# Freshwater Cyanobacteria - a brief overview

Sue Keydel
US EPA Region 9
San Francisco, CA

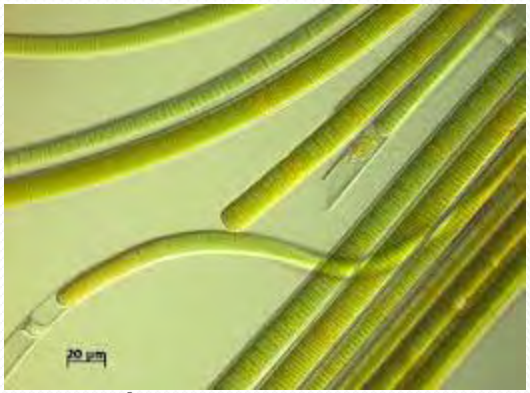
# Freshwater Cyanobacteria

- **What are they**
- **Designated Uses affected**
- **Challenges related to evaluating cyanobacteria**
- **National snap shot**
- **Highlights of some state programs**

# Cyanobacteria

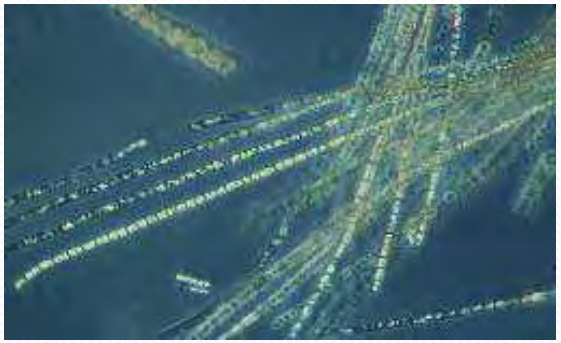
- >3 billion years old
- Occur in most waterbodies,
- Exist as single cells or as colonies
- Photosynthesize
- Some species have heterocysts (can fix nitrogen)
- Some can produce toxins

Anabaena



*Lyngbya*

*http://www.nioz.nl/press_releases.html*



Aphanizomenon

# Cyanotoxins

**Table 1.** Common genera of planktonic cyanobacteria that contain toxin and taste-and-odor producing strains.

[All data included in this table are based on documented production in laboratory cultures; data based on circumstantial evidence, such as co-occurrence of genera and toxin or taste-and-odor compounds in environmental samples, were not included in this table. LYN, lyngbyatoxin-a; APL, aplysiatoxins; LPS, lipopolysaccharides; CYL, cylindrospermopsins; MC, microcystins; NOD, nodularins; ATX, anatoxins; BMAA, β-N-methylamino-L-alanine; NEO, neosaxitoxins; SAX, saxitoxins; GEOS, geosmin; MIB, 2-methylisoborneol]

| Cyanobacterial Genera | Dermatoxins | | | Hepatotoxins | | | Neurotoxins | | | | Tastes and odors | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LYN | APL | LPS | CYL | MC | NOD | ATX | BMAA | NEO | SAX | GEOS | MIB |
| Colonial/filamentous | | | | | | | | | | | | |
| *Anabaena* | | | X | X | X | | X | X | X | X | X | |
| *Anabaenopsis* | | | X | | X | | | | | | | |
| *Aphanizomenon* | | | X | X | X | | X | X | X | X | X | |
| *Aphanocapsa* | | | X | | X | | | | | | | |
| *Cylindrospermopsis* | | | X | X | | | | X | | X | | |
| *Microcystis* | | | X | | X | | | X | | | | |
| *Nodularia* | | | X | | | X | | X | | | | |
| *Oscillatoria (Planktothrix)* | X | X | X | | X | | X | X | | X | X | X |
| *Pseudanabaena* | | | X | | X | | | | | | X | X |
| *Raphidiopsis* | | | X | X | | | X | | | | | |

Source: Graham, Loftin, Meyer, 2008. USGS SIR 2008-5038. http://pubs.usgs.gov/sir/2008/5038/pdf/SIR2008-5038.pdf

