New Jersey Department of Environmental Protection

Water Resource Management

Division of Water Monitoring and Standards

Cyanobacterial Harmful Algal Bloom (HAB)

Freshwater Recreational Response

2020 Summary Report

March 2021

Cover Photo- Lake Papaianni, Middlesex County

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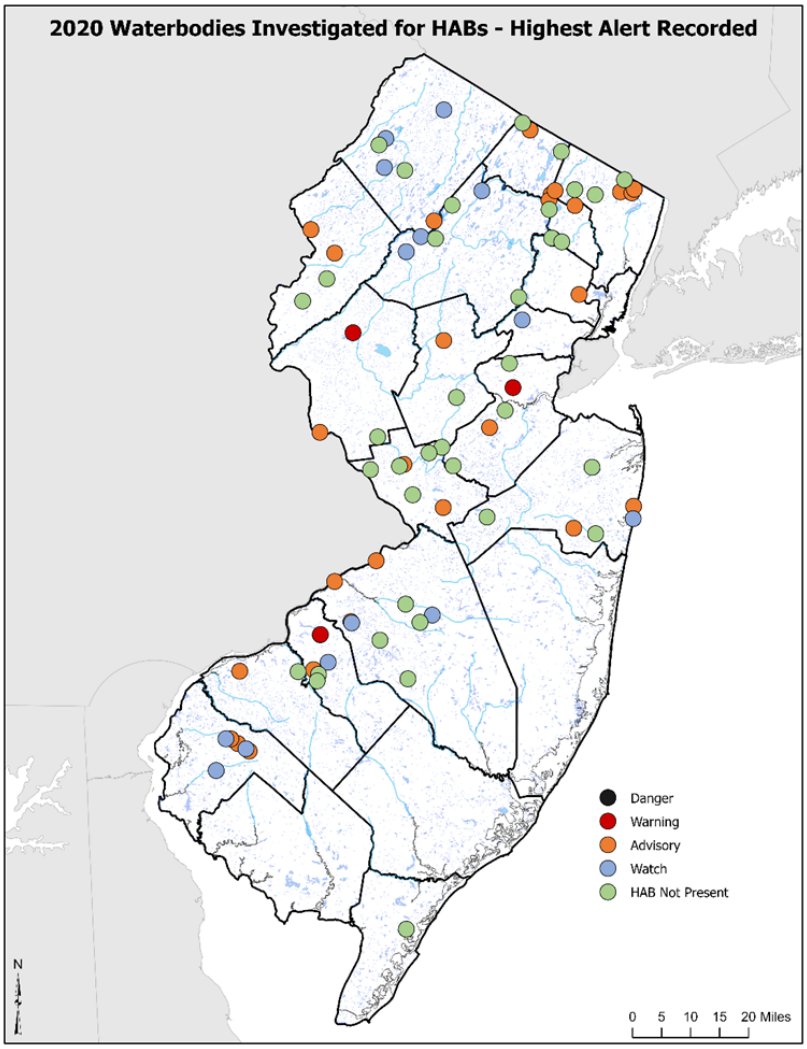
Cyanobacterial Harmful Algal Bloom (HAB) Freshwater 2020 Summary Report

Executive Summary

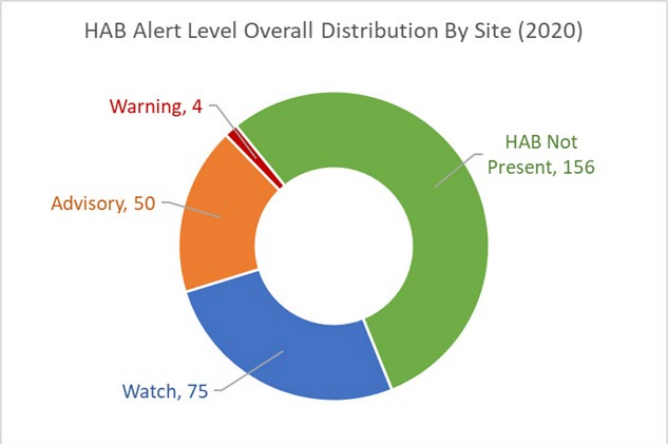
In 2017 the NJDEP implemented a Cyanobacterial Harmful Algal Bloom (HAB) Freshwater Recreational Response Strategy (Response Strategy). The purpose of the Response Strategy is to provide a unified statewide approach to respond to cyanobacterial HABs in freshwater recreational waters, public recreational bathing facilities and sources of drinking water, and to protect the public from risks associated with exposure to cyanobacteria and related toxins.



In 2020, a tiered public information and signage system was developed as an enhancement to the HAB Strategy. The Alert tiers provide clear guidance on advisable recreational activities in impacted water bodies when a HAB is present. At the same time, **the DEP HAB Interactive Map Reporting and Communication System** was developed and is used to gather initial information on suspected HABs and to communicate data and Alerts to the public.

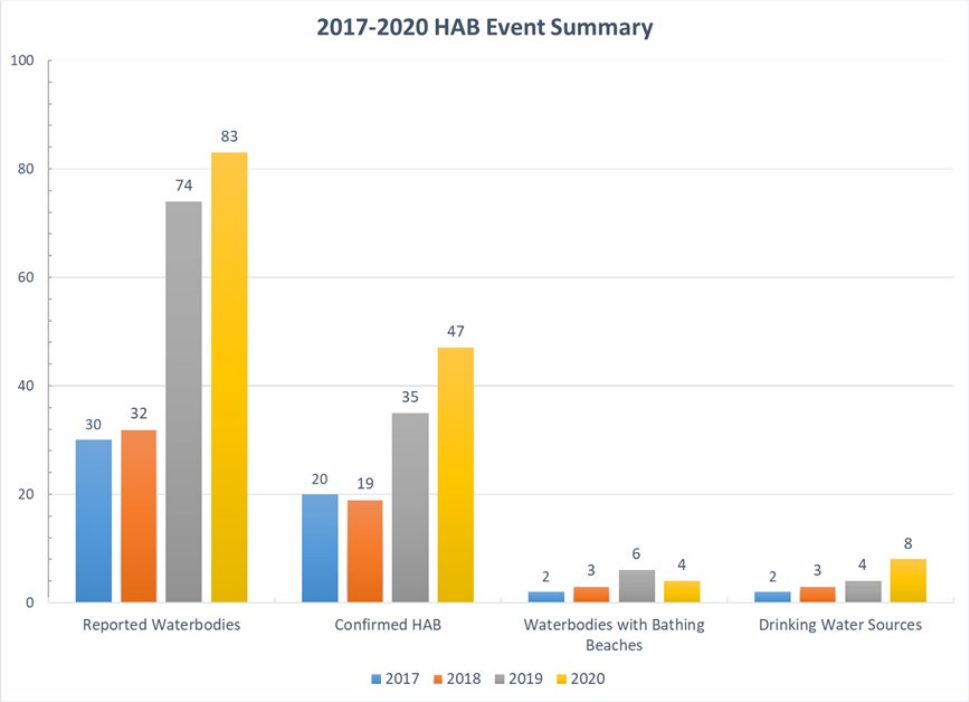
In 2020, DEP responded to suspected HAB reports at 83 waterbodies. Of these, 47 waterbodies had at least one site, confirmed by laboratory analysis, as having a HAB at or above a Watch Alert level (>20,000 cells/ml and/ or toxins above thresholds).

At each of the 83 waterbodies investigated, multiple sites may have been sampled depending on localized occurrences in the waterbody, totaling 129 site specific HAB alerts. The pie chart on the left shows all sites at all waterbodies.



This represented an 11% increase in reports of suspected HABs, since 2019. Although there was a slight increase in these reports, the number of waterbodies with confirmed HABs (Watch Alert or above) rose significantly by 26%.

HABs confirmed at drinking water sources increased from 2019. In addition, 54% of waterbodies with confirmed HABs in 2020, had confirmed HABs in a previous year since 2017. This indicates that the statewide occurrence of HABs in New Jersey is not only increasing but recurring in many waterbodies. Further evidence of increased HAB activity is the persistence of blooms into the winter. As of December 2020, there were 15 waterbodies with at least one site with a HAB Alert level of Watch or above. This is a 47% increase from 2019 when only 8 waterbodies had HABs continuing past December.



The expansion of the continuous buoy network will provide valuable data at waterbodies where HABs have reoccurred. In addition to informing immediate HAB response actions, continuous data will be used by DEP to research water quality factors that may predict or contribute to HAB formation.

The Division of Water Monitoring and Standards (DWMS) and the New Jersey Sea Grant Consortium (NJSGC) has recruited an Expert Team of lakes management and cyanobacterial HAB experts to develop guidance documents for the prevention and management of HABs and to provide technical advice on proposed mitigation technologies.

