NEW YORK
STATE OF
OPPORTUNITY

Department of
Environmental
Conservation

HARMFUL ALGAL BLOOMS (HABS)

PROGRAM GUIDE

www.dec.ny.gov

Contents

List of Tables

List of Figures

Abbreviations and Acronyms

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

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. The New York State 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 DEC identifies and documents cyanobacteria HABs, 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 bloom status (No Bloom, Confirmed Bloom, or Confirmed with High Toxins Bloom). The bloom status system provides a uniform way to rapidly communicate interpreted 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 the New York HAB System (NYHABS) which features an interactive map of current and archived bloom locations and 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 initiative to aggressively combat HABs, 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 HABs. The summits drove the creation of Action Plans for 12 priority lakes and advanced technology pilots. These efforts will lead to knowledge that can be applied to waterbodies across the state. This guide includes information regarding HAB prevention and control approaches; watershed-based 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).

What is the DEC HABs Program?

The program consists of DEC staff within DOW BWAM who work to identify bloom status, oversee HAB monitoring and surveillance activities, communicate public health risks, and conduct outreach, education, and research.

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.

What do HABs look like? Know it!

Cyanobacteria HABs can have a variety of appearances such as scattered green dots in the water, long, linear green streaks, pea soup or spilled paint appearance, or blue-green or white coloration. For more info: http://www.dec.ny.gov/chemical/81962.html

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 (BWAM) 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. BWAM programs address the mission of the DOW and identify water quality issues of concern 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 like 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.

What if you see a bloom? Avoid it! Report it!

People, pets and livestock should avoid contact with water that is discolored or has algal scums on the surface. If a bloom is present, do not use the water and report to DEC using the Suspicious Algal Bloom Report Form: on.ny.gov/habform

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 or sampling is done on individual waterbodies by agency staff, researchers, consultants, trained volunteers or as part of special studies. As described below, several 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 at times compromised drinking and recreational water uses. In response, a HABs program within DOW was developed to address blooms in New York. 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 reduce HABs or link algal blooms to nutrient concentrations or other causes

2.4. Agency Responsibilities

The DEC HABs Program consists of DEC staff within DOW, BWAM. The current structure of the DEC HABs Program relies on partnerships with state agencies and a wide range of external partners 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 (CWA). NYSDOH and OPRHP have separate statutory responsibility for protecting public health. For example, NYSDOH developed a HABs 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.

DEC coordinates additional HABs surveillance, monitoring and outreach with several 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 Alleghany Reservoir) 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 HABs include:

- DEC HABs Program:
  - Coordinate HABs surveillance and sampling statewide. Track and record bloom reports received from DEC regional and field staff, NYSDOH, OPRHP, federal agencies, the public, CSLAP, LCI and other HABs programs. The

program assigns bloom status, receives and interprets lab results and provides information about blooms through education and outreach materials.
    - Maintain contractual relationships with analytical labs for HAB sample analysis.
    - Prepare and issue updates on bloom status from May to October on the DEC HABs website. Maintain an online interactive map of bloom notifications from May-October (NYHABS).
    - Maintain an inter-agency database of report locations and preliminary laboratory results.
    - Maintain a drop box for HABs inquiries: HABsInfo@dec.ny.gov.
    - Publish results of findings in DEC reports, individual lake reports and other formats.
- Conduct statewide lake monitoring programs (LCI and CSLAP) and managing most lake-related public outreach (BWAM staff).
- Report blooms through NYHABS as they are encountered in the field (DEC field staff).

A HABs coordinator is assigned in each DEC region. Some coordinators serve primarily as conduits to the central office by sharing 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 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 report HAB occurrences and regulated bathing beach closures via NYHABS.
- 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. The lab possesses 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 public outreach materials, 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 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. Report HABs occurrences and bathing beach closures via NYHABS.
- 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; report HABs occurrences via NYHABS.

Table 2.1 Summary of state agency programmatic responsibilities

	DEC				NYSDOH & LHDs	OPRHP
	HABs Program	LCI	CSLAP	Other DEC Staff		
Surveillance & Monitoring						
Surveillance	✓	✓	✓	✓	✓	✓
Sampling	✓	✓	✓	✓	✓	✓
Analysis	✓ *				✓	
Outreach						
Public health					✓	
Beach closures					✓	✓
Email drop box	✓				✓	
Use NYHABS	✓			✓	✓	✓
HABs website	✓				✓	
Respond to public inquiries	✓			✓	✓	✓

