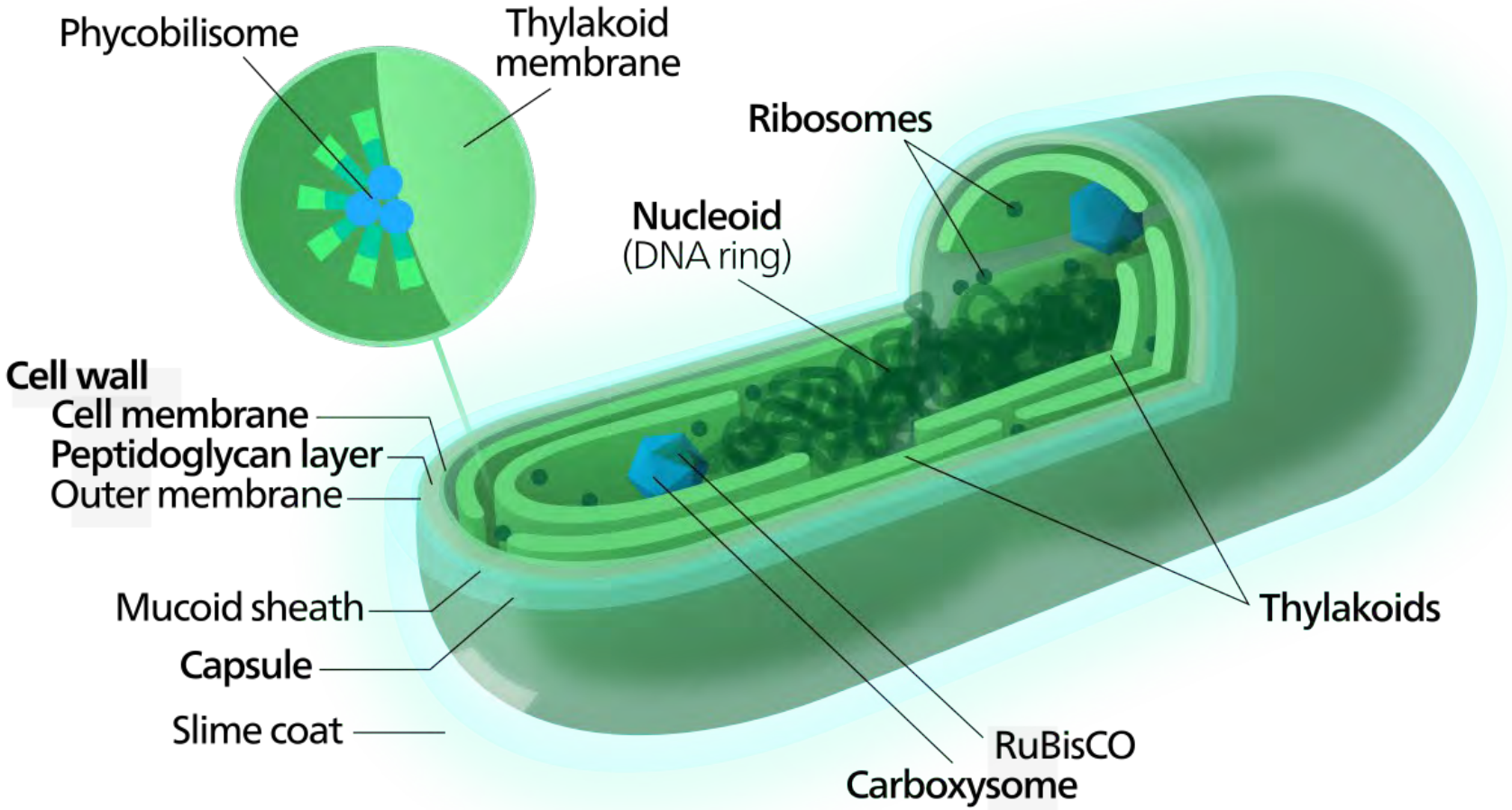
Cyanobacteria, Cyanotoxins, and Climate: Potential Impacts to Drinking Water in Maine

