Cyanobacteria Monitoring on Lake Champlain Summer 2015

Final Report for the Lake Champlain Basin Program

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Executive Summary

An annual 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 and private donors. Data are collected by state staff and an extensive network of trained citizen volunteers.

Cyanobacteria monitoring on Lake Champlain in 2015 continued to integrate qualitative observations, photographic documentation and quantitative analysis of algae populations into guidance for lake users. Analysis of water for the presence of microcystin, cylindrospermopsin and anatoxin, when warranted, provided additional data to inform public health decisions in response to the presence of cyanobacteria. Enhancements of the web-based tracking map maintained by the VDH resulted in near-real time reporting for 2015.

Objectives

- monitor cyanobacteria at locations on Lake Champlain through the established partnership between state and local officials, the Lake Champlain Committee and citizen volunteers;
- provide consistent quantitative data at selected locations around Lake Champlain;
- recruit additional volunteers to monitor conditions on selected Vermont lakes with periodic cyanobacteria blooms;
- test for the presence of cyanotoxins when algal density and composition triggers are reached at selected monitoring locations;
- facilitate communication about lake conditions through weekly updates to stakeholders via email and to the general public through the Vermont Department of Health webpage;
- provide outreach and assistance to beach managers, lakeshore property owners and the general public so they can learn to recognize and respond appropriately to the presence of cyanobacteria blooms

More than 1790 site-specific reports were submitted during 2015 from more than 150 locations on Lake Champlain and the four inland lakes. One hundred nineteen Champlain locations were monitored by citizen volunteers trained by the Lake Champlain Committee. Blooms, defined as category 3 of the visual protocol and alert level 2 of the tiered alert protocol, were reported 216 times during the monitoring period, a reflection of the persistent blooms observed over multiple days at many locations in 2016. The highest concentration of microcystin detected was 0.77 µg/L, at the St. Albans Bay Park on Lake Champlain August 24. No anatoxin or cylindrospermopsin was detected in 2015.

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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 monitoring program has been in place on Lake Champlain since 2002, developed initially by the University of Vermont (UVM). 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 and private donors. Data are collected by state staff and an extensive network of trained citizen volunteers.

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Methods

The 2015 cyanobacteria monitoring program was coordinated by the VT DEC and implemented in conjunction with the VDH and LCC. Quantitative samples were collected following a modification of the UVM tiered alert protocol at selected open water stations historically monitored by the program. Additional water samples for quantitative assessment were collected at selected shoreline locations.

Qualitative data were gathered following the protocol developed in 2012 by the LCC. Technical staff at the VDH developed a web-based data entry process in 2015, which was piloted by state staff, LCC and selected volunteers to facilitate management of the large amounts of data generated each week.

Sampling Locations

Routine reports were received from a total of 140 locations during the summer of 2015 (Figure 1). Occasional reports were received from an additional 53 stations. Table 1 provides a summary of stations by region, evaluation protocol, and proximity to shore. Full documentation of the sampling locations is located in Appendix A.

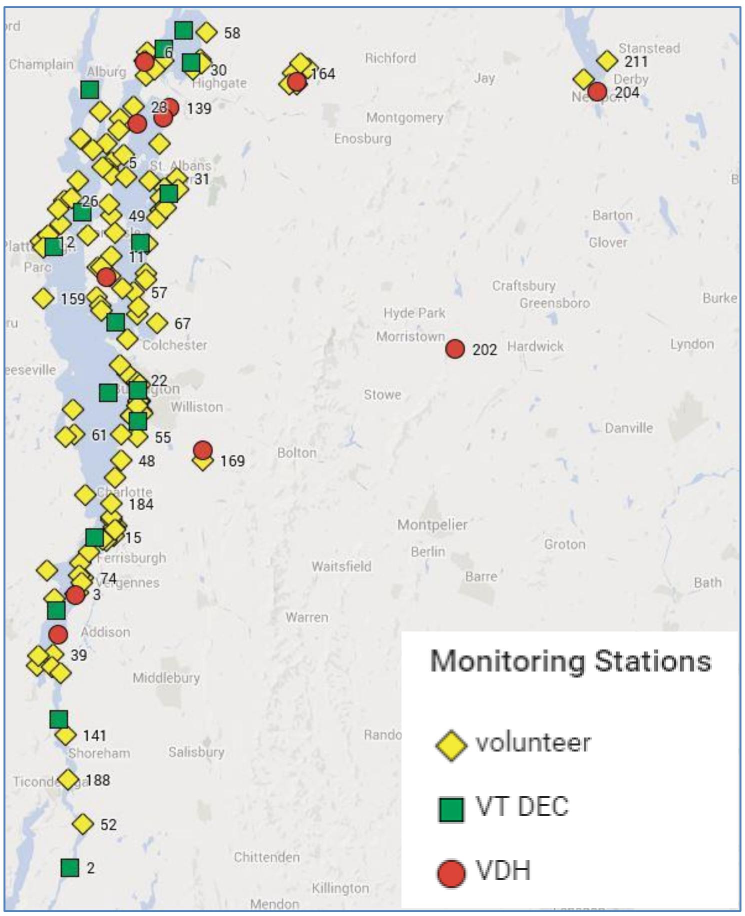

Figure 1. Cyanobacteria monitoring stations on Lake Champlain in 2015

Table 1. Stations monitored on Lake Champlain and selected Vermont lakes during 2015. Data compiled from the season summary spreadsheet available through the VDH Tracking Map.

			Number of Stations	
Lake	**Region**	**Assessment Type**	**Open Water**	**Shoreline**
Carmi		tiered Alert/visual		1
		Visual		5
Champlain	Inland Sea	Tiered Alert	1	
		tiered Alert/visual		4
		Visual		18
	Main Lake Central	Tiered Alert	4	
		tiered Alert/visual		2
		Visual		23
	Main Lake North	Tiered Alert	2	
		Visual		12
	Main Lake South	Tiered Alert	2	
		tiered Alert/visual		2
		Visual		20
	Malletts Bay	Tiered Alert	1	
		Visual		2
	Missisquoi Bay	Tiered Alert	3	
		tiered Alert/visual		2
		Visual		8
	South Lake	Tiered Alert	2	
		Visual		3
	St. Albans Bay	Tiered Alert	1	
		tiered Alert/visual		1
		Visual		6
Elmore		tiered Alert/visual		1
Iroquois		tiered Alert/visual		1
		Visual		1
Memphremagog		tiered Alert/visual		1
		Visual		2

Monitoring Protocols

The Tiered Alert Protocol

Quantitative data on taxonomic distribution, cell density and the presence of toxins were collected following the Tiered Alert protocol (Table 2). Monitoring began the week of June 1st and continued through mid-October. The DEC utilized this protocol at selected open water stations around Lake Champlain (Figure 1). Samples were collected at biweekly intervals, following the cell density triggers outlined in the protocol or the presence of visible extensive accumulations of cyanobacteria, in conjunction with the monitoring conducted for the Lake Champlain Long-term Water Quality and Biological Monitoring Program. Whole water samples collected weekly at selected shoreline locations by experienced monitors were also evaluated for the presence of cyanobacteria using the tiered alert cell count protocol.

Table 2. Outline of the Tiered Alert sampling protocol. *The presence of a visible scum automatically qualifies as Alert Level 2, regardless of previous conditions.

Framework Level	Frequency	Activity	Response
Qualitative*	2/month	3m vertical plankton tow (63µm mesh), screened within 72 hrs.	If potentially toxic taxa observed, proceed to *Quantitative Level* for next sampling visit
Quantitative*	2/month	3m vertical plankton tow (63µm mesh), enumeration within 72 hrs.	If potentially toxic taxa densities >2000 cells/mL, proceed to *Vigilance Level* for next sampling visit
Vigilance*	2/month	3m vertical plankton tow (63µm mesh), Full enumeration within 48 hrs.	If potentially toxic taxa densities >4000 cells/mL, proceed to *Alert Level1* for next sampling visit. Return to Quantitative Level if densities <2000 cells/mL.
Alert Level 1*	2/month	Collect whole water samples for phytoplankton and toxin analysis. Full enumeration and microcystin analysis with 48 hrs.	If microcystin >6µg/L (VT recreational standard) proceed to *Alert Level 2.* Return to Vigilance Level if densities <4000 cells/mL.
Alert Level 2	2/month	As for Alert Level 1	If microcystin >6µg/L, the VT recreational standard, remain at *Alert Level 2.* Return to Alert Level 1 if microcystin concentrations <6µg/L. VT, NY and QE public health officials follow their respective response plans.

Field Methods

Plankton and toxin samples were collected as whole water surface grabs or an integrated 63 µm mesh plankton net concentrate. When scums and blooms were observed, a single whole water sample was collected by placing a bucket carefully at the surface and tipping to fill. The sample was mixed thoroughly and decanted into sample bottles for subsequent enumeration or toxin analysis. Net concentrates were obtained by lowering the plankton net opening to 3m and drawing it steadily back to the surface. The total volume of the concentrate was noted before mixing and dividing into aliquots for analysis as needed. All samples were kept on ice in coolers until they reached the lab.

Plankton Enumeration

Plankton samples were analyzed using an inverted compound microscope at 200x in a Sedgewick Rafter cell. One mL aliquots were allowed to settle for 10 – 15 minutes before analysis. During qualitative analysis, SR cells were scanned rapidly for the presence of potentially toxic cyanobacteria, generating presence/absence data only. For quantitative analysis, estimates of cell density were obtained for all observed cyanobacteria and selected other taxa using the size categories noted in Table 3. 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. However, plankton counts were used to determine the cyanobacteria status only at the open water stations monitored by the VT DEC. Plankton samples were counted by VT DEC staff and uploaded to the VDH data interface, typically within 24 hours for tiered alert stations. Bloom and alert level samples were posted as soon as possible after samples were received at the laboratory.

Table 3. Size categories and cell factors used to estimate field densities of colonial algae.

Taxon	Unit Category	Estimated cells/unit	Cell factor
Anabaena *Aulocoseira* *Fragilaria*	Fragment Small Medium Large	< 20 20 – 100 100 – 1000 >1000	10 60 500 1000
Microcystis *Coelosphaerium* *Woronichinia*	Small Medium Large	<100 100 – 1000 >1000	50 500 1000
Gloeotrichia	Fragment Small Medium Large	Single trichome Quarter of a colony Half of colony Entire colony	20 2500 5000 10,000
Aphanizomenon	Fragment Small Medium Large	Single trichome Small flake Medium flake Large flake	Measured 200 500 1000
Limnothrix *Lyngbya/Scytonema*	fragment	Single trichome	Measured

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 (mid-June to early September). While the LCC did recruit to gain as wide a geographic distribution as possible, no volunteer was turned away. In a few areas of the lake, this did lead to a cluster of observation points. All volunteers attended a mandatory training session to learn to recognize cyanobacteria, become familiar with the assessment protocol, and learn how to submit their weekly reports. LCC staff met with or interacted with each volunteer 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.

Weekly Observation Process

The LCC trained more than 300 volunteer monitors in 23 training sessions during 2015. Over the course of the summer, monitors reported from 134 different locations, an increase of 47 stations from 2014 (Figure 1 and Appendix A). Protocols for the observation process, supporting documentation and the submittal process are located in Appendix B. Volunteers were asked to provide a single observation each week, preferably between 10am and 3pm, Sunday through Wednesday. Supplemental reports could also be provided. Volunteers evaluated algal conditions at their location using the prompts, photographs, and descriptions provided by the LCC, and assigned it one of the three categories:

- Category 1 – few or no cyanobacteria observed, recreational enjoyment not impaired by cyanobacteria. (Category 1 contained multiple subcategories.)
- 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 algal accumulations resulting in highly colored water and/or visible surface scums.

Each volunteer was asked to provide 3 photographs whenever category 2 or category 3 conditions were observed. All routine reports were submitted to the LCC by Wednesday each week. LCC staff reviewed all reports and photos, conferring with volunteers and the VT DEC as needed to verify the presence of cyanobacteria and appropriate status. The LCC approved reports submitted directly by volunteers to the VDH web interface and uploaded any sent directly to LCC as quickly as possible. Staff also followed up with volunteers when no reports were received. Category 2 and 3 reports were given priority, shared with partners at the VDH and DEC immediately, and posted immediately after any necessary verification.

In addition to the photos, five sites visited by volunteers were also assessed quantitatively (North Beach - Burlington VT, North Hero State Park - North Hero VT, Red Rocks Park – South Burlington VT, the Shipyard - Highgate VT, and St. Albans Bay Park). Each week, these volunteers made a visual assessment and collected water samples from the shore. These unfiltered samples were analyzed for microcystin, cylindrospermopsin, anatoxin and cyanobacteria density.

Toxin Analysis

Toxin analyses were conducted by the VDH laboratory in Burlington VT. Whole water samples were analyzed as received, without filtration, unless algal biomass was high enough to interfere with analytical procedures. In that event, aliquots were filtered using glass fiber filters and both filtrate and filter were analyzed for the presence of microcystin by ELISA. No phytoplankton filters were submitted for analysis by the VT DEC in 2015.

Filtered plankton samples for anatoxin analysis were extracted with methanol and acetonitrile and centrifuged. The supernatant was transferred to a clean vial, evaporated to dryness and reconstituted with MilliQ-grade water. The extracts were concentrated using solid phase extraction cartridges and analyzed by liquid chromatography-tandem mass spectrometry (LC/MS/MS). Whole water samples were concentrated using solid phase extraction cartridges before analysis unless large amounts of algae were present. In that event, aliquots were filtered using glass fiber filters, and both filtrate and filter were analyzed by LC/MS/MS.

Communication and Outreach

Members of the partner institutions LCC, VT DEC and VT VDH comprised an internal communication group which shared all bloom reports upon receipt and provided updates on response activities as needed. Partners also received automated notification of alert level 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, and the Quebec Ministrie de Développement durable, Environnement, et Lutte Contre les Changements Climatiques (MDDELCC) were also kept apprised of algal conditions. The MDDELCC shared their observations and analytical results from northern Missisquoi Bay over the summer, which were shared through the tracking map with the general public.

Weekly email updates summarizing reports, algal counts, species composition and toxin data were provided to a group of stakeholders responsible for public health. These were primarily state and town health officials, state and town waterfront managers, Champlain water suppliers, and researchers. Updates were released typically on Thursday afternoons but stakeholders also received email notification of extensive blooms as they occurred.

Notification of the Public

The Vermont Department of Health reported current cyanobacteria status on Lake Champlain on-line at http://healthvermont.gov/enviro/bg_algae/weekly_status.aspx. Status was presented as text and on an interactive web map that allowed viewers to find information by location around the lake. Results of the assessments translated to one of three map status categories:

VDH Map Status	Tiered Alert Protocol	Visual
Generally Safe (green)	Qualitative, Quantitative, Vigilance	Category 1
Low Alert (yellow)	Alert Level 1	Category 2
High Alert (red)	Alert Level 2	Category 3

Map status was based on the primary report type for each station, visual or tiered alert. At the VDH climate change sites and the five quantitative sites monitored by LCC volunteers, water samples for toxin and phytoplankton analysis were collected concurrently with the visual assessment. At these locations, 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 2015.

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 algal conditions, and shared that information 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 maintain individual websites highlighting monitoring activities, the interactive map and annual data. Partners also hold trainings, make presentations upon request, and respond to inquiries from the general public, lake users and the media.

Results

Overall effort

Nearly 1800 site-specific reports were made by project partners and volunteers during 2015 (Table 4). The majority of these were from the main Lake Champlain but regular reports were also received from four Vermont inland lakes through the VDH climate grant and volunteer efforts on lakes Carmi, Iroquois and Memphremagog. Reports based on the visual assessment protocol represented 81% of the total received. Reports from stations using both the tiered alert and visual assessment protocols represented 14%. The remaining reports were obtained using the tiered alert protocol.