*microscopy only

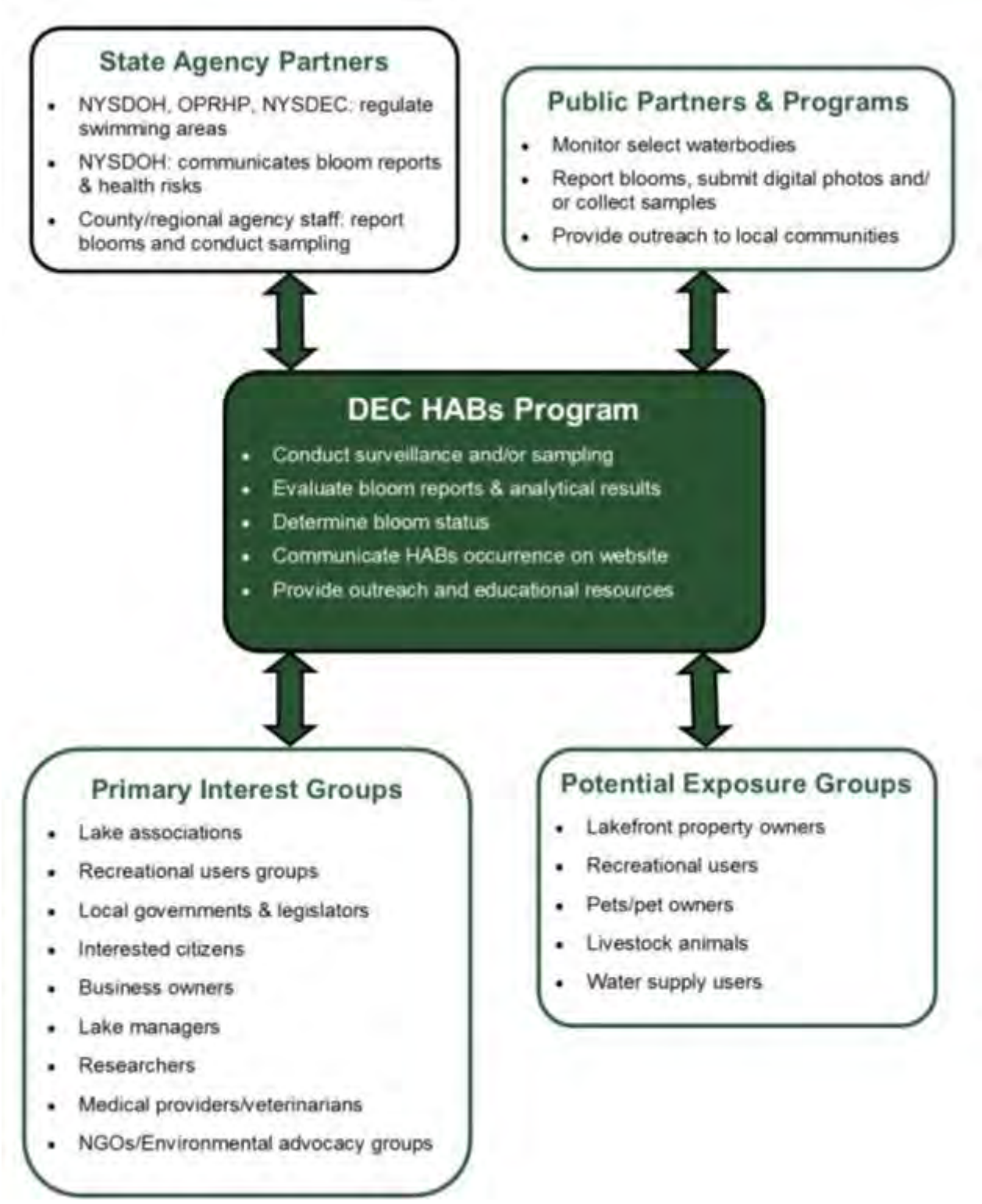


Figure 2.1 Summary of organization roles, interest groups, and exposure groups that are served by the DEC HABs Program.

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 report. 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, 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 reports and 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 other types of algal blooms less likely to produce toxins.

The DEC HABs Program has working relationships with several analytical labs that can analyze HABs samples. DEC utilizes the following analytical parameters to determine bloom status and evaluate HABs over time: 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: Applied to a HAB report evaluated by DEC HABs Program or NYSDOH staff to have a low likelihood of a cyanobacteria bloom present. At least one of the following criteria must be met: (1) visual evidence is not consistent with a cyanobacteria bloom; (2) BG chlorophyll levels ≤ 25 µg/L; (3) microscopic indication that sample is not dominated by cyanobacteria or not present in bloom-like density; or (4) total microcystins ≤ 4 µg/L (only in absence of the previous criteria being met).

Suspicious Bloom: Applied to any HAB report received that DEC or NYSDOH staff are unable to determine conclusively as a cyanobacteria bloom because photos were not provided, or the report was otherwise inconclusive.

Confirmed Bloom: Applied to a HAB report received from the public or a trained participant in a HAB reporting program that DEC or NYSDOH staff determine, based on digital photographs or a descriptive field report, is a cyanobacteria bloom; OR

HAB report received by DEC with associated laboratory analytical results from a sampled bloom, that meet the following criteria: (1) BG chlorophyll levels ≥ 25 µg/L; (2) microscopic confirmation that majority of sample is cyanobacteria and in absence of chlorophyll value, at a density indicative of bloom conditions; (3) only in absence of the previous criteria being met: total microcystins ≥ 4 µg/L but < 20 µg/L and digital photographs or a descriptive field report.

Confirmed with High Toxins Bloom: Applied to a HAB report received by DEC with associated laboratory analytical results from a sampled bloom, that meet the criteria of a Confirmed Bloom AND any of the following criteria: (1) total microcystins ≥ 20 µg/L (shoreline samples only); (2) total microcystins ≥ 10 µg/L (open water samples only); (3) DEC and NYSDOH staff determine potential risk of exposure to anatoxin or another cyanotoxin.