# Cyano HABs

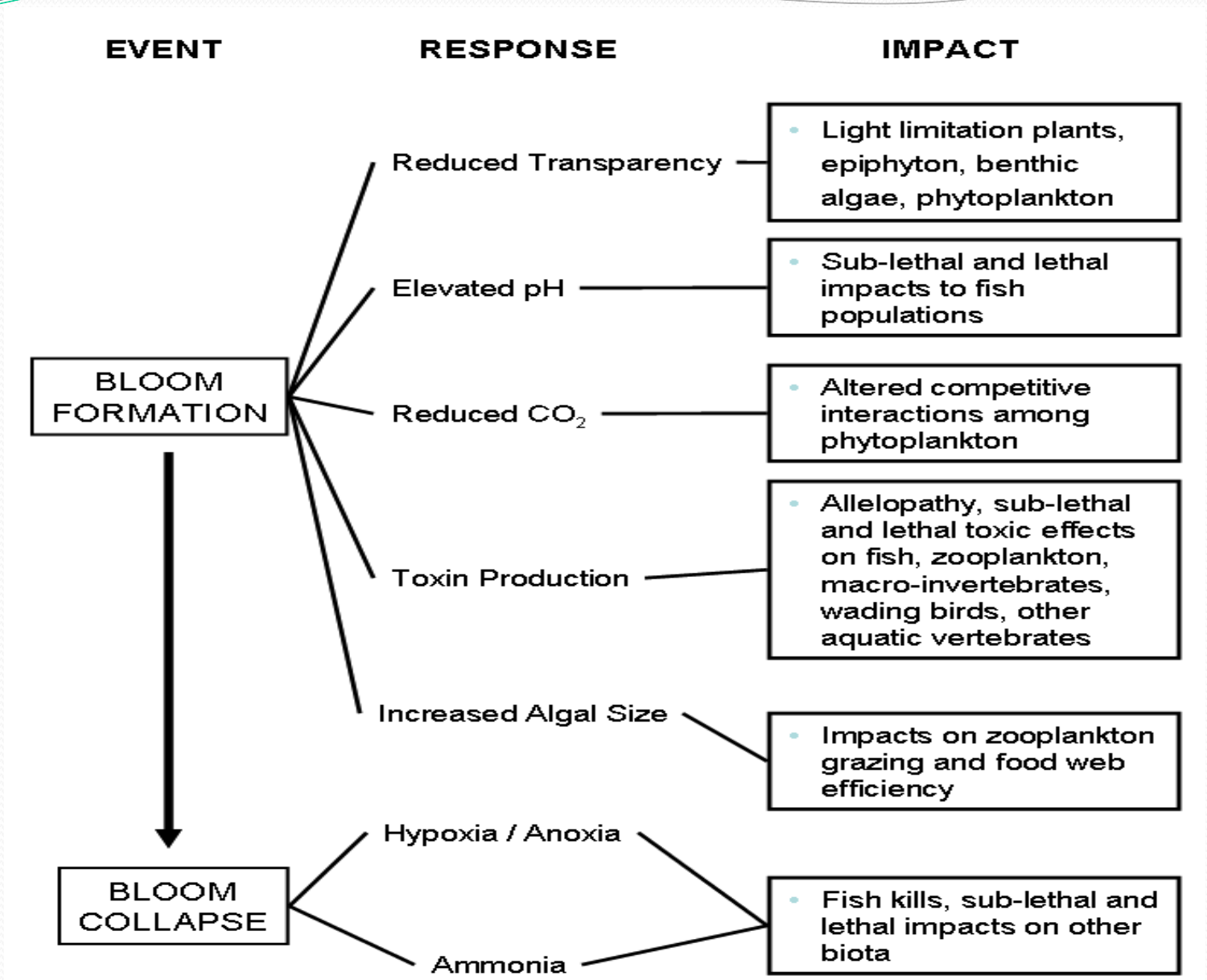
Copco Reservoir, Klamath River

# Designated Uses Affected

## Aquatic Life / Ecological

Pinto Lake, Watsonville CA

# Aquatic Life / Ecological Impacts




Karl Havens ISOC-HAB Ch. 33

# Designated Uses Affected

# Designated Uses Affected


Above: Iron Gate Reservoir
Left: Pinto Lake

# Designated Uses Affected

## Swimmable?

Thomas B Dunklin Gallery August 26, 2007

# Designated Uses Affected

Pinto Lake, Watsonville


## Recreational Uses

# Impacted Beneficial Uses

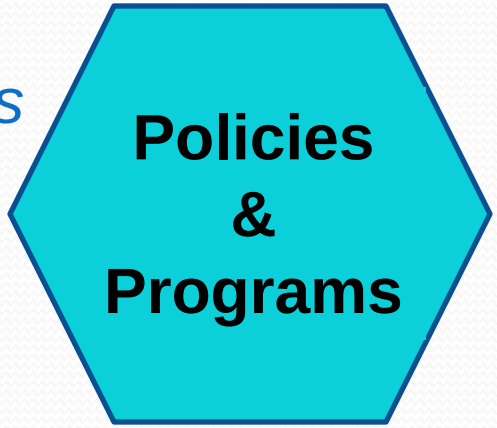
| **Aquatic Life**<br>COLD, WARM, SPWN, MIGR, EST, MAR | **Drinkable**<br>MUN, GWR | **Swimmable**<br>REC1, REC2 | **Fishable**<br>SHELL, COMM | **Other**<br>WILD, AGR/IRR |
|---|---|---|---|---|
| Water Quality (DO, OM, nutrients, light)<br><br>Food web impacts:<br>• Macro-invertebrates<br>• Fish and shellfish<br>• Otters | DW sources impacted - surface and Groundwater<br><br>DW Treatment required | Swimming (Ingestion and Dermal)<br><br>Jet skiing, air boating (inhalation) | Sport and commercial fishing and consumption limited (Fish, shellfish)<br><br>Fisheries and aquaculture (taste, odor, texture) | Animal Deaths<br>• livestock<br>• wildlife<br>• Pets<br>• birds<br><br>Agriculture<br>• Water intakes fouled<br>• Toxins in irrigated produce |

