2020 Cyanobacteria Monitoring Report
Oyster Pond, Falmouth, MA

Prepared for the Oyster Pond Environmental Trust (OPET)
By the Association to Preserve Cape Cod (APCC)

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Background

Part way through the 2020 cyanobacteria monitoring season, the Association to Preserve Cape Cod (APCC) set up a pilot cyanobacteria monitoring program in Oyster Pond to monitor cyanobacteria for the rest of the 2020 monitoring season. The goals of the program were to improve understanding of cyanobacterial populations in Oyster Pond, increase community awareness of harmful cyanobacteria blooms, and communicate results to help protect public health and safety. The 2020 monitoring detected no visible cyanobacteria blooms during the sampling season and all samples were ranked as "low" according to our warning tier system, indicating low concentrations of cyanobacteria detected. The 2020 monitoring results are summarized in this report. All monitoring results were shared with the Oyster Pond Environmental Trust (OPET), the Town of Falmouth's Health Department, and the public throughout the season.

Overview of APCC's Cyanobacteria Monitoring Program

Harmful cyanobacteria blooms are indicators of nutrient enrichment and warming temperatures due to climate change and are increasing in frequency and severity. Cyanotoxins pose health risks to humans and wildlife which ingest cyanotoxins present in water bodies. Harmful cyanobacteria blooms in freshwater bodies have become more common and 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 (WHO 1999).
- The Centers for Disease Control (CDC) call cyanotoxins "among the most powerful natural poisons known" (CDC Fact Sheet on Harmful Algal Blooms). The CDC's Physician Card on Harmful Algal Blooms (HABs) 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 (NEIWPCC) 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." EPA recreational waters
    - EPA Office of Ground Water and Drinking Water webpage. Managing Cyanotoxins in Public Drinking Water Systems. EPA drinking water
    - EPA webpage on nutrient pollution and HABs. EPA and nutrient pollution
- State agencies, including New York (NY), Vermont (VT), Rhode Island (RI), and New Hampshire (NH) have cyanobacteria monitoring programs and provide guidance concerning public health and environmental risks posed by cyanobacteria.
- Commonwealth of Massachusetts:
    - Cyanobacteria webpage: Massachusetts
    - Massachusetts Department of Public Health (MDPH) website on "Guidelines for cyanobacteria in freshwater recreational water bodies." MDPH

Over the course of the last decade, APCC has received input from many pond associations, organizations, and local and regional resource managers on Cape Cod regarding concerns about pond health, pond water quality and the need for data received in a timely manner to inform pond protection measures and ensure public safety. Harmful cyanobacteria blooms are indicators of nutrient enrichment and climate change. Blooms are increasing in frequency and severity and the cyanotoxins they produce pose concerning health risks to people, pets, and wildlife. In response to these concerns and limited pond water quality data, APCC developed its Cyanobacteria Monitoring Program in 2017 with guidance and input from state and federal agencies and scientists, including the EPA (EPA recreational waters), Massachusetts Department of Public Health (MDPH), and the town of Barnstable's Health Division (Town of Barnstable).

APCC's cyanobacteria monitoring program normally includes training for citizen scientists to collect water samples from shoreline stations. Volunteers then deliver samples to APCC for lab analysis and storage. These citizen scientists provide APCC with highly useful data and help to extend APCC's coverage of cyanobacteria monitoring across the region. In 2020, however, due to the COVID-19 pandemic and the need to limit exposure to volunteers and staff, APCC chose to have staff collect all samples and volunteers were not engaged.

APCC staff and interns interpret monitoring results within a guidance framework that incorporates the most recent scientific information as well as existing state and federal guidance (EPA recreational waters, MDPH). Results are provided to the pond associations and local

municipal officials along with recommendations concerning appropriate advisories for the public to minimize or avoid risks due to cyanobacteria exposure. Pond associations typically play a key role in raising awareness of the risks related to cyanobacteria exposure and alerting pond communities of APCC's findings throughout the season.