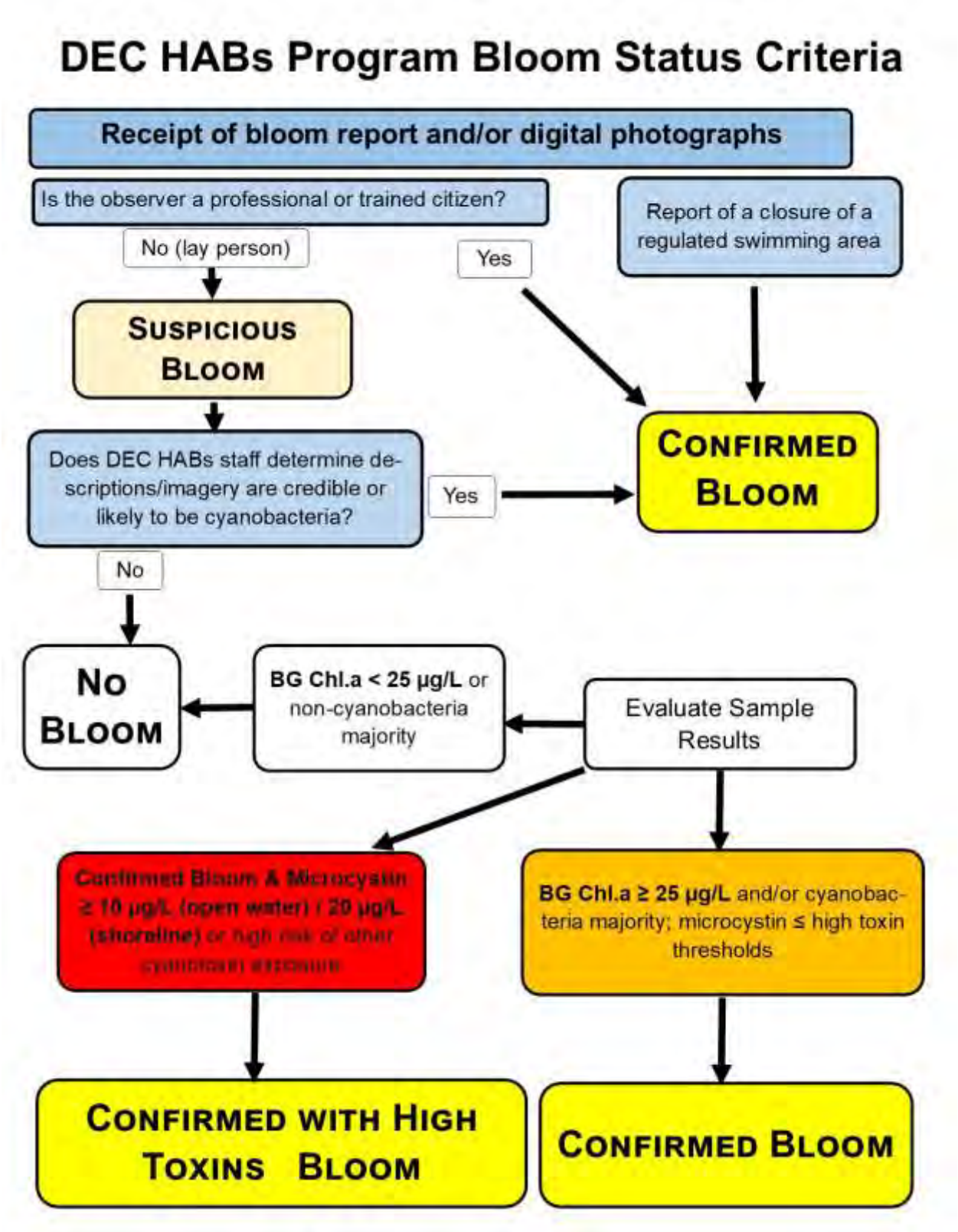


Figure 3.1 Decision tree that indicates the process by which DEC HABs Program staff determine the status of a potential bloom; updated in 2020.

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; updated in 2020.

Type of Information	Explanation	Format	Sources	Connection to Bloom Status Criteria
Visual/Field Report (Lay person)	Description of a suspected algal bloom	Online Report Form, or email to DEC or NYSDOH drop box, phone calls	Public	Can be used to designate a Suspicious or Confirmed Bloom
Visual/Field Report (Trained personnel: DEC or NYSDOH staff or reporting program participant)	Description of an algal bloom, with location, extent, etc.	Received through NYHABS Report Forms	NY Agency staff, CSLAP volunteers, HABs program partners	Can be used to designate a Confirmed Bloom
Digital Photograph	Photographs of an algal bloom in an electronic format	Digital photographs files received through NYHABS Report Forms	Public, DEC or NYSDOH staff, CSLAP volunteers, other HABs program partners	Can be used to designate a Confirmed Bloom
Quantitative Phytoplankton Count	Numerical count of algal abundance present in samples	Numerical data sent from external HABs programs to DEC HABs Program	Only received for Alleghany Reservoir (USACE), Lake Champlain (VT DEC), NYC reservoirs (NYCDEP)	Can be used to designate a Confirmed Bloom*
Qualitative Microscopy	Narrative describing the phytoplankton community composition present in water samples	Narrative data sent from labs to DEC HABs Program or as analyzed by DEC staff	Partner labs or DEC HABs Program staff	Can be used to designate a Confirmed Bloom
Pigment/chlorophyll Concentration	Extracted Chlorophyll a or Fluoroprobe chlorophyll concentrations (µg/L) present in water samples	Numerical data sent from labs to DEC HABs Program	Partner labs	Can be used to designate a Confirmed Bloom
Toxin Concentration	Concentrations of cyanotoxins (µg/L) present in water samples	Numerical data sent from labs to DEC HABs Program	ELAP certified labs for total microcystins	Can be used to designate a Confirmed with High Toxins Bloom

*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 cyanobacteria-dominated), a place-holding status (Needs Evaluation) was used internally in 2019. Beginning in 2020, the term Suspicious Bloom was used for the same function.

Recommended HAB Actions

- Know it! Avoid it! Report it!
- 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 NYSDOH
- Report blooms to DEC

A report will remain categorized as a Suspicious Bloom until additional information are received. When photos or lab results are received, they are evaluated following the criteria described above. If the digital photos, field report or lab results indicate that a cyanobacteria HAB is not present, the report is designated as No Bloom. If the photos indicate cyanobacteria HAB conditions or sample results meet the BG Chl.a threshold, the report will be designated as a Confirmed Bloom. A report of a Confirmed Bloom can later be changed to a Confirmed with High Toxins Bloom if the toxin threshold is exceeded.

A HAB sample only reflects the conditions at a single space and time and cannot be assumed with any certainty to reflect lasting conditions in an entire section of shoreline, or a whole waterbody. An individual sample may or may not reflect the highest densities of cyanobacteria or cyanotoxins present in a 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 has based bloom status criteria 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 WHO chlorophyll a guidance values based on fluoroprobes to rapidly detect cyanobacteria-specific pigments (BG Chl.a). A benchtop FluoroProbe (bbe moldaenke©) can be used to rapidly quantify relative quantities of algal pigments using fluorescence spectroscopy.

Table 3.2 WHO guidance values for the relative probability of health effects resulting from exposure to cyanobacteria blooms and microcystin

Relative Probability of Acute Health Effects	Cyanobacteria (cells/mL)	Microcystin-LR (µg/L)	Chlorophyll-a (µg/L)
Low	<20,000	<10	<10
Moderate	20,000-100,000	10-20	10-50
High	100,000-10,000,000	20-2,000	50-5,000
Very High	>10,000,000	>2,000	>5,000

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. Beginning in 2018, DEC adopted a BG chlorophyll threshold of 25 µg/L BG Chl.a and qualitative assessment of amount of cyanobacteria within a bloom under a microscope to verify "dominance."