Sophia Scott, Source Water Protection Coordinator
Maine CDC Drinking Water Program

https://www.wiscontext.org/cyanobacteria-stalemate-wisconsins-lakes

Maine's Drinking Water Program: Working together for safe drinking water

What are cyanobacteria?



http://www.turdak.com/siyanobaktericyanobacteria-tedavisinde-akilci-antibiyotik-kullanimi/

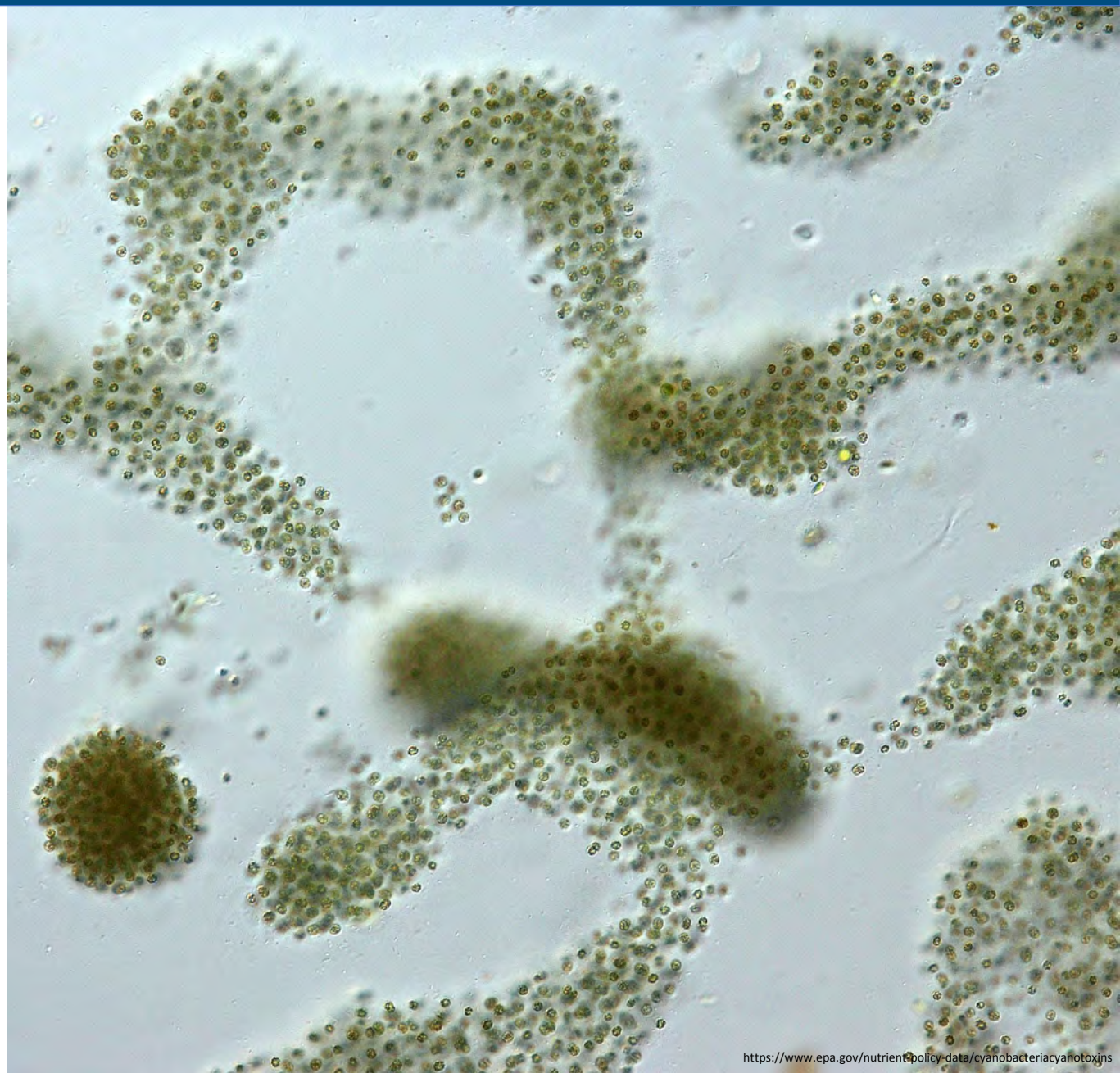
https://fishbio.com/field-notes/wildlife-ecology/manipulative-pond-scum

https://www.medoraco.com/applications/water-re-use/open-reservoirs/cyanobacteria-cyanotoxin-mitigation

