U.S.EPA Update on Development of Recreational Ambient Water Quality Criteria for Cyanotoxins

Public Stakeholder Webinar

February 22, 2016

Health and Ecological Criteria Division

Office of Water

Webinar Logistics

- Today's webinar will consist of a presentation discussing the basic science being considered in the development of the criteria followed by a Q&A section.
- Please mute your microphones.
- We will <u>only</u> take questions in the <u>Chat Box</u>.
- Please enter your questions in the chat box at any time during the webinar.
- Your questions will be discussed during the Q&A section.

Presenter

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Health and Ecological Criteria Division
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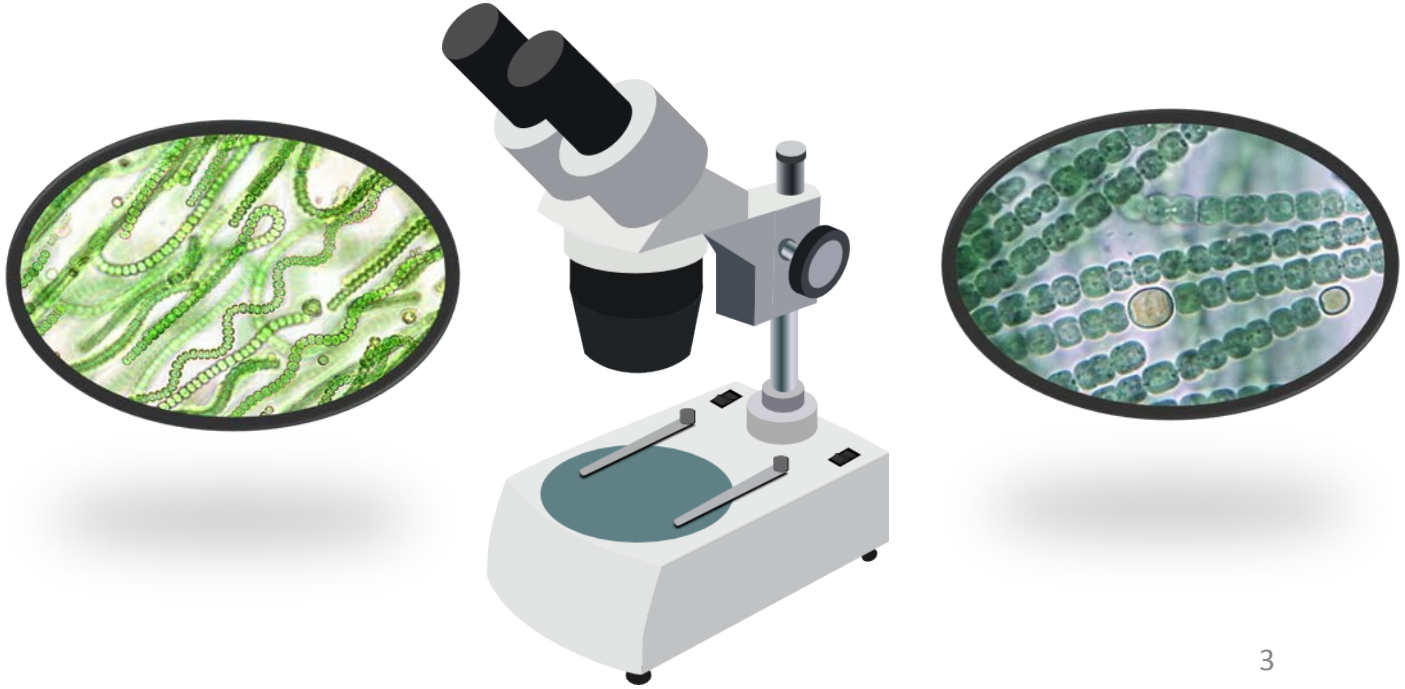
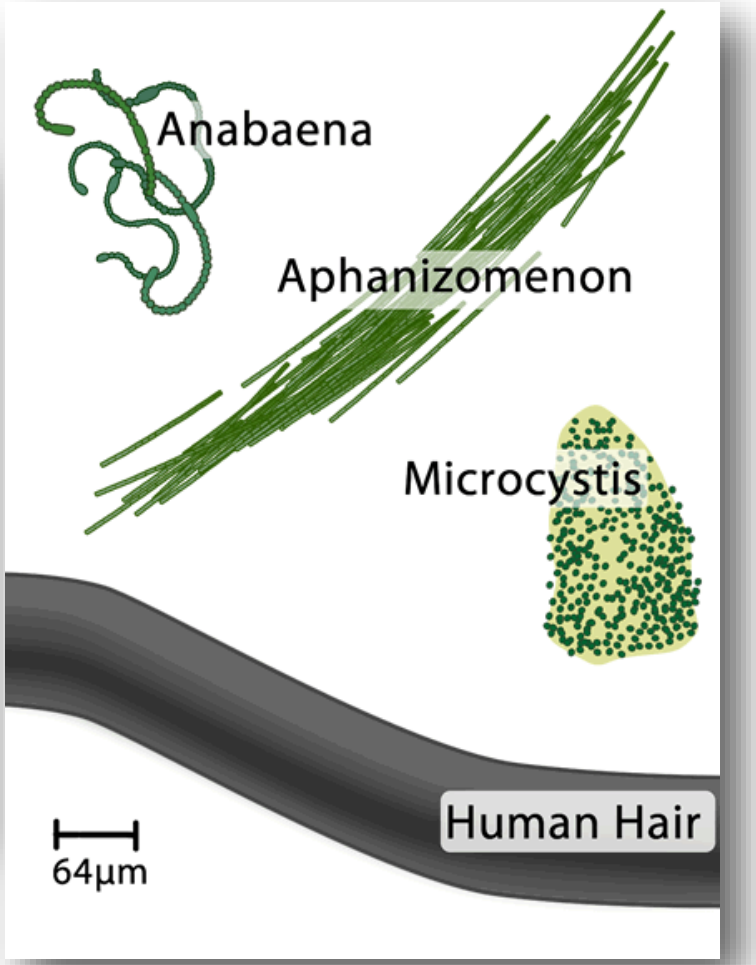
US Environmental Protection Agency



Cyanobacteria (aka Blue-green Algae)

