As discussed throughout this document, benthic HCBs present a unique challenge regarding ecology, cyanotoxins, exposure, management, monitoring, and the scientific community's understanding of benthic HCBs. Further, the public is far better educated on the tendencies of planktonic HCBs and will likely initially view information presented on benthic HCBs using planktonic HCBs assumptions. Therefore, communicating and responding to benthic HCBs must be considered carefully (Table 5-1).

It may be helpful when initially discussing benthic HCBs with the public to frame the issue in context with planktonic HCBs to address those differences and any assumptions the public may have. For example, you may want to begin by saying, "You may usually think about HCBs growing in nutrient-rich lakes and reservoirs. This is typically the case for free-floating, or planktonic, HCBs. However, benthic, or bottom-dwelling, HCBs can typically grow in clear, clean rivers, wadeable streams, and lakes." In the case of uncertainties due to lack of data, these uncertainties should be adequately presented. The public should be made aware that our understanding of benthic HCBs is continually improving, and while guidance may change based on new data, it reflects the scientific community's current understanding of these organisms.

**Table 5-1. Communication and response tasks, examples, and resources**

| Key Topics | Communication and Response Tasks | Examples and Resources |
|---|---|---|
| Reporting, Notification, and Coordination Section 5.1 | Establish mechanism(s) to report blooms and illnesses<br>Establish periodic coordination calls<br>Identify funding needs and potential opportunities<br>Create contacts<br>Organize meetings and workshops<br>Establish agreements and funding mechanisms | HCB-1 Section 5.1.1, Table 5.1 (ITRC 2021)<br>Arizona Water Watch Mobile App (AZ DEQ 2021)<br>New Jersey Department of Environmental Protection WARN NJDEP app (NJ DEP 2021)<br>New York State Department of Environmental Conservation HABs Notifications Page (NYS DEC 2021)<br>bloomWatch (Cyanobacteria Monitoring Collaborative 2021a)<br>USEPA list of health and environmental agencies by state or territory (USEPA 2021g)<br>USEPA state HABs resources web page (USEPA 2021k)<br>USEPA fact sheet on funding sources for managing cyanobacterial HABs and cyanotoxins in drinking water (USEPA 2017) |
| Visual Observations Section 5.2.1 | Acquire photos<br>Compare photos to Visual Guide<br>See Section 3, Monitoring, for additional details | California *Surface Water Ambient Monitoring Program Visual Guide to Observing Blooms* (SWAMP 2017b)<br>USEPA list of state HABs monitoring programs and resources (USEPA 2021k)<br>USGS *Field and Laboratory Guide to Freshwater Cyanobacteria Harmful Algal Blooms for Native American and Alaska Native Communities* (Rosen and St. Amand 2015)<br>National Centers for Coastal Ocean Science Phytoplankton Monitoring Network Freshwater Plankton Image Gallery (NCCOS 2017)<br>cyanoScope algae guide on visual signs of a cyanobacterial bloom (iNaturalist 2021) |
| Remote Sensing Section 5.2.2 | Use readily available tools and communicate applicable issues<br>Explore additional resources available | USEPA CyAN app (USEPA 2021b)<br>Sentinel Hub Sentinel Playground (SentinelHub 2021) |

| | | |
|---|---|---|
| Field Sampling<br>Section 5.2.3 | Conduct initial site visit and collect samples<br>Conduct follow-up monitoring until bloom dissipates<br>Prepare and stage sampling supplies<br>Evaluate sampling protocol<br>Train staff on sampling | Section 3 of this document<br>USGS *Guidelines for Design and Sampling for Cyanobacterial Toxin and Taste-and-Odor Studies in Lakes and Reservoirs* (Graham et al. 2008)<br>USGS *Field and Laboratory Guide to Freshwater Cyanobacteria Harmful Algal Blooms for Native American and Alaska Native Communities* (Rosen and St. Amand 2015)<br>Cyanos.org Cyanobacteria Monitoring Collaborative (Cyanobacteria Monitoring Collaborative 2021b)<br>USEPA tools for water body managers to monitor for and respond to cyanoHABs (USEPA 2021e) |
| Laboratory Analysis<br>Section 5.2.4 | Identify labs<br>Coordinate sample receipt and timing of results<br>Identify additional laboratories and contracting needs, both contract and internal laboratory<br>Establish and update analytical contracts | USEPA list of laboratories that analyze for cyanobacteria and cyanotoxins (USEPA 2021g) |
| Drinking Water Coordination and Planning<br>Section 5.3 | Identify potentially impacted source water and intakes<br>Identify potential alternative supplies and treatment options<br>Develop and maintain an emergency response plan | USEPA cyanotoxin management tools for PWSs (USEPA 2020a) |
| Advisories and Outreach<br>Section 5.5 | Identify thresholds<br>Post advisories<br>Communicate results<br>Lift advisories when criteria are reached<br>Evaluate and improve outreach, particularly through social media<br>Build list of common questions and responses (FAQs)<br>Review updated resources<br>Update outreach materials and web pages<br>Conduct surveys | Appendix B of this document<br>Utah Department of Environmental Quality HABs web page (UT DEQ 2021b)<br>Idaho Department of Environmental Quality HCB advisory web page (ID DEQ 2021)<br>CDC cyanobacteria blooms FAQs (CDC n. d.)<br>CDC Drinking Water Advisory Communication Toolbox (CDC 2021a)<br>USEPA drinking water health advisories for cyanotoxins (USEPA 2020b)<br>USEPA Drinking Water Cyanotoxin Risk Communication Toolbox (USEPA 2021c)<br>USEPA recreational water quality criteria and methods (USEPA 2021j)<br>USEPA templates and generic examples for communicating about cyanobacterial blooms and cyanotoxins in recreational waters (see USEPA 2021j) |

| | | |
|---|---|---|
| HCB-related Illness Section 5.6 | Collect information and conduct interviews<br>Coordinate with the poison control center and the appropriate state or local health departments<br>Evaluate information<br>Draft reports<br>Summarize illness information<br>Finalize and submit reports | USEPA health effects from cyanotoxins web page (USEPA 2021f)<br>CDC OHHABS (CDC 2021c) |
| Data Management and Mapping Section 5.7 | Develop an interactive map for HCB information<br>Establish a database to house information Identify long-term storage options | California HABs Portal (CCHAB 2021a)<br>Washington State Toxic Algae website (WA Ecology 2012)<br>Utah Department of Environmental Quality Harmful Algal Blooms web page (UT DEQ 2021b)<br>Ohio Environmental Protection Agency PWS HAB monitoring map (OH EPA 2021) |

