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

Recreational Waters Conference
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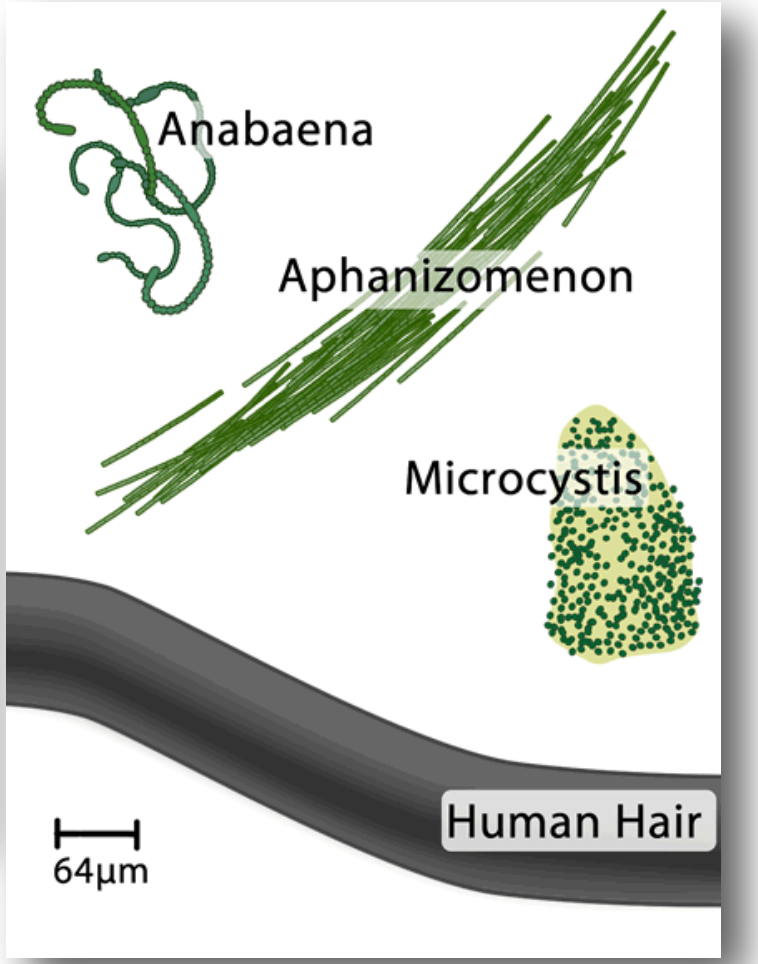
Cyanobacterial Harmful Algal Blooms

- 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.

Cyanobacteria (aka Blue-green Algae)

