Cyanobacteria Monitoring on Lake Champlain and Vermont Inland Lakes
Summer 2020

Annual Report for the Lake Champlain Basin Program

May 2021

Prepared by

Peter Isles, Project Coordinator

Watershed Management Division
Vermont Department of Environmental Conservation
Montpelier, Vermont

In conjunction with

Bridget O'Brien
Environmental Health Division
Vermont Department of Health
Burlington, Vermont

Lori Fisher
Lake Champlain Committee
Burlington, Vermont

Heather Campbell
Drinking Water & Groundwater Protection Division
Vermont Department of Environmental Conservation
Montpelier, VT

Executive Summary

An annual cyanobacteria monitoring program has been in place on Lake Champlain since 2002. Since 2012, oversight of the program has been the responsibility of the State of Vermont. The program represents a strong partnership between the Vermont Department of Environmental Conservation (VT DEC), the Vermont Department of Health (VDH), and the Lake Champlain Committee (LCC). Funding is provided by the Lake Champlain Basin Program, the State of Vermont, the Center for Disease Control (CDC), and private donors. Data are collected by State staff and an extensive network of trained community science volunteers. This report provides a summary of cyanobacteria monitoring efforts for Lake Champlain and for Vermont inland lakes, regardless of funding source, all of which is housed in the CyanoTracker database hosted by the VDH.

Due to the COVID-19 pandemic 2020 was a unique year, raising number of challenges to the monitoring program from public health, financial, and logistical perspectives. Despite these challenges, cyanobacteria monitoring on Lake Champlain in 2020 continued to integrate qualitative observations and photographic documentation into guidance for lake users at a similar rate to previous years. Quantitative microscopic analyses of cyanobacteria were not conducted as planned during 2020 due to the pandemic. Analysis of water samples for the presence of microcystin and anatoxin were conducted, and provided additional data to inform public health decisions in response to the presence of cyanobacteria.

Objectives:

- routinely monitor cyanobacteria at locations on Lake Champlain and Vermont inland lakes through the established partnership between Vermont state staff, the Lake Champlain Committee, community science volunteers, and state/municipal staff in New York,
- provide consistent quantitative data to inform public health decisions and assess long-term trends in Lake Champlain and selected inland lakes,
- test for the presence of cyanotoxins when visual reports or microscope analyses suggest high likelihood of blooms,
- conduct 12 weeks of cyanobacteria toxin testing for drinking water facilities drawing from Lake Champlain in Vermont,
- facilitate communication about lake conditions through weekly updates to stakeholders via email and to the public through the Vermont Department of Health webpage,
- provide outreach and assistance to beach managers, lakeshore property owners and the public so they can learn to recognize and respond appropriately to the presence of cyanobacteria blooms.

Community science volunteers, staff, and the general public submitted 2531 site-specific reports during 2020 from Lake Champlain and inland lakes in Vermont. Alert level conditions were reported 319 times on Lake Champlain during the monitoring period in 2020. Microcystin was detected at locations in Lake Carmi and Lake Champlain in 2020.

Introduction

Lake Champlain is one of the largest lakes in the United States and an important water resource for the states of Vermont and New York, and the province of Quebec. It is primarily a recreational lake, but also serves as an important drinking water source for all three jurisdictions. Cyanobacteria blooms have been documented in the lake since the 1970s, with some areas experiencing extensive annual blooms. In 1999, several dog deaths were attributed to cyanobacteria toxins, raising health and safety concerns regarding drinking water supplies and recreational activities such as swimming, boating, and fishing.

An annual cyanobacteria monitoring program has been in place on Lake Champlain since 2002 and continues to expand to inland lakes in Vermont. Monitoring is implemented through a partnership approach. Data are collected by State staff and an extensive network of trained community science volunteers. Qualitative observations, photographic documentation, and quantitative analysis of phytoplankton populations are synthesized into guidance for lake users. Analysis of water - when warranted - for the presence of microcystin, anatoxin and/or cylindrospermopsin provides additional data to inform public health decisions.

Objectives:

- routinely monitor cyanobacteria at locations on Lake Champlain and Vermont inland lakes through the established partnership between Vermont state staff, the Lake Champlain Committee, community science volunteers, and state/municipal staff in New York,
- provide consistent quantitative data to inform public health decisions and assess long-term trends in Lake Champlain and selected inland lakes,
- test for the presence of cyanotoxins when visual reports or microscope analyses suggest high likelihood of blooms,
- conduct 12 weeks of cyanobacteria toxin testing for drinking water facilities drawing from Lake Champlain in Vermont,
- facilitate communication about lake conditions through weekly updates to stakeholders via email and to the public through the Vermont Department of Health webpage,
- provide outreach and assistance to beach managers, lakeshore property owners and the public so they can learn to recognize and respond appropriately to the presence of cyanobacteria blooms.

Geographic Coverage and Funding

Responsibility for cyanobacteria response in the Champlain Basin is held by multiple jurisdictions. State or provincial departments of health and environmental protection typically lead response efforts while authority to close beaches and waterfront areas often resides with beach managers and municipalities. The goal of this project is to provide data to assist in cyanobacteria response around the Basin. For consistency, Vermont utilizes the same protocols developed for Lake Champlain across the entire state.

Lake Champlain Basin Program (LCBP) funding supports the project coordinator, housed in the Vermont Department of Environmental Conservation's (VT DEC) Watershed Management Division, through the Lake Champlain Long-term Water Quality and Biological Monitoring Project (CLTM). LCBP funding also supports volunteer coordination around Lake Champlain and several smaller Vermont lakes through a separate grant to the Lake Champlain Committee (LCC). In 2020, LCBP provided funding for cyanotoxin testing at Vermont drinking water facilities on Lake Champlain.

The Vermont Department of Health (VDH) and the VT DEC's Drinking Water and Groundwater Protection Division (DWGWPD) are strong partners in this monitoring program. Their funding is provided

by the VDH and VT DEC, respectively, and occasionally includes grants from other sources. In 2020, sampling at shoreline quality assurance stations was supported by the Centers for Disease Control and Prevention through the Safe Water for Community Health grant to VDH.

VDH provides the technical support underlying the CyanoTracker website, shoreline monitoring at selected locations, toxin testing for locations on Lake Champlain and Vermont inland lakes, and bloom response in Vermont. Technical and public water system support for cyanotoxin response is provided by the DWGWPD and VDH.

The New York Departments of Environmental Conservation and Health support this monitoring effort by sharing information regarding cyanobacteria blooms on Lake Champlain when received by their offices. They are responsible for bloom response on the New York shores of Lake Champlain. New York maintains their own cyanobacteria reporting protocols for inland lakes including Lake George – see the New York Harmful Algal Blooms notification – and that information is not part of this monitoring project.

Several monitoring locations are located on Missisquoi Bay in Quebec and volunteers there submit reports through the CyanoTracker interface. Provincial and municipal officials there are responsible for bloom response. Quebec maintains a website of cyanobacteria reports received from around the province.

This report provides a summary of cyanobacteria monitoring efforts for Lake Champlain and for Vermont inland lakes, all of which is housed in the CyanoTracker database hosted by the VDH.

Methods

The 2020 cyanobacteria monitoring program was coordinated by the VT DEC and implemented in conjunction with the VDH and LCC. Visual data from Lake Champlain and other Vermont lakes monitored by LCC volunteers were collected following the project protocols utilizing materials developed and maintained by the LCC. VT DEC volunteers reporting from lakes outside the Champlain Basin followed the same project protocols. Water samples and visual reports were collected by VT DEC staff at selected open water stations historically monitored by the LTM on Lake Champlain. Shoreline samples for toxin analysis were collected as part of the quality assurance protocol at select Vermont locations on Lake Champlain, Lake Carmi, and Lake Memphremagog by community science volunteers and DEC staff, but cyanobacteria counts were not conducted due to COVID-19. Additional samples, primarily from managed recreational areas, were also analyzed as part of this project. Reports from the monitoring partners and volunteers were uploaded to the Cyanobacteria Tracking map (CyanoTracker) maintained by the VDH.

Monitoring Locations

During the 2020 season, reports were routinely received from 208 monitored locations around Lake Champlain (154 sites) and from several Vermont inland lakes (54 sites). Table 1 provides a summary of stations by region, evaluation protocol, and type of site. Full documentation of the sampling locations is provided in Appendix A.

Table 1. Number of routinely monitored stations and sampling method in lakes monitored during 2020. Stations were evaluated on a weekly or biweekly basis. Data compiled from the season summary spreadsheet available through the VDH CyanoTracker. Further information about each station is found in Appendix A.

Region	Visual Assessment Protocol	Quality Assurance Protocol*
Adams Reservoir	2	
Caspian Lake	1	
Coles Pond	1	

Dewey Mills Pond		1	
Halfmoon Lake		1	
Indian Brook Reservoir		1	
Joes Pond		3	
Lake Carmi		8	2
Lake Champlain	Inland Sea	32	
	Main Lake Central	33	2
	Main Lake North	13	1
	Main Lake South	22	1
	Malletts Bay	9	
	Missisquoi Bay	3	1
	South Lake	6	
	St. Albans Bay	9	1
Lake Dunmore		1	
Lake Fairlee		1	
Lake Iroquois		2	
Lake Memphremagog		8	1
Lake Morey		1	
Lake Pinneo		1	
Lake Runnemede		1	
Mill Pond		1	
Salem Lake		1	
Shelburne Pond		1	
Waterbury Reservoir		1	

*Quality assurance sites were visited regularly and assessed visually and toxin samples were collected, but microscopy samples were not taken in 2020.

Monitoring Protocols

The Visual Monitoring Protocol

Volunteer Recruitment and Training

Volunteers were asked to commit to monitoring at least one location for the duration of the monitoring period (late-June through early November). No volunteer was turned away. On Lake Champlain, this can lead to a cluster of observation points in more populated areas or areas with high interest. Volunteers attended a mandatory training session online to learn to recognize cyanobacteria, become familiar with the assessment protocol, and learn how to submit their weekly reports. Partners interacted with volunteers in the weeks following the training to ensure consistency among volunteers and their assessment skills. Not all volunteers were able to use the internet-based reporting system and instead submitted their reports by telephone or email.

The LCC trained nearly 200 volunteer monitors and interested community members in 12 formal training sessions during the 2020 season. LCC also held informal training sessions with volunteers unable to attend the pre-scheduled trainings. Due to the pandemic, LCC did not conduct any in-person

trainings. Vermont State Park staff who participated in the monitoring project either attended an LCC virtual training or received monitoring guidance from VT DEC/VDH staff or State Parks staff. Over the course of the summer, LCC volunteer monitors reported from 123 different locations in 2020 (Appendix A).

VT DEC also recruited and trained volunteers to monitor at 37 inland Vermont lakes following the project protocols. Training was conducted by webinar. The webinar recording was posted on the VT DEC's cyanobacteria website as a resource for volunteers. Some monitors attended an LCC virtual training and all monitors were provided with LCC's weekly emails. Both LCC and VT DEC staff also interacted regularly with community science volunteer monitors.

Weekly Observation Process - Volunteers

The beginning of the monitoring period was complicated by statewide lockdowns due to the COVID-19 pandemic in spring 2020. At this point it was unclear whether public sites would be open and safe for monitoring visits, and whether it was safe to hand off samples and monitoring materials between volunteers and project partners. Despite these challenges, monitoring by volunteers began the week of June 28 Volunteers committed to monitoring through September and were asked to continue longer if they could.

Protocols for the observation process, supporting documentation and the submittal process are found in Appendix B. Volunteers were asked to provide a single observation each week, preferably between 10am and 3pm, on the same day of the week Sunday through Saturday. Supplemental reports could also be provided and volunteers were encouraged to report any blooms they witnessed, regardless of the reporting day, and to report daily for the duration of blooms whenever possible. Volunteers evaluated cyanobacteria conditions at their location using the prompts, photographs, and descriptions provided by the LCC and VT DEC, and assigned it one of the three categories:

- Category 1 – very few or no cyanobacteria observed, recreational enjoyment not impaired by cyanobacteria.
  - 1a – no cyanobacteria present, clear water
  - 1b – no cyanobacteria present, brown and turbid conditions
  - 1c – no cyanobacteria present, other plant material
  - 1d – little cyanobacteria present, generally safe conditions
- Category 2 – cyanobacteria present at less than bloom levels.
- Category 3 – cyanobacteria bloom in progress.

The description 'bloom' is not a well-defined scientific defined term. For the purposes of the visual monitoring protocol, blooms refer to very dense cyanobacteria accumulations resulting in highly colored water and/or visible surface scums. Dense accumulations of algae are also known as blooms but under this protocol are captured in Category 1.

Each volunteer was asked to provide three photographs whenever Category 1d, 2, or 3 conditions were observed. All reports were uploaded to the VDH tracking map via a secured interface or submitted to the LCC or VT DEC via their online forms. These online forms were also used when the VDH website interface occasionally was not functional. Partners reviewed all bloom reports and photos. They also conferred with volunteers as needed to verify the presence of cyanobacteria and appropriate status or when no reports were received. Tracker software automatically notifies partners of Category 2 and 3 reports so these can be reviewed and posted quickly.

Shoreline Quality Assurance Sampling

In 2020, shoreline sampling was handled differently compared to previous years to make better use of field staff and diversify the locations of samples being collected. While the four weekly LCC volunteer

sampling sites remained consistent, the sites previously sampled by VDH were redistributed to DEC staff and State Parks staff

Sampling locations were areas with high recreational usage or prone to blooms.

Site Number	Site Name (Location)	Waterbody (Region of Lake Champlain)	Sampler Affiliation	Number of Routine Shoreline Samples Collected
22	North Beach (Burlington, VT)	Lake Champlain (Main Lake Central)	LCC Volunteer	12
27	Red Rocks Beach (South Burlington, VT)	Lake Champlain (Main Lake Central)	LCC Volunteer	12
30	Shipyard, Highgate Springs (Highgate, VT)	Lake Champlain (Missisquoi Bay)	LCC Volunteer	12
31	St. Albans Bay Park (St. Albans Town, VT)	Lake Champlain (St. Albans Bay)	LCC Volunteer	12
180	Button Bay State Park (Ferrisburgh, VT)	Lake Champlain (Main Lake South)	DEC Staff	3
167	Lake Carmi, North Beach (Franklin, VT)	Lake Carmi	DEC Staff	6
484	Whipple Point F&W Access (Newport, VT)	Lake Memphremagog	DEC Staff	3
35	Alburgh Dunes State Park (Alburgh, VT)	Lake Champlain (Main Lake North)	VT State Parks	1
201	Lake Carmi State Park	Lake Carmi	VT State Parks	4

These unfiltered samples were analyzed for microcystin and anatoxin at the Vermont Public Health Laboratory. In normal years, cyanobacteria and algae would be identified and counted by DEC staff, to validate visual assessments and provide quantitative data, however in 2020 this was not possible due to the pandemic and related staffing issues. When occasional cyanobacteria samples were collected, a single whole water sample was collected by placing a 0.5-L bottle carefully at the surface and tipping to fill, avoiding dilution of the surface scum as much as possible. The sample was mixed thoroughly and decanted into sample bottles for subsequent cyanobacteria enumeration or toxin analysis. All samples were kept on ice in coolers or refrigerated until they reached the lab. These samples were used to evaluate the effectiveness of the visual assessment protocol and evaluate recreational risk.