In 2020, DEC broadened Confirmed Bloom status definition to be applied to visual reports (previously designated a Suspicious Bloom). The use of visual reports to confirm a HAB is consistent with DOH protocols for closing regulated swimming areas. As of 2020, the Suspicious Bloom status is applied to HAB reports that cannot be confirmed to be a HAB by DEC because photos were not provided, or the reports were inconclusive.

The DEC HABs Program uses pigment analyses (Chl.a) and visual observations (photos) as the primary information to determine bloom status and advisory language. This information can be evaluated more quickly than toxin data; this ensures that bloom reports are communicated to the public rapidly. Suspicious or Confirmed bloom status does not ensure that toxins are not present, but simply that the analytical information available did not indicate toxins were above the High Toxins threshold. DEC recommends that all HABs should be avoided, regardless of toxin data, because cyanobacteria HABs can produce other harmful compounds such as dermal irritants and other uncharacterized or unmeasured toxins.

Outreach messaging and avoidance language used by DEC and DOH are comparable for all waterbodies, regardless of bloom status.

3.3. Cyanotoxins and Other Harmful Compounds

There are three potential exposure routes for humans and animals to cyanotoxins and other cyanobacteria compounds: dermal, ingestion, or inhalation of aerosolized toxins.

Exposure may 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 may cause:

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

The mechanisms that produce cyanotoxin and conditions for toxin release are not well understood and the relationship between algal biomass and toxin concentration is not clear. Presently, the analytical methods available to detect cyanotoxins are expensive and require sophisticated laboratory equipment and trained analysts. There are several types of techniques to detect cyanotoxins or the potential for cyanotoxin production in samples including biological assays, chromatographic methods, or genetic methods.

The most common cyanotoxin detected by the DEC HABs Program is microcystin; anatoxin-a is detected less frequently. These cyanotoxins are listed on the USEPA's fourth Contaminant Candidate List. However, additional cyanotoxins and other bloom-related compounds may be of concern for public health risks.

Microcystins

Microcystin is the most commonly detected cyanotoxin. 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 Confirmed with High Toxin Bloom criteria is based on a 10 µg/L (open water) and 20 µg/L (shoreline) threshold for total microcystins. These values were derived from the WHO criteria moderate risk thresholds (Table 3.2).

For assessment purposes, EPA recommends that an exceedance during a 10-day, non-rolling assessment period is considered an excursion and that no more than 3 excursions should occur during a recreation season and that if that pattern reoccurs in more than 1 year, it may indicate that the waterbody is not supporting recreational uses. New York continues to evaluate EPA's values , in the context of the DEC bloom status criteria which is intended to be protective for recreational use of waterbodies.

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.

Given the lack of federal guidance and wide variations in individual state advisory values, the DEC HABs Program has not adopted a specific Confirmed with High Toxin threshold for anatoxin-a. This toxin is not detected often in water samples in New York State, because the toxin degrades rapidly in sunlight making anatoxin-a detection a monitoring and analytical challenge.

Cylindrospermopsin

Cylindrospermopsin is produced by several kinds of cyanobacteria, commonly encountered in New York, however, this toxin is rarely detected in water samples analyzed by the DEC HABs Program. DEC does not have a Confirmed with High Toxins Bloom threshold for cylindrospermopsin.

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. Due to lack of published data, absence federal guidelines, and low rates of occurrence of other cyanotoxins in New York the DEC HABs Program only has bloom status thresholds for total microcystins.

Additional information regarding HABs and health can be found at: DOH Blue-green Algae and Health webpage.

4. Bloom Reporting: HABs Documentation by DEC

4.1. Surveillance & Sampling: Two approaches

HABs are reported to the DEC HABs Program through two general mechanisms:

Surveillance

Bloom surveillance is a visual evaluation of lake conditions; a water sample may or may not be collected or analyzed. Reports may be a single observation reported by a member of the public to DEC by phone, an email to HABsinfo@dec.ny.gov, and/or the submission of a Suspicious Algal Bloom Report Form (see Section 7.2), or other communication which may or may not include digital photographs. DEC, NYSDOH, LHDs and OPRHP staff send in reports either generated by their own surveillance or after receiving reports from the public. Surveillance is conducted by external partner programs (e.g., local lake programs, lake communities, volunteer groups, and parks) that commit to routine surveillance at specific waterbodies. Participants in these

programs typically complete a trained user report form provided by the DEC HABs Program. The form collects information about field conditions. Surveillance reports may be used to designate a bloom as Suspicious.

NYSDOH has established protocols to close regulated beaches based on visual surveillance (see 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 by NYSDOH, NYSDEC and OPRHP for regulated swimming beaches. HABs-related beach closures were considered by DEC to be Suspicious Blooms prior to 2020. Beginning in 2020, they were designated as Confirmed Blooms.

Sampling

HAB samples are collected due a bloom report or based on pre-determined sampling program protocols. HABs samples, particularly when paired with water quality testing, can provide valuable data that may be used to better understand long-term patterns in geographic extent, toxicity, duration, and other characteristics of blooms in a waterbody. Analytical results from a sample 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:

- A trained member or affiliate of the partner organization (volunteer, employee, or agency worker) observes waterbody conditions. 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 contracted partner laboratory to be analyzed for phytoplankton community composition via microscopy, pigment concentration, and toxins (See Chapter 3 for more detail).
- Some programs report 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.

4.2. HABs Monitoring and Reporting 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. Data collected by LCI are used to monitor long term trends in New York State's ponded waters as well as to support water quality management functions within DOW including the development of Clean Water Plans, source water protection plans, nutrient criteria, and updates to the Waterbody Inventory /Priority Waterbodies List. 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 limited historical data or a potential water quality problem. A full suite of field data and laboratory water quality parameters (profiles, water chemistry, Secchi depth, etc.) are collected during sampling events. This program was developed to characterize overall water quality conditions, not necessarily HAB occurrences. When a HAB is encountered during sampling events, digital photographs and water samples are collected and submitted to NYHABS.