Anabaena

Microcystis

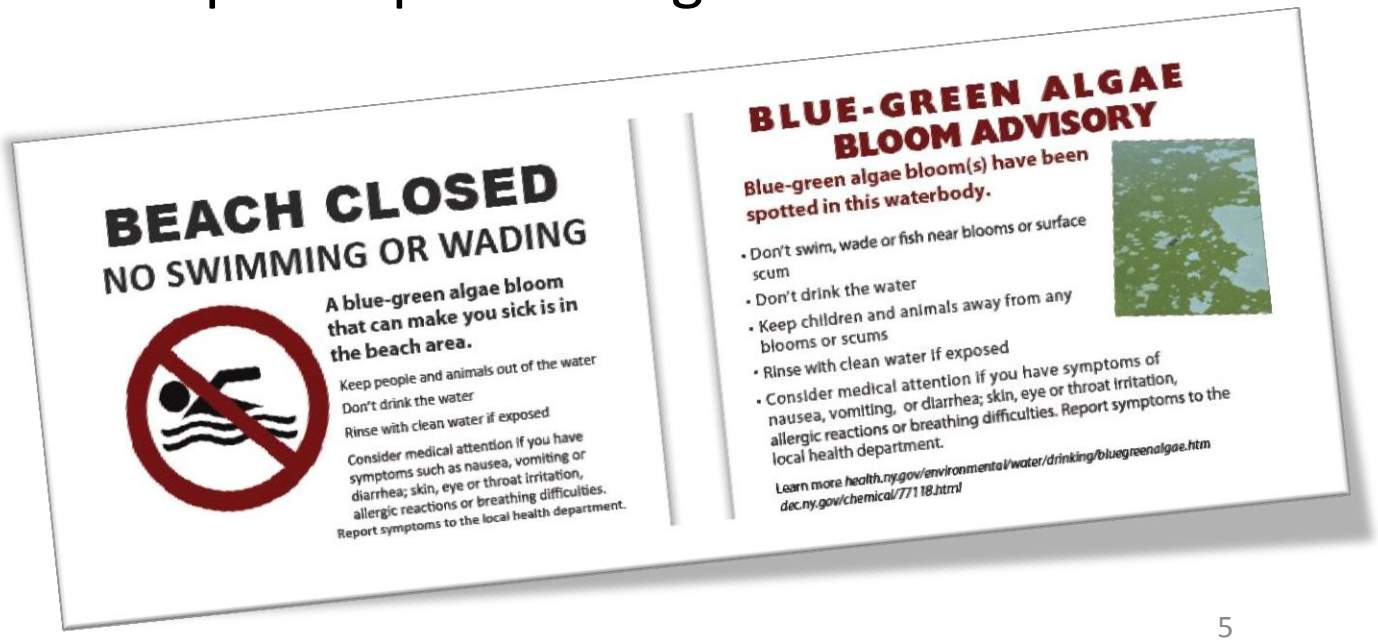


- In June 2015, EPA published Drinking Water Health Advisories for two cyanotoxins: Total Microcystins and Cylindrospermopsin.
- These 10–day health advisory values are based on consumption of finished drinking water containing these cyanotoxins.
- EPA recommended levels for two age groups: children 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.
- Different from the drinking water exposure scenario, people recreating on or in ambient waters can have direct exposure to both cyanotoxins and cyanobacterial cells.
- 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.



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 supported by the science.

Implementation of Recreational AWQC

- Recreational criteria are typically used for multiple purposes under the Clean Water Act.
- Beach notification
  - A conservative, precautionary tool for beach management decisions.
  - Expressed as a “Beach Action Value” or BAV.
  - Short-term measure
- Assessment
  - Water Quality Standard (WQS) used to evaluate if a waterbody is attaining the designated use.
  - Waters exceeding the WQS can be listed as impaired.
  - Expressed as a geometric mean (GM) and an upper percentile value (STV) of a water quality distribution.
  - Longer-term measure
- Would a similar approach with this AWQC be helpful?

