HARMFUL ALGAL BLOOMS (HABS) PROGRAM GUIDE
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# Abbreviations and Acronyms

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<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>µg/L</td>
<td>Micrograms per liter (parts per billion)</td>
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<td>BG</td>
<td>Blue-green</td>
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<tr>
<td>BWAM</td>
<td>Bureau of Water Assessment and Management</td>
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<td>CALM</td>
<td>Consolidated Assessment and Listing Methodology</td>
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<tr>
<td>CSLAP</td>
<td>Citizen Statewide Lake Assessment Program</td>
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<tr>
<td>CWA</td>
<td>Clean Water Act</td>
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<tr>
<td>DEC</td>
<td>Department of Environmental Conservation</td>
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<td>DESP</td>
<td>Division of Environmental Stewardship and Planning</td>
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<td>DOW</td>
<td>Division of Water</td>
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<tr>
<td>ELAP</td>
<td>Environmental Laboratory Approval Program</td>
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<td>HA</td>
<td>Health Advisory</td>
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<td>HAB</td>
<td>Harmful Algal Bloom</td>
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<tr>
<td>LCBP</td>
<td>Lake Champlain Basin Program</td>
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<tr>
<td>LCC</td>
<td>Lake Champlain Committee</td>
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<tr>
<td>LCI</td>
<td>Lake Classification and Inventory Program</td>
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<tr>
<td>LHD</td>
<td>Local Health Department</td>
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<tr>
<td>LMAS</td>
<td>Lake Management and Assessment Section</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<tr>
<td>NYC</td>
<td>New York City</td>
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<tr>
<td>NYCDEP</td>
<td>New York City Department of Environmental Protection</td>
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<td>NYSDOH</td>
<td>New York State Department of Health</td>
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<tr>
<td>NYHABS</td>
<td>New York HAB System</td>
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<tr>
<td>OPRHP</td>
<td>Office of Parks, Recreation and Historic Preservation</td>
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<tr>
<td>PWS</td>
<td>Public Water Supply</td>
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<tr>
<td>RIBS</td>
<td>Rotating Integrated Basin Sampling</td>
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<tr>
<td>SDWA</td>
<td>Safe Drinking Water Act</td>
</tr>
<tr>
<td>SSC</td>
<td>State Sanitary Code</td>
</tr>
<tr>
<td>SUNY</td>
<td>State University of New York</td>
</tr>
<tr>
<td>TMDL</td>
<td>Total Maximum Daily Load</td>
</tr>
<tr>
<td>TOGS</td>
<td>Technical &amp; Operational Guidance Series</td>
</tr>
<tr>
<td>USACE</td>
<td>United States Army Core of Engineers</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>VDH</td>
<td>Vermont Department of Health</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>WI/PWL</td>
<td>Waterbody Inventory/Priority Waterbodies List</td>
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</tbody>
</table>
1 Executive Summary

Harmful Algal Blooms (HABs) in freshwater generally consist of cyanobacteria (also referred to as blue-green algae). Cyanobacteria are naturally present in low numbers in most marine and freshwater systems but under certain conditions, particularly high nutrients and warm temperatures, the organisms can begin to multiply rapidly and form blooms. Several types of cyanobacteria have the potential to produce toxins and other harmful compounds that can pose a health risk to people and animals through ingestion, skin contact, or inhalation. DEC suggests avoiding contact with any water that is discolored or has algal scums on the surface.

The purpose of this guide is to describe how the New York State DEC identifies and documents cyanobacteria HABs throughout the state, communicates health risks to the public, provides guidance on bloom management, and conducts research. The primary audience for this guide is New York State agency staff, but the guide may be useful to others, particularly the wide range of partners involved in addressing HABs in New York. The DEC HABs Program uses a combination of visual surveillance, chlorophyll concentration (specifically, the portion of total chlorophyll that can be fluoroscopically attributed to cyanobacteria, also known as blue-green chlorophyll) and total microcystins concentration (a toxin produced by cyanobacteria) to determine a bloom status (Suspicious, Confirmed, or Confirmed with High Toxins Blooms). The status system provides a uniform way to rapidly communicate information about HABs throughout the state.

DEC receives HABs reports from state agency staff, the public, and several collaborating partners. DEC staff work to support structured monitoring on waterbodies prone to HABs through existing monitoring programs and site-specific partnerships.

Rapid and effective outreach is a critical component of the DEC HABs Program. Communication of information about HABs serves to inform the public's recreational choices. DEC maintains a HABs website of current and archived bloom locations, called NYHABS (New York HAB System), as well as maintains a shared inter-agency database for rapid communication of bloom occurrences and sampling results. The DEC HABs Program publishes annual and cumulative summaries of bloom reports.

At Governor Cuomo’s direction, DEC is leading a multi-agency, statewide $65- million initiative to aggressively combat HABs and protect drinking water quality and the economy. In 2018, four HABs summits brought together national, state, and local experts to discuss how to reduce the frequency of HABs. The summits drove the creation of Action Plans for 12 priority lakes, which will undergo intensive evaluation and support advanced technology pilots that can be applied to waterbodies across the State. This guide includes a discussion of HAB prevention and control approaches. Watershed nutrient input reduction, water treatment strategies, and in-lake control methods are summarized.
2 Introduction

2.1 Purpose of this Document

The purpose of the DEC HABs Program Guide is to describe how DEC identifies and documents freshwater cyanobacteria HABs throughout the state, communicates health risks to the public, provides guidance on bloom management, interacts with other agencies, and conducts research.

2.2 Scope, Jurisdiction and Audience

This guide follows the scope of the DEC HABs Program. The DEC HABs Program serves all surface waters in New York, although HABs are most likely to be observed and reported in lakes, reservoirs, or ponds. Because of an increased likelihood of public exposure, the program focuses on waterbodies that have public access, serve as drinking water supplies or have regulated bathing beaches. The jurisdictional framework in New York, and therefore the DEC HABs Program, does not distinguish between public and private waters since all of the waters of the state may be used by the public (see the New York State Clean Lakes Assessment).

This guide does not address marine blooms that occur in coastal and estuarine environments in New York. Many of the concepts discussed here could be used in the future to address blooms in these waters. Marine blooms are currently tracked and reported through the DEC Marine Biotoxin Monitoring Program.

This guide outlines the DEC HABs Program elements that are under the explicit or assumed authority of DEC but includes references to those elements assumed by the NYSDOH and/or the New York OPRHP.

The primary intended audience for this guide is state agency staff who are directly involved in implementing or work with the DEC HABs Program; the surveillance and monitoring partners described in this document; and those members of the public interested in background information about the development and implications of the HABs program.

2.3 Background

New York State has an abundance of water resources, both flowing and ponded. HABs are most commonly observed in ponded waters, although blooms have been documented in several streams and rivers. There is no formal legal definition of a lake, but by most common measures, there are between 7,500 and 16,000 ponded...
waters in New York. Lakes are heavily used and enjoyed by New Yorkers for a wide variety of purposes including recreation and as surface drinking water supplies. DOW is tasked with protecting and conserving the water resources of New York. This mission is achieved through a variety of programs and activities. The primary function of the DOW’s Bureau of Water Assessment and Management is to monitor and assess waterbodies of the state to determine whether they are supporting their best intended uses such as potable water, public bathing, and recreation. The bureau’s programs address the mission of the DOW and identify water quality issues in New York waterbodies.

One such challenge that has become increasingly prevalent throughout New York are HABs. HABs in freshwater generally consist of cyanobacteria (also referred to as blue-green algae). Cyanobacteria are naturally present in low numbers in most marine and freshwater systems, but under certain conditions (particularly high nutrients and warm temperatures) these organisms can begin to multiply rapidly and form blooms. Cyanobacteria, which are similar to algae, possess chlorophyll and are capable of photosynthesis. Several taxa have the potential to produce toxins. Whether toxins are present or not, exposure to any cyanobacterial blooms can cause health effects in people and animals when water with blooms is touched, swallowed, or when airborne droplets are inhaled.

Although HABs have been observed for many decades, recent high-profile blooms throughout the world and in New York have increased the need for enhanced education, documentation, and reporting of blooms. Since 2012, HABs have been documented in several hundred waterbodies in New York, and it is likely the true extent of bloom occurrence is substantially greater. It is not yet known if recent increases in bloom frequency and duration reflect changing environmental conditions or are a result of improved reporting and monitoring of their occurrence.