APCC's Cyanobacteria Monitoring Program provides a webpage with an interactive map where recent monitoring results are posted. Results are interpreted according to cyanobacteria risk levels related to existing local, state and federal guidance concerning people and pet exposure to cyanobacteria blooms (APCC Cyanobacteria). APCC's goals are to raise public awareness of the risks posed by cyanobacteria toxins related to cyanobacteria blooms (cyanotoxins), and to motivate public action to improve water quality. In 2020 APCC monitored over 40 ponds across Cape Cod, including Oyster Pond.

APCC collaborates with many local, regional, state and federal partners, including organizations, homeowners' associations, pond associations, water quality committees, municipal staff from Cape Cod and Martha's Vineyard towns, and state and federal agencies and organizations. Partners include the town of Barnstable, Cape Cod towns, Massachusetts Department of Public Health, Massachusetts Department of Environmental Protection, the U.S. EPA, Massachusetts Bays National Estuary Partnership, Massachusetts Division of Marine Fisheries, Barnstable County Department of Health and the Environment, with funding from Massachusetts Environmental Trust, Cape Cod Healthcare, private foundation grants, and dues and donations from APCC members.

Methods

APCC's Cyanobacteria Monitoring Program uses an EPA-approved monitoring protocol developed and published by the U.S. Environmental Protection Agency for the Cyanobacteria Monitoring Collaborative (CMC 2017) and published scientific articles (Leland and Haney, 2018; Leland, Haney, Conte, Malkus-Benjamin and Horsley, 2019). The protocol utilizes a combination of field observations, microscopy, and fluorometry to analyze cyanobacteria and cyanobacteria pigments in water samples from freshwater lakes and ponds. The data collected includes photographs and field observations, digital microscopy to identify composition (type of cyanobacteria present) and dominance, and concentrations of phycocyanin and chlorophyll pigments indicative of the amounts of cyanobacteria vs. general algae and phytoplankton, respectively.

APCC tracks changes in cyanobacterial composition, dominance and abundance on a biweekly basis from June to October. At this sampling frequency, APCC is often able to forecast when cyanobacteria blooms may be forming or when toxin concentrations may be approaching harmful levels. These signs instruct APCC to increase the frequency of testing and to inform town officials to be aware of potential threats and to plan for proactive management actions to protect public safety. In Oyster Pond this season, samples were collected at the location shown in Figure 1, between August and October.

Figure 1: Cyanobacteria Sampling Station in Oyster Pond, Falmouth, 2020

To estimate cyanotoxin levels, measured phycocyanin concentrations in samples are compared to published relationships between concentrations of phycocyanin in whole lake water and bloom-forming colonies and cyanotoxin concentrations (Leland and Haney, 2018; Leland, Haney, Conte, Malkus-Benjamin and Horsley, 2019). Cyanotoxin analysis is conducted for specific instances by our scientific collaborators at the University of New Hampshire and Lim-Tek, Inc. When possible, APCC also conducts tests for one common cyanotoxin (microcystin) using Abraxis cyanotoxin test strip kits. These tests are rather costly and APCC is always seeking appropriate funding for cyanotoxin testing. Increased availability of cyanotoxin data to supplement our data can be a useful measure to determine more exact risk levels. In Oyster Pond in 2020, APCC did not conduct any Abraxis cyanotoxin testing.

In contrast to measuring cyanobacteria using cell counts, which is one of the methods listed by the Massachusetts Department of Public Health (MDPH), APCC's method is less costly, offers a faster turn-around time for results, and is often useful for predicting cyanobacteria bloom formation. APCC's method of using both microscopy to determine dominance as well as fluorometry of phycocyanin also reveals expected genus-specific toxicity which is not found

through basic cell counts. Cyanobacteria pigment data and other collected data also support research efforts that will expand our understanding about the health of the ponds.