Approach to Criteria Development

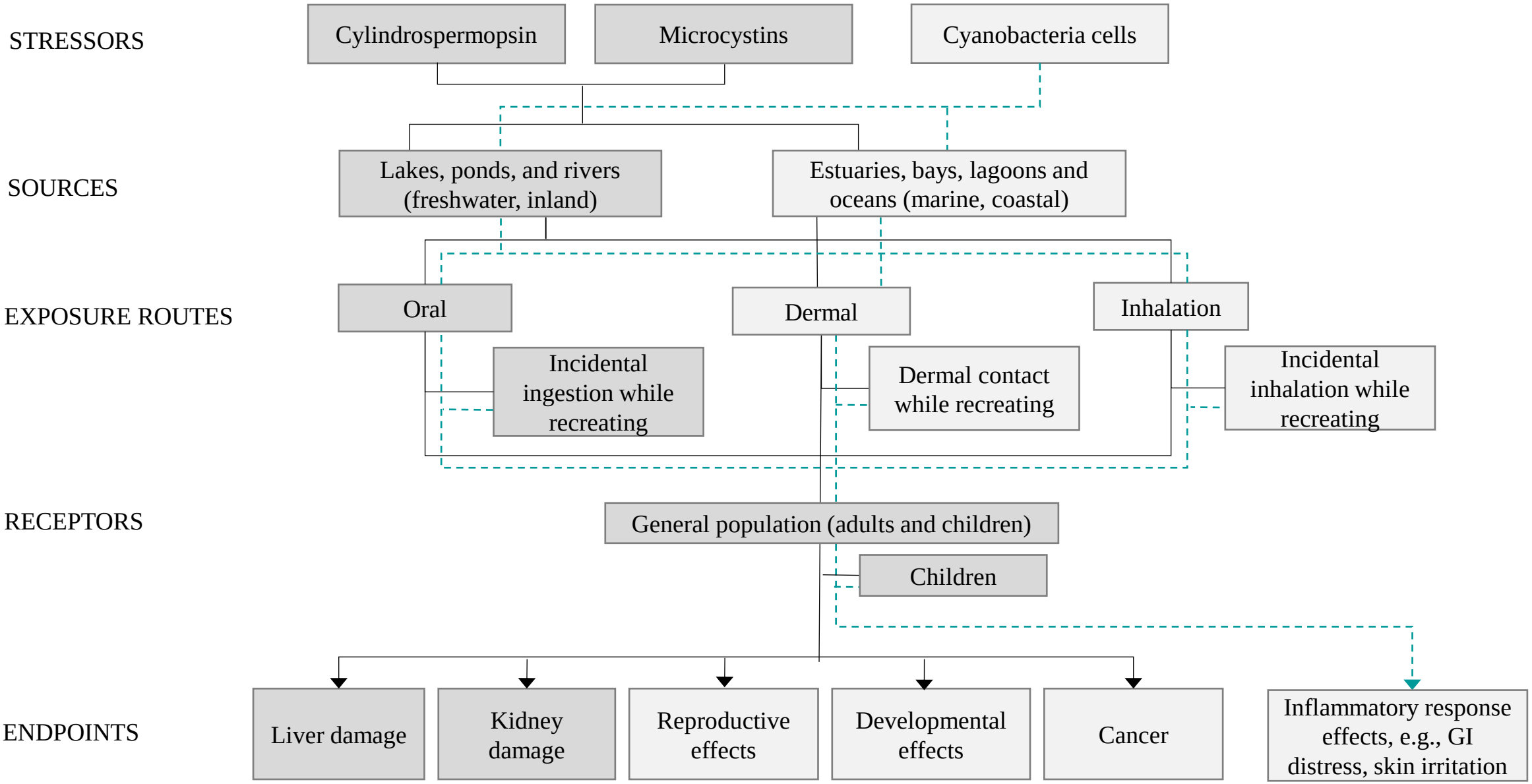
- Consider the state of the science to inform decision making
- Leverage the peer-reviewed science informing the drinking water health advisories
- Consider studies conducted by researchers within EPA (Office of Research and Development) and outside of EPA
- Input from other EPA Offices and Regions
- Input from Stakeholders
- Active communication and outreach




Scope of the AWQC

- 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 as data will support.
  - Consumption of fish and shellfish will not be considered in the assessments.
- Develop AWQC for microcystins and cylindrospermopsin based on the same peer-reviewed science as supported EPA's 10-day 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.

Conceptual Model of Cyanotoxin and Cyanobacteria Exposure Pathways While Recreating



Update on Criteria Development

- 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.
- Evaluate science describing health effects from exposure to cyanobacteria cells.
- Evaluate dermal and inhalation exposure routes.
- Characterize effects to domesticated animals and livestock.