Anabaena

Microcystis



Cyanobacterial Harmful Algal Blooms

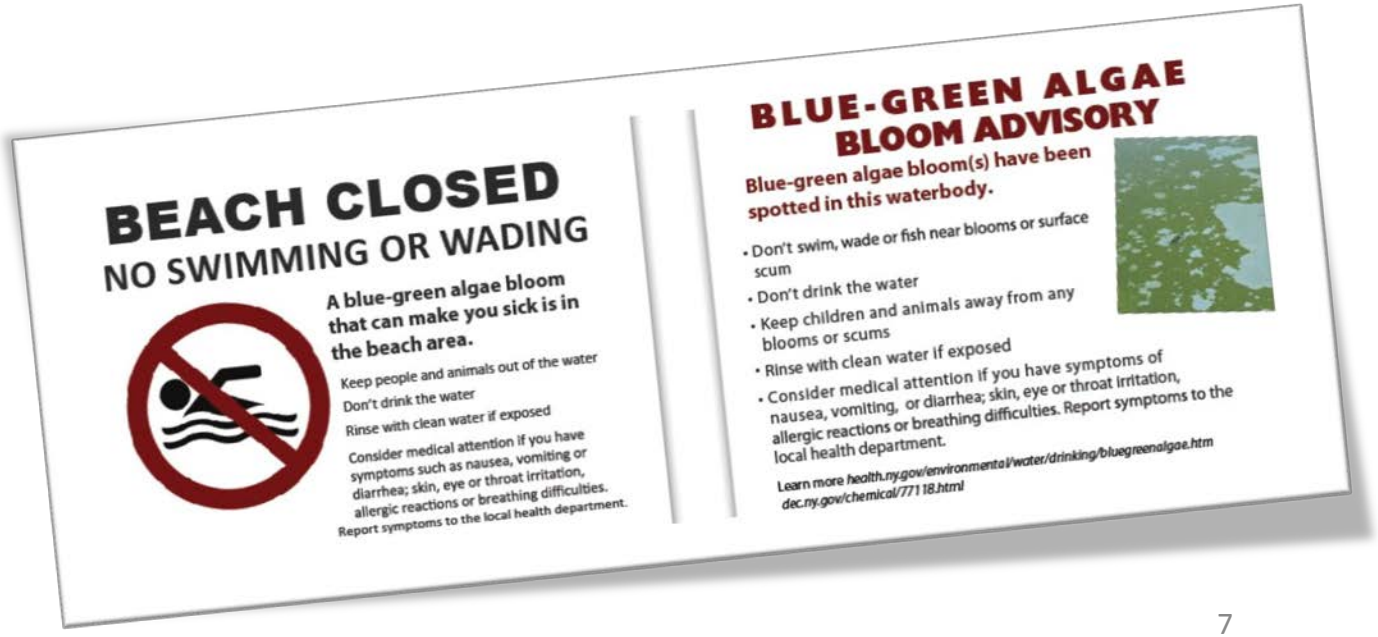
- Cyanobacteria occur naturally in marine and freshwater ecosystems.
- Some species can form blooms that can produce toxins, these are known as Harmful Algal Blooms (HABs).
- Blooms are dependent on numerous factors, including nutrient loading, temperature, and weather patterns.
- In freshwater, cyanobacteria are the most common; some produce highly potent cyanotoxins.
- Different toxins can be produced by a number of different species making visual monitoring difficult.

- In June 2015, EPA published Drinking Water Health Advisories for two cyanotoxins: Total Microcystins and Cylindrospermopsin.
- These advisories are based on consumption of finished drinking water containing these cyanotoxins.
- EPA recommended levels for two age groups: children pre-school age and younger (≤ 6yo); and, school-age children through adults (>6 yo)

Toxin	Health Advisory Values	
	≤ 6 yo	> 6 yo
Microcystins	0.3 µg/L	1.6 µg/L
Cylindrospermopsin	0.7 µg/L	3.0 µg/L

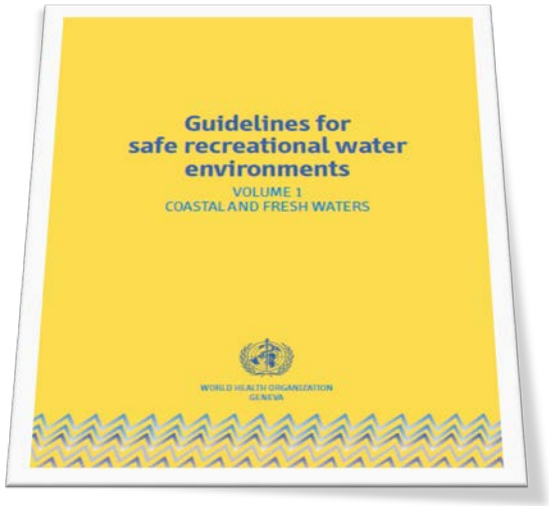
http://www.epa.gov/nutrient-policy-data/guidelines-and-recommendations

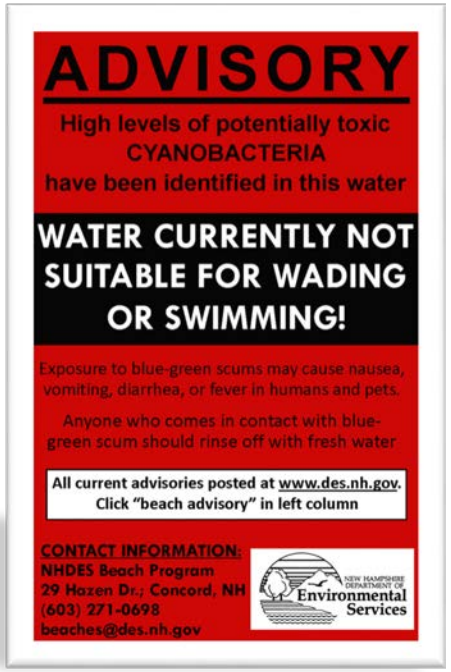
- People can also be exposed to cyanotoxins during recreational activities.
- EPA is currently reviewing the state of the science describing the human health effects from exposure to cyanobacteria and the toxins microcystins and cylindrospermopsin during recreation.
- EPA will use the information to support derivation of 304(a) ambient water quality criteria protective of primary contact recreation.



Regulatory Context

- Collecting information on guidelines recommended by other governments.
- Evaluating what is recommended and the scientific basis for the recommendation.