## 5.1 Reporting, Notification, and Coordination with Key Partners, Stakeholders, and the Public

The same consideration to timely notification, coordination, and engagement with key partners, stakeholders, and the public discussed in Section 5 of HCB-1 (ITRC 2021) should be applied to benthic HCBs. During benthic HCB events, special consideration should be made to engage downstream users of the water resources, as well as those upstream who may be experiencing an HCB. Please visit Section 3 to explore ways of monitoring a benthic HCB event. There are limited additions when including benthic blooms in existing HCB response plans. Where those additions do occur, they have been placed into the appropriate section categories below. Otherwise, please refer to Section 5.2 of HCB-1 (ITRC 2021) for specific conceptual consideration.

## 5.2 Bloom Identification

Once a benthic HCB has been reported, it is important to verify the report. The growth of benthic cyanobacteria in lakes and reservoirs often requires the use of underwater divers for visual monitoring of benthic cyanobacterial coverage. Although we are aware of approaches such as regular monitoring of transects for the presence of cyanobacterial mats, to our knowledge, very few formal guidelines for monitoring benthic HCBs have been developed at a regional or national level, with the exception of New Zealand's monitoring guidelines (Ministry for the Environment and Ministry for Health 2009).

Monitoring of large stretches of rivers or lake littoral zones is often impossible, especially given the patchy distribution and changing growth rates of mats. To overcome this, several countries have now adopted a proactive educational strategy. For example, monitoring agencies commonly use information signs to help educate the public on the appearance and risk the cyanobacteria pose, and this will allow them to make an informed decision on whether the water body is safe to use (SWAMP 2020, Wood et al. 2020). Finally, please refer to Section 3 for specific details regarding appropriate methods for the identification and quantification techniques discussed within Section 5.2.

### 5.2.1 Visual Observations

As mentioned in Section 1, benthic HCBs can be challenging to identify due to their variety of forms. Benthic HCBs are more of a catch-all categorization in this guidance than planktonic HCBs, as our treatment of the group encompasses species as varied as *Phormidium* mats adhering to rocks and sediments in shallow streams, globular *Aphanothece* and *Nostoc* colonies that grow on lake bottoms, and *Planktothrix* mats growing on lake sediments then floating to the surface. Their growth in inaccessible areas, such as deep in a lake, further complicates their detection and identification.

Benthic HCBs may lack some of the prominent visual cues, such as the "spilled paint" appearance, that indicate presence of a planktonic HCB. They can grow in locations with good water quality and clarity, not necessarily in impaired waters, and in a wide variety of water bodies from shallow streams to deep lakes, so their occurrence may not be considered until a cyanotoxin-related illness is reported.

Refer to the Visual Guide for guidance on evaluating and identifying common benthic HCBs in North America.

### 5.2.2 Remote Sensing

Because benthic blooms are primarily located on the bottom of a water body, using satellites to remotely sense benthic cyanobacteria presents several challenges that currently limit its application (ITRC 2021, Wood et al. 2020). However, drones and remote cameras may present more immediate options as satellite capabilities are developed.

### 5.2.3 Field Sampling

Benthic HCB monitoring should occur at sites where HCBs are known to occur, where the public accesses and recreates in the river, and where the river is used as a drinking water supply. The New Zealand Guidelines for Managing Cyanobacteria in Recreational Fresh Waters (Ministry for the Environment and Ministry for Health 2009) outline a process for sampling, briefly summarized in Wood (2017)

"…full details are given in the guidelines, but briefly it involves surveying four transects, positioned at right angles to the water's edge and extending to a depth of 0.6 m. The abundance of [benthic] mats is assessed at five points along each transect using a bathyscope. The average percent cover of [cyanobacteria] at each site is then calculated and used to identify the appropriate alert level (Table 2). At each level a series of monitoring and management actions are provided which regulators can use for a graduated response to the onset and progress of a cyanobacterial bloom or to respond to an unexpected cyanobacterial event."

The alert level framework and recommended actions are shown in Table 5-2.

**Table 5-2. Alert-level framework for benthic cyanobacteria (adapted from Ministry for the Environment and Ministry for Health 2009)**

| **Alert Level*** | **Actions** |
|---|---|
| **Surveillance (green mode)**<br>Up to 20% coverage** of potentially toxigenic cyanobacteria attached to substrate. | • Undertake fortnightly surveys between spring and autumn at representative locations in the water body where known mat proliferations occur and where there is recreational use. |
| **Alert (amber mode)**<br>20–50% coverage of potentially toxigenic cyanobacteria attached to substrate. | • Notify the public health unit.<br>• Increase sampling to weekly.<br>• Recommend erecting an information sign that provides the public with information on the appearance of mats and the potential risks.<br>• Consider increasing the number of survey sites to enable risks to recreational users to be more accurately assessed.<br>• If toxigenic cyanobacteria dominate the samples, testing for cyanotoxins is advised. If cyanotoxins are detected in mats or water samples, consult the testing laboratory to determine whether levels are hazardous. |
| **Action (red mode)**<br>*Situation 1*: Greater than 50% coverage of potentially toxigenic cyanobacteria attached to substrate<br>or<br>*Situation 2*: Up to 50% where potentially toxigenic cyanobacteria are visibly detaching from the substrate, accumulating as scums along the river's edge, or becoming exposed on the river's edge as the river level drops. | • Immediately notify the public health unit.<br>• If potentially toxic taxa are present, then consider testing samples for cyanotoxins.<br>• Notify the public of the potential health risks. |

