





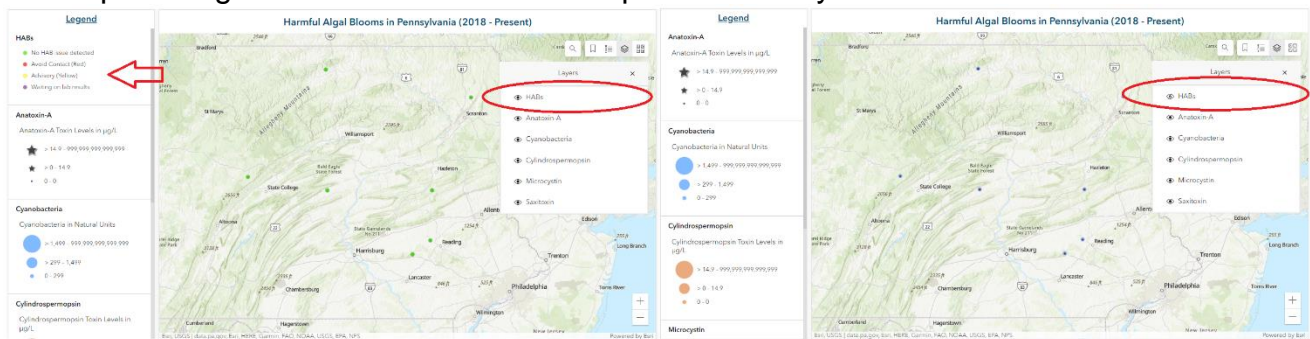
Bookmark: Click on the bookmark icon to open a list of bookmarks. Clicking on a bookmark in the list automatically zooms to that view. The only bookmark currently is the “Pennsylvania State” bookmark which zooms out to view the entire state.



Legend: Clicking on the legend icon brings up a pop-up of the same legend already docked to the left of the map.



Layers: Clicking on the layers icon allows users to hide or unhide layers of the map. This affects what variables are shown in the legend and on the map. The layers of this map are the response levels (layer name “HABS”), and the cyanobacteria natural units and toxin levels. The icon of an eye without a cross bar indicates the layer is turned on and visible on the map and legend. When the cross bar is present the layer is off.



Basemap Gallery: Click on the basemap gallery to choose from a variety of alternative basemaps (e.g., topographic, imagery, terrain) for desired background. The topographic map is the default.

The last tool on the map is the zoom tool located on the bottom right hand corner of the map.

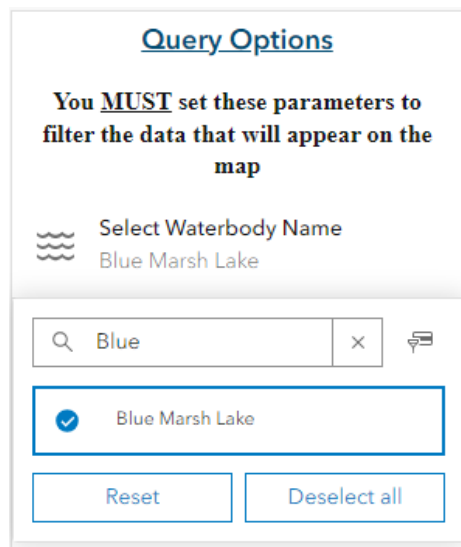


Clicking on the + and – signs at the bottom right corner of the map zooms the map in or out and changes the scale. This can also be done by scrolling with the mouse wheel or touchpad mouse on a device.

Using the Dashboard

Example: Determine whether Blue Marsh Lake had an “Avoid Contact (Red)” or “Advisory (Yellow)” response level in the month of August 2021.

