



Algae bloom risk-management toolkit

For recreational waters



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Introduction

Certain types of algae blooms can produce toxins called cyanotoxins that can be harmful to humans and animals. This toolkit is designed to assist recreational water managers in assessing the health impacts of water bodies with detectable levels of toxins.

This algae bloom risk-management toolkit is not a standard or regulation, nor does it create any new legal obligations. The toolkit was created as a supplement to the guidelines released by the U.S. Environmental Protection Agency (EPA) of Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin (EPA, 2016). The toolkit is advisory in nature, informational in content, and contains specific response steps intended to assist in the management of recreational waters to protect public health.

What is harmful algae?

Harmful algae (also known as blue-green algae) is common and natural to our waters and found throughout Colorado (see *Images of algal blooms*, below). The algae can multiply rapidly to form blooms and scums, particularly during spring, summer and fall.

Exposure to harmful algae

Both recreational and non-recreational activities can present opportunities for exposure to cyanotoxins through oral, dermal and inhalation exposure. Examples of recreational exposure in water containing cyanotoxins include: incidental ingestion of water during activities such as swimming, wading and surfing; water contact of exposed parts of the body while recreating; and inhalation of contaminated aerosols during activities such as boating, jet skiing and waterskiing. Exposure through non-recreational pathways can occur from activities such as consumption of cyanotoxin-contaminated drinking water and food (including fish), and during bathing or showering.

The primary route of exposure considered in this risk management toolkit is oral exposure via incidental ingestion while swimming. Dermal exposure happens during swimming; however, ingestion from inhalation is likely negligible compared to incidental ingestion while recreating (EPA, 2016).

Health effects

General health effects caused by exposure to harmful algae vary according to the type of toxin and exposure. Humans can present a range of symptoms including: skin irritation, stomach cramps vomiting, nausea, diarrhea, fever, sore throat, headache, muscle and joint pain, blisters of the mouth, kidney damage, liver damage, and neurotoxic effects. Swimmers in water containing harmful algae may suffer allergic reactions such as: blisters around the mouth and nose, increased asthma symptoms and rashes. According to EPA, there is inadequate evidence at this time to determine whether cyanotoxins cause cancer.

Identifying harmful algae

Harmful algae can resemble thick pea soup or look like spilled paint on the water's surface. It can create a thick mat of foam along the shoreline. Harmful algae is generally green or blue-green in color although it can be brown, purple or white. It can be made of small specks floating on or just beneath the surface of the water. Harmful algae is not stringy, grass-like or mustard yellow in color (the latter is probably pollen). Several images of different algae blooms occurring in Colorado are shown below.

Images of algae blooms



Risk management actions to protect public health

- Step 1: Assess vulnerability of the water body to harmful algae and prioritize recreational waters for monitoring.
- Step 2: Visually monitor recreational water body for signs of harmful algae at the beginning and throughout the recreational season.
- Step 3: Monitor for harmful algae blooms. If present, post signage; if above cyanotoxin advisory value, issue a No Contact Advisory until at least two consecutive tests show that the toxin level is below the advisory value.
- Step 4: Follow up cyanotoxin monitoring. At a minimum, continue to monitor until the toxin level is no longer measurable or consistently below the advisory value.

Monitoring recommendations adapted by CDPHE based on: *Recommendations for Cyanobacteria and Cyanotoxin Monitoring in Recreational Waters*; U.S. Environmental Protection Agency. Recommended actions reflect the December 2016 *Draft EPA Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin*.

Note: EPA does not regularly monitor recreational waters for harmful algae.

Recommended advisory values for harmful algae

Currently, laboratory analysis is necessary for all suspect cyanotoxins as existing field testing methods (e.g., dipstick-type tests) do not provide sufficiently low detection limits. While the sample is being tested at the laboratory, CDPHE advises posting “caution” signage indicating that harmful algae may be present. If laboratory test results indicate toxins exceed the recommended advisory values, CDPHE advises issuing a No Contact Advisory and posting “warning” signage. If a field test is determined to exceed the advisory, a No Contact Advisory may be issued based on the field test at the recreational water manager’s discretion.

Advisory value (µg/L)	Microcystin ^a	Cylindrospermopsin	Anatoxin	Saxitoxin ^a
No Contact Advisory	4	8	8 ^b	4 ^b

^aAdvisories are intended to be applied to the sum of the concentrations of all reported congeners of these toxins.

^bAnatoxin and saxitoxin advisories are based on the limited amount of available data, and should be considered provisional.

See page 5 for more information on testing and technical documentation.

Risk management definitions

A **Harmful Algae Caution** exists when potentially harmful algae are visible.