Many New York waterbodies are regularly monitored through formal monitoring programs. Over 200 lakes are sampled each year through two DEC ambient lake monitoring programs: The Citizens Statewide Lake Assessment Program (CSLAP) and the DEC Lake Classification and Inventory Program (LCI). In recent years, both programs expanded to include significant HABs monitoring components. Most other HABs surveillance and sampling is done on individual waterbodies by agency staff.
researchers, consultants, lake residents or as part of special studies. As described below, several monitoring partnerships have been established by DEC in recent years in response to increased public concern about HABs.

HABs exposure in New York has resulted in several dog deaths, public swimming beach closures, and have compromised drinking and recreational water uses. In response, a HABs program within DOW was developed to address blooms in New York. A primary objective of the DEC HABs Program is to protect human and animal health. Program staff facilitate bloom surveillance, sampling, and timely communication between state agencies and the public. Further objectives of the DEC HABs Program include education, documentation of blooms, and research that can link algal blooms to nutrient concentrations or other causes.

2.4 Agency Responsibilities

The DEC HABs Program consists of DEC staff within DOW’s Bureau of Water Assessment and Management (BWAM). The current structure of the DEC HABs Program relies on partnerships with state agencies and a wide range of stakeholders and seeks to provide a unified approach to HABs identification and communication in New York.

Many of the responsibilities of the DEC HABs Program described in this guide fall within the authority of DEC under the Federal Clean Water Act. NYSDOH and OPRHP have separate statutory responsibility for protecting public health. For example, NYSDOH developed a HAB protocol for swimming beaches under the authority of the State Sanitary Code (SSC). This protocol is used by local entities to make decisions regarding HABs in regulated swimming areas. Oversite of drinking water supplies is the responsibility of the NYSDOH under the federal Safe Drinking Water Act (SDWA) and the SSC.

The DEC HABs Program coordinates HABs surveillance, monitoring and outreach with additional agencies and partners (Table 2.1, Figure 2.1). This guide can and should be used to support those agencies and their efforts. Several large waterbodies in New York (notably Lake Erie, Lake Ontario, Lake Champlain, New York City drinking water reservoirs, and the Alleghany Reservoir) already have HAB management plans in place that are overseen by a jurisdiction other than DEC. Below is a summary of the roles of the major government entities that manage inland waterbodies and HABs in New York.

DEC

DEC programmatic functions and activities support the agency mission in compliance with the CWA and state Environmental Conservation Law and are structured to provide environmental and health protection throughout the state. Several DEC roles that relate to the HABs Program include:
• DEC HABs Program:
  o Coordinate HABs surveillance and sample statewide. Track and record bloom reports received from DEC regional and field staff, NYSDOH, OPRHP, federal agencies, the public, CSLAP, LCI and other HABs sampling programs. The program assigns bloom status, receives and interprets lab results, supports development of HABs surveillance and/or sampling programs and provides general information about blooms through education and outreach.
  o Maintain contractual relationships with analytical labs for HABs sample analysis.
  o Prepare and issue updates on bloom status from May to October on the [DEC HABs website](http://www.dec.ny.gov/hab). Maintain an online interactive map of bloom notifications from May-October: on.ny.gov/nyhab.
  o Maintain an inter-agency database of report locations and preliminary laboratory results.
  o Maintain a drop box for HABs inquiries: [HABsInfo@dec.ny.gov](mailto:HABsInfo@dec.ny.gov).
  o Publish results of findings in DEC reports, individual lake reports, and in other formats.

• Conduct two statewide lake monitoring programs (LCI and CSLAP) and managing most lake-related public outreach (BWAM staff).

• Report blooms to the HABs Program as they are encountered in the field (DEC field staff).

A HABs coordinator is assigned in each DEC regional office. Some coordinators serve primarily as conduits to the DEC HABs Program by forwarding bloom reports, press inquiries, and other programmatic requests. Other coordinators and regional staff take a more active role, such as sample collection and follow up evaluation of publicly reported blooms.

**NYSDOH**

NYSDOH programs and activities support their mission to comply with the SDWA and Public Health Law to oversee public health protection at regulated sites. Several NYSDOH roles that relate to the DEC HABs Program include:

• Oversee HABs monitoring at PWS through their statutory responsibility as part of the 1974 SDWA and SSC within the source water protection program.
• Responsible for the development and distribution of beach protocols at all regulated bathing beaches, including many children’s camps. Staff communicate HAB occurrences and regulated bathing beach closures and re-openings to DEC and OPRHP.
• Support the DEC HABs Program in the form of surveillance or sampling assistance, often conducted by staff at LHDs.
• Support PWS sampling and regulated swimming area monitoring at the Wadsworth Laboratory in Albany. They possess analytical capabilities to analyze toxins, perform microscopic analyses, and conduct quantitative polymerase chain reaction analysis.
• Maintain an email for HABs inquiries: harmfulalgae@health.ny.gov
• Produce HABs public outreach materials, including a blue-green algae website and brochures.
• Investigate reports of human illnesses that may be related to HABs. Analyze human health data related to epidemiological issues and provide technical advice on public health aspects of HABs.
• Coordinate interagency communication with LHDs, the NYC Department of Health and Mental Hygiene and NYSDOH Regional and District Offices.

County health departments perform environmental health functions in most New York counties; NYSDOH District Offices provide the environmental functions in those counties that do not. These offices, collectively known as LHDs, implement PWS and beach outreach and monitor programs, include the deployment of beach protocols and make final determinations about beach closures. Some county or District Office staff may post closure or advisory signs, issue press releases, and dedicate staff to investigate blooms reported by the public.

OPRHP- Division of Environmental Stewardship and Planning
• Manage regulated swimming areas and other lake or river access points at state parks.
• Provide training on HABs identification and response protocols to parks’ staff.
• Conduct visual surveillance of beach conditions in support of beach closure decisions. HABs occurrences and bathing beach closures and re-openings are communicated to NYSDOH and DEC.
• Provide outreach and education to park patrons through a HABs brochure.
• Conduct periodic water quality monitoring and wastewater system surveys to evaluate causes of HABs in state parks’ lakes and ponds.

Federal and Other Agencies
• USEPA: conduct research, organizing educational webinars and meetings, and creating federal regulations and advisory guidelines regarding HABs.
• NOAA: Oversee sampling and response to HABs in Lake Erie and Lake Ontario.
• USACE: Monitor HABs and provide regular updates to the DEC HABs Program regarding Alleghany Reservoir.
• Vermont DEC and VDH: Oversee a public-private monitoring partnership in Lake Champlain, including phytoplankton enumeration and toxin analysis; providing regular updates to the DEC HABs Program.
• NYCDEP: Oversee water quality monitoring in NYC reservoirs; providing DEC HABs Program with updates on bloom conditions, if present.
## Table 2.1 Summary of state agency programmatic responsibilities

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<thead>
<tr>
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<th>DEC</th>
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<th>NYSDOH &amp; LHDs</th>
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<td>Beach closures</td>
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<td>Email drop box</td>
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<td><strong>NYHABS</strong></td>
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<td>HABs website</td>
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<td>Annual reports</td>
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<td>Respond to public inquiries</td>
<td>✓</td>
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*microscopy only
Figure 2.1 Summary of organization roles, interest groups, and exposure groups that are served by the DEC HABs Program.
3 DEC Bloom Status Designation in New York

3.1 Bloom Status Criteria

Bloom reports and lab data from a wide variety of sources (Table 3.1) are received and interpreted by DEC HABs Program staff who then designate a bloom status for each waterbody. The DEC HABs Program has adopted a combination of visual surveillance and a surrogate measure for cyanobacteria density (specifically, the portion of total chlorophyll that can be fluoroscopically attributed to cyanobacteria, also known as blue-green chlorophyll or BG Chl.a), and toxin concentration to determine bloom status. A decision tree process can be followed to determine bloom status (Figure 3.1).

There were several factors that led the DEC HABs Program to adopt the current bloom status criteria: (a) the need for rapid analysis and reporting turnaround time, (b) a suitable way to evaluate a high volume of samples from a large number of waterbodies, (c) limited analytical capabilities associated with microscopic enumeration or taxonomic evaluations, (d) lags in completion of toxin analysis, and (e) a need to distinguish cyanobacteria HABs from non-toxin producing algal blooms.

The DEC HABs Program has working relationships with several analytical labs that can analyze HABs samples. DEC utilizes the following parameters to determine bloom status: total microcystins, algal pigment concentrations, and algal community composition via microscopy.