The Open Water Protocol

Due to issues with funding and staffing, and to safety concerns related to the COVID-19 pandemic, only sporadic samples for cell density were collected by the VT DEC following the Open Water Protocol. VT DEC staff continued to conduct cyanobacteria assessments during their biweekly monitoring for the Champlain Long-term Water Quality and Biological Monitoring Project (CLTM) utilizing the visual assessment protocol to evaluate cyanobacteria conditions, but 3m plankton tows were not collected regularly. Cyanobacteria observed during transit were also assessed using the visual assessment

protocol. When category 3 conditions were observed, whole water surface grabs were collected for the analysis of toxins (microcystin and anatoxin) and sometimes for cyanobacteria density. At locations where blooms were uncommon, whole water surface grabs for toxin and cyanobacteria were also collected during category 2 conditions. Routine monitoring began June 8th and continued through early October.

VT DEC staff also routinely visited open water stations on Lake Carmi and Ticklenaked Pond in Vermont beginning in May. Visual assessments were made at these stations June to October. Taxonomic information on phytoplankton communities collected as part of routine DEC monitoring were shared through CyanoTracker. Water samples were collected from open water location during bloom events on Lake Carmi.

Field Methods

Under normal circumstances, plankton are collected as integrated 63 µm mesh plankton net for determination of cyanobacteria density. Net concentrates were obtained by lowering the plankton net opening to 3m and drawing it steadily back to the surface. At DEC stations on Lake Carmi and Ticklenaked Pond, plankton nets were lowered to twice the secchi to be consistent with historical data from these locations.

When alert level conditions are observed, a single whole water sample is normally collected by placing a bucket carefully at the surface and tipping to fill, avoiding dilution of the surface scum as much as possible. The samples are mixed thoroughly and decanted into sample bottles for subsequent cyanobacteria enumeration or toxin analysis. All samples are kept on ice in coolers until they reach the lab.

Plankton Enumeration

In 2020 microscopic analyses were only performed rarely. Plankton samples were analyzed using an inverted compound microscope at 200x in a Sedgewick Rafter (SR) cell. One mL aliquots were settled for 10 – 15 minutes before analysis. Estimates of cell density were obtained for all observed cyanobacteria and selected other taxa using the size categories noted in Table 2. Observed individuals or colonies were assigned to a unit category, or several categories, as needed. The number of units in each category is then multiplied by the cell factor to obtain an estimate of cell density/mL in the sample. During the analysis, all cyanobacteria were identified to the lowest possible taxonomic level while most other algae were identified simply at the division level, e.g. green algae or diatoms. Identical counting protocols were used for whole water and plankton concentrates. Plankton samples were counted by VT DEC staff or trained interns and data were uploaded to the VDH data interface, typically within 24 - 48 hours for open water stations. Alert level samples were analyzed and posted as soon as possible after samples were received at the laboratory.

Table 2. Size categories and cell factors used to estimate field densities of colonial algae.

Taxon	Unit Catgory	Estimated cells/unit	Cell factor
Dolichospermum *Aulacoseira* *Fragilaria*	Fragment	< 20	10
	Small	20 – 100	60
	Medium	100 – 1000	500
	Large	>1000	1000
Microcystis *Coelosphaerium* *Woronichinia*	Small	< 100	50
	Medium	100–1000	500
	Large	>1000	1000
Gloeotrichia	Fragment	Single trichome	20
	Small	Quarter of a colony	2500

	Medium Large	Half of colony Entire colony	5000 10,000
Aphanizomenon	Fragment Small Medium Large	Single trichome Small flake Medium flake Large flake	Measured 200 500 1000
Limnothrix *Lyngba/Scytonema*	Fragment	Single trichome	Measured

Source of Reports

In addition to the trained community science volunteers and field staff in VT DEC VDH, and LCC, cyanobacteria reports were received from numerous other sources. The NY DEC and the NY Department of Health notified Vermont when blooms were reported on their shores. Vermont state park staff at several locations received training and provided reports. The general public provided reports by email and telephone. All reports were evaluated and confirmed utilizing photos, descriptive information, and available corroborating information before posting to the CyanoTracker map.

Toxin Analysis

Toxin analyses were conducted by the Vermont Public Health Laboratory in Colchester, VT. Whole water samples for microcystin were analyzed as received unless biomass was high enough to interfere with analytical procedures. In that event, samples were diluted prior to analysis of microcystin by ELISA.

Whole water samples for anatoxin analysis were concentrated using solid phase extraction cartridges unless large amounts of biomass were present. In that event, aliquots were diluted prior to extraction. Samples were run by LC/MS/MS.

Toxin Monitoring at Vermont Drinking Water Facilities

In 2020, the DWGWPD and the VDH received funding from the Lake Champlain Basin Program to support 12 weeks of voluntary cyanotoxin monitoring at Vermont public drinking water systems drawing from Lake Champlain. Weekly raw and finished water samples were collected by facility staff and transported to the VDH Public Health Laboratory for analysis of microcystin by ELISA. All sample containers and labels were provided to the facilities. Sample drop-off and pick-up opportunities were also provided.

Sampling began the week of July 13, 2020 and went through the week of September 28, 2020, though several systems do not operate after Labor Day. Twenty of the 22 public facilities participated. Results were shared with operators by the VDH lab by mail, by DWGWPD by email, and posted on the DWGWPD website.

Communication and Outreach

Members of the partner institutions (LCC, VT DEC, and VDH) comprised an internal communication group that shared all bloom reports upon receipt and coordinated response activities as needed. Partners received automated notification of category 2 and 3 reports posted to the tracking database, facilitating communication, and enabling volunteer reports to be reviewed and approved quickly. The group also shared literature and other pertinent information. The LCBP, NY DEC, NY DOH, and Vermont State Parks staff were also kept apprised of cyanobacteria conditions through the automated notification system.

Weekly email updates summarizing reports and toxin data were provided to a group of stakeholders. These were primarily state and town health officials, state and town waterfront managers, Champlain water suppliers, and researchers. Updates were released typically on Thursday mornings, but

stakeholders also received email notification of extensive blooms as they occurred. The Lake Champlain Committee also provided weekly emails to volunteer monitors and partner agencies as well as interested community members, other agencies, and the media.

Notification of the Public

The Cyanobacteria Tracker, housed on the VDH website (http://healthvermont.gov/tracking/cyanobacteria-tracker), displayed the most up to date information on the presence of cyanobacteria blooms on Lake Champlain and in Vermont. On the website, a table listed all reports that had been received and approved during the 2020 season, and a map displayed the status of the most recent report for a given site. Reports received in the past two weeks were displayed on the map.

Map status was based on the visual assessment. At locations where water had also been sampled and analyzed, the visual assessment was used to generate the map status unless subsequent toxin analysis results indicated that this should change. No changes were necessary in 2020.

Results of the assessments translated to one of three map status categories:

VDH Map Status	Visual
Generally Safe (green)	Category 1
Low Alert (yellow)	Category 2
High Alert (red)	Category 3

A list of locations where blooms had been reported for the previous week was also compiled and displayed on the VDH webpage each week (https://www.healthvermont.gov/health-environment/recreational- water/lake-conditions).

Response to Monitoring Reports

Three jurisdictions were covered by the monitoring program efforts (New York, Vermont, and Quebec). While the monitoring program provided a lake-wide system of assessing and reporting cyanobacteria conditions shared via email and the VDH webpage, response to specific events was coordinated and implemented by the appropriate jurisdiction following their respective response protocols.

Outreach

Partners maintained individual websites highlighting monitoring activities, the interactive CyanoTracker map and annual data. Partners also held trainings, made presentations upon request, and responded to inquiries from the public, lake users and the media. Additionally, LCC posted a link to their weekly report on Facebook, emailed a weekly report to monitors tailored to their needs, and another to interested community members and the media.

Results

Overall effort

In 2020, 2531 site-specific reports were received between late May and the end of November (Fig. 1). These were provided by project partners, volunteers, and others (Table 3). Most were from Lake Champlain; however, routine reports were also provided from 19 inland lakes in Vermont by DEC staff and volunteers coordinated by LCC or VT DEC, with supplemental reports from an additional 18 lakes. Reports based on the visual assessment protocol represented all of the reports, because the COVID-19 pandemic prevented routine counting of plankton samples. In several samples, cyanobacteria taxa were identified microscopically but not counted.

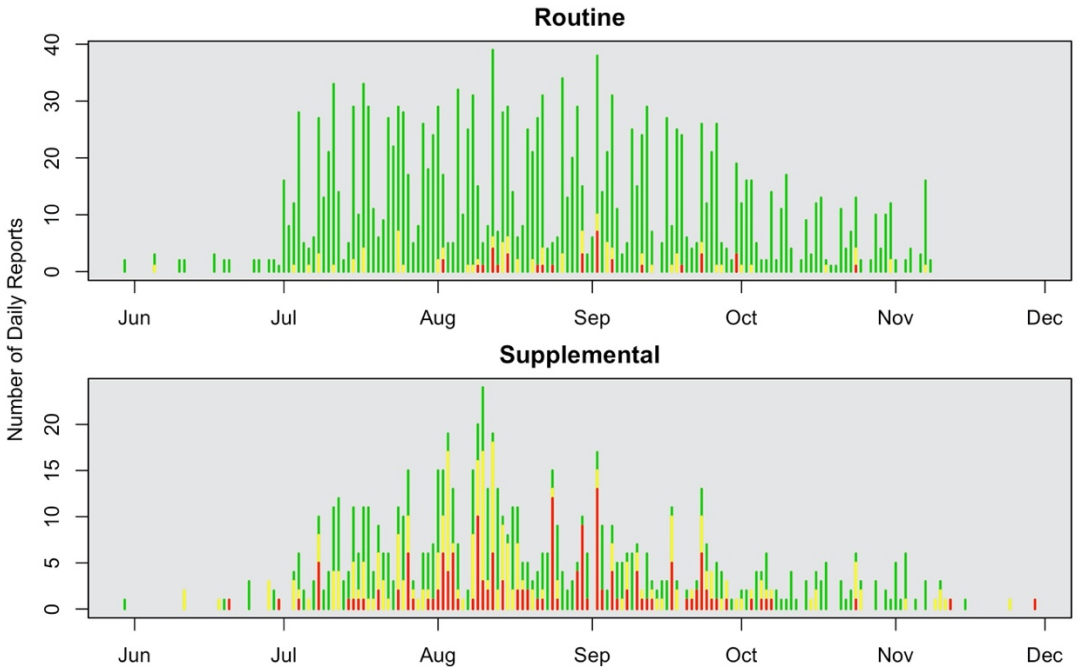


Figure 1. Number of visual assessment reports received on each day of the monitoring period in 2020 in Lake Champlain and Vermont inland lakes. Top panel shows routine reports, bottom panel shows supplemental reports. Green = "Generally Safe", yellow = "Low Alert", red = "High Alert"

Table 3. Summary of the 2020 cyanobacteria monitoring station reports. Supplemental reports are from locations other than regularly monitored sites or between regular reporting times. Data compiled from the season summary spreadsheet available through the VDH Tracking Map. Reports provided by the public and others outside of the monitoring program were interpreted using the visual assessment process and confirmed with photos. Further information about routine locations can be found in Appendix A.

Waterbody and Region	Affiliation	Report Frequency	# of Assessments
Adams Reservoir	VT State Parks	Routine - Weekly	22
		Supplemental	2
Bristol Pond (Lake Winona)	LCC Volunteer	Supplemental	1
Caspian Lake	VT DEC Volunteer	Routine - Weekly	11
Clyde Pond	MWA Volunteer	Supplemental	1
Coles Pond	VT DEC Volunteer	Routine - Weekly	11
Dewey Mills Pond	VT DEC Volunteer	Routine - Weekly	6
East Long Pond	General Public	Supplemental	1
Fairfield Pond	VT DEC	Supplemental	1
Halfmoon Lake	VT State Parks	Routine - Weekly	7
Halls Lake	General Public	Supplemental	2
Harriman Reservoir	General Public	Supplemental	1
Indian Brook Reservoir	General Public	Supplemental	1
	LCC Volunteer	Routine - Weekly	13
	LCC Volunteer	Supplemental	2
Joes Pond	LCC Staff	Supplemental	1

	VT DEC	Routine - Weekly	1
	VT DEC Volunteer	Routine - Weekly	36
	VT DEC Volunteer	Supplemental	2
Lake Carmi	General Public	Supplemental	41
	LCC Volunteer	Routine - Weekly	10
	LCC Volunteer	Supplemental	5
	VT DEC	Routine - Biweekly	21
	VT DEC	Supplemental	3
	VT State Parks	Routine - Weekly	42
	VT State Parks	Supplemental	49
	VTDEC	Routine - Biweekly	5
Champlain - Inland Sea	General Public	Supplemental	20
	LCC Staff	Supplemental	1
	LCC Volunteer	Routine - Weekly	319
	LCC Volunteer	Supplemental	120
	VT DEC	Routine - Biweekly	4
	VT State Parks	Routine - Weekly	49
	VT State Parks	Supplemental	10
Champlain - Main Lake Central	General Public	Supplemental	9
	LCC Staff	Routine - Weekly	38
	LCC Staff	Supplemental	100
	LCC Volunteer	Routine - Weekly	359
	LCC Volunteer	Supplemental	132
	VDH	Supplemental	1
	VT DEC	Routine - Biweekly	17
Champlain - Main Lake North	General Public	Supplemental	2
	LCC Volunteer	Routine - Weekly	149
	LCC Volunteer	Supplemental	26
	VT DEC	Routine - Biweekly	7
	VT State Parks	Routine - Weekly	7
	VT State Parks	Supplemental	5
Champlain - Main Lake South	General Public	Supplemental	4
	LCC Staff	Supplemental	5
	LCC Volunteer	Routine - Biweekly	6
	LCC Volunteer	Routine - Weekly	168
	LCC Volunteer	Supplemental	20
	VT DEC	Routine - Biweekly	9
	VT DEC	Supplemental	3
	VT State Parks	Routine - Weekly	47
	VT State Parks	Supplemental	9
Champlain - Malletts Bay	General Public	Supplemental	2
	LCC Volunteer	Routine - Weekly	64
	VT DEC	Routine - Biweekly	2