Introduction

In 2017 the NJDEP implemented a Cyanobacterial Harmful Algal Bloom (HAB) Freshwater Recreational Response Strategy (Response Strategy). The purpose of the Response Strategy is to provide a unified statewide approach to respond to cyanobacterial HABs in freshwater recreational waters and sources of drinking water, and to protect the public from risks associated with exposure to cyanobacteria and related toxins. Although the primary focus of the Response Strategy is the protection of human health, it provides some information and recommendations regarding exposure and prevention of potential impacts to domestic animals (pets), livestock, and wildlife, as well.

The scope of the Response Strategy is for freshwater lakes, ponds, rivers and streams with potential public access, recreational use, public recreational bathing facilities as defined in N.J.A.C. 8:26, and sources of drinking water. These waterbodies may be owned or operated by state, county, municipal, federal or private entities. As such, coordination of the investigation and response activities will vary depending on ownership.

Direct drinking water related HAB concerns are addressed by the Department of Environmental Protection's (DEP's) Division of Water Supply & Geoscience (DWSG). The DWSG has an emergency protocol in place for responding to and handling HAB/cyanotoxin events that affect a drinking water source. The protocol outlines the communication during a HAB/cyanotoxin event, including the coordination between the Division of Water Monitoring and Standards (DWMS), the Division of Water Supply and Geoscience (DWSG), and the public water system(s). Internal email notifications are sent during all stages of the incident to provide details and keep all relevant staff updated on the incident. Additional parties included on these emails includes NJDEP OEM and Enforcement, and outside State agencies such as the New Jersey Department of Health, Board of Public Utilities, New Jersey Water Supply Authority, and New Jersey Department of Community Affairs, if appropriate.

The DWSG also focuses on working with water systems to be better prepared for HAB/cyanotoxin events. This includes providing guidance on how best to prevent, mitigate, and treat HABs/cyanotoxins as well as having public water systems who are at risk for HABs plan for such events as part of their Cyanotoxin Management Plan. For more information on drinking water and HABs, see the DWSG website: http://www.nj.gov/dep/watersupply/.
Since 2017, NJDEP has continued to enhance all aspects of its approaches including, response monitoring, testing, and notification methods. This report focuses on the response and monitoring performed in 2020. Other enhancements have been developed and implemented such as a new website, training workshops, and research can be found on the main HAB Website: https://www.state.nj.us/dep/hab/

In 2020, a tiered public information and signage system was developed as an enhancement to the HAB Strategy. The Alert tiers (Table 1) provide clear guidance on advisable recreational activities in impacted water bodies, depending on levels of cyanobacteria and/or cyanotoxins present. Color-coded signs provide the public with current conditions and recommendations on which recreational activities are advisable and those that are not. The index makes it clear to the public that, in some instances, boating and related activities may still be suitable when lower levels of harmful algal blooms are detected.

HAB ALERT LEVEL	CRITERIA	RECOMMENDATIONS
NONE	HAB report investigated and no HAB found	None
WATCH *Suspected or confirmed HAB with potential for allergenic and irritative health effects*	Suspected HAB based on visual assessment or screening test **OR** Lab confirmed cell counts between 20k – 40k cells/mL **AND** No known toxins above public health thresholds	Public Bathing Beaches Open (dependent upon local health authority evaluation and assessment) Waterbody Accessible: • Use caution during primary contact (e.g. swimming) and secondary (e.g. non-contact boating) recreational activities Do not ingest water (people/pets/livestock) Do not consume fish
ALERT *Confirmed HAB that requires greater observation due to increasing potential for toxin production* **PUBLIC BATHING BEACHES INCREASE MONITORING**	Lab confirmed cell counts between 40k – 80k cells/mL **AND** No known toxins above public health threshold	**WATCH remains in effect.** **Public Bathing Beaches Open (dependent upon local health authority evaluation and assessment) and should observe and report changing bloom conditions** Waterbody Accessible: • Use caution during primary contact (e.g. swimming) and secondary (e.g. non-contact boating) recreational activities Do not ingest water (people/pets/livestock) Do not consume fish
ADVISORY *Confirmed HAB with **moderate risk of adverse health effects** and increased potential for toxins above public health thresholds*	Lab testing for toxins exceeds public health thresholds **OR** Lab confirmed cell counts above 80K cells/mL **OR** Field measurement evidence indicating HAB present and above guidance thresholds (e.g. phycocyanin readings)	Public Bathing Beaches Closed Waterbody Remains Accessible: • Avoid primary contact recreation (e.g. swimming) • Use caution for secondary contact recreation (e.g. boating without water contact) Do not ingest water (people/pets/livestock) Do not consume fish
WARNING *Confirmed HAB with **high risk of adverse health effects** due to high toxin levels*	Toxin (microcystin) 20 - 2000 µg/l **AND/OR** Additional evidence, including, expanding bloom, increasing toxin levels (i.e. duration, spatial extent or negative human or animal health impacts) indicates that additional recommendations are warranted	Public Bathing Beaches Closed Waterbody Remains Accessible: • Avoid primary contact recreation (e.g. swimming) • May recommend against secondary contact recreation (e.g. boating without water contact) with additional evidence Do not ingest water (people/pets/livestock) Do not consume fish
DANGER *Confirmed HAB with **very high risk of adverse health effects** due to very high toxin levels*	Toxin (microcystin) > 2000 µg/l **AND/OR** Additional evidence, including, expanding bloom, increasing toxin levels (i.e. duration, spatial extent or negative human or animal health impacts) indicates that additional recommendations are warranted	Closure of Public Bathing Beaches Possible closure of all or portions of waterbody and possible restrictions access to shoreline. Avoid primary contact recreation (e.g. swimming) May recommend against secondary contact recreation with additional evidence Do not ingest water (people/pets/livestock) Do not consume fish

Table 1. HAB Alert Table

A winter watch sign (Figure 1) was recently developed to be used during the 2020-2021 winter season. Over the winter, HABs may persist at some water bodies or recur at other waterbodies. Day-to-day conditions may change and not reflect past Alert postings. The winter watch sign is intended to be used at these water bodies where HABs have a likelihood of recurring during the winter. Because signs posted during the recreational season may not reflect current conditions, or the public may disregard signs they perceive as "old", this new sign provides a fresh perspective during the off season to alert users to be cautious.

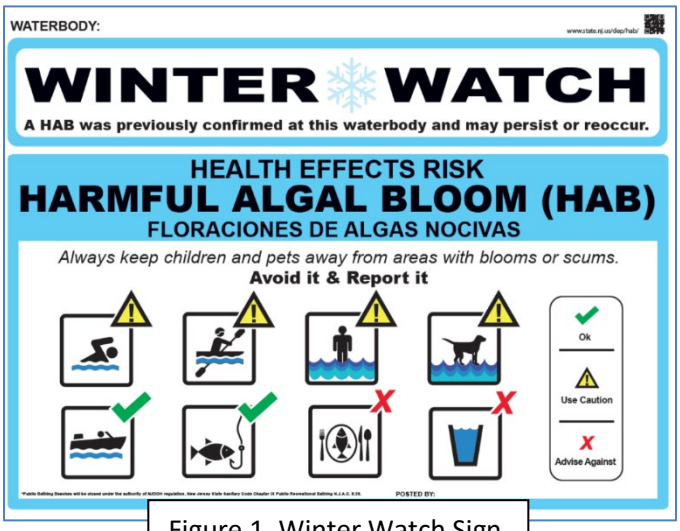


Figure 1. Winter Watch Sign

The DEP HAB Interactive Map Reporting and Communication System (Figure 2) was developed in 2020 and is used to gather initial information such as: location coordinates, photos, known recreational activities, and extent of the waterbody. This information is used to inform DEP to initiate appropriate response actions. Once the DEP completes the investigation of the suspected HAB, results and any recommendations for public Alerts is communicated through the HAB System.

All Alert information and HAB data is accessible by clicking each point on the interactive map. The map reflects sampling results for suspected or confirmed HAB events reported to DEP.

