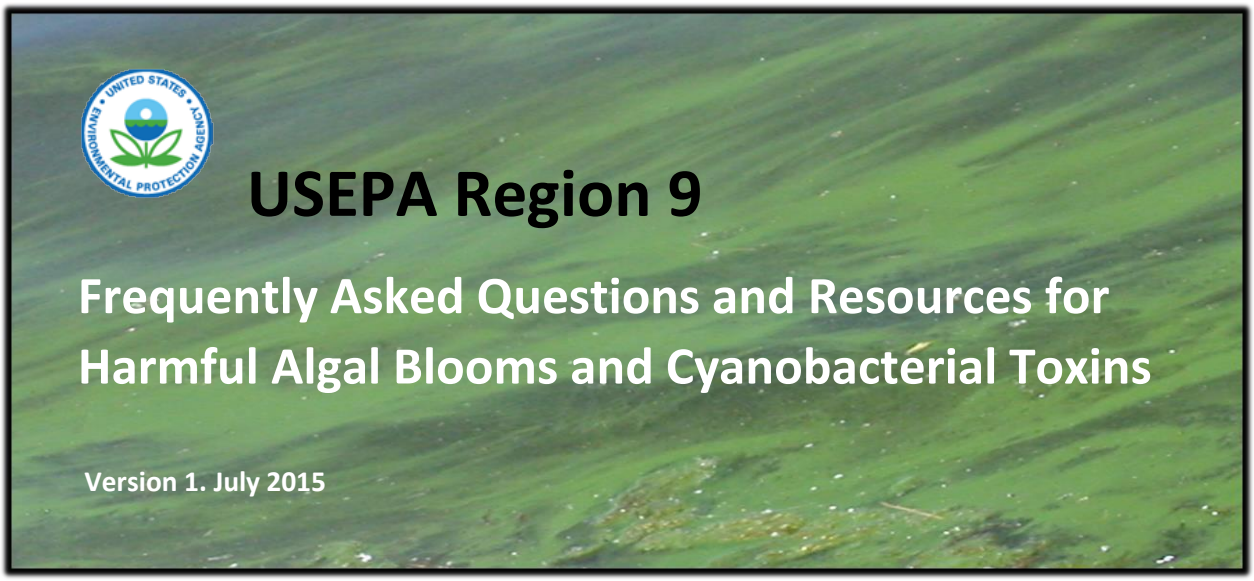

USEPA Region 9

Frequently Asked Questions and Resources for Harmful Algal Blooms and Cyanobacterial Toxins

Version 1. July 2015

Recognizing the growing concerns with harmful algal blooms (HABs), and in response to worsening conditions brought on by the current drought, U.S. EPA Region 9 has produced this list of frequently asked questions and resources on HABs and cyanobacterial toxins or "cyanotoxins." The document is intended to help provide interested stakeholders, members of the public, as well as Region 9 staff and managers, a basic understanding of HABs and issues pertaining to HABs as well as links to resources and contact information for more in-depth information.

What are harmful algal blooms?

Algae are very important to both freshwater and marine environments and most species are harmless under normal circumstances. Cyanobacteria are commonly referred to as "algae" or "blue-green algae" but they are actually photosynthetic bacteria that share properties with algae. They are naturally found in fresh and marine aquatic water bodies and when present in large quantities as "blooms", they can impact recreational, aesthetic, aquatic life and drinking water beneficial uses of waterbodies. Biomass from blooms can cause anoxia, hypoxia, and habitat alteration, and impact drinking water systems; and cyanobacteria can produce toxic compounds (cyanobacterial toxins or "cyanotoxins") that can pose a significant potential threat to human and ecological health and affect taste, odor and safety of drinking water. These harmful cyanobacterial blooms, commonly referred to as "harmful algal blooms"(cyanoHABs) have the potential to cause adverse health effects in humans and animals through the degradation of waterways used for recreational purposes and as drinking water supplies.

What are the common causes of harmful algal blooms?