	VT State Parks	Routine - Weekly	20
	VT State Parks	Supplemental	1
Champlain - Missisquoi Bay	General Public	Supplemental	2
	LCC Volunteer	Routine - Weekly	24
	LCC Volunteer	Supplemental	11
	VT DEC	Routine - Biweekly	4
	VT DEC	Supplemental	1
Champlain - South Lake	LCC Volunteer	Routine - Weekly	46
	VT DEC	Routine - Biweekly	9
Champlain - St. Albans Bay	General Public	Supplemental	1
	LCC Staff	Supplemental	1
	LCC Volunteer	Routine - Weekly	76
	LCC Volunteer	Supplemental	42
	VT DEC	Routine - Biweekly	4
	VT State Parks	Routine - Weekly	12
	VT State Parks	Supplemental	12
Lake Derby	MWA Volunteer	Supplemental	1
Lake Dunmore	LCC Volunteer	Supplemental	2
	VT DEC Volunteer	Routine - Weekly	7
Lake Fairlee	VT DEC Volunteer	Routine - Weekly	11
	VT DEC Volunteer	Supplemental	4
Lake Iroquois	LCC Volunteer	Routine - Weekly	28
	LCC Volunteer	Supplemental	6
Lake Memphremagog	MWA Volunteer	Routine - Weekly	34
	MWA Volunteer	Supplemental	21
	VT DEC	Routine - Biweekly	12
	VT DEC	Supplemental	1
	VT DEC Volunteer	Routine - Weekly	14
	VT DEC Volunteer	Supplemental	1
	VTDEC	Supplemental	2
Lake Morey	General Public	Supplemental	3
	LCC Volunteer	Routine - Weekly	1
	VT DEC Volunteer	Routine - Weekly	14
	VT DEC Volunteer	Supplemental	6
Lake Ninevah	VT DEC Volunteer	Supplemental	1
Lake Parker	General Public	Supplemental	1
Lake Pinneo	VT DEC Volunteer	Routine - Weekly	5
Lake Raponda	General Public	Supplemental	2
Lake Runnemede	VT DEC Volunteer	Routine - Weekly	7
Lake Salem	VT DEC Volunteer	Supplemental	1
Lake St. Catherine	General Public	Supplemental	1
	VT State Parks	Supplemental	4
Lake Willoughby	VT DEC Volunteer	Supplemental	4

Mill Pond	VT DEC Volunteer	Routine - Weekly	7
Molly's Falls Pond	General Public	Supplemental	3
North Hartland Reservoir	VT DEC Volunteer	Supplemental	2
Pond Brook	General Public	Supplemental	1
Salem Lake	VT DEC Volunteer	Routine - Weekly	7
Shelburne Pond	LCC Volunteer	Routine - Weekly	13
	LCC Volunteer	Supplemental	9
Ticklenaked Pond	VT DEC	Supplemental	5
	VT DEC Volunteer	Supplemental	4
Upper Knapp Pond	General Public	Supplemental	1
Waterbury Reservoir	LCC Volunteer	Routine - Weekly	7
Total Reports			**2531**

Project partners collected 75 samples for microcystin and 68 for anatoxin. Most toxin samples were collected for quality control purposes and were not triggered by assessment reports. Cylindrospermopsin was not analyzed in 2020.

Assessment Results – Recreational Monitoring

Summaries of the assessment results from regularly monitored sites in 2020 is presented in Figure 2. The highest monitoring category reached in each region of Lake Champlain and Vermont inland lakes is noted in Table 5. The full list of records is available upon request or can be downloaded from the VDH website (http://www.healthvermont.gov/tracking/cyanobacteria-tracker).

Most reports (80%) received from Lake Champlain and Vermont inland lakes indicated that few or no cyanobacteria were present (category 1 of the visual protocol). In all, 487 reports of alert conditions (categories 2 and 3) were received during the summer of 2020, 19% of the total reports received.

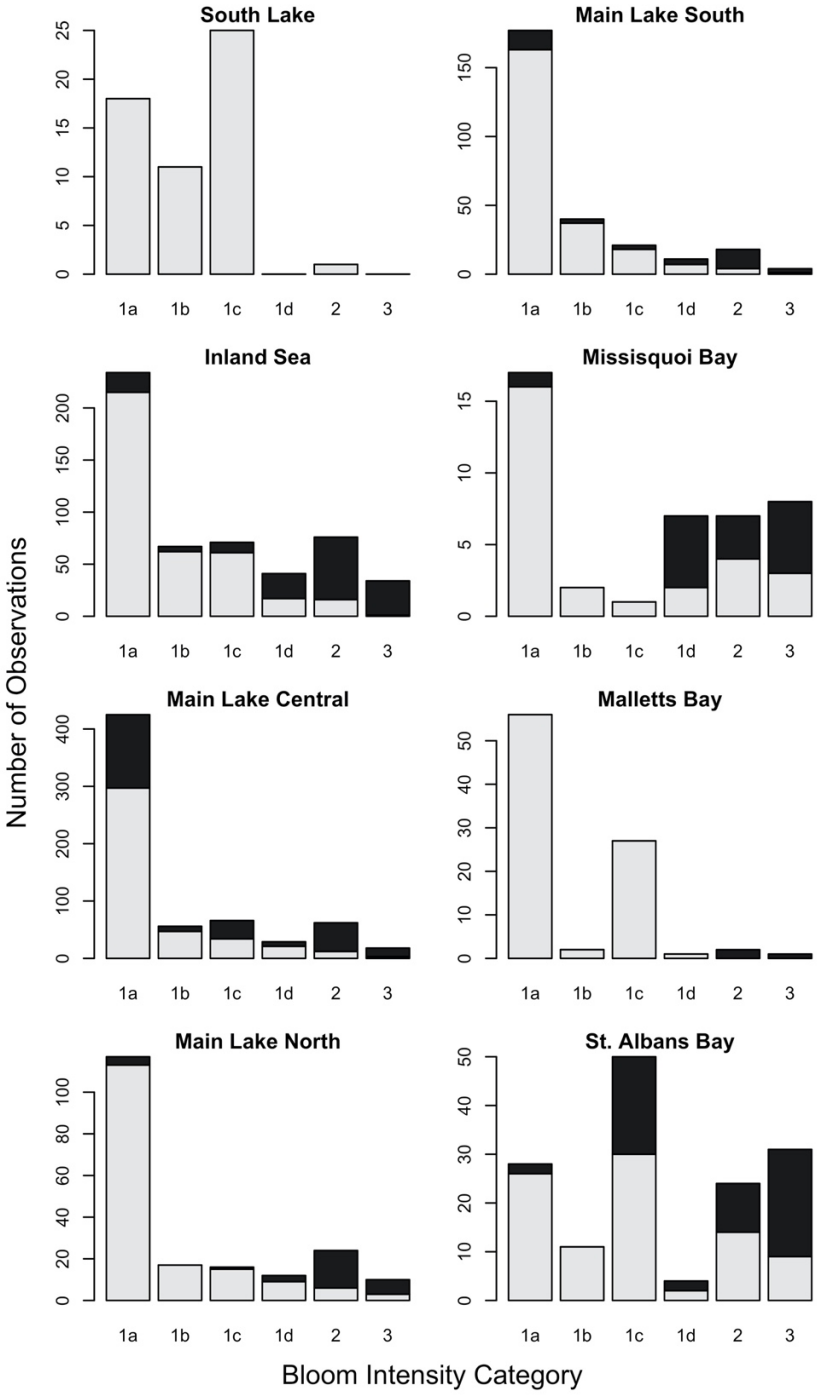


Figure 2. Summary of assessment reports received in 2020 in Lake Champlain. Data compiled from the season summary spreadsheet available through the VDH Tracking Map. Dark shading indicates supplemental reports. NOTE the difference in scale between basins. Category 1a = clear water, 1b = brown and turbid, 1c = other plant material, 1d = small amount of cyanobacteria. Category 2 = low alert. Category 3 = high alert.

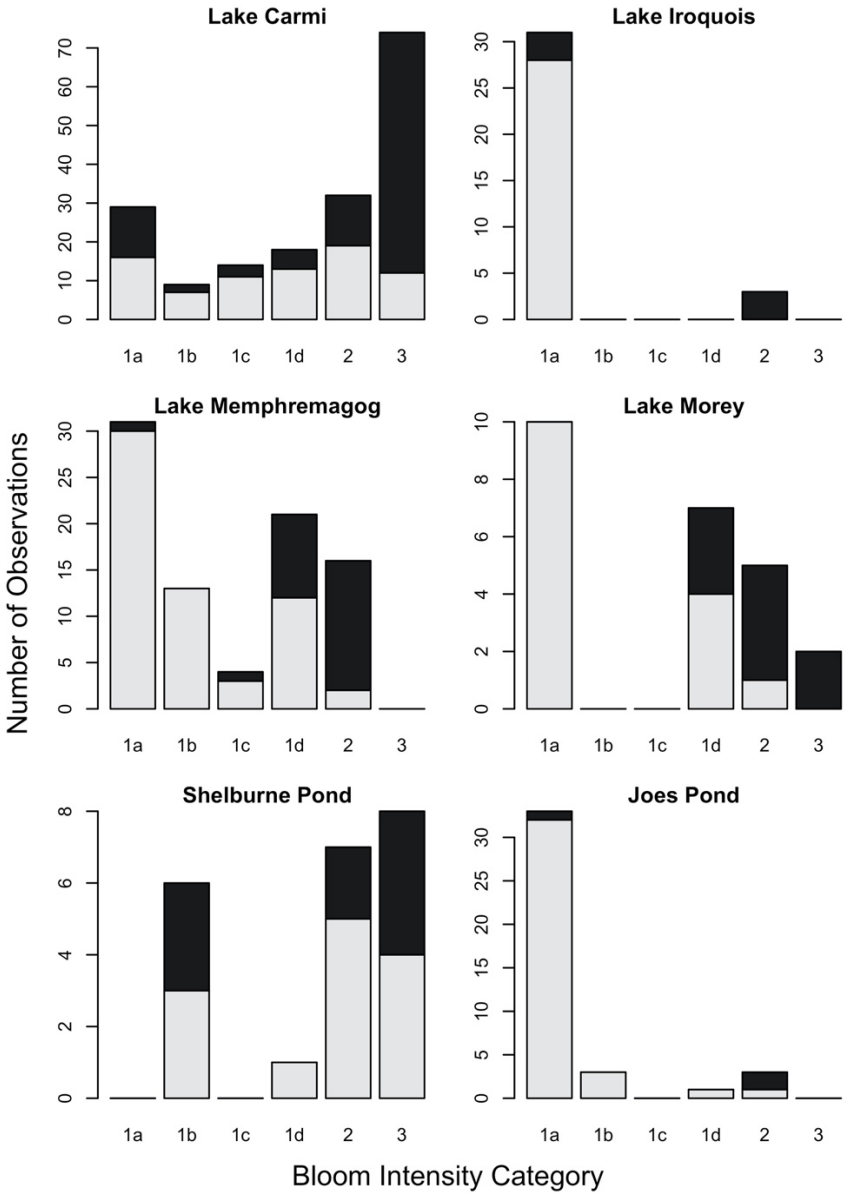


Figure 3. Summary of assessment reports received in 2020 from selected Vermont inland lakes. Data compiled from the season summary spreadsheet available through the VDH Tracking Map. Dark shading indicates supplemental reports. NOTE the difference in scale between lakes. Category 1a = clear water, 1b = brown and turbid, 1c = other plant material, 1d = small amount of cyanobacteria. Category 2 = low alert. Category 3 = high alert.

A total of 75 samples were analyzed for the presence of microcystin and 68 for anatoxin in 2020 (Table 4) from both routine sites and post-bloom sampling by beach managers.. This is a significant decline from the number of samples analyzed in 2019 (137 and 115 for microcystin and anatoxin respectively) and reflects challenges associated with the COVID-19 pandemic and using Vermont State Park and DEC field staff to sample as opposed to VDH staff. This number includes 58 samples from Lake Champlain, 13 from Lake Carmi, 3 from Lake Memphremagog, and 1 from Ticklenaked Pond. Microcystin was detected at three locations over the summer of 2020 – St. Albans Bay and the Main Lake Central location on Lake Champlain, and Lake Carmi. The highest observed concentration of microcystin was measured on August

12 at St. Albans Bay (0.22 µg/L), well below the recreational guidance level of 6 µg/L. Anatoxin was not detected in any samples in 2020.

Table 4. Highest status reached in each waterbody in 2020. Data compiled from the season summary spreadsheet available through the VDH Tracking Map. All assessments used the visual protocol.

Waterbody	Region	Year	Highest Status Observed	Highest Microcystin measured	Highest Anatoxin measured
Adams Reservoir		24	Generally Safe	Not Measured	
Bristol Pond (Lake Winona)		1	Generally Safe	Not Measured	
Caspian Lake		11	Generally Safe	Not Measured	
Clyde Pond		1	Generally Safe	Not Measured	
Coles Pond		11	Generally Safe	Not Measured	
Dewey Mills Pond		6	Generally Safe	Not Measured	
East Long Pond		1	Generally Safe	Not Measured	
Fairfield Pond		1	High Alert	Not Measured	
Halfmoon Lake		7	Generally Safe	Not Measured	
Halls Lake		2	High Alert	Not Measured	
Harriman Reservoir		1	Low Alert	Not Measured	
Indian Brook Reservoir		16	Low Alert	Not Measured	
Joes Pond		40	Low Alert	Not Measured	
Lake Carmi		176	High Alert	0.17	<0.5
Champlain - Inland Sea		523	High Alert	Not Measured	
Champlain - Main Lake Central		656	High Alert	0.17	<0.5
Champlain - Main Lake North		196	High Alert	<0.16	<0.5
Champlain - Main Lake South		271	High Alert	<0.16	<0.5
Champlain - Malletts Bay		89	High Alert	Not Measured	
Champlain - Missisquoi Bay		42	High Alert	<0.16	<0.5
Champlain - South Lake		55	Low Alert	Not Measured	
Champlain - St. Albans Bay		148	High Alert	0.22	<0.5
Lake Derby		1	Generally Safe	Not Measured	
Lake Dunmore		9	Generally Safe	Not Measured	
Lake Fairlee		15	Generally Safe	Not Measured	
Lake Iroquois		34	Low Alert	Not Measured	
Lake Memphremagog		85	Low Alert	<0.16	<0.5
Lake Morey		24	High Alert	Not Measured	
Lake Ninevah		1	Generally Safe	Not Measured	
Lake Parker		1	High Alert	Not Measured	
Lake Pinneo		5	Generally Safe	Not Measured	
Lake Raponda		2	Low Alert	Not Measured	

Lake Runnemede	7	Generally Safe	Not Measured	
Lake Salem	1	Low Alert	Not Measured	
Lake St. Catherine	5	Low Alert	Not Measured	
Lake Willoughby	4	Generally Safe	Not Measured	
Mill Pond	7	Generally Safe	Not Measured	
Molly's Falls Pond	3	High Alert	Not Measured	
North Hartland Reservoir	2	Generally Safe	Not Measured	
Pond Brook	1	Low Alert	Not Measured	
Salem Lake	7	Generally Safe	Not Measured	
Shelburne Pond	22	High Alert	Not Measured	
Ticklenaked Pond	9	High Alert	<0.16	<0.5
Upper Knapp Pond	1	Low Alert	Not Measured	
Waterbury Reservoir	7	Generally Safe	Not Measured	

Taxonomic analyses were severely restricted in 2020 due to complication arising from the COVID 19 pandemic. In all, three potentially toxic genera (Aphanizomenon, Microcystis, and Dolichospermum) were observed in samples from two lakes, Ticklenaked Pond and Lake Memphremagog, however due to the very low numbers of samples analyzed (2), these observations are not comprehensive or representative.