Outreach Efforts and Stakeholder Engagement

- Communicating our approach to stakeholders within EPA and to external audiences
  - Federal-State Toxicology Risk Analysis Committee (FSTRAC)
  - Regional Water Division Directors meeting
  - Regional workshops and meetings
  - ACWA
  - Source Water Collaborative
  - Public webinar (Feb. 22)

Update on Our Progress Since the Stakeholder Webinar

- Identified studies describing quantitative values for ingestion of water while recreating.
- Identified studies describing human health effects from exposure to cyanobacterial cells.
- Reviewed publically-available information that describe HAB-related effects to companion animals and livestock.

Summary of Recreational Incidental Ingestion

- Identified six studies which quantified recreational water ingestion.
  - Swimming is associated with the highest incidental ingestion rates compared to other recreational activities.
  - Children generally ingest more water while recreating compared to adults.
  - Four studies reported children ingestion separately from adults
  - One study characterized child cohorts that separated younger children from older children.
  - Duration of exposure varied among the studies.
- Currently evaluating age ranges and groups considered in these studies to inform decisions on target population.

Inventory of Recreational Ingestion Studies

- Dorevitch, S; Panthi, S; Huang, Y; Li, H; Michalek, AM; Pratap, P; Wroblewski, M; Lui, L; Scheff, PA; Li, A. (2011) Water ingestion during water recreation. Water Res 45(5):2020–2028.
- Dufour AP, Evans O, Behymer TD, & Cantú R. (2006). Water ingestion during swimming activities in a pool: A pilot study. Journal of Water Health, 4, 425-430.
- Evans OM, Wymer LJ, Behymer TD, & Dufour AP. (2006). An Observational Study: Determination of the Volume of Water Ingested During Recreational Swimming Activities. Paper presented at the National Beaches Conference, Niagara Falls, NY. (paper in preparation)
- Schets FM, Schijven JF, & de Roda Husman AM. (2011). Exposure assessment for swimmers in bathing waters and swimming pools. Water Res, 45(7), 2392-2400. doi: 10.1016/j.watres.2011.01.025
- Schijven, J. F., and A. M. de Roda Husman. 2006. A survey of diving behavior and accidental water ingestion among Dutch occupational and sport divers to assess the risk of infection with waterborne pathogenic microorganisms. Environ. Health Perspect. 114:712–717.
- Suppes LM, Abrell L, Dufour AP, & Reynolds KA. (2014). Assessment of swimmer behaviors on pool water ingestion. J Water Health, 12(2), 269-279. doi: 10.2166/wh.2013.123

Studies Characterizing Human Health Effects from Exposure to Cyanobacterial Cells

- Identified four epidemiological studies describing human health effects from exposure to recreational waters containing cyanobacteria.
  - Levesque et al. (2014) Prospective study of acute health effects in relation to exposure to cyanobacteria. Sci Tot Environ 466-467:397-403
  - Lin et al. (2016) A prospective study of marine phytoplankton and reported illness among recreational beachgoers in Puerto Rick, 2009. Environ Hlth Perspect 124(4):477-483
  - Pilotto et al. (1997) Health effects of exposure to cyanobacteria (blue-green algae) during recreational water-related activities. Aus NZ J Pub Hlth.l 21(6):562-566
  - Stewart et al. (2006) Epidemiology of recreational exposure to freshwater cyanobacteria – an international prospective cohort study. BMC Pub Hlth 6:93 doi:10.1186/1471-2458-6-93