The number of samples analyzed in 2015 is summarized in Table 5. Three hundred thirty-one water samples were analyzed for phytoplankton density and 633 for toxins. More than half of the toxin analyses were conducted as part of the routine climate change monitoring grant received by the VDH and were not triggered by density of potential toxin producers. Thirty-six supplemental samples for phytoplankton analysis and 30 for toxin analysis were by provided by project partners after observing blooms. No plankton filters were analyzed for toxins in 2015.

Assessment Results

A summary of the assessment results from regularly monitored stations in 2015 is presented in Table 6. The highest monitoring category reached at each is noted in Table 7. Supplemental reports (n = 310) were identified by the following criteria: locations not monitored regularly, made outside of the regular monitoring period for LCC volunteers, or represented additional reports filed during the weekly monitoring period. There were no reports of cyanobacteria mats in 2015. The full list of records is available upon request or can be downloaded from the VDH website (https://apps.health.vermont.gov/gis/vttracking/BlueGreenAlgae/2015Summary). No reports of human or animal illness due to cyanobacteria were confirmed in 2015.

More than 75% of the reports from regularly monitored stations indicated that few or no cyanobacteria were present (category 1 of the visual protocol and qualitative/quantitative/vigilance levels of the tiered alert protocol). Blooms, identified as category 3 of the visual protocol or alert level 2 of the tiered alert protocol, were reported 56 times at regularly monitored stations. Ninety-two supplemental reports indicated bloom conditions, many representing multiple reports for blooms which persisted over several days. In all, 148 reports of high alert conditions were received during the summer of 2015, 8% of the total reports received. The highest density of potentially toxic cyanobacteria was observed at the Alburgh VT shoreline of Missisquoi Bay on August 25 (2,882,400 cells/mL).

Table 4. Summary of the 2015 cyanobacteria monitoring station reports distributed through the email update and on-line status map. () indicates supplemental reports 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.

Lake	Region	Monitor	Quantitative	Visual	Visual/ Quantitative
Carmi		LCC		71 (9)	
		VDH			14 (6)
Champlain	Inland Sea	LCC		205 (47)	13
		VDH		1	41 (2)
		VT DEC	7	2	
	Main Lake Central	LCC		268 (37)	32 (13)
		VDH		(2)	(2)
		VT DEC	17	2	
	Main Lake North	LCC		149 (18)	
		VT DEC	10	1 (1)	
	Main Lake South	LCC		220 (27)	
		VDH			28
		VT DEC	9	3	
	Malletts Bay	LCC		24 (7)	
		VT DEC	4	1	
	Missisquoi Bay	LCC		83 (26)	16 (16)
		VDH			14
		VT DEC	20	7 (3)	
		Other		11	
	Champlain - South Lake	LCC		35 (7)	
		VT DEC	14		
	St. Albans Bay	LCC		68 (53)	15 (9)
		VDH		(2)	(2)
		VT DEC	9	(4)	
Elmore		VDH		1	10
Iroquois		LCC		15 (3)	
		VDH			11
Memphremagog		MWA		36	
		VDH			11
Other	Lower Poultney River	other		(1)	
Total			90	1448	257

Table 5. Number of water and phytoplankton samples collected and analyzed in 2015. Data compiled from the season summary spreadsheet available through the VDH Tracking Map.

	Phytoplankton		Microcystin		Anatoxin		Cylindrospermopsin	
	Net	Whole water	Plankton filters	Whole water	Plankton filter	whole water	Plankton filter	whole water
VDH Climate change sites		129	-	130	-	130	-	130
LCC Quality Control sites		62	-	60	-	60	-	60
DEC Tiered Alert Sites	104		-	11	-	11	-	11
Supplemental Samples		36	-	10	-	10	-	10
Total	**331**		**211**		**211**		**211**	

Table 6. Summary of assessment reports received in 2015. () indicate supplemental reports. Data compiled from the season summary spreadsheet available through the VDH Tracking Map.

		Tiered Alert Protocol			Visual Protocol		
		Vigilance or Lower	Alert 1	Alert 2	Category 1	Category 2	Category 3
Lake Champlain	Inland Sea	5	0	0	258 (37)	2 (8)	2 (6)
	Main Lake Central	17	0	0	297 (48)	4 (5)	1 (1)
	Main Lake North	9	0	0	146 (9)	5 (7)	0 (3)
	Main Lake South	9	0	0	248 (22)	1 (4)	2 (1)
	Malletts Bay	4	0	0	25 (7)	0	0
	Missisquoi Bay	16	1	0	92 (12)	8 (7)	23 (37)
	South Lake	12	0	0	37 (7)	0	0
	St. Albans Bay	5	1	0	59 (29)	7 (7)	20 (34)
Lake Carmi					77 (5)	1 (1)	7 (9)
Lake Elmore					11	0	0
Lake Iroquois					25 (3)	0	1
Lake Memphremagog					46	1	0
Lower Poultney River	Champlain – South Lake						(1)
Grand Total		77	2	0	1321 (179)	29 (39)	56 (92)

Table 7. Highest status reached at each monitored station in 2015. Data compiled from the season summary spreadsheet available through the VDH Tracking Map. *indicates locations which were not monitored routinely. **delayed start to monitoring. Shaded boxes indicate analyses that are not applicable to the sample. Methods: T/V = QA/QC station utilizing both tiered alert and visual protocols, V= visual protocol, T = tiered alert protocol

Lake/ Region	**Station**	**Method**	**Report Type**	**# of rep-orts**	**Status**	**Date**	**Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)**	**Highest Anatoxin Observed (ug/L)**	**Highest Cylindro-spermo-psin Observed (ug/L)**	**Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)**	**Cyanobacteria Present when Max Density Achieved**
Carmi	Carmi State Park	T/V	Weekly	14	1d	8/12/15	0.35 (8/26/15)	<0.5	<0.5	178,900 (8/26/15)	Anabaena, Aphanizomenon, Aphanothece, Scytonema spp, Oscillatoria, unidentified Oscillatoriaceae, Woronichinia/ Coelosphaerium
	Carmi State Park South	V	Weekly	13	1d	8/17/15					
			Supple-mental	1	3	9/22/15					
	Black Woods	V	Weekly	12	1d	8/24/15					
	Dewing Road	V	Weekly	17	3	9/16/15					
			supplemen tal	2	3	9/21/15					
	Hammond Rd.	V	Suppleme ntal	3	3	9/8/15					
	North Beach	V	Weekly	15	3	8/18/15					
		T/V	Suppleme ntal	9	3	9/21/15	0.40 (9/21/15)	<0.5	<0.5	924,400 (8/19/15)	Anabaena, Aphanothece, Scytonema spp, Microcystis, unidentified Oscillatoriaceae, Woronichinia/Coelosphaerium
	Westcott Shore	V	Weekly	14	3	9/8/15					
	Vics Crossing Road*	V	supplemen tal	1	3	10/8/15					
Champlain Inland Sea	Blockhouse Point Rd.*	V	supplemen tal	1	3	9/10/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain - Inland Sea	Butler Island*	V	supplemen tal	1	2	8/28/15					
	Carry Bay*	V	supplemen tal	1	3	8/9/15					
	Cedar Ledge	V	Weekly	9	1a	all reports					
	City Bay - Rt 2*	V	supplemen tal	5	1a	all reports					
	Cohen Park St. Albans	V	Weekly	12	1d	7/15/15					
	Dunham Bay	V	Weekly	10	3	8/15/15					
			supplemen tal	2	3	8/26/15					
	Everest Rd.	V	Weekly	14	1d	9/1/15					
			supplemen tal	1	1d	8/30/15					
	Georgia Shore South	V	Weekly	13	2	8/22/15					
			supplemen tal	1	3	8/23/15					
	Grand Isle State Park*	V	supplemen tal	5	1a	all reports					
	Grand Isle State Park Beach*	V	supplemen tal	1	1d	8/28/15					
	Grand Isle State Park Boat Launch*	V	supplemen tal	1	2	8/28/15					
	Keeler Bay Boat Launch	V	Weekly	14	1c	7/14/15					
	Keeler Bay East	V	Weekly	15	1a	all reports					
	Keeler Bay, South Hero	T/V	Weekly	14	1d	8/25/15	<0.16	<0.5	<0.5	301,300 (8/25/15)	Anabaena, Aphanizomenon

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain – Inland Sea	Knight Island	V	Weekly	13	1c	6/22/15					
	Knight Point State Park	V	Weekly	10	1b	8/15/15					
			supplemental	2	1a	6/16/15					
	Lombard Lane- South Hero*	V	supplemental	5	1b	7/1/15					
	LTM 34	T	Biweekly	7	Quantitative	6/4/15	not tested	not tested	not tested	229 (9/15/15)	Anabaena, Aphanizomenon, Microcystis
	Maquam Beach	V	Weekly	11	3	7/13/15					
			supplemental	11	1d	7/14/15					
	Maquam Shore Road, Swanton	T/V	Weekly	14	1d	9/8/15	<0.16	<0.5	<0.5	9810 (9/8/15)	Anabaena, Microcystis
	Marycrest Beach	V	Weekly	14	1d	7/24/15					
	Milton	V	Weekly	9	1a	6/21/15					
	Nichols Point*	V	supplemental	1	1a	6/29/15					
	North Hero*	V	supplemental	1	3	8/26/15					
	North Hero State Park	T/V	Weekly	13	1d	8/24/15	0.2 (8/10/15)	<0.5	<0.5	92,400 (9/8/15)	Anabaena, Aphanizomenon, Aphanothece, Microcystis
	offshore, middle of Keeler Bay*	V	supplemental	1	1d	9/1/15					
	offshore, west side of Savage Island*	V	supplemental	1	2	9/1/15					
	Pelots Bay*	V	supplemental	3	2	9/19/15					

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Champlain – Inland Sea	Sand Bar State Park	V	Weekly	7	1c	8/26/15					
			supplemental	6	1d	8/28/15	not tested	not tested	not tested	not tested	Gloeotrichia, Anabaena, Scytonema
	South Alburgh - Squires Bay	V	Weekly	14	1d	8/16/15					
			supplemental	2	2	8/8/15					
	South Hero Fish and Wildlife Boat Access*	V	supplemental	11	1b	7/18/15					
	Stephenson Point Fish and Wildlife Access	T/V	Weekly	14	2	9/8/15	<0.16	<0.5	<0.5	289,200 (9/8/15)	Anabaena, Aphanizomenon, Microcystis
	The Gut	V	Weekly	15	1b	6/23/15					
			supplemental	2	1a	7/24/15					
	Van Everest Boat Launch Milton	V	Weekly	13	1c	7/23/15					
			Supplemental	1	3	8/28/15					
	Woods Island*	V	Weekly	11	1a	6/15/15					
			supplemental	1	1a	7/24/15					
	Woods Island campsite 3*	V	supplemental	1	2	7/24/15					
	Woods Island West*	V	supplemental	1	1a	7/27/15					
	Allen Point	V	Weekly	16	1a	6/15/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain - Main Lake Central	Beech Bay*	V	supplemental	5	1a	7/28/15					
	Buena Vista Park, Willsboro NY	V	Weekly	13	1a	6/22/15					
	Burlington, VT - Texaco Beach	V	Weekly	8	2	7/29/15					
	Charlotte Town Beach	V	Weekly	9	1a	7/7/15					
	Community Sailing Center	V	Weekly	7	1d	7/8/15					
			supplemental	1	2	7/10/15					
	LaPlatte River mouth, Shelburne Bay	V	Weekly	12	1c	9/3/15					
			supplemental	11	1c	7/21/15					
	Law Island*	V	supplemental	1	1a	7/1/15					
	Leddy Park	V	Weekly	12	2	8/17/15					
			supplemental	7	1b	7/9/15					
	LTM 16	T	Biweekly	4	Quantitative	7/6/15	not tested	not tested	not tested	130 (8/17/15)	Anabaena, Aphanizomenon, Aphanothece
	LTM 19	T	Biweekly	4	Quantitative	7/6/15	not tested	not tested	not tested	127 (8/17/15)	Anabaena, Aphanizomenon, Aphanothece
	LTM 21	T	Biweekly	5	Quantitative	7/6/15	not tested	not tested	not tested	44 (8/17/15)	Anabaena, Aphanizomenon
	LTM 33	T	Biweekly	6	Quantitative	6/3/15	not tested	not tested	not tested	321 (7/17/15)	Anabaena, Aphanizomenon, Aphanothece
	North Beach	T/V	Weekly	15	3	7/28/15	<0.16	<0.5	<0.5	14,200 (9/8/15)	Aphanothece