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 250 lake associations and 2,000 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 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 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 Reporting Programs:

Several lake communities have developed structured HAB reporting 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 local organizational frameworks. Most programs only report HABs while a few monitor further water quality parameters in addition.

NYC and Long Island Enhanced HAB Reporting:

The NYC Department of Parks and Recreation and researchers at Stony Brook University oversee a hybrid sampling, reporting and research partnership for waterbodies within New York City parks and Long Island. Routine reporting and/or sampling is conducted on lakes with persistent blooms and episodic reporting is conducted on other lakes with HABs as they are observed.

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 4 µg/L microcystin. Sample analyses are 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; DEC provides a link on the HABs notification page.

Great Lakes (Lake Erie and Lake Ontario):

There is no basin-wide defined HABs response or management plan for the Great Lakes that border New York. 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.

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 cyanobacteria based on visual appearance 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 Reporting 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.

5.1. Communication to Collaborators

The communication process begins when a report of a potential bloom is submitted to NYHABS. This report includes digital photographs and 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, staff work to transmit relevant information as quickly as possible. Rapid and broad-reaching responses rely on the use of NYHABS and DEC HABs website by state agency staff.

NYHABS Data Elements

NYHABS facilitates the collection of field and lab reports into a single data storage location. Records from the two Survey123 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)

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.

Attachments

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

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, 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 sufficiently protective for public health 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 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 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 sampling season ends, even if some blooms persist into the fall.

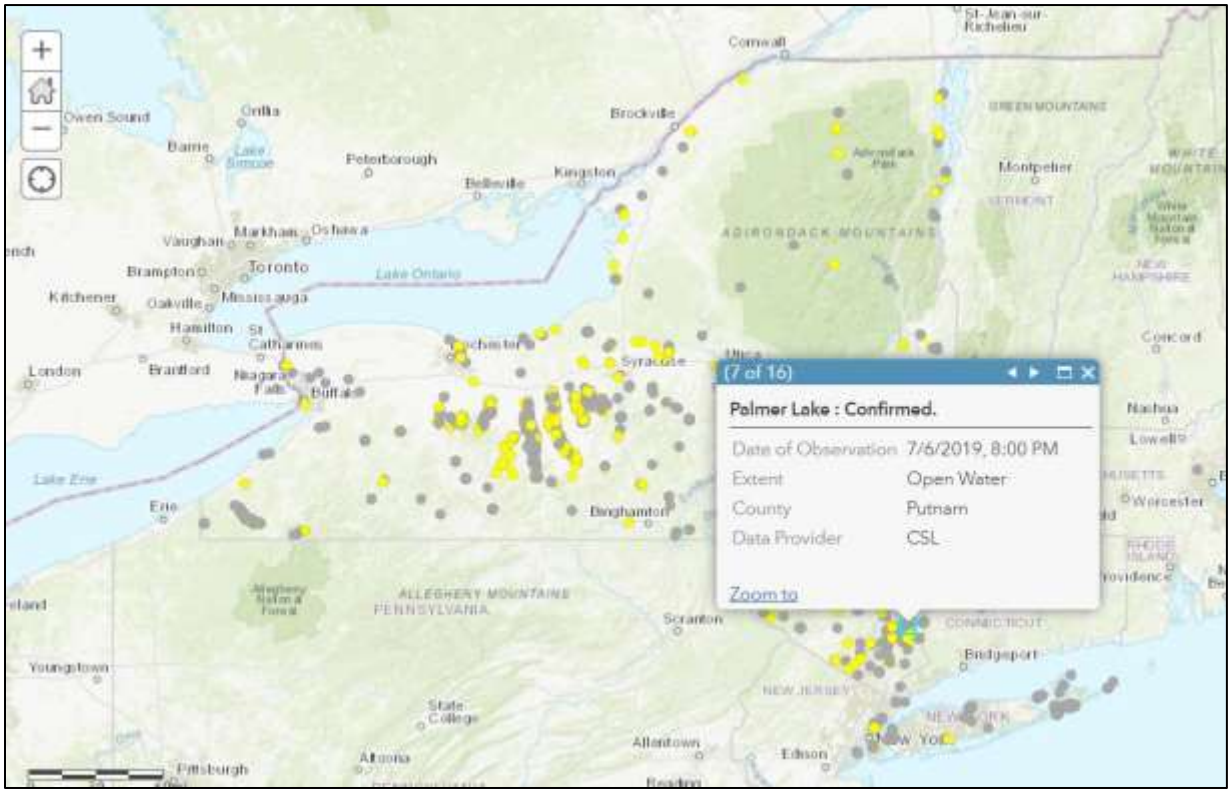


Figure 5.1 Example of the statewide map of HABs locations that is displayed on the DEC HABs notifications page through NYHABS.

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 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 (Available for download; see section 7.3).
- 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 *Making Waves*, DEC's weekly email newsletter regarding water issues.
- 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.
- Members of the public can directly access the NYHABS Suspicious Algal Bloom Report Form. Users are instructed to complete the form and submit it with digital photographs.
- NYSDOH has maintained a HABs webpage since 2003. Several local health department 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 during 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 educational materials for publication in lake association newsletters, DEC's *Conservationist* magazine, peer reviewed literature, and other outreach methods.
- DEC HABs Program staff participate in regional and national HABs working groups and share data and program development strategies with other states or agencies.

5.4. DEC Monitoring Program Reporting

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 a DEC website. The 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 LCI monitoring locations. The reports include annual and cumulative summaries of all LCI program information, with a focus on physical and chemical limnological indicators.

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 initiated several mitigation pilot projects in 2018 on small waterbodies selected for their history of documented HABs, nutrient levels, relative size, and uses. DEC is assessing the data from these projects 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, in 2018 DEC began collaborating with the USGS Troy Water Science Center, on an advanced HABs monitoring pilot on three Finger Lakes (Seneca,

Skaneateles, and Owasco 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 be 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. 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 managing the cause of blooms. 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 6.1 Summary of water management techniques used for algal blooms or nutrient control, their effectiveness, DEC permitting requirements and relative cost.

