2024 Cyanobacteria Monitoring Report for Town of Eastham, Massachusetts

December 18, 2024

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1. SUMMARY

In 2024, the Association to Preserve Cape Cod (APCC) continued cyanobacteria monitoring in Eastham for the Town of Eastham, following similar monitoring conducted in 2020 through 2023. From June 6 through November 7, 2024, APCC conducted biweekly sampling at eight sampling locations: (see Appendix 4 for sampling locations). APCC conducted 94 sampling events and collected a total of 94 samples and analyzed samples for cyanobacteria composition and phycocyanin, a cyanobacteria pigment that provides a measure of cyanobacteria biomass. APCC also collected a water sample at each sampling event that was preserved for later analysis of cyanobacteria toxin if needed (see below). APCC utilizes a three-level risk characterization system known as "Risk Categories" to describe the results of cyanobacteria monitoring in terms of low, moderate, and high potential risks to human health and pets exposed to harmful cyanobacteria blooms (HCBs). The three Risk Categories are: "Acceptable" (low risk for humans and pets), "Potential for Concern" (moderate risk for humans and pets), and "Use Restriction Warranted" (high risk for humans and pets).

During the 2024 monitoring season, cyanobacteria levels in the eight ponds monitored by APCC did not reach either APCC's "Potential for Concern" Risk Category or the higher "Use Restriction Warranted" Category at any time during the monitoring season.

In 2022, APCC partnered with the Barnstable County Department of Health and the Environment Water Quality Lab (County Lab) to incorporate complementary testing for one cyanobacteria toxin (microcystin). The County Lab is a state-certified laboratory that has the capability to analyze samples for microcystin utilizing an EPA-approved analytical protocol. Toxin testing for microcystin continued this year following the process described here. If APCC identified a sample as at-risk for an exceedance of the Massachusetts Department of Public Health (MDPH) guideline for microcystin in recreational waters of 8 parts per billion (ppb), the duplicate sample was sent to the County Lab for testing of microcystin. This year the County Lab conducted testing for microcystin and then communicated test results in terms of the state limit to APCC and the town health department.

During the 2024 monitoring season APCC did not send any water samples, collected for the Town of Eastham, to the county lab for testing for microcystin because all the samples were found to be in the Acceptable risk tier or with mixed taxa with low biomass.

This year APCC partnered with the County Lab to conduct a pilot study to document and understand the presence of anatoxin-a in the Cape's freshwater ponds. APCC also did not send samples, collected for the Town of Eastham, to county lab because all ponds were found to be in the Acceptable risk tier or with mixed taxa with low biomass.

APCC shared all monitoring results with the Town of Eastham and the public throughout the season via emailed updates, e-newsletters, frequent updates to our online map at https://apcc.org/our-work/science/community-science/cyanobacteria/, and written reports, including this report. This report should be printed in color, as some sections are color-coded.

2. BACKGROUND

APCC's Cyanobacteria Monitoring Program partners with officials at the town, county, state, and federal levels as well as local pond associations and residents to conduct cyanobacteria monitoring in select Cape Cod ponds. Each season, water samples are collected biweekly for monitoring of cyanobacteria and the results are shared with local officials and the general public through reports, emails, and an interactive map of monitoring results provided on our website (https://apcc.org/cyano). Our goals are to raise public awareness of the health and ecological risks posed by harmful cyanobacteria blooms (HCBs), to collect scientific monitoring data to help inform proper responses to cyanobacteria blooms to protect public health, to monitor priority ponds across the Cape, and to motivate public action to address the causes of HCBs by improving water quality.

Cyanobacteria are an ancient group of photosynthetic microorganisms common in freshwater systems on Cape Cod, in the U.S., and worldwide. Under the right conditions, they can multiply rapidly and form harmful cyanobacteria blooms (HCBs). According to the Centers for Disease Control and Prevention (CDC), certain common cyanobacteria genera can produce toxins known as cyanotoxins that can be harmful to humans (https://www.cdc.gov/harmful-algal-blooms/about/?CDC_AAref_Val=https://www.cdc.gov/habs/general.html). HCBs have increased worldwide, including in the U.S., due to nutrient enrichment and rising water temperatures due to climate change. As the occurrence of HCBs increases, so too has the need for cyanobacteria monitoring and awareness of potential health risks increased. Additional resources on cyanobacteria are provided in Appendix 1.

Cape Cod ponds are commonly used for recreation, including swimming, boating, paddle boarding, fishing, as well as for dog walking and swimming. Due to the increasing prevalence of HCBs and the resulting increased threat of public exposure to cyanobacteria and their toxins, MDPH provides guidelines for municipal officials to post and remove advisories at ponds based on established thresholds for cyanobacteria risks (https://www.mass.gov/info-details/guidelines-for-cyanobacteria-at-recreational-freshwater-locations) in recreational waters. Frequent cyanobacteria monitoring of ponds provides fact-based data for resource managers to track

cyanobacteria trends in their ponds throughout the season, apply relevant public health criteria, and proactively post and remove recreational advisories. Cyanobacteria monitoring data also provides information on pond health and water quality and helps to address data gaps caused by lack of conventional pond water quality monitoring data.

3. METHODS

Overview

APCC's Cyanobacteria Monitoring Program provides scientifically sound data on cyanobacteria community composition, biomass, and estimated toxin concentrations. Our monitoring program follows a Quality Assurance Project Plan (QAPP) for our Cape Cod Cyanobacteria Monitoring Program (Cape Cod Cyanobacteria Monitoring Program (CCCMP) QAPP 2024-2029), approved by EPA and DEP this year. The APCC QAPP is based on the EPA-approved Quality Assurance Project Plan (CMC QAPP) for cyanobacteria monitoring, developed by EPA for the Cyanobacteria Monitoring Collaborative. The CMC QAPP was developed by EPA Region 1 scientists, including Hillary Snook and others, with the goal of encouraging and facilitating widespread monitoring of cyanobacteria. The QAPP is based on methods created by EPA scientists and other cyanobacteria specialists, including Dr. James Haney at the University of New Hampshire Center for Freshwater Biology and Nancy Leland of Lim-Tex, Inc. The method involves taking concentrated samples of "Bloom Forming Colonies" (BFCs) of cyanobacteria from the pond using a 3-meter student plankton net tow and unconcentrated samples of "Whole Lake Water" (WLW) using a 1-meter integrated tube. Samples are first examined for cyanobacteria composition using microscopy. Cyanobacteria composition is important to document because toxicity varies according to cyanobacteria genus. Samples are then analyzed for phycocyanin concentrations using fluorometry. Phycocyanin is an algal pigment produced by cyanobacteria, different and distinct from chlorophyll, which is produced by algae and plants. Phycocyanin concentrations provide a measure of cyanobacteria biovolume and abundance. The combination of information on composition (obtained through microscopy) and information on cyanobacteria pigment concentrations enables an estimation of risk posed by cyanobacteria at the time of monitoring.