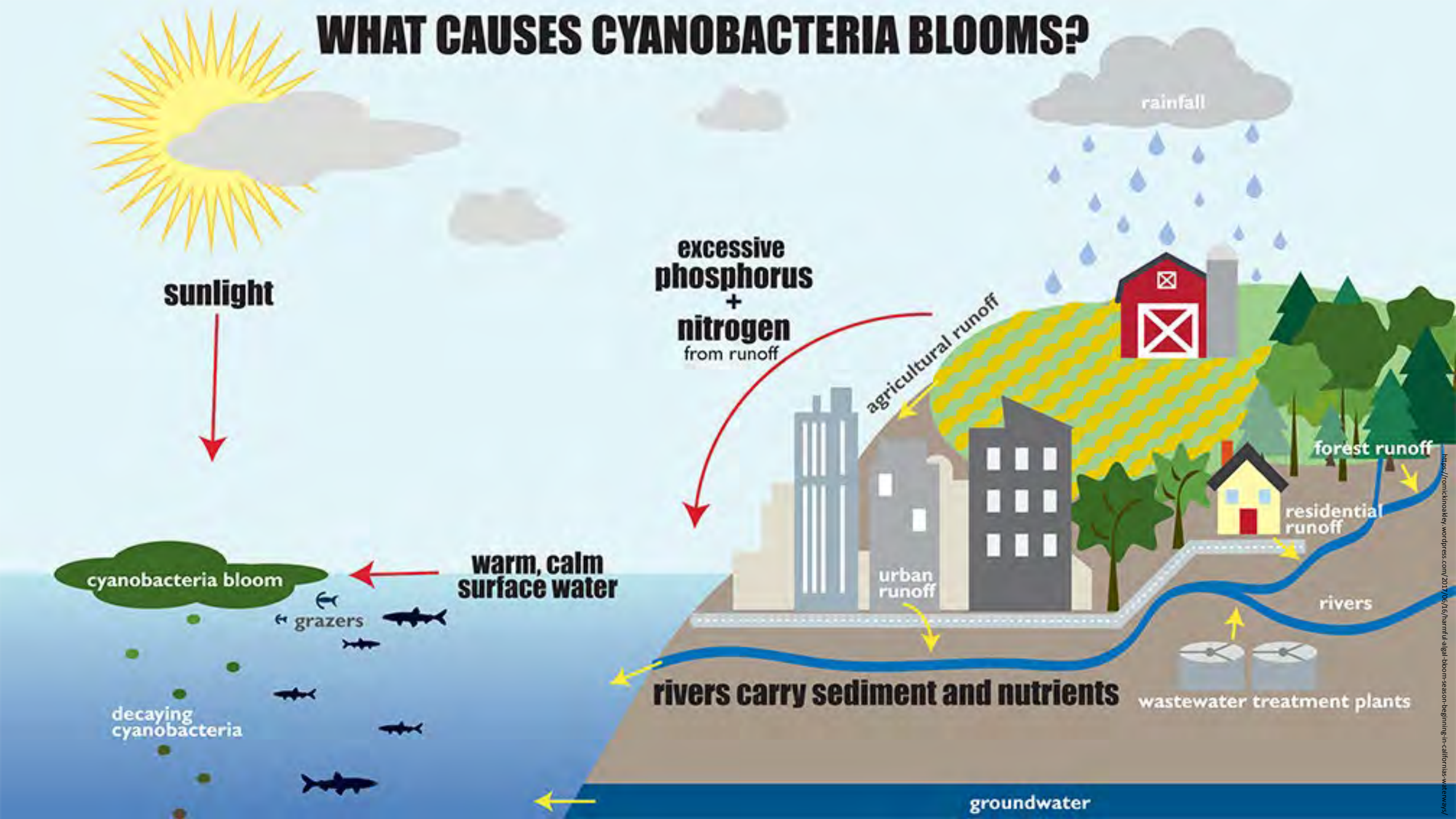
https://esemag.com/water/cyanobacterial-blooms-drinking-water/

What are cyanotoxins?