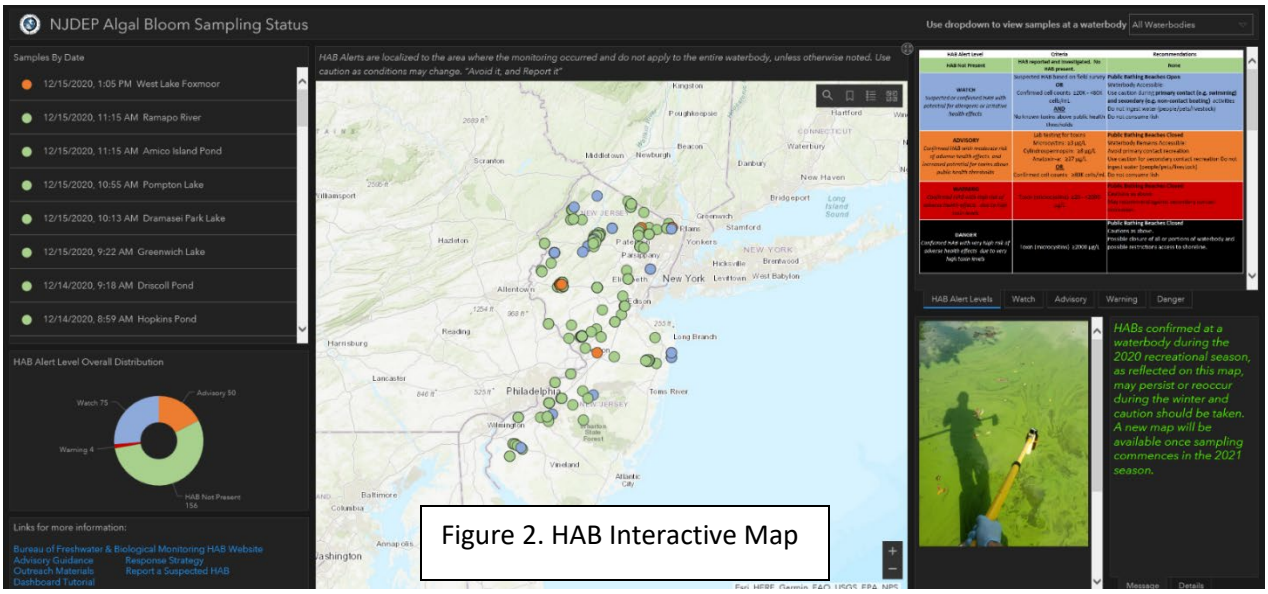


Figure 2. HAB Interactive Map

Cyanobacterial Harmful Algal Bloom (HAB) Freshwater Recreational Response Procedures

If BFBM staff observe a suspected HAB while collecting water quality samples as part of the routine Ambient Lakes Monitoring Network, they immediately perform a field survey and collect samples as needed. Flight surveillance results* and continuous monitoring buoy data are interpreted by BFBM and DWMS designated staff to determine if a site survey and sampling is needed. Staff are deployed to areas of the waterbody, as shown by fight data or at the location of the buoy where a HAB is suspected to be above NJ Guidance Thresholds for cell concentration.

Upon receipt of suspected HAB report from outside of DEP, the BFBM HAB coordinator or designee, assesses the information provided in the suspected HAB report, deploys staff, and/ or coordinates with partners as necessary. The BFBM HAB coordinator also notifies the responsible agency designated for the water body, e.g. a State Park, Watershed Management Area (WMA), local health department. If the responsible agency has trained HAB sampling staff and proper sampling equipment and supplies, they may be requested to perform some of the response activities as in this SOP.

Every effort is made to respond to reported suspected HABs as soon as possible, but usually within one day. In the event resources are limited, the monitoring will be prioritized based on risk to public health. Approaches are listed in
Table 2.

*Flights are performed weekly weather permitting, and described in section xxx

1. Approach for Lakes, Ponds, Reservoirs, Rivers & Streams including Delaware and Raritan Canal

a. Drinking Water Sources

Initial Response	Sampling Frequency	Duration/Season	Final Response
Confirm ASAP	*per BSDW direction*	*Year Round*	*Continue monitoring at predetermined frequency until clear or per BSDW direction*

b. **Public Recreational Beaches (PRB)** (in-season, out-of-season skip to *c. Other Recreational Use*) and Secondary Contact Recreational Waters

Initial Response	Sampling Frequency	Duration/Season	Final Response
Confirm ASAP	*Alert tier for bathing beaches only (see table 1) – coordinate with partners on additional monitoring. Beach Closing – Sample after visually or by phyco measurement clear for 5 days.*	*May through September*	*After September 30 sample when notified HAB has visually subsided.*

c. **Other Recreational Use** - boating, fishing, public bathing beach (out of season), hunting, domestic animal use, wildlife

Initial Response	Sampling Frequency	Duration/Season	Final Response
Confirm ASAP	*Sample when notified by partners. visually or by phyco measurement*	*Recreational Season or Year Round if necessary*	*December. If HAB is still present or likely to reoccur, a "Winter Watch" alert is posted*

2. Approach for Private Lakes wholly on private property, Ditches, Canals, Stormwater Basins

Initial Response	Sampling Frequency	Duration/Season	Final Response
Assess public access and use. Contact owner. Sample on case by case basis.	*As needed*	*As needed*	*When clear*

Table 2. Response and Monitoring Priorities

Field Survey

A field survey is performed to gather information following reports of suspected HABs. BFBM staff record site coordinates, observations, take photos, phycocyanin measurements, and determine if sampling is warranted. All survey and subsequent sampling information is recorded and submitted via a State cell phone using the NJDEP HAB Interactive Map Reporting and Communication System.

Figure 3. Field Fluorometer For Measuring Phycocyanin

Phycocyanin is a pigment unique to cyanobacteria, therefore the presence of a high concentration of phycocyanin is an indicator of a cyanobacteria bloom. Handheld field fluorometers measure the presence and relative concentration of phycocyanin and are used to qualitatively demonstrate whether cyanobacteria, if present, are in bloom densities. Phycocyanin measurements are used to approximate cell concentration and cannot predict toxin production, toxin levels, identify taxa present, nor quantify cell density directly. However, these measurements can be used as a screening tool for suspected HABs and to monitor the status of confirmed HABs.

Figure 4. Continuous multi-parameter meter.

BFBM uses three types of fluorometers: a field meter, laboratory meter, and a YSI data sonde. The YSI data sonde is used for real time continuous monitoring in conjunction with telemetry buoys (Figure 4), but units can also be used for discreet measurements by samplers.

The DWMS has developed correlations between phycocyanin measurements and cell concentration. All New Jersey specific available data from 2017-2019, where both cell count and phycocyanin samples were analyzed, were used to statistically correlate these parameters. Note that model of meter has different ranges and requires a separate correlation (Figures 5 & Table 3).

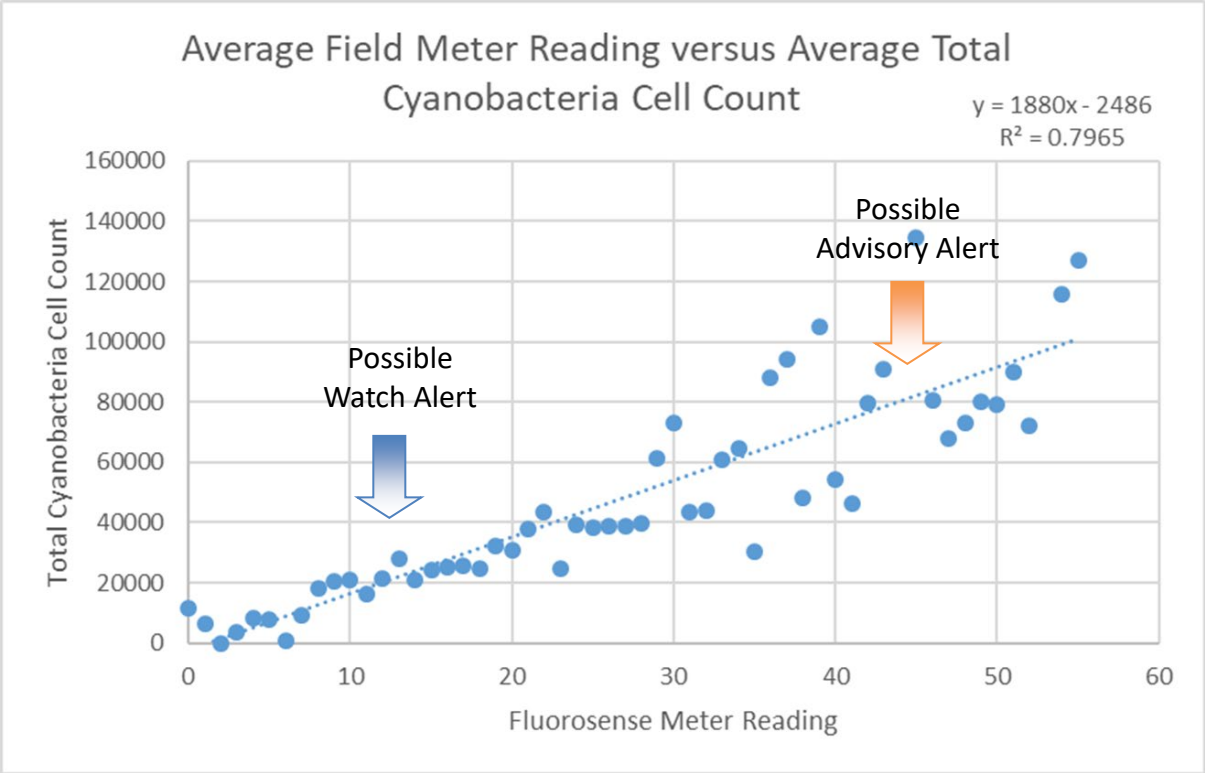


Figure 5. Phycocyanin and cell count correlation for FluoroSense field meter

Estimated individual cell counts cells/ml	Continuous & Discreet Meter µg/l	Estimated FluoroSenseRFU	Estimated Lab Fluorometer RFU
20000	1.15	12	33
40000	1.87	23	45.9
80000	3.29	44	71.5
100000	4.00	44	84.3

Table 3. Phycocyanin and cell count correlation for all meters used.