Drinking Water Supply Monitoring

In 2020, the VDH and DWGWPD offered, with support from the Lake Champlain Basin Program, free weekly microcystin testing for public drinking water facilities in Vermont from the week of July 13 through the week of September 28. Results of the summer's testing are can be found online at https://dec.vermont.gov/water/drinking-water/water-quality-monitoring/blue-green-algae/cyanotoxin-monitoring. The raw water sample taken at Grand Isle Fire District 4 on 9/15 had microcystin detected at 0.45 ug/L; the associated finished water sample did not have microcystin detected. Following the DEC Process for Managing Cyanotoxin Detections, confirmation raw and finished water samples were taken on 9/18, and microcystin was not detected in either of these samples.

Volunteer training

Due to the COVID-19 pandemic all LCC Volunteer trainings were conducted virtually rather than held at different locations around the Lake Champlain Basin. LCC trained nearly 200 potential monitors and interested community members at 12 formal Zoom sessions. LCC outreach, social media postings and media interviews and appearances alerted the public to the opportunity to become a volunteer monitor. LCC staff provided additional trainings throughout the season with virtual sessions held during May, June, July, August and September. In 2020, reports were provided from 18 Vermont and 1 New York state parks by staff, LCC volunteers, and VDH staff. VT DEC provided training for watershed associations and others on Vermont inland lakes located outside the Champlain Basin LCC provided ongoing support as needed and weekly monitoring emails to monitors outside the Basin as well.

Training sessions provided information about cyanobacteria – causes, conditions that favor the development of blooms, appearance, associated health concerns, and management efforts aimed at reducing bloom frequency. Monitors were taught to distinguish cyanobacteria from other phenomena they might see in the lake such as green algae and pollen. Training sessions also introduced volunteers

to the online LCC and VT DEC cyanobacteria resources and report forms, and the VDH Tracker reporting process.

The volunteer monitor program has an impact beyond the recruitment of volunteers and collection of data. As awareness of the possible health effects associated with cyanobacteria spreads, the interest in learning more about these organisms increases. While not all trained volunteers go on to report, all became familiar with cyanobacteria, potential health risks associated with them, and the water quality conditions that increase the likelihood of blooms.

Outreach and Assistance

Project partners continue to provide outreach and assistance to individuals and municipalities, primarily through phone calls and email. In addition, the LCC sends out a weekly update on conditions to their volunteers and provides separate weekly emails to a list-serve of interested community members and agencies along with media reports throughout the season. Guidance and assistance to town health officers, beach managers, and residents was provided by partners during bloom events. All partners had webpages with resources and contacts for anyone seeking information about cyanobacteria. Partners also responded to media inquiries.

Communication with the Stakeholders and the Public

Results of the weekly assessments were communicated via email to a variety of stakeholders. The 156 recipients who received the VT DEC emails were largely associated with the states of Vermont and New York. Other recipients included federal officials and LCBP, provincial officials in Quebec, water facilities, local governmental organizations, or municipal staff, non-profits and universities, and unknown recipients. As noted earlier, LCC also provided weekly emails to all monitors and partner agencies as well as separate weekly emails to a list-serve and regular emails to the media once blooms began.

Information was shared with the public via the VDH cyanobacteria webpages - see table below. Between June and December 2020, the VDH Cyanobacteria website received nearly 8,000 visits (Table 5). Activity was greatest in July and August, peak months of recreational activity. The monitoring data was also accessible through the VDH's Environmental Public Health Tracking page http://healthvermont.gov/tracking/index.aspx.

VDH Cyanobacteria Webpages	URL
VDH Cyanobacteria Landing Page	healthvermont.gov/cyanobacteria
VDH Cyanobacteria Lake Conditions Page	healthvermont.gov/health-environment/recreational-water/lake-conditions
EPHT CyanoTracker Landing Page	healthvermont.gov/tracking/cyanobacteria-tracker
VDH Climate Change and Cyanobacteria Page	http://www.healthvermont.gov/health-environment/climate- health/cyanobacteria

Table 5. Usage of the VDH Cyanobacteria webpages in 2020

2020 Month	VDH Cyanobacteria Landing Page – Unique Page views*	VDH Cyanobacteria Tracker— Unique Page Views
June	738	1,051
July	2,617	14,152
August	2,598	13,485
September	954	2,965
October	413	688
November	232	367
December	146	180
Total	7,698	32,888

Note that in past years, State IP addresses were removed from the page view numbers reported. As state employees were working remotely in 2020, these views could not be removed from the above data and are therefore included.

Challenges

Each year, project partners train community science volunteers to recognize cyanobacteria using visual cues and knowledge gained over the 20-year life span of the monitoring effort. Our focus is on the typical appearance of cyanobacteria blooms and other aquatic phenomena. We remind our monitors that there are always exceptions and encourage them to share unusual observations with us. In turn, these are shared by the LCC with the wider team of volunteers and continue to enhance their ability to distinguish cyanobacteria from other aquatic phenomena.

Discussion

The primary role of the cyanobacteria monitoring program is to provide data on cyanobacteria occurrence and abundance so that health protective decisions can be made for recreational water uses. The program serves an education and outreach role, helping volunteers and others recognize situations when recreational activities might not be prudent. Data also contribute to a historical perspective of bloom events and water quality in the Basin.

The data provided by the program assists drinking water facilities around Lake Champlain to evaluate the quality of their raw and finished water, and, in Vermont, provides operators with specific information about the presence/absence of selected cyanotoxins.

2020 presented unique challenges to the implementation of the monitoring program. Lockdowns related to COVID precluded routine delivery of samples and materials, restricted access to some sampling locations, precluded teams of multiple people from sampling together, and reduced volunteer participation at some sites. Rapidly changing public health guidance made it difficult to plan monitoring activities. Funding challenges resulting from the pandemic also affected operations and staffing of project partners. The project partners remained in close communication during the monitoring season, and at the request of partners, regular meetings were facilitated by the LCBP to discuss challenges. Despite these challenges, the program increased the number of visual assessment reports over previous years, with particularly large increases in inland Vermont lakes (Figs. 4, 8)

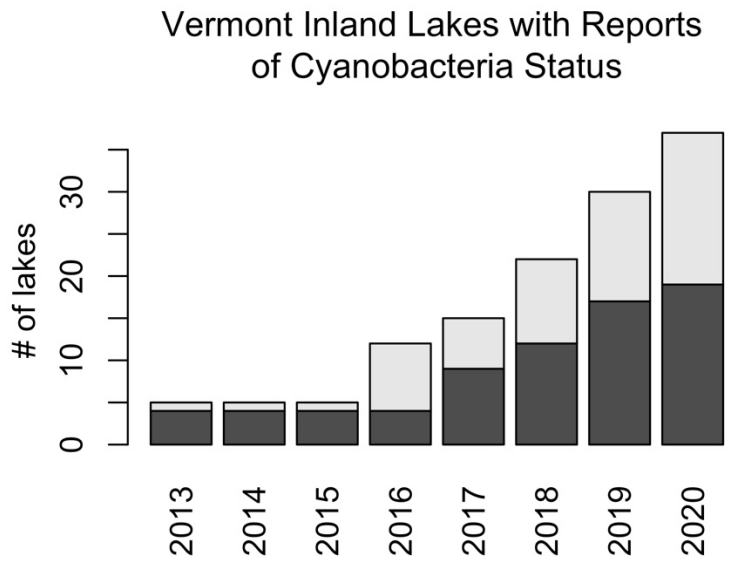


Figure 4: Number of lakes delivering reports of cyanobacteria status using the visual monitoring protocol. Dark bars indicate lakes with at least one routine reporting site, light gray bars indicate sites with only supplemental reports. NOTE: This does not mean that all lakes experienced cyanobacteria blooms, only that reports (including reports of "Generally Safe" conditions) were delivered.

Effectiveness of the visual monitoring protocol

Due to the lack of microscopy analysis in 2020, quantitative plankton counts could not be used to confirm the effectiveness of the visual assessment protocols as a tool to assess potential recreational risk; however, results from previous year support the effectiveness of this protocol. The majority of reports from quality control sites reported Category 1 (generally safe) conditions (Appendix C), and did not contain detectable toxins.

Figure 4 shows the growth of the cyanobacteria monitoring program in inland lakes form 2013–2020, demonstrating increased participation by volunteers in both routine monitoring and the collection of supplemental samples. This growth reflects efforts on the part of project partners to increase participation, as well as increased interest on the part of the public. The changing frequency of reports suggests the need to develop methods to develop unbiased metrics to track incidence of cyanobacteria blooms on Vermont lakes over time—routine monitoring reports are important for these efforts.

Anatoxin was not detected in any samples. Microcystin was detected in four samples in Categories 1a, 1d, and 3 reports. All were well below the Vermont recreational guidance level of 6 µg/L for microcystin and 10 µg/L for anatoxin.

Each year, there are unusual observations that challenge our monitors as they utilize the visual protocol. We continue to update training materials to include the unusual as well as common appearance of cyanobacteria and other aquatic phenomena.

Cyanobacteria conditions in 2020

Vermont inland lakes

Historical data from routinely monitored Lake Carmi, Shelburne Pond, Lake Iroquois, and Lake Memphremagog are presented in Figures 5 and 6. Conditions in 2020 in these lakes were not obviously

different from conditions observed in recent years, although further analysis at the individual station level may reveal other patterns.

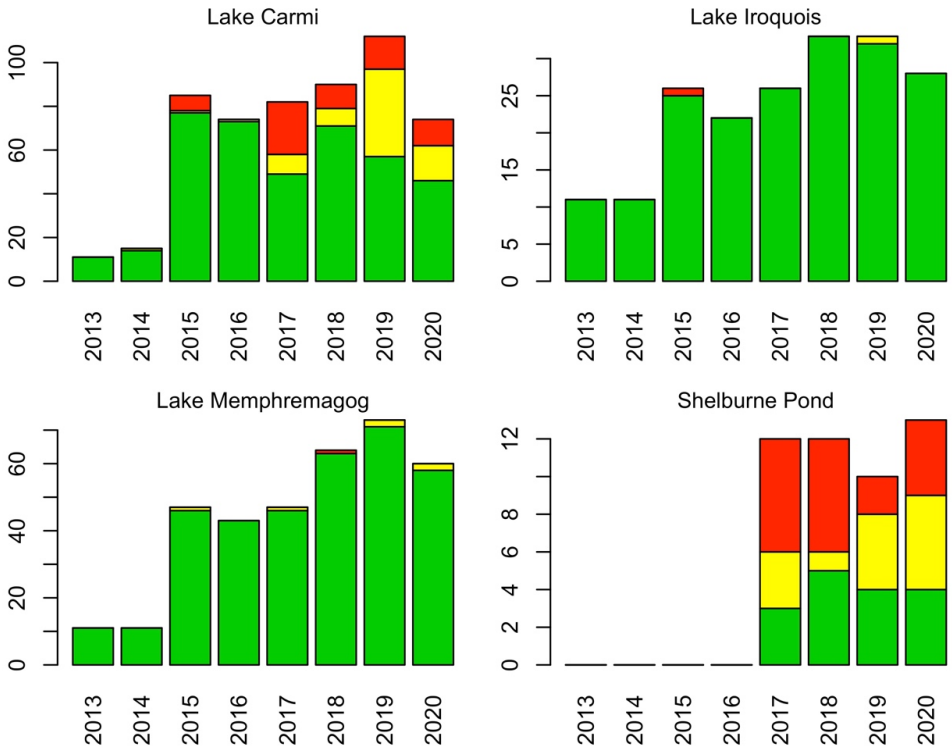


Figure 5: Web Report alert levels for selected inland lakes showing the total number of reports in each alert category. Green indicates “generally safe” conditions, yellow indicates “low alert”, and red indicates “high alert”. Supplemental reports are excluded.

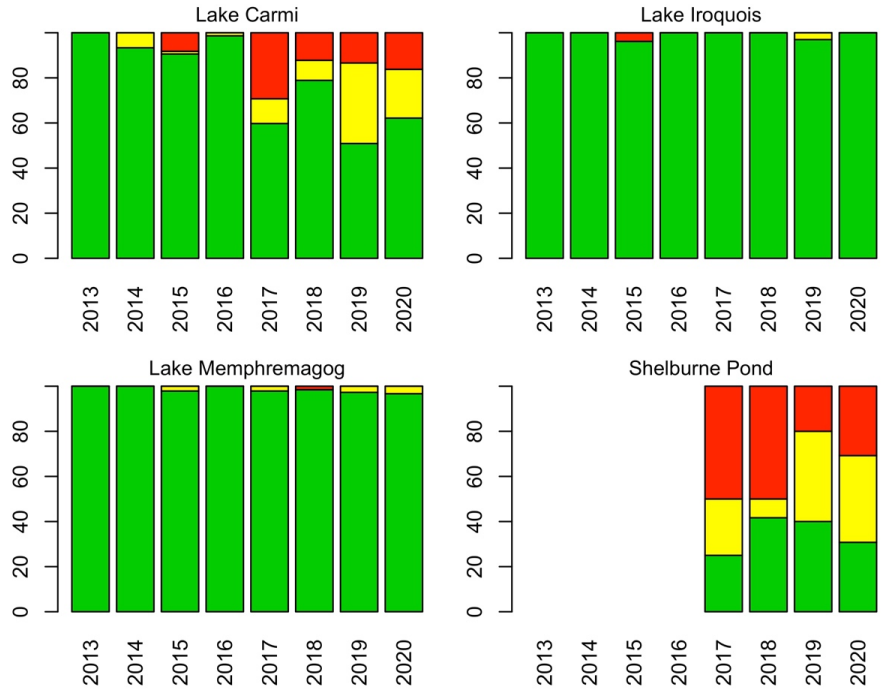


Figure 6: Web Report alert levels for selected inland lakes showing the percentage of reports in each alert category. Green indicates "generally safe" conditions, yellow indicates "low alert", and red indicates "high alert". Supplemental reports are excluded.

Other waterbodies with reports of category 2 or 3 blooms in 2020 in Vermont included:

Lake Carmi	Lake St. Catherine	Fairfield Pond	Molly's Falls Pond
Lake Memphremagog	Joes Pond	Lake Parker	Lake Raponda
Indian Brook Reservoir	Ticklenaked Pond	Shelburne Pond	Upper Knapp Pond
Lake Morey	Pond Brook	Harriman Reservoir	Lake Iroquois
Halls Lake	Lake Salem		

Table 6 summarizes microcystin concentrations observed at Lake Carmi since 2013. Microcystin was detected three times on Lake Carmi this year. All were well below Vermont's recreational guideline of 6 µg/L.

Table 6. Microcystin concentrations in Lake Carmi, 2013 - 2020. The reporting limit is 0.16 µg/L.

Lake		2013	2014	2015	2016	2017	2018	2019	2020
Lake Carmi	median	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
	range	<0.16–0.21	<0.16–0.39	<0.16–0.40	<0.16	<0.16–4.4	<0.16–1.19	<0.16–1.1	<0.16–0.17
	#samples	10	19	17	25	35	32	36	13
	#stations	1	4	2	3	3	4	4	4

Cyanobacteria Conditions on Lake Champlain:

Eighty-four percent of the Champlain reports from 2020 indicated generally safe conditions (n=1796, Figures 5 and 6). Alert-level conditions were reported 345 times, many of which were supplemental reports. Alert level conditions were reported most frequently in the Inland Sea (n=93), St. Albans Bay (n=90), and Main Lake Central (n=48).