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain - Main Lake Central			supplemental	4	3	7/13/15	<0.16	<0.5	<0.5	109,200 (7/13/15)	Anabaena
	Oakledge Park Blanchard Beach	V	Weekly	10	1d	9/8/15					
			supplemental	1	1a	7/13/15					
	Oakledge Park rocky shoreline	V	Weekly	11	1b	7/2/15					
			supplemental	1	2	7/13/15					
	Oakledge Park South Cove	V	Weekly	10	1c	7/29/15					
			supplemental	1	1a	7/13/15					
	Peru Boat Launch	V	Weekly	11	1b	6/14/15					
	Phelps Point*	V	supplemental	1	1a	6/29/15					
	Plattsburgh Boat Launch	V	Weekly	9	1b	7/11/15					
	Plattsburgh City Beach	V	Weekly	9	1b	7/5/15					
	Potash Brook	V	Weekly	7	1d	7/5/15					
	Red Rocks Beach	T/V	Weekly	17	2	7/13/15	<0.16	<0.5	<0.5	88,100 (7/13/15)	Anabaena
			Supplemental	11	1c	7/22/15					
	Shelburne Beach	V	Weekly	11	1c	7/28/15					
	Shelburne Farms	V	Weekly	11	2	7/28/15					
	Shelburne Point	V	Weekly	16	1c	8/29/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain - Main lake Central	Shelburne Shipyard	V	Weekly	16	1c	7/11/15					
	South Cove Beach*	V	Suppleme ntal	5	1d	7/11/15					
	South of Perkins Pier*	T/V	Suppleme ntal	1	1a		<0.16	<0.5	<0.5	173 (7/14/15)	Anabaena
	Starr Farm Beach	V	Weekly	14	1b	7/20/15					
	Sunset/Cresce nt Beach	V	Weekly	14	1c	6/22/15					
	Teddy Bear Point Cove, Willsboro NY	V	Weekly	15	1b	6/14/15					
	White's Beach in Crescent Bay	V	Weekly	13	1d	9/15/15					
			supplemen tal	2	1a	7/8/15					
	Willsboro Boat Launch	V	Weekly	13	1c	8/24/15					
	Winooski R. mouth*	V	Suppleme ntal	1	1a	7/1/15					
	Wilcox Dock, Plattsburgh	V	Weekly	9	1b	7/5/15					
	South of Perkins Pier*	V	Suppleme ntal	1	2	7/10/15					
Champlain - Main Lake North	Alburgh Dunes State Park	V	Weekly	12	2	9/1/15					
			supplemen tal	7	2	8/15/15					
	Grand Isle Ferry*	V	Suppleme ntal	1	1a	6/29/15					
	Holcomb Boat Launch	V	Weekly	13	2	8/25/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain - Main Lake North	Horicans Fish and Wildlife Access	V	Weekly	13	1d	8/4/15					
			supplemen tal	1	2	8/19/15					
	LTM 36	T	Biweekly	6	Quant itative	6/3/15	not tested	not tested	not tested	171 (7/17/15)	Anabaena, Aphanizomenon, Aphanothece
	LTM 46	T	Biweekly	5	Quant itative	9/4/15	not tested	not tested	not tested	143 (9/4/15)	Anabaena, Aphanizomenon, Aphanothece, Microcystis
	north of Rt 129 Bridge, Alburgh - Isle LaMotte*	V	Suppleme ntal	1	2	8/19/15					
	Oliver Bay	V	Weekly	12	1c	6/24/15					
	Pelots Point West	V	Weekly	11	1d	7/6/15					
			supplemen tal	7	3	8/18/15					
	Pt. Au Roche Boat Launch	V	Weekly	14	1b	6/17/15					
	Pt. Au Roche S.P. Deep Bay	V	Weekly	12	2	7/21/15					
			supplemen tal	1	1d	7/28/15					
	Pt. Au Roche State Park Beach	V	Weekly	12	1a	6/15/15					
			supplemen tal	1	1a	7/27/15					
	Stoney Point, Isle la Motte	V	Weekly	13	1d	9/1/15					
	Treadswell Bay, Beekmantow n NY	V	Weekly	14	1b	7/18/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
	Vantines Boat Launch	V	Weekly	14	1d	9/14/15					
Champlain – Main Lake South	Arnold Bay	V	Weekly	8	1b	6/24/15					
	Arnold Bay, Panton	T/V	Weekly	14	1d	9/8/15	<0.16	<0.5	<0.5	4800 (8/10/15)	Oscillatoria, unidentified Oscillatoriaceae
	Beggs Park Beach, Essex NY	V	Weekly	10	1d	7/27/15					
	Bulwagga Bay*	V	Suppleme ntal	1	1a	7/30/15					
	Bulwagga Bay/Port Henry	V	Weekly	11	1a	6/17/15					
			supplemen tal	3	2	7/29/15					
	Button Bay Boat Launch	V	Weekly	11	3	7/28/15					
	Button Bay South	V	Weekly	7	3	7/25/15					
			supplemen tal	3	3	7/27/15					
	Button Bay State Park*	V	Weekly	1	1a	6/23/15					
	Camp Dudley, Westport NY	V	Weekly	13	1c	8/18/15					
	Chimney Point	V	Weekly	12	1b	6/16/15					
	Converse Bay	V	Weekly	10	1b	6/23/15					
	DAR State Park*	V	Suppleme ntal	4	1c	6/24/15					
	Ferrisburgh Stone Beach	V	Weekly	11	1d	8/18/15					
			supplemen tal	1	2	9/8/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain – Main Lake South	Ferrisburgh Town Beach	V	Weekly	13	1d	7/28/15					
	Hawkins Bay	V	Weekly	16	1b	6/16/15					
	Kingsland Bay State Park	V	Weekly	8	2	7/23/15					
			supplemental	2	2	7/24/15					
	Lane's Lane Landing	V	Weekly	14	1c	7/6/15					
	Long Point	V	Weekly	8	1c	7/28/15					
	Long Point South	V	Weekly	12	1b	6/24/15					
	Long Pt, (Wood) Ferrisburgh*	V	Supplemental	3	1b	7/11/15					
	LTM 07	T	Biweekly	6	Quantitative	6/25/15	not tested	not tested	not tested	95 (9/25/15)	Anabaena, Aphanizomenon
	LTM 09	T	Biweekly	6	Quantitative	6/25/15	not tested	not tested	not tested	98 (9/2/15)	Anabaena, Aphanizomenon, Aphanothece
	North Harbor*	V	Supplemental	6	1a	6/29/15					
	Panton Shore North	V	Weekly	12	1d	9/23/15					
	Port Henry Boat Launch*	V	Supplemental	1	1a	9/8/15					
	Port Henry village beach*	V	Supplemental	1	2	9/8/15					
	Summer Point	V	Weekly	13	1a	6/14/15					
	Town Farm Bay	V	Weekly	12	1b	6/16/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain – Main Lake South	Town of Moriah beach*	V	Suppleme ntal	1	1a	9/8/15					
	Tri-Town Road, West Addison	T/V	Weekly	14	1d	7/27/15	<0.16	<0.5	<0.5	4580 (8/24/15)	Anabaena, Aphanothece
	Westport Boat Launch	V	Weekly	13	1c	6/19/15					
Champlain - Malletts Bay	Camp Kiniya	V	Weekly	11	1a	6/26/15					
	Clay Point*	V	Suppleme ntal	1	1b	6/21/15					
	LTM 25	T	Biweekly	5	Quant itative	6/26/15	not tested	not tested	not tested	194 (8/20/15)	Anabaena, Aphanizomenon, Aphanothece, Woronichinia/Coelosphaerium
	Niquette Bay State Park	V	Weekly	13	1c	6/15/15					
	Rosetti Park*	V	Suppleme ntal	6	1b	6/17/15					
Champlain - Missisquoi Bay	Alburgh Bridge*	V	Suppleme ntal	1	1d	8/26/15					
	Alburgh Springs*	V	Suppleme ntal	2	3	8/23/15					
	Alburgh Springs North*	V	Suppleme ntal	1	3	8/25/15					
	Alburgh VT - shoreline	T/V	Weekly	14	2	8/25/15	0.43 (8/25/15)	<0.5	<0.5	2,882,400 (8/25/15)	Anabaena, Aphanizomenon
	Alburgh VT - shoreline 2	V	Weekly	9	1d	8/25/15					
	areas of shoreline, north of the border*	V	Suppleme ntal	1	3	9/1/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain - Missisquoi Bay	Chapman Bay	V	Weekly	15	2	8/23/15					
			supplemental	1	1a	8/27/15					
	Donaldson Point	V	Weekly	16	1d	8/9/15					
	Fadden Road - Swanton	V	Weekly	9	3	8/24/15					
	Goose Bay*	V	Supplemental	1	3	8/26/15					
	Highgate Cliffs	V	Weekly	7	3	7/25/15					
			supplemental	1	1a	7/26/15					
	Highgate Springs	T	Biweekly	9	3	8/19/15	0.18 (8/19/15)	<0.5	<0.5	43,600 (8/19/15)	Anabaena, Microcystis
	Highgate Springs	T	supplemental	4	3	8/24/15					
	Jameson Point QE south to the US border*	V	Supplemental	2	3	8/18/15					
	Larry Greene Fish and Wildlife Access	V	Weekly	13	3	8/13/15					
			supplemental	13	3	8/8/15					
	LTM 50	T	Biweekly	9	3	8/19/15	<0.16	<0.5	<0.5	29,900 (9/17/15)	Anabaena, Aphanizomenon, Microcystis
	LTM 51	T	Biweekly	9	3	8/19/15	0.27 (9/4/15)	<0.5	<0.5	45,000 (8/19/15)	Anabaena, Aphanizomenon, Aphanothece, Microcystis
	midbay - north of the border*	V	Supplemental	1	3	9/1/15					
	mouth of the Pike River*	V	Supplemental	2	3	8/18/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain - Missisquoi Bay	offshore, north of Rock River Bay*	V	Suppleme ntal	1	3	8/25/15					
	open water, north of the Rt 78 Bridge*	V	Suppleme ntal	1	3	8/9/15					
	Phillipsburg QE south to the US border*	V	Suppleme ntal	2	3	7/22/15					
	Rock River - Highgate	V	Weekly	13	3	8/10/15					
	Rock River Wildlife Management area*	V	Suppleme ntal	1	3	8/10/15					
	Shipyard Road*	T/V	Suppleme ntal	1	3	8/9/15					
	Shipyard, Highgate Springs	T/V	Weekly	16	3	8/10/15	0.38 (9/21/15)	<0.5	<0.5	1,911,200 (9/21/15)	Anabaena, Microcystis
			Suppleme ntal	16	3	8/7/15					
	St. Armand*	V	Suppleme ntal	1	3	9/8/15					
	Venise-en-Quebec Bay*	V	Suppleme ntal	2	3	8/18/15					
	Missisquoi Delta*	V	Suppleme ntal	1	1a	6/28/15	Champlain	Missisquo i Bay	Missisquo i Delta*	V	Supplemental
Champlain - South Lake	Allen Bay	V	Weekly	9	1a	6/18/15					
	Lapham Bay	V	Weekly	15	1b	6/16/15					
	LTM 02	T	Biweekly	7	Quant itative	6/11/15	not tested	not tested	not tested	205 (7/9/15)	Aphanizomenon

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
Champlain – South Lake	LTM 04	T	Biweekly	7	Quant itative	6/11/15	not tested	not tested	not tested	444 (7/23/15)	Anabaena, Aphanizomenon, Aphanothece
	McCuen Slang Waterfowl Area	V	Weekly	11	1b	6/22/15					
	Ticonderoga Boat Launch*	V	Suppleme ntal	7	1b	6/20/15					
St. Albans Bay	Black Bridge**	V	Weekly	7	3	7/13/15					
			Suppleme ntal	7	3	7/13/15					
	Ferrand Rd. St. Albans	V	Weekly	15	2	7/13/15					
			Suppleme ntal	3	3	8/13/15					
	Georgia Beach	V	Weekly	7	3	8/13/15					
			Suppleme ntal	8	3	8/18/15					
	Georgia Shore North	V	Weekly	13	3	8/23/15					
			Suppleme ntal	15	3	8/13/15					
	Hathaway Point Rd*	V	Suppleme ntal	1	1d	7/12/15					
	Kill Kare State Park*	V	Suppleme ntal	2	3	8/26/15					
	LTM 40	T	Biweekly	9	3	9/1/15	<0.16	<0.5	<0.5	61,600 (9/1/15)	Anabaena, Aphanizomenon, Microcystis
	Martha Drive*	V	Suppleme ntal	1	3	8/23/15					
	Melville Landing	V	Weekly	12	3	8/13/15					
			Suppleme ntal	11	3	7/20/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
St. Albans Bay	offshore, outer St. Albans Bay towards Ball island*	V	Suppleme ntal	1	2	9/1/15					
	offshore, St. Albans Bay Park to Lazy Lady Island*	V	Suppleme ntal	1	3	9/1/15					
	offshore, vicinity of St. Albans town park*	V	Suppleme ntal	1	3	10/6/15					
	St. Albans Bay Park	T/V	Weekly	15	3	7/13/15	0.44 (7/13/15)	<0.5	<0.5	191,000 (8/17/15)	Anabaena, Aphanizomenon
			Suppleme ntal	12	3	7/28/15	0.77 (7/28/15)	<0.5	<0.5	1,900,800 (7/28/15)	Anabaena, Aphanizomenon, Gloeotrichia, Microcystis, Woronichinia/Coelosphaerium
	St. Albans Boat Launch	V	Weekly	13	1d	7/31/15					
			Suppleme ntal	5	3	8/15/15					
	Georgia Beach*	V	Weekly	1	3	8/25/15					
Elmore	Lake Elmore State Park	T/V	Weekly	11	1c	6/22/15	0.19 (8/19/15)	<0.5	<0.5	22,500 (7/29/15)	Anabaena, Aphanothece, Woronichinia/Coelosphaerium
Iroquois	Lake Iroquois Beach	T/V	Weekly	11	1c	6/22/15	<0.16	<0.5	<0.5	14,800 (7/27/15)	Anabaena, Aphanizomenon, Aphanothece
	Lake Iroquois Southwest	V	Weekly	15	3	9/1/15					
			supplemen tal	3	1d	9/2/15					
Memphre-magog	Derby Bay	V	Weekly	18	2	9/23/15					
	Holbrook Bay	V	Weekly	18	1d	9/23/15					

Lake/ Region	Station	Method	Report Type	# of rep-orts	Status	Date	Highest Micro-cystin Observed (ug/L as micro-cytin-LR equi-valents)	Highest Anatoxin Observed (ug/L)	Highest Cylindro-spermo-psin Observed (ug/L)	Maximum Density of Potentially Toxic Cyano-bacteria (cells/ml)	Cyanobacteria Present when Max Density Achieved
	Prouty Beach	T/V	Weekly	11	1c	6/22/15	0.17	<0.5	<0.5	4270 (6/29/15)	unidentified Oscillatoriaceae
River	Lower Poultney River, West Haven*	V	Suppleme ntal	1	3	9/18/15					

A total of 209 samples were analyzed for the presence of microcystin in 2015 (Table 8). Microcystin was detected in 23 samples (11% of the samples). None of these exceeded the Vermont recreational guidance level of 6µg/L. The highest concentration was 0.77µg/L and observed in St. Albans Bay. Anatoxin and cylindrospermopsin were not detected in 2015.

Table 8. Number of cyanotoxin samples tested and maximum concentrations measured in 2015. Data compiled from the season summary spreadsheet available through the VDH Tracking Map.

			Microcystin			Anatoxin			Cylindrospermopsin		
Waterbody	**Region**	**Station**	**Samples tested (N)**	**Above detection (N)**	**Maximum (ug/L)**	**Samples tested (N)**	**Above detection (N)**	**Maximum (ug/L)**	**Samples tested (N)**	**Above detection (N)**	**Maximum (ug/L)**
Champlain	Inland Sea	North Hero State Park	13	2	0.2	13	0	<0.5	13	0	<0.5
		Stephenson Point Fish and Wildlife Access	14	0	<0.16	14	0	<0.5	14	0	<0.5
		Keeler Bay, South Hero	14	0	<0.16	14	0	<0.5	14	0	<0.5
		Maquam Shore Road, Swanton	14	0	<0.16	14	0	<0.5	14	0	<0.5
	Main Lake Central	North Beach	13	0	<0.16	13	0	<0.5	13	0	<0.5
		Red Rocks Beach	13	0	<0.16	13	0	<0.5	13	0	<0.5
	Main Lake South	Arnold Bay, Panton	14	0	<0.16	14	0	<0.5	14	0	<0.5
		Tri-Town Road, West Addison	14	0	<0.16	14	0	<0.5	14	0	<0.5
	Missisquoi Bay	Highgate Springs	3	1	0.18	3	0	<0.5	3	0	<0.5
		Shipyard, Highgate Springs	15	4	0.38	15	0	<0.5	15	0	<0.5
		LTM 50	3	0	<0.16	3	0	<0.5	3	0	<0.5
		LTM 51	3	2	0.27	3	0	<0.5	3	0	<0.5
		Alburgh VT - shoreline	14	1	0.43	14	0	<0.5	14	0	<0.5
	St. Albans Bay	St. Albans Bay Park	10	6	0.77	10	0	<0.5	10	0	<0.5
		LTM 40	2	0	<0.16	2	0	<0.5	2	0	<0.5
Elmore		Lake Elmore State Park	11	1	0.19	11	0	<0.5	11	0	<0.5
Iroquois		Town Beach	11	0	<0.16	11	0	<0.5	11	0	<0.5
Memphremagog		Prouty Beach	11	1	0.17	11	0	<0.5	11	0	<0.5
Carmi		North Beach	3	2	0.4	3	0	<0.5	3	0	<0.5
		Carmi State Park	14	3	0.35	14	0	<0.5	14	0	<0.5
TOTAL			**209**	**23**		**209**	**0**		**209**	**0**	

Twenty cyanobacteria taxa were observed in Lake Champlain or the four inland lakes during the 2015 monitoring period (Table 9). The majority have been identified as potential toxin producers in the scientific literature. *Scytonema crispum*, the benthic cyanobacterium first observed near Rouses Point in 2012, was present in several samples from Lake Carmi as well as a single sample each from Malletts Bay, Sandbar State Park, and LTM 51 in Missisquoi Bay.