Laboratory Analysis

Analysis is performed at the BFBM laboratory and uses an Enzyme-Linked Immunosorbent Assay (ELISA) method with Abraxis brand test kits for cyanotoxin analysis of microcystins, anatoxin-a, and cylindrospermopsin. Assays are performed using the Cyanotoxin Automated Analyzer System (CAAS) (Figure 6), Abraxis brand, PN 475200S or equivalent Microtiter plate reader capable of reading sample Absorbance at 450 nm. Reporting levels for each toxin are adequate to accurately detect and quantify toxins below NJ Health Guidance.

Currently EPA Standardized Analytical Method for Determining Total Microcystins by the use of the ELISA Method (EPA 546) is the only EPA approved ELISA method for toxin analysis. Anatoxin-a and cylindrospermopsin is also analyzed using the ELISA method, procedures specific to these toxins follow the manufacturer's instructions for the instrumentation.

Cyanobacteria cell concentrations are determined using direct counts on a Hemocytometer. Standard phytoplankton identification guides are for taxa identification. Cell counts are reported as cells/ml and all taxa are identified. The dominant taxa, i.e. most abundant, is noted and posted with the data on the interactive map.

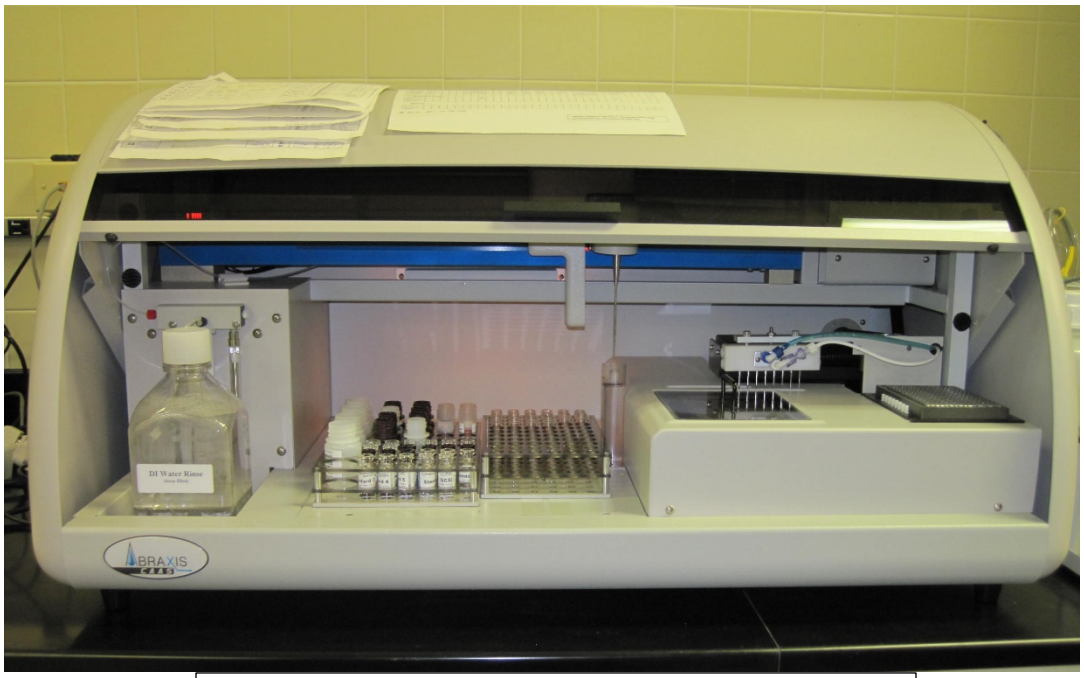


Figure 6. Cyanotoxin Automated Analyzer System (CAAS)

2020 Results and Discussion

Waterbody Summary

In 2020, BFBM responded to suspected HAB reports at 83 waterbodies. Of these, 47 waterbodies had at least one site, confirmed by laboratory analysis, as having a HAB at or above a Watch Alert level (>20,000 cells/ml and/ or toxins above thresholds). At each of the 83 waterbodies investigated, multiple sites may have been sampled depending on localized occurrences in the waterbody. In addition, sites may have been sampled many times over the season due to changing conditions and concerns. The Alert levels are for the immediate area where the HAB occurred and the rest of the water body can be used for recreation with normal appropriate precautions. When Alerts are posted it is noted that there may be other HABs occurring which have been reported and confirmed. As always, recreators are advised to avoid anything that looks like a HAB and to report it to the DEP ("Avoid It and Report It") Figure 7 shows a map of the waterbodies investigated in 2020 with the highest alert level recorded for that waterbody for the season. Table 4 lists these waterbodies by county.