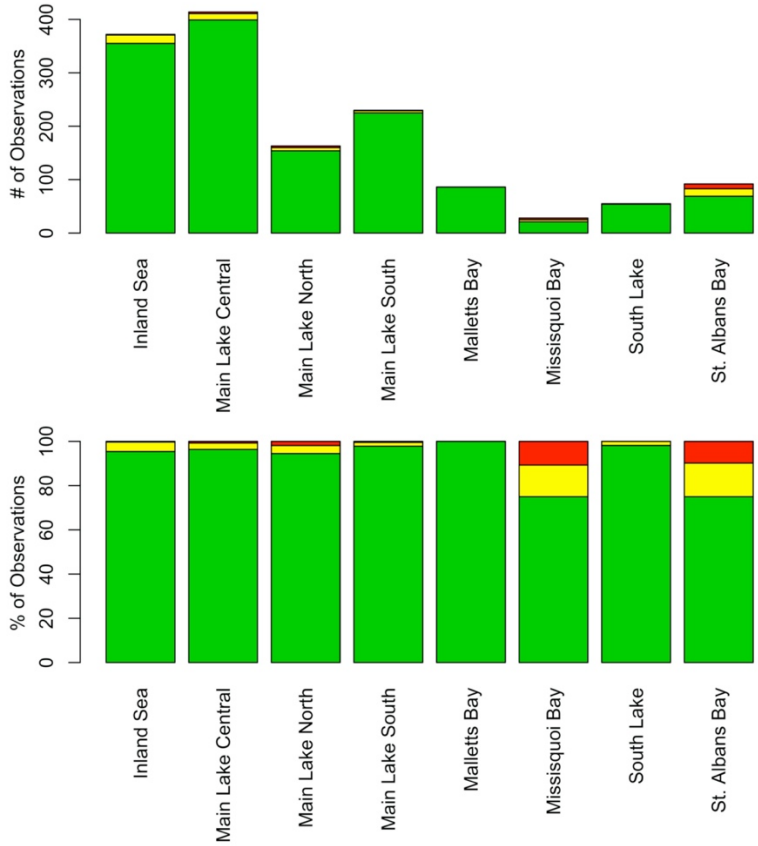


Figure 7: 2020 Web Report alert levels from routine reports for the basins of Lake Champlain. Green indicates "generally safe" conditions, yellow indicates "low alert", and red indicates "high alert". Top panel shows number of observations in each basin, bottom panels show the percentage of each report category in each basin. Supplemental reports are excluded.

In 2020, there were more frequent reports of bloom conditions in the Inland Sea than in previous years. These conditions were not evident in the routine monitoring data (Fig. 9), but they were evident in a large increase in supplemental reports in 2020 relative to previous years (Fig. 11). There was also a relatively large number of supplemental reports from the Main Lake, second only to 2019. It is not clear whether the increased numbers of reports reflect increased bloom severity or more public awareness and participation in the monitoring program. Several (14) inland lakes delivered their first reports of blooms in categories 2 or 3, which might suggest that 2020 was a relatively strong bloom year, but which might also reflect the growth of the inland lakes monitoring program, increased public interest in cyanobacteria blooms, or different behavior during the 2020 season when travel and other restrictions were in place. Sit es of particular concern in Lake Champlain, including St. Albans and Missisquoi Bays, had blooms reported at similar levels as previous years (Figs. 9,10), however the number of both routine and supplemental reports from Missisquoi Bay was very low compared to previous years.

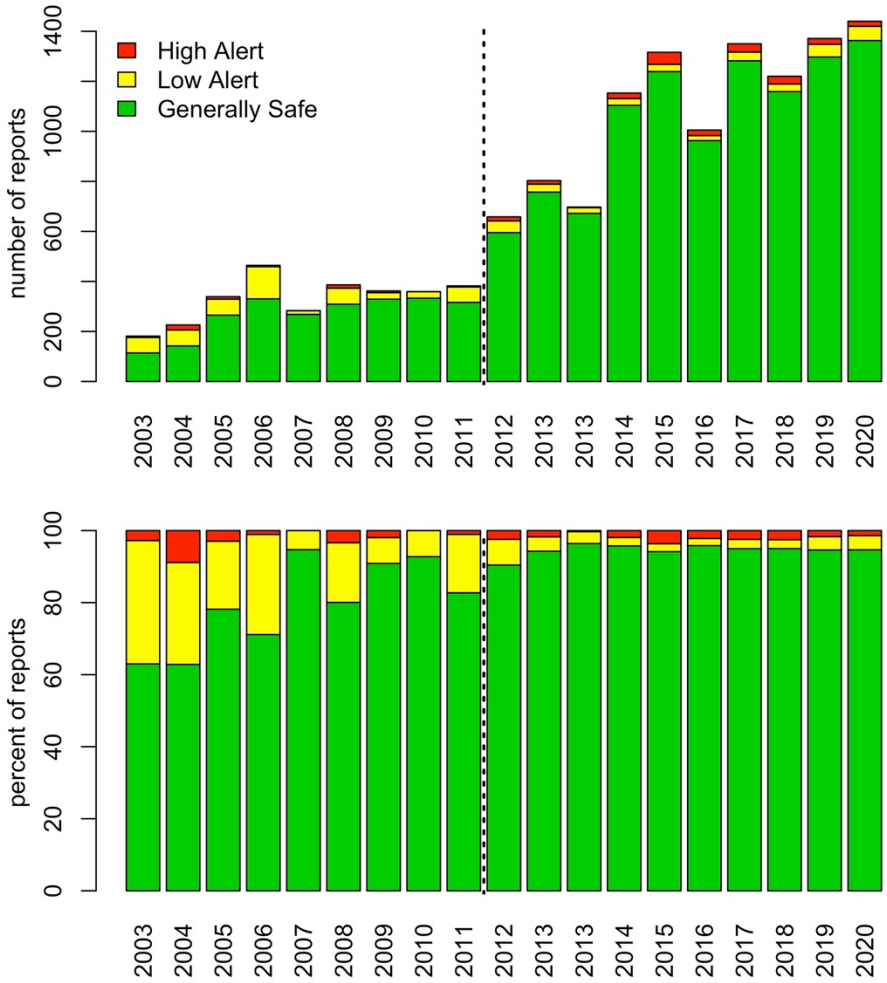


Figure 8: Web Report alert levels from routine reports for the basins of Lake Champlain during the years 2003 – 2020. Alerts before the dashed line (2011 and earlier) used a microscopy-based quantitative protocol. Status reports after the dashed line use the visual protocol. Green indicates "generally safe" conditions, yellow indicates "low alert", and red indicates "high alert". Top panel shows number of observations in each year, bottom panels show the percentage of each report category in each basin. Supplemental reports are excluded.

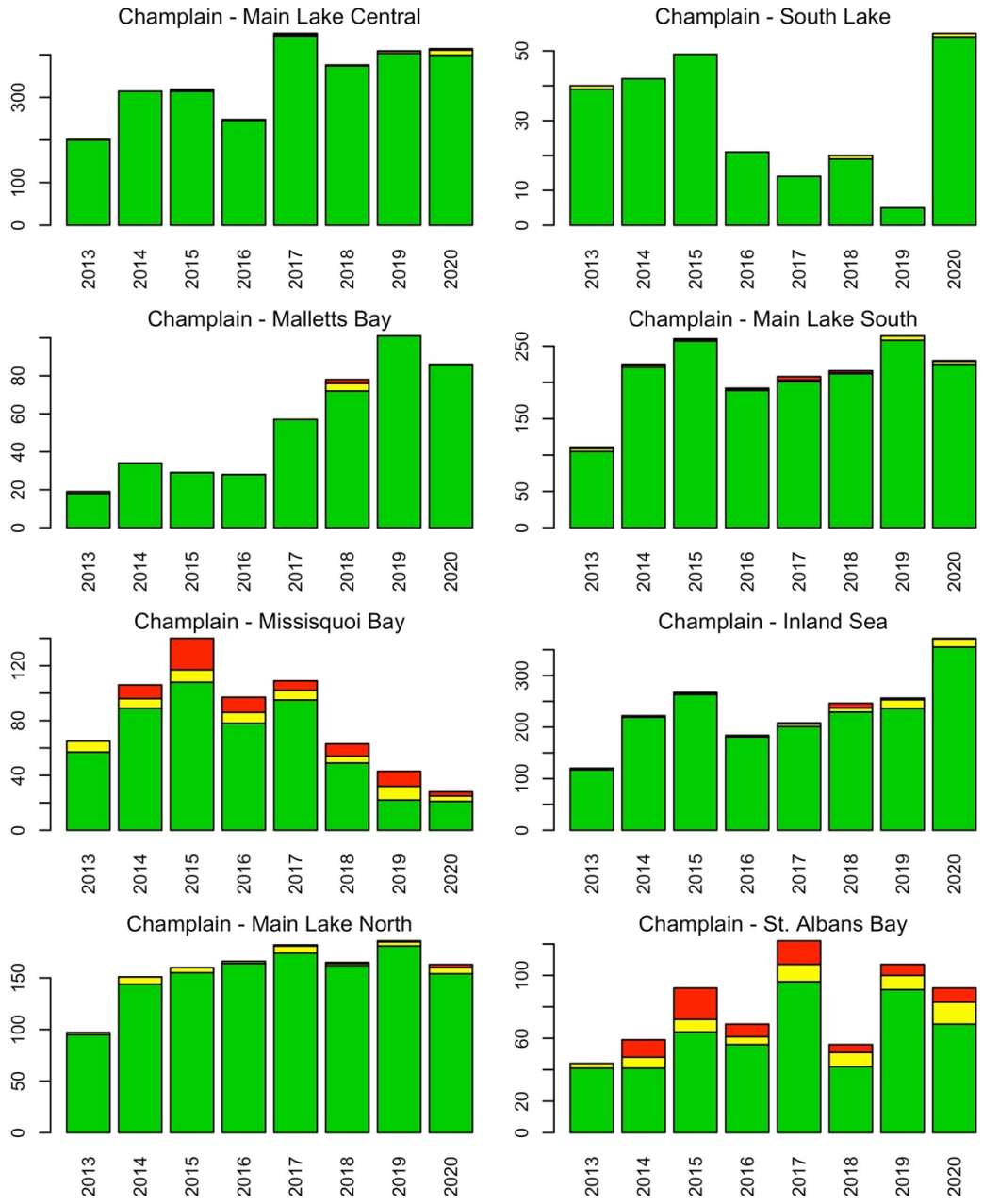


Figure 9: Web Report alert levels from routine reports for the basins of Lake Champlain during the years 2013 – 2020 showing the number of reports received in each year. Green indicates "generally safe" conditions, yellow indicates "low alert", and red indicates "high alert". Supplemental reports are excluded.

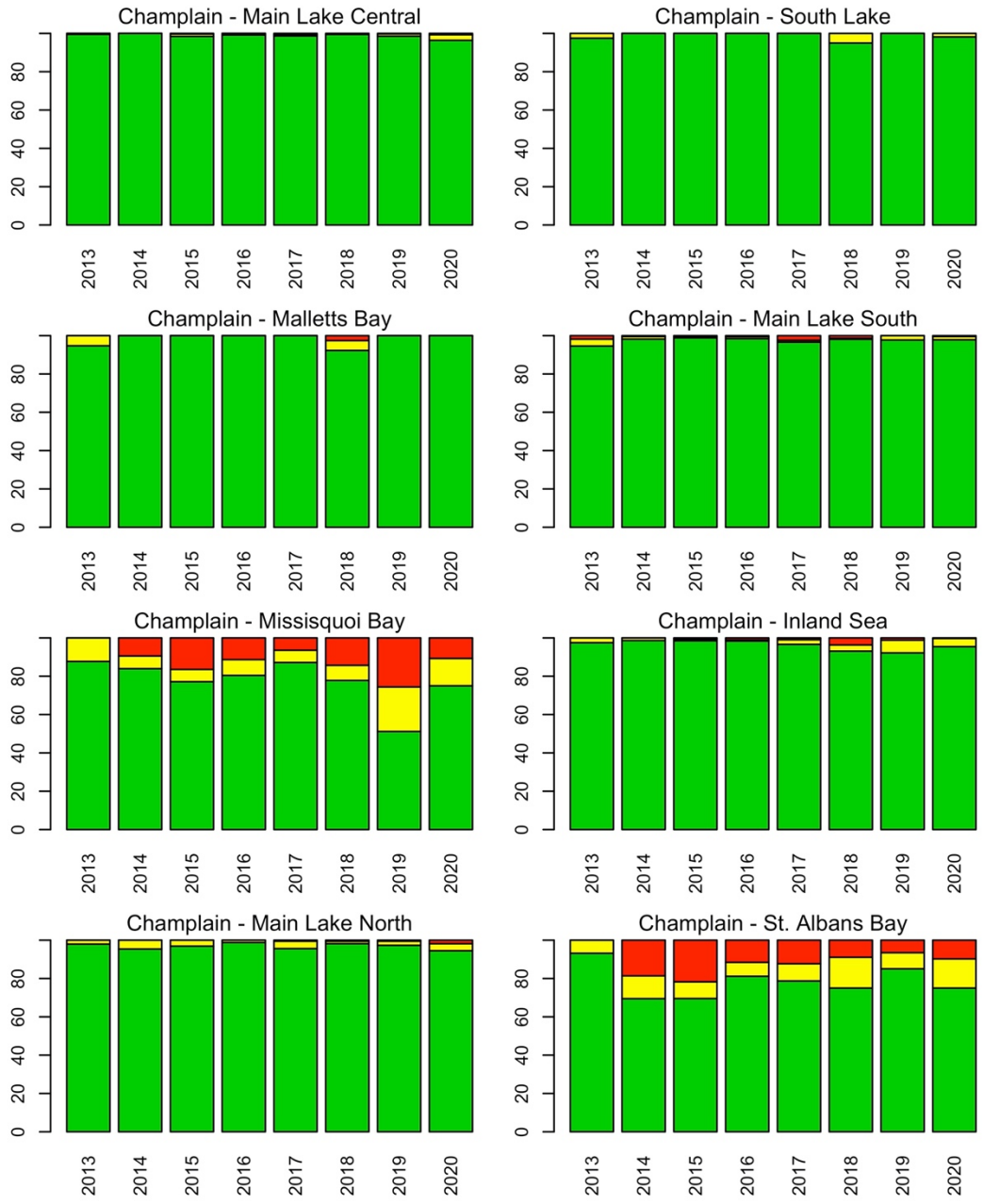


Figure 10: Web Report alert levels from routine reports for the basins of Lake Champlain during the years 2013 – 2020 showing the percentage of reports in each alert category. Green indicates “generally safe” conditions, yellow indicates “low alert”, and red indicates “high alert”. Supplemental reports are excluded.