- Collating state-reported information on recreational 'health advisories' issued due to HABs.
- Including the toxin occurrence and concentration, when reported.

Summary of State Recreational Water Guidelines for Cyanobacteria and Cyanotoxins

Recreational Water Guideline Type and Scope	Number of States and List of States	Additional Information
Quantitative guidelines for cyanobacterial cells only	6 states Arizona, Connecticut, Idaho, Maine, New Hampshire, and Wisconsin	Measurements for these criteria including cyanobacterial cell densities, proportion of toxigenic cyanobacteria, chlorophyll concentration, and Secchi disk depth measurements.
Quantitative guidelines for cyanotoxins only	8 states California, Illinois, Iowa, Nebraska, New York, Ohio, Vermont, and Washington	State guidelines address four cyantoxins in order from most to least common: microcystins (17 states) cylindrospermopsin (7 states) anatoxin-a (6 states) saxitoxin (3 states)
Quantitative guidelines for both cyanotoxins and cyanobacterial cells	10 states Indiana, Kansas, Kentucky, Massachusetts, Oklahoma, Oregon, Rhode Island, Texas, Utah, and Virginia	
Qualitative guidelines only	6 states Delaware, Maryland, Montana, North Carolina, North Dakota, and West Virginia	Examples include: presence of surface scum visible discoloration presence of potentially toxic algae

Note: EPA found that Texas and North Carolina published guidelines in the past, but the guidelines can no longer be found on their website.

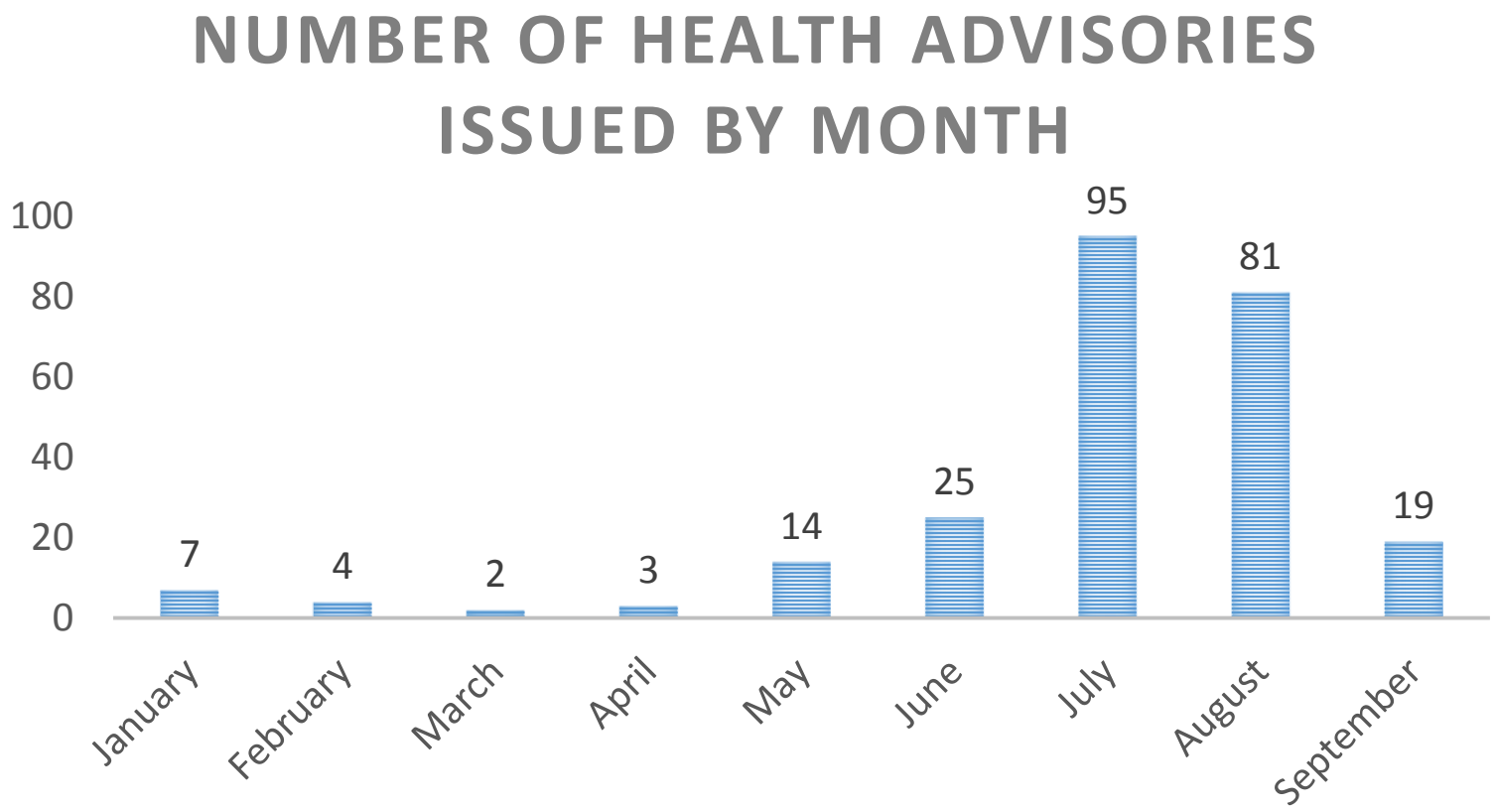
Selected International Recreational Water Guidelines for Cyanotoxins

Authority/State	Recreational Water Guidance/Action Level			
WHO (2003)	Relative Probability of Acute Health Effects	Cyanobacteria (cells/mL)	Chlorophyll-a (µg/L)	Estimated Microcystin Levels (µg/L)*
	Low	< 20,000	<10	<10
	Moderate	20,000-100,000	10-50	10-20
	High	100,000-10,000,000	50-5,000	20-2,000
	Very High	> 10,000,000	>5,000	>2,000
Australia	10 µg/L microcystins(total); cyanobacteria (total) >= 4 mm^3/L (biovolume); Microcystis aeruginosa > 50,000 cells/mL			
Canada	20 µg/L microcystins (total); cyanobacteria (total): >= 100,000 cells/mL			
New Zealand	12 µg/L microcystin (total); cyanobacteria (total) >= 1.8 mm^3/L (biovolume)			