Table 9. Cyanobacteria taxa observed in Lake Champlain cyanobacteria monitoring samples. Year of first report refers only to the cyanobacteria monitoring program. *Prior to 2012, cyanobacteria were noted to genus only.

Name	Toxin producer	Present in 2015	Year of first report
Anabaena circinalis	yes	yes	2003*
Anabaena planctonica	yes	yes	2003*
Anabaena spp	yes	yes	2003*
Aphanizomenon spp. (likely *A. gracile*)	yes	yes	2012
Aphanizomenon flos-aquae	yes	yes	2003*
Aphanocapsa spp.	no	yes	2004
Aphanothece spp.	yes	yes	2012
Arthrospira spp.	no	no	2012
Chroococcus spp.	no	yes	2003
Coelosphaerium spp.	Yes	no	2003
Gloeotrichia spp.	yes	yes	2003
Gloeocapsa spp.	yes	yes	2004
**Limnothrix* spp.	possible	yes	2012
Merismospedia spp.	no	yes	2003
Microcystis spp.	yes	yes	2003*
Microcystis wesenbergii	yes	yes	2012
Oscillatoria spp.	yes	yes	2005
**Pseudanabaena* spp	yes	yes	2012
**Radiocystis* spp.	possible	no	2012
**Scytonema crispum* (synonym *Lyngbya cinncinata*)	yes	yes	2012
Snowella spp	no	yes	2012
Trichodesmium spp	no	yes	2015
Woronichinia spp (formerly *Gomphosphaeria* spp.)	yes	yes	2012
Colonial cyanobacterium (possible *Cyanonephron* spp.)	no	yes	2015

Reproducibility of Assessment Results

Environmental variability

Phytoplankton composition and density is highly variable in natural environments such as Lake Champlain. Cyanobacteria, in particular, exhibit considerable variation in population density within very short distances and time intervals. The effectiveness of the tiered alert protocol in light of this variability was documented by Rogalus and Watzin (2008). In 2015, consistency between duplicates was generally good (Table 10). Of the 22 duplicate counts made over the summer, there were four instances where the second count indicated a change of status from generally safe to alert level.

Total cell counts are strongly influenced by the presence of a few large colonies or filaments in a single aliquot when overall density is low. Three of the changes noted in Table 10 occurred at low overall densities, where cyanobacteria were observed in only one of the two aliquots analyzed.

Table 10. Comparability of phytoplankton quality control samples in 2015.

Test	N	Status Identical	Change from generally safe to alert (N)
Field duplicates	2	1	1
Laboratory duplicates	20	13	3

Volunteer training

Volunteer trainings were conducted by LCC staff at locations around the Lake Champlain Basin. Twenty-three formal sessions trained more than 300 potential volunteers. Numerous media interviews and appearances alerted the public to the opportunity to become a volunteer monitor. LCC staff provided training for Vermont drinking water facility operators and for watershed organizations on Lakes Carmi, Iroquois and Memphremagog who wished to develop volunteer monitoring networks at those lakes.

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 on-line LCC cyanobacteria resources and report forms.

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. Follow-up with workshop attendees indicated that many shared that knowledge with neighbors and took personal action to reduce 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 others around the Basin. Guidance and assistance to town health officers, beach managers, and local residents was provided during bloom events. All partners maintained webpages with resources and contacts for anyone seeking information about cyanobacteria. Partners also responded to media inquiries, including a segment for the Vermont Edition program on Vermont Public Radio.

In 2015, the VDH offered free weekly toxin testing for public drinking water facilities in Vermont from July through September. The DWGWPD organized sessions for facility operators, where LCC provided training on the visual assessment system and VDH provided an overview of Vermont's guidance for cyanotoxins in drinking water. Results of the summer's testing can be found online at http://drinkingwater.vt.gov/pcwswqbga.htm. No detections of microcystin, cylindrospermopsin or anatoxin occurred in finish water from facilities participating in the program. VDH and DWGWPD also hired a contractor, Vermont Rural Water, to assist Vermont public drinking water facilities develop facility-specific cyanobacteria emergency response plans.

Regional and National Activities

Project partners are active at the local, regional and national level. Several partners continue to participate in the NEIWPCC regional cyanobacteria workgroup, which is now in its third year of activity. The DEC field staff also continue to participate in EPA Region 1 effort to develop a field screening method for cyanobacteria based on phycocyanin, a photosynthetic pigment found in cyanobacteria but few other algae.

Partners participated in the national discussion on cyanobacteria organized by the Interagency Working Group of the Harmful Algal Bloom and Hypoxia Research and Control Act (IWG-HABHRCA) in 2015. The IWG was tasked with gathering data and developing an action plan to inform the national approach to HAB and hypoxia events. Their first product, the Harmful Algal Blooms and Hypoxia Comprehensive Research Plan and Action Strategy (February 2016), includes a case study on Champlain cyanobacteria monitoring activities (pg 9 of the report).

The combined qualitative and quantitative approach utilized by the Champlain cyanobacteria monitoring project will also support national efforts to develop remote sensing platforms for use across the country. The CyAN Project (Cyanobacteria Assessment Network) is a collaborative effort of EPA, NASA, NOAA and the USGS to develop a satellite-based early warning indicator system. Historic and current data from the Champlain project will support ground-truthing and algorithm development activities in 2016.

Partners participated in the International Association of Great Lakes Research annual conference, held in Burlington VT during May:

- The LCC offered a talk entitled *Establishing a Volunteer Cyanobacteria Bloom Monitoring Network.*
- The VT DWGWPD co-chaired a session with NEIWPCC on HABs considerations for drinking water suppliers.
- The VT Watershed Management Division co-chaired a session with the VDH on cyanobacteria and human health.

The VDH and LCC also participated on a discussion panel– Cyanobacteria, lake ecology and human health – facilitated by the VT DEC at the New England Chapter of the North American Lake Management Society, held in May.

Communication with the Stakeholders and the General Public

Results of the weekly assessments were communicated via email to a variety of stakeholders. The 99 recipients were largely associated with the states of Vermont and New York (n = 57, including partners). Other recipients included federal officials (5), provincial officials in QE (4), water facilities or municipal staff (12), non-profits and universities (11, including partners), and unknown recipients (10).

Information was shared with the general public via the VDH cyanobacteria webpages - http://healthvermont.gov/enviro/bg_algae/bgalgae.aspx. Between May and November 2015, the tracking map landing page received over 30,000 visits while the interactive map received more than 9000 (Table 11). Activity was greatest in July and August, corresponding to peak months of recreational activity. The monitoring data was also accessible through the VDH's Environmental Public Health tracking portal at http://healthvermont.gov/tracking/index.aspx.

Table 11. Viewer data for the Vermont Department of Health cyanobacteria webpages in 2015. Data do not distinguish between internal and external viewers.

	Tracking Map Landing Page	**Tracking Map**
May	1177	1192
June	1894	1474
July	11193	2658
August	10710	2299
September	4786	840
October	1692	157
November	1224	540
Total	**32676**	**9160**

Typically, the VDH distributes a press release in early July that reminds parents, boaters, swimmers and pet owners to watch for cyanobacteria when enjoying the water. This year, two releases were made. The first, in May, shared information about the newly released EPA guidance for cyanotoxins in drinking water (http://healthvermont.gov/news/2015/051215_bga_epa.aspx). The second, in July, announced the new monitoring program for Vermont public drinking water facilities. (http://healthvermont.gov/news/2015/070715_bga.aspx).

Discussion

The primary role of the monitoring program is to provide data on cyanobacteria occurrence and abundance to the VDH and other partners for the protection of public health. The program serves an education and outreach role, helping volunteers and others recognize situations when recreational activities might not be prudent. Data also provide insight as to the effectiveness of the monitoring approach and contribute to a historical perspective of bloom events in the Basin.

Effectiveness of the visual monitoring protocol

Quantitative data collected in conjunction with visual assessments at selected sites continue to support the visual assessment protocols as an effective tool to assess potential recreational risk. In 2015, volunteers at Red Rocks and North Beaches in the Burlington area, the Shipyard at Highgate Springs, the St. Albans Bay Park and North Hero State Park collected water samples when they made their assessments. VDH staff did the same at the 10 Climate Change sites on Champlain and the inland lakes.

The majority of reports reflected Category 1 (generally safe conditions), with correspondingly low concentrations of potentially toxic cyanobacteria (Appendix C). Low concentrations of microcystin were present in some instances, but in most cases Category 1 assessments had no detectable microcystin. One instance of low microcystin (0.17µg/L) was observed when no cyanobacteria were present in the corresponding water sample. Eight observations reporting generally safe conditions had low concentrations of microcystin (<0.36 µg/L). In all cases, concentrations of microcystin were well below the VDH recreational guidance value of 6µg/L and consistent with the generally safe designation.

Cyanobacteria conditions on the four inland lakes

Monitoring by the VDH at the four inland lakes continued to employ the visual assessment protocol combined with samples for phytoplankton density, microcystin and anatoxin. Lake associations at Iroquois, Carmi and Memphremagog initiated monitoring at other sites on their respective lakes utilizing the visual assessment system but did not collect water samples. Volunteer participation greatly increased the number of reports received from these lakes this year.

Elmore had generally safe conditions all summer (Figure 2). Memphremagog and Iroquois each had one report of alert level conditions in September. Lake Carmi, however, experienced bloom conditions beginning in late August and continuing into October. Eighteen alert level reports were received (10 as supplemental reports), 18% of the reports provided from Carmi during 2015.

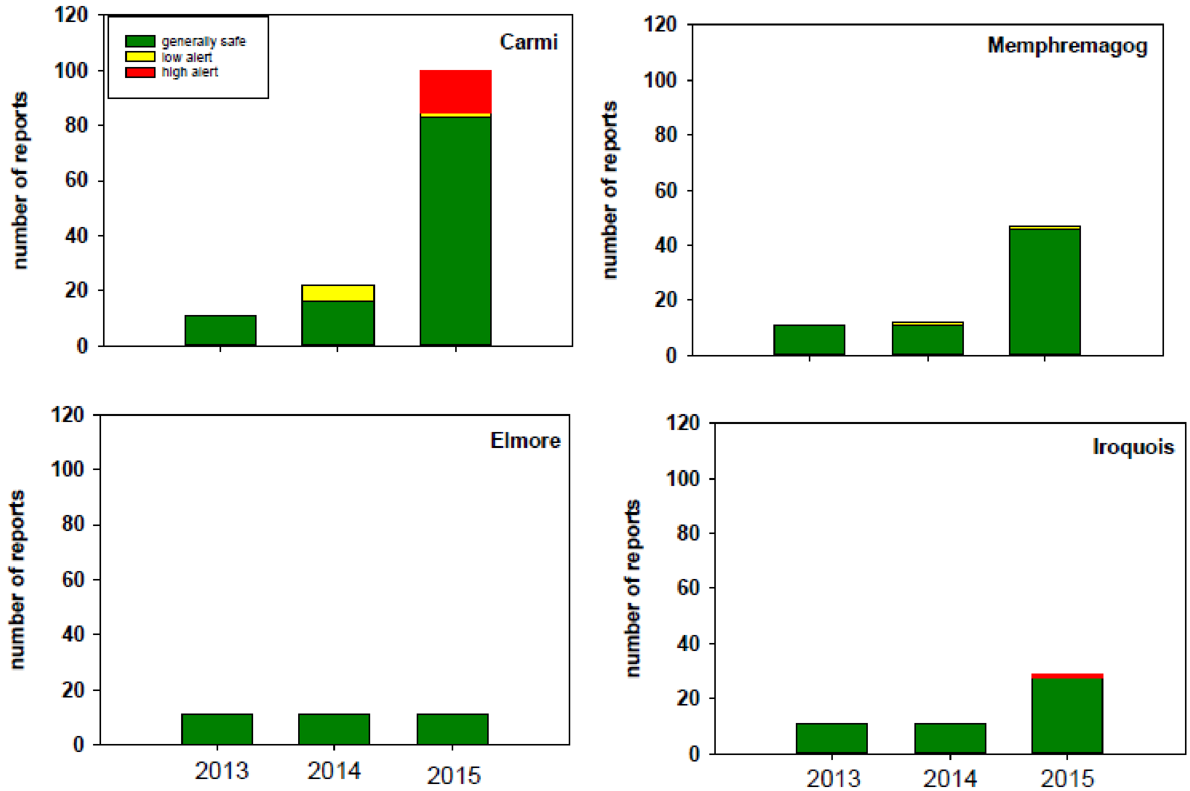

Figure 2. Webpage status reports on selected inland lakes since 2013. Supplemental reports are included.

Table 12 summarizes microcystin concentrations observed at the inland lakes since monitoring began in 2012. Low levels of microcystin (0.40 µg/L or less) were detected in 2015 at Lakes Elmore, Memphremagog, and Carmi. There were no detections of anatoxin or cylindrospermopsin.

Table 12. Microcystin concentrations in selected Vermont lakes, 2013 - 2015. Stations were monitored weekly. Supplemental bloom samples are also included. ND = not detected.

Lake		2013	2014	2015
Lake Carmi	median	<0.16	<0.16	<0.16
	range	ND - 0.21	ND - 0.39	ND – 0.40
	#samples	10	19	17
	#stations	1	4	2
Lake Elmore	median	<0.16	<0.16	<0.16
	range	ND	ND - 0.18	ND – 0.19
	#samples	11	11	11
	#stations	1	1	1
Lake Iroquois	median	<0.16	<0.16	<0.16
	range	ND	ND	ND
	#samples	11	11	11
	#stations	1	1	2
Lake Memphremagog	median	<0.16	<0.16	<0.16
	range	ND	ND	ND – 0.17
	#samples	11	11	11
	#stations	1	1	1

The VDH will discontinue climate change monitoring on Elmore, Memphremagog (Prouty Beach) and Iroquois (Hinesburg Town Beach) in 2016. They will continue to monitor on Lake Carmi. Volunteer monitoring on Lakes Carmi, Memphremagog and Iroquois is expected to continue in 2016.

Cyanobacteria Conditions on Lake Champlain:

Alert-level conditions were reported 197 times (120 as supplemental reports) in 2015 (Figure 3), representing 12% of the reports submitted (Figure 4). More than 85% of the reports from 2015 indicated generally safe conditions. Alert level conditions were reported most frequently in Missisquoi Bay and St. Albans Bay in 2015 (Figure 5).

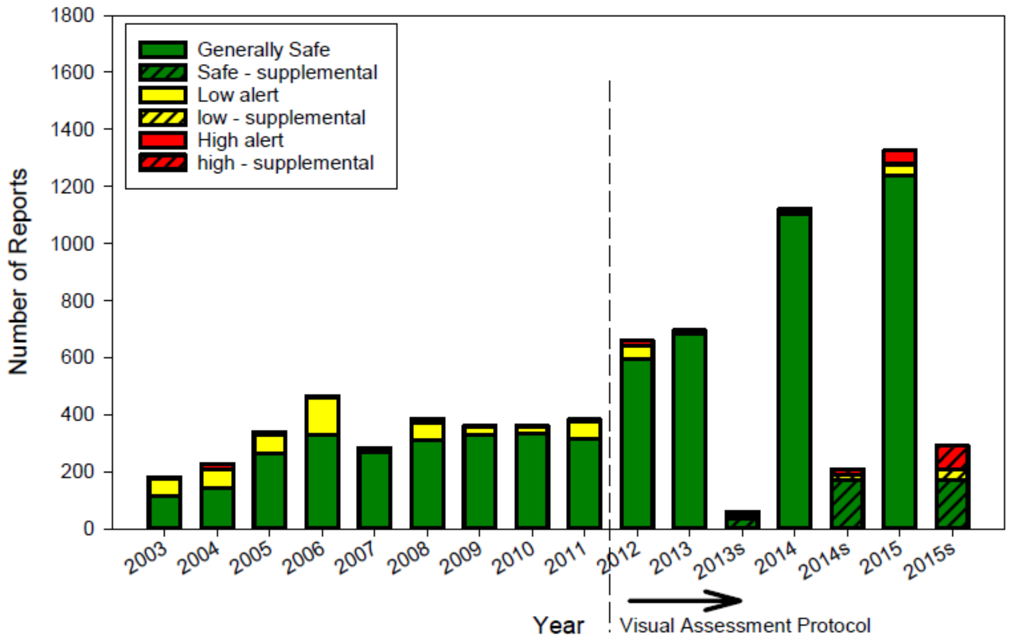

Figure 3. Number of yearly cyanobacteria status reports for Lake Champlain by category. Records prior to 2012 were determined using historical cell count and toxin data. Beginning in 2012, summaries include records obtained using the visual assessment protocol. The status generated by the visual assessment protocol is used at locations where both types of assessment were employed. Supplemental reports are included separately, indicated by an 's' following the year on the x axis.