1. First use **Query Options** described in item 3 in the Dashboard tools above. Navigate to the “Select Waterbody Name” query option and type “Blue” in the text field to render a drop-down list of all waterbodies containing the word “Blue” and select “Blue Marsh Lake”



Query Options

You **MUST** set these parameters to filter the data that will appear on the map

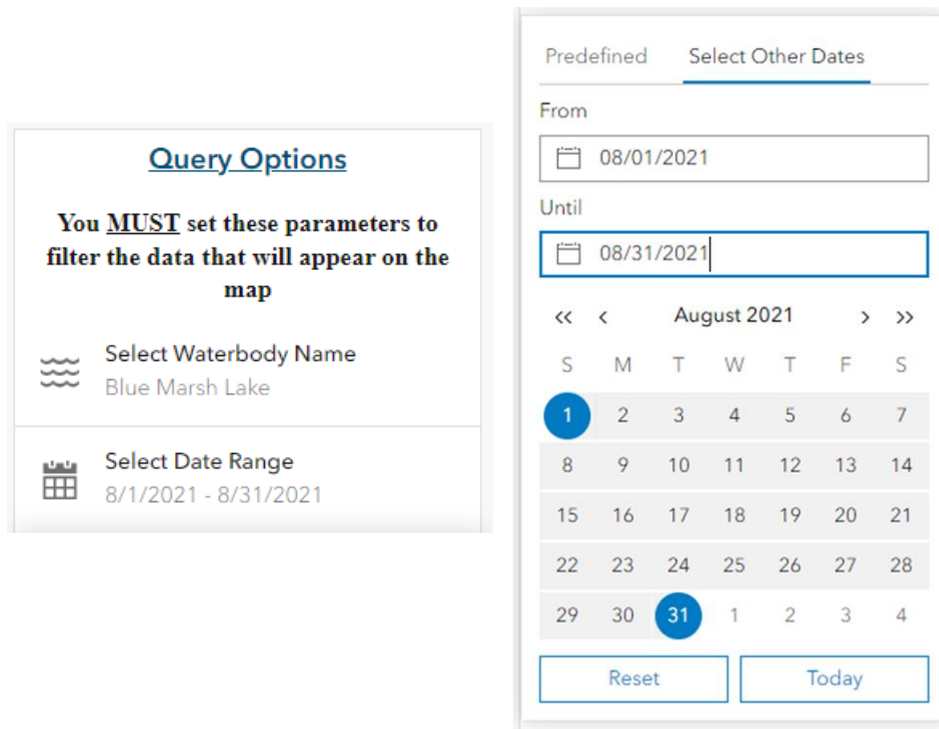
Select Waterbody Name
Blue Marsh Lake

Search: Blue

Selected: Blue Marsh Lake

Buttons: Reset, Deselect all

2. Next, go to **Select Date Range** → **Select Other Dates** → Place the cursor in the “From” box and type or click on “08/01/2021” and in the “Until” box click or type “08/31/2021” to designate the period of interest.



Query Options

You **MUST** set these parameters to filter the data that will appear on the map

Select Waterbody Name
Blue Marsh Lake

Select Date Range
8/1/2021 - 8/31/2021

Predefined | **Select Other Dates**

From: 08/01/2021

Until: 08/31/2021

Calendar: August 2021


S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

Buttons: Reset, Today


- To display samples with a “Avoid Contact (Red)” or “Advisory (Yellow)” status, click on the corresponding options in the drop-down list under **Select Response Level**. A blue check mark will appear to the left of the corresponding selected response level(s) and the List of Waterbodies will populate.

Query Options


You MUST set these parameters to filter the data that will appear on the map



Select Waterbody Name
Blue Marsh Lake



Select Date Range
8/1/2021 - 8/31/2021



Select Response Level
Advisory (Yellow), Avoid Con... 2

Advisory (Yellow)

Avoid Contact (Red)