# Challenges:

*Ecology*

*Toxicology & Criteria/Action Levels*

*Monitoring – objective & approach*




*Occurrence Documentation*

*Analytical Methods*

*Communication & Management*

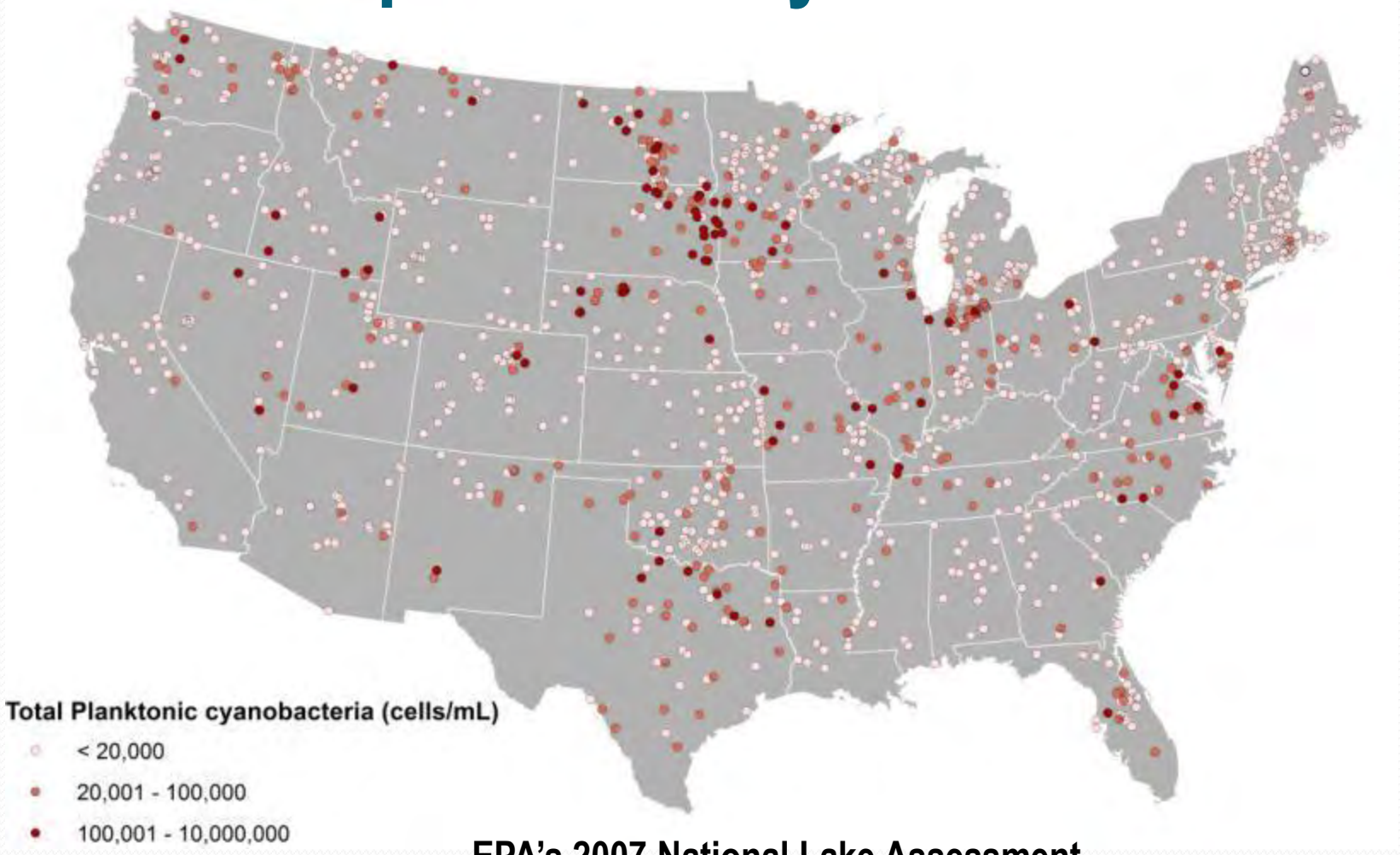
# Guidance and Regulations

- WHO Guidance values for recreational exposure (relative probability of acute health effects)

| Relative Probability of Acute Health Effects | Cyanobacteria (cells/mL) | Microcystin-LR (µg/L) | Chlorophyll-a (µg/L) |