Method	Principle	Pros	Cons	Limitations	DEC Permits	Cost
BIOLOGICAL CONTROL METHODS						
Biomanipulation	Manipulate trophic interactions by stocking piscivorous fish to eat planktivorous fish	Once stocked, fish are inconspicuous, may improve sports fishery, method is regarded as "natural," inexpensive	Risk of disrupting fish community or other unexpected consequences, highly variable success rate, assumes planktivorous fish dominate lake food web	Need to evaluate fisheries data on existing food web & probable changes related to manipulation	Article 11 stocking permit	Highly variable; $100-$2k/acre
Floating islands	Artificial wetlands outcompete algae for suspended nutrients; islands act as nutrient sinks	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	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	Not known	Not known	Not known
CHEMICAL CONTROL METHODS						
Algaecides	Kill algal cells through cellular toxicity (copper-based) or oxidation (hydrogen peroxide)	Immediate response, long history of copper usage in NYS, scalable	May have limited duration, potential non-target impacts, controversial in some settings, cell lysing can spill toxins into water, spot treatment may be difficult	Some water quality restrictions	Article 15/Part 327, Article 17/SPDES General Permit needed, Article 24 wetlands permit may be needed	Highly variable, $5-25 per acre-foot
Nutrient Precipitation and Inactivation	Precipitate nutrients in water and/or seal nutrients in the sediment, primarily with use of alum (aluminum sulfate), PhosLock (lanthanum-based), or iron	Can have immediate response & long-term duration, may address significant internal nutrient sources, non-pesticidal, may minimize spillage of toxins from HABs	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	Presently not allowed in NYS, but a permitting approval method may be developed in the future.	Not presently allowed	$100 - >$500/acre

Method	Principle	Pros	Cons	Limitations	DEC Permits	Cost
PHYSICAL CONTROL METHODS						
Surface aeration, including oxygenation & circulation	Inject oxygen or air to keep water moving, prevent nutrient release from anaerobic sediments	Reduces taste & odor, reduce nutrient release in deep lakes, reduces surface scums, fast	Breaks down thermal layer, may move nutrients to surface, high cost for aerators/operation	Need access to power source, need expert to size & install except in small ponds	Article 15 Protection of Waters may be required	Variable; $150-$2500/acre, DEC funds might support projects
Hypolimnetic aeration or oxygenation (not circulation)	Inject oxygen or air to prevent nutrient release from anaerobic sediments in deep lake areas	Reduce taste & odor problems for potable water, might enhance deepwater fisheries, may improve quality of downstream water	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	Needs access to power source/batteries for compressors, large hypolimnion, & an expert to size & install except in small ponds	Article 15 Protection of Waters may be required	>$2,500/acre, DEC funds might support projects in some limited cases
Drawdown	Reduce water level in autumn to expose sediments to winter freezing/desiccation and to consolidate sediments	Inexpensive & easy for some waterbodies, can be combined with dock repair or macrophyte control, potential exposure impact to overwintering cyanobacteria cysts	Impacts non-target plants, invertebrates or fish, refill rates unpredictable, deep drawdown is needed to expose anoxic sediments & cyanobacteria cysts, variable success at best, takes time	A dam or control structure is needed, deep drawdown permitting is unlikely	Article 15 Protection of Waters and Article 24 wetland permits may be required	Essentially no cost if a dam control structure is present
Hypolimnetic Withdrawal	Selectively remove water from hypolimnion, slowly replenish deepwater oxygen, and reduce nutrient release from sediments	Inexpensive if a siphon/deep outfall exists, removes nutrient source, inconspicuous, downstream cold water refugia are created	Potential impacts to aquatic life, potability, aesthetics (odor & color), significant withdrawal rate needed for highly anoxic hypolimnia, risk of destratification, takes time	Need a deepwater siphon or deep outfall	Article 15 Protection of Waters permit may be required	Mostly valve operational costs if a deep outfall exists, up to $10,000 annual operating costs for siphons
Ultrasonic waves	Apply 20kHz- 1MHz sound waves to disrupt cyanobacteria cell walls & gas vacuoles	Inconspicuous, works immediately	Multiple units needed, potential effects on non-target organisms, need to find correct frequency to target cyanobacteria, requires persistent use	Need local power source (or batteries), ultrasonic structure may be considered a regulated fill by permit offices	Consult with regional offices, may be considered to be pesticidal	$5,000/unit + operating costs

7. Appendices

7.1. Appendix A. Glossary

Algal toxin: A toxin produced by cyanobacteria, also called a cyanotoxin. Most are classified as hepatotoxins, neurotoxins, or other.

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. Photosynthetic prokaryotic bacteria that can produce toxins and other harmful substances that pose a health risk to humans or animals exposed through dermal contact, ingestion or inhalation. Cyanobacteria may be unicellular, colonial, or filamentous. Some genera are capable of fixing nitrogen.

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 *open water*.

Report: Any information regarding a potential bloom including visual surveillance, submissions of online forms to NYHABS (on.ny.gov/habform or on.ny.gov/habproform), emails, digital photographs, or bloom samples.