To interpret the results based on the dominant cyanobacteria genus in the sample and concentration of phycocyanin (PC) pigment measured in micrograms per liter (ug/L) to estimate cyanotoxin levels, the threshold *s* in Table 1 are used. These phycocyanin values correspond to expected microcystin concentrations and each threshold denotes a regulatory standard for microcystin or the expectation of a cyanobacteria bloom formation. WLW stands for Whole Lake Water and denotes unconcentrated samples taken near shore with an integrated tube. The cyanobacteria concentrations in this sample reveal what was found in the water at moment of sample collection. BFC stands for Bloom-Forming Colonies and denotes samples taken with student plankton net towed over 3 meters near shore. The cyanobacteria concentrations in this sample reveal cyanobacteria growth and activity much more clearly than the WLW samples. BFC samples can describe exponential growth of cyanobacteria to predict blooms and can be used to forecast imminent threats due to cyanobacteria blooms. BFC concentrations are typically similar to a potential impending visible cyanobacteria scum accumulation. When these concentrations reach a certain threshold, we are often able to discern that a visible cyanobacteria bloom may have formed in another area of the pond not sampled or that a bloom likely recently formed or will form in the near future. BFC is APCC's preferred metric for cyanobacteria concentrations due to this forecasting ability, although WLW data is useful as well. As continued understanding of cyanobacteria risks emerge, APCC will update these tiers, as necessary.

Along with phycocyanin measurements, a visible cyanobacteria scum line or bloom formation in the pond may trigger a "high" warning tier designation. Exponential growth rates are also taken into account when assigning a warning tier. Finally, town advisory postings for cyanobacteria are taken into account along with APCC's data interpretations when assigning a tier designation. Once a pond reaches APCC's "high" warning tier, APCC will keep the pond in that tier until monitoring results fall below the criteria for the tier over two consecutive sampling events taken a week apart. This protocol is taken from the Massachusetts Department of Public Health (MDPH). When relating the findings to town officials, pond associations and the public, APCC uses the following descriptions:

Low indicates general safety for recreational activities according to our data. Assignment of results to this level indicates that monitoring data indicate no or low concentrations of cyanobacteria detected. To the best of our knowledge at the time and location of sample collection, regular recreational usage of the pond is safe with respect to cyanobacteria and toxins. On APCC's interactive map of results, the map color is blue.

Moderate indicates the cyanobacteria concentrations in the pond are particularly dangerous to children or pets if ingested and is very similar to the town of Barnstable's "Pet Advisory" level. Assignment of results to this level indicates that monitoring data indicate moderately high levels of cyanobacteria concentrations detected. While these conditions pose low to minimal health risks to adults, they can be dangerous for children or pets if water is ingested accidentally or incidentally during recreational activities. Pet exposure can be from drinking water or grooming after swimming. Due to lower body masses, children and pets are more susceptible to impacts at lower concentrations than adults. This tier is consistent with the town of Barnstable's "Pet

Advisory." If a town official declares a Pet Advisory for a pond at a given time, APCC will designate the pond in the Moderate tier. On APCC's interactive map of results, the map color is yellow.

High indicates that APCC found that either toxin levels approached state standards for recreation or that a visible cyanobacteria scum was present; each poses a considerable risk for human and pet interactions with the pond. This tier is between the town of Barnstable's "Warning" and "Closure" tiers. Assignment of results to this level indicates that monitoring data indicate high levels of cyanobacteria concentrations were detected. Health risk to adults is high and is especially dangerous for children and pets when ingested. APCC found cyanobacteria concentrations near or exceeding state recreational standards with potential for exponential growth rates of cyanobacteria. Any accidental consumption of pond water is considered dangerous and interacting with the pond in general carries risk for adverse health effects. If a town official declares a Warning or Closure for a pond at a given time, APCC will designate the pond in the High tier. On APCC's interactive map of results, the map color is red.

Table 1: APCC Cyanobacteria Monitoring Results With Map Colors

Warning Tier	Dominant Genus	WLW	BFC
High	*Microcystis* spp.	PC > 110 ug/L	PC >390 ug/L
	Other	PC > 1,100 ug/L	PC >3,900 ug/L
Moderate	*Microcystis* spp.	16 ug/L < PC < 110 ug/L	110 ug/L < PC < 390 ug/L
	Other	160 ug/L < PC < 1,100 ug/L	1,110 ug/L < PC < 3,900 ug/L
Low	*Microcystis* spp.	PC <16 ug/L	PC < 110 ug/L
	Other	PC <160 ug/L	PC < 1,110 ug/L

Results

Oyster Pond

A. Cyanobacteria Community Composition

Microscopic analysis revealed the composition and dominance of cyanobacteria found in Oyster Pond was 99% *Dolichospermum* spp. and 1% *Microcystis* spp.