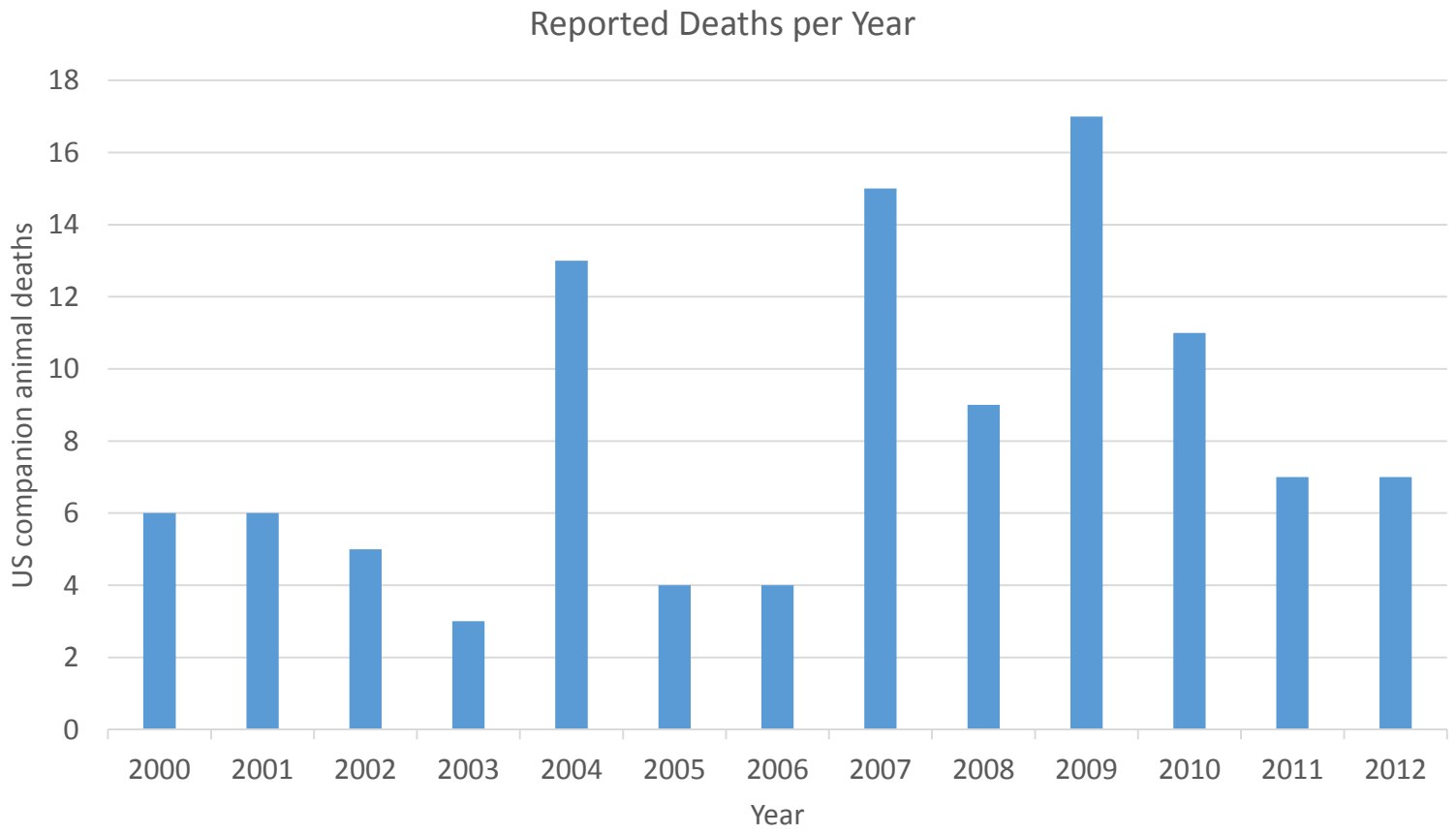
Summary of Reported Epidemiological Study Results

- All four studies report statistically-significant human health endpoints.
  - GI Illness – diarrhea, vomiting, nausea and fever, or abdominal cramps and fever (Levesque)
  - Respiratory symptoms – difficulty breathing, coughing, runny nose, unusual sneezing, sore throat, wheezing (Stewart)
  - Combined symptomology – GI Illness, flu-like symptoms, rashes, respiratory, mouth ulcers, fever or eye or ear irritations (Pilotto, Stewart)
- All four studies significantly associate a health endpoint(s) to densities of cyanobacterial cells.
  - 20,000 – 100,000, 100,000 cells/ml (Levesque: 19% effect for GI)
  - >5,000 cells/ml >60 min (Pilotto: 10% overall effect)
  - ≥ 100,000 cells/ml (Stewart: 18% effect for respiratory, 33% effect combined)
  - 37-1461 cells/ml (Lin: 3.2% effect earache, 5.5% rash, 7.8% respiratory symptoms)