No HAB issue detected

Reset
Select all

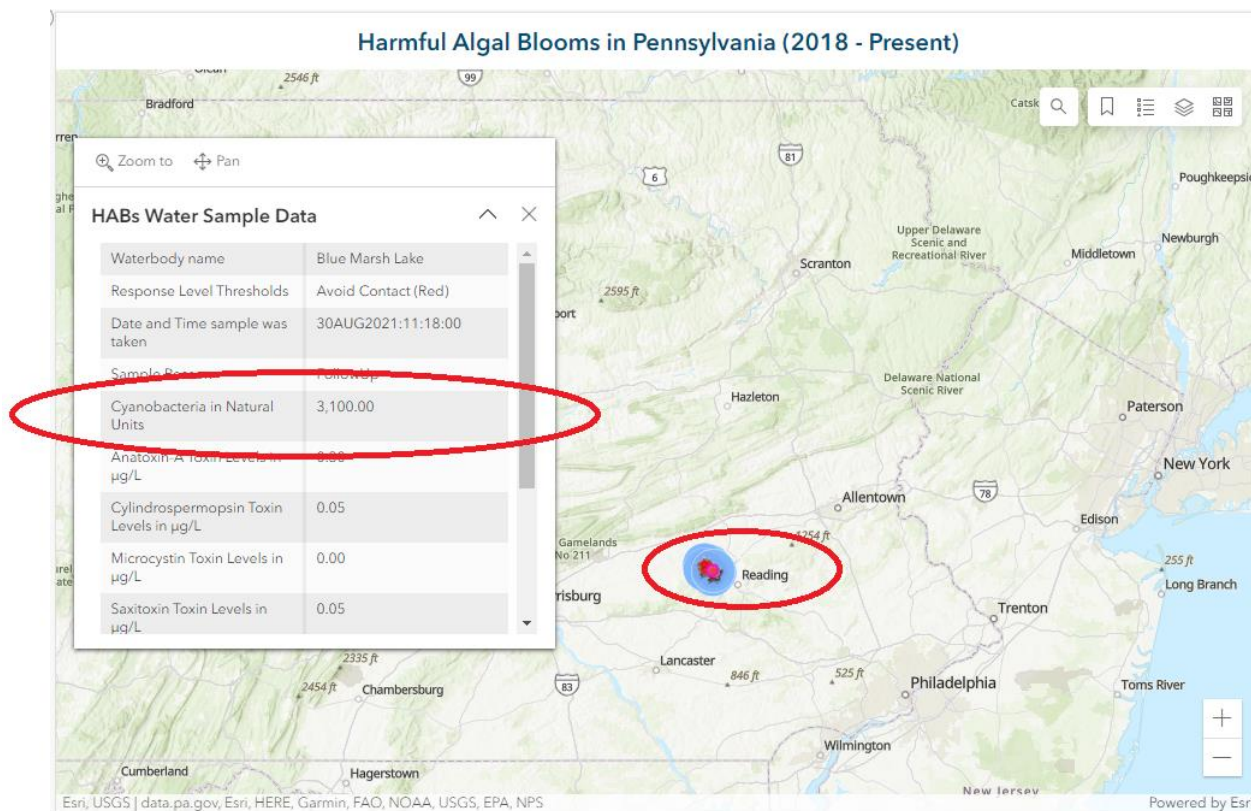
List of Waterbodies

List will appear when both Query Options for DATE RANGE SELECTOR and RESPONSE LEVEL are set