APCC also utilizes the CyanoCasting method developed by Nancy Leland (http://lim-tex.com/wp-content/uploads/2018/05/CyanoCasting_Handbook_v18.pdf), which builds on the methods described in the QAPP by including metrics that allow for the forecasting of potential imminent cyanobacteria blooms and estimates of cyanotoxin (i.e., microcystin) concentrations. The forecasting ability of this method provides valuable advance warnings of potential HCBs to inform proactive responses, such as increased sampling frequency or precautionary advisories of ponds to warn the public of the potential for cyanobacteria blooms. The ability to anticipate potential HCBs and estimate their microcystin concentrations based on frequent monitoring is a unique and valuable feature of APCC's program and stands in contrast to reactive responses involving measurement of cyanobacteria concentrations after a bloom has occurred (https://www.scirp.org/journal/PaperInformation?paperID=86671&, https://www.scirp.org/journal/paperinformation?paperid=93424).

In 2024, APCC decided to use the same methodology developed by Nancy Leland to develop a new regression equation to predict microcystin concentrations using APCC's phycocyanin and microcystin data collected in 2022 and 2023. This includes all phycocyanin and microcystin measurements from all ponds monitored by APCC for cyanobacteria, i.e., the data were collected from various ponds located in all 15 towns on Cape Cod. Two regression formulas were developed, one to predict microcystin concentrations for cyanobacteria blooms that are strongly dominated by the genus *Microcystis* (i.e., at least 98% *Microcystis* dominant) and a second regression formula for cyanobacteria blooms that are less strongly dominated by *Microcystis* (i.e., 70%-98% *Microcystis* dominant).

As a complement to APCC's established monitoring program, the County Lab provides cyanobacteria toxin testing to provide local officials with measurements of microcystin toxin from ponds pre-screened by APCC as potentially containing cyanobacteria toxin levels of concern based on monitoring results. Microcystin is one type of cyanobacteria toxin and the only toxin for which MDPH provides guidelines in recreational waters. This is the third year that the County Lab has provided this valuable service. The screening process was as follows: At each cyanobacteria sampling event, APCC collected separate water samples for toxin analysis if needed. APCC then analyzed cyanobacteria as described above and used the results to screen samples. If samples had cyanobacteria results (i.e., risk categories) that indicated a possibility of an exceedance of MDPH microcystin guidelines (i.e., 8 ppb for recreational waters), APCC sent the separate water samples to the County Lab to conduct confirmatory toxin testing of microcystin. Toxin test results were then compared with the MDPH guideline of 8 ppb and the results were used to determine whether an advisory was warranted. If so, APCC provided a recommendation to the local health official to post an advisory. Local health officials are responsible for deciding whether to post advisories and often rely on consultation with MDPH. To assist with decision-making, APCC conducted follow-up monitoring that included information on when cyanobacteria levels decreased to the point where an advisory, if posted, could be lifted.

As of May 2024, the Barnstable County Lab has the capacity to test for the cyanotoxin anatoxin-a on a monthly basis. Anatoxin-a is a potent neurotoxin commonly produced by *Dolichospermum*, one of the dominant cyanobacteria species found on Cape Cod. Due to the significant presence of *Dolichospermum* in Cape Cod freshwater ponds, anatoxin-a may be a public health concern. While there is no federal or state guidance on anatoxin-a concentration thresholds for public health in recreational waters currently, it can have health impacts on humans and pets according to the EPA (https://www.epa.gov/habs/what-are-effects-habs). To address this concern, APCC conducted a pilot study to gain preliminary information on the extent and occurrence of anatoxin-a in order to inform future planning, monitoring, and development of appropriate response. For this pilot study, when APCC determines that a pond has a *Dolichospermum* spp. dominant cyanobacteria bloom of sufficient density that indicates a cause for concern, APCC staff will collect and send water samples to be analyzed by the Barnstable County Laboratory. All participants in this pilot study have agreed to the protocols used to govern when sampling will occur and how the data will be handled and communicated to the public (https://apcc.org/wp-content/uploads/2024/06/APCC-Anatoxin-a-Pilot-Study-2024.pdf). Due to the exploratory nature of this study, the samples will be analyzed by the Barnstable County Lab on a monthly basis and the pond will be marked as yellow "Potential for

Concern" on the APCC map. APCC hopes that the data and results will be used to inform public health decisions in the future and keep our community safe.

Sampling Locations
Samples were collected for the Town of Eastham at the locations shown in Figure 1.

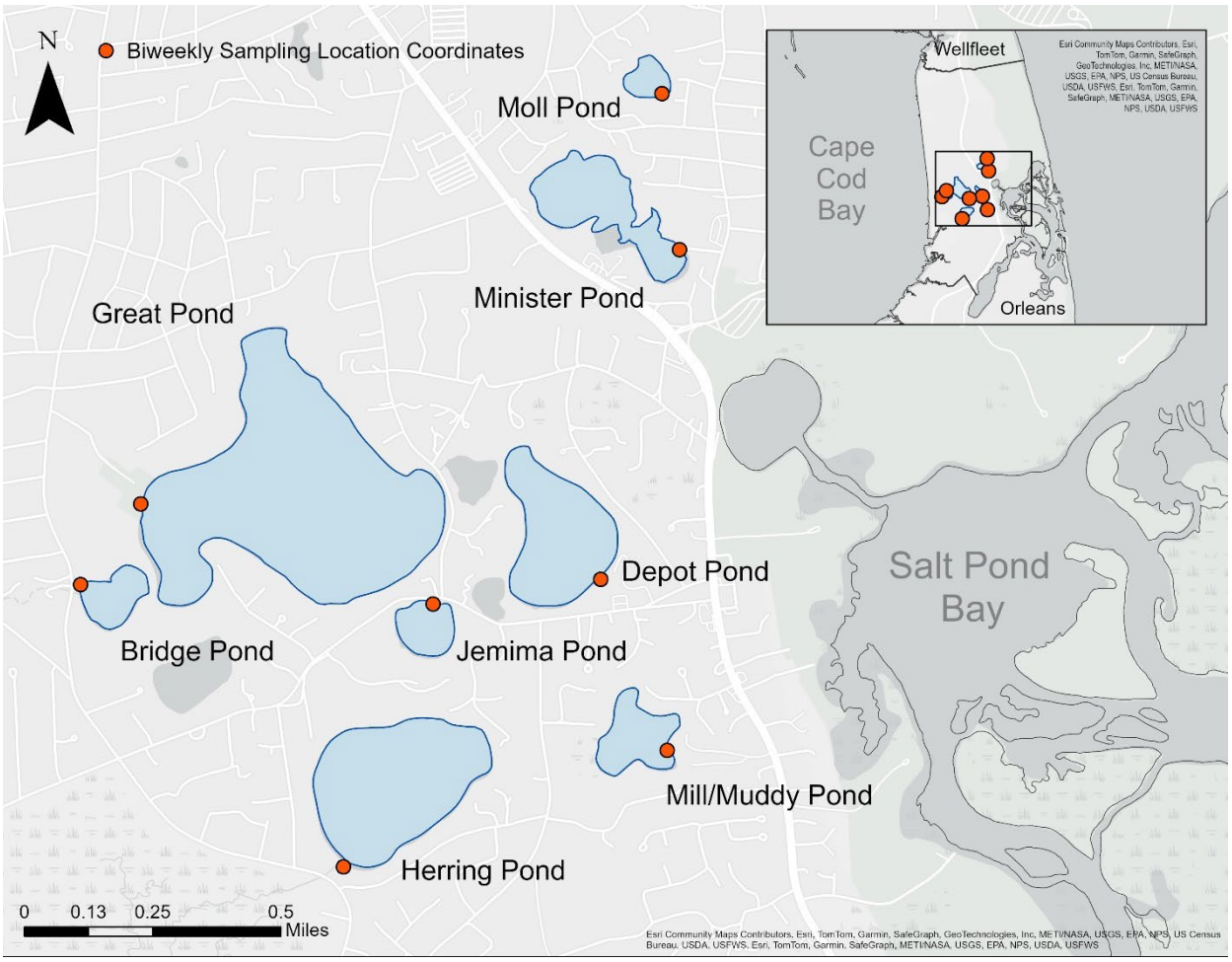

Figure 1. Sampling Locations for Town of Eastham in 2024.