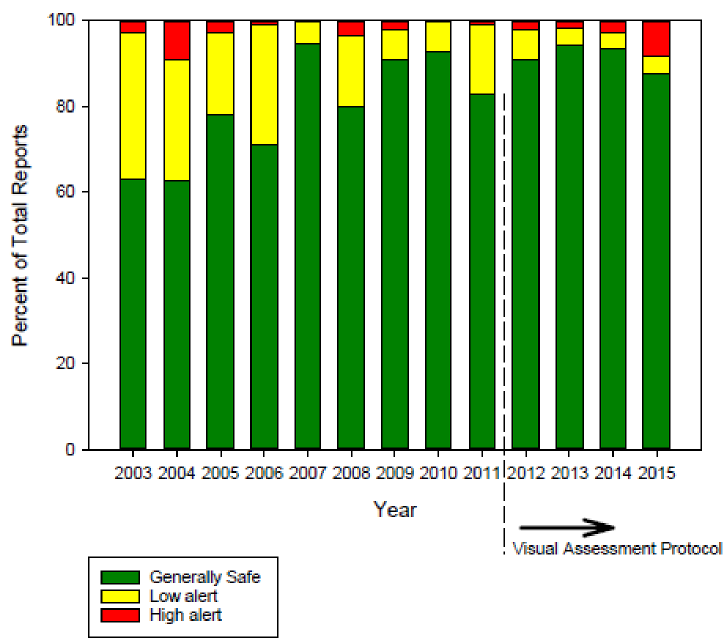

Figure 4. Cyanobacteria status reports Lake Champlain by category, percent of total reports received. Records prior to 2012 were determined using historical cell count and toxin data. Beginning in 2012, summaries include records obtained using the visual assessment protocol. The status generated by the visual assessment protocol is used at locations where both types of assessment were employed. Supplemental reports are included but not reported separately.

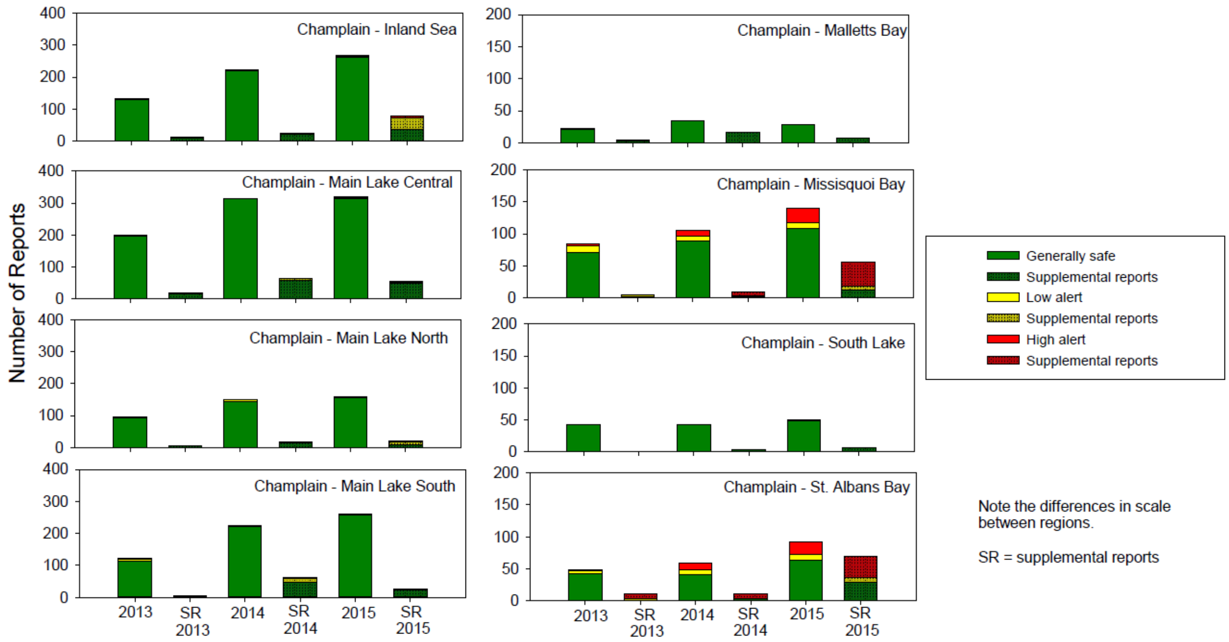

Figure 5. Number of yearly cyanobacteria reports for Lake Champlain by region, 2013 – 2015. The status generated by the visual assessment protocol is used at locations where both types of assessment were employed. Supplemental reports are included separately, indicated by an 'sr' preceeding the year on the x axis.

The number of microcystin samples obtained on Lake Champlain has decreased in recent years, however visible surface scums were sampled whenever they were encountered on the lake by DEC field staff. VDH staff also obtained samples for toxin analysis from visible scums reported by the public whenever possible. Because microcystin concentrations are expected to be highest in these situations, this targeted sampling increases the opportunity to capture high microcystin events. Despite targeted sampling efforts, over the last five summers, microcystin concentrations exceeding Vermont's recreational guideline of 6µg/L are rarely documented and have occurred only in Missisquoi Bay (Table 16).

Persistence of Blooms in 2015

The participation of several watershed groups in 2015 as well as the number of supplemental reports provided by volunteers at their monitoring stations provides some insight into bloom dynamics. On both Missisquoi and St. Albans Bay, some locations experienced bloom conditions beginning in mid-July (Figure 6). These blooms were not widespread, as indicated by the limited number of alert -level reports received from monitors. They also appeared to be short-lived, as indicated by the lack of alert level reports in subsequent days. By mid-August, volunteers were reporting alert-level conditions from multiple stations on both Missisquoi and St. Albans, and those blooms were reported over multiple days. Blooms persisted on both bays into mid-September.

The pattern on Lake Carmi was similar - isolated short-term blooms occurring several weeks prior to a period of widespread and more persistent alert-level conditions. However, the first bloom reports from Carmi were received in mid-August, about a month later than the Champlain stations. The persistent multi-day blooms were also delayed, occurring in late September. The number of overall reports decreased in October as volunteers closed down camps for the summer but a multi-day bloom event was reported in mid-October 2015. An intensive late-season bloom also occurred in October 2014 and persisted into early November (Shambaugh, personal communication). Lake Carmi does experience strong summer stratification and the pattern of blooms suggests that fall turnover, and the resulting distribution of phosphorus from the hypolimnion, is likely driving the late fall bloom events. The Champlain bays experience fewer stratification events because of their shallow depth, but experience internal phosphorus loading frequently during the summer months when environmental conditions are right (Isles et al 2015, Smith et al 2011, Druschel et al 2008).

Table 16. Microcystin concentrations in major lake segments, 2011 – 2015. Data are from routine monitoring locations and bloom events. Data do not distinguish between net plankton and whole water samples. ND = not detected. Shaded boxes = not applicable. Full historical data can be found in Appendix D.

Lake Segment		Max 2003 - 2010	2011	2012	2013	2014	2015
Inland Sea	median	1.10	0.08		<0.16	<0.16	<0.16
	range	0.01 – 22.5	0.01-0.82		ND - 0.43	ND - 0.28	ND – 0.02
	#samples		9	0	45	56	26
	#stations		4		4	4	4
Main Lake Central	median	7.42	0.02	0.13	<0.16	<0.16	<0.16
	range	0.01 -23.3	0.01-0.03	0.13-0.64	ND -0.17	ND -0.19	All ND
	#samples		4	3	23	31	27
	#stations		4	1	2	2	2
Main Lake North	median						
	range	0.01 – 1.56	0.01				
	#samples		1	0	0	0	0
	#stations		1				
Main Lake South	median	0.04	0.01		<0.16	<0.16	<0.16
	range	ND – 3.47	0.01		ND - 0.16	ND-0.51	All ND
	#samples		2	0	22	33	28
	#stations		2		2	3	2
St. Albans Bay	median	0.30	0.04	0.03	0.032	<0.16	<0.16
	range	ND – 22.48	0.02-0.14	0.03-0.04	0.002-0.062	ND - 0.2	ND – 0.77
	#samples		12	5	2	4	12
	#stations		2	1	2	2	2
Malletts Bay	median	0.04					
	range	0.04 – 0.08	0.04				
	#samples		1	0	0	0	0
	#stations		1				
South Lake	median	0.96					
	range	0.53 – 1.86	0.02				
	#samples		1	0	0	0	0
	#stations		1				
Missisquoi Bay	median	2.56	0.65	0.99	<0.16	<0.16	<0.16
	range	ND - 6490	0.02-180.2	0.26-54.76	ND - 1.3	ND -2.29	ND – 0.43
	#samples		59	36	30	40	38
	#stations		8	3	6	7	5

Figure 6. Summer patterns of cyanobacteria occurrence from Missisquoi and St. Albans bays on Lake Champlain, and Lake Carmi VT. Supplemental reports included.

Federal Response to Cyanobacteria and Cyanotoxins

In May 2015, the EPA released new federal health advisories regarding the concentrations of two cyanotoxins, microcystin and cylindrospermopsin, in drinking water. These advisories provide informal technical guidance and are not legally enforceable standards. The VDH and DWGWPD used the information to revise Vermont's voluntary guidance for drinking water facilities prior to the start of the monitoring in 2015. (see the Process for Managing Anatoxin, Cylindrospermopsin and Microcystin Detections in Raw and Finished Water Samples for Public Surface Water Systems, http://drinkingwater.vt.gov/wqmonitoring/pdf/FINAL_CYANOPRACTICE2015.pdf). EPA is currently developing health advisories for cyanobacteria and cyanotoxins in recreational waters. They anticipate releasing a draft for public comment in the fall of 2016 (https://www.epa.gov/nutrient-policy-data/public-meeting-and-webinar-presentations-update-development-recreational). The EPA determined there is insufficient data to support development of a health advisory for anatoxin at this time.

The National Science and Technology Council provided a comprehensive research plan and action strategy for harmful algal blooms (HABs) and hypoxia events to Congress in February 2016 (https://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/habs_hypoxia_research_plan_and_action_-_final.pdf). Though much of the emphasis is placed on the Great Lakes and Coastal regions, the Champlain Basin will benefit from activities associated with several recommendations e.g.:

- Add to and improve scientific understanding of HABs and improve testing and research methods
- Strengthen and integrate new and existing monitoring programs
- Improve predictive capacity
- Improve stakeholder communication and a better understanding of the socioeconomic and health-related impacts

The Vermont Portion of the Champlain TMDL

Nutrient reduction continues to be the primary strategy for reducing the occurrence and intensity of cyanobacteria blooms. Efforts across the Basin to reduce cyanobacteria on the lake focus on phosphorus loading.

The final draft of the Vermont Lake Champlain Phosphorus TMDL was released in mid-summer 2015. Comments were taken on the draft through October and EPA anticipates releasing the final TMDL before summer 2016. Though the in-lake phosphorus standards will not change, revised modeling incorporating recent data will change loading allocations across the Vermont portion of Champlain's watershed. Vermont's Phase I Implementation Plan (https://www.epa.gov/sites/production/files/2015-09/documents/vt-lake-champlain-tmdl-phase1-ip.pdf) and the Vermont Clean Water Act signed in June 2015 (http://legislature.vermont.gov/assets/Documents/2016/Docs/ACTS/ACT064/ACT064%20As%20Enacted.pdf) outline how Vermont will expand their on-going efforts to address phosphorus loading across the state.

Conclusions

The monitoring project continues to grow. Watershed association participation increased the number of reports provided for lakes Carmi, Iroquois and Memphremagog in 2015. A small number of dedicated volunteers provided daily supplemental reports at sites which experienced extended blooms. This greatly improved coverage at the selected inland lakes and provided insight on the persistence of blooms when they occurred. Volunteers continue to be the backbone of the monitoring program, providing areal coverage and report frequencies which are difficult to obtain with a traditional monitoring program. While several federal agencies are cooperating to develop satellite monitoring for the Northeast, volunteers will continue to be essential to this monitoring program because of their ability to report more frequently and without interruption by cloud cover.

As in years past, the majority of monitoring reports noted generally safe conditions on Lake Champlain and the four Vermont inland lakes. Persistent and extensive blooms did occur on St. Albans Bay, Missisquoi Bay and Lake Carmi in late summer and early fall. New research from Missisquoi Bay identifies internal phosphorus loading and water circulation as key drivers of bloom dynamics in this part of the lake. The pending Vermont Phosphorus TMDL and associated Phase 1 Implementation Plan outline the necessary loading reductions and how Vermont will enhance its ongoing effort to reduce nutrient inputs to all of Lake Champlain.