*The alert-level framework is based on an assessment of the percentage of river bed that a cyanobacterial mat covers at each site. However, local knowledge of other factors that indicate an increased risk of toxic cyanobacteria (e.g., human health effects, animal illnesses, prolonged low flows) should be taken into account when assessing a site status and may, in some cases, lead to an elevation of site status (e. g., from surveillance to action, irrespective of mat coverage).
**A description on how to undertake a site survey is provided in the guidelines (Ministry for the Environment and Ministry for

Health 2009).
Samples should also be collected to understand “background” conditions. Benthic HCBs can be more challenging to detect than planktonic HCBs. If you have locations known to have ongoing benthic HCB issues, consider collecting samples from targeted benthic habitats to understand the “background” conditions. Depending on the species present and magnitude of the issue, collection may be done from shore, while wading or scuba diving, or by deployment of a dredge from a boat (see Section 3.2). Target attached or floating mats or colonies and material washed up near shore.

Whereas planktonic HCB events tend to occur in ponds, lakes, and reservoirs with fixed boundaries, benthic HCBs tend to occur in rivers and wadeable streams, which can extend for hundreds of miles. Therefore, determining the extent can be a challenge in benthic HCBs. Water body managers should collect data to understand the environmental conditions that are conducive to HCB formation, such as water quality conditions, flow, geomorphic setting, solar availability, and substrate.

### 5.2.4 Laboratory Analysis

Guidelines from the WHO, the USEPA, and most states were developed for planktonic HCBs, so assessing laboratory results and interpreting risk levels from benthic HCBs can be challenging. Refer to Section 2 for more information on public health guidelines.

Benthic mats and colonies contain very high concentrations of cells, so cyanotoxin concentrations can also potentially be extremely elevated. The water surrounding benthic mats may contain little to no cyanotoxins. Standard reporting units for cyanotoxins from planktonic HCBs in water are µg/L. Benthic HCB samples should be assessed as concentrations within the mat material (µg cyanotoxin/g mat material or cells/$cm^2$) for accurate evaluation of the risk from direct ingestion of mats. Laboratories may lack standard procedures for processing benthic HCB samples, so work with the laboratory to confirm processing techniques and desired reporting units. Refer to Section 2 and Section 3 for additional details.

Interpretation and communication of lab results can be challenging given the very different risks between benthic mats or colonies containing high cyanotoxin concentrations and surrounding water that may have low to undetectable cyanotoxin levels. Key points to communicate are:

- **Where the benthic HCB is located**. Is it only on the bottom, or is it floating to the surface where mat location is influenced by flow or wind? How will that influence recreational users’ ability to detect and avoid the benthic HCB?
- **What the cyanotoxin results represent**. Are separate cyanotoxin results or cell counts reported for mats and surrounding water, and is there a difference? If a grab sample of mat and surrounding water was analyzed, communication of results should indicate that results are qualitative in that the cyanotoxin concentration in the mats is approximate, but because cyanotoxin concentrations are potentially very high in mats, the primary risk associated with mats is from ingesting the mat material and secondarily from consuming the surrounding water.
- **Analytical results reflect the conditions that existed when the sample was collected**. Unless analytical methods with a short turnaround time are employed, communication of results should indicate that results reflect conditions at the time and location of sample collection, and do not necessarily reflect past or future conditions, or conditions at other locations.

## 5.3 Drinking Water Sources

### 5.3.1 Coordination with Drinking Water Utilities

Although planktonic species have been the subject of research, studies, and investigations in terms of risk assessment, little is known about benthic forms and their impact on water quality and drinking water. In addition, while more is known about benthic production of taste and odor compounds, the rate of cyanotoxin production and release from benthic species is not well defined and evaluating the impact and fate of cyanotoxins from these attached species in source waters is difficult given current knowledge.

Benthic cyanobacteria in source waters (reservoirs, rivers, and streams) can be difficult to identify and sample because they are often not visible through the water column and too deep for most water managers to sample. When floating, they may be misidentified as filamentous green algae or decomposing organic matter. Benthic cyanobacteria may grow attached to or entangled in green algae or plants. Benthic mats can be overlooked and underreported because many water managers are taught to focus on planktonic scums or discolored water as an indicator of potentially cyanotoxin-producing blooms. Continued education and training for water managers on the identification of benthic species is necessary because managers monitor and report what they are trained to seek.

Benthic cyanobacteria can also go unnoticed in treatment plants, which can lead to unidentified aesthetic and toxicity issues. Although in source water, benthic species may not easily be resuspended into the water column, if disturbed, or if mats become detached, cyanotoxins produced can be released and dispersed and could break through into water treatment plants. More is known about the aesthetic issues of taste and odor than is currently known about the rate of cyanotoxin production and release from benthic HCBs. Research has shown, however, that benthic HCBs have produced taste and odor metabolites and cyanotoxins in various parts of the world and have been determined to be a source of cyanotoxins in Australian source waters (Gaget, Lau, et al. 2017).

Given that there are no simple and standard sampling and monitoring techniques for benthic HCBs, it is important that water managers, regulatory and response agencies, and water suppliers are prepared to consider benthic HCBs as a potential source of cyanotoxins. This is especially true when typical planktonic blooms may not be present in the source water, or cyanotoxins concentrations from a planktonic bloom are determined to be nondetect or below a level of concern.

Efforts made to adapt monitoring and management strategies to improve how public water systems (PWSs) provide safe drinking water should be coordinated so that PWSs can manage and treat their source water appropriately and immediately when cyanotoxins are detected. Special drinking water treatment options should be reviewed for benthic HCBs and incorporated into a PWS's planktonic cyanotoxin management plan or emergency response document to address the actions necessary to reduce or eliminate cyanotoxins when benthic HCBs are identified. If a PWS does not currently have a management plan or response document, it is recommended that one be developed for both types of cyanobacteria.