Water Sampling

Between June 6, 2024, and November 7, 2024, APCC conducted 12 biweekly sampling events at each location, with one exception at Moll Pond (due to technicians not finding the sampling location on June 6 and September 12, 2024) for a total of 94 sampling events. The types of samples collected are described below.

Whole Lake Water (WLW) Sample

The pond water sample that is collected using the 1-meter tube is called the Whole Lake Water (WLW) sample. This is an unconcentrated water sample containing cyanobacteria from the full

extent of the 1-meter sampling depth from the pond surface to just above the bottom near shore. This sample is processed by APCC staff to obtain data on cyanobacteria size fractions in the water column. This process is further explained in the "Lab Analysis" section. This sample is not used to forecast future bloom accumulations, as it contains cyanobacteria currently in the water column near shore.

Bloom Forming Colonies (BFC) Sample

The second sample, which is collected near the pond surface using the student plankton net, is called the NET Sample or Bloom Forming Colonies (BFC) sample. This is a concentrated sample of cyanobacteria and algae obtained by towing the student plankton net across a 3-meter cast near the surface. This sample contains larger cyanobacteria colonies, which tend to form visible blooms and scums. This sample creates an artificial cyanobacteria accumulation similar to a natural cyanobacteria accumulation that may occur on a pond if the wind condensed cyanobacteria over a distance of three meters into a potentially harmful accumulation near shore. Nearshore accumulations of cyanobacteria are considered to pose a higher risk because this is where children and pets typically interact with the pond.

The concentrations of cyanobacteria in BFC samples can fluctuate dramatically, and sudden and steady increases of cyanobacteria concentrations in BFC samples can foreshadow cyanobacteria bloom formations in the near future. Understanding the toxin concentrations of this sample can also provide information on the likelihood of a future microcystin exceedance. This concept is discussed in more detail below.

Microcystin Toxin Sample

The third sample is a simple grab of pond water collected using a 125-milliliter (mL) amber glass bottle with a PTFE-lined cap. This sample is called the microcystin toxin sample. When APCC's metrics using cyanobacteria composition and concentration indicate a likelihood that microcystin concentrations may exceed 8 ppb, APCC delivers this sample to the County Lab for analysis of microcystin.

Cyanobacteria Scum Sample

The fourth sample, taken only when a scum is observed at the time of sampling, is called the scum sample and may contain cyanobacteria bloom material. Although visual evidence alone of potential cyanobacteria bloom material can be compelling, microscope and fluorometry analysis of the material is needed to confirm whether the material is indeed a cyanobacteria bloom rather than an accumulation of other algae, diatoms, etc. Microscope analysis of the bloom material also provides information on the genus of cyanobacteria making up the bloom, providing an understanding of the types of toxins that may be present. For example, the cyanobacteria genus *Microcystis* is known to produce microcystin that is a liver toxin, while the genus *Dolichospermum* is known to produce a different toxin called anatoxin, a neurotoxin of concern for which there is not yet an MDPH standard.

Field Observations

APCC staff documented field conditions at each sampling event by completing field data sheets with information on weather, visual appearance of pond surface, water temperature, etc. Photographs were taken of the pond's shoreline at each sampling event, providing documentation of pond appearance and visible conditions and evidence of bloom accumulations.

Lab Analysis

Sample processing

Samples collected by APCC staff or volunteers are returned to the APCC lab the same morning for processing. Excess samples collected in the 500 ml amber HDPE bottles are properly disposed of, and the bottles rinsed with potable water and reused. Once fluorometer measurements have been completed, the samples are dumped or refrozen for a future application.

"Whole Lake Water" (WLW)

The WLW sample may be processed immediately after arrival at the lab and is only prepared for fluorometry, as it is not used for microscopy. The sample is split into two sub-samples, a WLW sample that reflects the entire sample and a <50 µm sample to study picophytoplankton presence in the pond. The WLW sample is taken from the original sample bottle and transferred into three black 5 ml micro vials using a 5 ml pipette, creating triplicate samples for fluorometry analysis. The WLW vials are frozen for at least two hours until analysis. The <50 µm sample is taken from the original sample bottle and filtered through a <50 µm filter into a clean cup. From the cup they are transferred into three black 5 ml micro vials using a 5 ml pipette, creating triplicate samples for fluorometry analysis. The <50 µm sample vials are frozen for at least two hours until analysis.

"Bloom Forming Colonies" (BFC) from the NET sample

The BFC sample is used for species ID during microscopy and for fluorometry analysis to predict potential toxicity of a bloom. The sample must be kept in a refrigerated dark space for at least two hours before being transferred into ZAPPR's (plankton separators) to "dark acclimate" to allow the cyanobacteria to respire and float to the surface once in the ZAPPR. When the sample has been refrigerated for at least two hours, it is decanted into four ZAPPR's. The sample needs to stay in the ZAPPR for 30 minutes, to give the cyanobacteria time to float to the dark top and the zooplankton time to move towards the light at the bottom. After 30 minutes, the first ZAPPR is opened, and a pipette is used to transfer the cyanobacteria that may have accumulated near the surface water in the ZAPPR into a black 5 ml micro vial. This is repeated for three of the four ZAPPR's, resulting in three black 5 ml micro vials, creating triplicates for fluorometry analysis. The vials are frozen for at least two hours until analysis. A drop of water with the cyanobacteria that may have accumulated in the surface water of the fourth ZAPPR are transferred to a gridded microscope slide and immediately analyzed under a microscope.

Microcystin

A microcystin sample is collected during every sampling event by submerging the 125 ml wide-mouth amber glass bottle in the water. It is stored in a cooler and frozen upon arrival at the APCC lab, according to MDPH and U.S. EPA protocols (https://www.mass.gov/doc/beach-

testing-guidelines-for-boards-of-health-and-beach-operators/download, https://www.epa.gov/sites/default/files/2016-09/documents/method-546-determination-total-microcystins-nodularins-drinking-water-ambient-water-adda-enzyme-linked-immunosorbent-assay.pdf) until transfer to the Barnstable County laboratory for analysis if photos, bacterial growth rates and phycocyanin to microcystin regression indicate high microcystin values (> 4 microgram per Liter (µg/L)).