Table 2. Cyanobacteria Genera Dominance in Oyster Pond

Sampling Date	APCC Map Warning Tier	Percent Dominance of each genus identified
8/26/2020	Low	100% *Dolichospermum* spp.
9/9/2020	Low	100% *Dolichospermum* spp.
9/23/2020	Low	99% *Dolichospermum* spp., 1% *Microcystis* spp.
10/7/2020	Low	100% *Dolichospermum* spp.

B. Cyanobacteria Abundance based on Phycocyanin Pigment Concentrations

In Oyster Pond. The lowest phycocyanin concentrations recorded was 9.35 micrograms per liter (ug/L) on September 23, 2020 and the highest phycocyanin concentrations recorded was 97.25 ug/L on September 9, 2020.

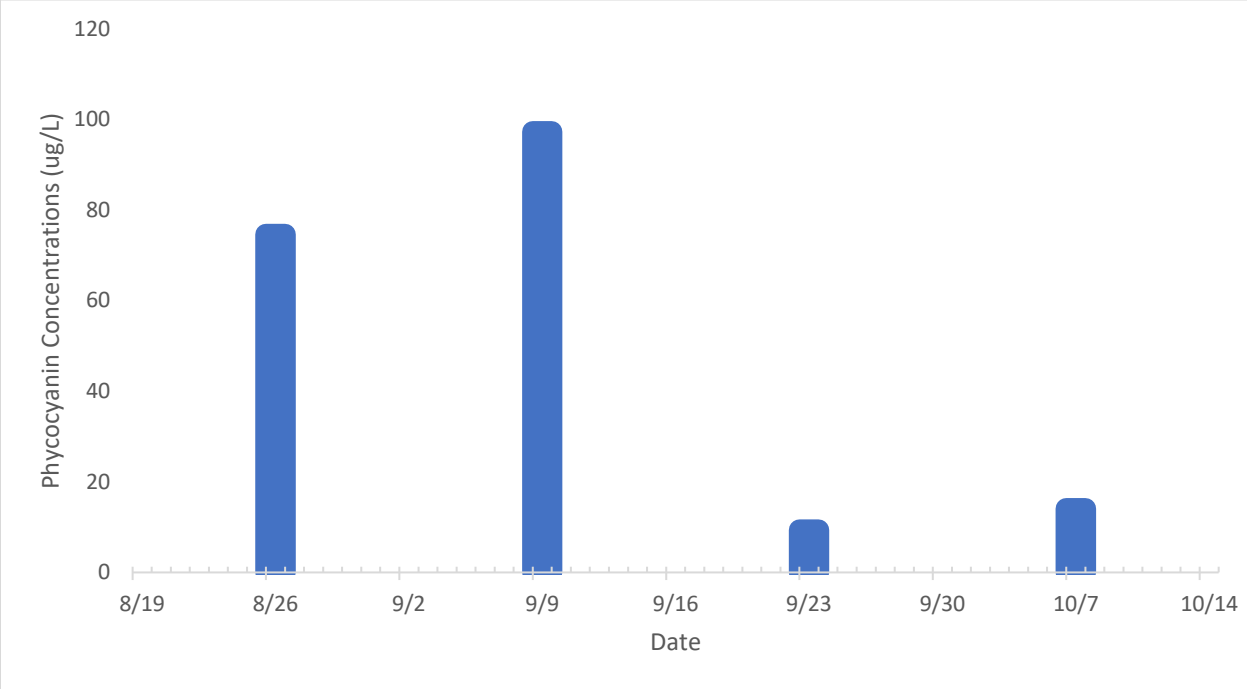

Figure 2. Phycocyanin Concentrations in Oyster Pond in 2020

C. Warnings, Advisories and APCC Cyanobacteria Map Levels

The highest warning tier Oyster Pond reached was the “low” warning tier. No visible blooms were seen on Oyster Pond by APCC staff.