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

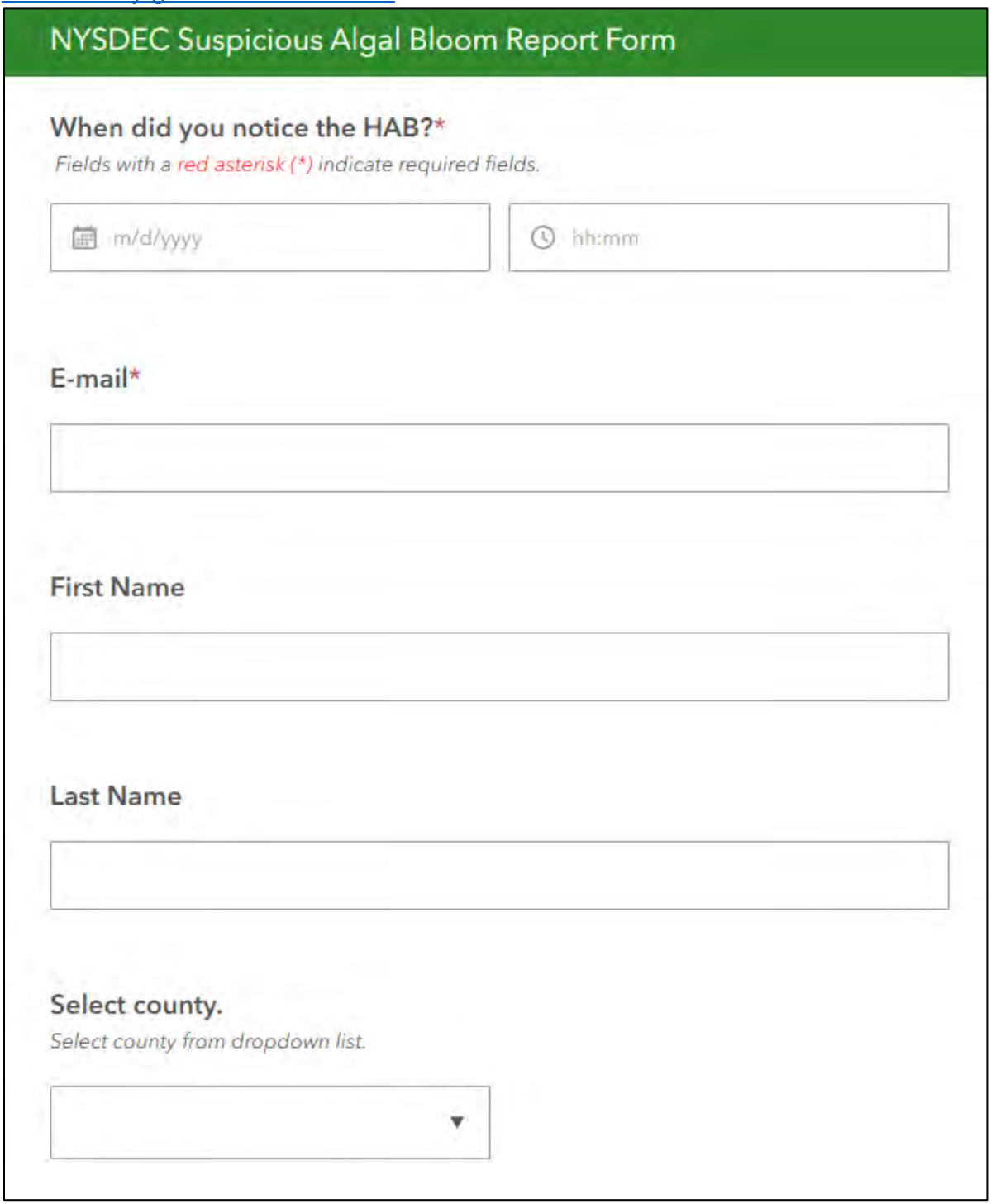
Scum: An algal bloom with dense surface accumulation of cells or filamentous material.

Status: Bloom designation assigned according to DEC criteria as *No Bloom*, *Suspicious*, *Confirmed*, or *Confirmed with High Toxins*.

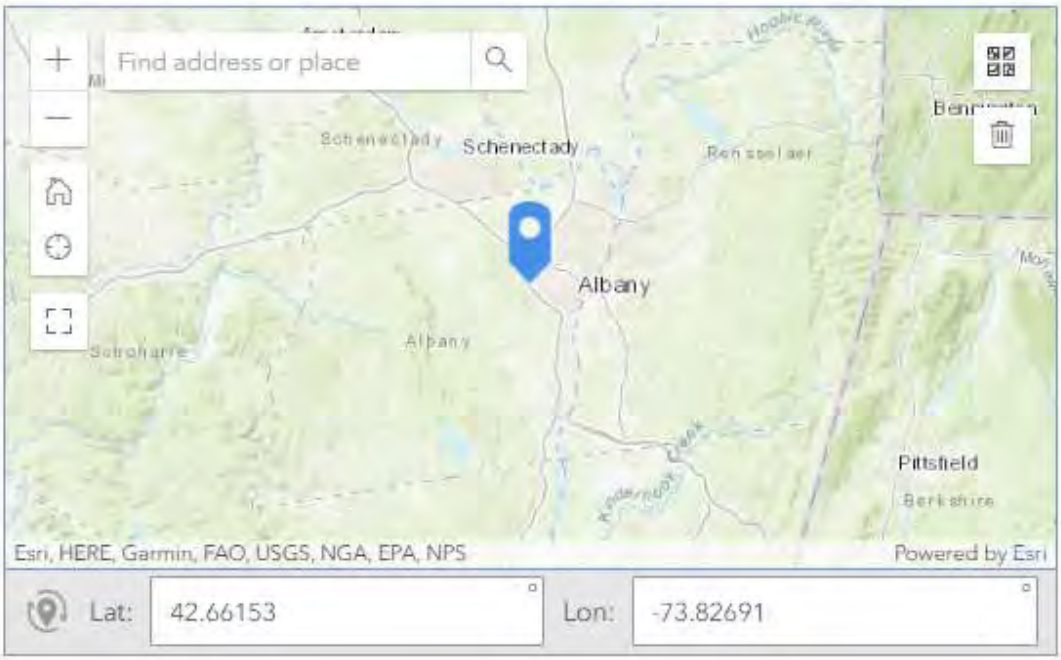
Surveillance: A report on the visual evaluation of lake conditions as a means for detecting potential blooms.

7.2. Appendix B. DEC Suspicious Algal Bloom Report Form

Below are the questions included in the public Suspicious Algal Bloom Report Form. A digital version of this form is accessible at: on.ny.gov/habform or by going to www.dec.ny.gov/chemical/77118.