Scum (If applicable)

If a scum is present and a scum sample has been collected, it is refrigerated until analysis. To prepare the sample for analysis a drop of sample water is collected with a pipette and transferred to a gridded microscope slide and immediately analyzed under a microscope.

Microscopy

Using light microscopy, APCC staff and interns counted colonies of cyanobacteria from a 1 mL sample from the BFC sample, counting up to 100 colonies per mL. The information was used to estimate dominance of different cyanobacteria genera. If one genus was found to be the "dominant genus" (defined as 70% of the cyanobacteria community on the slide), then APCC targeted the toxins produced by that genus of cyanobacteria as the toxins of concern for that pond at that time. In APCC's monitoring program, the only toxin that is considered is microcystin. Cyanobacteria produce other toxins, but at present, this toxin is the only one for which there are state guidelines and the ability to analyze at the County Lab. If a scum sample was taken, APCC also analyzed it under the microscope to inspect genus composition and to confirm whether the scum was indeed composed of cyanobacteria.

Fluorometry to measure phycocyanin pigments

Each triplicate 5 mL sample was frozen and thawed for the purpose of lysing cells to liberate cyanobacteria pigments. Samples were then analyzed for cyanobacteria pigments (phycocyanin) and non-cyanobacteria algal pigments (chlorophyll-a) using a calibrated fluorometer in parts per billion (ppb). APCC uses phycocyanin concentrations as a quantitative indicator of cyanobacteria biomass rather than cell counts. Phycocyanin concentrations are expressed in units of micrograms per liter (ug/L). Understanding cyanobacteria biomass using fluorometry allows APCC to track cyanobacteria community trends over time. All data were stored on APCC's online server.

Microcystin testing by County Lab

At each sampling event, APCC collected extra samples for analysis of microcystin if cyanobacteria risk levels were in the "Use Restriction Warranted" category. To ensure that samples for toxin testing were collected on the same date, time, and place as samples for cyanobacteria monitoring, APCC collected grab samples for toxin analysis at the same time and location as our samples for cyanobacteria analyses. Samples for toxin analyses were collected and preserved according to MDPH and EPA protocols (https://www.mass.gov/doc/beach-testing-guidelines-for-boards-of-health-and-beach-operators/download, https://www.epa.gov/sites/default/files/2016-09/documents/method-546-determination-total-

microcystins-nodularins-drinking-water-ambient-water-adda-enzyme-linked-immunosorbent-assay.pdf). If APCC's cyanobacteria data indicated the likelihood of an exceedance of the 8 ppb microcystin guideline occurring, the corresponding GRAB sample(s) were sent to the County Lab for toxin analysis. The County Lab then analyzed the sample for microcystin and then forwarded toxin test results and recommendations of a recreational advisory, when warranted, to local officials and APCC. Toxin testing results supplemented and complemented APCC's cyanobacteria monitoring data. The simultaneous collection of samples for cyanobacteria and cyanotoxins helped to ensure that cyanotoxin analyses (if warranted) correspond to cyanobacteria monitoring data in terms of time and place. This proactive sampling approach avoids a common pitfall of reactive sampling that can occur when cyanobacteria monitoring data are collected on one date and confirmatory samples are collected several days to a week later when conditions may have changed.

Interpretation of Results

APCC staff interpreted the results within a cyanobacteria risk guidance framework that incorporates the most recent scientific information as well as existing state and federal guidance (https://www.epa.gov/habs/protecting-human-health-cyanotoxin-exposure-during-recreation, https://www.mass.gov/info-details/guidelines-for-cyanobacteria-at-recreational-freshwater-locations).

Massachusetts Department of Public Health (MDPH) Guidelines for Cyanobacteria

The MDPH cyanobacteria webpage provides guidelines for cyanobacteria in recreational freshwater bodies that are described in italics as follows ("Guidelines for Cyanobacteria at Recreational Freshwater Locations") (https://www.mass.gov/info-details/guidelines-for-cyanobacteria-at-recreational-freshwater-locations).

[Issuing a Public Health Advisory]
"DPH recommends issuing a public health advisory for HABs at recreational freshwater locations when at least one of the following criteria is met:

1. ***A visible cyanobacteria scum or mat is evident.***
2. ***Total cell count of cyanobacteria exceeds 70,000 cells/mL.***
3. ***Concentration of the toxin microcystins exceeds 8 µg/L (8 ppb); or***
4. ***Concentration of the toxin cylindrospermopsin exceeds 15 µg/L (15 ppb)***

Guideline values are based on U.S. Environmental Protection Agency (https://www.epa.gov/sites/default/files/2019-05/documents/hh-rec-criteria-habs-document-2019.pdf) and World Health Organization (https://www.who.int/publications/m/item/toxic-cyanobacteria-in-water-a-guide-to-their-public-health-consequences-monitoring-and-management) (https://iris.who.int/bitstream/handle/10665/42591/9241545801.pdf?sequence=1)(https://www.who.int/publications/m/item/toxic-cyanobacteria-in-water---second-edition) recommendations. When issuing an advisory, signage should be posted at each access point at the waterbody warning against any contact with the water.

Rescinding a Public Health Advisory

Cyanobacteria cells can release cyanotoxins into the water when they die. Therefore, algal toxins may be present when a visible scum or mat is no longer evident. DPH recommends the rescinding of a public health advisory after two successive samples, collected a week apart, demonstrate cell counts or toxin levels below the quantitative guideline values." (https://www.mass.gov/info-details/guidelines-for-cyanobacteria-at-recreational-freshwater-locations)

Cyanobacteria Risk Categories

APCC interpreted cyanobacteria data using a tiered risk system called "Cyanobacteria Risk Categories." This data interpretation system was created using guidance and feedback from cyanobacteria researchers, Cape Cod health agents, and state guidance. The criteria for the Risk Categories do not include cell counts or cylindrospermopsin (another cyanobacteria toxin), as neither APCC nor the County Lab test for these metrics.

APCC tracked changes in cyanobacteria concentrations between each sampling event. The reason for tracking changes in cyanobacteria concentrations over time is that rapid growth rates, defined here as net daily cyanobacteria growth rates greater than or equal to 0.05 growth rate per day (ud-1), may indicate that a cyanobacteria bloom formation or exceedance of the 8 ppb microcystin level is about to occur. Alternatively, cyanobacteria concentrations may peak and then decrease before a cyanobacteria bloom or microcystin exceedance occurs. If any APCC sample had a confirmed net daily cyanobacteria growth rate greater than or equal to 0.05, then APCC recommended more frequent weekly testing of ponds. Before August 1, 2022, APCC would also place ponds in the "Potential for Concern" category for one week following a growth rate above 0.05. However, following new guidance from program partners, starting on August 1, 2022, APCC stopped recommending a change in risk category based on cyanobacteria growth rate data alone. Instead, if growth rates exceeded 0.05 (ud-1), APCC increased the sampling frequency to one-week intervals in order to catch potential increase in cyanobacteria that might occur.