D. Discussion

Oyster Pond did not experience visible cyanobacteria bloom accumulations during the 2020 sampling period, but the pond has experienced bloom conditions in the past according to Oyster Pond’s residents. For the most part, APCC staff found the pond to be quite turbid during sampling events suggesting that phytoplankton were present. Oyster Pond is used for general recreational purposes throughout the year and future robust monitoring efforts would do well to track conditions in this salt pond. Fortunately, over the course of the monitoring period, Oyster Pond exhibited a low risk for cyanobacteria exposure with cyanobacteria concentrations remaining well below state standards.

Conclusions

This first partial season of cyanobacteria monitoring in Oyster pond was a success in terms of collecting and analyzing samples and documenting results on every intended date. The monitoring data provide a baseline for monitoring future cyanobacteria trends in Oyster Pond. All results throughout the season were posted promptly to the APCC Interactive Map following the completion of sample analysis (APCC Cyanobacteria).

APCC hopes to perform pilot studies of a poorly researched cyanotoxin, anatoxin-a, in 2021 using samples from select ponds across Cape Cod. Anatoxin-a is a neurotoxin produced by *Dolichospermum* spp., a common cyanobacteria genus detected in 2020 in Oyster Pond. The occurrence of anatoxin-a in natural water bodies has not been adequately researched, and more data could help to characterize the risk potential from this neurotoxin.

In addition, APCC hopes to follow cyanobacteria and cyanotoxin monitoring projects in Martha's Vineyard ponds, that have saltwater influences, to gain a better understanding for cyanobacteria community structure and cyanotoxin production in these environments. Monitoring of a few Martha's Vineyard salt ponds in the fall of 2020 revealed some unique findings (Vineyard Gazette). Perhaps the results of these projects will help lead to an improved understanding of the unique risks posed by salt ponds like Oyster Pond.

Overall, Oyster Pond fared well due to the low cyanobacteria risk in the 2020 season with no potentially harmful cyanobacteria blooms seen or reported. However, as it is common for ponds to experience elevated cyanobacteria concentrations during periods of pond turnover (Paerl et al., 2001) in spring and fall, more monitoring earlier in the season and later into the fall (e.g., May through October) could shed light on potential cyanobacteria bloom conditions outside of the monitoring period executed in the 2020 season. Although residents may interact with these ponds less during these times, there are still potential dangers posed to pets who may consume or swim in these waters during colder months.

Recommendations

Monitoring over multiple years would provide greater understanding of cyanobacteria concentrations and communities in Oyster Pond. More years of data will allow us to draw better predictions year over year. Continued monitoring will also allow us to track changes in the pond, as harmful cyanobacteria blooms are considered linked to nutrient loading and climate change. Monitoring will shed light on such changes and will help to inform actions to protect and potentially rehabilitate the pond. Monitoring in the early and late season will also lead to an increased understanding of cyanobacteria community trends and types of cyanotoxins present.

To promote improved pond health, residents surrounding vulnerable pond ecosystems should take action to reduce potential nutrient pollution from their properties. Excess fertilizer use, improper management of septic systems, poor stormwater management infrastructure, and a lack of adequate vegetation buffers are all examples of human activities that exacerbate nutrient loading of water bodies such as Oyster Pond where there is development along the shoreline and

in the watershed. For a complete list of actions which residents can take to promote pond health, please visit APCC's Recommended Actions for Ponds page, at APCC's State of the Waters: Cape Cod project (State of the Waters).