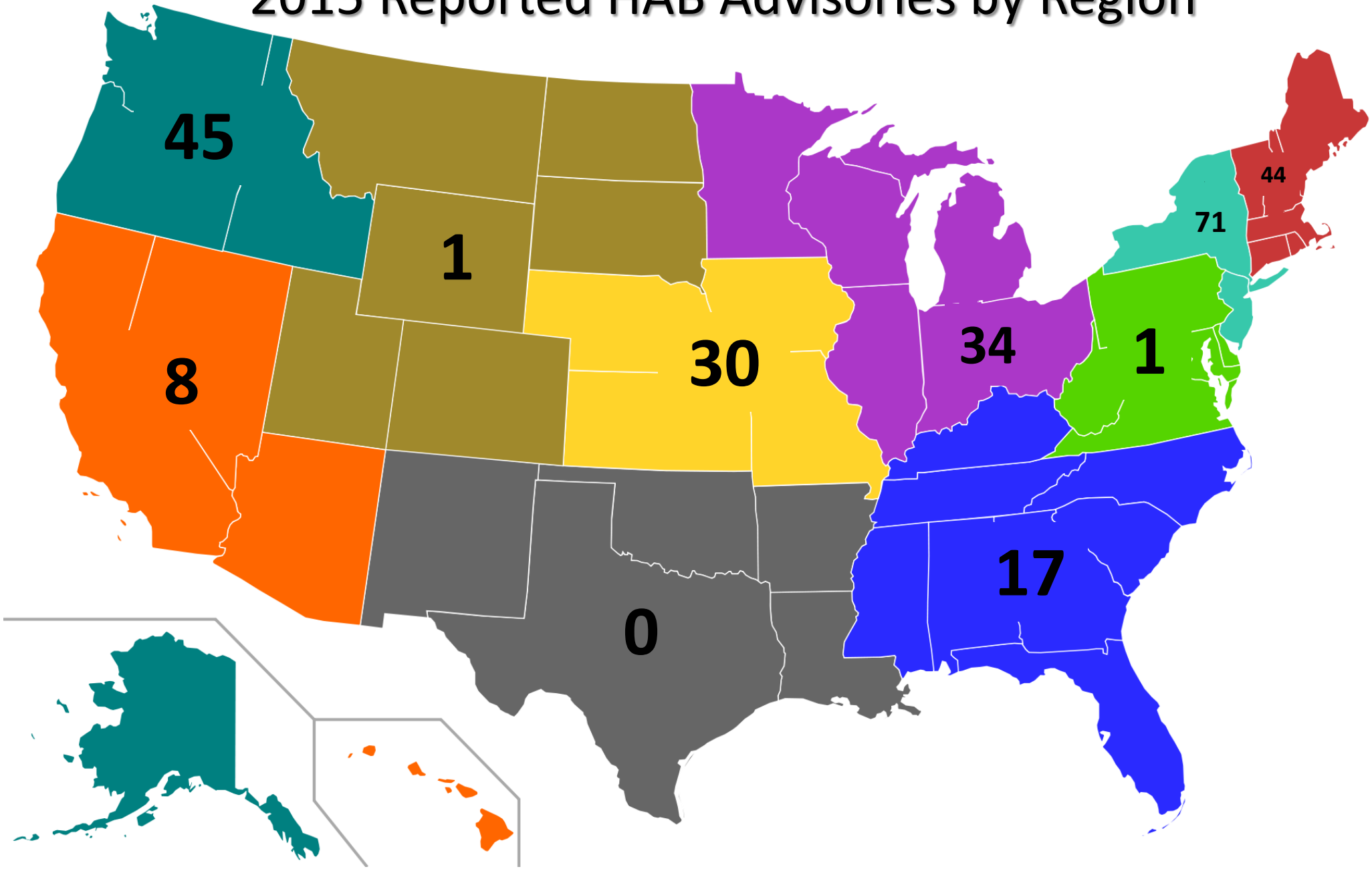
- Other countries have developed guidelines for cyanobacteria and cyanotoxins.
- Some use or adapt recommendations made by the World Health Organization (WHO) in 2003.
- Some have derived their guidelines using local monitoring information, specific risk assessments or other metrics.

HABs Monitoring in Recreational Waters - 2015

- States reported at least 252 notices for HABs.
- These included cautions, warnings, public health advisories, and public health warnings, due to the presence of algae or toxins or both.

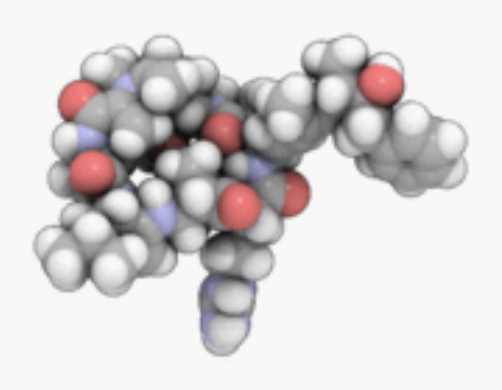


2015 Reported HAB Advisories by Region



Range of 2015 Reported Microcystin Levels

	Microcystin
Average Cyanotoxin Concentration (µg/L)	627.7
Median Cyanotoxin Concentration (µg/L)	20
Range of Cyanotoxin Concentration (µg/L)	0.2-42000



Microcystin

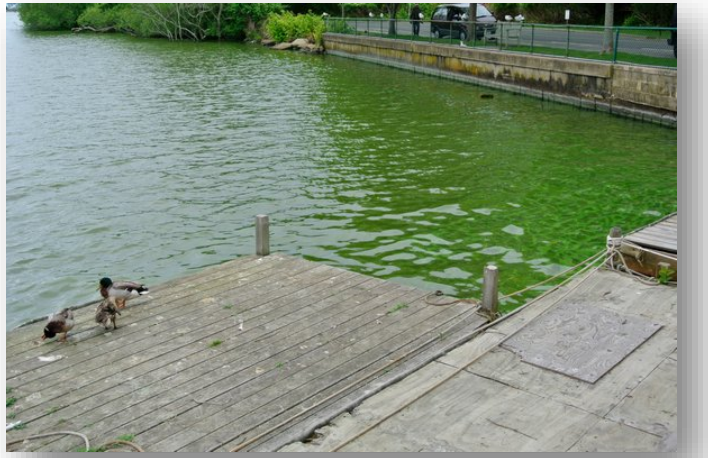
Ambient Water Quality Criteria (AWQC) Development for Recreational Exposures

- Clean Water Act §304(a) recreational Ambient Water Quality Criteria (AWQC) recommend values protective of human health given a primary contact recreational exposure scenario.