Under the right conditions cyanobacteria can multiply rapidly, forming a bloom in the water; sometimes a blue-green "scum" forms on the water surface, though blooms can be green, blue, red or brown. While not well understood, when conditions are favorable, cyanobacteria can produce cyanotoxins. Increased inputs of nutrients like nitrogen and phosphorous, often from human land use practices, promote cyanobacterial growth and can lead to increased occurrences of HABs. Low flows, stagnant water, increased intensity and duration of sunlight, and sustained high temperatures, as we've experienced with the current drought, create the ideal conditions for freshwater cyanoHABs and can lead to new, larger and prolonged blooms.

What are the possible effects of harmful algal blooms?
Human exposure to cyanobacteria and cyanotoxins generally occurs through recreational contact (ingestion, inhalation, dermal contact) and ingestion of drinking water. The acute effects of contact recreational exposure from activities like swimming, jet skiing, etc., can result in a wide range of symptoms in humans including skin and eye irritation, fever, headaches, muscle and joint pain, blisters, stomach cramps, diarrhea, vomiting, mouth ulcers and allergic reactions. Effects can occur within minutes to days after exposure. In severe cases, seizures, liver failure, respiratory arrest, and (rarely) death may occur. In the most recent survey by the Centers for Disease Control and Prevention (CDC), for the years 2009-2010, eleven freshwater HAB-associated outbreaks were reported by New York, Ohio and Washington and resulted in 61 known illnesses, 2 hospitalizations and no deaths.[i] The most common effects are observed in dogs and livestock due to consumption of water with cyanotoxins or grooming after swimming. In 2015 alone, several dog deaths have been linked to cyanoHAB exposure from California waters. Fish and aquatic animal and plant die-offs can also occur when blooms block sunlight or when they decay and oxygen in the water is depleted resulting in hypoxic conditions.[ii]

When located near drinking water intakes, HABs can result in taste and odor problems in treated drinking water. Management practices that water utilities already use to address taste, odor and operational effects of algae are generally effective at removing cyanobacteria and cyanotoxins but there is potential for drinking water to contain cyanotoxins if the proper treatment process is not used.

In estuaries and marine environments, both freshwater and marine cyanobacteria with associated toxins can accumulate in fish and shellfish that can, if gone undetected, be consumed by humans and result in poisoning.[iii] These cyanotoxins are also known to impact health and cause death in fish and marine mammals.

Economic losses can occur due to impacts on recreation, such as fishing, swimming and concessions, and increased costs to manage and treat drinking water supplies.

How can cyanotoxins be detected?
The presence of cyanotoxins cannot be determined simply by looking at a bloom. Detection of cyanotoxins requires collecting representative samples and analyzing for cyanobacteria and/or cyanotoxin levels. There are several monitoring methods designed for different types of cyanotoxins and with varying levels of accuracy, cost, availability and detection limits. The most common are commercially available field test kits that easily detect presence and absence and do not require expensive equipment or extensive training. More precise analytical methods are recommended as follow up when presence is detected.[iv]

How can you protect yourself from exposure to cyanotoxins?
The following recommendations are based on guidance from the State of California and should be followed to avoid recreational exposure to cyanotoxins:[v]

- Avoid wading, swimming or jet or water skiing in water containing cyanobacteria blooms or scums or mats.
- Do not drink, cook or wash dishes with untreated surface water from these areas under any circumstances; common water purification techniques (e.g., camping filters, tablets and boiling) do not remove toxins. Even when blooms are not present, still carefully watch young children and warn them not to swallow the water.

- People should not eat mussels or other bivalves collected from impacted areas. Limit or avoid eating fish; if fish are consumed, remove guts and liver, and rinse filets in clean drinking water.
- Get medical treatment immediately if you think that you, your pet, or livestock might have been poisoned by cyanotoxins. Be sure to alert the medical professional to the possible contact with cyanobacteria.
- Take care that pets and livestock do not drink the water, swim through algae, scums or mats, or lick their fur after going in the water. Rinse pets in clean drinking water to remove algae from fur.

How can harmful algal blooms be treated and managed?