In general, APCC does not support the use of aluminum sulfate (alum) treatments to alleviate phosphorus loading and cyanobacteria blooms. While these treatments often produce desired results in the short term, they only provide temporary relief from one factor (phosphorus) contributing to the increasing issue of excessive cyanobacteria growth, and they raise significant concern among environmentalists for a variety of reasons. Recent research has found that alum treatments can produce "unintended ecological consequences," including increasing dissolved aluminum and sulfate in lake water, altering important nitrogen cycling processes, and affecting benthic communities (Nogaro et al., 2013). Negative side-effects of dissolved forms of aluminum may harm certain invertebrates and are known to be toxic to fish (Gensemer and Playle, 1999). Alum treatment may also cause unintended effects, including release of microcystin toxin and reduced activity of beneficial cyanobacteria-lysing and microcystin-degrading bacteria (Han et al., 2013).

Furthermore, there is growing evidence that management of nitrogen in addition to phosphorus is important in controlling cyanobacteria blooms. Nitrogen loading has been found to promote blooms of certain non-nitrogen fixing genera of cyanobacteria including *Microcystis* spp. (Paerl et al., 2010), which was present in Oyster Pond this season. *Microcystis* spp. have been found to dominate waters with low phosphorus concentrations and nitrogen loading may "selectively promote the abundance of *Microcystis* spp." (Gobler et al., 2016).

In addition to managing nutrients, changing climate conditions, including the currently warming atmosphere and altered rainfall patterns, are believed to play a significant role in the increasing frequency and intensity of harmful cyanobacteria blooms (Paerl et al., 2019).

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Literature Cited

Publications

Gensemer, Robert W. & Playle, Richard C.. 1999. The Bioavailability and Toxicity of Aluminum in Aquatic Environments. Critical Reviews in Environmental Science and Technology, 29:4, 315-450. https://www.tandfonline.com/doi/abs/10.1080/10643389991259245

Gobler, C.J., Burkholder, J.M., Davis, T.W., Harke, M.J., Johengen, T., Stow, C.A., and Van de Waal, D.B. 2016. The dual role of nitrogen supply in controlling the growth and toxicity of cyanobacterial blooms. Harmful Algae. 54: 87-97. https://pubmed.ncbi.nlm.nih.gov/28073483/

Han. J, Bong-seok, J., Noriko, F., and Ho-Dong, P. 2013. The effect of alum coagulation for in-lake treatment of toxic *Microcystis* spp. and other cyanobacteria related organisms in microcosm experiments. Ecotoxicology and Environmental Safety. 96: 17-23 https://www.researchgate.net/publication/249647068_The_effect_of_alum_coagulation_for_in-lake_treatment_of_toxic_*Microcystis* spp._and_other_cyanobacteria_related_organisms_in_microcosm_experiments

Leland, N.J. and Haney, J.F. .2018. Alternative Methods for Analysis of Cyanobacterial Populations in Drinking Water Supplies: Fluorometric and Toxicological Applications Using Phycocyanin. Journal of Water Resource and Protection, 10, 740-761. https://www.scirp.org/journal/PaperInformation.aspx?paperID=86671

Leland, N.J., Haney, J.F., Conte, K., Malkus-Benjamin, K. and Horsley, B. 2019. Evaluation of Size Structure in Freshwater Cyanobacterial Populations: Methods to Quantify Risk Associated with Changes in Biomass and Microcystin Concentrations. Journal of Water Resource and Protection, 11, 810-829. https://www.scirp.org/journal/paperinformation.aspx?paperid=93424

Nogaro, G., Burgin, A.J., Schoepfer, V.A., Konkler, M.J., Bowman, K.L., and Hammerschmidt, C.R. 2013. Aluminum sulfate (alum) application interactions with coupled metal and nutrient cycling in a hypereutrophic lake ecosystem. Environmental Pollution, 176: 267-274. https://pubmed.ncbi.nlm.nih.gov/23454589/

Paerl, H.W., Fulton, Roland S., Moisander, Pia H., Dyble, Julianne 2001. Harmful Fresh Water Algal Blooms with an Emphasis on Cyanobacteria. The Scientific World. 76-113. https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/petitioners_exhibit/dwr/DWR-734.pdf

Paerl, H.W., Havens, K.E., Hall, N.S., Otten, T.G., Zhu, M., Xu, H., Zhu, G., and Qin, B. 2019. Mitigating a qglobal expansion of toxic cyanobacterial blooms: confounding effects and challenges posed by climate change. Marine & Freshwater Research. Published online March 26, 2019. http://paerllab.web.unc.edu/files/2020/06/Paerl-and-Barnard-2020-Harmful-Algae.pdf