Acknowledgements

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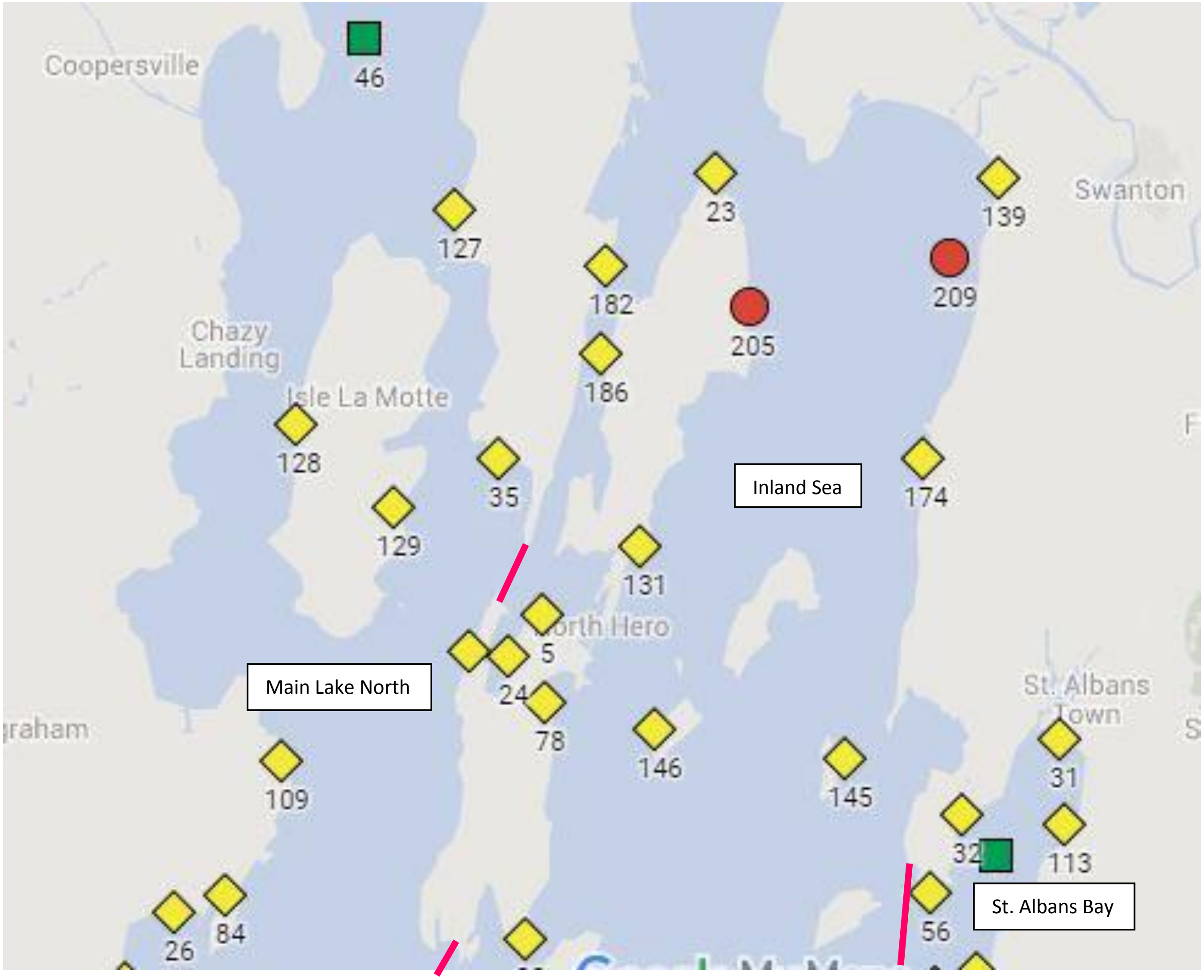
Appendix A - 2015 Sampling locations

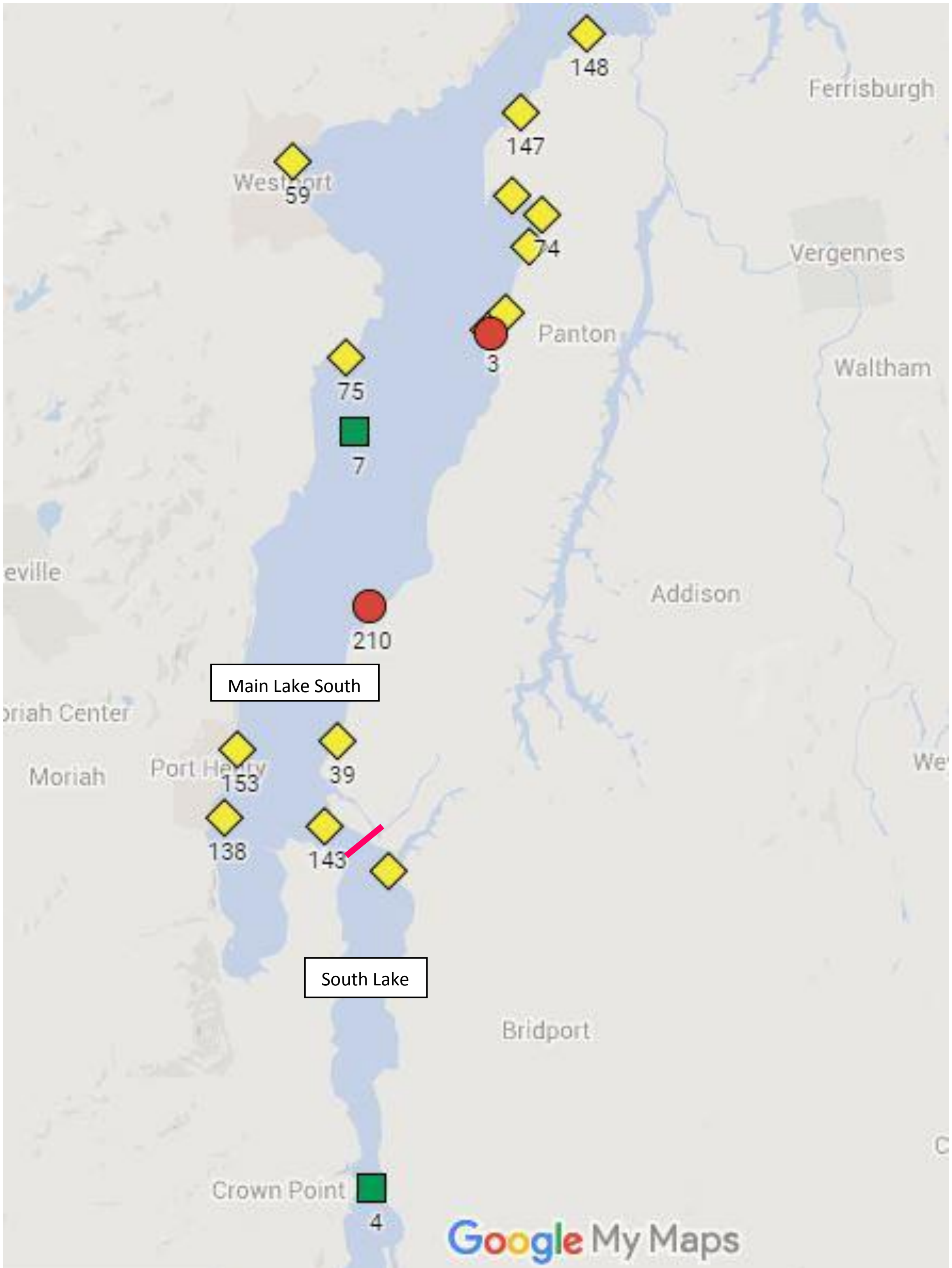
Red = VDH stations, yellow = LCC stations, green = VT DEC stations



The Main Lake North zone extends north from the Grand Isle Ferry route, and west from the causeways at Carry Bay and the Gut.

The Inland Sea region extends north from the Sandbar Causeway to the Rt 78 bridge south of Missisquoi Bay, and west to the Gut and Carry Bay Causeway. The Malletts Bay region lies between the Sandbar Causeway and the Malletts Bay Causeway. The Main Lake Central region ends at the Cumberland – Grand Isle Ferry.

The Main Lake South region begins south of the Charlotte to Essex ferry route and extends to the Champlain Bridge.



The Main Lake South region ends at the Champlain Bridge.

The South Lake Region extends from the Champlain Bridge to LTM station 2.

Waterbody	Region	Station	Site	Latitude	Longitude
Champlain	Inland Sea	Blockhouse Point Rd.		44.850032	-73.2841
		Butler Island		44.839526	-73.2326
		Carry Bay	5	44.833592	-73.2899
		Cedar Ledge	131	44.846952	-73.2622
		City Bay - Rt 2	78	44.815894	-73.2891
		Cohen Park St. Albans	174	44.864582	-73.1828
		Dunham Bay	186	44.885701	-73.2731
		Everest Rd.	185	44.649828	-73.2131
		Georgia Shore South	163	44.758833	-73.1794
		Grand Isle State Park	11	44.686021	-73.2891
		Grand Isle State Park Beach	11	44.686021	-73.2891
		Grand Isle State Park Boat Launch	11	44.686021	-73.2891
		Keeler Bay Boat Launch	135	44.667908	-73.3199
		Keeler Bay East	134	44.654142	-73.292
		Keeler Bay, South Hero	207	44.653897	-73.3009
		Knight Island	146	44.810722	-73.2581
		Knight Point State Park	80	44.768669	-73.2945
		Lombard Lane- South Hero	177	44.668999	-73.3105
		LTM 34	34	44.708167	-73.2268
		Maquam Beach	139	44.920807	-73.1614
		Maquam Shore Road, Swanton	209	44.904515	-73.1748
		Marycrest Beach	116	44.723362	-73.2815
		Milton	81	44.658992	-73.2142
		Nichols Point		44.746424	-73.3298
		North Hero		44.854333	-73.283
		North Hero State Park	23	44.921754	-73.2408
		offshore, middle of Keeler Bay		44.664251	-73.308
		offshore, west side of Savage Island		44.701533	-73.2555
		Pelots Bay	24	44.82537	-73.2991
		Sand Bar State Park	57	44.628758	-73.2399
		South Alburgh - Squires Bay	182	44.903004	-73.2719
		South Hero Fish and Wildlife Boat Access	110	44.636405	-73.2652
		Stephenson Point Fish and Wildlife Access	205	44.89486	-73.2315
		The Gut	49	44.751374	-73.2903
		Van Everest Boat Launch Milton	175	44.705866	-73.2104
		Woods Island	145	44.804871	-73.2045
		Woods Island campsite 3		44.801543	-73.2116
		Woods Island West		44.801543	-73.2116

Waterbody	Region	Station	Site	Latitude	Longitude
Champlain	Main Lake Central	Allen Point	189	44.599276	-73.3114
		Beech Bay		44.608883	-73.3158
		Buena Vista Park, Willsboro NY	61	44.403947	-73.3735
		Burlington, VT - Texaco Beach	72	44.487636	-73.2321
		Charlotte Town Beach	76	44.334725	-73.2829
		Community Sailing Center	107	44.48206	-73.2255
		LaPlatte River mouth, Shelburne Bay	55	44.400342	-73.2335
		Law Island		44.560298	-73.3118
		Leddy Park	54	44.500826	-73.2534
		LTM 16	16	44.425	-73.232
		LTM 19	19	44.471	-73.299
		LTM 21	21	44.474833	-73.2317
		LTM 33	33	44.701167	-73.4182
		North Beach	22	44.491058	-73.2404
		Oakledge Park Blanchard Beach	42	44.45744	-73.2255
		Oakledge Park rocky shoreline	44	44.456715	-73.228
		Oakledge Park South Cove	43	44.454958	-73.23
		Peru Boat Launch	159	44.618839	-73.4404
		Phelps Point		44.61843	-73.3459
		Plattsburgh Boat Launch	150	44.69916	-73.4417
		Plattsburgh City Beach	47	44.719494	-73.4308
		Potash Brook	171	44.438672	-73.2206
		Red Rocks Beach	27	44.441999	-73.2241
		Shelburne Beach	48	44.363061	-73.2676
		Shelburne Farms	123	44.404449	-73.2683
		Shelburne Point	125	44.43447869	-73.2512
		Shelburne Shipyard	124	44.434579	-73.247
		South Cove Beach	173	44.450003	-73.2316
		South of Perkins Pier		44.473078	-73.2209
		Starr Farm Beach	108	44.513764	-73.2714
		Sunset/Crescent Beach	132	44.608883	-73.3158
		Teddy Bear Point Cove, Willsboro NY	63	44.442723	-73.3743
		White's Beach in Crescent Bay	114	44.621145	-73.3234
		Willsboro Boat Launch	68	44.39945	-73.3916
		Winooski R. mouth		44.52965	-73.2774
		Wilcox Dock, Plattsburgh	12	44.708179	-73.4439
		South of Perkins Pier		44.473078	-73.2209
	Main Lake North	Alburgh Dunes State Park	35	44.864624	-73.302
		Grand Isle Ferry		44.68885	-73.3524

Waterbody	Region	Station	Site	Latitude	Longitude
		Holcomb Boat Launch	129	44.854684	-73.3316
Champlain	Main Lake North	Horicans Fish and Wildlife Access	127	44.914084	-73.3145
		LTM 36	36	44.756167	-73.355
		LTM 46	46	44.948333	-73.34
		north of Rt 129 Bridge, Alburgh - Isle LaMotte		44.907025	-73.3178
		Oliver Bay	45	44.737454	-73.4023
		Pelots Point West	130	44.826076	-73.3101
		Pt. Au Roche Boat Launch	109	44.804399	-73.363
		Pt. Au Roche S.P. Deep Bay	84	44.777511	-73.3789
		Pt. Au Roche State Park Beach	26	44.774136	-73.3938
		Stoney Point, Isle la Motte	128	44.871482	-73.3594
		Treadswell Bay, Beekmantown NY	64	44.760077	-73.4075
		Vantines Boat Launch	115	44.719813	-73.3419
	Main Lake South	Arnold Bay	3	44.149739	-73.3695
		Arnold Bay, Panton	206	44.148573	-73.3686
		Beggs Park Beach, Essex NY	60	44.308462	-73.3473
		Bulwagga Bay	138	44.036878	-73.4548
		Bulwagga Bay/Port Henry	138	44.036878	-73.4548
		Button Bay Boat Launch	74	44.176162	-73.3523
		Button Bay South	183	44.168977	-73.3561
		Button Bay State Park	180	44.180926	-73.3618
		Camp Dudley, Westport NY	75	44.143222	-73.4157
		Chimney Point	143	44.034809	-73.4226
		Converse Bay	184	44.293963	-73.2898
		DAR State Park	39	44.054526	-73.4183
		Ferrisburgh Stone Beach	137	44.237899	-73.3083
		Ferrisburgh Town Beach	117	44.235937	-73.301
		Hawkins Bay	105	44.243757	-73.2834
		Kingsland Bay State Park	15	44.240302	-73.2987
		Lane's Lane Landing	121	44.273405	-73.2889
		Long Point	18	44.258135	-73.2776
		Long Point South	187	44.252618	-73.2808
		Long Pt, (Wood) Ferrisburgh	41	44.256623	-73.2831
		LTM 07	7	44.126	-73.4128
		LTM 09	9	44.242167	-73.3292
		North Harbor	147	44.199725	-73.3588

Waterbody	Region	Station	Site	Latitude	Longitude
Champlain	Main Lake South	Panton Shore North	151	44.153539	-73.3643
		Port Henry Boat Launch	153	44.052777	-73.4506
		Port Henry village beach		44.064703	-73.4496
		Summer Point	148	44.218251	-73.338
		Town Farm Bay	119	44.269164	-73.2887
		Town of Moriah beach		44.050701	-73.452
		Tri-Town Road, West Addison	210	44.085383	-73.4079
		Westport Boat Launch	59	44.188732	-73.4328
	Malletts Bay	Camp Kiniya	142	44.606441	-73.2291
		Clay Point	133	44.593928	-73.2318
		LTM 25	25	44.582	-73.2812
		Niquette Bay State Park	67	44.581294	-73.1889
		Rosetti Park	111	44.555009	-73.2528
	Missisquoi Bay	Alburgh Bridge		44.978469	-73.2159
		Alburgh Springs	86	44.993016	-73.2159
		Alburgh Springs North	86	44.996014	-73.2173
		Alburgh VT - shoreline	208	44.991352	-73.216
		areas of shoreline, north of the border		45.050699	-73.0793
		Chapman Bay	6	45.00785	-73.2112
		Donaldson Point	10	44.993203	-73.1753
		Fadden Road - Swanton	181	44.97943	-73.1928
		Goose Bay		44.983921	-73.1176
		Highgate Cliffs	172	44.996109	-73.093
		Highgate Springs	14	44.991767	-73.1134
		Jameson Point QE south to the US border		45.028614	-73.0918
		Larry Greene Fish and Wildlife Access	87	44.970804	-73.2117
		LTM 50	50	45.013333	-73.1738
		LTM 51	51	45.041667	-73.1297
		midbay - north of the border		45.054528	-73.1051
		mouth of the Pike River		45.070439	-73.0966
		mouth of the Pike River		45.070439	-73.0966
		offshore, north of Rock River Bay		45.004537	-73.1028
		open water, north of the Rt 78 Bridge		44.973712	-73.2149
		Phillipsburg QE south to the US border		45.031555	-73.0897
		Phillipsburg QE, south to US border		45.03202	-73.0896
		Phillipsburg, QC	58	45.039064	-73.0787
		Rock River - Highgate	178	44.989379	-73.0893