To assign a Cyanobacteria Risk Category to a pond for a given monitoring period, the most hazardous result among multiple criteria determined the risk category in which the pond was placed. A pond that met even a single criterion in the "Use Restriction Warranted" category was placed in that category. Likewise, a pond that met even a single criterion in the "Potential for Concern" category but did not meet any criteria in the "Use Restriction Warranted" category, was placed in the "Potential for Concern" category. If a pond met no criteria in the "Use Restriction Warranted" or the "Potential for Concern" categories, that pond was placed in the "Acceptable" category. All descriptions and criteria for these categories are summarized in Appendix 2 and discussed below.

APCC Cyanobacteria Risk Categories

Acceptable

Definition: No concerning cyanobacteria results at the time and place of sampling. To the best of APCC's knowledge and based on our monitoring results, regular recreational usage of the pond is safe with respect to cyanobacteria and toxins. The map color is blue.

Recommended Sampling Frequency: Biweekly. In samples containing low levels of cyanobacteria with high growth rates, APCC will recommend weekly sampling.
Recommended Action: None.

Potential for Concern

Definition: Monitoring results or the presence of cyanobacteria scum at the time and place of sampling indicates a potential for increased risk for exposure to cyanobacteria toxins approaching but below state standards. Conditions do not yet warrant the posting of a recreational human health advisory according to guidelines from the Massachusetts Department of Public Health (MDPH). While these conditions pose low health risks to adults, risks are higher for children or pets based on lower body mass, particularly if contaminated water is incidentally ingested. Children may inadvertently consume pond water while swimming and pet exposure can result from drinking or ingesting pond water or from grooming after swimming. The map color is yellow. Map color yellow with crosshatching indicates a municipal pet advisory has been issued. Formerly the Moderate Warning Tier[1,2,4].
Recommended Sampling Frequency: Weekly.
Recommended Action:

1. APCC or the town will provide a GRAB sample for toxin analysis to the Barnstable County Lab for samples suspected of possibly exceeding the MDPH guidelines for microcystin in recreational waters.
2. The posting of a "Pet Advisory" or similar advisory according to municipal policies and procedures until the pond returns to "Acceptable" status.
3. Sampling should be increased to weekly until all results are once again in the "Acceptable" category.

Use Restriction Warranted

Definition: Monitoring results at the time and place of sampling indicate the pond is unsafe for recreation by humans and pets based on one or more of the following criteria: 1) presence of microcystin at or above state standards (8 ppb microcystin) as described in MDPH guidance, 2) presence of significant cyanobacteria scum layers according to MDPH guidance, 3) a municipal health agent issues a closure for any other reason related to cyanobacteria. Recreational risk to adults is moderate following exposure. Recreational risks are especially high for children and pets following exposure through accidental ingestion of contaminated water. Children may inadvertently consume pond water while swimming and pet exposure can result from ingestion or directly drinking pond water or from grooming after swimming. Due to their lower body masses, children and pets are more susceptible to cyanobacteria risks than adults. Map color is red. Map color red with crosshatching indicates a municipal advisory has been issued. Formerly the High Warning Tier[3].
Recommended Sampling Frequency: Weekly.
Recommended Action:

1. APCC or the town will provide a GRAB sample for toxin analysis to the Barnstable County Lab for samples suspected of possibly exceeding the MDPH guidelines for microcystin in recreational waters.
2. The town should post a recreational advisory or similar advisory according to municipal policies and procedures and otherwise notify the public to avoid contact and exposure

until the pond meets criteria to be reopened or the advisory is lifted by the local health agent.

3. Sampling should be conducted weekly until there are two consecutive weeks when results include no significant cyanobacteria scum and toxin testing of samples contain a microcystin concentration below 8 ppb.

Recommendations for posting Use Restrictions and Advisories

While APCC provides recommendations for use restrictions or advisories based on risk categories, use restrictions and advisories are issued at the discretion of the municipal health agents. When there is a "Use Restriction is Warranted," towns generally issue a Public Health Advisory or when there is a "Potential for Concern," the town of Barnstable generally issues a Pet Advisory. As of now, there is no commonly utilized set of guidelines in use by health agents across the Cape that provides consistency in posting criteria. As a result, members of the public are advised to contact the health agent in their town (see the contact list provided on APCC's website) to determine the official status of the pond in which they are interested. While ponds exceeding MDPH standards as discussed above were marked in red on APCC's map, this coloration does not always mean that a use restriction was issued by the town. APCC updates our list of restricted ponds as we are informed by the respective towns, but APCC does not speak for the towns unless otherwise and explicitly noted on our posting map.

APCC's recommendation for removing a recreational use advisory mirrors the reopening guidance from MDPH. For a microcystin toxin exceedance or cyanobacteria scum, APCC will recommend lifting a recreational use advisory or closure after two consecutive tests a week apart show microcystin concentrations less than 8 ppb and little to no presence of cyanobacteria bloom material, depending on the basis for the original restriction. Health agents are solely responsible for the issuance and removal of other non-cyanobacteria-related recreational use advisories or closures related to water clarity, such as clarity less than four feet.

Reporting

<u>Biweekly reports</u>

Results are provided in biweekly reports to local municipal officials and pond associations. Depending on results, reports include recommendations concerning appropriate advisory posting or removal for the public to minimize or avoid risks due to cyanobacteria exposure. During periods of possible harmful cyanobacteria bloom formation requiring weekly sampling, additional reports and updates are sent to officials and pond associations. Pond associations play a key role in raising public awareness of cyanobacteria risks and alerting pond residents of cyanobacteria monitoring results throughout the season.

<u>Interactive map</u>

APCC's cyanobacteria website contains an interactive map where recent monitoring results are posted throughout the season. Updates are submitted on an automated basis every six hours, starting at 8am. In some cases, automated map updates are postponed one day if a town official

requested additional time to review results before they are posted. The interactive map is located at https://apcc.org/cyano.

Email alerts

APCC provides an email registry signup on our website designed to update interested residents and visitors when harmful cyanobacteria blooms are identified. A quick link to sign up for the Cyanobacteria Alert is on our homepage (https://apcc.org/our-work/science/community-science/cyanobacteria/cyanobacteria-alert/).

4. RESULTS

Cyanobacteria monitoring results, Risk Categories, and risk communication are described in this section. For each pond, a table is provided to describe results and risk categories for each sampling event. The table of results is provided in Attachment 1 containing the data collected for the Town of Eastham in 2024. The Risk Category criteria are included in Appendix 2. Data interpretation and risk communication to town officials and the public for each sampling event are described in this section as well. Appendix 3 is the 2024 Cyanobacteria Risk Comparison which shows the results from previous years where data is available.

Results for the sampling locations are described below. APCC sampled from eight locations: (see Appendix 4 for a list of sampling locations).

Bridge Pond

During the 2024 monitoring season, Bridge Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC's "Acceptable" category for the entire season. (Table 1 below).