- Goal: To provide guidance to ensure safety for recreational exposures to cyanobacteria and cyanotoxins.

- Objective 1: To develop §304(a) recreational AWQC recommendations for the cyanotoxins microcystin and cylindrospermopsin.

- Objective 2: To evaluate state of the science in regards to human health effects from recreational exposures to cyanobacteria and discuss within the AWQC as appropriate.



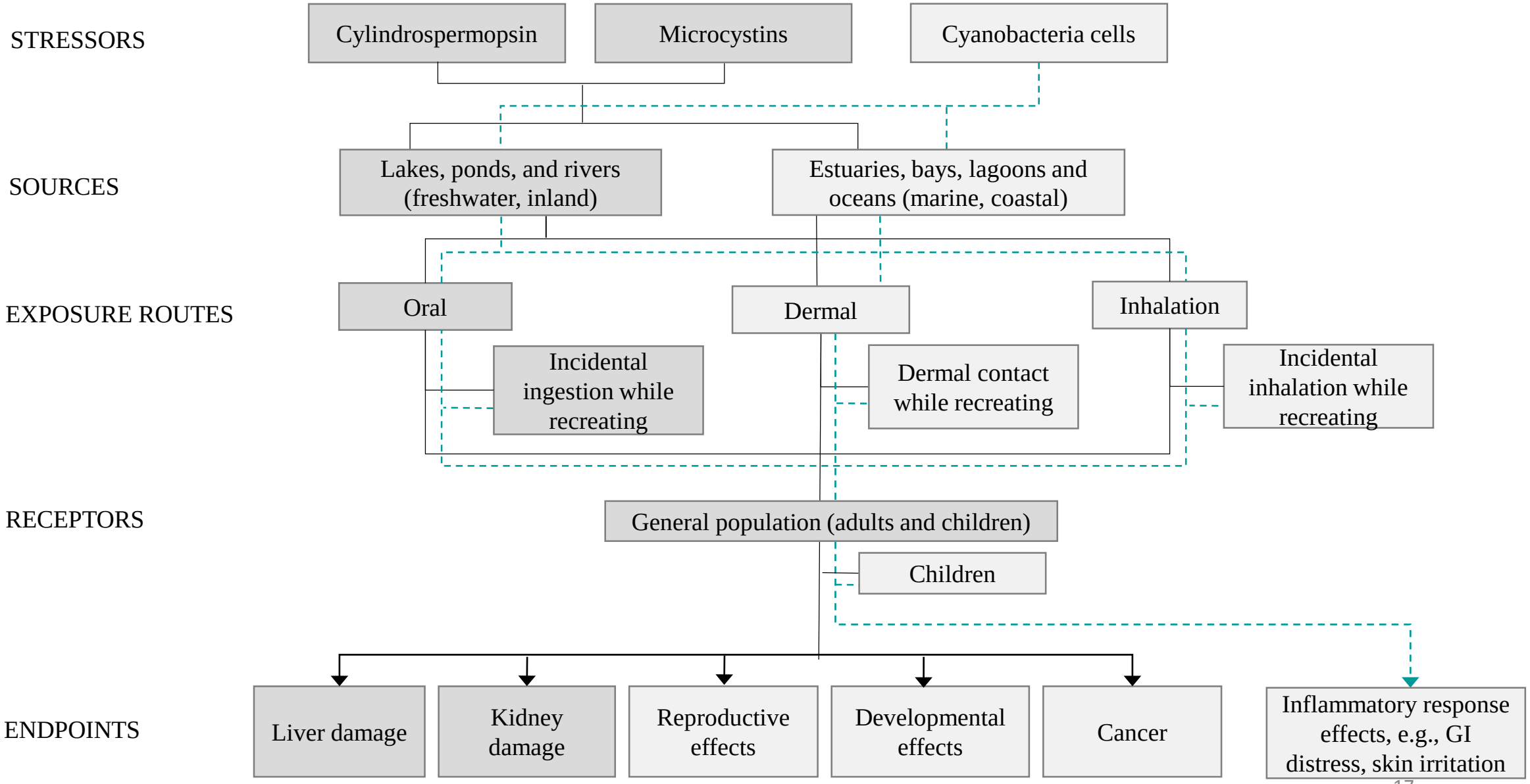
Scoping the criteria

- Focus on human exposure as a result of primary contact recreation activities such as swimming where immersion and incidental ingestion of ambient water are likely.
  - Dermal and inhalation exposures associated with primary contact recreation will be considered if data are sufficient.
  - Consumption of fish and shellfish will not be considered in the assessments.
- Develop AWQC based on the same peer-reviewed science as supported EPA's Drinking Water Health Advisories for microcystins and cylindrospermopsin.
  - The Health Effects Support Documents (HESDs) discussed the human health effects from exposure to these toxins and the key studies used to derive a reference dose (RfD).
  - The health advisories used the RfDs to derive health-protective recommendations given a drinking water exposure scenario.
  - EPA plans to use the same RfD values to derive health-protective AWQC recommendation given a recreational exposure scenario.

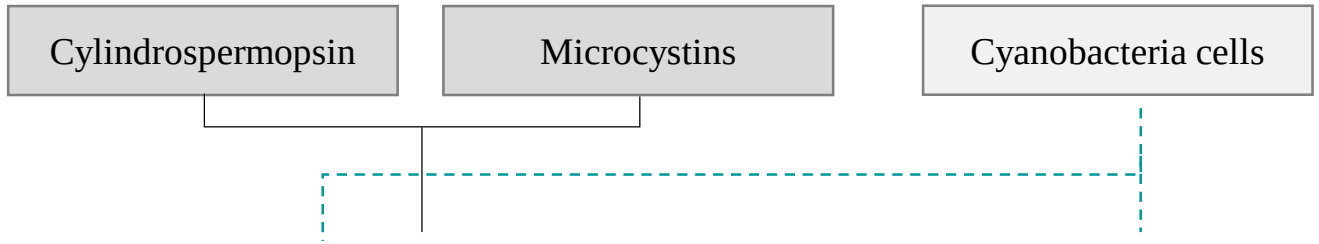
Scoping the criteria

- Develop a conceptual model to help guide the AWQC development.
- Identify the potential pathways of human health risk from recreational exposures to cyanobacteria and their toxins.
- Identify factors and endpoints that will be addressed quantitatively and qualitatively within the criteria document.