Waterbody	Region	Station	Site	Latitude	Longitude
Champlain	Missisquoi Bay	Rock River Wildlife Management area		44.997047	-73.0726
		Shipyard Road		44.977567	-73.1115
		Shipyard, Highgate Springs	30	44.98076	-73.1079
		St. Armand		45.05951	-73.0935
		Venise-en-Quebec Bay		45.069226	-73.1438
		Missisquoi Delta		45.010169	-73.1533
	South Lake	Allen Bay	52	43.783007	-73.354
		Lapham Bay	141	43.92598	-73.3927
		LTM 02	2	43.714	-73.383
		LTM 04	4	43.951004	-73.407
		McCuen Slang Waterfowl Area	179	44.024305	-73.4016
		Ticonderoga Boat Launch	188	43.854812	-73.3849
		Lower Poultney River, West Haven		43.570906	-73.3917
	St. Albans Bay	Black Bridge		44.810209	-73.1518
		Ferrand Rd. St. Albans	113	44.791711	-73.1425
		Georgia Beach		44.768331	-73.1626
		Georgia Beach		44.768331	-73.1626
		Georgia Shore North	106	44.7587	-73.1792
		Hathaway Point Rd		44.794823	-73.1659
		Hathaway Point Road		44.794823	-73.1659
		Kill Kare State Park	56	44.777702	-73.1808
		LTM 40	40	44.785333	-73.1622
		Martha Drive		44.785259	-73.1735
		Melville Landing	176	44.76174	-73.1676
		offshore, outer St. Albans Bay towards Ball island		44.766876	-73.1841
		offshore, St. Albans Bay Park to Lazy Lady Island		44.804147	-73.1464
		offshore, vicinity of St. Albans town park		44.808192	-73.1462
		St. Albans Bay Park	31	44.808658	-73.1444
		St. Albans Boat Launch	32	44.793721	-73.1714
Elmore		Lake Elmore State Park	202	44.540398	-72.5273
Iroquois		Lake Iroquois Southwest	169	44.363273	-73.0856
		Lake Iroquois	203	44.378068	-73.0867
Memphremagog		Derby Bay	211	44.994377	-72.1884
		Holbrook Bay	212	44.963922	-72.2397
		Lake Memphremagog	204	44.945012	-72.21
Carmi		Lake Carmi State Park	201	44.960813	-72.8767
		Lake Carmi State Park South	165	44.956922	-72.8773

Waterbody	Region	Station	Site	Latitude	Longitude
Carmi		Lake Carmi, Black Woods	164	44.975297	-72.8855
		Lake Carmi, Dewing Road	166	44.982139	-72.8535
		Lake Carmi, Hammond Rd.		44.980168	-72.857
		Lake Carmi, North Beach	167	44.990535	-72.8703
		Lake Carmi, Westcott Shore	168	44.957115	-72.894
		Vics Crossing Road		44.98544	-72.8607

Appendix B. Visual assessment protocols

B.1. On-line reporting form

Reporting Blue-Green Algae on Lake Champlain

Please use this form to report on water quality conditions with regard to algae on Lake Champlain.

Blue-green algae blooms can be easily confused with other natural phenomena. Please consult our guide to Recognizing Blue Green Algae in Lake Champlain before reporting a bloom. If there is a bloom, avoid direct contact (*see Vermont Department of Health link*).

Also, our guide to categories of algae bloom intensity and our instructions for photographing algae blooms will be helpful in filling out the form below.

Algae Report Form

Type of report	◯ Regular weekly ◯ Supplemental
Water body or section of Lake Champlain or GPS coordinates	
Municipality of observation	
Date of observation	
Time of observation	
Please choose the category (see links above) that best describes the intensity of any bloom present	◯ 1a - Little or no blue-green algae present - clear water ◯ 1b - Little or no blue-green algae present - brown or turbid water ◯ 1c - Little or no blue-green algae present - other material present ◯ 1d - Little blue-green algae present but enjoyment of water not impaired ◯ 2 - Blue-green algae present -less than bloom levels - enjoyment of water slightly impaired (include photos) ◯ 3 - Blue-green algae bloom in progress - enjoyment of water substantially impaired (include photos)
Photo - water surface close-up	Browse... No file selected.
Photo - water surface broad view	Browse... No file selected.
Photo - water sample in clear container	Browse... No file selected.

Photo - water sample in clear container	Browse... No file selected.
Extent of algae bloom on open water (Evaluate the area within 100 yards of where you are).	○ No Bloom ○ Very Limited ○ <50% cover ○ Between 50 and 75% cover ○ Coverage greater than 75%
Algae Color	○ None ○ Green ○ Turquoise ○ Reddish ○ Yellow ○ Other (add details below)
Other details	
Water temperature	
Water Surface	○ Calm ○ Rolling ○ White-caps
Name	
Email	
Address	
Telephone	

Submit Form

B.2. Determining Algae Bloom Intensity

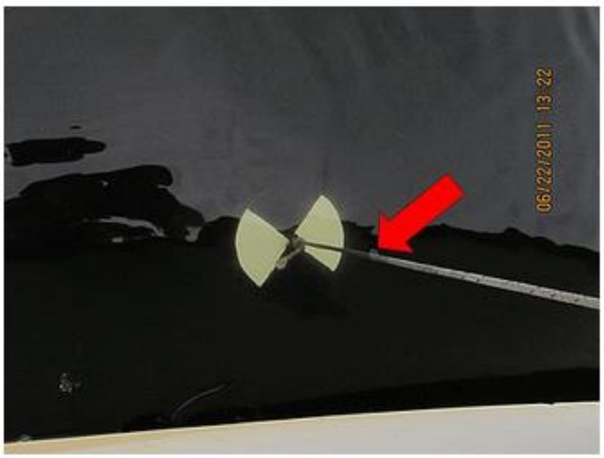
General Instructions

Observations should be made at the same location once per week. Observations must be made between 10:00 AM and 3:00 PM. At that time the algae have had a chance to rise from lower in the water column, but cells are not yet likely to have ruptured from the heat of mid-day. Only observations submitted online **by noon on Wednesday** will be included in the weekly report. Anyone providing reports should include information on the extent and type of algae and plant growth, the color of the water, and rate the algae intensity. The rating scale runs from one (a, b, c, or d) to three, with one being clear water with little to no blue-green algae present and three being a blue-green algae bloom in progress.

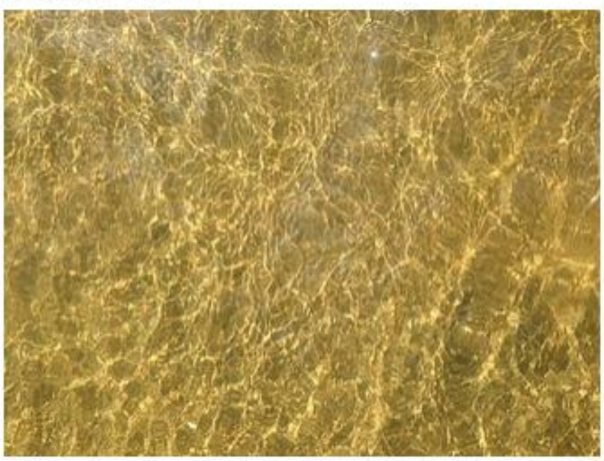
For category 2 and 3 conditions, three digital photographs should be submitted via the online form. Remember to avoid direct contact if the bloom is well developed.

Category 1a: Little to no blue-green algae present - clear water

Any organisms floating in water column are clear (e.g. insect 'skins') rather than green. Leafy or grass-like plants (including duckweed) may be present. Foam may be present.



Objects sitting lower in the water column are clearly visible (red arrow indicates water surface)



Overall appearance of water is clear

Category 1b - Little to no blue-green algae present - brown and turbid

Brown turbid low visibility through water column

Brown and cloudy does not indicate presence of blue-green algae

Category 1c - Little to no blue-green algae present - other material

Other material that doesn't count as blue-green algae might include:

- Long strands that tangle around paddles or boat hooks
- Small bright mustard yellow (pollen) or grass green (duckweed) particles
- Algae attached to rocks or the lake bottom.

Green dots are duckweed; stringy algae are not blue-green algae

From a distance duckweed can look like algae

Stringy algae attached to the bottom are not blue-greens

Duckweed up close

Category 1d - Little blue-green algae present - enjoyment of water not impaired

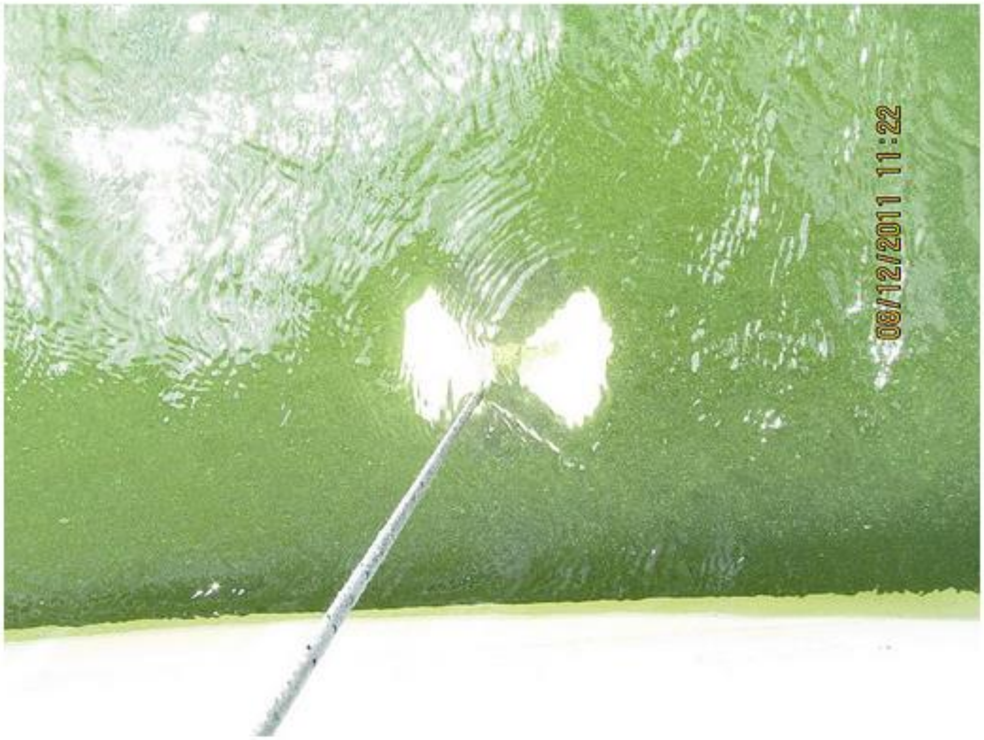
Green floating balls may be visible, but only on close inspection and in densities so low that they do not impair recreational enjoyment of the water. There are no surface or near shore accumulations of blue-green algae.

Water appears perfectly clear

But close inspection shows some blue-green algae present

Category 2: Blue-green algae present, but at less than 'bloom' levels - enjoyment of water slightly impaired

Numerous green balls (pinhead size or larger) floating in water column, but not accumulated at water surface. Possible small (smaller than a softball) patches of algae accumulation. Open water color **not** green. Possible narrow band of algae accumulation at shoreline.

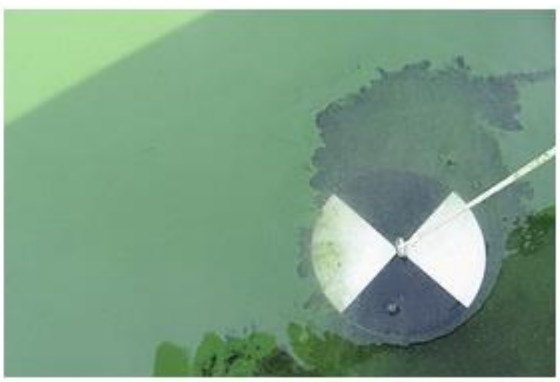


Some algae in water but not a uniform layer

Possible narrow band of algae at shoreline

Category 3: Blue-green algae bloom in progress - enjoyment of water substantially impaired

Extensive surface scum on water – color may range from green to electric blue (not yellow/pollen). Usually accompanied by a thick accumulation at shoreline. Open water appears green.



Continuous layer of algae at the surface - not stringy

Thick surface scum present

Open water surface green to turquoise

B.3. Guidelines for Photographic Documentation

Instructions for Photographing Algae Blooms

Please take digital photographs of the water when category 2 or 3 bloom conditions are observed.

We need three photographs:

1. A close-up of the water surface,
2. A broad view of water in the vicinity, and
3. A close-up of a water sample in a clear container and placed against a background that provides contrast such as a sheet of paper or a wall. Darker colors provide more contrast.

1.Use your camera's date stamp, or hold up a card in the photo with time, date, and location.

2. Photograph both a close-up and a broad view.

3. For close-ups, take a sample of water in a clear container and photograph against a contrasting background. Over about 1/2 hour algae will rise toward the surface; detritus will sink.

When collecting a water sample to photograph take care to avoid exposure to blue-green algae. Wear gloves, don't wade or immerse yourself in the water and wash any exposed portions of your body immediately after collecting the sample. It is okay not to collect a physical sample for photography if you are uncomfortable doing so.

All photographs should include the time, date, and location. This information can be added by using the date stamp in your camera or by holding a piece of paper with the relevant information in the picture. Name the photograph file using the year, month, day-photographer's name-location-photo type.

Example file name: 2014-07-15_MWinslow_DonaldsonPt_Closeup

Appendix C – QA/QC Sample Data for 2015.