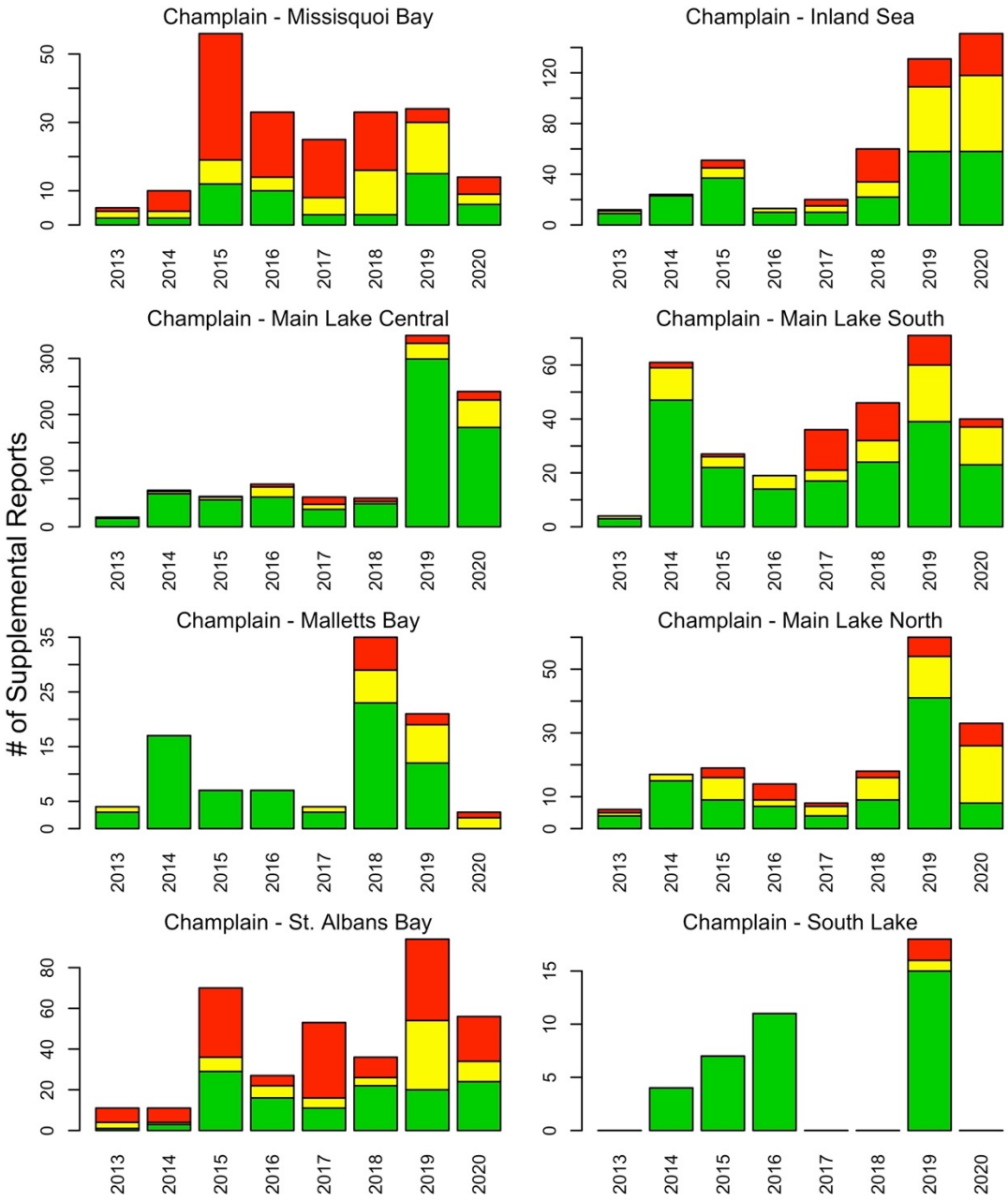


Figure 11: Web Report alert levels in Supplemental Reports for the basins of Lake Champlain during the years 2013 – 2020 showing the percentage of reports in each alert category. Green indicates "generally safe" conditions, yellow indicates "low alert", and red indicates "high alert". Supplemental reports reflect public interest and participation in bloom monitoring activities, as well as actual bloom conditions on the lake.

Table 7. Microcystin concentrations in major lake segments, 2003 – 2020. Data are from routine monitoring locations and bloom events. Data do not distinguish between net plankton, which were tested through 2012, and whole water samples. ND = not detected. Shaded boxes = not applicable. Detailed data for 2003 - 2013 can be found in Appendix D.

Lake Region		Max 2003-2013	2014	2015	2016	2017	2018	2019	2020
Inland Sea	median	1.10	<0.16	<0.16			<0.16	<0.16	
	range	0.01–22.5	<0.16–0.28	<0.16–0.02			All <0.16	<0.16–0.36	
	#samples		56	26	0	0	5	4	0
	#stations		4	4			5	4	
Main Lake Central	median	7.42	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
	range	0.01 -23.3	<0.16–0.19	All <0.16	All <0.16	<0.16–1.25	All <0.16	All <0.16	<0.16–0.17
	#samples		31	27	26	31	36	36	28
	#stations		2	2	2	4	4	6	4
Main Lake North	median				<0.16	<0.16	<0.16	<0.16	<0.16
	range	0.01–1.56			All <0.16	All <0.16	All <0.16	All <0.16	All <0.16
	#samples		0	0	12	10	11	11	2
	#stations				1	1	1	2	1
Main Lake South	median	0.04	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
	range	<0.16–3.47	<0.16–0.51	All <0.16	All <0.16	<0.16–4.25	All <0.16	All <0.16	All <0.16
	#samples		33	28	12	16	21	13	3
	#stations		3	2	1	3	4	1	1
St. Albans Bay	median	0.30	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
	range	<0.16–22.48	<0.16–0.2	<0.16–0.77	All <0.16	<0.16–0.35	<0.16–0.38	All <0.16	<0.16–0.22
	#samples		4	12	15	21	13	16	12
	#stations		2	2	3	3	1	3	2
Malletts Bay	median	0.04					<0.16	<0.16	
	range	0.04–0.08					All <0.16	NA	
	#samples		0	0	0	0	6	1	0
	#stations						3	1	0
South Lake	median	0.96							
	range	0.53–1.86							
	#samples		0	0	0	0	0	0	0
	#stations								
Missisquoi Bay	median	2.56	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
	range	<0.16–6490	<0.16–2.29	<0.16–0.43	All <0.16	<0.16–5.6	<0.16–0.38	<0.16–0.93	All <0.16
	#samples		40	38	19	18	16	14	13
	#stations		7	5	6	3	4	1	2

Summary

The cyanobacteria monitoring program continues to operate through a strong partnership between the State of Vermont, the Lake Champlain Committee, and the Lake Champlain Basin Program. As in years past, the majority of monitoring reports documented generally safe conditions on Lake Champlain and selected Vermont inland lakes. Some locations on Champlain and some Vermont inland lakes received higher numbers of reports of bloom conditions in 2020 compared to previous years, but the unusual circumstances during 2020 and lack of quantitative samples makes it difficult to make confident comparisons between years. Microcystin and anatoxin detections were infrequent and observed concentrations were all below the Vermont recreational guidance levels in 2020.

Partners continue to use the visual assessment protocol to communicate cyanobacteria conditions across Lake Champlain, supported by toxin data collected routinely at key locations. The visual assessment protocol facilitates outreach on inland lakes, providing a common way to visually evaluate and communicate conditions to individuals who may be experiencing cyanobacteria for the first time, and the increased reporting in inland lakes was a positive outcome in 2020. Outreach continues to be an important component of the monitoring program.

Routine monitoring occurs on one day each week and alert level conditions are most likely to be captured in supplemental reports made during the rest of the week, requiring extra effort on the part of our monitors. Because of their diligence and the increasing number of volunteers gathering data for this project, we have a good understanding of cyanobacteria conditions on Lake Champlain and several Vermont inland lakes. VDH and VT DEC are developing two cyanobacteria severity metrics to assist with outreach and investigation of bloom frequency temporal patterns.

Acknowledgements

Project funding was provided by the Lake Champlain Basin Program, the State of Vermont, CDC grants to the VDH, and private funding to the Lake Champlain Committee. This project is very much a collaborative effort and we'd like to thank all those who have contributed to its successful implementation – Jeremy Howland, Pete Stangel, and Kelcie Bean (VT DEC Watershed Management); Angela Shambaugh (formerly of VT DEC); Obehi (Ob) Ilenikhena (CDC/VDH), Marie Sawyer and Suzy Stanton (VDH Laboratory); Jan Leja and Dan Jarvis (developers of the Tracker map); Lindsey Carlsen, Alexa Hachigian, Grace Jia, and Lauren Sopher (LCC); staff at VT State Parks; and especially the community science volunteer monitors who continue to be the backbone of this monitoring effort.

Appendix A. 2020 Routine Sampling Locations

Waterbody	Site.Name	Town	State	Affiliation	Site Number	Latitude	Longitude
Adams Reservoir	Woodford State Park - Camper Beach	Bennington	VT	VT State Parks	444	42.8847867	-73.039084
	Woodford State Park - Day Beach	Bennington	VT	VT State Parks	443	42.8890116	-73.038349
Caspian Lake	Caspian Lake	Greensboro	VT	VT DEC Volunteer	306	44.5768413	-72.298097
Coles Pond	Coles Pond	Walden	VT	VT DEC Volunteer	311	44.5025614	-72.21414
Dewey Mills Pond	Dewey Mills Pond	Hartford	VT	VT DEC Volunteer	487	43.6432469	-72.405993
Halfmoon Lake	Half Moon State Park - Camper Beach	Hubbardton	VT	VT State Parks	437	43.6945364	-73.219084
Indian Brook Reservoir	Indian Brook Reservoir Boat Launch	Essex	VT	LCC Volunteer	491	44.5321093	-73.096067
Joes Pond	Clubhouse Circle	West Danville	VT	VT DEC Volunteer	465	44.4171408	-72.221378
	The Narrows, Joes Pond	West Danville	VT	VT DEC Volunteer	463	44.4089049	-72.211622
	Town Beach, Joes Pond	West Danville	VT	VT DEC	464	44.4103809	-72.198719
	Town Beach, Joes Pond	West Danville	VT	VT DEC Volunteer	464	44.4103809	-72.198719
Lake Carmi	Carmi DEC01-Central Open Water	Franklin	VT	VT DEC	409	44.9726087	-72.874501
	Carmi DEC02-Southern Open Water	Franklin	VT	VT DEC	410	44.9592085	-72.886901
	Carmi DEC03-Northeastern Open Water	Franklin	VT	VT DEC	411	44.9832886	-72.859881
	Lake Carmi State Park	Franklin	VT	VT State Parks	201	44.9609036	-72.87497
	Lake Carmi State Park - Area B	Franklin	VT	VT State Parks	415	44.9558144	-72.884044
	Lake Carmi State Park South	Franklin	VT	VT State Parks	165	44.956905	-72.876666
	Lake Carmi, Black Woods	Franklin	VT	LCC Volunteer	164	44.9753062	-72.885461
	Lake Carmi, North Beach	Franklin	VT	VT DEC	167	NA	NA
	Lake Carmi, North Beach	Franklin	VT	VTDEC	167	NA	NA
Lake Champlain Champlain - Inland Sea	Alburgh East Shore - Town Beach	Alburgh	VT	LCC Volunteer	430	44.9542848	-73.263829
	Alburgh Lakeshore Park	Alburgh	VT	LCC Volunteer	510	44.9714874	-73.229676
	Burton Island State Park	St. Albans Town	VT	VT State Parks	37	44.7764466	-73.196544

	Carry Bay	North Hero	VT	LCC Volunteer	5	44.8336008	-73.289907
	Carry Bay - East Shore	North Hero	VT	LCC Volunteer	420	44.8350556	-73.27263
	Cedar Ledge	North Hero	VT	LCC Volunteer	131	44.8469649	-73.262188
	Chilconi Cove	St. Albans Town	VT	LCC Volunteer	498	44.7836195	-73.184909
	City Bay - Rt 2	North Hero	VT	LCC Volunteer	78	44.8159027	-73.289082
	Dunham Bay	North Hero	VT	LCC Volunteer	186	44.8856281	-73.273369
	East Shore North	Grand Isle	VT	LCC Volunteer	501	44.760083	-73.272166
	Fee Fee Point	North Hero	VT	LCC Volunteer	461	44.8959753	-73.267176
	Grand Isle State Park	Grand Isle	VT	VT State Parks	11	44.685855	-73.290856
	Graveyard Point	North Hero	VT	LCC Volunteer	473	44.8307886	-73.286401
	Idlewild Road	South Hero	VT	LCC Volunteer	427	44.6644709	-73.277575
	Keeler Bay Boat Launch	South Hero	VT	LCC Volunteer	135	44.6681823	-73.318381
	Keeler Bay East	South Hero	VT	LCC Volunteer	134	44.6541181	-73.291941
	Kings Bay Fishing Access	North Hero	VT	LCC Volunteer	432	44.8698116	-73.250475
	Knight Island State Park	North Hero	VT	VT State Parks	146	44.8107167	-73.258055
	Knight Point State Park	North Hero	VT	VT State Parks	80	44.7686121	-73.294412
	Lapan Bay	St. Albans Town	VT	LCC Volunteer	385	44.8155601	-73.178104
	LTM 34	Milton	VT	VT DEC	34	44.7081752	-73.226835
	Maquam Beach	Swanton	VT	LCC Volunteer	139	44.9208312	-73.161099
	Maquam Shore Road, Swanton	Swanton	VT	LCC Volunteer	209	44.904524	-73.174834
	Marycrest Beach	Grand Isle	VT	LCC Volunteer	116	44.7233712	-73.281548
	North Hero State Park	North Hero	VT	LCC Volunteer	23	44.9217627	-73.240785
	Ransoms Bay - Blue Rock	Alburgh	VT	LCC Volunteer	508	44.9603611	-73.25175
	Sand Bar State Park	Milton	VT	VT State Parks	57	44.628409	-73.240172
	South Alburgh - Squires Bay	Alburgh	VT	LCC Volunteer	182	44.9030142	-73.271733
	South Hero Fish and Wildlife Boat Access	South Hero	VT	LCC Volunteer	110	44.6363402	-73.265208
	Strong House Lane	North Hero	VT	LCC Volunteer	435	44.9078703	-73.2325
	The Gut	Grand Isle	VT	LCC Volunteer	49	44.7513827	-73.290262