Although the following resources and templates were created for use in developing planktonic cyanotoxin management and emergency response plans, they can also be used to develop stand-alone plans or to update current plans to include benthic HCBs and any specific challenges:

- USEPA has compiled cyanotoxin management tools for PWSs (USEPA 2020a). Resources include a cyanotoxin management plan template, a document on effective drinking water treatment approaches, methods for monitoring and sampling raw and finished water, and a Drinking Water Cyanotoxin Risk Communication Toolbox (USEPA 2021c).
- CDC's Drinking Water Advisory Communication Toolbox (CDC 2021a) provides useful tools and templates to communicate with partners and the public about drinking water advisories resulting from various causes.
- AWWA has also created documents that address frequently asked questions regarding HCBs and cyanotoxins (AWWA 2001, AWWA/WRF 2015, 2016, CDC 2021a).
- The Association of State Drinking Water Administrators has compiled a list of resources that address issues surrounding drinking water and HCBs (ASDWA 2021).
- WHO Drinking Water Guidance, Chapter 6, presents a proactive risk assessment/risk management framework for water systems to protect public health (Chorus and Welker 2021).
- The Utah Department of Environmental Quality also has a basic cyanotoxin management plan template that can help water systems get started with plan development (UT DEQ 2021a).
- LakeLine Magazine, Summer 2019, published in September by NALMS. This edition includes an article that focuses on introducing those who manage aquatic systems to the risks associated with benthic cyanobacteria and highlights the current shortcomings regarding available guidance and criteria for dealing with benthic HCBs (NALMS 2019).

Surface water treatment processes within the facility are the same when dealing with planktonic and benthic blooms. However, source water protection methods may differ as benthic blooms can be dislodged by disturbances upstream of an intake. If operators see indications that a disturbance has occurred, such as an increase in turbidity, they should watch for signs of a benthic bloom, such as dark, floating mats that may have been dislodged from the streambed. It is recommended to send any backwash water to waste when any type of bloom occurs rather than recycle it and risk re-introducing any cyanotoxins into the treatment stream.

### 5.3.2 Private (Nonregulated) Drinking Water Treatment

Sources of drinking water include private systems, including those that pull source water through private intakes. Some homes may have in-home purification systems that treat water for domestic use. Private systems can be point of use, treating water in batches and providing it to a single kitchen tap, or point of entry (whole house) systems treating most of the water that enters the residence. These private intakes and in-home systems are very effective at reducing and/or eliminating many types of bacteria and other contaminants; however, few are successful at reducing or eliminating microcystins, and none are currently capable of reducing other cyanotoxins produced by planktonic and benthic HCBs. Many individuals and tribal communities rely on private systems, because public systems are not always available due to

accessibility or the price of service. Generally, individuals on these systems live in rural areas.

Although individuals on private systems do not have the ability to adapt treatment to reduce or eliminate cyanotoxins at this time, education and outreach materials and risk communication plans are being developed for planktonic species by a handful of states using grant money provided through the CDC. Once developed, these materials could be revised to cover benthic HCBs and cyanotoxins in the event these species are identified, because the cyanotoxins they produce are the same as those from planktonic HCBs. The challenge is in dealing with the difference between cells in a planktonic bloom and those in a benthic mat. States developing these materials include Oregon, California, Florida, and Tennessee. Look for these materials to be provided on state websites once completed and published. Oregon has a web page that discusses the private drinking water pilot project the Oregon Health Authority is currently engaged in with a local coastal community. The website has information about the pilot project, and once published, will house a risk communication plan and outreach materials (OR HA 2021b).

Existing in-home treatment options for cyanotoxins are certified only for microcystin reduction to below the USEPA drinking water criteria by the National Sanitary Foundation (NSF) International and the American National Standards Institute (ANSI). See details under the P477 and NSF 53 standard (NSF 2012). Please note that these systems are not capable of reducing all cyanotoxins that may be present in the source water, making it necessary for homeowners to choose an alternative source of drinking water during a bloom.

## 5.4 Thresholds for HCB Advisories for Drinking Water, Recreation, and Pets/Livestock

There remain significant knowledge gaps in determining appropriate thresholds related to benthic HCBs in humans, pets, and livestock. Please refer to Section 2.5 for more in-depth information on the latest science and knowledge related to threshold determination. In this section, we summarize and provide examples of how this information can be applied to benthic HCB response and communication to stakeholders.

### 5.4.1 Drinking Water Advisory Thresholds

Please see Section 2.6.1.1 as well as Section 5.1.3 of HCB-1 (ITRC 2021) for a discussion on drinking water advisory thresholds for finished drinking water which may be applied to drinking water in benthic HCB events.

### 5.4.2 Recreation Advisory Thresholds

Advisory thresholds for consumption of cyanotoxins in the water through recreational activities have been established by the WHO (Chorus and Welker 2021), USEPA (2019), and many state agencies and were previously discussed in HCB-1 (ITRC 2021). As mentioned in Section 2.5, to date, all established recreational advisory thresholds based on cyanotoxin concentration rely upon exposure assumptions applied to planktonic HCBs where cyanotoxins are readily available in the water column. Although some cyanotoxins may be releases extracellularly and exist in the water column surrounding the cyanobacteria mats in benthic HCBs, the greatest concentration of cyanotoxins is intracellular and may be released when the cell dies or is ingested. Therefore, established thresholds for cyanotoxin concentration in the water column should be considered cautiously in a benthic bloom (Section 2.5 and Section 2.6.2). Sampling cyanotoxin concentrations of the water column around the benthic cyanobacterial mats will not represent the human health or animal consequences of exposure to the mat material. Several entities have adopted some level of recreation advisories based on the presence or suspected presence of known cyanotoxin-producing benthic species, percent cover of toxigenic species' mat material on the water body bottom, by applying existing planktonic HCB cyanotoxin thresholds in a modified sampling approach described below that incorporate SPATT results. There is a need to conduct research that may aid in unifying these various approaches to best characterize recreational risk during benthic HCB events. These uncertainties in recreational risk from exposure to the mat material should be appropriately presented to the public during a benthic HCB event.