|---|---|---|---|
| Low | < 20,000 | <10 | <10 |
| Moderate | 20,000–100,000 | 10–20 | 10–50 |
| High | 100,000–10,000,000 | 20–2,000 | 50–5,000 |
| Very High | > 10,000,000 | >2,000 | >5,000 |

- U.S. federal guidelines –
  - no water quality criteria or regulations
  - CCL3 listed microcystin-LR, anatoxin-a, and cylindrospermopsin

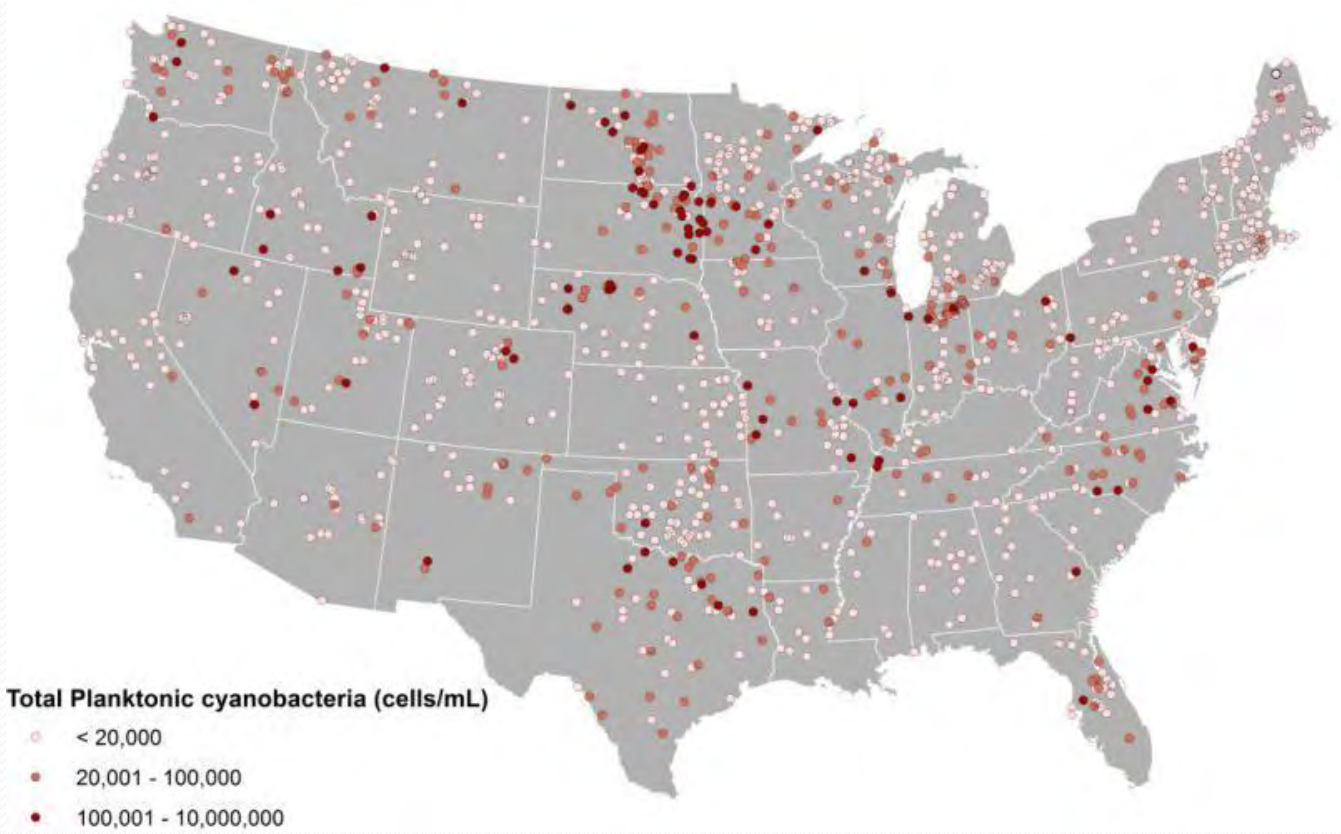
# How widespread are Cyanobacteria?