Conceptual Model of Cyanotoxin and Cyanobacteria Exposure Pathways While Recreating



Stressors: agents that cause an effect



- Some States already use both measures as criteria.
- Considering both the cyanotoxins (quantitatively) and cyanobacterial cells (qualitatively).
- Toxin-related effects:
  - Liver (microcystin)
  - Kidney (cylindrospermopsin)
- Cell-related effects:
  - Various endpoints with many considered inflammatory responses.
  - Gastrointestinal (GI), Dermatologic, Eye/ear, Respiratory
  - Dermatologic, GI and respiratory symptoms are the most frequently reported following outbreaks of HAB-related illness in recreational waters (CDC)

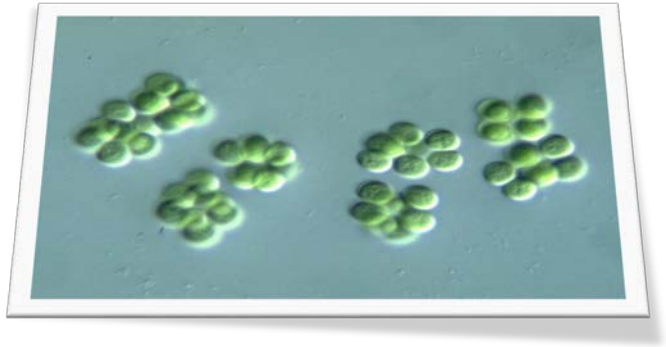
Stressor: Cylindrospermopsin

- Exposure pathway: oral ingestion of drinking water (by gavage)
- Key Study Selected: Humpage and Falconer (2002, 2003); 11 weeks drinking water study in mice
- Most sensitive endpoint: kidney damage
  - Increased weight of kidney and decreased urinary protein

Information on this slide taken from EPA's *Drinking Water Health Advisory for the Cyanobacterial Toxin Cylindrospermopsin* (2015).

Stressor: Microcystins

- Microcystin-LR, considered a surrogate for all microcystins
  - Toxicity data are most complete
  - LR is the same or more toxic than other congeners, based on available data
- Key Study Selected: Heinze, 1999; 28 day drinking water study in rats
- Most sensitive endpoint: liver toxicity
  - Increase in liver weight and in liver enzymes

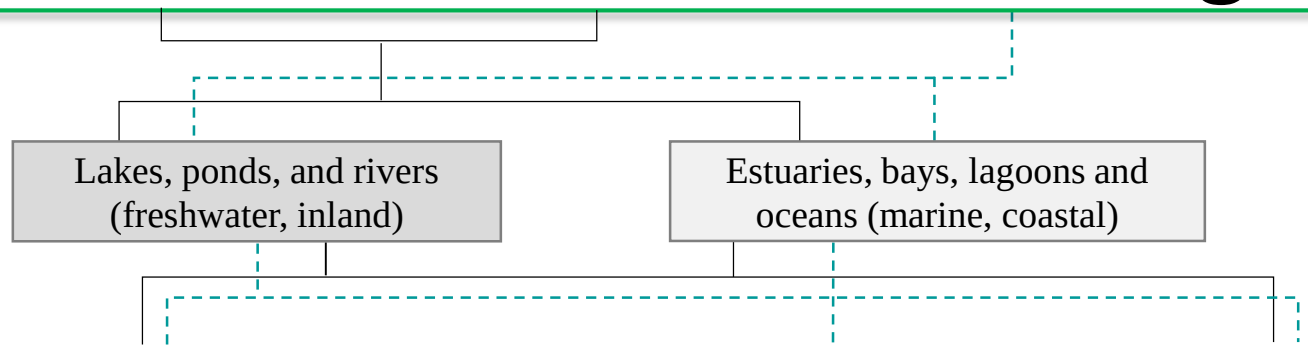


Information on this slide taken from EPA's *Drinking Water Health Advisory for the Cyanobacterial Microcystin Toxins* (2015).

Stressor: Cyanobacterial Cells

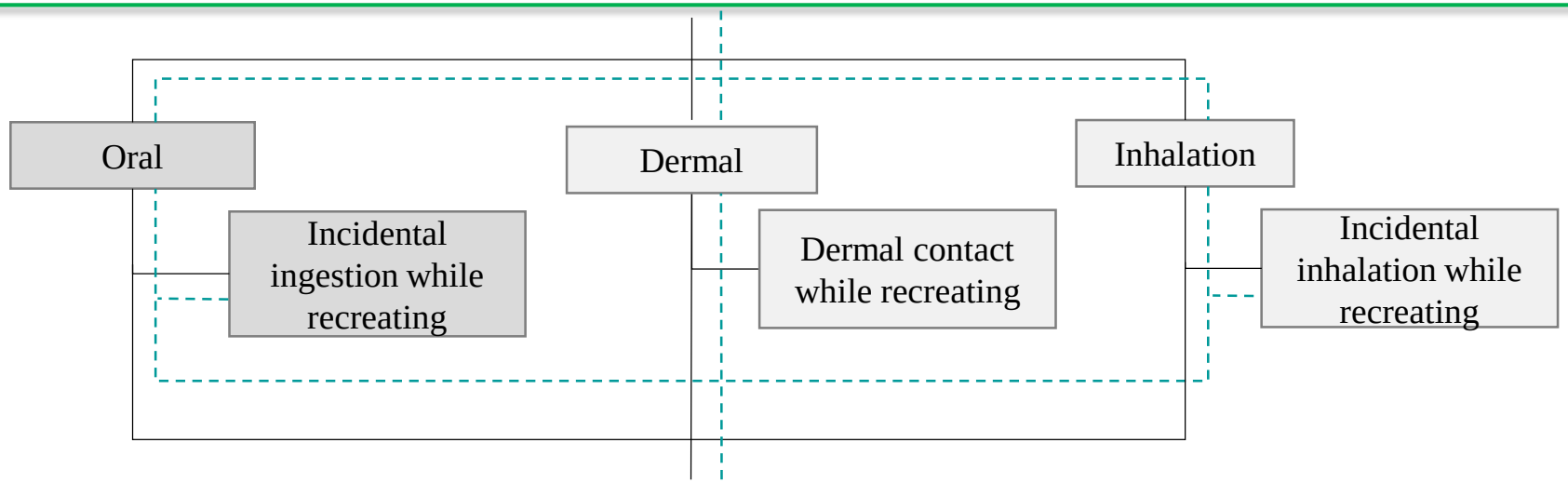
- Cell components other than the toxins produced have been implicated as etiologic agents (e.g., lipopolysaccharides, phycocyanins)
- Linkage to health suggested by epidemiological evidence
  - Pilotto (1997) informed the recommendations made by the WHO in *Guidelines for Safe Recreational Water Environments* (2003).
    - Demonstrated a significant trend for increasing symptom occurrence with an increase in cell density.
    - Did not observe an association between the presence of hepatotoxins and symptom occurrence
- HAB-related illness outbreaks in recreational waters reported by CDC suggests that cell-related endpoints can be an important public health consideration.
- EPA envisions a qualitative evaluation of health effects from cyanobacterial cells.