- Microcystins
- Cylindrospermopsin
- Anatoxins
- Saxitoxins

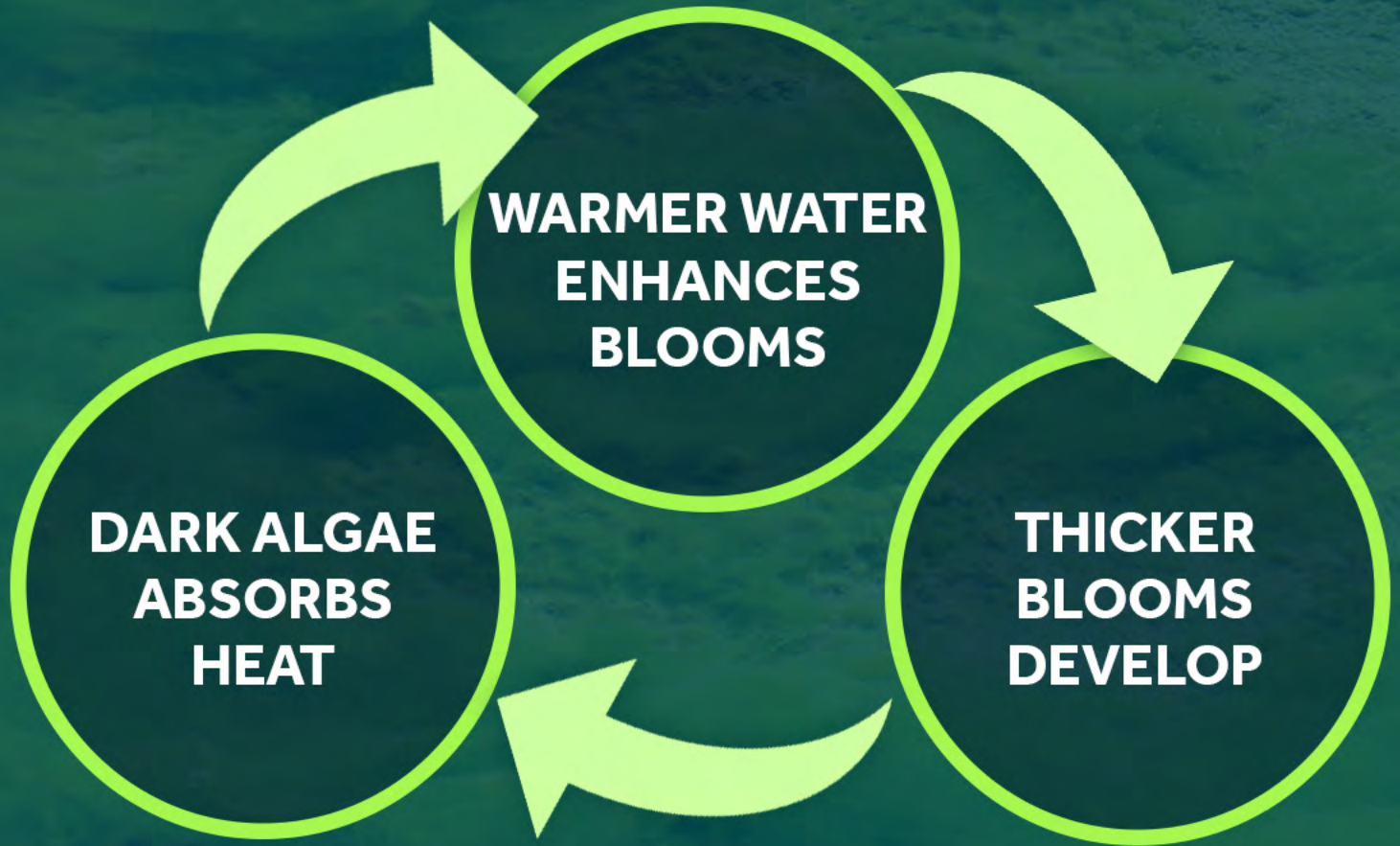


https://www.epa.gov/nutrient-policy-data/cyanobacteriacyanotoxins


WHAT CAUSES CYANOBACTERIA BLOOMS?
sunlight
excessive
phosphorus
+
nitrogen
from runoff
rainfall
agricultural runoff
forest runoff
residential
runoff
urban
runoff
rivers
cyanobacteria bloom
warm, calm
surface water
grazers
decaying
cyanobacteria
rivers carry sediment and nutrients
wastewater treatment plants
groundwater
https://romickinoakley.wordpress.com/2017/06/16/harmful-algal-bloom-season-beginning-in-californias-waterways/

ALGAE BLOOM FEEDBACK

An Unhealthy Cycle



Source: EPA

CLIMATE CENTRAL

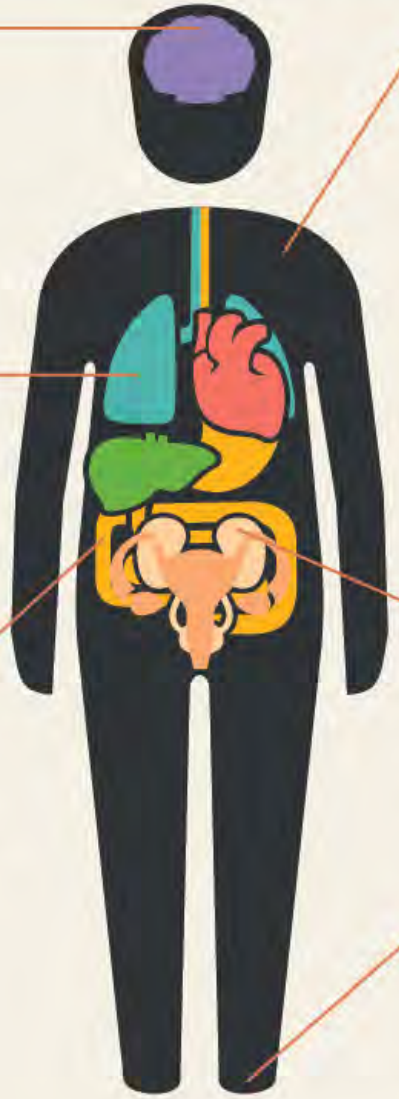
Cyanotoxins are a public health issue

IN HUMANS

Brain
Source: Ingestion
Symptoms:
- Headache
- Incoherent speech
- Drowsiness
- Loss of coordination

Respiratory System
Source: Inhalation
Symptoms:
- Dry cough
- Pneumonia
- Sore throat
- Shortness of breath
- Loss of coordination

Digestive System
Source: Ingestion, drinking contaminated water, or eating contaminated fish
Symptoms:
- Abdominal pain
- Nausea
- Vomiting
- Diarrhea
- Stomach cramps



Body
Source: Contact, e.g. swimming
Symptoms:
- Irritation in eyes, nose, and throat
- Blistering around the mouth
- Skin rash, including tingling, burning and numbness
- Fever
- Muscle aches (from ingestion)
- Weakness (from ingestion)

Organs
Source: Ingestion
Symptoms:
- Kidney damage
- Abnormal kidney function
- Liver inflammation