Epidemiological Study Considerations

- Study size – affects the power of the study and the ability to detect associations when they are present.
  - Highly significant effects in small scale studies can be notable.
  - Higher numbers of participants can increase the ability of researchers to detect a difference when one exists.
- Number of participants:
  - Levesque: 466 subjects included
  - Pilotto: 855 (777 exposed, 75 not exposed)
  - Stewart: 1311 subjects enrolled and completed the follow-up
  - Lin: 15,726 individuals successfully completed all follow-up interviews
- Study locations: 3 freshwater, 1 tropical marine (Lin)

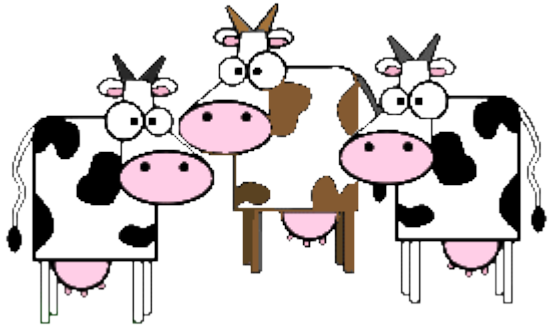
Number of Reported HAB-related Companion Animal Deaths per Year in the U.S.



- From 2000-2012, we found 115 HAB-related events published in the literature.
- ~89% involved fatal exposures.
- 58% attributed to Anabaena and/or anatoxin (76 dogs)
- 26% attributed to Anabaena, Microcystis, and/or microcystins (14 dogs)
- 16% attributed to bloom exposure (8 dogs)
- 30 non-fatal poisoning events accompanied the fatal events.

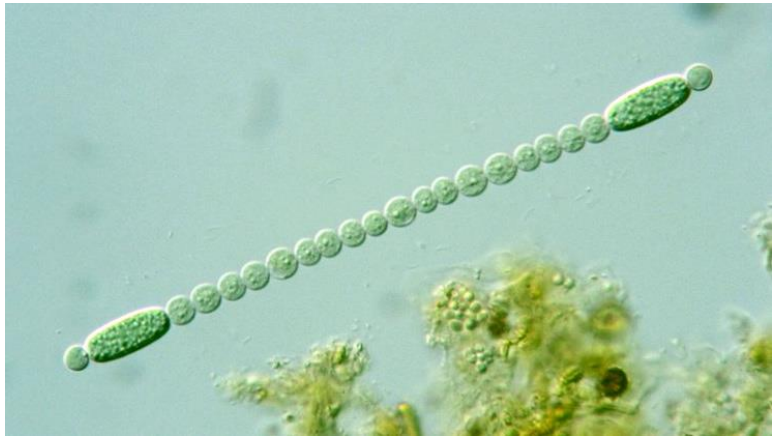
HAB-related Effects on Agricultural Animals in the U.S.

- Available information on livestock effects less well characterized.
- Agricultural animals are usually exposed to HABs from drinking water ponds and enclosures.
- Signs of toxicity can include weakness, weight loss, excessive salivation, bloody stool, sudden collapse, and death.
- Data gaps in consistent reporting prevent a systematic evaluation of effects.