Sources: where is the stressor coming from?



- Focusing on freshwater occurrence of HABs producing microcystin and cylindrospermopsin.
  - All HAB-related outbreaks reported by CDC in the last two reporting cycles occurred in fresh water.
- Evaluating reports of upstream fresh water HAB events affecting the downstream interface with estuarine/marine waters.

Exposure Routes: How are recreators exposed?



- Surveying the scientific literature for information on the three exposure routes.
- Evaluating literature to identify differences in exposure levels used by EPA, States, and other regulatory authorities to inform the recreational exposure scenario in this AWQC
- Finding less information is available on dermal and inhalation exposure routes compared to ingestion.
- HAB-related illness outbreaks in recreational waters reported by CDC suggests dermal and inhalation pathways can be important to consider.
  - Outbreaks: dermal > ingestion > inhalation

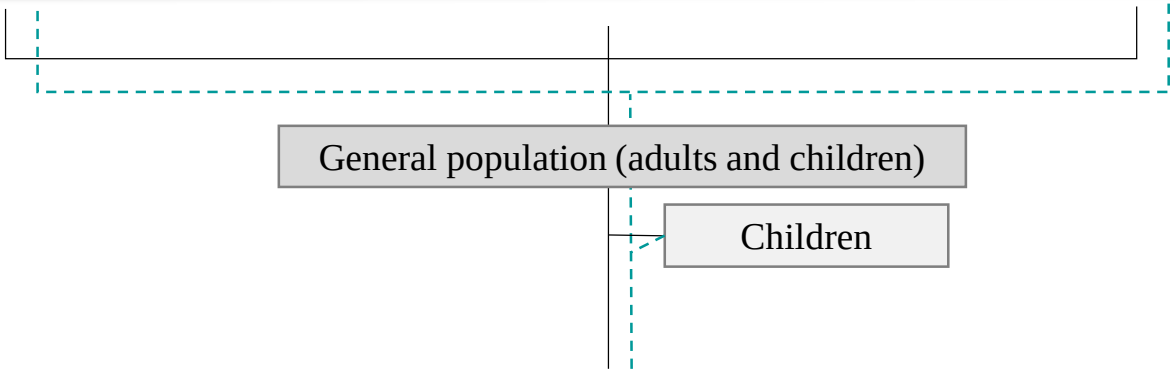
Exposure Routes: Incidental Ingestion while Recreating

- Evaluating studies which measured or surveyed recreational water ingestion (n=6).
- Swimming is associated with the highest incidental ingestion rates compared to other recreational activities.
- Ingestion volumes described in these studies ranged from 0 to 0.154 L (duration of ingestion varied among the studies).
- Ingestion average for adults: 0.016 L
- Ingestion average for <18 yo: 0.037 L
- Currently evaluating age ranges and groups considered in these studies.

Exposure Routes: Current Thinking

- EPA plans to include the oral ingestion route quantitatively within the AWQC.
- EPA envisions discussing dermal and inhalation exposures qualitatively.
- Specialized exposures, such as ceremonial uses of surface waters, will also be discussed qualitatively.

Receptors: Populations and/or life stages exposed to the stressor



- Evaluating children-specific parameter values that could support the development of AWQC benchmarked to children's recreational exposures.
  - Four states (CA, OH, IN, and MA), Grayson Co., TX, Australia, and New Zealand calculated guideline values based on both children-specific and adult exposure parameters.
  - Five states (ID, OR, UT, VA, and WA) and Canada calculate guidelines values based on children-specific parameters <u>only</u>.

Receptors: Identifying the population

- Children's smaller body mass compared to adults increase the potential for toxic effects.
- Children tend to have more exposure during recreation:
  - Ingest more water, both incidentally and hand-to-mouth
  - Spend more time in contact with near shore waters.
- CDC reports that 66% of HAB-associated outbreaks in 2009-2010 were < age 19. Thirty-five percent were age 9 or younger.
- 80% of all confirmed illness reports due to fresh water cyanotoxin exposure involved (or exclusively involved) children (Weirich and Miller, 2014).

Receptors: Pets and Agricultural Animals

- Searching the literature and reviewing published reports for information on animal (pets and livestock) poisonings linked to exposure to cyanotoxins.
- Envision discussing how states could use and/or adapt the AWQC for developing values protective of animals.

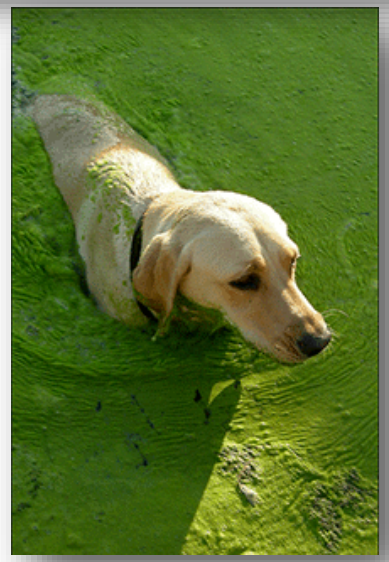
Receptors: Current Thinking

- Because:
  - Children incidentally ingest more water during recreational activities than adults.
  - Children spend more time swimming in fresh waters compared to adults.
  - Children can be exposed more frequently compared to adults.

- EPA intends to derive criteria protective for a child who ingests water incidentally while swimming.