The development, size and persistence of HABs can potentially be reduced through source reduction of nutrients such as nitrogen and phosphorous that are commonly more prevalent due to human activities such as application of fertilizers. When and where HABs do develop, effective drinking water management strategies will depend on the growth patterns and species of cyanobacteria that dominates the bloom, and whether cyanotoxins are present. Applying the wrong treatment process could damage cyanobacteria cells and result in the release of intracellular toxins, rather than the removal of cyanotoxins.[vi]

Currently there are no U.S. federal water quality criteria or regulations for cyanobacteria or cyanotoxins in drinking water under the Safe Drinking Water Act (SDWA) or in ambient waters under the Clean Water Act (CWA). In June 2015, EPA issued drinking water health advisories (HAs) for the cyanobacterial toxins microcystins and cylindrospermopsin. Health advisories describe non-regulatory concentrations of drinking water contaminants at or below which adverse health effects are not anticipated to occur over specific exposure durations. HAs are not legally enforceable federal standards. EPA has recommended HA levels at or below 0.3 micrograms per liter for microcystins and 0.7 microgram per liter for cylindrospermopsin in drinking water for children pre-school age and younger (<6 years). For school age children through adults, the recommended HA levels for drinking water are at or below 1.6 micrograms per liter for microcystins and 3.0 micrograms per liter for cylindrospermopsin. EPA also published health effects support documents containing the health effects basis for these cyanobacteria. A health effects support document was also published for anatoxin-a, but EPA concluded there was not adequate information to support a health advisory for this toxin. These three cyanobacterial toxins are the most commonly occurring in water bodies that are a source of drinking water in the U.S. and were placed on the Contaminate Candidate List which identifies contaminants that may need regulation under the Safe Drinking Water Act. [vii]

The World Health Organization (WHO) Guidelines recommend concentrations of microcystins in drinking water be controlled to 1 microgram per liter, taking into consideration lifetime exposure levels. For recreational exposure in freshwater, to avoid the risk of health effects WHO recommends a range of guidelines including 10 micrograms per liter to avoid allergenic effects, 50 micrograms per liter to avoid moderate health risks, and avoiding waters with the presence of cyanobacterial scum in swimming areas.[viii]

California is the only state in Region 9 that has issued health-based action levels or voluntary guidelines for recreational exposure to cyanotoxins. They include action levels for humans, pets and livestock under selected scenarios for microcystins, cylindrospermopsin, and anatoxin-a. California recommends public advisories for recreational exposure and additional monitoring at or above 0.8 microgram per liter for microcystins, 4 micrograms per liter for cylindrospermopsin, and 90 micrograms per liter for anatoxin-a. However, levels protective of pets and livestock differ and are in several cases lower than

action levels for human exposure. Guidelines for health based action levels were also derived for concentrations in sport fish and shellfish.[ix]

What is EPA doing to address HABs?

In addition to the recently released health advisories and the health effects support documents for common cyanotoxins in drinking water, EPA is working on various efforts nationally to address HABs and cyanotoxins. EPA's CyanoHabs website[x] provides an online resource for freshwater cyanobacterial HABs, including causes, detection, treatment, health and ecological effects, current research in the U.S. and policies and regulations at the state and international levels. EPA also co-hosts the Inland HABs Discussion Group[xi] with the U.S. Geological Survey (USGS) and the Centers for Disease Control and Prevention (CDC) to provide a forum for interested parties to discuss issues pertaining to HABs. EPA is also teamed with NOAA, NASA and USGS on the Cyanobacteria Assessment Network (CyAN) project, developing an approach using satellites as remote sensing technology for early warning of nuisance algal blooms and water quality monitoring in coasts, estuaries, and lakes.

EPA Region 9 efforts are primarily focused on providing expertise and resources to build capacity of state and local agencies, focused on California, to help them prevent and respond to potential health threats to the public in drinking water systems and from recreational exposure to cyanotoxins. As part of this effort, Region 9 is participating in workgroups to assist state agencies and county health departments to improve their HAB monitoring and response strategies, and to update California's recreational exposure guidance. Ongoing efforts to address human and environmental health issues in targeted priority watersheds include Region 9 support for cyanotoxin monitoring and analysis. Region 9 is also a collaborator on the CyAN project, with California being an early participant in that study.

Where are harmful algal blooms occurring in Region 9?

Based on previous years' experience, EPA is aware of numerous water bodies in Region 9 where HABs are known to occur. EPA continues to learn of new and persistent HABs through working with federal, state and local partners and will continue to provide support to address this serious issue. Water bodies with recurrent HABs include Pinto Lake near Monterey; Lake Temescal, Lake Chabot and Del Valle Reservoir in the San Francisco Bay Area; San Francisco Bay Delta, including the North and South Bay Aqueducts; the San Joaquin River and Clifton Court Forebay near Stockton; Bethany Reservoir near Livermore; Clear Lake; Klamath River and Iron Gate and Copco reservoirs; Eel River; Trinity River; and the Colorado River, Lake Mead, Lake Powell, and Central Arizona Project.