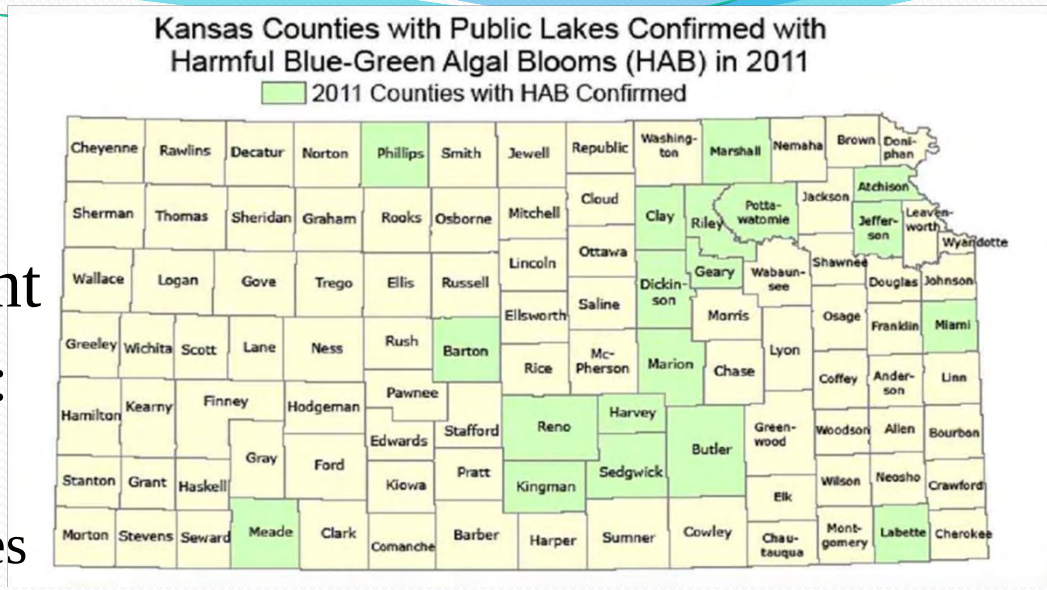

**EPA's 2007 National Lake Assessment**
**Integrated Photic Zone – Total Cyanobacteria (USGS)**

# What are others doing?

- Kansas
- Oklahoma
- Washington



# Kansas




Dept of Health & Environment

On-line reporting system for:

- Bloom observations
- Human and Animal illnesses

Web page - http://www.kdheks.gov/algae-illness/index.htm

- Current status (list of Advisories and Warnings plus mapping)

Weekly news release (coordinated with KWP&T and ACOE)

- Kansas Health Alert Network Distribution
- Toll free HAB Hotline
- Facebook postings (“Odin” )

# KDHE Facebook Postings

# Oklahoma

- Pre-2011 -
  - State had no guidance
  - US ACOE used WHO guidelines (2003)
- 2012 –

  Emergency Act - Oklahoma SB 259 signed into law

  https://www.sos.ok.gov/documents/legislation/53rd/2012/2R/SB/259.pdf

## After Getting Sick From Algae Bloom Exacerbated by Heat Wave and Drought, Inhofe Jokes the "Environment Strikes Back"

By **Stephen Lacey** on Jul 1, 2011 at 6:05 pm

Irony can be so ironic. A day after cancelling his keynote address at the Heartland climate denial conference because he felt "under the weather," Republican Senator Jim Inhofe today insisted his sickness was due to a toxic algae bloom on the Grand Lake in Oklahoma where he has a home – joking to a local newspaper that "the environment strikes back" and "Inhofe is attacked by the environment."