*Recreational advisories based on presence or suspected presence of known cyanotoxin-producing species:* The State of California issues two levels of recreation advisories based on the presence or suspected presence of known cyanotoxin-producing cyanobacteria in a water body (CCHAB 2020a). Awareness signs are posted to inform people that known cyanotoxin-producing benthic cyanobacteria mats may be present, provide them with information about how to identify benthic mats, and advise people on preventive practices to reduce the risk of exposure to benthic mats. General Awareness signs (Figure 5-1) may be posted in water bodies in which known cyanotoxin-producing benthic cyanobacteria are likely to occur. Trigger Level signs are posted when potentially toxigenic benthic mats, floating mat material, or stranded mats on the shoreline are observed, or when cyanotoxins or cyanotoxin genes are detected within mat material. Trigger Level signs (Figure 5-2) are posted to inform people that known cyanotoxin-producing cyanobacteria mats are present, provide them

with information for how to identify benthic mats, and advise people on preventive practices to reduce the risk of exposure to benthic mats.


**Figure 5-1. General awareness sign.**

*Source: California Cyanobacteria and Harmful Algal Bloom Network (CCHAB 2020a).*


**Figure 5-2. Trigger level sign.**

*Source: California Cyanobacteria and Harmful Algal Bloom Network (CCHAB 2020a).*

*Recreational Advisories Based on Percent Cover:* New Zealand has adopted percent cover as a threshold for issuance of advisories in benthic HCB events. As outlined in Table 5.2, guidelines suggest warning signage be posted in the case of greater than 20% coverage (Figure 5-3).

**WARNING**

**Toxic cyanobacteria (blue-green algae) health hazard**

Warning: potentially toxic cyanobacteria (blue-green algae) are present in this river/stream and may affect the health of persons or animals coming into contact with the water.

Contact with the water may cause skin and eye irritation. Drinking or accidentally swallowing water may result in illness.

Cyanobacteria usually occur as dark brown/black mats attached to rocks. These mats can detach and accumulate along the riverbank.

Don't let your dog eat anything from the riverbank or come in contact with the water. Contact your vet or doctor immediately if illness occurs.

**NOTICE POSTED ON: <Date>**

**EFFECTIVE UNTIL : <Date>**

**NOTICE POSTED BY: <Name of organisation>**

**<Contact>**

**<Website>**

**Figure 5-3. Example of warning sign.**

*Source: New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters–Interim Guidelines (Ministry for the Environment and Ministry for Health 2009).*

*Recreational Advisories Based on Applying Planktonic HCB Cyanotoxin Thresholds and SPATT:* Zion National Park has adopted criteria which incorporate the presence of toxigenic cyanobacteria, a novel sampling methodology called benthic disturbance, and SPATT deployments (see Appendix B.2). Benthic disturbance samples aim to capture the reasonable worst-case recreational exposure scenario by artificially disturbing colonies of toxigenic cyanobacteria and create a reasonable exposure situation for which the thresholds set by the State of Utah can be applied. This sampling method aims to use the exposure assumptions developed for planktonic toxigenic cyanobacteria and apply them to a benthic HCB scenario. Benthic disturbance samples consist of stepping on a roughly one square meter area with a toxigenic species present for five seconds, mimicking reasonable recreational activity in the river by disturbing the mats and releasing cyanotoxins and mat material into the water column then using a 2.5-gallon bucket to scoop the disturbed water and sub-sampling from the bucket. This sampling method can be reasonably applied to Zion National Park as Zion National Park sees heavy recreational use where benthic mats can be artificially disturbed by visitors regularly. SPATT is another emerging technology that passively collects cyanotoxins in the water column over a period of time. Concentrations of cyanotoxins in the SPATT samples may be subject to a variety of factors such as flow and turbidity. Therefore, under guidance from Utah Department of Environmental Quality, Zion National Park implements advisories from SPATT cyanotoxin results as detect or nondetect rather than a concentration (Table 5-3).

**Table 5-3. Zion National Park benthic HCB recreational advisory decision criteria.**

*Source: National Park Service.*

| **ZION Benthic HCB Recreational Advisory Decision Criteria** |
|---|

| Advisory | Permitted Activities | Human Health Risk | Data | | |
|---|---|---|---|---|---|
| | | | **Presence of Toxigenic Cyanobacteria Species** | **Benthic Disturbance Sample** | **8 to 10-day SPATT** |
| | | | 1.Visual inspection (25 meters upstream/downstream of the SPATT site) | | |
| | | | 2.Taxonomic analysis | | |
| | | | 3.Found anywhere in the waterbody | | |
| **Danger Advisory (avoid all contact with the water, never drink the water)** | Permitted waterbody-related activities allowed; language in the permits indicating Danger | Potential for acute poisoning<br>Potential for long-term illness<br>Short term effects (e.g. skin and eye irritation, nausea, vomiting, diarrhea) | | Greater than 90 µg/L of anatoxin-a | |
| **Warning Advisory (avoid primary contact recreation, never drink the water)** | Permitted waterbody-related activities allowed; language in the permits indicating Warning | Potential for long-term illness<br>Short term effects (e.g. skin and eye irritation, nausea, vomiting, diarrhea) | | Less than 90 µg/L but greater than 15 µg/L of anatoxin-a | Detection anatoxin-a |
| **Health Watch (avoid primary contact recreation, never drink the water)** | Permitted waterbody-related activities allowed, permanent language indicating risk | Unknown | Toxigenic cyanobacteria present | Detection of anatoxin-a but less than 15 µg/L | Non-detect anatoxin-a |
| **No Advisory (never drink the water)** | Permitted waterbody-related activities allowed, permanent language indicating risk | | Toxigenic cyanobacteria not present | Non-detect anatoxin-a | Non-detect anatoxin-a |

### 5.4.3 Pet/Livestock Advisory Thresholds

Pets and livestock are incredibly vulnerable to benthic HCB events. In fact, many benthic HCB events are identified because of an illness or death of a domestic animal. Several states have adopted or proposed cyanotoxin thresholds for pets and livestock based on cyanotoxin concentrations in the water column. Please see Table 2-9 for a summary of these cyanotoxin thresholds.