	West Shore Rd. North Hero 2	North Hero	VT	LCC Volunteer	492	44.7940144	-73.313232
Lake Champlain Champlain - Main Lake Central	Ausable Point Campground Beach	Peru, NY	NY	LCC Volunteer	376	44.5721384	-73.426571
	Ausable Point Road - Lake side	Peru, NY	NY	LCC Volunteer	434	44.5728776	-73.432739
	Burlington, VT - Texaco Beach	Burlington	VT	LCC Staff	72	44.4876442	-73.232127
	Burlington, VT - Texaco Beach	Burlington	VT	LCC Volunteer	72	44.4876442	-73.232127
	Clearwater Road	Shelburne	VT	LCC Volunteer	500	44.4141944	-73.219806
	Community Sailing Center	Burlington	VT	LCC Volunteer	107	44.4820095	-73.224639
	Corlear Bay, Port Douglas Boat Launch	Chesterfield, NY	NY	LCC Volunteer	160	44.4861245	-73.411743
	Dead Creek Inlet	Peru, NY	NY	LCC Volunteer	413	44.5725409	-73.434046
	Delta Park	Colchester	VT	LCC Volunteer	405	44.5367128	-73.277492
	Essex Road	Willsboro, NY	NY	LCC Volunteer	382	44.3435623	-73.358118
	Kessel Park Beach	Port Douglas	VT	LCC Volunteer	493	44.4775175	-73.413366
	Lakeside Beach	Burlington	VT	LCC Volunteer	514	44.4600692	-73.222118
	LaPlatte River mouth, Shelburne Bay	Shelburne	VT	LCC Volunteer	55	44.4009397	-73.233932
	Leddy Park	Burlington	VT	LCC Volunteer	54	44.5008483	-73.253372
	LTM 16	Shelburne	VT	VT DEC	16	44.4250086	-73.232001
	LTM 19	South Burlington	VT	VT DEC	19	44.4707634	-73.299687
	LTM 21	Burlington	VT	VT DEC	21	44.474842	-73.231668
	LTM 33	Plattsburgh, NY	NY	VT DEC	33	44.7011754	-73.418168
	North Beach	Burlington	VT	LCC Staff	22	44.4910673	-73.240373
	North Beach	Burlington	VT	LCC Volunteer	22	44.4910673	-73.240373
	North Shore Beach	Burlington	VT	LCC Volunteer	391	44.5207662	-73.269585
	Oakledge Park Blanchard Beach	Burlington	VT	LCC Staff	42	44.4574493	-73.225508
	Oakledge Park Blanchard Beach	Burlington	VT	LCC Volunteer	42	44.4574493	-73.225508
	Oakledge Park rocky shoreline	Burlington	VT	LCC Staff	44	44.4567255	-73.228032
	Oakledge Park rocky shoreline	Burlington	VT	LCC Volunteer	44	44.4567255	-73.228032
	Oakledge Park South Cove	Burlington	VT	LCC Staff	43	44.4549655	-73.230045
	Oakledge Park South Cove	Burlington	VT	LCC Volunteer	43	44.4549655	-73.230045

	Port Kent Beach 2	Chesterfield, NY	NY	LCC Volunteer	394	44.5274123	-73.404878
	Red Rocks Beach	South Burlington	VT	LCC Staff	27	44.4420075	-73.224134
	Red Rocks Beach	South Burlington	VT	LCC Volunteer	27	44.4420075	-73.224134
	Rock Point - Eagle Bay	Burlington	VT	LCC Volunteer	509	44.4954888	-73.246387
	Shelburne Farms - Inn Beach	Shelburne	VT	LCC Volunteer	499	44.4005697	-73.272376
	South Beach Road	South Burlington	VT	LCC Volunteer	467	44.4239907	-73.217787
	South Cove Beach	Burlington	VT	LCC Volunteer	173	44.4499316	-73.231081
	Starr Farm Beach	Burlington	VT	LCC Volunteer	108	44.5138095	-73.271447
	Sunset/Crescent Beach	South Hero	VT	LCC Volunteer	132	44.6088924	-73.315848
	Teddy Bear Point Cove, Willsboro NY	Willsboro, NY	NY	LCC Volunteer	63	44.4427319	-73.374284
	US Coast Guard Boat Access Ramp	Burlington	VT	LCC Volunteer	417	44.4803227	-73.223105
	Whiskey Bay	Charlotte	VT	LCC Volunteer	426	44.2704913	-73.301746
Lake Champlain Champlain - Main Lake North	Alburgh Dunes State Park	Alburgh	VT	LCC Volunteer	35	44.8644117	-73.301875
	Alburgh Dunes State Park	Alburgh	VT	VT State Parks	35	44.8644117	-73.301875
	Carrying Place South	North Hero	VT	LCC Volunteer	474	44.8252615	-73.27657
	Holcomb Boat Launch	Isle la Motte	VT	LCC Volunteer	129	44.8546931	-73.331621
	Horicans Fish and Wildlife Access	Alburgh	VT	LCC Volunteer	127	44.9140924	-73.314492
	Lighthouse Point Road	Isle la Motte	VT	LCC Volunteer	472	44.9062083	-73.346187
	LTM 36	Grand Isle	VT	VT DEC	36	44.7561756	-73.355001
	LTM 46	Alburgh	VT	VT DEC	46	44.9483422	-73.340001
	Oliver Bay	Plattsburgh, NY	NY	LCC Volunteer	45	44.738636	-73.404931
	Pelots Point West	North Hero	VT	LCC Volunteer	130	44.8259762	-73.309975
	Point of the Tongue	Alburgh	VT	LCC Volunteer	494	44.8551675	-73.293223
	Rouses Pt	Alburgh	VT	LCC Volunteer	28	44.9949936	-73.360792
	Stoney Point, Isle la Motte	Isle la Motte	VT	LCC Volunteer	128	44.8714914	-73.359441
	Vantines Boat Launch	Grand Isle	VT	LCC Volunteer	115	44.7198617	-73.341769
Lake Champlain Champlain - Main Lake South	Beggs Park Beach, Essex NY	Essex, NY	NY	LCC Volunteer	60	44.308471	-73.347325
	Bulwagga Bay/Port Henry	Port Henry, NY	NY	LCC Volunteer	138	44.0344058	-73.456482
	Burgey Farm Road	Addison	VT	LCC Volunteer	380	44.0559489	-73.417177

	Button Bay Boat Launch	Ferrisburgh	VT	LCC Volunteer	74	44.1761706	-73.352251
	Button Bay Boat Launch	Ferrisburgh	VT	VT State Parks	74	44.1761706	-73.352251
	Button Bay State Park	Ferrisburgh	VT	VT State Parks	180	44.1809368	-73.361645
	Button Bay State Park - the Point	Ferrisburgh	VT	VT State Parks	421	44.1781257	-73.370722
	Camp Dudley, Westport NY	Westport, NY	NY	LCC Volunteer	75	44.1432058	-73.41567
	Camp Greylock	Ferrisburgh	VT	LCC Volunteer	118	44.2431811	-73.292528
	Charlotte Town Beach	Charlotte	VT	LCC Volunteer	76	44.3347342	-73.282904
	Chimney Point	Addison	VT	LCC Volunteer	143	44.0348182	-73.422603
	DAR State Park	Addison	VT	LCC Volunteer	39	44.0574792	-73.417408
	DAR State Park	Addison	VT	VT State Parks	39	44.0574792	-73.417408
	Ferrisburgh Town Beach	Ferrisburgh	VT	LCC Volunteer	117	44.2359456	-73.300977
	Kingsland Bay State Park	Ferrisburgh	VT	VT State Parks	15	44.2403419	-73.298695
	Long Point	Ferrisburgh	VT	LCC Volunteer	18	44.2582625	-73.277669
	Long Point Beach	Ferrisburgh	VT	LCC Volunteer	460	44.2529087	-73.279601
	LTM 07	Panton	VT	VT DEC	7	44.1260084	-73.412834
	LTM 09	Ferrisburgh	VT	VT DEC	9	44.2421752	-73.329168
	Port Henry Boat Launch	Port Henry, NY	NY	LCC Volunteer	153	44.0525002	-73.452979
	Porter Bay	Ferrisburgh	VT	LCC Volunteer	136	44.2214408	-73.315776
	Town Farm Bay	Charlotte	VT	LCC Volunteer	119	44.2691726	-73.28875
	Westport Boat Launch	Westport, NY	NY	LCC Volunteer	59	44.1882052	-73.432718
	Westport Public Beach	Westport, NY	NY	LCC Volunteer	517	44.1827655	-73.431272
Lake Champlain Champlain - Malletts Bay	Bayside Beach	Colchester	VT	LCC Volunteer	377	44.5456836	-73.215972
	LTM 25	Colchester	VT	VT DEC	25	44.5820084	-73.281168
	Malletts Bay Boat Launch	Colchester	VT	LCC Volunteer	120	44.5541998	-73.231043
	Marble Island	Colchester	VT	LCC Volunteer	387	44.5703218	-73.23271
	Niquette Bay State Park	Colchester	VT	VT State Parks	67	44.5818913	-73.188361
	Niquette Bay State Park - Cove Beach	Colchester	VT	VT State Parks	416	44.5804302	-73.196201
	Outer Bay	Colchester	VT	LCC Volunteer	496	44.56693	-73.23797
	Pebble Beach	Colchester	VT	LCC Volunteer	497	44.5722097	-73.23571

	Sandbar Wildlife Mgmt. Area	Colchester	VT	LCC Volunteer	503	44.6253074	-73.240157
Lake Champlain Champlain - Missisquoi Bay	LTM 50	Swanton	VT	VT DEC	50	45.0133423	-73.173834
	Phillipsburg, QC	Philipsburg, QC	VT	LCC Volunteer	58	45.0390732	-73.078694
	Shipyard, Highgate Springs	Highgate	VT	LCC Volunteer	30	44.9810279	-73.108181
Lake Champlain Champlain - South Lake	Gilligan's Bay	Crown Point, NY	NY	LCC Volunteer	511	43.952608	-73.411289
	LTM 02	Benson	VT	VT DEC	2	43.7140082	-73.383001
	LTM 04	Bridport	VT	VT DEC	4	43.9510085	-73.407001
	Monitor Bay Boat Launch	Crown Point, NY	NY	LCC Volunteer	513	43.947834	-73.413224
	Mud Flats-Addison	Addison	VT	LCC Volunteer	456	44.0315379	-73.408289
	Ticonderoga Boat Launch	Ticonderoga, NY	NY	LCC Volunteer	188	43.8547379	-73.385038
Lake Champlain Champlain - St. Albans Bay	Boat Launch on Hathaway Point Rd	St. Albans Town	VT	LCC Volunteer	379	44.7941863	-73.172236
	Ferrand Rd. St. Albans	St. Albans Town	VT	LCC Volunteer	113	44.7917202	-73.142542
	Georgia Beach	Georgia	VT	LCC Volunteer	193	44.7682091	-73.162601
	Hackett's Way	St. Albans Town	VT	LCC Volunteer	402	44.7843971	-73.173967
	Hathaway Point Road	St. Albans Town	VT	LCC Volunteer	403	44.7963778	-73.163122
	Kill Kare State Park	St. Albans Town	VT	VT State Parks	56	44.7781231	-73.183605
	LTM 40	St. Albans Town	VT	VT DEC	40	44.785342	-73.162168
	Melville Landing	St. Albans Town	VT	LCC Volunteer	176	44.7620083	-73.167403
	St. Albans Bay Park	St. Albans Town	VT	LCC Volunteer	31	44.8086674	-73.144363
Lake Dunmore	Pine Lane, Salisbury VT	Salisbury	VT	VT DEC Volunteer	485	43.92256	-73.0797
Lake Fairlee	Outlet, Lake Fairlee	Fairlee	VT	VT DEC Volunteer	481	43.8836445	-72.243045
Lake Iroquois	Lake Iroquois	Williston	VT	LCC Volunteer	203	44.3780772	-73.086739
	Lake Iroquois Southwest	Hinesburg	VT	LCC Volunteer	169	44.3632817	-73.085643
Lake Memphremagog	Derby Bay	Derby	VT	MWA Volunteer	211	44.9948071	-72.189791
	Newport Marina	Newport	VT	MWA Volunteer	478	44.9378066	-72.217728
	Prouty Beach	Newport	VT	VT DEC Volunteer	204	44.9465045	-72.208694
	South Bay F&W Access, Newport VT	Newport	VT	MWA Volunteer	425	44.9540417	-72.233614
	Sunset Acres, Derby Bay	Derby	VT	VT DEC Volunteer	423	44.9832704	-72.185802
	VT DEC Station 3, Memphremagog	Newport	VT	VT DEC	479	44.9664992	-72.225601

	VT DEC Station 4, Memphremagog	Newport	VT	VT DEC	480	44.9817994	-72.216797
	Whipple Point F&W Access, Lake Memphremagog	Newport Town	VT	MWA Volunteer	484	44.9540419	-72.233615
Lake Morey	VT Fish and Wildlife Access, Lake Morey VT	Fairlee	VT	LCC Volunteer	451	43.9215474	-72.159171
Lake Morey	VT Fish and Wildlife Access, Lake Morey VT	Fairlee	VT	VT DEC Volunteer	451	43.9215474	-72.159171
Lake Pinneo	Beach, Lake Pinneo	Hartford	VT	VT DEC Volunteer	486	43.6496361	-72.431945
Lake Runnemede	Lake Runnemede (Evarts Pond)	Windsor	VT	VT DEC Volunteer	354	43.4831243	-72.391568
Mill Pond	Kayak Access, Mill Pond VT	Windsor	VT	VT DEC Volunteer	452	43.4763768	-72.396312
Salem Lake	Orcutt Brook area, Salem Lake VT	Derby	VT	VT DEC Volunteer	449	44.9267285	-72.09728
Shelburne Pond	Shelburne Pond Boat Launch	Shelburne	VT	LCC Volunteer	396	44.3773508	-73.161782
Waterbury Reservoir	Waterbury Reservoir Boat Launch	Waterbury	VT	LCC Volunteer	490	44.38347	-72.77409

Appendix B. Visual Assessment Protocols – Lake Champlain Committee

https://www.lakechamplaincommittee.org/get-involved/volunteers/cyanobacteriamonitors/algaebloomintensity/

Lake Shop Subscribe Contact Us Donate to LCC

= Site Menu

In This Section

- Overview
- Join LCC/Donate
- Calendar of Events
- Volunteer
- Water Conservation
- Take the Lake Protection Pledge
- Send LCC Your Photos!
- Job Openings

Category 3 cyanobacteria bloom in Clarenceville, Quebec. Photo by Nathalie Fortin.

Categorization of Water Conditions

- General Instructions
- Category 1a: No cyanobacteria observed—clear water
- Category 1b: No cyanobacteria observed—brown or turbid water
- Category 1c: No cyanobacteria observed—other material present
- Category 1d: Little cyanobacteria observed—recreation not impaired—tiny specks present, but no streaks or patches—include photos
- Category 2: Cyanobacteria present, but at less than bloom levels—include photos
- Category 3: Cyanobacteria bloom in progress—include photos
- Jar Test of Each Category

General Instructions

Remember to avoid direct contact with Category 2 and 3 conditions.

All observations that are submitted and approved will be posted on the Vermont Department of Health Cyanobacteria Tracker.

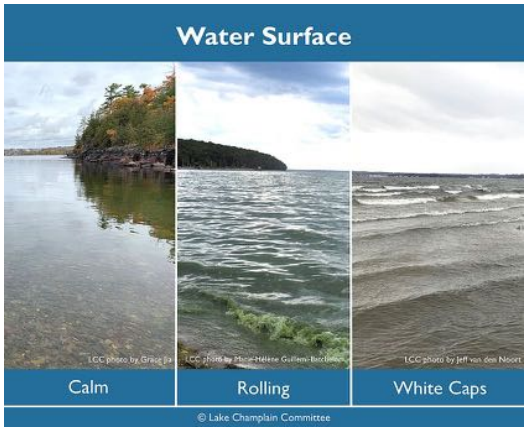
Please make observations at the same location once per week. Routine observations should be made no earlier than 10:00 AM and preferably by 3:00 PM. Blooms most frequently appear during this timeframe because cyanobacteria have had a chance to rise from lower in the water column in response to light and heat. Reports of good conditions outside of this timeframe may be rejected.