For total microcystins analysis, laboratories must be certified through the Environmental Laboratory Approval Program (ELAP). For more information go to:

https://www.wadsworth.org/regulatory-programs/regulatory-programs/environmental-laboratory-approval-program/microcystin
The DEC HABs Program has established four levels of bloom status:

**No Bloom**: A report has been evaluated by DEC HABs Program or NYSDOH staff, and there is a low likelihood that a cyanobacteria bloom is present. At least one of the following criteria must be met: (1) in the absence of a sample, visual evidence is not consistent with a cyanobacteria bloom; (2) BG chlorophyll levels ≤ 25 µg/L; (3) microscopic confirmation sample is not dominated by cyanobacteria and not present in bloom-like density; or (4) only in absence of the previous criteria being met: total microcystins ≤ 4 µg/L.

**Suspicious Bloom**: DEC HABs Program or NYSDOH staff have determined that a report of a bloom is likely to be cyanobacteria; digital photographs, a descriptive field report from professional staff or trained volunteer or closure of a regulated swimming area all may constitute reports that can be considered Suspicious Blooms. For surveillance reports received from the public, lay monitors, etc., DEC HABs Program staff will determine if a bloom is Suspicious and whether collection of a sample is feasible or warranted.

**Confirmed Bloom**: The DEC HABs Program receives laboratory analytical results from a sampled bloom that fulfills at least one of the following criteria: (1) BG chlorophyll levels ≥ 25 µg/L; (2) microscopic confirmation that majority of sample is cyanobacteria and present in bloom-like densities; (3) only in absence of the previous criteria being met: total microcystins ≥ 4 µg/L but less than high toxin thresholds and accompanied by ancillary evidence of the presence or recent history of a bloom.

**Confirmed with High Toxins Bloom**: The DEC HABs Program receives laboratory analytical results from a waterbody with a Confirmed Bloom that meets either of the following criteria: (1) total microcystins ≥ 20 µg/L (shoreline samples only); (2) total microcystins ≥ 10 µg/L (open water samples only); (3) known risk of exposure to anatoxin or another cyanotoxin, based on consult between DEC HABs Program and NYSDOH staff.
Figure 3.1 Decision tree that indicates the process by which DEC HABs Program staff determine the status of a potential bloom.
### Table 3.1 Summary of the types of information regarding HABs that are received by the DEC HABs Program and descriptions of how this information is used to determine bloom status

<table>
<thead>
<tr>
<th>Type of Information</th>
<th>Explanation</th>
<th>Format</th>
<th>Sources</th>
<th>Connection to Bloom Status Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual/Field Reports (Lay person)</td>
<td>Description of a suspected algal bloom</td>
<td>Online Report Form, or email to DEC or NYSDOH drop box, phone calls</td>
<td>Public</td>
<td>Can be used to designate a Suspicious Bloom</td>
</tr>
<tr>
<td>Visual/Field Report (Trained personnel such as DEC or NYSDOH professional or trained volunteer)</td>
<td>Description of an algal bloom, sometimes with location, extent, etc.</td>
<td>Report Forms</td>
<td>DEC or NYSDOH staff, CSLAP volunteers, other HABs program partners</td>
<td>Can be used to designate a Suspicious Bloom</td>
</tr>
<tr>
<td>Digital Photograph</td>
<td>Digital photographs of an algal bloom</td>
<td>Digital photographs files received through Report Forms</td>
<td>Public, DEC or NYSDOH staff, CSLAP volunteers, other HABs program partners</td>
<td>Can be used to designate a Suspicious Bloom</td>
</tr>
<tr>
<td>Quantitative Phytoplankton Count</td>
<td>Quantitative enumeration of algal abundance present in samples</td>
<td>Quantitative data sent from external HABs programs to DEC HABs Program</td>
<td>Only received for Alleghany Reservoir (USACE), Lake Champlain (VT DEC), NYC reservoirs (NYCDEP)</td>
<td>Can be used to designate a Confirmed Bloom*</td>
</tr>
<tr>
<td>Qualitative Microscopy</td>
<td>Narrative indicating qualitative phytoplankton community composition present in water samples</td>
<td>Qualitative data sent from labs to DEC HABs Program or as analyzed by DEC staff</td>
<td>Partner labs or DEC HABs Program staff</td>
<td>Can be used to designate a Confirmed Bloom (if accompanied with visual evidence of a bloom)</td>
</tr>
<tr>
<td>Pigment/chlorophyll Concentration</td>
<td>Extracted Chlorophyll a or Fluoroprobe chlorophyll concentrations (µg/L) present in water samples</td>
<td>Quantitative data sent from labs to DEC HABs Program</td>
<td>Partner labs</td>
<td>Primary tool used to potentially designate a Confirmed Bloom</td>
</tr>
<tr>
<td>Toxin Concentration</td>
<td>Concentrations of cyanotoxins (µg/L) present in water samples</td>
<td>Quantitative data sent from labs to DEC HABs Program</td>
<td>ELAP certified labs</td>
<td>Primary tool used to designate a Confirmed with High Toxins Bloom</td>
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</table>

*Cell counts are interpolated using the WHO recreation guidelines (Table 3.2)*
If an algal bloom report does not include enough information to determine a bloom status (for example, a written description from a member of the public and/or digital photographs that are of insufficient quality to determine if a bloom is a HAB), a place-holding status ("Needs Evaluation") is used internally. DEC HABs Program staff work to acquire additional information to inform bloom designation. However, in the absence of additional information, there may not be a resolution.

A bloom remains categorized as a Suspicious Bloom until lab results are received. When results are received, they are evaluated following the criteria described above. If the results indicate that a cyanobacteria HAB is not present, the bloom is designated as Not a Bloom. If the sample meets the BG Chl.a threshold, it may be designated as a Confirmed Bloom. A Confirmed Bloom can later be changed to a Confirmed with High Toxins Bloom if the toxin threshold is met.

The spatial and temporal heterogeneity of cyanobacteria HABs means that a sample will only reflect conditions at a single space and time and cannot be assumed with any certainty to reflect lasting conditions in an entire section of shoreline, much less a whole waterbody. An individual sample may or may not reflect the highest densities of cyanobacteria or cyanotoxins present in a waterbody. The results, therefore, indicate the potential for such conditions to exist in the area sampled, and potentially in the whole waterbody.

3.2 Threshold Development

The DEC HABs Program bloom status criteria rely on a combination of visual assessment, pigment concentration (BG Chl.a), toxin concentrations and professional judgment (Figure 3.1). In the absence of accepted federal guidelines on exposure to cyanotoxins in recreational waters, the DEC HABs Program bloom status criteria are based on an adaptation of the WHO guidance values for moderate risk of acute health effects from recreational exposure to harmful algal blooms (Table 3.2). WHO recommends the use of cyanobacteria cell counts to trigger alert and advisory systems and cites chlorophyll a or toxins as suitable alternative alert or advisory triggers. The DEC HABs Program interprets the chlorophyll a guidance values in the context of the capability of fluoroprobes to rapidly detect cyanobacteria-specific pigments (BG Chl.a). A benchtop FluoroProbe (bbe moldaenke©) can be

Recommended action for any HAB

- Avoid exposure. Keep children and pets away from scums or discolored water
- Seek immediate medical assistance for symptoms consistent with exposure
- Report any symptoms to local or state NYS Department of Health
- Report blooms to DEC through HABsInfo@dec.ny.gov

Recommended action for any HAB
used to rapidly quantify relative quantities of algal pigments using fluorescence spectroscopy.

<table>
<thead>
<tr>
<th>Relative Probability of Acute Health Effects</th>
<th>Cyanobacteria (cells/mL)</th>
<th>Microcystin-LR (µg/L)</th>
<th>Chlorophyll-a (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt;20,000</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Moderate</td>
<td>20,000-100,000</td>
<td>10-20</td>
<td>10-50</td>
</tr>
<tr>
<td>High</td>
<td>100,000-10,000,000</td>
<td>20-2,000</td>
<td>50-5,000</td>
</tr>
<tr>
<td>Very High</td>
<td>&gt;10,000,000</td>
<td>&gt;2,000</td>
<td>&gt;5,000</td>
</tr>
</tbody>
</table>

For the first few years of the DEC HABs Program, the WHO guideline (10-50 µg/L of chlorophyll-a and a description of cyanobacteria “dominance”) was interpreted by DEC to be ≥ 25 to 30 µg/L BG Chl.a and ≥ 50% of the algal community comprised of cyanobacteria. As a result of practical application, a BG chlorophyll threshold of 25 µg/L BG Chl.a and qualitative verification the presence of bloom quantities of cyanobacteria via microscopy was adopted.