However, to date, no governmental agency has adopted an advisory threshold based on cyanotoxins within the biomass of mat material. The State of California has proposed some cyanotoxin thresholds for cattle and dogs based on cyanotoxin concentrations within the mat material, however these thresholds have not been formally adopted. A discussion of these proposed thresholds can be found in Section 2.6.2.2. Despite a lack of established guidance, it is important to communicate with the public that there is a significant risk to pets and livestock during a benthic HCB. Pets and livestock are difficult to control around water bodies which is often a site of play or refreshment and may be attracted to the smell of cyanobacteria. The State of California has included verbiage to keep dogs away from the mat material and to not drink the water in their benthic HCB advisory signage (CCHAB 2020a). Zion National Park includes verbiage on their warning signs to keep dogs leashed, out of the water and to not let them drink the water during a benthic HCB.

## 5.5 Results, Risks, and Advisory Communication

First, it is important to educate the public that their safety is their responsibility, and one should not rely solely upon monitoring results to determine risks. Monitoring results show a particular condition in a moment of time. Bloom conditions, such as extent and toxicity, can change rapidly, diminishing following a heavy rain and scouring stream flows and expand rapidly under low flow conditions. Further, unlike planktonic HCBs which tend to occur in ponds, lakes, and reservoirs with finite boundaries, benthic HCBs tend to occur in rivers and wadeable streams without fixed boundaries where water bodies can extend for hundreds of miles. Therefore, determining the bloom extent can be a particular challenge. It is important to communicate to the public what the potentially toxic benthic HCBs look like, where benthic mats tend to be found in the system (such as along the river edge or on a particular substrate) and to remain vigilant for benthic HCBs when making choices about where and if to recreate in the water body.

Key strategies in communicating information and education materials about benthic HCB warnings include, press releases, websites, social media messaging, hotline messages, government messaging (for example GovDelivery), robocalls, radio, television, and newspaper interviews, articles and advertising, notification to stakeholders, etc. This information should include details about where benthic HCBs have been identified and how they can become detached and flow downstream or become detached, float and get pushed into other areas of a lake. It is recommended that signs be posted at high-risk sites/areas providing educational information and ways to reduce exposure. It is important to keep signage up to date or risk the public becoming complacent, believing that the warning signs are always up even when there is no risk. When available, information pamphlets and/or text alerts could be sent to the public, registered dog owners, local veterinarians, pet-related businesses, and community groups at the start of each summer to remind them to remain vigilant at certain sites or when benthic HCBs may have been identified.

- Identify groups representing different types of water body users, such as lake associations, fishing groups, watershed management groups, homeowners' associations, community science groups, and others, and consider how best to notify them of an identified bloom or persistent issue. (See Appendix B).
- Communicate the status of benthic issues through regular updates at a central location (e.g., a dedicated web page) during the benthic HCB event, including any cyanotoxin data collected or when a warning has been lifted.
- Communicate where and when new information will be available. Acknowledge unknowns, such as how long the warning will last.
- Define the parameters required to issue and lift a benthic HCB warning. Parameters may include, the extent of the benthic bloom and indications of pieces becoming detached from the original bloom, cyanotoxin sampling results or the biovolume of the mat, indications of mat materials along the shoreline either lakeside or downstream of a bloom. A predetermined period of time after which the warning is no longer necessary should also be determined. In some cases, permanent warning signs in high-risk areas, especially rivers and streams may need to be left in place throughout the recreational season. For more information on how benthic HCBs are sampled and cyanotoxins are collected, refer to Section 3.

Many states have the resources to translate warning signs and HCB-related messaging and information into different languages to ensure the health and safety of non-English-speaking residents. Not all programs have these resources, so using signage and materials from other state and federal agencies who do translations can be very helpful. If possible or available, warning signs should be posted in the most predominant languages in your area. Regardless of whether translated

signs can be produced, it is very important to use simple icons that indicate prohibited activities that everyone can understand, including individuals that may not be able to read well. Fact sheets translated into languages commonly used by area residents can be distributed to local, non-English-speaking media outlets to help disseminate information about ongoing warnings and the risks of exposure. If translations cannot be provided due to resource constraints, these groups may be able to provide translation for free to ensure their community members are safe. Installation of a Google Translate button on your benthic HCB web page or site is an effective way to direct web visitors to translation services for 64 languages.

Templates for communicating the risk of exposure to benthic mats and cyanotoxins such as press releases, warning signs and communication plans should be developed well in advance of HCB season. Even though you may not currently be aware of benthic mats in your state, these species of cyanobacteria can be found in all freshwater environments, and at some point, could become a problem for recreation, public drinking water utilities and domestic drinking water systems. It is also recommended that pre-season materials be developed to remind the public and the media each year that HCB season is coming and what people should be looking for before they choose to recreate in a water body or use drinking water from an in-home domestic system. Pre-season information can cover both planktonic and benthic HCBs and can be as minimal as a press release and information provided on a website.

When benthic HCBs are confirmed above recommended or established guidance thresholds as described in Section 2.6, communicate with partners as soon as possible so that necessary warning signs can be posted, and any other recreational or drinking water notifications can be posted or communicated. Although the types of cyanotoxins benthic HCBs can produce are the same as planktonic species, where benthic HCBs grow and how people or animals are exposed are different. Therefore, it may require specific communications regarding exposure, health risks, and recommended precautions.