Paerl, H.W., Xu, H., McCarthy, M.J., Zhu, G., Qin, B., Li, Y., Gardner, W.S. 2010. Controlling harmful cyanobacteria blooms in a hyper-eutrophic lake (Lake Taihu, China): The need for a

dual nutrient (N&P) management strategy. Water Research. 45, 5: 1973-1983. https://pubmed.ncbi.nlm.nih.gov/20934736/

Agencies and Organizations

Association to Preserve Cape Cod (APCC) webpage on Cyanobacteria Monitoring Program at: https://apcc.org/our-work/science/community-science/cyanobacteria/

Centers for Disease Control (CDC). Facts about Harmful Algal Blooms for Health Care Professionals. Posted at: https://www.cdc.gov/habs/materials/factsheet-cyanobacterial-habs.html

Centers for Disease Control (CDC). Physician Reference card for cyanobacteria. Posted at: https://www.cdc.gov/habs/pdf/habsphysician_card.pdf

Commonwealth of Massachusetts webpage on cyanobacteria: https://www.mass.gov/guides/cyanobacterial-harmful-algal-blooms-cyanohabs-water

Cyanobacteria Monitoring Collaborative Program (CMC). 2017. Quality Assurance Program Plan (QAPP) for the Cyanobacteria Monitoring Collaborative Program. Rev: 0, April 26, 2017: Posted at: https://cyanos.org/wp-content/uploads/2017/04/cmc_qapp_final.pdf

Environmental Protection Agency (EPA), webpage on Harmful Algal Blooms, at https://www.epa.gov/nutrientpollution/harmful-algal-blooms Hyperlink: EPA and nutrient pollution EPA website on "Monitoring and Responding to Cyanobacteria and Cyanotoxins in Recreational Waters". https://www.epa.gov/cyanohabs/monitoring-and-responding-cyanobacteria-andcyanotoxins-recreational-waters Hyperlink: EPA recreational waters EPA Office of Ground Water and Drinking Water webpage. Managing Cyanotoxins in Public Drinking Water Systems. https://www.epa.gov/ground-water-and-drinking-water/managingcyanotoxins-public-drinking-water-systems

Massachusetts Department of Public Health (MDPH) website on "Guidelines for cyanobacteria in freshwater recreational water bodies". https://www.mass.gov/info-details/guidelines-forcyanobacteria-in-freshwater-recreational-water-bodies

New England Interstate Water Pollution Control Commission (NEIWPCC), webpage on Harmful Algal Blooms, at https://neiwpcc.org/our-programs/wetlands-aquatic-species/habs/

New Hampshire state issues cyanobacteria advisories and alerts, at https://www.des.nh.gov/news-and-media/state-issues-cyanobacteria-advisories-and-alerts-new-hampshire

New York State Department of Health, Harmful algal bloom program. Website: https://www.health.ny.gov/environmental/water/drinking/bluegreenalgae/

Rhode Island Department of Health website on harmful algal blooms, at https://health.ri.gov/healthrisks/harmfulalgaeblooms/

State of the Waters: Cape Cod 2020. Action Plan for Homeowners/Business Owners. Posted at: https://capecodwaters.org/action-plan/#ponds-hom

Town of Barnstable Health Division. Beach Status and Water Quality. Posted at: https://town.barnstable.ma.us/Departments/healthdivision/Health_Notices/Beach-Status---Water-Quality.pdf

World Health Organization. 1999. Toxic cyanobacteria in water: a guide to their public health consequences, monitoring and management. https://www.who.int/water_sanitation_health/resourcesquality/toxcyanbegin.pdf

Additional Sources

Asimow, Noah (2020, October 1). *Dangerous Toxins Found in Island Ponds*. The Vineyard Gazette. https://vineyardgazette.com/news/2020/10/01/dangerous-bacteria-found-island-ponds-alarming-scientists