> "There is no question," the Oklahoma Republican said, linking what he thought was a routine dive into the lake last Monday morning to a severe upper respiratory illness.
>
> "That night, Monday night, I was just deathly sick."
>
> Inhofe and his wife, Kay, have had a home on the lake for decades, **and he has never seen that kind of algae in the water previously.**

Inhofe's run-in with algae comes as his state deals with a record-setting heat wave and drought not seen since the 1930's – creating perfect conditions for blue-green algal blooms that can cause respiratory problems, diarrhea, skin irritation and, in rare cases, death. **In Texas, cattle have been dying from drinking blue-green algae that scientists explain have blossomed due to severe drought conditions.**

# Oklahoma - SB 259 for Rec waters

- Objective - Allow public to check the water quality, as it adversely affects human and mammalian animal health

- Waters managed by state or federal agencies or entities
  - Advisories based on WHO moderate/high probability;
    - CyanoHAB ≥ 100,000 cells/ml; microcystin ≥ 20 ug/l
    - Post signs at major access points
    - Identify where information on water quality is available
  - develop /maintain website: www.checkmyoklake.com
  - written information for the public - available on location
  - provide educational material and information to physicians, hospital personnel, and local health

OTRD written information for the public

# Blue-Green Algae Checklist

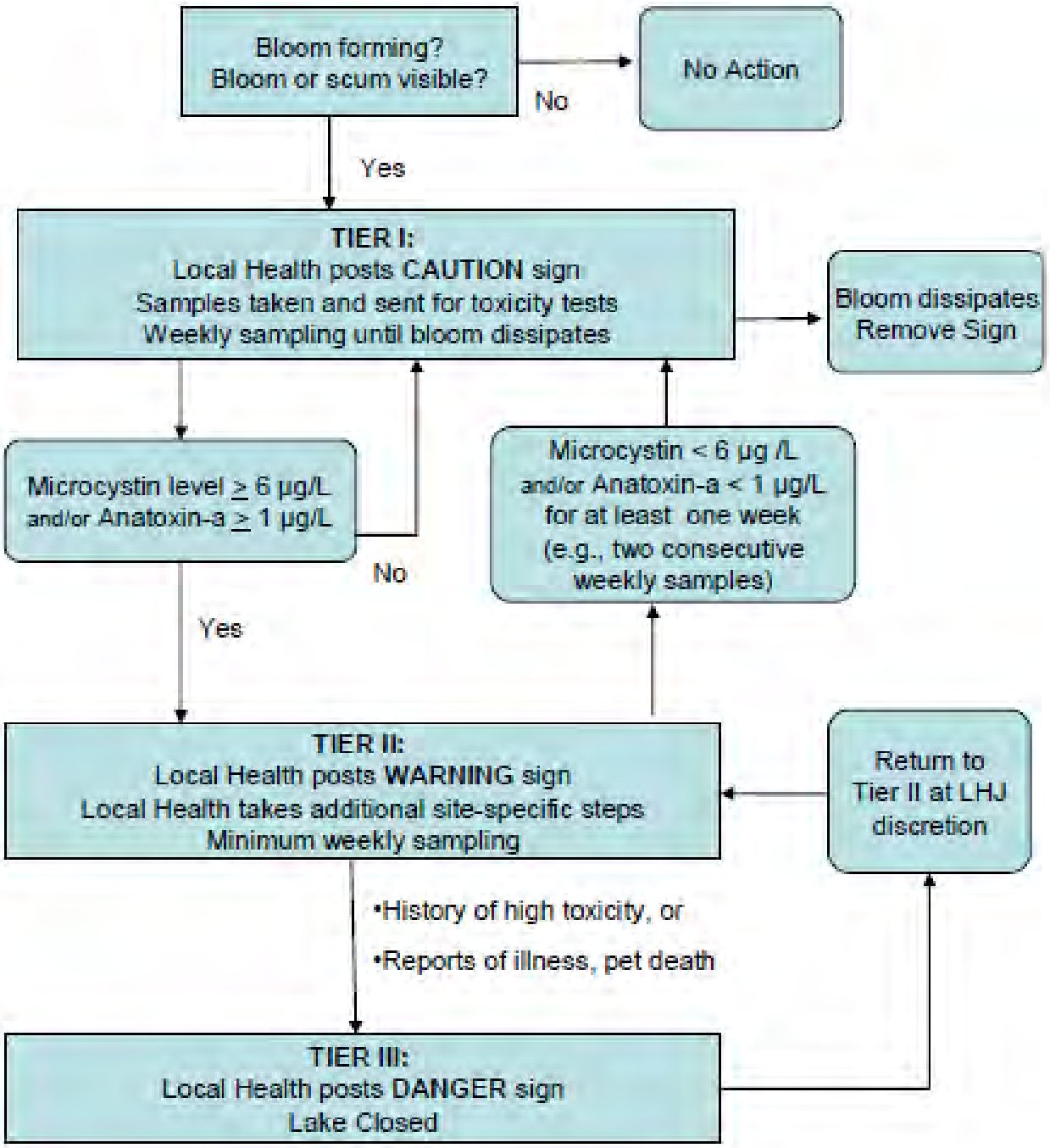
IF IT IS GREEN ON TOP


- To protect yourself and your pets, do not swim, boat, ski, play in, or ingest water that looks like "pea soup," green or blue paint, or that has a scum layer or puffy blobs floating on the surface.
- Symptoms related to blue-green algae exposure include a rash, hives or skin blisters, stomach cramps, diarrhea, vomiting, headache, fever, muscle weakness, or difficulty breathing. If you experience any of these symptoms, contact your doctor or the Poison Control Center at 800.222.1222 immediately.
- Take a shower after coming into contact with surface water, whether or not a blue-green algae bloom appears to be present, to wash away any potentially harmful bacteria.
- Pets are also impacted by swimming in or drinking water with blue green algae blooms. If you think your pet may have been affected, call your veterinarian right away.