The DEC HABs Program does not use toxins as a primary determinant in bloom status designation. Pigment analyses and visual assessments can be completed more quickly than toxin analyses, so turnaround time to determine bloom status and communicate risk to the public can be conducted quickly. The designation of a bloom as Suspicious or Confirmed does not ensure that toxins are not present, but merely that they were not above the High Toxins threshold. Additionally, cyanobacteria HABs produce other harmful compounds such as dermal irritants and other uncharacterized or unmeasured toxins, so contact with all blooms should be avoided. Outreach messaging and communications are comparable for all waterbodies, regardless of bloom status.

### 3.3 Cyanotoxins and Other Harmful Compounds

The potential routes of exposure for humans and animals to cyanotoxins and other harmful compounds created by cyanobacteria can be broadly classified into three categories: dermal, ingestion, or inhalation of aerosolized toxins.

Exposure can occur during:

- recreation
- fishing
- household use of untreated or in-home treated surface waters when there is a bloom
- consumption of water that contains cyanobacteria or cyanotoxins

Exposure to high levels of HABs and cyanotoxins can cause:

- diarrhea
- nausea or vomiting
- skin, eye or throat irritation
- allergic reactions
- breathing difficulties

Cyanotoxin production mechanisms and triggers are not well understood and the relationship between algal biomass and toxin concentration is not clear. Presently, the analytical methods available for detection of the wide range of cyanotoxins are expensive and require a high level of laboratory equipment and trained analysts. There are several types of techniques used for detecting cyanotoxins or the potential for cyanotoxin production in environmental samples including biological assays, chromatographic methods, or genetic methods.

Of the cyanotoxins that are routinely tested for by the DEC HABs Program, the most commonly detected are total microcystins and anatoxin-a, with the former detected substantially more frequently.

NYS DOH guidance advises operators of community drinking water systems to increase visual monitoring and to test their untreated water for toxin should there be any changes in turbidity, color and other qualities in the raw water associated with HABS. In the presence of HABs water systems operators are advised to optimize their treatment system to destroy and absorb toxins. NYS DOH consults closely with local health departments to provide guidance to water operators on treatment optimization and also on any additional response actions as needed.

**Microcystins**

The most commonly detected cyanotoxin is microcystin. Microcystin is produced by several genera of cyanobacteria. There are more than 100 congeners (forms) of microcystin which are collectively referred to as total microcystins.

The DEC HABs Program bloom status criteria for a Confirmed with High Toxin Bloom is based on a threshold for total microcystins of 10 µg/L (open water) and 20 µg/L (shoreline). These values were derived from the WHO criteria moderate risk thresholds (Table 3.2).

**Anatoxin-a**

Anatoxin-a is one of several alkaloid neurotoxins produced by some types of cyanobacteria. Several incidents of pet and livestock poisonings have been reported.
after exposure to cyanobacterial blooms. Symptoms of exposure from animal case reports include staggering, paralysis, muscle twitching, gasping, convulsions, and death. Dogs are at risk of exposure to cyanobacteria and cyanotoxins through grooming of their fur and dose response effect related to their relative body mass.

This toxin is not often detected in water samples in New York State, in part because the rapid photo-degradation rate thwarts detection. Detection of anatoxin-a presents a monitoring and analytical challenge.

**Cylindrospermopsin**

Cylindrospermopsin is produced by several kinds of cyanobacteria, including genera commonly encountered in New York, however, this toxin is rarely detected in water samples analyzed by the DEC HABs Program.

**Other Cyanotoxins and Harmful Compounds**

Cyanobacteria have been shown to produce a wide range of additional compounds that have not been thoroughly identified or studied. The rapidly changing landscape of the research regarding cyanotoxins and cyanobacterial blooms supports an overall policy of caution and avoidance of blooms by the public. At this time, a lack of substantial published data, no federal guidelines, and low rates of occurrence in New York warrants that the DEC HABs Program should not include bloom status thresholds for any cyanotoxins other than total microcystins.

Additional information regarding HABs and health can be found on the [DOH Blue-green Algae and Health webpage](https://www.dec.ny.gov/).
trained user report form provided by the DEC HABs Program which includes information about field conditions. Surveillance reports can be used to designate a bloom as Suspicious.

NYSDOH has established a regulated beach closure protocol based on visual surveillance, as described in greater detail in Section 4.2. If a beach manager believes that conditions within the swimming beach fit the description of a HAB, the manager will prohibit swimming, wading and other water contact. If these conditions are not apparent on the beach but are observed or reported on the waterbody near the beach, the manager may post advisory signs. This protocol has been adopted for regulated swimming beaches by NYSDOH, NYSDEC and OPRHP. HABs beach closures are routinely considered by DEC to be Suspicious Blooms.

Sampling

Bloom sampling may be conducted because of a bloom report or following a pre-determined sampling program protocol. HABs sampling, particularly when paired with water quality testing, can provide valuable data that can be used to better understand long-term patterns in geographic extent, toxicity, duration, and other characteristics of blooms in a waterbody. Analytical results from sampling can be used to designate a Confirmed Bloom or Confirmed with High Toxins Bloom.

The DEC HABs Program works with several partners to conduct structured surveillance and/or sampling programs throughout the state; these programs are described in more detail below. Sampling supports and supplements overall statewide surveillance efforts and increases the likelihood of rapid observation and public notification of bloom occurrence. Although monitoring plan details (number, frequency, and types of samples analyzed) differ among partners, they generally consist of the following:

- Observations of waterbody condition are conducted by a trained member or affiliate of the partner organization (volunteer, employee, or agency worker). Surveys are usually conducted by a person familiar with the waterbody. Training helps improve the likelihood that algal blooms are correctly identified in the field and that reports of non-cyanobacteria blooms are minimized.
- Trained users are provided a Trained User Report Form to submit bloom reports to the DEC HABs Program.
- Samples are usually collected from the densest portion of the bloom (the “worst case scenario”) to be as protective as possible regarding exposure risk.
- Samples are collected and sent to a partner laboratory to be analyzed for phytoplankton community composition via microscopy, pigment concentration, and toxins (See Chapter 3 for more detail).
- Some programs survey and/or sample only when visible scums or blooms occur (episodic). Other programs perform these tasks on a regular basis, regardless of
the visual state of the waterbody (routine). Some programs follow a combination of these protocols (hybrid).

4.2 HABs Programs in New York

The Lake Classification and Inventory Program (LCI)
The DEC DOW Lake Management and Assessment Section conducts lake water quality sampling through the LCI Program to support lake assessment and management activities. Data collected as part of LCI are used to update the New York WI/PWL and to identify waterbodies that do not attain their designated uses. LCI data supports DEC outreach, education and waterbody assessment programs. Waterbodies that are selected for sampling are grouped by drainage basin and follow the five-year RIBS schedule. The waterbodies selected each year generally have a paucity of historical data or evidence of a current water quality problem. A full suite of field data and laboratory water quality parameters (profiles, water chemistry, Secchi depth, etc.) are collected at each sampling event. This program was developed to characterize overall water quality conditions, not necessarily HAB occurrences. Digital photographs and water samples are collected when blooms are encountered and submitted through the Trained User Report Form.

The Citizens Statewide Lake Assessment Program (CSLAP)
CSLAP is a volunteer lake sampling and education program that is jointly managed by DEC and NYSFOLA. Over 240 lake associations and 1,500 volunteers have participated in CSLAP since its inception. The program has delivered high quality data to many DEC programs for over 30 years. Annually, about 120 lakes throughout the state participate in the program. CSLAP supports sampling by shoreline resident members of lake associations that apply to participate in CSLAP through their affiliation with NYSFOLA. A full suite of water quality parameters is measured throughout the summer months (8x/ season) from each lake. Samples are collected from a single open water site (the deepest part of the lake); HABs surveys are conducted periodically at all lakes and on each sampling date for lakes prone to HABs. Shoreline HABs surveys can lead to episodic HABs reports and sampling if a shoreline scum is observed between scheduled sampling events.

Lake-specific Professional and Semi-professional Programs
Several lake communities have developed structured surveillance and sampling programs in response to annually recurring HABs. These programs have been developed in cooperation with DEC and other partners. The programs vary in structure, but most involve leveraging existing analytical partnerships and sampling frameworks. Most programs only collect HABs samples while a few also monitor further water quality parameters through separate programs.
NYC and Long Island Enhanced HABs Monitoring

The NYC Department of Parks and Recreation and researchers at SUNY Stony Brook oversee a hybrid sampling, surveillance and research partnership in New York City parks and in Suffolk County, Long Island. Routine surveillance and/or sampling is conducted on lakes with persistent blooms and episodic surveys are conducted on other lakes with potential HABs as they are observed. Sampling occurs weekly in lakes with persistent cyanobacteria blooms.