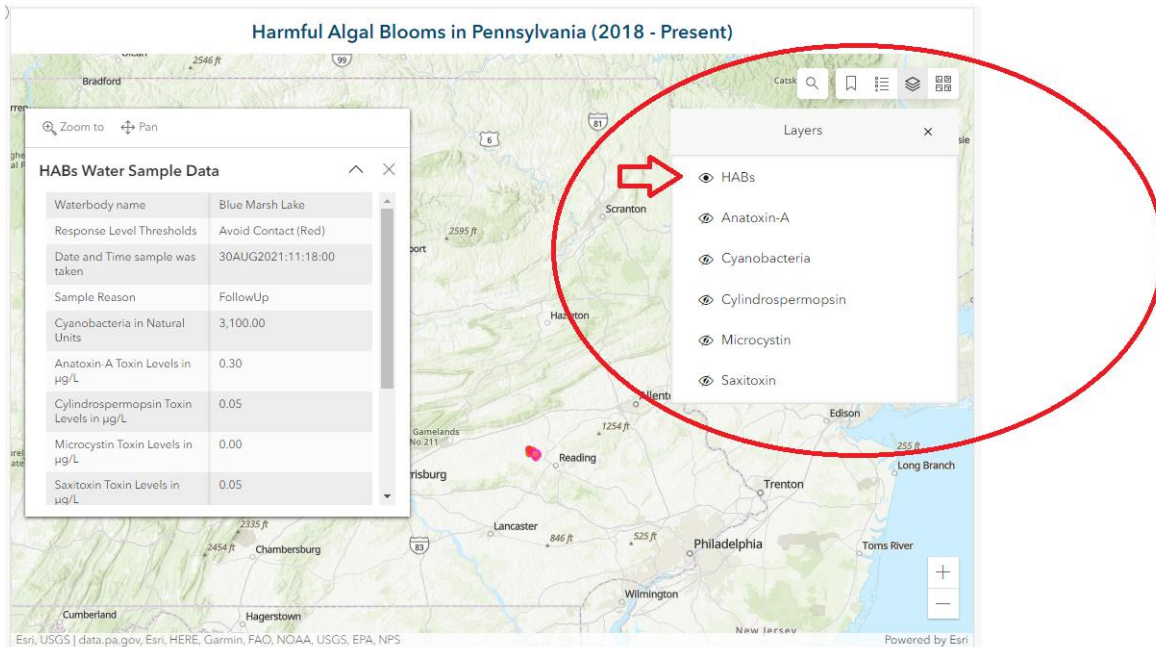
- Blue Marsh Lake, Avoid Contact (Red)
30AUG2021:11:18:00
- Blue Marsh Lake, Avoid Contact (Red)
30AUG2021:11:32:00
- Blue Marsh Lake, Avoid Contact (Red)
25AUG2021:20:19:00
- Blue Marsh Lake, Avoid Contact (Red)
25AUG2021:20:24:00
- Blue Marsh Lake, Avoid Contact (Red)
22AUG2021:14:11:00
- Blue Marsh Lake, Avoid Contact (Red)
22AUG2021:14:34:00
- Blue Marsh Lake, Avoid Contact (Red)
22AUG2021:15:06:00
- Blue Marsh Lake, Avoid Contact (Red)
22AUG2021:15:13:00
- Blue Marsh Lake, Avoid Contact (Red)
22AUG2021:12:25:00
- Blue Marsh Lake, Avoid Contact (Red)
22AUG2021:12:31:00
- Blue Marsh Lake, Avoid Contact (Red)

4. After zooming in, users can click on the red and yellow dots representing unique samples to see pop-ups with specific data on cyanobacteria natural units' count and toxin levels. In the screenshot below, the pop-up shows the number of natural units of cyanobacteria is high, 3,100.00 and meets the threshold criterion for the "Avoid Contact (Red)" response level, while the other toxin levels are beneath that response level threshold. Therefore, the high cyanobacteria count is the agent responsible for the Avoid Contact (Red) response level in this sample. Other samples can be selected, and the pop-ups reviewed in this manner. Additionally, we can see that the cyanobacteria symbols are predominating. We can further refine our view by turning on and off different map layers.