- Always be cautious while in or near the water and remember these lifesaving words:

# Washington


Programs
Services
Publications & Forms
Databases
Laws & Rules
Public Involvement Calendar
Public Records
Freshwater Algae Control Program
ALGAE CONTROL HOME
Public Health & Algae
Algae Bloom Monitoring
Lakes & Algae Management
Grants for Algae Management
Water Quality > Freshwater Algae Control Program
Introduction
In 2005, the Washington State Legislature established funding for an algae control program and asked the Washington Department of Ecology (Ecology) to develop the program. Reducing nutrient input to lakes is the only long-term solution to prevent algae blooms. However the amount of money available for this program (about $250,000 per year) is not enough to fund comprehensive lake-wide and watershed-wide nutrient reduction projects. Instead the program focuses on providing local governments with the tools they need to manage algae problems. The program targets blue-green algae (also known as cyanobacteria) because these algae pose a health risk to humans, pets, and livestock.
Ecology's algae program provides for:
• Algae identification.
• Toxicity testing (microcystin, anatoxin-a, cylindrospermopsin, and saxitoxin).
• An on-line database to post the laboratory results.
• Small grants (up to $50,000) for algae or nutrient management projects (see the latest funding list)

# Washington




http://www.doh.wa.gov/Portals/1/Documents/4400/334-177-recguide.pdf

# Washington


**Tier I**. A CAUTION sign is intended to provide the public with information that a public health hazard might exist. It is posted if a bloom is forming or a bloom or scum is visible.


**Tier II.** A WARNING sign is posted if microcystins levels are 6 µg/L or higher and/or anatoxin-a levels are 1 µg/L or higher. The lake should be sampled weekly, at a minimum, with the WARNING sign posted as long as toxin concentrations remain above 6 µg/L (microcystins) or 1 µg/L (anatoxin-a).


**Tier III.** Under certain circumstances, a local health jurisdiction may want to close a lake with unusually high microcystin or anatoxin-a concentrations. A water body can be posted as DANGER – Closed – at the discretion of the local health jurisdiction or appropriate agency. Examples include: very dense blooms covering an entire lake, confirmed pet illnesses or death, and reported human illness.