New York State OPRHP DESP

Division of Environmental Stewardship and Planning (DESP) staff work closely with DEC and NYSDOH to provide outreach to State Park managers and staff on how to recognize and respond to HABs. A formal reporting protocol has been defined by DESP through consultation with DEC and NYSDOH. Routine surveillance is conducted by individual beach or State Park managers at parks with waterbodies that are prone to HABs. That information is reported to central DESP staff, who then communicate information to DEC and NYSDOH. When the bloom is at a bathing beach, State Park managers, in consultation with DESP, can make the decision whether to close or reopen a beach, in compliance with NYSDOH beach closure protocols.

Regulated Swimming Beaches

Bathing beaches are regulated by NYSDOH District Offices, County Health Departments, the New York City Department of Health and Mental Hygiene, or operated by OPRHP, and DEC in accordance with the SSC. The SSC contains qualitative water quality requirements for protection from HABs. NYSDOH developed an interactive intranet tool that provides guidance to County, City and State District NYSDOH staff to standardize the process for identifying blooms, closing beaches, sampling, reopening beaches and reporting activities. The protocol uses a visual assessment to initiate beach closures as it affords a more rapid response than sampling and analysis. Beaches are reopened when a bloom dissipates (visually) and samples collected the following day confirm the bloom has dissipated and show toxin levels are below a guidance value. Sample analysis is conducted at an ELAP certified laboratory.

Lake Champlain

HABs surveillance and sampling in Lake Champlain is coordinated by joint efforts among the VT DEC, VDH, LCBP, and LCC. Over 50 trained citizen monitors conduct shoreline surveys at locations throughout the lake in both Vermont and New York. Additionally, VT DEC staff conduct sampling at 15 fixed sites (both shoreline and open water). Samples are evaluated following a tiered alert protocol. Results are posted online in the VDH Blue Green Algae Tracker interactive map and not the on the DEC HABs website. DEC provides a link to the tracker on the HABs notifications page.
Great Lakes (Lake Erie and Lake Ontario)

There is not basin-wide defined HABs response or management plan for the Great Lakes. NOAA and DEC respond to concerns and issues related to HABs on Lake Erie or Lake Ontario on an episodic basis, including reports of blooms from embayments to the lakes.

Episodic HABs Surveillance and Sampling by DEC and LHD Staff

DEC and LHD staff occasionally conduct site visits in response to bloom reports from the public. While at the waterbody, they assess if a bloom is likely to be cyanobacteria and determine whether sample collection is warranted. Site visits are often triggered by phone calls, emails or suspicious algal bloom Report Forms submitted by the public to DEC and/or NYSDOH. A shortage of staff to conduct this on-demand sampling has led to the development of the programs described above.

Episodic HABs Surveillance by the Public

The public often encounter algal blooms and report their findings to the DEC HABs Program. These reports include phone calls, emails, or completion of a Suspicious Algal Bloom Report Form (See Section 5.2). Occasionally, DEC HABs Program staff will request that members of the public conduct follow up surveillance as deemed appropriate; this facilitates tracking the duration and size of the bloom.

5 Outreach

A critical component of the DEC HABs program is outreach: communication of information about HABs and the results of surveillance and sampling programs to inform public decisions about recreational choices. HABs bloom statuses are based in part on the need to provide information to lakefront residents, visitors and their families as quickly as possible.

5.1 Communication to Collaborators

The communication process begins when a report of a potential bloom is sent to DEC HABs Program staff. This report can include digital photographs, a description of the bloom and/or a sample collection. These reports are primarily submitted through the Suspicious Algal Bloom Report Form or the Trained User Report Form. In addition, phone calls or emails may be received directly by DEC, NYSDOH or LHDs. Partner analytical laboratories send HAB sample results to DEC. If sample results indicate a HAB is present, a record will be included in the New York HABs System (NYHABS). NYHABS is the comprehensive data management system used to communicate with interagency staff, collaborators and the public regarding HABs.

Because of the public health risks related to HABs exposure, DEC HABs Program staff work to transmit relevant information as quickly as possible. Rapid and broad-
reaching responses rely on the use of NYHABS by state agency staff and DECHABS website.

NYHABS Data Elements

NYHABS facilitates the collection of field and lab data into a single location. Data elements from the two Report Forms and data from analytical laboratories contribute to the interpreted status of a HAB report. A number of these elements are included on NYHABS, and include:

- Waterbody
- Date of Observation
- HAB Status (see section 3.1)
- Extent
- Data Provider
- County
- Attachments (photos)

Attachments
If digital photographs were received with a bloom report that meets the criteria of a HAB, they will be included in NYHABS. Photos help agency staff determine if or where to conduct any follow up investigations.

Raw data are available for state agency staff and provide support for the bloom status designation and are disseminated with the recognition that state agency staff are able to properly interpret the information. These data are not included on the DEC HABs website (See Section 5.2) or NYHABS.

### The Extent of a Bloom

**Extent** is a rough estimate of the size of the bloom within the waterbody.

**Small Localized:** Bloom affects a small area of the waterbody, limited from one to several neighboring properties.

**Large Localized:** Bloom affects many properties within an entire cove, along a large segment of the shoreline, or in a specific region of the waterbody.

**Widespread/Lakewide:** Bloom affects the entire waterbody, a large portion of the lake, or most to all of the shoreline.

**Open Water:** Sample was collected near the center of the lake and may indicate that the bloom is widespread, and conditions may be worse along shorelines or within recreational areas. Special precautions should be taken in situations when a Confirmed with High Toxins Bloom is reported with an Open Water extent because toxins are likely to be even higher in shoreline areas.

5.2 **DEC HABs Webpages**

DEC’s website has several informative HABs webpages: a [landing page](#), a [notifications page](#), an [archive page](#), a [photo gallery](#) of HABs and non-HABs algal blooms, an [FAQs page](#), and [additional information about HABs](#). The content of these pages is updated periodically. The notifications page includes a link to NYHABS. NYHABS is updated throughout the season (late May through October). On the archive page, there is information about HABs data from previous years.

The DEC HABs Program established a public notification system in 2012, as part of an on-going agency effort to improve public reporting and outreach regarding environmental hazards. The HABs notification program is intended to improve public awareness about this pressing environmental issue, improve transparency regarding information collected by DEC monitoring and reporting programs. NYHABS serves to assist the public in making informed decisions about recreation and other water uses. The structure of some features of the pages reflects DEC rules, requirements and limitations associated with current web page formats.
Notifications Page

The page includes a statewide map of waterbodies with current HABs reports. The map has locations of current reports of Suspicious, Confirmed, or Confirmed with High Toxin Blooms within the last two weeks (Figure 5.1).

Bloom status designations are intended to be sufficient for public health protection without requiring interpretation of analytical data.

Archive Page

The page includes links to downloadable PDFs of tables with bloom information from previous years. Each table includes all waterbodies for which a bloom was documented in a year. Waterbodies that were cited as having a Suspicious Bloom that was later determined not to be a bloom are not included. For each cited waterbody, the first and last report dates and the cumulative duration of the blooms are included. A cumulative archive showing all waterbodies with reported blooms since 2012 is also available for download.

Updates to Bloom Status

The DEC HABs Program and its partners consistently seek current information to provide the most up-to-date bloom notifications. Attempts are made to update the status of blooms with more recent reports. Information gathering is done by email requests for updates and/or site visits by DEC and NYSDOH staff. CSLAP samplers and other DEC surveillance partners usually conduct surveillance in 1-3 week intervals, allowing for routine updates. However, the frequency of bloom reporting can be sporadic and decreases after the routine water sampling season ends, even if some blooms persist into the fall.
5.3. Additional Outreach Efforts

Pamphlets, flyers, and other published informative documents play an important role in educating the public about HABs in New York. Outreach materials provide precautionary information that instructs readers to be aware of HABs and may include additional instructions about exposure risk, likely symptoms, how to report blooms and appropriate steps to take if exposed to HABs. In outreach materials, care is taken to provide precautionary advice without triggering public alarm about risks, particularly in large waterbodies with blooms found only at limited locations. The DEC HABs Program supports several outreach strategies:

**Signs**

- A warning sign was developed by DEC and NYSDOH for use by lake associations or other parties at public access points (See Appendix C).
- Limitations in personnel, resources, and logistics prevent DEC from being able to post advisory notices at public access points on the large number of waterbodies in New York that have documented HABs. The DEC HABs Program and NYSDOH provide general guidance that instructs lake residents and visitors to be on the lookout for blooms at any time once they have been documented for a waterbody. This is based on the expectation that even vigilant surveillance might not catch all blooms and that all lakes with previously confirmed blooms are highly susceptible to future blooms.
Brochures and Pamphlets

- DEC developed a brochure specially focused on HABs in 2017.
- Some individual lake associations have developed HABs brochures for their communities. The DEC HABs program often supports these initiatives with feedback on content and by providing photographs that can be used.
- NYSDOH released a HABs brochure in 2016, which supplements a public FAQ document that has been available since 2003.