Table 1. Summary of cyanobacteria monitoring results for Bridge Pond, Eastham, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/6/2024	Acceptable	Mixed	108	-
6/20/2024	Acceptable	Mixed	23	-
7/2/2024	Acceptable	*Woronchinia* spp.	3	-
7/18/2024	Acceptable	*Woronchinia* spp.	6	-
8/1/2024	Acceptable	*Microcystis* spp.	13	-
8/15/2024	Acceptable	Mixed	3	-
8/28/2024	Acceptable	*Woronchinia* spp.	12	-

9/12/2024	Acceptable	Mixed	173	-
9/26/2024	Acceptable	N/A	13	-
10/10/2024	Acceptable	Mixed	51	-
10/24/2024	Acceptable	*Woronchinia* spp.	9	-
11/7/2024	Acceptable	Other	2	-

Depot Pond

During the 2024 monitoring season, Depot Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC's "Acceptable" category for the entire season. (Table 2 below).

Table 2. Summary of cyanobacteria monitoring results for Depot Pond, Eastham, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/6/2024	Acceptable	N/A	5	-
6/20/2024	Acceptable	*Dolichospermum* spp.	1	-
7/2/2024	Acceptable	N/A	2	-
7/18/2024	Acceptable	Mixed	2	-
8/1/2024	Acceptable	N/A	1	-
8/15/2024	Acceptable	*Dolichospermum* spp.	10	-
8/28/2024	Acceptable	N/A	9	-
9/12/2024	Acceptable	*Dolichospermum* spp.	24	-
9/26/2024	Acceptable	*Dolichospermum* spp.	84	-
10/10/2024	Acceptable	*Dolichospermum* spp.	10	-
10/24/2024	Acceptable	*Dolichospermum* spp.	42	-
11/7/2024	Acceptable	*Dolichospermum* spp.	8	-

Great Pond

During the 2024 monitoring season, Great Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC's "Acceptable" category for the entire season. (Table 3 below).

Table 3. Summary of cyanobacteria monitoring results for Great Pond, Eastham, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/6/2024	Acceptable	Mixed	11	-
6/20/2024	Acceptable	*Microcystis* spp.	34	-
7/2/2024	Acceptable	*Microcystis* spp.	13	-
7/18/2024	Acceptable	*Microcystis* spp.	8	-
8/1/2024	Acceptable	*Microcystis* spp.	133	-
8/15/2024	Acceptable	Mixed	89	-
8/28/2024	Acceptable	Mixed	127	-
9/12/2024	Acceptable	Mixed	607	-
9/26/2024	Acceptable	Mixed	150	-
10/10/2024	Acceptable	*Microcystis* spp.	32	-
10/24/2024	Acceptable	Mixed	48	-
11/7/2024	Acceptable	Mixed	49	-

Herring Pond

During the 2024 monitoring season, Herring Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC's "Acceptable" category for the entire season. (Table 4 below).

Table 4. Summary of cyanobacteria monitoring results for Herring Pond, Eastham, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/6/2024	Acceptable	N/A	3	-
6/20/2024	Acceptable	N/A	1	-
7/2/2024	Acceptable	N/A	5	-
7/18/2024	Acceptable	N/A	3	-
8/1/2024	Acceptable	*Dolichospermum* spp.	6	-
8/15/2024	Acceptable	*Dolichospermum* spp.	20	-
8/28/2024	Acceptable	N/A	17	-

9/12/2024	Acceptable	*Dolichospermum* spp.	40	-
9/26/2024	Acceptable	Other	79	-
10/10/2024	Acceptable	*Dolichospermum* spp.	23	-
10/24/2024	Acceptable	*Dolichospermum* spp.	28	-
11/7/2024	Acceptable	N/A	2	-

Jemima Pond

During the 2024 monitoring season, Jemima Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC's "Acceptable" category for the entire season. (Table 5 below).

Table 5. Summary of cyanobacteria monitoring results for Jemima Pond, Eastham, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/6/2024	Acceptable	N/A	2	-
6/20/2024	Acceptable	N/A	1	-
7/2/2024	Acceptable	N/A	3	-
7/18/2024	Acceptable	N/A	12	-
8/1/2024	Acceptable	N/A	3	-
8/15/2024	Acceptable	N/A	1	-
8/28/2024	Acceptable	N/A	28	-
9/12/2024	Acceptable	N/A	14	-
9/26/2024	Acceptable	N/A	2	-
10/10/2024	Acceptable	N/A	0	-
10/24/2024	Acceptable	N/A	4	-
11/7/2024	Acceptable	Other	2	-

Minister Pond

During the 2024 monitoring season, Minister Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC's "Acceptable" category for the entire season. (Table 6 below).

Table 6. Summary of cyanobacteria monitoring results for Minister Pond, Eastham, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/6/2024	Acceptable	*Woronchinia* spp.	3	-
6/20/2024	Acceptable	*Woronchinia* spp.	7	-
7/2/2024	Acceptable	*Woronchinia* spp.	22	-
7/18/2024	Acceptable	*Woronchinia* spp.	5	-
8/1/2024	Acceptable	*Dolichospermum* spp.	10	-
8/15/2024	Acceptable	*Woronchinia* spp.	5	-
8/28/2024	Acceptable	*Woronchinia* spp.	5	-
9/12/2024	Acceptable	Other	11	-
9/26/2024	Acceptable	N/A	3	-
10/10/2024	Acceptable	*Woronchinia* spp.	3	-
10/24/2024	Acceptable	N/A	4	-
11/7/2024	Acceptable	*Woronchinia* spp.	7	-

Moll Pond

During the 2024 monitoring season, Moll Pond contained no concerning cyanobacteria results at the time and place of each sampling event*, keeping the pond in APCC's "Acceptable" category for the entire season. (Table 7 below).

Table 7. Summary of cyanobacteria monitoring results for Moll Pond, Eastham, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/20/2024	Acceptable	N/A	5	-
7/2/2024	Acceptable	N/A	1	-
7/18/2024	Acceptable	*Aphanizomenon* spp.	47	-
8/1/2024	Acceptable	*Dolichospermum* spp.	11	-
8/15/2024	Acceptable	*Dolichospermum* spp.	12	-
8/28/2024	Acceptable	*Aphanizomenon* spp.	27	-
9/26/2024	Acceptable	N/A	15	-
10/10/2024	Acceptable	N/A	4	-

10/24/2024	Acceptable	N/A	6	-
11/7/2024	Acceptable	N/A	2	-

*APCC did not sample Moll Pond on June 6 and September 12, 2024, due to technicians not finding the pond. APCC was unable to reschedule that week for resampling.

Muddy Pond

During the 2024 monitoring season, Muddy Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC's "Acceptable" category for the entire season. (Table 8 below).

Table 8. Summary of cyanobacteria monitoring results for Muddy Pond, Eastham, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/6/2024	Acceptable	*Dolichospermum* spp.	22	-
6/20/2024	Acceptable	*Woronchinia* spp.	1	-
7/2/2024	Acceptable	N/A	3	-
7/18/2024	Acceptable	*Dolichsopermum* spp.	12	-
8/1/2024	Acceptable	*Aphanizomenon* spp.	4	-
8/15/2024	Acceptable	*Aphanizomenon* spp.	4	-
8/28/2024	Acceptable	N/A	36	-
9/12/2024	Acceptable	N/A	6	-
9/26/2024	Acceptable	N/A	4	-
10/10/2024	Acceptable	N/A	2	-
10/24/2024	Acceptable	N/A	26	-
11/7/2024	Acceptable	*Aphanizomenon* spp.	1	-

Result Summary

In 2024, eight ponds were monitored by APCC in the town of Eastham; (see Appendix 4 for sampling locations). None of these ponds reached either APCC's "Potential for Concern" Risk Category or the higher "Use Restriction Warranted" Category at any time during the monitoring season.