Drinking water utilities should be contacted so they can sample and analyze the facilities incoming raw water. Depending on state (or primary agency) guidance and requirements, when available, utilities may be required to alert consumers about the possible presence of benthic HCBs and cyanotoxins in the raw water, and to issue “do not drink” advisories when cyanotoxins above federal or state drinking water thresholds are confirmed in finished water. If individuals are known to be on private intakes pulling source water directly into their homes for drinking water, it is recommended that educational information be provided and that users be advised to use an alternate source of drinking water until the water is determined to be safe for drinking. Unfortunately, at this time, only sampling at the tap on a routine basis can ensure that benthic cyanotoxins are not entering the system, or that the in-home treatment system is effective at reducing the cyanotoxin(s) present.

To our knowledge, there are currently no portable drinking water treatment systems that have been tested and certified as being effective at removing cyanotoxins from natural water bodies. Therefore, communications with campers, hikers, and backpackers in areas where water bodies have known or suspected benthic HCBs should be advised to not rely on portable treatment systems to remove toxins from impacted surface waters. It’s imperative that recreators learn to recognize and avoid pulling drinking water from sources with benthic HCBs and floating or disturbed mats. The communication should emphasize preventive measures such as supplying their own drinking water or, if bringing sufficient drinking water is not possible, to target spring water source origins. Every attempt should be made to communicate with backcountry recreators prior to the start of the trip so that recreators can properly plan and prepare. Communication should be made in the permitting process of a permitted trip and on land management agency websites. As a last form of communication, impacts to backcountry drinking water and recommended mitigations should be posted at trailheads.

Benthic HCBs like planktonic HCBs are prolific, however, unlike the planktonic species, benthic HCBs grow in different environments, under different conditions, and their physical appearance is different. Although they are found in lakes and reservoirs, they are often found in clear flowing systems like rivers and streams presenting unique issues for water managers and health agencies because of the connectivity of these flowing systems. Because benthic HCB mats can break off and flow downstream and potentially into other rivers, streams and lakes, issues with mats and cyanotoxins could be found beyond where the original benthic HCBs was identified (see Section 1.3.5). Therefore, defining an area for a warning is a particular challenge in benthic HCBs. It is recommended that a more general approach to issuing warnings in affected areas be used. Warnings should be issued for whole sections of the river and signage should be placed in areas with high recreational exposure.

Because benthic HCBs are found in rivers and streams and mats can detach, flow downstream, and clump together to form mats along shorelines, a general approach to risk communications should be implemented. This may include educational information and signage in highly trafficked and high-risk areas with pictures of benthic HCBs to alert the public of what to look for and recommendations on how the public and their pets can recreate safely. It is recommended that responding agencies and health officials review and use USEPA’s Good Practices When Developing Notifications for the Public (USEPA 2021a), which can assist in developing risk communications when benthic HCBs are identified.

Water-based recreation exposes individuals to a plethora of risks and cyanotoxin exposure is just one of them. Messaging

and imagery on benthic HCBs should balance the health risks of exposure with alarmism. As a water body manager, it is your duty to provide recreators with information to make an informed decision on if and how to recreate in a water body with a benthic HCB.

Although many states have developed guidance, communications templates and signage for planktonic HCBs, only a few have formally developed these materials for benthic species. Other states are in the development process and will make their materials available as they finalize and begin to use them. It is recommended that federal and state websites be monitored routinely to get the most up-to-date information on benthic species, and to keep abreast of any changes or updates made to the materials provided. Until more information is available in each state, you can find helpful information from the resources provided below.

*Recreational water:*

- California Cyanobacteria and Harmful Algal Bloom Network benthic cyanobacteria (toxic algal mats) signs and posting guidelines (CCHAB 2020a).
- New Zealand has advice for health risks and communication (Wood 2017), as well as posting criteria and signage for benthic cyanobacteria.
- New Zealand has a video discussing Benthic HCBs and showing examples of signage (Cawthron Institute 2016).
- Wisconsin Department of Health Services provides signs that include photos of the common benthic species identified in the state. Local health agencies have the ability to customize the signs to meet local needs (WI DHS 2020).

The following states provide guidance for planktonic HCBs and signage that could be revised for benthic HCBs to fit individual needs and particular circumstances. Benthic HCBs can produce the same cyanotoxins as planktonic HCBs, the difference would be appearance, the environments they grow in, and how to identify them.

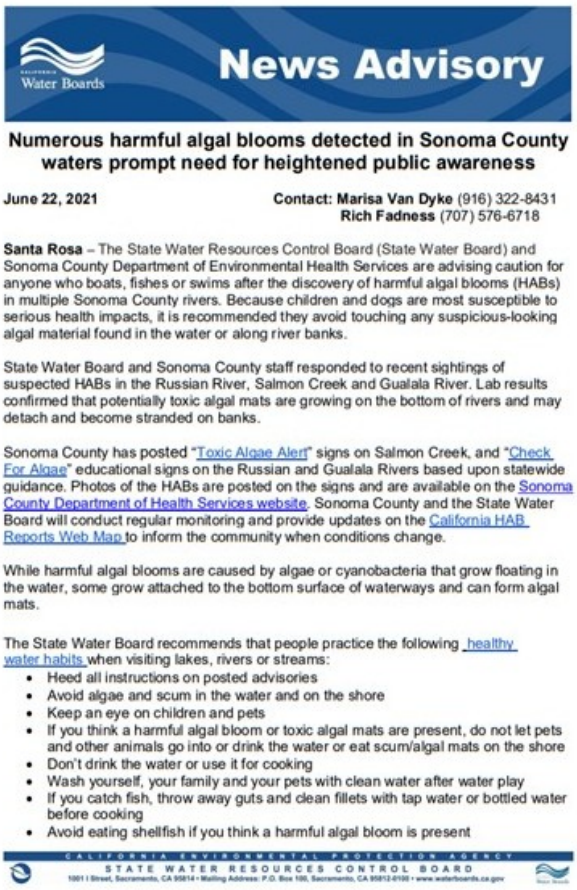
- Utah Department of Environmental Quality HAB web page and health advisory flow chart (UT DEQ 2021b)
- Oklahoma State Department of Health blue-green algae fact sheet (OKS DH 2012)
- Idaho Department of Environmental Quality recreation water quality health advisories (ID DEQ 2021)
- Oregon Health Authority current cyanobacteria advisories web page (OR HA 2021a)
- USEPA template and example advisory notices for recreational water (USEPA 2021a)