Online

- During the summer notification period, a link to NYHABS is included in MakingWaves, DEC’s weekly email newsletter regarding water issues in New York State.
- During the summer notification period, weekly updates on the number of blooms with a link to the Notifications page and additional information about blooms are posted on DEC’s Facebook page and Twitter account.
- There are several locations on the DEC HABs website where members of the public can access the Suspicious Algal Bloom Report Form. Users are instructed to complete the form and submit it, along with digital photographs, to the NYHABS.
- NYSDOH has maintained a HABs webpage since 2003. Several LHD websites have specific HABs pages, some of which include real-time information on local bloom status and beach closures.

Other

- Several state or regional agencies issue press releases to inform communities about the potential risks associated with HABs. Some releases are issued proactively in early summer in advance of the upcoming recreational season, usually before any blooms are observed. Other press releases are issued in the midst of bloom season or in response to a high-profile bloom. DEC HABs Program staff write or contribute to these press releases on an as needed basis, usually at the request of regional agency staff.
- DEC HABs Program staff regularly give presentations regarding HABs issues to a variety of audiences including: agency staff, individual lake associations, local government, the public, training workshops and lake-related conferences.
- DEC HABs Program staff periodically provide articles or other education materials for publication in lake association newsletters, DEC’s Conservationist magazine, and other outreach methods.
- DEC HABs Program staff regularly participate in regional and national HABs working groups and share data and program development strategies with all interested parties.
5.4 Publication and Use of DEC HABs Data

DEC HABs Program staff evaluate HABs data and contribute to several different publication outlets.

**CSLAP Reports**

Annual reports are issued to participating lake associations for every CSLAP lake. All CSLAP lake reports completed since 1996 are posted on the NYSFOLA website and the most recent year’s reports are posted on DEC’s website. These reports include annual and cumulative summaries of all CSLAP program information, with a focus on physical and chemical water quality indicators. The analysis and reporting of HABs-related information include the following:

- For each year of HABs sampling, graphs show seasonal distribution of algae communities (as measured by total and component chlorophyll a) and microcystin in open water and shoreline bloom samples
- Tabular summaries of total and component chlorophyll a and major toxins (microcystin and anatoxin-a), including minimum, long term average, present year average, and maximum values during the current year
- Narrative summaries of sampling results and a summary of microscopic analyses
- A comparison of fluoroprobe and toxin results to the DEC HABs thresholds for Confirmed and Confirmed with High Toxins Blooms

**LCI Reports**

Summary reports are issued for select LCI lakes. The reports include annual and cumulative summaries of all LCI program information, with a focus on physical and chemical limnological indicators. The analysis and reporting of HABs-related information include the following:

- Narrative summaries of sampling results and a summary of microscopic analyses
- A comparison of fluoroprobe and toxin results to the DEC HABs thresholds for Confirmed and Confirmed with High Toxins Blooms

**6 Methods for Bloom Prevention and Control**

**6.1 2018 Governor’s HABs Initiative**

At Governor Cuomo’s direction, DEC is leading a multi-agency, statewide $65-million initiative to aggressively combat HABs and protect drinking water quality and the economy. In 2018, four summits brought together national, state, and local experts to discuss how to reduce the frequency of these blooms. Recordings from the summits are available at: https://livestream.com/hvccstreaming/habssummits.
The summits drove the creation of Action Plans for 12 priority lakes, which will undergo intensive evaluation and support mitigation efforts and advanced technology pilots that can be applied to waterbodies across the state.

DEC began mitigation pilot projects in summer 2018 on small waterbodies selected for their history of documented HABs, nutrient levels, relative size, and uses. DEC is assessing the data from this project to determine the efficacy of future use of these mitigation strategies, and to provide recommendations for additional work or studies on the impact of innovative treatments for HABs.

In addition, DEC is collaborating with USGS on an advanced HABs monitoring pilot on several Finger Lakes to comprehensively evaluate several of the environmental factors that cause HABs to occur.

6.2 Bloom Prevention

Most research indicates that the primary cause of HABs is excessive nutrients (phosphorus and nitrogen) so watershed management efforts should be targeted at measures to reduce the input of phosphorus and nitrogen to waterbodies. Nutrient reduction through watershed management strategies is the most effective method of preventing eutrophication and potentially preventing blooms from occurring.

Numeric nutrient thresholds refer to an ambient phosphorus or nitrogen concentration above which designated use impairments are documented or likely occurring. The establishment of these nutrient thresholds continues to be an active subject of research and data evaluation, as required by USEPA as part of the numeric nutrient criteria development process.

The process by which numeric thresholds are established and promulgated to protected designated uses in most waterbodies, including ponded and flowing waters, is discussed in the DEC Nutrient Plan. Currently, New York has a narrative standard for nutrients: none in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages (6 NYSCRR Part 703.2). An ambient water guidance value of 20 µg/L (0.020 mg/L) total phosphorus has been developed for ponded waters (TOGS 1.1.1), in order to protect aesthetics. Additional research and data evaluation are on-going to identify appropriate thresholds to protect primary and secondary contact recreation best uses. Site-specific criteria may be needed for waterbodies with nutrient levels below the thresholds and that have recurrent HABs.

Waterbodies exceeding these thresholds are identified by the DEC and USEPA as impaired and are cited on the federal 303(d) list. For these waterbodies, monitoring and/or modeling analysis are required to determine the primary source(s) of nutrients. Then, a Clean Water Plan (a TMDL or a Nine Element Watershed Plan) that identifies pollutant sources and strategies for reducing the nutrient loading from these sources is developed for the waterbody.
In some waterbodies, the primary source of nutrients is discharge from a wastewater treatment plant, referred to as a point source. In New York, most point source discharges to lakes are associated with long-standing outfalls from small municipal treatment plants to big lakes. Discharges to rivers are more common and HABs have been documented on some large river systems.

DEC has been delegated authority by USEPA to regulate point source pollutant discharges under the SPDES Permit Program. SPDES permits may authorize phosphorus or nitrogen permit limits through a process that establishes nutrient permit limits according to up-to-date wastewater treatment technologies and practices (TOGS 1.3.6). This guidance considers both receiving and downstream waters. Discharge limits are established to meet the point source pollutant reductions necessary to bring ambient nutrient levels in the receiving waterbody below the numeric nutrient thresholds described above.

In most impaired waterbodies in New York, nonpoint source pollution is the primary source of nutrient inputs. The fundamental goal of the DEC Nonpoint Source (NPS) Management Program is to encourage comprehensive management of nonpoint pollutant sources in order to protect and conserve all waters of New York State for beneficial uses. The NPS Program offers guidance and technical support through the process of writing watershed plans, identifying best management practices, and implementing planned actions that can control impacts from nonpoint sources. Common preventative measures include targeted management of septic systems, advanced wastewater treatment, reduced or eliminated use of lawn and agricultural fertilizers, and stormwater management.

A detailed discussion of nutrient management activities is beyond the scope of this document, but given limited resources and agencies' regulatory reach, nutrient management is largely conducted by a coalition of agencies, local officials, and lake communities. Watershed management techniques for lake communities and lake residents are discussed in Chapter 9 of the 2009 DEC publication Diet for a Small Lake: the expanded guide to New York State lake and watershed management, collaboratively written by DEC and NYSFOLA.

6.3 Bloom Management at Drinking Water Treatment Plants

Municipalities are responsible for providing high quality water for a variety of domestic purposes, including drinking. In New York, there are nearly 1,500 surface water supplies. DOH and LHDs provide guidance and technical assistance to public water suppliers to respond to HABs in water supplies that use surface waters. For more information, see www.health.ny.gov/harmfulalgae or contact the NYSDOH Bureau of Water Supply Protection at bpwsp@health.ny.gov.

6.4 In-Lake Bloom Control Options
Efforts to minimize or eliminate the frequency of HABs should focus on prevention, specifically the reduction of ambient waterbody nutrient concentrations. However, the timeline for implementation and success of most preventative measures will exceed a single bloom season. For many lake residents or lake communities, bloom control must include causal management. Concurrent to the implementation of prevention and nutrient management measures, there are some steps to take to reduce the intensity or occurrence of blooms.