In the previous three years of monitoring, APCC's monitoring data and the presence of cyanobacteria scums were used to estimate cyanobacteria risk. In 2024, the County Water

Quality Lab's capability to conduct microcystin analyses provided the town health department and APCC with direct measurements of toxin, increasing understanding of current toxin risks.

This year APCC partnered with the County Lab to conduct a pilot study to document and understand the presence of anatoxin-a in the Cape's freshwater ponds. APCC did not send samples, collected for the Town of Eastham, to county lab because all ponds were found to be in the Acceptable risk tier or with mixed taxa with low biomass.

APCC's 2024 cyanobacteria monitoring program collected and analyzed 94 samples and documented field conditions on each of the scheduled twelve sampling dates throughout the season. All results were promptly shared with the Town of Wellfleet via biweekly reports and then entered into the APCC Interactive Map following the completion of sample analysis (https://apcc.org/cyano).

5. RECOMMENDATIONS

Based on the results from the 2024 monitoring season and previous monitoring work, APCC provides the following recommendations:

Recommendation 1: Continue yearly cyanobacteria monitoring. Monitoring over multiple years for full seasons would provide greater understanding of the cyanobacteria community in Bridge Pond, Depot Pond, Great Pond, Herring Pond, Jemima Pond, Minister Pond, Moll Pond, and Muddy Pond. More seasons of data will allow us to draw better predictions year after year. Continued monitoring will also allow for the ability to track degradation in the ponds as increased occurrence of harmful cyanobacteria blooms point to larger issues of pond impairment. Monitoring efforts will shed light on the ponds most in need of protection and restoration.

Recommendation 2: Reduce nutrient loading to freshwater ponds. Algal blooms and cyanobacteria blooms in ponds are associated with nutrient loading to ponds. Furthermore, there is mounting evidence that nitrogen, as well as phosphorus, is involved in stimulating algal blooms in freshwater ponds. Residents living adjacent to ponds and within the pond watershed should reduce sources of nutrient pollution flowing from their properties towards the pond. Excess fertilizer use, septic systems around ponds, poor stormwater management infrastructure, and a lack of adequate vegetation buffers exacerbate nutrient loading of ponds. Reducing or eliminating fertilizer use, maintaining septic systems or upgrading to better wastewater management systems that remove more nutrients, treating stormwater runoff before it enters wetlands or ponds, and planting vegetated buffers where none exist will help to protect pond water quality.

Recommendation 3: Recognize that scientific understanding of the causes of HCBs continues to evolve. In addition to managing nutrients, climate change, including the currently warming atmosphere and altered rainfall patterns, is believed to play a significant role in the increasing frequency and intensity of harmful cyanobacteria blooms (https://www.publish.csiro.au/MF/MF18392).

Residents and officials should understand that there may be many factors that cause HCBs on Cape Cod. Continued monitoring of cyanobacteria and water quality will lead to increased understanding and awareness, a safer public, and hopefully improved health of our freshwater ponds.

Recommendation 4: Consider carefully before planning or undertaking pond restoration and protection options. If a pond is impacted by HCBs, here are some steps to consider:

- Identify the important uses and desirable features of the pond and surrounding areas.
- Consider the natural evolution of a pond over time, from open water to vegetated marsh to wet meadow.
- Identify potential causes of HCBs (e.g., stormwater runoff, fertilized lawns, etc.);
- Identify potential actions to promote pond health and reduce HCBs.
    - For a comprehensive list of actions that residents, municipalities, and state agencies can take to promote pond health, visit APCC's State of the Waters: Cape Cod website (https://capecodwaters.org/action-plan/#ponds-hom), specifically, the Action Plan for ponds.
    - Under the Freshwater Initiative, the Cape Cod Commission is developing a Pond Restoration Technologies matrix to identify potential methods for pond protection and restoration. Each pond is unique, and restoration technology that works for one pond may not work well for another. Evaluate whether potential actions to reduce HCBs may impact other pond characteristics or aquatic organisms that are important for pond health. Treating a single problem without considering the effects on other pond resources could potentially harm the entire pond ecosystem and its resources.
- Develop a comprehensive plan for pond protection and restoration that addresses the causes as well as the symptoms of impaired pond health.
- Planning for pond restoration should be done to address not only short-term solutions but also medium-term and long-term solutions.
- Develop a watershed management plan and continue to engage residents around the pond and within the watershed about best land care practices, pond ecology, etc.

6. ACKNOWLEDGEMENTS

APCC collaborates with many local, regional, state and federal partners, including organizations, homeowner associations, pond associations, water quality committees, municipal staff from Cape Cod, and state and federal agencies and organizations. Partners include scientists affiliated with Barnstable County Department of Health and the Environment, the Cape and Islands Health Agents Coalition, Massachusetts Department of Public Health, Massachusetts Department of Environmental Protection, the U.S. Environmental Protection Agency, and Massachusetts Bays National Estuary Partnership. Funding was provided by the Mary-Louise Eddy and Ruth N. Eddy Foundation, the Bilezikian Family Foundation, the Cape Cod 5 Foundation, the Eversource Energy Foundation, Inc., private foundation grants, dues, and donations from APCC members.

APCC wishes to thank the following individuals and organizations for their support of this project: Barry H. Rosen, Ph.D. of Florida Gulf Coast University for providing a taxonomic workshop and keys for identification of freshwater cyanobacteria and green algae, Mindy L. Richlen, Ph.D. of Woods Hole Oceanographic Institution for producing Save Our Ponds and supporting the Cyanobacteria Workshop, Haley Miller U.S. Environmental Protection Agency, and Jasper Sha of Massachusetts Department of Environmental Protection for their review and approval of our Cape Cod Cyanobacteria Monitoring Program (CCCMP) Quality Assurance Project Plan (QAPP) 2024-2029; and Hillary Greenberg-Lemos, Director of Health and Environment, for addressing cyanobacteria concerns in Bridge Pond, Depot, Great Pond, Herring Pond, Jemima Pond, Minister Pond, Moll Pond, and Muddy Pond on behalf of the town; and APCC also thanks our 2024 cyanobacteria interns, including Dara Estes, James Marino, May Lopopolo, Casey Proto, Meribeth Ratzel, and Jacob Scola.

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8. APPENDICES

Appendix 1. Resources on Cyanobacteria

Harmful cyanobacteria blooms in freshwater bodies are the subject of numerous reports published by scientists, state and federal agencies, and organizations, some of which are listed here:

- The World Health Organization recognized the public health consequences of cyanobacteria in water in 1999 (https://cdn.who.int/media/docs/default-source/wash-documents/water-safety-and-quality/toxic-cyanobacteria---1st-ed.pdf?sfvrsn=338a8c22_1&download=true).