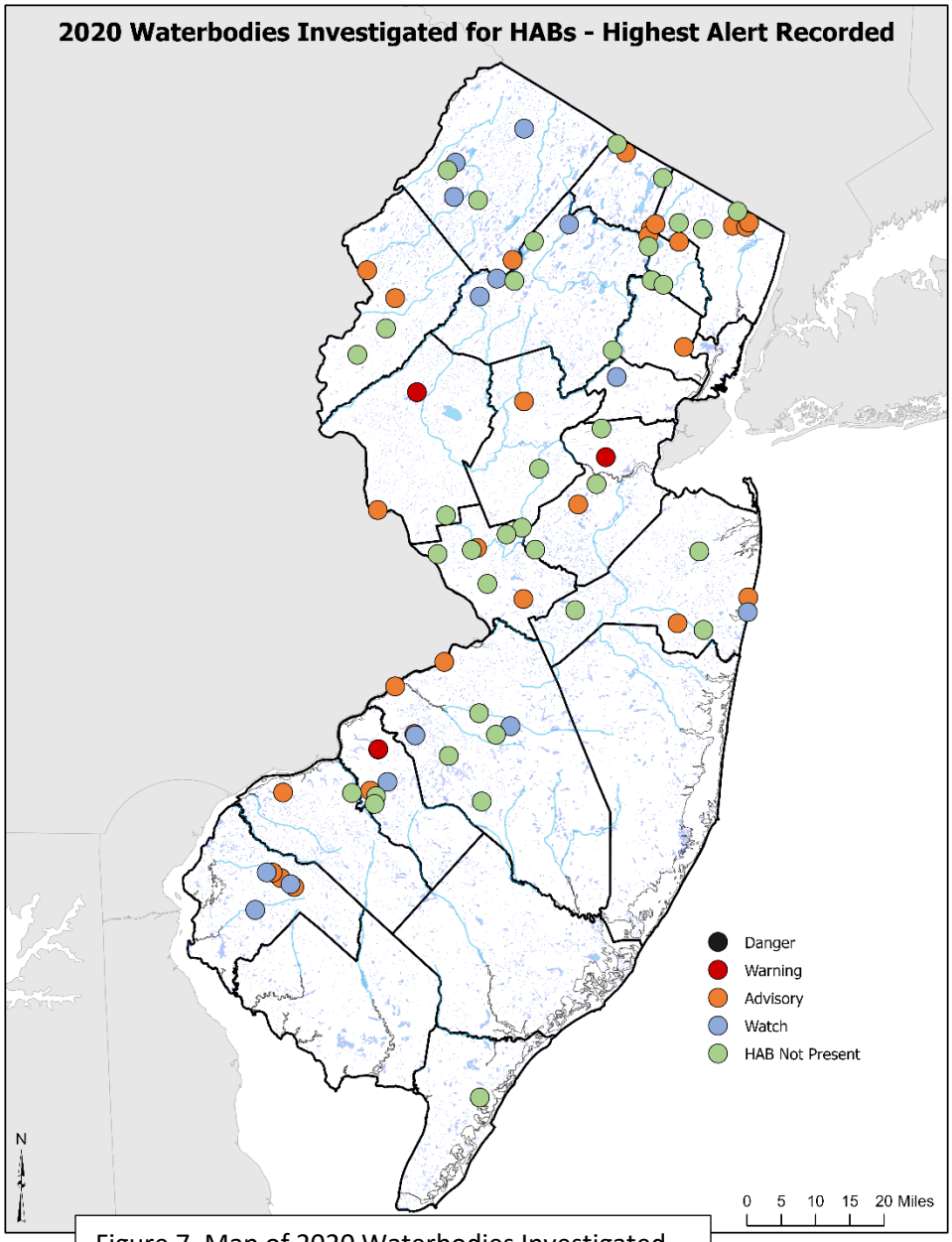


Figure 7. Map of 2020 Waterbodies Investigated

Waterbody Name	County	Alert Tier
Franklin Lakes Public Library Memorial Garden Pond	Bergen	HAB Not Present
Habernickel Park Pond	Bergen	HAB Not Present
Hackensack River	Bergen	Advisory
Huff Pond	Bergen	HAB Not Present
Ramapo River - Oakland	Bergen	Advisory
Tappan Lake	Bergen	Advisory
Woodcliff Lake	Bergen	Advisory
Amico Island Pond	Burlington	Advisory
Burlington Island Lake	Burlington	Advisory
Indian Mills Lake	Burlington	HAB Not Present
Jade Run	Burlington	HAB Not Present
Lake Elizabeth - Birchfield	Burlington	Watch
Lake Sarah - Birchfield	Burlington	Watch
Lake Virginia - Birchfield	Burlington	Advisory
Pemberton Lake	Burlington	Watch
Smithville Lake	Burlington	HAB Not Present
Trib to S. Branch Rancocas Creek	Burlington	HAB Not Present
Camden County College Lake	Camden	HAB Not Present
Dramasei Park Lake	Camden	Advisory
Driscoll Pond	Camden	Warning
Hopkins Pond	Camden	Warning
Kirkwood Lake	Camden	Watch
Millbridge Lake	Camden	HAB Not Present
Pine Haven Camping Resort Swimming Lake	Cape May	HAB Not Present
Branch Brook Park Lake	Essex	Advisory
Almonesson Lake	Gloucester	HAB Not Present
Greenwich Lake	Gloucester	Advisory
Amwell Lake	Hunterdon	HAB Not Present
Quarry Pond	Hunterdon	Advisory
Spruce Run Reservoir	Hunterdon	Watch
Church Pond	Mercer	HAB Not Present
Colonial Lake	Mercer	HAB Not Present
Curliss Lake	Mercer	HAB Not Present
Palmer Lake	Mercer	HAB Not Present
Rosedale Lake	Mercer	Advisory
Smoyer Park Pond	Mercer	HAB Not Present
West Lake Foxmoor	Mercer	Advisory
Farrington Lake	Middlesex	Advisory
Lake Papaianni	Middlesex	Warning
Plainsboro Canal	Middlesex	HAB Not Present
Spring Lake	Middlesex	HAB Not Present
Westons Mill Pond	Middlesex	HAB Not Present

Table 4. 2020 Waterbodies Investigated/ Highest Recorded Alert

Waterbody Name	County	Alert Tier
Manasquan Floodplain near Mill Run	Monmouth	HAB Not Present
Manasquan Reservoir	Monmouth	Advisory
Stone Tavern Lake	Monmouth	HAB Not Present
Sunset Lake - Asbury	Monmouth	Advisory
Swimming River Reservoir	Monmouth	HAB Not Present
Sylvan Lake	Monmouth	Watch
Budd Lake	Morris	Watch
Camp Jefferson Pond	Morris	HAB Not Present
Cozy Lake	Morris	Watch
Kelly Pond	Morris	HAB Not Present
Lake Musconetcong	Morris	Watch
Lake Rogerene	Morris	HAB Not Present
Passaic River - 01382000	Morris	HAB Not Present
Duck pond	Passaic	HAB Not Present
Greenwood Lake	Passaic	Advisory
Haledon Reservoir	Passaic	Advisory
Passaic River - 01389005	Passaic	Advisory
Passaic River - Island Ave	Passaic	HAB Not Present
Pompton Lake	Passaic	Advisory
Pompton River at Pompton Plains	Passaic	HAB Not Present
Ramapo River - Pompton Lakes	Passaic	Advisory
Upper Greenwood Lake	Passaic	HAB Not Present
Alloway Lake	Salem	Watch
Avis Mill Pond	Salem	Advisory
Daretown Lake	Salem	Advisory
East Lake	Salem	Advisory
Memorial Lake	Salem	Watch
Slabtown Lake	Salem	Watch
Millstone River	Somerset	HAB Not Present
Sunset Lake	Somerset	Advisory
Crandon Lake	Sussex	HAB Not Present
Don Bosco Pond Sussex Community College	Sussex	HAB Not Present
Lake Hopatcong	Sussex	Advisory
Lake Neepaulin	Sussex	Watch
Lake Owassa	Sussex	Watch
Swartswood Lake	Sussex	Watch
Lake Surprise	Union	Watch
Delaware Lake	Warren	Advisory
Furnace Lake	Warren	HAB Not Present
Merrill Creek Reservoir	Warren	HAB Not Present
Mountain Lake	Warren	Advisory

Table 4 continued. 2020 Waterbodies Investigated/ Highest Recorded Alert

Data and Alert Levels for all sites sampled can be found on the DEP HAB Interactive Map Reporting and Communication System. Figure 8 shows the distribution of all sites and Alert levels in 2020.

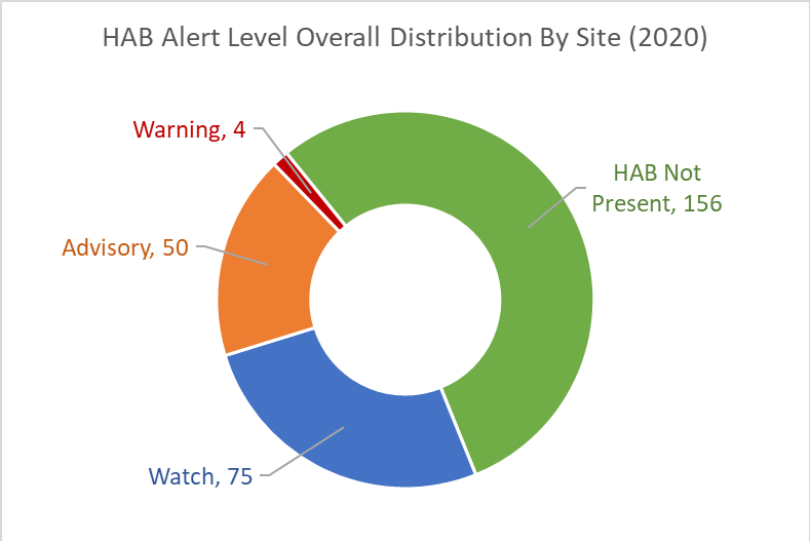


Figure 8. HAB Alert Distribution by Site

Although there was a decrease in waterbodies with beach closures, there was an increase in HABs at drinking water sources (Figure 9).

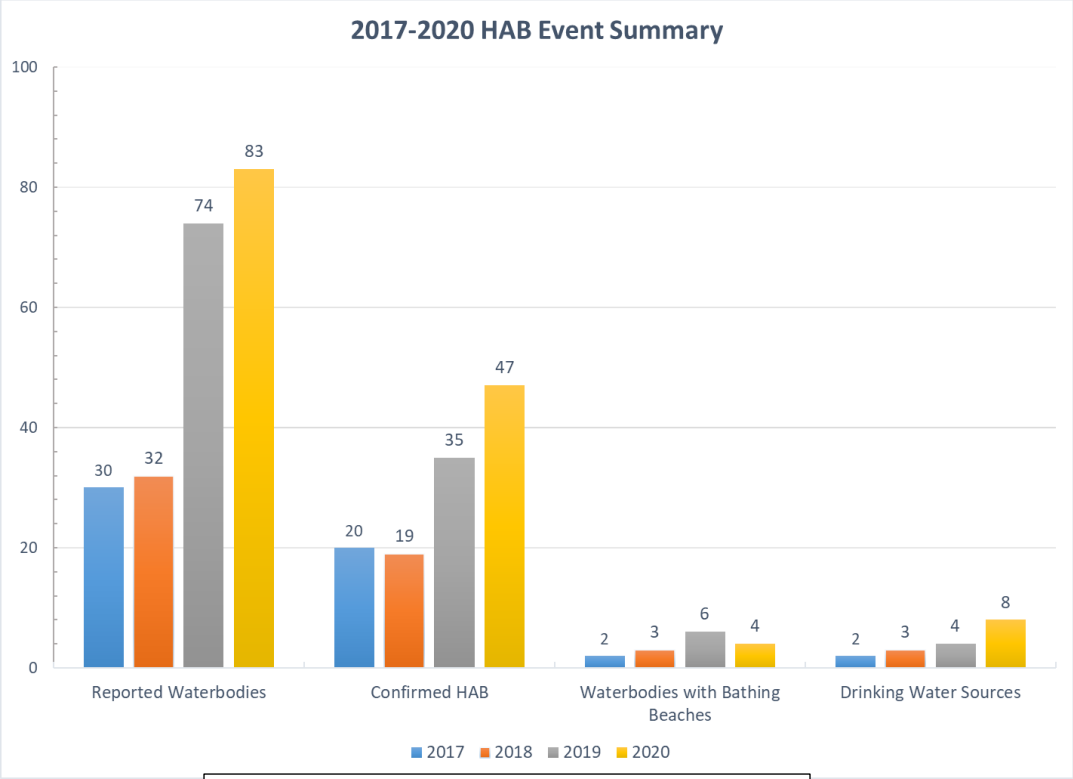


Figure 9. HAB Event Summary by Waterbody

Public Recreational Bathing Beaches (PRB) and Drinking Water Sources

Beaches:

1. Mountain Lake
2. Spruce Run
3. Crescent Cove (Lake Hopatcong)

Drinking Water Sources:

1. Spruce Run
2. Manasquan
3. Lake Tappan/ Hackensack River
4. Farrington Lake
5. Ramapo River/ Pompton Lake
6. Pompton R
7. Passaic R
8. Woodcliff Lake

When a HAB was confirmed at Advisory/ Beach Closure levels at Public Recreational Bathing Beaches (PRB), the NJ Department of Health, Youth Camps/PRB Project Coordinator was immediately notified. The DOH PRB Coordinator then notified the appropriate local authority of the closure Alert and ensured on site notices were posted. BFBM, or with the assistance of local authorities, monitored the status conditions of the HAB at these PRBs. The Strategy protocol recommends monitoring the HAB status at PRBs until conditions dissipate to below Advisory/ Beach Closure levels, at which time samples are collected for laboratory confirmation analysis. Guidance in the Strategy further states that PRB closures should not be lifted until:

- With no phycocyanin field measurements - two (2) subsequent lab analyses were below cell count and toxin thresholds, or
- If phycocyanin measurements were below thresholds for 5 consecutive days, then only one laboratory analysis with cell count and toxin results below thresholds was necessary.

Of the three PRBs listed, all were closed for the recreational season. Crescent Cove Beach was closed on 8/17/2020 and results did not fall below Advisory/ Beach Closure levels until 9/22/20. Although Mountain Lake Beach and Spruce Run Beach may have been opened due to periodic dissipation of the HABs, the operators chose to have the beaches remain closed due to the unpredictability of the HAB occurrence.

When a HAB was confirmed at a Drinking Water sources, the Division of Water Supply & Geoscience was immediately notified. DWSG then informed the appropriate system operators who then sampled their raw and finished water per their specific Cyanotoxin Management Plan.

Laboratory Cell Count and Toxin Results

Excluding the intensive surveys performed in 2019 at Lake Hopatcong and Greenwood Lake (data available at: https://njdep.maps.arcgis.com/apps/webappviewer/index.html?id=561a697f0b594258a4b2e7f2d23e30b7), there was an increase in cell count analysis performed in 2020. The decline in toxin analysis from 2019 was largely due to a focus on response sampling. While developing toxin analysis capacity in previous years, samples were collected for special studies as well as during routine lake sampling. Because routine lake sampling does not target active HABs, results were nearly all non- detect, or very low detection unless a HAB was occurring at the time of sampling. In 2020, toxin sampling at Ambient Lake Monitoring Network sites unless an active HAB was visually observed or measured by field meters. Therefore, the overall toxin analysis was reduced. (Figure 10).

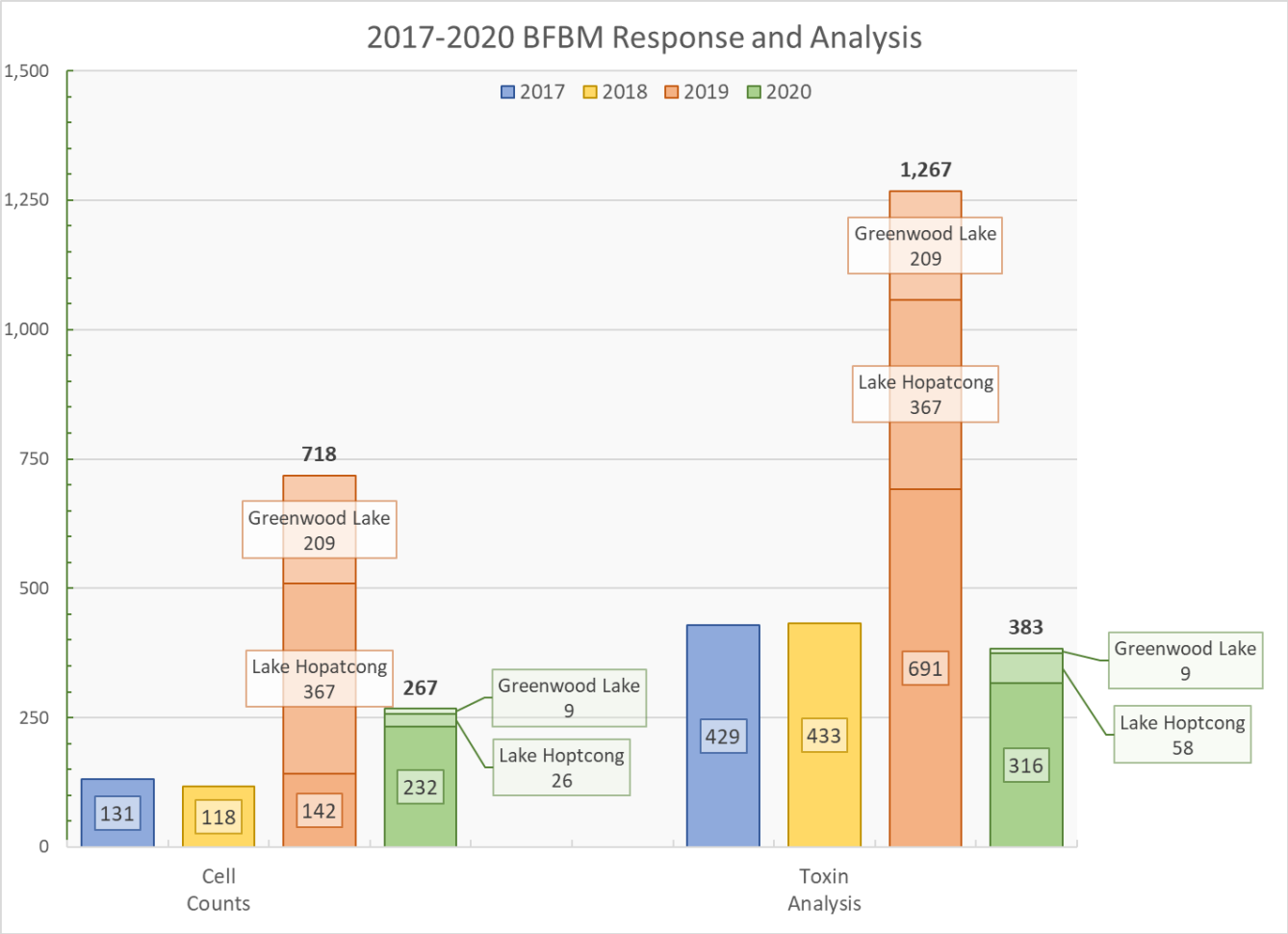


Figure 10. Summary Laboratory Analysis

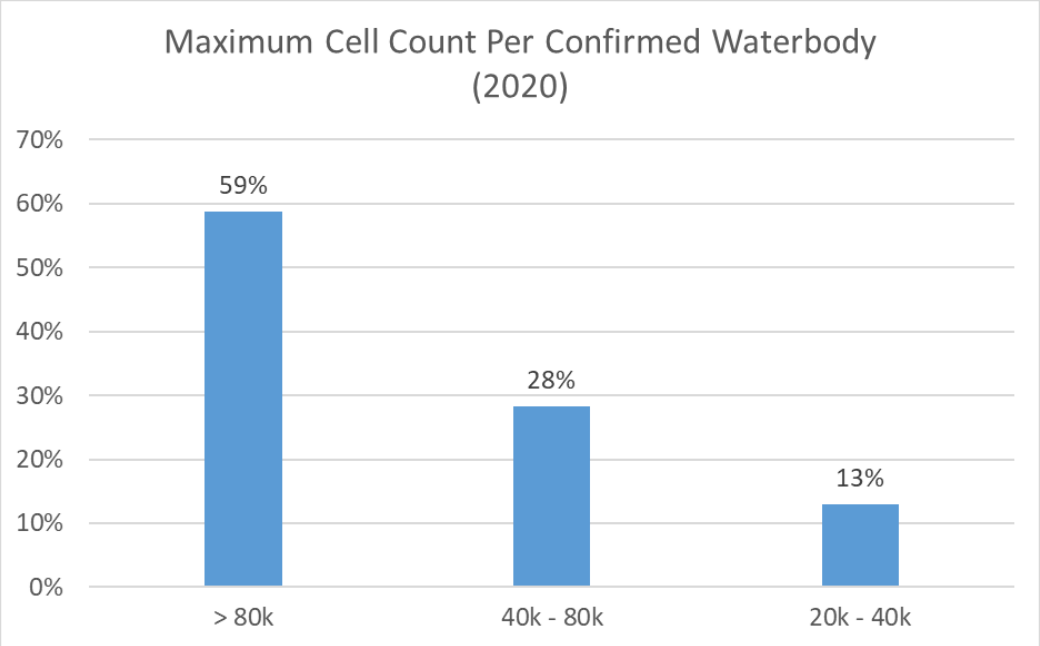


Figure 11. Maximum Cell Count by Waterbody

Figure 11 summarizes the maximum cell count density at any given waterbody investigated during the 2020 season. The majority (59%) of waterbodies with confirmed HABs had a peak cell count greater than 80,000 cells/ml, placing it in the Advisory Alert or higher category. 41% of waterbodies with confirmed HABs had a peak alert in the Watch category between 20,000 and 80,000 cells/ ml. An internal action level of 40,000 to 80,000 cells/ ml initiates additional monitoring at bathing beaches only. This to ensure the levels do not exceed the bathing beach closure threshold of 80,000 cells/ ml and the proper Alert level is in place to protect bathers.