Algal blooms can be controlled using a variety of physical, chemical, or biological strategies. A short summary of algae control measures that have been used or could be considered for use in New York is provided in Table 6.1. Readers are encouraged to learn more about in-lake control techniques on the USEPA control and treatment website. The control measures discussed below are covered in much greater detail in Chapter 7 of Diet for a Small Lake, Algae and Other Undesirables: Getting Rid of Yuck. Many algal control measures require permits from DEC Regional Environmental Permit Administrators, who should be consulted before any algal control measure is implemented.
<table>
<thead>
<tr>
<th>Method</th>
<th>Principle</th>
<th>Pros</th>
<th>Cons</th>
<th>Limitations</th>
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</tr>
<tr>
<td>Biomanipulation</td>
<td>Manipulate trophic interactions by stocking piscivorous fish to eat planktivorous fish</td>
<td>Once stocked, fish are inconspicuous, may improve sports fishery, method is regarded as &quot;natural,&quot; inexpensive</td>
<td>Risk of disrupting fish community or other unexpected consequences, highly variable success rate, assumes planktivorous fish dominate lake food web</td>
<td>Need to evaluate fisheries data on existing food web &amp; probable changes related to manipulation</td>
<td>Article 11 stocking permit</td>
<td>Highly variable; $100-$2k/acre</td>
</tr>
<tr>
<td>Floating islands</td>
<td>Artificial wetlands outcompete algae for suspended nutrients; islands act as nutrient sinks</td>
<td>Natural appearance, some evidence of success in small ponds, other potential beneficial uses (such as acting as a nursery for terrestrial plantings), a long-term control strategy</td>
<td>Limited history of use in NYS, may be unsightly or impact active recreation, limited to small ponds or isolated portions of larger waterbodies, need to harvest islands to prevent nutrients from migrating back to water</td>
<td>Not known</td>
<td>Not known</td>
<td>Not known</td>
</tr>
</tbody>
</table>

**CHEMICAL CONTROL METHODS**

<table>
<thead>
<tr>
<th>Method</th>
<th>Principle</th>
<th>Pros</th>
<th>Cons</th>
<th>Limitations</th>
<th>DEC Permits</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algaecides</td>
<td>Kill algal cells through cellular toxicity (copper-based) or oxidation (hydrogen peroxide)</td>
<td>Immediate response, long history of copper usage in NYS, scalable</td>
<td>May have limited duration, potential non-target impacts, controversial in some settings, cell lysing can spill toxins into water, spot treatment may be difficult</td>
<td>Some water quality restrictions</td>
<td>Article 15/Part 327, Article 17/SPDES General Permit needed, Article 24 wetlands permit may be needed</td>
<td>Highly variable, $5-25 per acre-foot</td>
</tr>
<tr>
<td>Nutrient Precipitation and Inactivation</td>
<td>Precipitate nutrients in water and/or seal nutrients in the sediment, primarily with use of alum (aluminum sulfate), PhosLock (lanthanum-based), or iron</td>
<td>Can have immediate response &amp; long-term duration, may address significant internal nutrient sources, non-pesticidal, may minimize spillage of toxins from HABs</td>
<td>Permitting issues, fish toxicity in low pH lakes, public perception of chemical use, floc/sludge removal if nutrients intercepted, may have limited effectiveness in waterbodies that are not strongly stratified, high cost</td>
<td>Presently not allowed in NYS, but a permitting approval method may be developed in the future.</td>
<td>Not presently allowed</td>
<td>$100 - $500/acre</td>
</tr>
</tbody>
</table>

Table 6.1 Summary of various water management techniques used for algal blooms, their effectiveness, DEC permitting requirements and relative cost.
<table>
<thead>
<tr>
<th>Method</th>
<th>Principle</th>
<th>Pros</th>
<th>Cons</th>
<th>Limitations</th>
<th>DEC Permits</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>PHYSICAL CONTROL METHODS</strong></td>
<td></td>
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</tr>
<tr>
<td>Surface aeration, including oxygenation &amp; circulation</td>
<td>Inject oxygen or air to keep water moving, prevent nutrient release from anaerobic sediments</td>
<td>Reduces taste &amp; odor, reduce nutrient release in deep lakes, reduces surface scums, fast</td>
<td>Breaks down thermal layer, may move nutrients to surface, high cost for aerators/operation</td>
<td>Need access to power source, need expert to size &amp; install except in small ponds</td>
<td>Article 15 Protection of Waters may be required</td>
<td>Variable; $150-$2500/acre, DEC funds might support projects</td>
</tr>
<tr>
<td>Hypolimnetic aeration or oxygenation (not circulation)</td>
<td>Inject oxygen or air to prevent nutrient release from anaerobic sediments in deep lake areas</td>
<td>Reduce taste &amp; odor problems for potable water, might enhance deepwater fisheries, may improve quality of downstream water</td>
<td>Break down of thermal layer can be detrimental to coldwater fish, nutrient diffusion to the surface, high cost for aerators and their operation, takes time to be effective</td>
<td>Needs access to power source/batteries for compressors, large hypolimnion, &amp; an expert to size &amp; install except in small ponds</td>
<td>Article 15 Protection of Waters may be required</td>
<td>&gt;$2,500/acre, DEC funds might support projects in some limited cases</td>
</tr>
<tr>
<td>Drawdown</td>
<td>Reduce water level in autumn to expose sediments to winter freezing/desiccation and to consolidate sediments</td>
<td>Inexpensive &amp; easy for some waterbodies, can be combined with dock repair or macrophyte control, potential exposure impact to overwintering cyanobacteria cysts</td>
<td>Impacts non-target plants, invertebrates or fish, refill rates unpredictable, deep drawdown is needed to expose anoxic sediments &amp; cyanobacteria cysts, variable success at best, takes time</td>
<td>A dam or control structure is needed, deep drawdown permitting is unlikely</td>
<td>Article 15 Protection of Waters and Article 24 wetland permits may be required</td>
<td>Essentially no cost if a dam control structure is present</td>
</tr>
<tr>
<td>Hypolimnetic Withdrawal</td>
<td>Selectively remove water from hypolimnion, slowly replenish deepwater oxygen, and reduce nutrient release from sediments</td>
<td>Inexpensive if a siphon/deep outfall exists, removes nutrient source, inconspicuous, downstream cold water refugia are created</td>
<td>Potential impacts to aquatic life, potability, aesthetics (odor &amp; color), significant withdrawal rate needed for highly anoxic hypolimnia, risk of destratification, takes time</td>
<td>Need a deepwater siphon or deep outfall</td>
<td>Article 15 Protection of Waters permit may be required</td>
<td>Mostly valve operational costs if a deep outfall exists, up to $10,000 annual operating costs for siphons</td>
</tr>
<tr>
<td>Ultrasoundic waves</td>
<td>Apply 20kHz-1MHz sound waves to disrupt cyanobacteria cell walls &amp; gas vacuoles</td>
<td>Inconspicuous, works immediately</td>
<td>Multiple units needed, potential effects on non-target organisms, need to find correct frequency to target cyanobacteria, requires persistent use</td>
<td>Need local power source (or batteries), ultrasonic structure may be considered a regulated fill by permit offices</td>
<td>Need to consult with regional offices, may be considered to be pesticidal</td>
<td>$5000/unit + operating costs</td>
</tr>
<tr>
<td>Barley straw</td>
<td>Limit algae through contact with straw via rotifer predation, released hydrogen peroxide, adsorption, or other unknown mechanisms</td>
<td>Often deemed as a “natural” control method, can be done by non-professionals, inexpensive, can be removed if not working</td>
<td>Little empirical evidence of effectiveness, removal of spent bales can be difficult, may be unsightly</td>
<td>None</td>
<td>Need to consult with regional offices, may be considered to be pesticidal</td>
<td>$20-50/acre</td>
</tr>
</tbody>
</table>
7 Glossary

**Algal toxin**: A toxin produced by cyanobacteria, also called a cyanotoxin.

**Beach**: A public swimming area regulated by trained NYSDOH or OPRHP staff and routinely monitored for public safety.

**Bloom**: High concentrations of algal cells that may form surface scums, mats, or other dense accumulations of algal material.

**Blue-green algae**: An outdated, but still commonly used term for the class of bacteria now known as cyanobacteria.

**Cyanobacteria**: Also known as blue-green algae. Photosynthesizing bacteria that can produce toxins and other harmful substances that pose a health risk to exposed humans or animals. Cyanobacteria may be unicellular, colonial, or filamentous. Some genera are capable of fixing nitrogen.