A **No Contact Advisory** exists when any of the following are true:

1. Microcystin or saxitoxin levels are 4 µg/L or greater.
 2. Cylindrospermopsin or anatoxin levels are 8 µg/L or greater.
 3. A recent human illness or animal death associated with cyanobacterial toxins has been reported in affected area.
-

Sample language for signage

CAUTION

Harmful algae may be present

- Use caution when contacting water and wash with clean water afterward
- Do not let people/animals eat algae or drink untreated water
- Avoid areas of algae accumulation
- Keep pets away from water
- Fishing permitted (clean fish well and discard guts appropriately)
- Boating permitted (avoid boating near or through algae)
- Contact Poison Control Center (or veterinarian) if you (or your pets) experience nausea, vomiting, diarrhea, rash, irritated eyes, seizures, breathing problems or other unexplained illness
- For further information:
<http://www.cdc.gov/healthcommunication/toolstemplates/entertainmented/tips/algalblooms.html> (or <http://1.usa.gov/1GMKryF>)

NO CONTACT ADVISORY

WARNING

Harmful algae present

People & animals may get sick

- Area is closed to full-body contact
- Do not let people/animals eat algae or drink untreated water
- Avoid areas of algae accumulation
- Keep pets away from water
- Fishing permitted (clean fish well and discard guts appropriately)
- Boating permitted (avoid boating near or through algae)
- If people/pets contact the water, wash with clean water as soon as possible
- Contact Poison Control Center (or veterinarian) if you (or your pets) experience nausea, vomiting, diarrhea, rash, irritated eyes, seizures, breathing problems or other unexplained illness
- For further information:
<http://www.cdc.gov/healthcommunication/toolstemplates/entertainmented/tips/algalblooms.html> (or <http://1.usa.gov/1GMKryF>)

To ensure public safety, CDPHE recommends maintaining signage until the toxin level is no longer measurable or consistently below the advisory value.

See appendix on page 7 for example signage.

Technical documentation

Background

Given that cyanobacterial blooms are typically seasonal events, recreational exposures are likely to be episodic, and short-term in nature. Short-term recreational water advisory values are based on available toxicological information. These values may change if updated toxicity values and/or exposure assumptions become available. These advisory values assume 80% of an individual's intake is from incidental ingestion during recreational activities such as swimming and wading and 20% is set aside for exposures from other sources (e.g., exposures to contaminated fish and shellfish, or drinking water) and exposure routes (e.g., dermal and inhalation routes) in accordance with EPA's recent draft recreational guidelines (EPA 2016). Exposure assumptions used in deriving recreational water advisory values are based on EPA's standard assumptions. These assumptions are considered reasonably protective but may over- or underestimate risk for other ages and exposure times. The following are not addressed due to the lack of available information:

- Exposure to a mixture of cyanotoxins.
- Effects of long-term exposures to cyanotoxins (cancer and non-cancer).

Method

To calculate recreational use water advisory values, the method described in EPA's draft recreational guidelines (EPA 2016) was used:

$$\text{Recreational use water advisory value } (\mu\text{g/L}) = \frac{\text{RfD} \times \text{RSC} \times \text{BW}}{\text{IR}}$$

Where:

RfD = Reference dose ($\mu\text{g}/\text{kilograms [kg]}$ body weight [bw]/day [d])

RSC= Relative source contribution of 80%

BW = Mean body weight (kg)

IR = Ingestion rate (L/d) at approximately the 90th percentile

EPA fully describes their conservative approach in deriving the advisory level based on incidental ingestion of 0.33 L/day of water during recreational swimming and the body weight for a 6-11 year old child of 31.8 kg. A full description of the EPA exposure assumptions are provided in [Draft Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin](https://www.epa.gov/sites/production/files/2016-12/documents/draft-hh-rec-ambient-water-swimming-document.pdf) (https://www.epa.gov/sites/production/files/2016-12/documents/draft-hh-rec-ambient-water-swimming-document.pdf).

Exposure parameters and reference dose for short-term recreational use of surface water containing cyanotoxins

Cyanotoxin	Age (years)	Body Weight (kg)	Incidental Water Ingestion Rate (L/d)	Relative Source Contribution (RSC)	Short-term Reference Dose (RfD) (µg/kg/d)	Recreation use water advisory value (µg/L)
Microcystin	6-11 ^a	31.8 ^a	0.33 ^a	0.8 ^a	0.05 ^a	4
Cylindrospermopsin					0.1 ^a	8
Anatoxin					0.1 ^b	8
Saxitoxin					0.05 ^c	4

^a U.S. EPA Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin - Draft. 2016.