Anyone providing reports should include the following information:

Water Temperature (°F)

Water Surface

1. Calm
2. Rolling
3. White Caps



Bloom Intensity

The rating scale runs from 1 (a, b, c, or d) to 3, with 1a being no cyanobacteria observed—clear water and 3 being a cyanobacteria bloom observed in progress.

- Category 1a
- Category 1b
- Category 1c
- Category 1d
- Category 2

- Category 3

Approximately how far along the shore the bloom extends (in feet).

Approximately how far out into the water the bloom extends (in feet).

Photographs

- For category 1d, 2, and 3 conditions, three digital photographs should be submitted via the online form:

1. Jar
2. Close
3. Broad

Category 1a: No cyanobacteria observed—clear water

There is high visibility through the water column. Objects lower in the water column—sand, rocks, or plants—are clearly visible. The overall appearance of the water is clear.

What you may observe:

Foam

Shed insect skins

Sporadic plants, like duckweed or American eelgrass

In This Section

Overview
Join LCC/Donate
Calendar of Events
Volunteer
Water Conservation
Take the Lake Protection Pledge
Send LCC Your Photos!
Job Openings

Category 3 cyanobacteria bloom in Clarenceville, Quebec. Photo by Nathalie Fortin.

Categorization of Water Conditions

General Instructions
Category 1a: No cyanobacteria observed—clear water
Category 1b: No cyanobacteria observed—brown or turbid water
Category 1c: No cyanobacteria observed—other material present
Category 1d: Little cyanobacteria observed—recreation not impaired—tiny specks present, but no streaks or patches—include photos
Category 2: Cyanobacteria present, but at less than bloom levels—include photos
Category 3: Cyanobacteria bloom in progress—include photos
Jar Test of Each Category

General Instructions

Remember to avoid direct contact with Category 2 and 3 conditions.

All observations that are submitted and approved will be posted on the Vermont Department of Health Cyanobacteria Tracker.

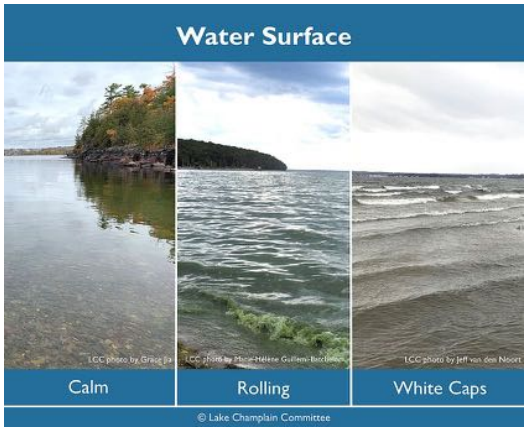
Please make observations at the same location once per week. Routine observations should be made no earlier than 10:00 AM and preferably by 3:00 PM. Blooms most frequently appear during this timeframe because cyanobacteria have had a chance to rise from lower in the water column in response to light and heat. Reports of good conditions outside of this timeframe may be rejected.

Anyone providing reports should include the following information:

Water Temperature (°F)

Water Surface

1. Calm
2. Rolling
3. White Caps



Bloom Intensity

The rating scale runs from 1 (a, b, c, or d) to 3, with 1a being no cyanobacteria observed—clear water and 3 being a cyanobacteria bloom observed in progress.

- Category 1a
- Category 1b
- Category 1c
- Category 1d
- Category 2

- Category 3

Approximately how far along the shore the bloom extends (in feet).

Approximately how far out into the water the bloom extends (in feet).

Photographs

- For category 1d, 2, and 3 conditions, three digital photographs should be submitted via the online form:

1. Jar
2. Close
3. Broad

Category 1a: No cyanobacteria observed—clear water

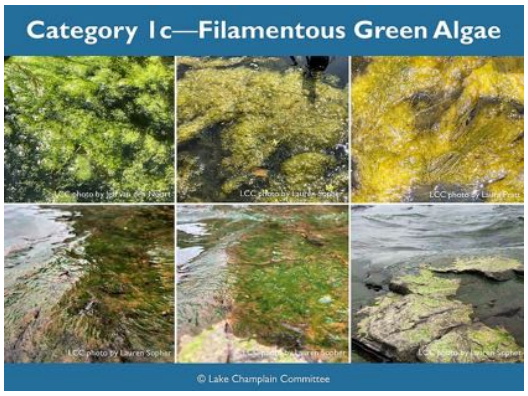
There is high visibility through the water column. Objects lower in the water column—sand, rocks, or plants—are clearly visible. The overall appearance of the water is clear.

What you may observe:

Foam
Shed insect skins
Sporadic plants, like duckweed or American eelgrass

Color: green or brown

Where: the water surface or bottom of lakes, ponds, rivers, and streams; attached to rocks above and below the water



Not sure if you're seeing potentially toxic cyanobacteria or non-toxic filamentous green algae? A stick test is a good way to differentiate cyanobacteria from plant matter. If you can pick it up with a stick or paddle, or see plant leaves, it's generally not cyanobacteria.

Keep in mind that the stick test is not 100% reliable because some types of cyanobacteria, like *Scytonema* sp., can be picked up with a stick.

Iron Bacteria

What: organisms that obtain energy by oxidizing dissolved iron

Looks Like: red, orange, or brown slime and oily sheens

Color: red, orange, and brown

Where: locations that have iron in the soil and are frequently wet

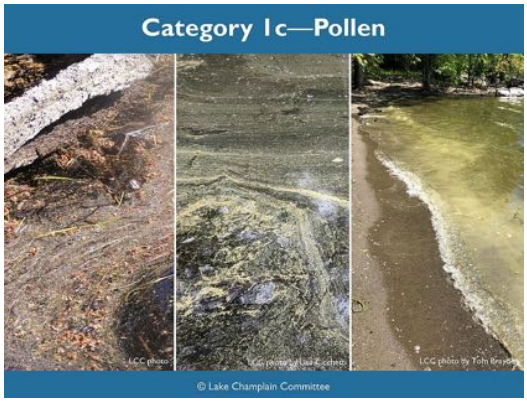
Pollen

What: a fine, powdery fertilizing element of flowering plants

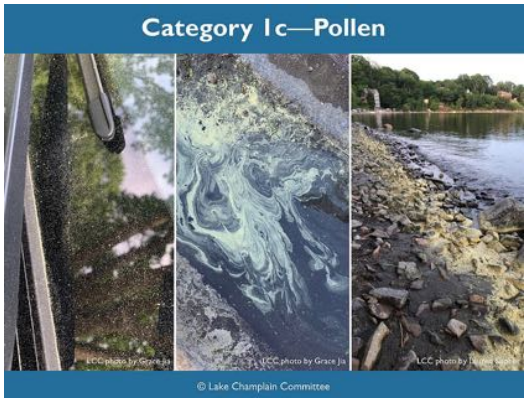
Looks Like: a thin film of sawdust on the water

Color: mustard yellow

Where: the surface of any body of water, especially at shorelines; accumulating on hard surfaces like vehicle windshields, sidewalks, and parking lots



Cyanobacteria are generally restricted to the water, whereas pollen can show up not only on the waterbody, but also in the vicinity. Reference the image below to see pollen on the windshield of a parked car (left), in a parking lot (middle), and along a shoreline (right).

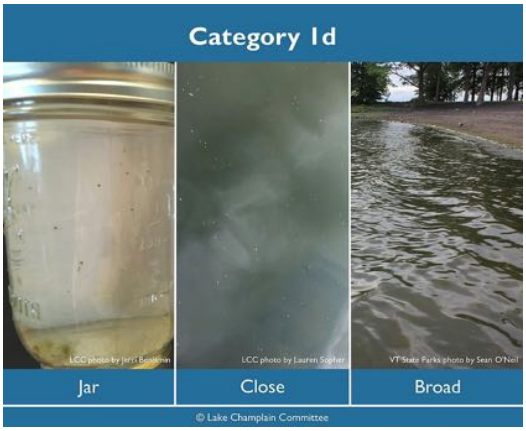


Category 1d: Little cyanobacteria observed—recreation not impaired—tiny specks present, but no streaks or patches—include photos

When cyanobacteria start to be visible in water, they often appear as tiny specks or fuzzy balls; cyanobacteria can occur in densities so low that they do not impair recreational enjoyment of the water.

What you may observe:

- Water can appear clear, but green **tiny specks** or fuzzy balls may be visible upon close inspection
- No surface or shoreline accumulations of cyanobacteria

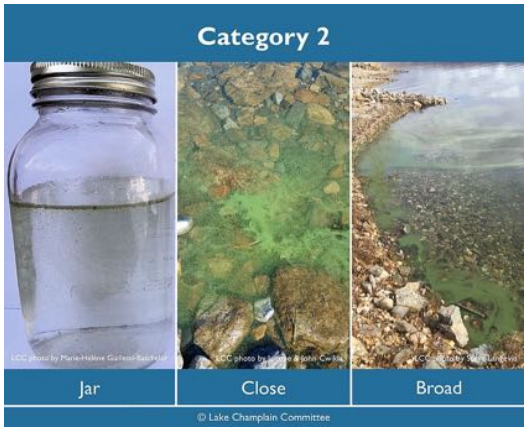


Category 2: Cyanobacteria present, but at less than bloom levels—include photos

Some cyanobacteria accumulation in the water column or on the surface, but not a continuous layer.

What you may observe:

- Open water **does not** appear green, blue, or blue-green
- **Streaks** of cyanobacteria on the water surface, but not a continuous layer
- **Small patches** of cyanobacteria on the water surface, but not a continuous layer
- A **narrow** band of cyanobacteria accumulation at the shoreline

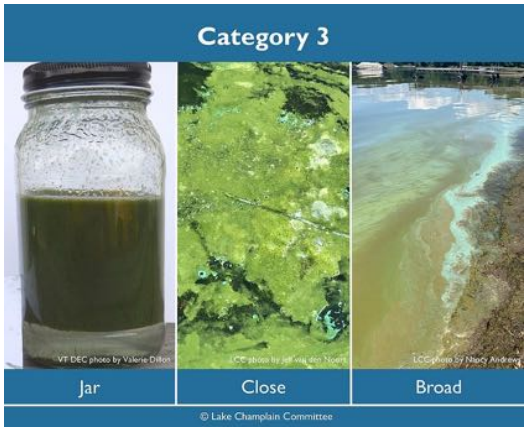


Category 3: Cyanobacteria bloom in progress—include photos

Extensive cyanobacteria accumulation in the water column or on the surface, forming a continuous layer.

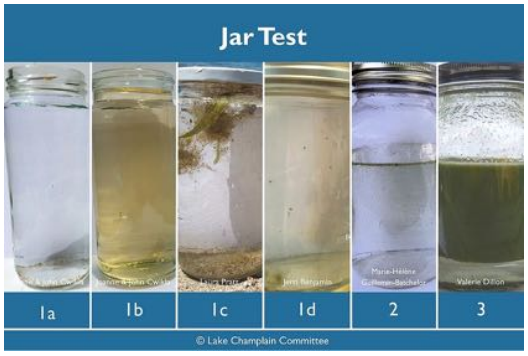
What you may observe:

- Open water **does** appear green, blue, or blue-green
- Continuous layer of **surface scum** on the water
- A **wide** band of cyanobacteria accumulation at the shoreline that extends at least 10-15 feet offshore



Jar Test of Each Category

The jar test line-up compares and contrasts the six bloom intensity categories: 1a, 1b, 1c, 1d, 2, and 3. View instructions for taking water samples here.



GET INVOLVED

- Overview
- Join LCC/Donate
- Calendar of Events
- Volunteer
- Water Conservation
- Take the Lake Protection Pledge
- Send LCC Your Photos!
- Job Openings

Home Site Map Contact Us Donate to LCC

lcc@lakechamplaincommittee.org • Tel: (802) 658-1414

208 Flynn Avenue, Building 3, Studio 3F • Burlington, Vermont 05401

Appendix C. Historical Microcystin Data for Lake Champlain

Lake Segment		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Inland Sea	median	0.05	0.41	0.08	0.27	0.05	1.10	0.07	0.03	0.08		<0.16
	range	0.05 - 0.18	0.08-17.56	0.01-0.19	0.04-42.14	0.04-0.07	0.03-22.50	0.06-0.08	0.03-0.13	0.01-0.82		<0.16 - 0.43
	#samples	6	8	8	16	4	11	2	3	9	0	45
	#stations	1	3	3	7	3	4	2	2	4		4
Main Lake Central	median	0.05	NA	7.42	NA	2.82	0.25	0.03	0.10	0.02	0.13	<0.16
	range	0.01-0.12	NA	6.04-8.80	NA	0.02-5.61	0.03-0.47	0.03-23.36	0.02-0.14	0.01-0.03	0.13-0.64	<0.16 -0.17
	#samples	19	0	2	0	2	2	6	8	4	3	23
	#stations	4	NA	1	NA	2	2	3	5	4	1	2
Main Lake North	median	NA	NA	NA	NA	NA	NA	NA	NA	NA		
	range	NA	NA	NA	NA	NA	1.56	0.03	NA	0.01		
	#samples	0	0	0	0	0	1	1	0	1	0	0
	#stations	NA	NA	NA	NA	NA	1	1	NA	1		
Main Lake South	median	NA	NA	0.04	NA	NA	NA	NA	NA	0.01		<0.16
	range	0.07	NA	ND - 0.07	3.47	NA	NA	NA	NA	0.01		<0.16 - 0.16
	#samples	1	0	2	1	0	0	0	0	2	0	22
	#stations	1	NA	1	1	NA	NA	NA	NA	2		2
St. Albans Bay	median	0.05	0.05	0.30	0.06	0.05	0.04	0.02	0.05	0.04	0.03	0.032
	range	0.01-0.41	ND - 22.48	0.06-0.82	0.01-0.43	0.02-0.54	0.02-0.12	0.01-0.17	0.01-0.80	0.02-0.14	0.03-0.04	0.002-0.062
	#samples	32	29	18	36	20	10	4	10	12	5	2
	#stations	1	2	1	2	4	3	2	3	2	1	2
Malletts Bay	median	NA	NA	NA	0.04	NA	NA	NA	NA	NA		
	range	NA	NA	NA	0.04-0.08	NA	NA	NA	NA	0.04		
	#samples	0	0	0	7	0	0	0	0	1	0	0
	#stations	NA	NA	NA	2	NA	NA	NA	NA	1		
South Lake	median	0.96	NA	NA	NA	NA	NA	NA	NA	NA		
	range	0.53-1.38	NA	0.01	NA	NA	NA	NA	NA	0.02		
	#samples	2	0	1	0	0	0	0	0	1	0	0
	#stations	2	NA	1	NA	NA	NA	NA	NA	1		
Missisquoi Bay	median	0.09	0.84	0.66	0.52	NA	2.56	0.54	0.03	0.65	0.99	<0.16
	range	ND - 23.91	0.01-6490.06	ND - 22.11	0.01-21.29	NA	0.06-94.58	0.03-54.16	0.01-0.12	0.02-180.2	0.26-54.76	<0.16 - 1.3
	#samples	341	228	146	152	0	81	29	10	59	36	30
	#stations	14	11	10	12	NA	10	8	7	8	3	6