Current Thinking Summary

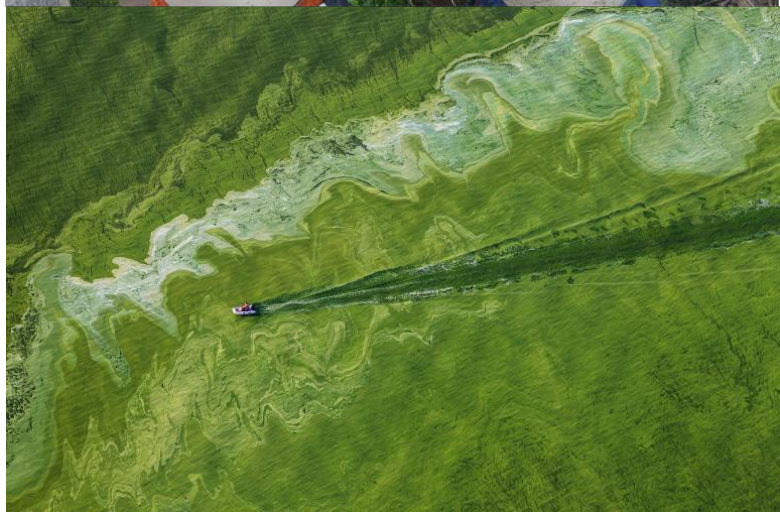
- Focus on a recreational scenario where immersion and incidental ingestion of ambient water are likely.
- Focus on fresh waters, but consider reports of potential effects at the estuarine interface.
- Recommend AWQC for the cyanotoxins microcystins and cylindrospermopsin.
- Benchmark the AWQC to children's exposures.
- Consider cell densities (for now, qualitatively)
- Evaluate dermal and inhalation exposure routes.
- Characterize effects to domesticated animals and livestock



Outreach and Stakeholder Engagement

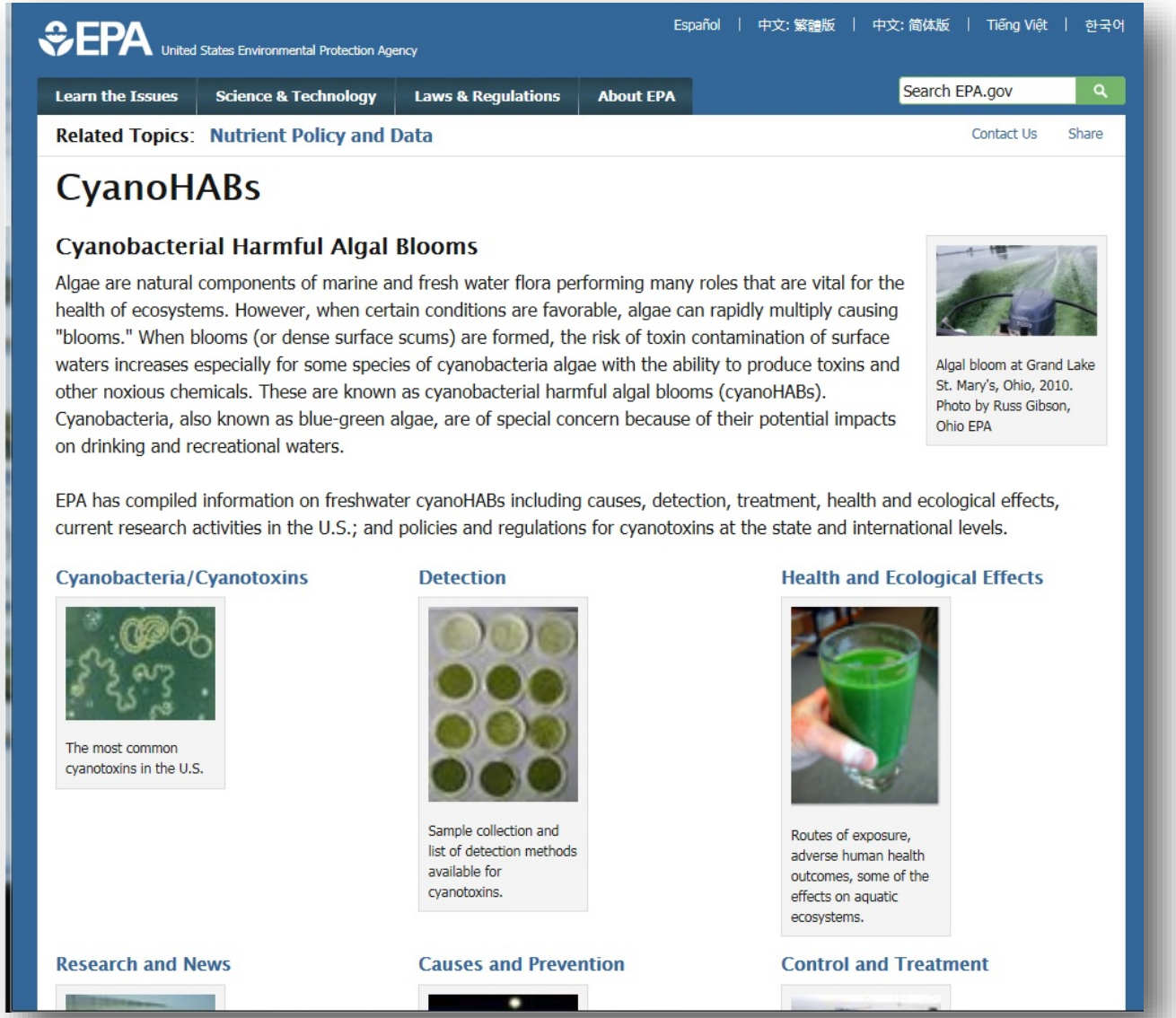
- EPA is planning to have a HAB-related session at the 2016 Recreational Water Conference in April.
- EPA is planning to hold additional webinars in 2016.
  - Engage with stakeholders
  - Communicate our progress
  - Provide a venue for feedback
  - Forum for information/data sharing

- We want to hear from you!
  - Do you have information that you think would be helpful to EPA's efforts?
  - Topics for consideration for future webinars?



EPA HAB information

- EPA's CyanoHAB web portal:
  - http://www.epa.gov/cyanohabs
  - Information about:
    - cyanobacteria and cyanotoxins
    - Detection methodologies
    - Health and ecological effects
    - Research news
    - Causes and prevention
    - Control and treatment
  - Lesley D'Anglada danglada.lesley@epa.gov



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