^b Farrer, D., Counter, M., Hillwig, R., Cude C. Health-based cyanotoxin guideline values allow for cyanotoxin-based monitoring and efficient public health response to cyanobacterial blooms. *Toxins*. 2015 7:457-477. NOAEL for mortality = 0.1 mg/kg/day /uncertainty factor of 1000

^c Acute Reference dose (ARfD) was derived from a European Food Safety Authority (2009) publication based on available intoxication reports in humans across the European population. NOAEL for neurological effects = 0.0005 mg/kg/day /uncertainty factor of 10

Testing information

Test strip kits or dipstick-type tests are available for use in acquiring preliminary semi-quantitative test results in the field for microcystin, cylindrospermopsin and anatoxin. One manufacturer of rapid environmental test systems, Abraxis, Inc. (<https://www.abraxiskits.com/products/algal-toxins/>), currently produces test strip kits that detect cyanotoxins within a range of 1-5 and 1-10 µg/L for microcystin; 0.5-10 µg/L for cylindrospermopsin; and 0.4-2.5 µg/L for anatoxin. Test strip kits are not currently available for saxitoxin.

Field tests can be effective to screen for cyanotoxins, however laboratory testing is recommended when toxins are present. CDPHE's Laboratory Services Division tests water for microcystin, cylindrospermopsin and anatoxin by both ELISA and liquid chromatography and tandem mass spectrometry (LC/MS/MS) detection. CDPHE's cyanotoxin sampling and shipping instructions are available here:

<https://drive.google.com/file/d/0B0tmPQ67k3NVTm1yWmFLREcyRG8/view?usp=sharing>

Contact

General water chemistry testing information
 CDPHE Chemistry Laboratory - 303-692-3048
cdphe_chemistry@state.co.us

For subject matter questions
 Caroline Wang - 303-692-3174

Appendix

Examples of harmful algae caution and warning signs used by the Colorado Department of Parks and Wildlife are included for reference.

CAUTION

Toxic Algae May be Present

- Do not drink lake water
- Avoid contact with floating algae mats
- Keep pets away
- Fishing Permitted
- Boating Permitted



Call your doctor or veterinarian if you or your animals have nausea, vomiting, diarrhea, rash, irritated eyes, seizures or breathing problems.
For more information: <http://1.usa.gov/1oRiyNV>



PRECAUCIÓN

Se Habrán Presentes Algas Tóxicas

- No beba agua del lago
- Evite el contacto con esteras de algas flotantes
- Mantenga a las mascotas lejos
- Pesca Permitida
- La Navegación Permitida



Llame a su médico o veterinario si usted o sus animales tiene náuseas, vómitos, diarrea, erupción cutánea, irritación de los ojos, convulsiones o problemas respiratorios.
For more information: <http://1.usa.gov/1oRiyNV>



WARNING

Toxic Algae Present

AREA IS CLOSED TO FULL-BODY CONTACT

- Do Not Drink Lake Water
- No Swimming or Body Contact
- No Water Skiing
- No Jet Skiing
- No Paddle Boarding
- No Pets in Water



•Boating Permitted

•Fishing Permitted - clean fish well and discard guts

Call your doctor or veterinarian if you or your animals have nausea, vomiting, diarrhea, rash, irritated eyes, seizures or breathing problems.
For more information: <http://1.usa.gov/1oRiyNV>



ADVERTENCIA

Algas Tóxicas Están Presentes

ZONA ESTÁ CERRADA AL CONTACTO CORPORAL

- No Beba Agua Del Lago
- No Natación o Cuerpo de Contacto
- No Esquí Acuático
- No Moto de Agua
- No Surf del Remo
- No Se Admiten Mascotas En El Agua



•Paseos En Barco Permitido

•Pesca Permitida - eviscero y limpie bien a los pescados y deseche las vísceras

Llame a su médico o veterinario si usted o sus animales tiene náuseas, vómitos, diarrea, erupción cutánea, irritación de los ojos, convulsiones o problemas respiratorios.

Para más información : <http://1.usa.gov/1oRiyNV>



WARNING

Toxic Algae Present

LAKE IS CLOSED TO FULL-BODY CONTACT

- Do Not Drink Lake Water
- No Swimming or Body Contact
- No Water Skiing
- No Jet Skiing
- No Paddle Boarding
- No Pets in water



•Boating Permitted

•Fishing Permitted - clean fish well and discard guts

Call your doctor or veterinarian if you or your animals have nausea, vomiting, diarrhea, rash, irritated eyes, seizures or breathing problems.

For more information: <http://1.usa.gov/1oRiyNV>



ADVERTENCIA

Algas Tóxicas Están Presentes

LAGO ESTÁ CERRADA AL CONTACTO CORPORAL

- No Beba Agua Del Lago
- No Natación o Cuerpo de Contacto
- No Esquí Acuático
- No Moto de Agua
- No Surf del Remo
- No Se Admiten Mascotas En El Agua



•Paseos En Barco Permitido

•Pesca Permitida - eviscere y limpie bien a los pescados y deseche las vísceras

Llame a su médico o veterinario si usted o sus animales tiene náuseas , vómitos , diarrea , erupción cutánea, irritación de los ojos , convulsiones o problemas respiratorios.

Para más información : <http://1.usa.gov/1oRiyNV>