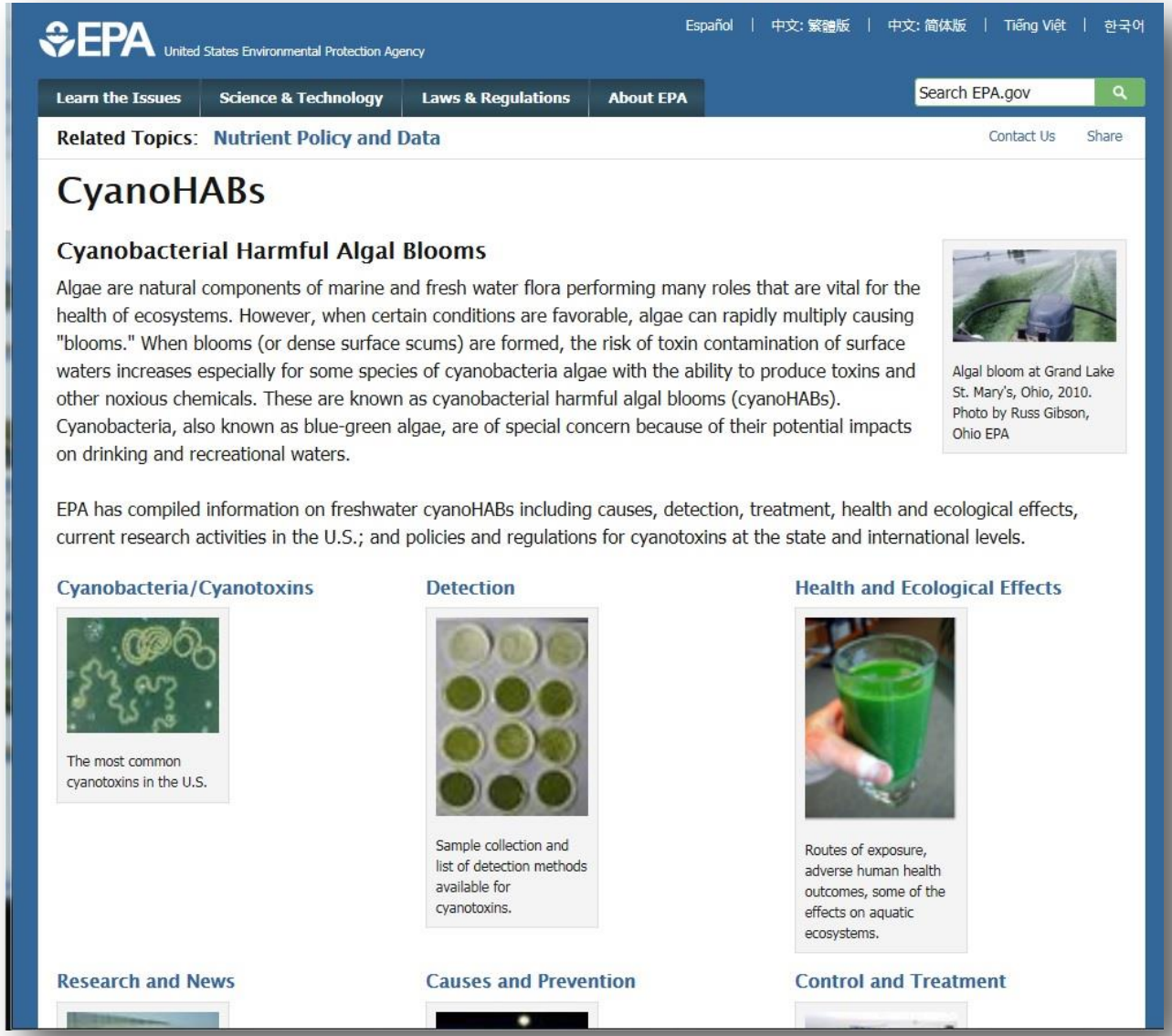
Next Steps

- Continue to evaluate the study results describing health effects from exposure to cyanobacterial cells.
- Continue to evaluate available information on target population parameters.
- Integrate information into criteria development.
- Hold a second public webinar to provide an update on the AWQC.
- Publish a draft AWQC for public comment by end of summer 2016.



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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