# Washington

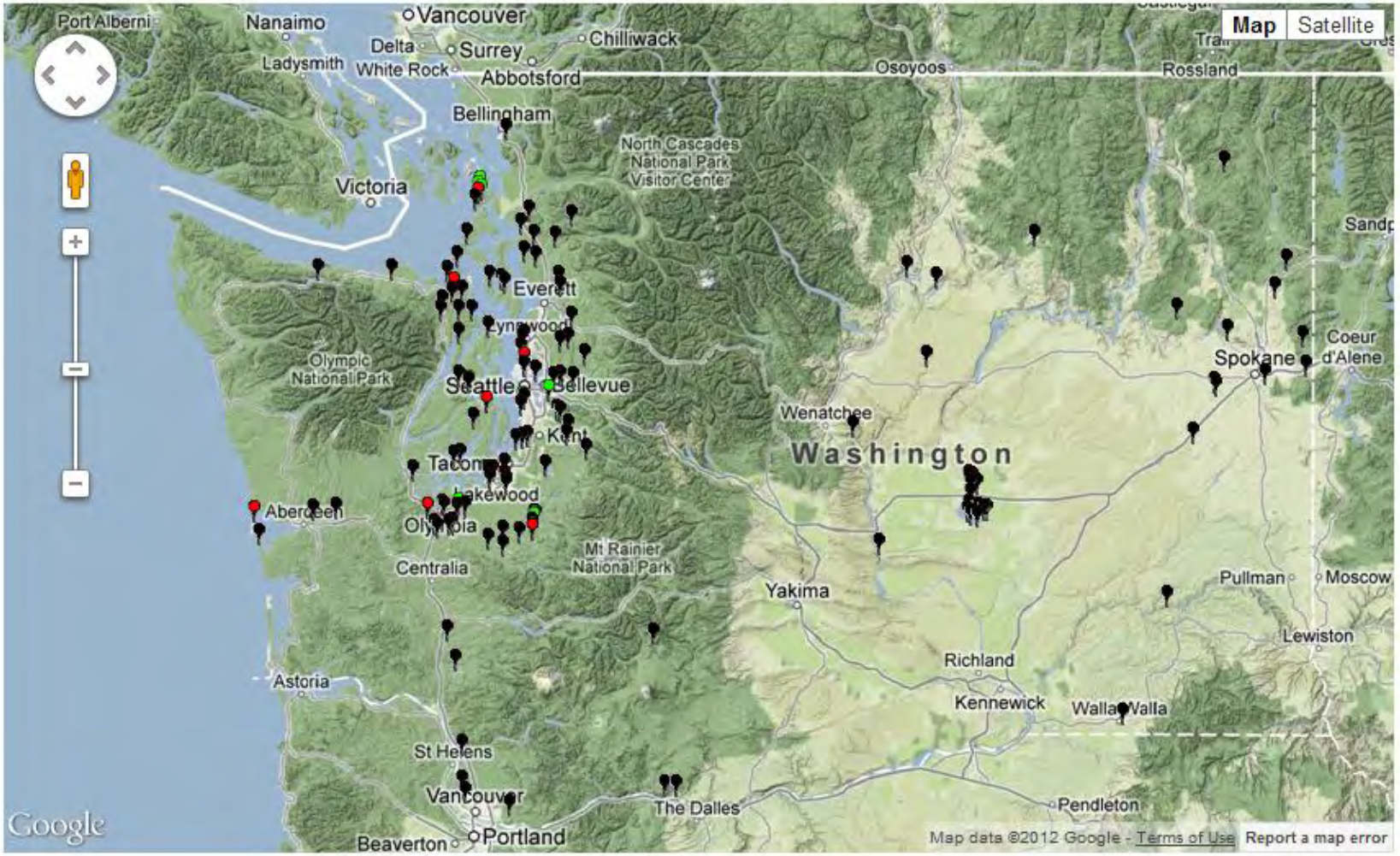
Washington State Toxic Algae

Freshwater algae bloom monitoring program

Home | Find lake | Report a bloom | Health risks | About toxic algae | Summaries | Program

Find your lake

**Map Legend:** Exceeded state recreation guideline | Within state recreation guideline | No data is available for the past 4 weeks.

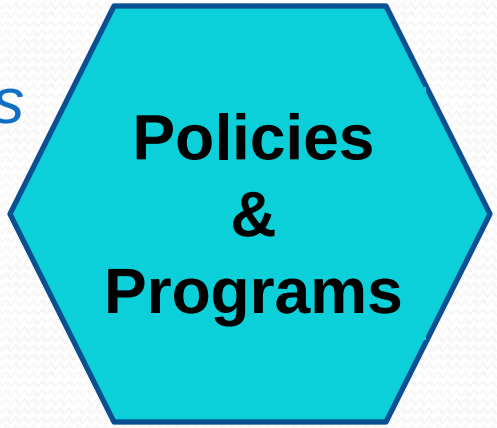


# Summary

*Ecology*

*Toxicology & Criteria/Action Levels*

*Monitoring – objective & approach*




*Occurrence Documentation*

*Analytical Methods*

*Communication & Management*