Use the map below to locate the position of the HAB.*



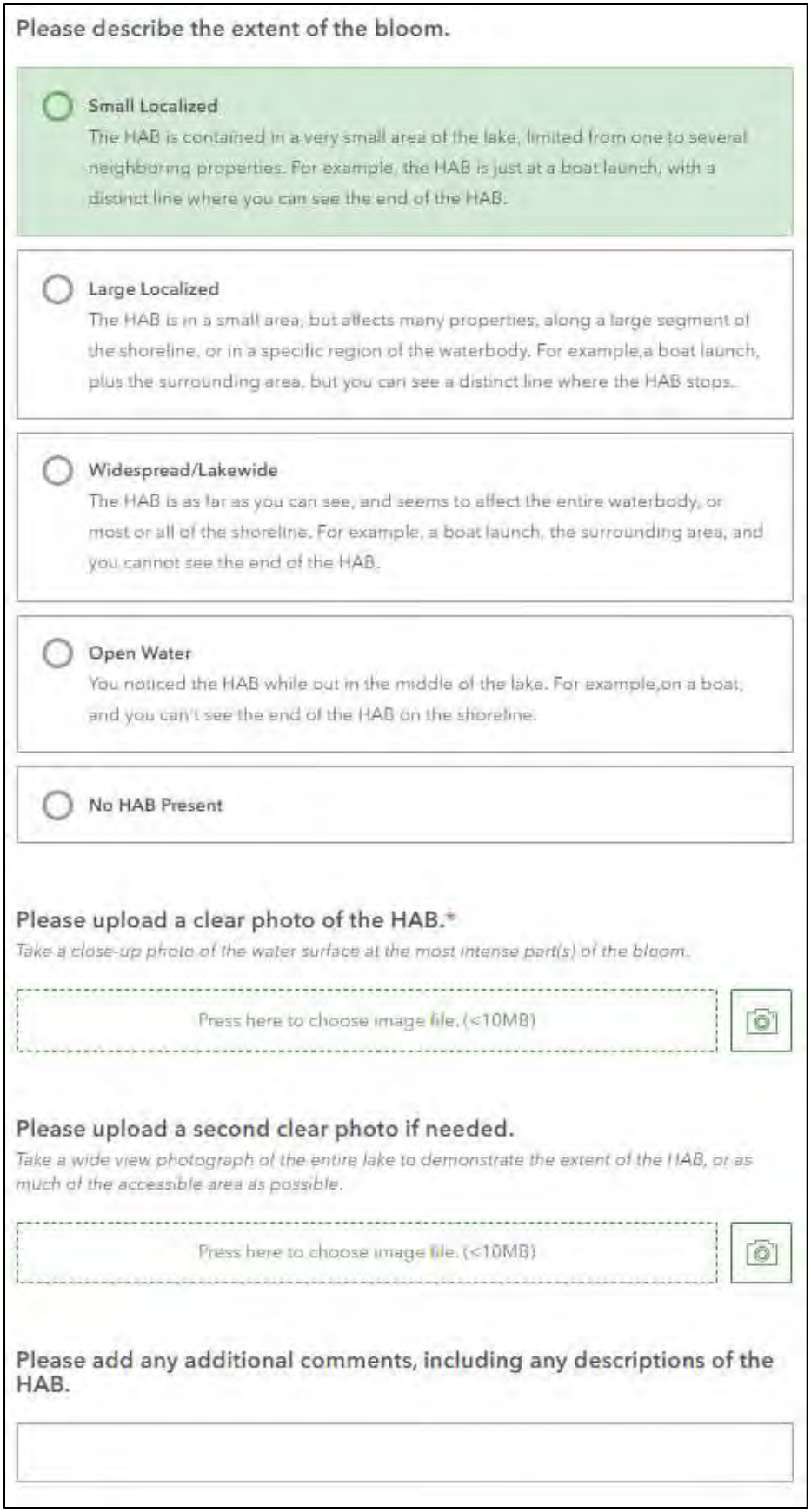
Name of the Lake*

Provide the name of the waterbody below.

Which sections of the lake have a bloom?

Choose all that apply.

- [ ] North
- [ ] East
- [ ] West
- [ ] South


Please describe the extent of the bloom.
Small Localized
The HAB is contained in a very small area of the lake, limited from one to several neighboring properties. For example, the HAB is just at a boat launch, with a distinct line where you can see the end of the HAB.
Large Localized
The HAB is in a small area, but affects many properties, along a large segment of the shoreline, or in a specific region of the waterbody. For example,a boat launch, plus the surrounding area, but you can see a distinct line where the HAB stops.
Widespread/Lakewide
The HAB is as far as you can see, and seems to affect the entire waterbody, or most or all of the shoreline. For example, a boat launch, the surrounding area, and you cannot see the end of the HAB.
Open Water
You noticed the HAB while out in the middle of the lake. For example,on a boat, and you can't see the end of the HAB on the shoreline.
No HAB Present
Please upload a clear photo of the HAB.*
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.
Take a wide view photograph of the entire lake to demonstrate the extent of the HAB, or as much of the accessible area as possible.
Press here to choose image file. (<10MB)
Please add any additional comments, including any descriptions of the HAB.

7.3. Appendix C. Warning Sign

This sign 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.

7.4. Appendix D. References and Resources

- **DEC Harmful Algal Blooms webpage**
  www.dec.ny.gov/chemical/77118
- **DEC HABs Brochure**
  http://www.dec.ny.gov/docs/water_pdf/habsbrochure.pdf
- **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
- **World Health Organization: Guidelines for Safe Recreational Waters, 2009**
  www.who.int/water_sanitation_health/water-quality/recreational/guidelines-for-safe-recreational-environments/en/
- **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
- **New York State Soil and Water Conservation District Listing**
  https://agriculture.ny.gov/soil-and-water/soil-water-conservation-district-offices
- **Cyanobacteria HAB Educational Videos**:
  - NYSDEC: Harmful Algal Bloom (HAB) Identification: Tips and Tricks
    https://www.youtube.com/watch?v=8nL_s77FV-o
  - HealthVermont: How to identify cyanobacteria
    https://www.youtube.com/watch?v=ea0EHw5suDs