Who should you contact with questions or concerns about HABs in Region 9?

Recreational Waters

Within EPA Region 9, the majority of HABs in recreational waters have occurred in California where you can contact the following:

- County health department listings and contact information are available at the California Department of Public Health's website: http://www.cdph.ca.gov/programs/immunize/pages/californialocalhealthdepartments.aspx.
- California Regional Water Quality Control Boards: http://www.waterboards.ca.gov/about_us/contact_us/rwqcbs_directory.shtml

In Arizona contact Jason Jones, Surface Water Monitoring and Assessment Unit at jdj@azdeq.gov and (602) 771-2235.

Drinking Water

For questions and concerns related to drinking water exposure in California, contact the county health department at the link listed above under Recreational Waters, or contact the nearest State Water Resources Control Board Division of Drinking Water District Offices at: http://www.waterboards.ca.gov/drinking_water/programs/index.shtml#north_south.

In Arizona contact Jon Fiegen, Drinking Water Monitoring and Protection Unit at jfb@azdeq.gov and (602) 771-4596.

In Nevada contact the Nevada Division of Environmental Protection, Bureau of Safe Drinking Water at http://ndep.nv.gov/BSDW/index.htm and (775) 687-9520 or the Southern Nevada Health District Office http://southernnevadahealthdistrict.org/ and (702) 759-1000.

You can also find contact information within your state, including a list of laboratories that analyze cyanotoxins, at EPA's CyanoHABs website: http://www2.epa.gov/nutrient-policy-data/state-resources.

HABs related questions within EPA Region 9 can be directed to Dr. Bruce Macler, EPA Region 9 Toxicologist for drinking water exposure at Macler.Bruce@epa.gov and (415) 972-3569, and for recreational exposure, Susan Keydel, EPA Region 9 Environmental Scientist at Keydel.Susan@epa.gov and (415) 972-3106.

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[i] Centers for Disease Control and Prevention, 2014: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6301a3.htm

[ii] USEPA's *Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems* http://www2.epa.gov/sites/production/files/2015-06/documents/cyanotoxin-management-drinking-water.pdf

[iii] World Health Organization Guidelines for safe recreational water environments: http://www.who.int/water_sanitation_health/bathing/srwe1execsum/en/index6.html

[iv] USEPA's *Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems* http://www2.epa.gov/sites/production/files/2015-06/documents/cyanotoxin-management-drinking-water.pdf

[v] California Department of Public Health: http://www.cdph.ca.gov/HealthInfo/environhealth/water/Documents/BGA/BGAdraftvoluntarystatewideguidance-07-09-2010.pdf

[vi] USEPA's *Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems* http://www2.epa.gov/sites/production/files/2015-06/documents/cyanotoxin-management-drinking-water.pdf

[vii] USEPA 2015 Drinking Water Health Advisories for Two Cyanobacterial Toxins: http://www2.epa.gov/sites/production/files/2015-06/documents/cyanotoxins-fact_sheet-2015.pdf

[viii] World Health Organization Guidelines for safe recreational water environments: http://www.who.int/water_sanitation_health/bathing/srwe1execsum/en/index7.html

[ix] California Environmental Protection Agency, 2012: http://www.swrcb.ca.gov/water_issues/programs/peer_review/docs/calif_cyanotoxins/cyanotoxins053112.pdf

[x] EPA's CyanoHABs website: http://www2.epa.gov/nutrient-policy-data/cyanohabs

[xi] Inland HAB Discussion Group: http://www2.epa.gov/nutrient-policy-data/inland-hab-discussion-group

Resources for Harmful Algal Blooms and Cyanobacterial Toxins

There is a substantial and growing collection of information on HABs, and the following is a selection of useful links by agency and topic for more information on HABs, cyanobacteria and cyanotoxins:

U.S. Environmental Protection Agency
Cyanobacterial Harmful Algal Blooms website:
http://www2.epa.gov/nutrient-policy-data/cyanohabs