The Centers for Disease Control (CDC) call cyanotoxins "among the most powerful natural poisons known" (https://stacks.cdc.gov/view/cdc/36648). The https://www.cdc.gov/harmful-algal-blooms/media/pdfs/habsphysician_card.pdf states that swallowing water containing cyanobacteria can damage the central nervous system, liver or kidneys; skin contact can cause allergic dermatitis and conjunctivitis; and inhalation of aerosols containing cyanobacteria or their toxins can cause wheezing, coughing, chest tightness, and shortness of breath.

- New England Interstate Water Pollution Control Commission (https://neiwpcc.org/our-programs/wetlands-aquatic-species/habs/) is an interstate commission that helps the states of the Northeast preserve and advance water quality. NEIWPCC's webpage states that "the frequency of HAB occurrence is on the rise and cyanobacteria toxicity has been associated with human health impacts including skin rashes, gastrointestinal and respiratory disease, and liver damage. Effects can be even more pronounced (potentially even fatal) in animals ranging from cattle to dogs. HABs have direct implications to the use of recreational waterbodies for contact recreation, the susceptibility of public water supplies to toxins, and the overall degradation of our aquatic resources."
- U.S. Environmental Protection Agency (EPA):
    - "Monitoring and Responding to Cyanobacteria and Cyanotoxins in Recreational Waters." (https://www.epa.gov/habs/visually-identifying-signs-cyanobacterial-bloom)
    - EPA Office of Ground Water and Drinking Water webpage. Managing Cyanotoxins in Public Drinking Water Systems. (https://www.epa.gov/sites/default/files/2016-09/documents/method-546-determination-total-microcystins-nodularins-drinking-water-ambient-water-adda-enzyme-linked-immunosorbent-assay.pdf)
    - EPA webpage on nutrient pollution and HABs. (https://www.epa.gov/habs/visually-identifying-signs-cyanobacterial-bloom)
    - EPA webpage on Cyanobacteria HABs. (https://www.epa.gov/habs)

State agencies, including New York (https://www.health.ny.gov/environmental/water/drinking/bluegreenalgae/), Rhode Island (https://health.ri.gov/healthrisks/harmfulalgaeblooms/), and New Hampshire (https://www.des.nh.gov/water/healthy-swimming/healthy-swimming-mapper) have cyanobacteria monitoring programs and provide guidance concerning public health and environmental risks posed by cyanobacteria.

- Commonwealth of Massachusetts:

- Cyanobacteria webpage: (https://www.mass.gov/guides/cyanobacterial-harmful-algal-blooms-cyanohabs-water)
- Massachusetts Department of Public Health (MDPH) website on "Guidelines for cyanobacteria in freshwater recreational water bodies." (https://www.mass.gov/info-details/guidelines-for-cyanobacteria-at-recreational-freshwater-locations)

Appendix 2. APCC's Cyanobacteria Risk Categories.

APCC 2024 Cyanobacteria Risk Categories Revised 7/26/2022				
Criteria		**APCC Acceptable**	**APCC Potential for Concern**	**APCC Use Restriction Warranted**
Microcystin	Potential microcystin calculated by APCC based on measurement of phycocyanin in Bloom Forming Colony samples.	Potential microcystin calculated at low levels that do not warrant additional toxin testing[2,4].	Potential microcystin is elevated to a point where an exceedance of 4 ppb is deemed possible and confirmatory toxin testing warranted[2,4].	
	Measured microcystin by Barnstable County Water Quality Lab.	Less than 4 ppb microcystin measured in GRAB sample.	Between 4 and 8 ppb microcystin measured in GRAB sample.	Greater than 8 ppb microcystin measured in GRAB sample[3].
Cyanobacteria Blooms and Scums	Cyanobacteria bloom material reported and confirmed by APCC.	None present at the time and place of sample collection.	A cyanobacteria scum or bloom is present but is deemed to be insignificant by the Massachusetts Department of Public Health and the town's health agent.	A cyanobacteria scum or bloom is present and is deemed to be significant by the Massachusetts Department of Public Health or the town's health agent[3].
Notes	To interpret cyanobacteria data using this table, the most hazardous result determines the category the pond is placed in from right to left. A pond that meets even a single criterion in the "Use Restriction Warranted" column will be placed in that category. Likewise, a pond that meets even a single criterion in the "APCC Potential for Concern" category but does not meet any criteria in the "APCC Use Restriction Warranted" category, will be placed in the "APCC Potential for Concern" category. If a pond meets no criteria in the "APCC Use Restriction Warranted" or the "APCC Potential for Concern" category, that pond is placed in the "APCC Acceptable" category. [2] Developed with recommendations from Nancy Leland of Lim-Tex Inc. and affiliated with the University of New Hampshire Center for Freshwater Biology. [3] Criteria attributed to MDPH. [4] Predictive cyanobacteria metrics that project and estimate risks, rather than reactive cyanobacteria metrics that measure risk after a bloom has occurred.			

Appendix 3. Bridge Pond, Depot, Great Pond, Herring Pond, Jemima Pond, Minister Pond, Moll Pond, and Muddy Pond 2021-2024 Cyanobacteria Risk Comparison.

As of 2024, APCC has completed four seasons of cyanobacteria monitoring for the town of Eastham. The tables below detail APCC's communication of cyanobacteria risk for Bridge Pond, Depot, Great Pond, Herring Pond, Jemima Pond, Minister Pond, Moll Pond, and Muddy Pond each season. Red indicates a "Use Restriction Warranted" or "High Warning Tier" designation and yellow indicates a "Potential for Concern" or "Moderate Warning Tier" designation, and blue indicates an "Acceptable" or "Low Warning Tier" designation. The coloring indicates the worst-case from any location in the pond. See previous APCC reports for the Town of Eastham for more information on findings and risk communication in these sampling seasons.

Bridge Pond 2021-2024 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2021												
2022												
2023												
2024												

Depot Pond 2021-2024 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2021												
2022												
2023												
2024												

Great Pond 2021-2024 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2021												

2022												
2023												
2024												

Herring Pond 2021-2024 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2021												
2022												
2023												
2024												

Jemima Pond 2021-2024 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2021												
2022												
2023												
2024												

Minister Pond 2021-2024 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2021												
2022												
2023												
2024												

Moll Pond 2024 Cyanobacteria Risk Comparison

	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2024												

Muddy Pond 2021-2024 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2021												
2022												
2023												
2024												

Appendix 4. Sampling Locations

- Bridge Pond: Landing off Herring Brook Rd.
- Depot Pond: Small beach behind the Eastham Library
- Great Pond: Wiley Park Beach from Herring Brook Rd.
- Herring Pond: Herring Pond beach off Herring Brook Rd.
- Jemima Pond: Public fishing landing off Samoset Rd.
- Minister Pond: Fishing landing off Fisherman's Landing Rd.
- Moll Pond: Private residence off Bayveiw Ave. (Private)
- Muddy Pond: Neighborhood beach off Rt. 6 (Private)