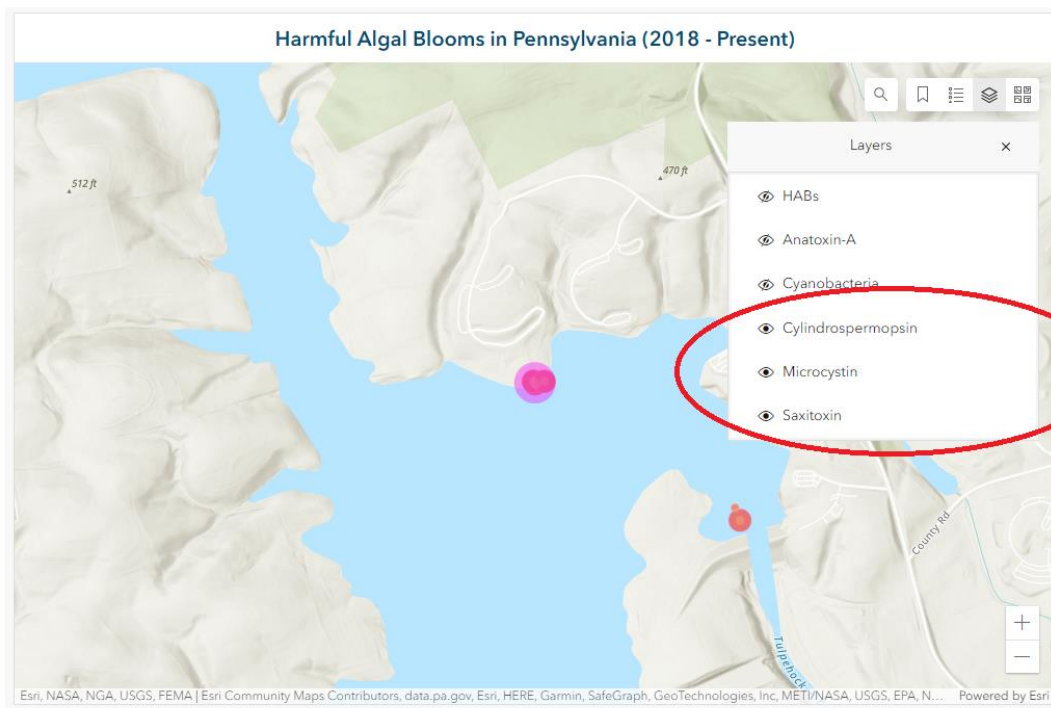
All layers are turned on in this screen shot.



Here is the same screen shot with only the HABs layer turned on so only the response level is visible.



Here is a zoomed in screen shot of this sample with the first three layers turned off. Clicking off each layer one by one to see the layer beneath allows the user to see the other cyanobacteria toxins levels are the smallest symbols and it becomes clear that HAB events in Blue Marsh Lake were due to high Cyanobacteria counts and not high amounts of the other toxins in the samples tested within the month of August 2021. Using the technique of turning on and off layers allows the user to see this without reviewing all the sample's pop-up information.



Citations

1. Jeppesen E, Kronvang B, Meerhoff M, et al. Climate change effects on runoff, catchment phosphorus loading and lake ecological state, and potential adaptations. *J Environ Qual*. 2009; 38(5): 1930-1941.
2. Coles JF and Jones RC. Effect of temperature on photosynthesis-light response and growth of four phytoplankton species isolated from a tidal freshwater river. *Journal of Phycology*. 2000; 36:(1): 7–16.
3. Kosten S, Huszar VLM, Bécares E, et al. Warmer climates boost cyanobacterial dominance in shallow lakes. *Global Change Biology*. 2012; 18(1), 118-126.
4. Ross DP. Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin. Federal Register. The Daily Journal of the United States Government. Published June 6, 2019. Accessed December 3, 2021. www.federalregister.gov/documents/2019/06/06/2019-11814/recommended-human-health-recreational-ambient-water-quality-criteria-or-swimming-advisories-for.
5. Environmental Protection Agency. Office of Water. Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin. Published 2019. Accessed 3 December 2021. <https://www.epa.gov/sites/default/files/2019-05/documents/hh-rec-criteria-habs-document-2019.pdf>.
6. World Health Organization. Cyanobacterial Toxins: Saxitoxins. Published June 2020. Accessed 3 December 2021. <https://apps.who.int/iris/bitstream/handle/10665/338069/WHO-HEP-ECH-WSH-2020.8-eng.pdf?sequence=1&isAllowed=y>.
7. World Health Organization. Cyanobacterial Toxins: Anatoxin-a. World Health Organization. Draft Version for Public Review November 22, 2019. Accessed 3 December 2021. https://www.who.int/water_sanitation_health/water-quality/guidelines/chemicals/anatoxin-a-gdwq-bd-for-review-20191122.pdf.
8. Ohio Department of Health, Environmental Protection Agency, Department of Natural Resources. State of Ohio Harmful Algal Bloom Response Strategy for Recreational Waters. State of Ohio. Available at: <https://epa.ohio.gov/portals/35/hab/HABResponseStrategy.pdf>. Published August 2020. Accessed 3 December 2021.
9. World Health Organization. Guidelines for safe recreational water environments. *Coastal and Fresh Waters*. 2003;1,1-253.