LCC volunteer data

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermopsin (ug/L)
Champlain	North Beach	6/23/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		6/30/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		7/7/15	1b	857	Anabaena	<0.16	<0.5	<0.5
		7/14/15	1c	1170	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		7/20/15	1d	2480	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		7/28/15	3	13200	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		8/12/15	1a	3000	Aphanothece	<0.16	<0.5	<0.5
		8/18/15	1d	8530	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/25/15	1a	9030	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		9/1/15	1a	3390	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		9/8/15	1a	14200	Aphanothece	<0.16	<0.5	<0.5
	North Hero State Park	6/22/15	1c	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		6/29/15	1b	2270	Aphanothece, Microcystis	<0.16	<0.5	<0.5
		7/6/15	1a	1200	Aphanothece	<0.16	<0.5	<0.5
		7/13/15	1a	2370	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		7/20/15	1a	6130	Aphanothece	<0.16	<0.5	<0.5
		7/27/15	1a	3060	Aphanothece	<0.16	<0.5	<0.5
		8/10/15	1	17300	Anabaena, Aphanizomenon, Aphanothece	**0.2**	<0.5	<0.5
		8/18/15	1c	17700	Anabaena, Aphanothece	**0.16**	<0.5	<0.5
		8/24/15	1d	12000	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		8/31/15	1a	1600	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		9/8/15	1d	92400	Anabaena, Aphanizomenon, Aphanothece, Microcystis	<0.16	<0.5	<0.5
	Red Rocks Beach	6/21/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		6/29/15	1a	93	Anabaena	<0.16	<0.5	<0.5
		7/6/15	1a	307	Anabaena	<0.16	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermopsin (ug/L)
Champlain	Red Rocks Beach	7/13/15	2	88100	Anabaena	<0.16	<0.5	<0.5
		7/20/15	1a	1040	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		7/27/15	1b	1890	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/3/15	1b	1600	Aphanothece	<0.16	<0.5	<0.5
		8/10/15	1b	933	Aphanothece	<0.16	<0.5	<0.5
		8/17/15	1c	2660	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/24/15	1b	4840	Aphanothece, Oscillatoria, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		8/31/15	1b	1200	Aphanothece	<0.16	<0.5	<0.5
		9/7/15	1c	2530	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
	Shipyard, Highgate Springs	6/22/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		6/29/15	1a	2340	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		7/6/15	1a	11600	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		7/13/15	1d	110300	Aphanizomenon, Aphanothece, Gloeotrichia, Microcystis	<0.16	<0.5	<0.5
		7/27/15	1a	1860	Aphanothece	<0.16	<0.5	<0.5
		8/3/15	1d	14700	Anabaena, Aphanizomenon, Aphanothece, Microcystis	**0.23**	<0.5	<0.5
		8/10/15	3	154700	Anabaena, Microcystis	<0.16	<0.5	<0.5
		8/17/15	1d	1920	Anabaena, Microcystis	**0.16**	<0.5	<0.5
		8/24/15	3	134800	Anabaena, Microcystis	**0.22**	<0.5	<0.5
		9/1/15	2	12100	Anabaena, Aphanizomenon, Aphanothece, Microcystis	<0.16	<0.5	<0.5
		9/7/15	1d	17400	Anabaena, Aphanothece, Microcystis, Pseudanabaena	<0.16	<0.5	<0.5
		9/14/15	1d	63000	Anabaena, Aphanizomenon, Microcystis	<0.16	<0.5	<0.5
		9/21/15	3	1911200	Anabaena, Microcystis	**0.38**	<0.5	<0.5
	St. Albans Bay Park	7/13/15	3	13300	Anabaena, Aphanizomenon, Gloeotrichia, Microcystis	**0.44**	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermopsin (ug/L)
Champlain	St. Albans Bay Park	8/10/15	1b	19100	Anabaena, Aphanothece, Microcystis	<0.16	<0.5	<0.5
		8/17/15	2	191000	Anabaena, Aphanizomenon	**0.22**	<0.5	<0.5
		8/24/15	3	45100	Anabaena, Aphanizomenon	**0.27**	<0.5	<0.5
		8/31/15	3	60100	Anabaena, Aphanizomenon	<0.16	<0.5	<0.5
		9/8/15	3	20000	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
Carmi	North Beach	9/9/15	1a	68300	Anabaena, Aphanizomenon, Aphanothece, Microcystis	<0.16	<0.5	<0.5

VDH Climate Change Data

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
Champlain	Alburgh VT – shoreline	6/23/15	1c	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		6/30/15	1a	3800	Aphanothece	<0.16	<0.5	<0.5
		7/7/15	1a	7270	Aphanothece	<0.16	<0.5	<0.5
		7/14/15	1a	10900	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		7/21/15	1a	7740	Aphanothece	<0.16	<0.5	<0.5
		7/28/15	1a	13300	Aphanothece	<0.16	<0.5	<0.5
		8/4/15	1a	3060	Aphanothece	<0.16	<0.5	<0.5
		8/11/15	1a	30900	Anabaena, Microcystis, Oscillatoria	<0.16	<0.5	<0.5
		8/18/15	1c	2670	Aphanothece	<0.16	<0.5	<0.5
		8/25/15	2	2882400	Anabaena, Aphanizomenon	**0.43**	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
Champlain	Alburgh VT – shoreline	9/1/15	1d	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		9/8/15	1d	33600	Anabaena, Aphanizomenon, Aphanothece, Microcystis	<0.16	<0.5	<0.5
		9/15/15	1a	2720	Anabaena, Aphanizomenon	<0.16	<0.5	<0.5
		9/22/15	1a	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
	Arnold Bay, Panton	6/23/15	1a	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		6/30/15	1c	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		7/6/15	1a	267	Aphanothece	<0.16	<0.5	<0.5
		7/13/15	1a	381	Aphanothece	<0.16	<0.5	<0.5
		7/20/15	1a	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		7/27/15	1a	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		8/3/15	1c	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		8/10/15	1a	4800	Oscillatoria, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		8/17/15	1a	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		8/24/15	1c	533	unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		8/31/15	1a	1600	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		9/8/15	1d	2630	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		9/14/15	1a	2750	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		9/21/15	1a	256	Aphanothece	<0.16	<0.5	<0.5
	Keeler Bay, South Hero	6/23/15	1c	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		6/30/15	1c	0	no potentially toxic cyanobaceria observed	<0.16	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
Champlain	Keeler Bay, South Hero	7/7/15	1c	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		7/14/15	1c	0	no potentially toxic cyanobaceria observed	<0.16	<0.5	<0.5
		7/21/15	1c	0	no potentially toxic cyanobaceria observed	<0.16	<0.5	<0.5
		7/28/15	1a	0	no potentially toxic cyanobaceria observed	<0.16	<0.5	<0.5
		8/4/15	1a	53	Anabaena	<0.16	<0.5	<0.5
		8/11/15	1c	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		8/18/15	1c	667	Aphanothece	<0.16	<0.5	<0.5
		8/25/15	1d	301300	Anabaena, Aphanizomenon	<0.16	<0.5	<0.5
		9/1/15	1a	3790	Anabaena, Aphanizomenon	<0.16	<0.5	<0.5
		9/8/15	1c	17000	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		9/15/15	1a	5730	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		9/22/15	1c	2720	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
Carmi	Lake Carmi State Park	6/22/15	1c	7440	Anabaena, Aphanothece, Microcystis, Woronichinia/C	<0.16	<0.5	<0.5
		6/29/15	1c	33600	Anabaena, Aphanizomenon, Aphanothece, unidentified	<0.16	<0.5	<0.5
		7/8/15	1c	30700	Aphanizomenon, Aphanothece, Woronichinia/Coelo spha	<0.16	<0.5	<0.5
		7/15/15	1c	119800	Anabaena, Aphanizomenon, Aphanothece, Microcystis, unidentified Oscillatoriaceae, Woronichinia/Coelo sphaerium	<0.16	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
Carmi	Lake Carmi State Park	7/22/15	1c	123800	Anabaena, Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae, Pseudanabaena	<0.16	<0.5	<0.5
		7/29/15	1c	128000	Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		8/5/15	1b	67800	Anabaena, Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae	**0.21**	<0.5	<0.5
		8/12/15	1d	63200	Aphanizomenon, Aphanothece, Scytonema spp, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		8/19/15	1c	100300	Anabaena, Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae	**0.22**	<0.5	<0.5
		8/26/15	1d	178900	Anabaena, Aphanizomenon, Aphanothece, Scytonema spp, Oscillatoria, unidentified Oscillatoriaceae, Woronichinia/Coelo sphaerium	**0.35**	<0.5	<0.5
		9/2/15	1c	37500	Anabaena, Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		9/9/15	1a	42400	Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		9/15/15	1d	95700	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		9/21/15	1d	85200	Aphanizomenon, Aphanothece, Microcystis	<0.16	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
Carmi	Lake Carmi, North Beach	8/19/15	2	924400	Anabaena, Aphanothece, Scytonema spp, Microcystis, unidentified Oscillatoriaceae, Woronichinia/Coelo sphaerium	**0.22**	<0.5	<0.5
		9/21/15	3	416400	Anabaena, Aphanizomenon, Microcystis, Scytonema spp.	**0.40**	<0.5	<0.5
Elmore	Elmore State Park	6/22/15	1c	16700	Aphanothece	<0.16	<0.5	<0.5
		6/29/15	1a	13500	Aphanothece	<0.16	<0.5	<0.5
		7/8/15	1a	19200	Aphanothece, Woronichinia/Coelo sphaerium	<0.16	<0.5	<0.5
		7/22/15	1a	6140	Aphanothece, Woronichinia/Coelo sphaerium	<0.16	<0.5	<0.5
		7/29/15	1a	22500	Anabaena, Aphanothece, Woronichinia/Coelo sphaerium	<0.16	<0.5	<0.5
		8/5/15	1a	16400	Aphanothece	<0.16	<0.5	<0.5
		8/12/15	1a	10800	Aphanothece	<0.16	<0.5	<0.5
		8/19/15	1a	20000	Anabaena, Aphanothece	**0.19**	<0.5	<0.5
		8/26/15	1b	13400	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		9/1/15	1a	15700	Aphanothece	<0.16	<0.5	<0.5
Iroquois	Town Beach	6/22/15	1c	3120	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		6/29/15	1c	3770	Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		7/6/15	1a	2220	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		7/13/15	1c	6130	Anabaena, Aphanothece	<0.16	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
Iroquois	Town Beach	7/20/15	1a	1200	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		7/27/15	1c	14800	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		8/3/15	1c	13300	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/10/15	1a	11700	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		8/17/15	1b	4190	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/24/15	1c	3470	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/31/15	1a	880	Anabaena, Aphanothece	<0.16	<0.5	<0.5
Memphre magog	Prouty Beach	6/22/15	1c	0	indeterminate Oscillatoriaceae	**0.17**	<0.5	<0.5
		6/29/15	1c	4270	unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		7/8/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		7/15/15	1c	356	Aphanothece	<0.16	<0.5	<0.5
		7/22/15	1a	2070	Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		7/29/15	1c	1520	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		8/5/15	1c	720	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		8/12/15	1c	667	Aphanothece	<0.16	<0.5	<0.5
		8/19/15	1c	3010	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		8/26/15	1c	2800	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		9/2/15	1a	3040	Aphanothece, Microcystis, Woronichinia/Coelo sphaerium	<0.16	<0.5	<0.5
Champlain	Maquam Shore Road, Swanton	6/23/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		6/30/15	1c	4480	Aphanizomenon, Microcystis	<0.16	<0.5	<0.5
		7/7/15	1a	0	unidentified Oscillatoriaceae	<0.16	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
Champlain	Maquam Shore Road, Swanton	7/14/15	1d	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		7/21/15	1b	160	Aphanizomenon	<0.16	<0.5	<0.5
		7/28/15	1a	1120	Anabaena, Aphanizomenon	<0.16	<0.5	<0.5
		8/4/15	1c	4050	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/11/15	1b	1890	Aphanothece, Microcystis	<0.16	<0.5	<0.5
		8/18/15	1a	800	Aphanothece	<0.16	<0.5	<0.5
		8/25/15	1c	8290	Anabaena, Aphanizomenon, Aphanothece, unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		9/1/15	1a	1870	Anabaena	<0.16	<0.5	<0.5
		9/8/15	1d	9810	Anabaena, Microcystis	<0.16	<0.5	<0.5
		9/15/15	1a	1890	Anabaena, Aphanothece, Microcystis	<0.16	<0.5	<0.5
		9/22/15	1a	3740	Aphanothece	<0.16	<0.5	<0.5
	Stephens on Point Fish and Wildlife Access	6/23/15	1b	0	no potentially toxic taxa present	<0.16	<0.5	<0.5
		6/30/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		7/7/15	1a	667	Aphanothece	<0.16	<0.5	<0.5
		7/14/15	1a	213	Anabaena	<0.16	<0.5	<0.5
		7/21/15	1a	654	Aphanothece	<0.16	<0.5	<0.5
		7/28/15	1a	1830	Microcystis	<0.16	<0.5	<0.5
		8/11/15	1b	960	Aphanizomenon	<0.16	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
Champlain	Stephens on Point Fish and Wildlife Access	8/18/15	1c	2640	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		8/25/15	1d	279900	Anabaena, Gloeotrichia	<0.16	<0.5	<0.5
		9/1/15	1a	7810	Anabaena, Aphanizomenon, Microcystis	<0.16	<0.5	<0.5
		9/8/15	2	289200	Anabaena, Aphanizomenon, Microcystis	<0.16	<0.5	<0.5
		9/15/15	1a	2400	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		9/22/15	1a	2930	Anabaena, Aphanothece	<0.16	<0.5	<0.5
	Tri-Town Road, West Addison	6/23/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		6/30/15	1a	533	unidentified Oscillatoriaceae	<0.16	<0.5	<0.5
		7/6/15	1b	889	Aphanothece	<0.16	<0.5	<0.5
		7/13/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		7/20/15	1a	1580	Anabaena, Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		7/27/15	1d	4320	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/3/15	1a	2670	Aphanothece	<0.16	<0.5	<0.5
		8/10/15	1a	0	No cyanobacteria observed	<0.16	<0.5	<0.5
		8/17/15	1a	0	no potentially toxic cyanobacteria observed	<0.16	<0.5	<0.5
		8/24/15	1c	4580	Anabaena, Aphanothece	<0.16	<0.5	<0.5
		8/31/15	1a	1860	Aphanothece	<0.16	<0.5	<0.5
		9/8/15	1c	747	Aphanizomenon, Aphanothece	<0.16	<0.5	<0.5
		9/14/15	1a	960	Aphanizomenon	<0.16	<0.5	<0.5

Lake	Station	Report Date	Bloom Intensity	Density of Potentially Toxic Cyano (cells/mL)	Cyanobacteria Taxa Present	Microcystin – LR equivalents (µg/L)	Anatoxin (µg/L)	Cylindro-spermop-sin (ug/L)
	Tri-Town Road, West Addison	9/21/15	1a	480	Aphanizomenon	<0.16	<0.5	<0.5

Appendix D – Historical Microcystin Data for Lake Champlain

Lake Segment		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Inland Sea	median	0.05	0.41	0.08	0.27	0.05	1.10	0.07	0.03	0.08	NA	<0.16	<0.16	<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	NA	ND - 0.43	ND - 0.28	ND – 0.02
	#samples	6	8	8	16	4	11	2	3	9	0	45	56	26
	#stations	1	3	3	7	3	4	2	2	4	NA	4	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	<0.16	<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	<0.16 -0.19	All ND
	#samples	19	0	2	0	2	2	6	8	4	3	23	31	27
	#stations	4	NA	1	NA	2	2	3	5	4	1	2	2	2
Main Lake North	median	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	range	NA	NA	NA	NA	NA	1.56	0.03	NA	0.01	NA	NA	NA	NA
	#samples	0	0	0	0	0	1	1	0	1	0	0	0	0
	#stations	NA	NA	NA	NA	NA	1	1	NA	1	NA	NA	NA	NA
Main Lake South	median	NA	NA	0.04	NA	NA	NA	NA	NA	0.01	NA	<0.16	<0.16	<0.16
	range	0.07	NA	ND - 0.07	3.47	NA	NA	NA	NA	0.01	NA	ND - 0.16	ND- 0.51	All ND
	#samples	1	0	2	1	0	0	0	0	2	0	22	33	28
	#stations	1	NA	1	1	NA	NA	NA	NA	2	NA	2	3	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	<0.16	<0.16
	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	ND - 0.2	ND – 0.77
	#samples	32	29	18	36	20	10	4	10	12	5	2	4	12
	#stations	1	2	1	2	4	3	2	3	2	1	2	2	2
Malletts Bay	median	NA	NA	NA	0.04	NA	NA	NA	NA	NA	NA	NA	NA	NA
	range	NA	NA	NA	0.04-0.08	NA	NA	NA	NA	0.04	NA	NA	NA	NA
	#samples	0	0	0	7	0	0	0	0	1	0	0	0	0
	#stations	NA	NA	NA	2	NA	NA	NA	NA	1	NA	NA	NA	NA
South Lake	median	0.96	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	range	0.53-1.38	NA	0.01	NA	NA	NA	NA	NA	0.02	NA	NA	NA	NA
	#samples	2	0	1	0	0	0	0	0	1	0	0	0	0
	#stations	2	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
Missisquoi Bay	median	0.09	0.84	0.66	0.52	NA	2.56	0.54	0.03	0.65	0.99	<0.16	<0.16	<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	ND - 1.3	ND - 2.29	ND – 0.43
	#samples	341	228	146	152	0	81	29	10	59	36	30	40	38
	#stations	14	11	10	12	NA	10	8	7	8	3	6	7	5