- Cyanobacteria/Cyanotoxins
  http://www2.epa.gov/nutrient-policy-data/cyanobacteriacyanotoxins
- Detection
  http://www2.epa.gov/nutrient-policy-data/detection
- Health and Ecological Effects
  http://www2.epa.gov/nutrient-policy-data/health-and-ecological-effects
- Research and News
  http://www2.epa.gov/nutrient-policy-data/research-and-news
- Causes and Prevention
  http://www2.epa.gov/nutrient-policy-data/causes-and-prevention
- Control and Treatment
  http://www2.epa.gov/nutrient-policy-data/control-and-treatment
- Policies and Guidelines
  http://www2.epa.gov/nutrient-policy-data/policies-and-guidelines
- Guidelines and Recommendations
  http://www2.epa.gov/nutrient-policy-data/guidelines-and-recommendations
- State Resources
  http://www2.epa.gov/nutrient-policy-data/state-resources
- More Information
  http://www2.epa.gov/nutrient-policy-data/more-information

Health Advisory information for microcystins and Cylindrospermopsin and the three health effects support documents, including anatoxin-a, can be found at EPA's Drinking Water Science and Regulatory Support website and the Human Health Risks Webinar:
http://www2.epa.gov/nutrient-policy-data/drinking-water-health-advisory-documents,
http://www2.epa.gov/nutrient-policy-data/health-effects-support-documents,
http://www2.epa.gov/nutrient-policy-data/human-health-risks-exposure-cyanotoxins-webinar

Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water, June 2015
http://www2.epa.gov/sites/production/files/2015-06/documents/cyanotoxin-management-drinking-water.pdf

Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems, September 2014
http://www2.epa.gov/sites/production/files/2014-08/documents/cyanobacteria_factsheet.pdf

National Oceanic and Atmospheric Administration
Harmful Algal Blooms website:
http://oceanservice.noaa.gov/hazards/hab/

Centers for Disease Control and Prevention
Harmful Algal Blooms website:
http://www.cdc.gov/healthcommunication/ToolsTemplates/EntertainmentEd/Tips/AlgalBlooms.html

State of California:
California CyanoHAB Network
http://www.mywaterquality.ca.gov/monitoring_council/cyanohab_network/

State Water Resources Control Board Blue-Green Algae and Harmful Blooms website:
http://www.waterboards.ca.gov/water_issues/programs/bluegreen_algae/

American Water Works Authority
A Water Utility Manager's Guide to Cyanotoxins, 2015
http://www.awwa.org/resources-tools/public-affairs/press-room/press-release/articleid/3402/cyanotoxins-guide-targets-blooming-issue.aspx

Algae Source to Treatment Manual of Water Supply Practice M57, 2010 is available for purchase at the AWWA website at www.awwa.org

Monitoring:
U.S. Geological Survey: *Guidelines for Design and Sampling for Cyanobacterial Toxin and Taste-and-Odor Studies in Lakes and Reservoirs, 2008*
http://pubs.usgs.gov/sir/2008/5038/pdf/SIR2008-5038.pdf

U.S. Geological Survey and Vermont Department of Environmental Conservation: *State Monitoring Programs for Cyanobacterial Toxins in Recreational Fresh Waters of the US, 2009*
http://ks.water.usgs.gov/static_pages/studies/water_quality/cyanobacteria/LLsummer-graham2.pdf

California State Water Resources Control Board/Department of Public Health/Office of Environmental Health and Hazards Assessment: *Cyanobacteria in California Recreational Water Bodies, July 2010 Draft* (Appendix 1 - monitoring)
http://www.cdph.ca.gov/HealthInfo/environhealth/water/Documents/BGA/BGAdraftvoluntarystatewideguidance-07-09-2010.pdf

Oregon Public Health Division: *Sampling Guidelines for Cyanobacterial Harmful Algal Blooms in Recreational Waters, October 2012*
http://public.health.oregon.gov/HealthyEnvironments/Recreation/HarmfulAlgaeBlooms/Documents/HAB%20Sampling%20Guidance%2001032014.pdf

Oregon Health Authority: Algae Resources for Drinking Water website (includes monitoring guidelines)
http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Treatment/Pages/algae.aspx