The highest recorded cell concentration, 7,000,000 cells/ml, was at Lake Papaianni, Middlesex County. This lake also recorded the highest microcystin toxin result (Figure 12) of 729.2 µg/L.

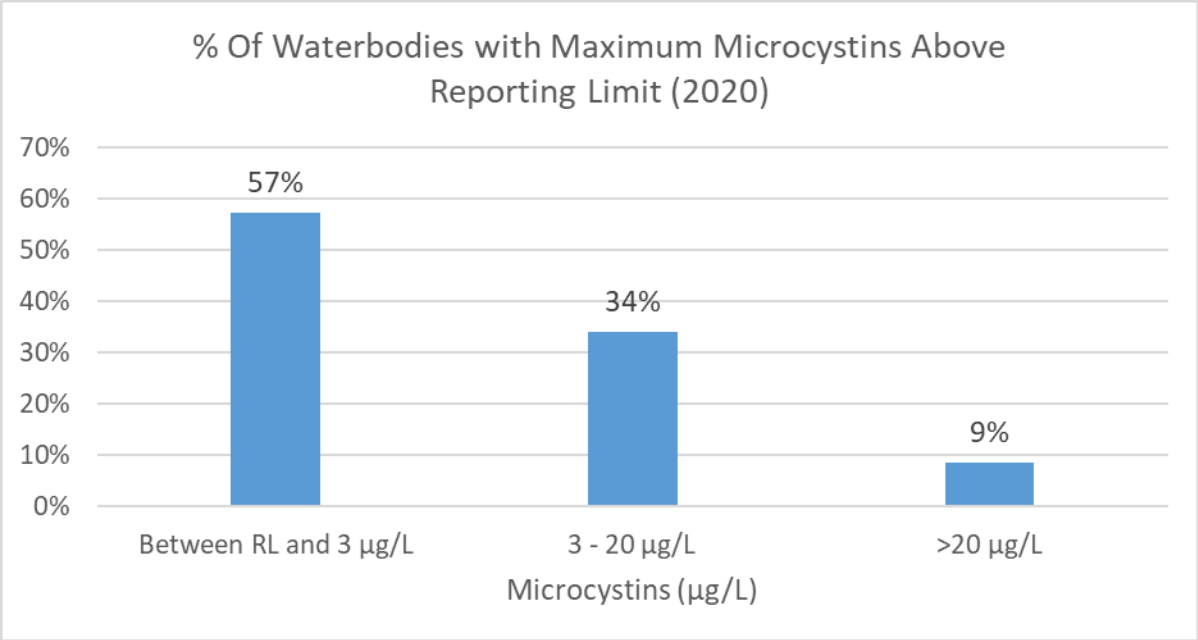


Figure 12. Maximum Toxin Level by Waterbody

The majority of peak microcystin concentration at waterbodies with confirmed HABs, 57%, were between the analysis Reporting Level (RL) of 0.15 µg/L and the Advisory Alert threshold of 3.0 µg/L. 34% were in the Advisory Alert category and only 9% in the Warning Alert category.

Table 5 lists the waterbodies with the highest microcystins and cell count concentrations.

Waterbody	Highest Microcystins (µg/L)	Highest Cell Count (cells/ml)	Date
Papaianni Lake	729.2	7000000	9/15/2020
Hopkins Pond	69.95	68000	7/29/2020
Driscoll Pond	35.7	58750	7/29/2020
Ramapo River	17.05	1500000	9/13/2020
Delaware Lake	10.4	123500	7/29/2020
Burlington Island Pond	6.99	44000	8/2/2020
Greenwich Lake	5.29	473000	7/28/2020
Farrington Lake	5.29	158750	9/28/2020
Greenwood Lake	4.76	100500	7/27/2020
Spruce Run Reservoir	4.29	150000	11/9/2020
Pompton Lake	3.36	675000	9/1/2020

Table 5. Maximum Toxin and Cell Count by Waterbody

Supporting Programs

As part of HAB response and monitoring, BFBM partners with several DEP and external partners. DEP's Division of Water Compliance and Enforcement provided assistance in response screening and sampling. In addition, C&E have provided the use of their boat and staff for sampling at Lake Hopatcong.

The State Park Service is also a significant partner providing assistance with response screening and sampling as well as posting Alerts when needed and monitoring the daily status of Park waterbodies.

NJ Forest Fire Service perform flight (Figure 13) surveillance at several larger Northern NJ lakes of concern. Visual observations are recorded as well as remote sensing of phycocyanin pigment. DWMS Bureau of Marine Water Monitoring developed a customized algorithm that can reliably detect and estimate phycocyanin concentrations in freshwaters through wave length reflectance signatures. These measurements are not used as a replacement for confirmation analysis, but as a screening and status monitoring tool to detect relative increases and decreases in phycocyanin pigment concentrations. When levels change significantly, sampling staff are deployed for confirmation laboratory analysis.

Figure 13. Forest Fire Service

Flights were performed once per week during the recreational season at the following lakes (weather permitting):

Lake Hopatcong, Greenwood Lake, Musconetcong Lake, Budd Lake, Spruce Run, Lake Mohawk, Swartswood Lake, and Round Valley Reservoir (non-HAB control lake). Other lakes were added as needed. Figure 14 shows examples of the flight data recorded.