**Cyanotoxin**: A toxin produced by cyanobacteria. Most are classified as hepatotoxins, neurotoxins, or other.

**Episodic surveillance/sampling**: Conducted outside of programs, or between routine surveillance/sampling, on an as-observed basis, in reply to bloom reports.

**Extent**: The geographic span of a bloom along the shoreline; during surveys, extent is recorded as *Small Localized, Large Localized, Widespread/Lakewide*, or present in open water.

**Hybrid**: A combination of event-based and routine programs. Includes adapting sampling locations to account for sampling conducted at bloom locations that may occur in addition to routine survey times or sampling sites.

**Report**: Any information regarding a potential bloom including visual surveillance, Suspicious Algal Bloom Report Form, emails, digital photographs, or bloom samples.

**Routine surveillance/sampling**: Conducted on a pre-determined schedule in pre-determined locations (particularly open water sites and locations known to be prone to blooms/scum accumulation). This type of program is most often conducted on lakes that have a documented history of HABs.

**Sampling**: Collecting representative water from suspected blooms as a means for detection and report generation regarding potential blooms.

**Scum**: An algal bloom that has a dense surface accumulation of cells or filamentous material.

**Stakeholder**: A person, business, or other organized entity that has an interest in a particular issue. Their interest may be financial, personal, or academic.
**Status**: Bloom designation assigned according to DEC criteria as *No Bloom*, *Suspicious*, *Confirmed*, or *Confirmed with High Toxins*.

**Surveillance**: A report on the visual evaluation of lake conditions as a means for detecting potential blooms.

**Suspicious Algal Bloom Report Form**: online reporting form for entering HAB reports into NYHABS.

**Zone**: Geographic span along shoreline subject to HAB surveillance.
8 Appendices
Appendix A. Generalized DEC HABs Sampling

For use and adaptation by DEC-approved programs that collect HABs samples. Additional training materials are available from the DEC HABs Program upon request.

Instructions

- **Prepare**: Bring DEC-provided sample form, digital camera, HAB image gallery sheet (if available), sample bottles, and gloves. Only collect samples if visual evidence of bloom is apparent. When in doubt, a sample should be collected, and DEC can advise (via email or phone) if samples should be submitted. If conducting surveillance by boat, make sure that personal flotation devices and other safety equipment are deployed as appropriate.

- **Digital photographs**: If a suspected bloom is observed, take a close-up photograph (within 10-20 feet if possible) of the water surface at the most intense part(s) of the bloom. This will help to characterize the bloom. For small lakes that can be completely surveyed from a single site, photograph a wide view of the entire lake to demonstrate the extent of the bloom. For lakes with public and/or surveyor access limited to discrete locations, photograph a wide view of this accessible site that shows as much of the bloom area as possible. Go to next accessible site and repeat these procedures until as much of the lakeshore has been surveyed as possible. For all photos, label the image files with the waterbody name, location/site name or description, and date.

- **Bloom visual description**: If a lake-specific HAB Bloom Sample Data Sheet has been provided, consult the thumbnail images or another visual HAB photo gallery (if available) to categorize the bloom conditions visible on the lake.

<table>
<thead>
<tr>
<th>Collect a HABs Sample</th>
<th>Do Not Collect a HABs sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spilled paint appearance on surface</td>
<td>Bubbling scum on surface</td>
</tr>
<tr>
<td>Pea soup</td>
<td>Slight greenish or brownish tint</td>
</tr>
<tr>
<td>Streaks</td>
<td>Duckweed or watermeal (floating plants)</td>
</tr>
<tr>
<td>Green dots or clumps</td>
<td>Other</td>
</tr>
</tbody>
</table>

- **Bloom extent**: If no blooms are observed, check the box on the field form stating *no bloom present*. If blooms are observed, describe the extent of the overall bloom conditions on the lake as *small localized* (covering < 100 feet, affects a small area of the waterbody, limited from one to several neighboring properties), *large localized* (covering many properties within an entire cove, along a large segment of the
shoreline, or in a specific region of the waterbody), or widespread/lakewide (covering the entire waterbody, a large portion of the lake, or most to all of the shoreline). Describe the extent of the shoreline surveyed (provide locations and sizes of sections surveyed if the entire lake was not surveyed). Use the lake map to sketch the extent of visible surface or immediate subsurface algal bloom coverage (scums, streaks, dots, etc.). Use the map scale or landmarks to guide the drawing.

- **Sample collection:** If a bloom is not apparent, there is no need to collect a sample. If any suspected blooms are observed, identify the most intense (thickest or most discolored scum, streaks, or concentration of dots or surface material) part of the bloom. **Sample from a boat if possible rather than entering the water.** Protect yourself with disposable gloves. Limit any exposure to scums. Skim the surface to collect a sample with the densest amount of scum possible. Collect a sample in the sample bottle by slowly plunging the inverted bottle beneath the surface the water, avoiding bloom exposure to the skin. Tip the bottle slightly upward to allow air to exit and the bottle to fill up to the neck, then cap the bottle. **If possible, rinse the side of the closed bottle with clean water from the lake to minimize exposure to the bloom.** Wash any areas of the skin that contact scums with clean water. Monitor yourself for any exposure symptoms.
2  DEC Suspicious Algal Bloom Report Form

A digital version of this form is accessible through a link found at:
www.dec.ny.gov/chemical/77118
Please use the map below to locate the position of the bloom.*

Name of the Lake?*
* Please input the name of the waterbody below.

Is there public access to this location?

- Yes
- No

Which sections of the lake have a bloom?
* Please choose all that apply.

- North
- East
- West
- South
Please describe the extent of the bloom.

- **Small Localized**
  The bloom is contained to a very small area of the lake, limited from one to several neighboring properties. i.e. The bloom is clearly just at a boat launch, with clear margins where you can see the end of the bloom.

- **Large Localized**
  The bloom is in a small area, but extends beyond a feature, affecting many properties with an entire cove, along a large segment of the shoreline, or in a specific region of the waterbody. i.e. A boat launch, plus the surrounding area, but you can see a clear margin where the bloom stops.

- **Widespread/Lakewide**
  The bloom is as far out as you can see, and seems to affect the entire waterbody, or most or all of the shoreline. i.e. A boat launch, the surrounding area, and you cannot see the end of the bloom.

- **Open Water**
  You noticed the bloom while out in the middle of the lake. i.e. On a boat, and you don’t know, or can’t see the end of the bloom on the shoreline.

- **No Bloom Present**
Does the water look like any of the following descriptions?
Click on the photo for a larger image. Please choose all that apply.

- Bubbling scum on the surface.
- Green dots/clumps on or in the water.
- Hairy, silky strands on rocks, plants or water.
- Green streaks on the water surface.
- Pea soup appearance within the water.
- Spilled paint appearance on the surface of the water.
- Other, please specify below.
Please describe the appearance of the bloom, or any additional comments.

Please upload a clear photo of the bloom.
*Please take a close-up photo of the water surface at the most intense part(s) of the bloom.*

Press here to choose image file. (<10MB)

Please upload a second clear photo if needed.
*Please take a wide view photograph of the entire lake to demonstrate the extent of the bloom, or as much of the accessible area as possible.*

Press here to choose image file. (<10MB)

Submit
3 HABs Warning Sign

This poster is available on the DEC HABs website at: www.dec.ny.gov/chemical/77118

The sign is for lake communities to alert lake users of the potential presence of a HAB on a waterbody.

[Image of the HABs Warning Sign]

Avoid Harmful Blue-green Algae Blooms while swimming, fishing and boating

Keep kids and pets away from areas with blooms or scum.
Swim, fish and boat in areas with no blooms or scum.

Contact can make people and animals sick.

If contact occurs, rinse with clean water.
If symptoms occur, contact a medical provider.

Blooms can look like streaks, spilled paint, pea soup, floating clumps or dots.

Learn more: www.health.ny.gov/HarmfulAlgae and on.ny.gov/hab
4 References and Resources

DEC Harmful Algal Blooms webpage
www.dec.ny.gov/chemical/77118

NYS Department of Health Blue-green Algae and Health webpage
www.health.ny.gov/environmental/water/drinking/bluegreenalgae

U.S. Environmental Protection Agency: CyanoHABs Webpage
www.epa.gov/cyanohabs


New York Citizens Statewide Lake Assessment Program (CSLAP) Sampling Protocol
www.dec.ny.gov/docs/water_pdf/cslapsampro.pdf

New York Federation of Lake Associations
www.nysfola.org