*Drinking water:*

- USEPA Drinking Water Cyanotoxin Risk Communication Toolbox with templates and advisories for drinking water (USEPA 2021c)
- CDC Drinking Water Advisory Communication Toolbox with templates of how, what, and when to communicate with stakeholders (CDC 2021a)

Press releases (Figure 5-4) about warnings should provide three to five communication objectives:

1. What was found and where.
2. How to stay safe when recreating (such as avoid benthic HCBs on rocks or from sediment and accumulations of mat material, don’t swim, wade, or submerse your head in the water in a specified area).
3. Outline the people and pets most at risk (e.g., small children and dogs) and the need to prevent them from contact with or ingestion of benthic HCBs.
4. Define what drinking water is safe and clearly state that recreators in the backcountry should not be drinking in-stream water.
5. Mention the kinds of activities that can still be enjoyed during a benthic HCB.



News Advisory

**Numerous harmful algal blooms detected in Sonoma County waters prompt need for heightened public awareness**

**June 22, 2021** **Contact: Marisa Van Dyke** (916) 322-8431
**Rich Fadness** (707) 576-6718

**Santa Rosa** – The State Water Resources Control Board (State Water Board) and Sonoma County Department of Environmental Health Services are advising caution for anyone who boats, fishes or swims after the discovery of harmful algal blooms (HABs) in multiple Sonoma County rivers. Because children and dogs are most susceptible to serious health impacts, it is recommended they avoid touching any suspicious-looking algal material found in the water or along river banks.

State Water Board and Sonoma County staff responded to recent sightings of suspected HABs in the Russian River, Salmon Creek and Gualala River. Lab results confirmed that potentially toxic algal mats are growing on the bottom of rivers and may detach and become stranded on banks.

Sonoma County has posted "Toxic Algae Alert" signs on Salmon Creek, and "Check For Algae" educational signs on the Russian and Gualala Rivers based upon statewide guidance. Photos of the HABs are posted on the signs and are available on the Sonoma County Department of Health Services website. Sonoma County and the State Water Board will conduct regular monitoring and provide updates on the California HAB Reports Web Map to inform the community when conditions change.

While harmful algal blooms are caused by algae or cyanobacteria that grow floating in the water, some grow attached to the bottom surface of waterways and can form algal mats.

The State Water Board recommends that people practice the following healthy water habits when visiting lakes, rivers or streams:

- Heed all instructions on posted advisories
- Avoid algae and scum in the water and on the shore
- Keep an eye on children and pets
- If you think a harmful algal bloom or toxic algal mats are present, do not let pets and other animals go into or drink the water or eat scum/algal mats on the shore
- Don't drink the water or use it for cooking
- Wash yourself, your family and your pets with clean water after water play
- If you catch fish, throw away guts and clean fillets with tap water or bottled water before cooking
- Avoid eating shellfish if you think a harmful algal bloom is present

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
STATE WATER RESOURCES CONTROL BOARD

News Advisory

Get medical treatment immediately if you think any person, pet or livestock has become sick after going in the water. Be sure to alert the medical professional to the possible contact with cyanobacteria. Also, please contact the local county public health department.

**To report a bloom, do one of the following:**

- Fill out the Bloom Report form on the State Water Board HABs portal
- Email: CyanoHAB.reports@waterboards.ca.gov
- Call the HABs hotline: 1-844-729-6466 (toll free)
- Contact Sonoma County Environmental Health: 707- 565-6565

**For more information about HABs, please visit:**
California Harmful Algal Blooms Portal
Sonoma County Cyanobacteria website

*Follow us on twitter: @CaWaterBoards*

**Figure 5-4. Example of a harmful algal bloom press release.**

*Source: California State Water Boards (2021).*

More related resources and options to consider when more planning time is available are presented in Section 5.2.5 of HCB-1 (ITRC 2021)

## 5.6 HCB-related Illnesses Documentation and Evaluation

Refer to Section 5.1.6 of HCB-1 (ITRC 2021) for guidance on evaluation and documentation of HCB-related illnesses. When inquiring about environmental conditions at the time of exposure, determine if floating mats, colonies, or submerged mats were present at the time of exposure.

## 5.7 Maps and Data Management Optimization and Improvement

See Section 5.2.5.3 in HCB-1 (ITRC 2021) for information on and examples of sharing HCB data with the public using maps of HCB occurrences and advisories. When mapping benthic HCBs, it is especially important to include information for the public on differentiating benthic HCBs from planktonic HCBs. It is essential to share caveats and disclaimers about monitoring, advisory, and HCB occurrence data with the public, so they understand that monitoring data are accurate for conditions at the time and location of sample collection, and do not necessarily reflect past or future conditions or other locations on the water body.

When mapping satellite-detected HCBs, it is important to convey the limitations of the data, including that estimated measurements of cyanobacteria may not accurately assess conditions in the nearshore or beach areas, and are not real-time data. For example, see the disclaimers on the California Satellite CyanoHAB Map (CCHAB 2021c).

When designing repositories for management and storage of HCB data, consider all possible users, including PWSs, public health agencies, and recreational property managers. HCB data also inform water quality management strategies, so building HCB databases that communicate with or integrate with existing databases, such as the USEPA Water Quality Exchange or state-level beach health databases, will maximize the use of your HCB data.