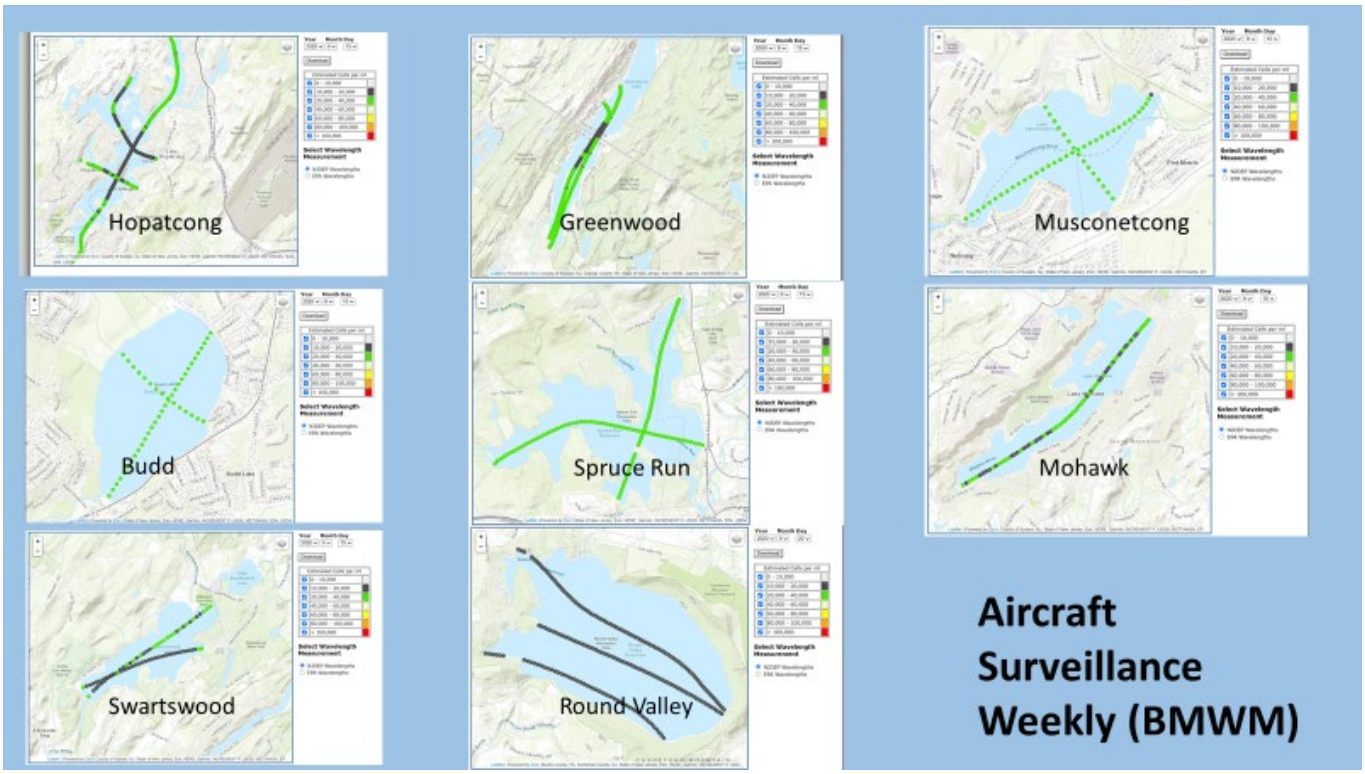
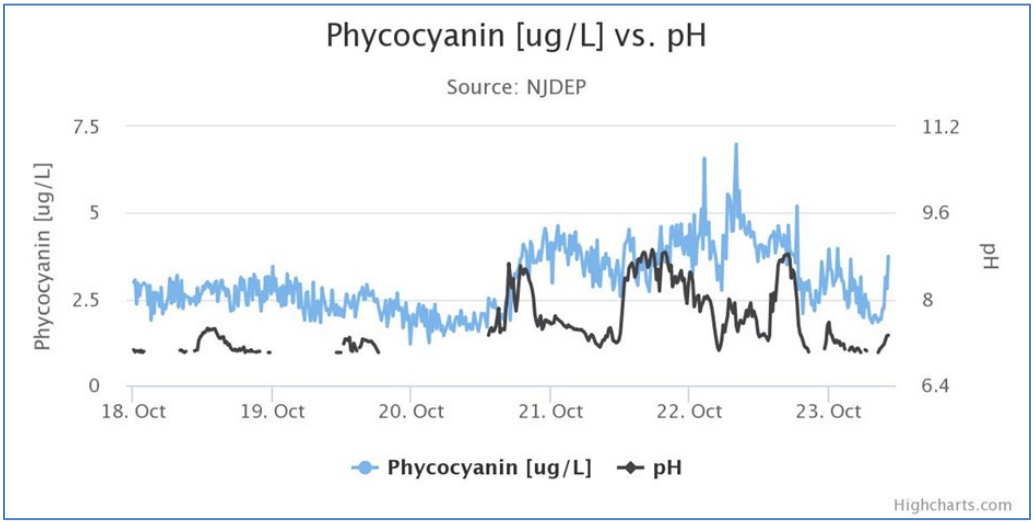


Figure 14. Examples of Fight Data

The Bureau of Marine Water Monitoring has also assisted in deploying continuous monitoring meters with buoy technology at Manasquan Reservoir and Lake Hopatcong. The buoy at Lake Hopatcong was damaged and removed early in the season. These meters also measure other water quality parameters: temperature, dissolved oxygen, and pH. As with other phycocyanin measurements previously mentioned, this data is used for screening and status monitoring. In addition, water quality data may be used to assess factors that may contribute to or characterize HAB production. Data can be downloaded in real time **NJDEP DWM&S Continuous Data Monitoring Program** website. Figure 15 shows an example of a downloadable graph comparing phycocyanin and pH at Manasquan Reservoir.



Cells per ml	Meter
20000	1.15
40000	1.87
80000	3.29
100000	4.00

Figure 15. Example Real Time Continuous Data Download

An additional 10 buoy systems have been purchased with expected deployment for the 2021 season.

A field phycocyanin meter loan program was implemented in 2020. These meters were loaned to various partners both internally and externally:

- 3 Parks Regions and Spruce Run. (Spruce Run Park staff also coordinated with the NJ Water Supply Authority to collect field measurements and samples for BFBM lab analysis)
- 9 provided to BFBM by EPA and loaned to:
    - DEP Northern C&E
    - Greenwood lake (Parks)
    - Sussex Co HD
    - Monmouth Co HD
    - Salem Co HD
    - Burlington Co HD
    - Mercer Co Park Commission
    - Watershed Institute (2)

A NJ Contract Vendor has been identified and a purchase order is in progress for 17 more. These partners played a significant role in screening, status monitoring, and sampling. Partners contributed to approximately 20% of all samples collected for lab analysis.

Conclusions

In 2020 there was a 11% increase in reports of suspected HABs. Although there was a slight increase in these reports, the number of waterbodies with confirmed HABs (Watch Alert or above) rose significantly by 26%. In addition, 54% of waterbodies with confirmed HABs in 2020, had confirmed HABs in a previous year since HAB response was initiated in 2017 (Table 6). This indicates that the statewide occurrence of HABs in New Jersey is not only increasing but recurring in many waterbodies.

2020 Confirmed HAB Waterbodies with Previous HABs	
Waterbody Name	**County**
Amico Island Pond	Burlington
Lake Sarah - Birchfield	Burlington
Pemberton Lake	Burlington
Smithville Lake	Burlington
Dramasei Park Lake	Camden
Hopkins Pond	Camden
Branch Brook Park Lake	Essex
Amwell Lake	Hunterdon
Spruce Run Reservoir	Hunterdon
Colonial Lake	Mercer
Rosedale Lake	Mercer
Lake Papaianni	Middlesex
Manasquan Reservoir	Monmouth
Sunset Lake - Asbury	Monmouth
Budd Lake	Morris
Lake Rogerene	Morris
Greenwood Lake	Passaic
Avis Mill Pond	Salem
Daretown Lake	Salem
East Lake	Salem
Memorial Lake	Salem
Slabtown Lake	Salem
Lake Hopatcong	Sussex
Lake Owassa	Sussex
Swartswood Lake	Sussex
Mountain Lake	Warren

Table 6. 2020 Confirmed HAB Waterbodies with Previous HABs

Further evidence of increased HAB activity is the persistence of blooms into the winter. Sampling and confirmation analysis for 2020 was completed in mid-December. As of December 22, 2020 there were 15 waterbodies with at least one site with a HAB Alert level of Watch or above (Table7). This is a 47% increase from 2019 when only 8 waterbodies had HABs continuing past December. A Winter Watch Alert was posted for the 2020/2021 winter season at these waterbodies.

2020 HABs Not Dissipated by End of Year	
Waterbody Name	**County**
Hackensack River	Bergen
Tappan Lake	Bergen
Pemberton Lake	Burlington
Kirkwood Lake	Camden
Branch Brook Park Lake	Essex
Spruce Run Reservoir	Hunterdon
Sunset Lake	Monmouth
Sylvan Lake	Monmouth
Budd Lake	Morris
Cozy Lake	Morris
Lake Musconetcong	Morris
Slabtown Lake	Salem
Neepaulin Lake	Sussex
Lake Hopatcong	Sussex/Morris
Mountain Lake	Warren

Table 7. 2020 HABs Not Dissipated by End of Year

The USEPA states (https://www.epa.gov/cyanohabs/causes-cyanohabs): “There is widespread agreement within the scientific community that the incidence of HABs is increasing both in the U.S. and worldwide. This recent increase in the occurrence of HABs has been attributed to increasing anthropogenic activities and their interaction with factors known to contribute to the growth of cyanobacterial blooms. Point sources (which may include discharges from municipal and industrial wastewater treatment plants, concentrated animal feeding operations (CAFOs), Municipal Separate Storm Sewer Systems (MS4s), stormwater associated with industrial activity, and other and non-point sources (which may include diffuse runoff from agricultural fields, roads and stormwater), may be high in nitrogen and phosphorus and can promote or cause excessive fertilization (eutrophication) of both flowing and non-flowing waters.”

The expansion of the continuous buoy network will provide valuable data at waterbodies where HABs have reoccurred. In addition to informing immediate HAB response actions, continuous data will be used by DEP to research water quality factors that may predict or contribute to HAB formation.

In addition, The Division of Water Monitoring and Standards (DWMS) and the New Jersey Sea Grant Consortium (NJSGC) has recruited a team of lakes management and cyanobacterial HAB experts to address the second component of the Governor's HAB initiative focusing on enhancing scientific expertise and building the state's capacity for HAB response. The HAB Expert Team's primary objective is to provide guidance to DEP on HAB prevention, mitigation and management for NJ lakes and other waterbodies. The team will complete a comprehensive literature review on the prevention and treatment of HABs, review HAB and water quality data, and develop guidance documents for lake management in New Jersey. Guidance documents will include best management practices (BMPs) for the prevention and management of HABs to be used by NJ lake managers.

The team will also provide technical advice and reviews on proposed mitigation technologies for NJ lakes and review the progress of DEP-funded HAB mitigation grant projects. Additionally, the team will develop a HAB lake management training program for DEP staff and interested stakeholders and conduct a minimum of three one-day training workshops at various locations in the state.