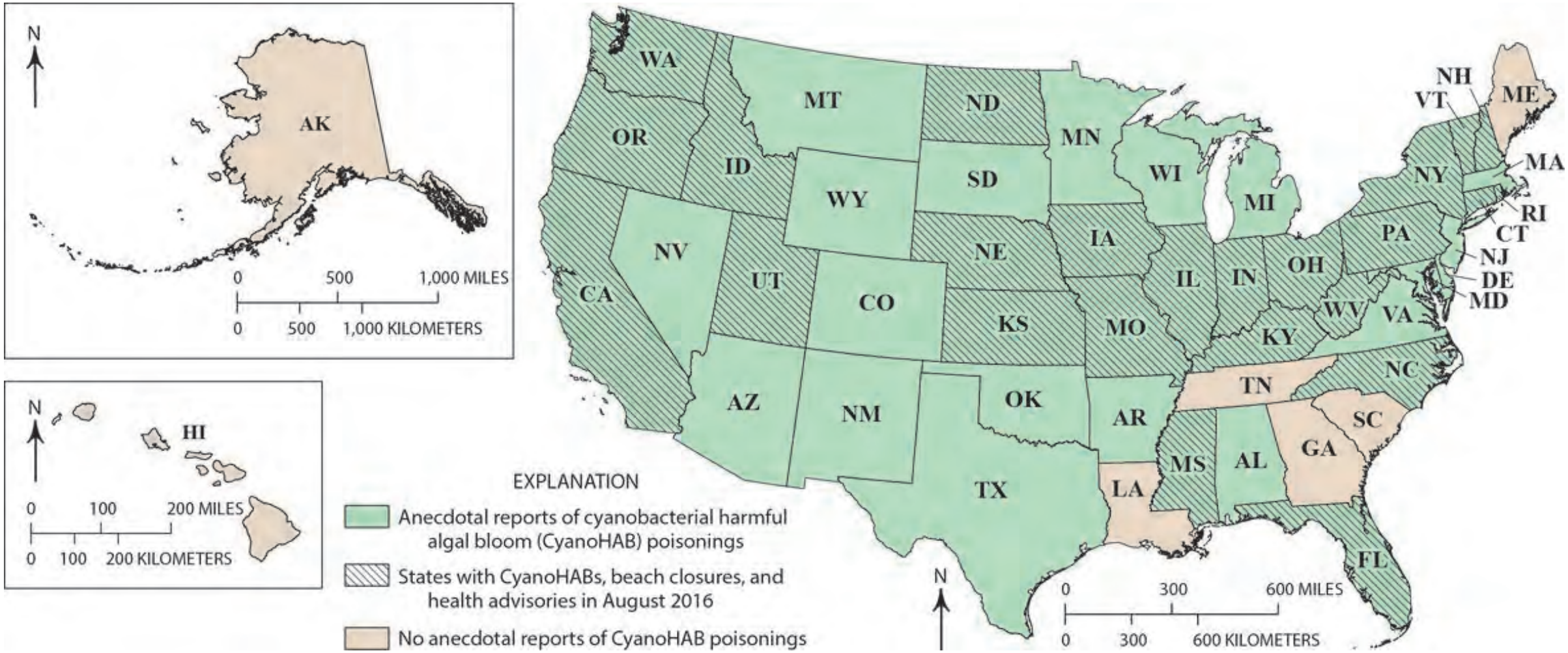
Nervous System
Source: Ingestion
Symptoms:
- Tingling
- Burning
- Numbness

IN PETS

Symptoms:
Vomiting
Fatigue
Shortness of breath
Difficulty breathing
Coughing
Convulsions
Liver failure
Respiratory paralysis leading to death

http://www.cleanwateraction.org/features/harmful-algal-blooms-and-drinking-water

Cyanotoxins are impacting most states



Cyanobacteria: National Significance

A toxic algae scare has left 500,000 people in Ohio without drinking water

By Brad Plumer | @bradplumer | brad@vox.com | Aug 3, 2014, 11:10am EDT

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Independent laboratory finds cyanobacteria in Adrian drinking water

TOM HENRY
Blade Staff Writer
thenry@theblade.com

JAN 15, 2019 6:48 PM

Michigan Environment Watch

Lake Erie's algae bloom is growing again after paralyzing Toledo water system

Algae Toxins Prompt Toledo To Ban Its Drinking Water

By BILL CHAPPELL • AUG 3, 2014

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Aundrea Simmons stands next to her minivan with cases of bottled water she bought after Toledo warned residents not to use its water Saturday.

npr

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PUBLIC HEALTH

Algae Toxins In Drinking Water Sickened People In 2 Outbreaks

November 9, 2017 · 4:16 PM ET

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Local Environment News Water Health

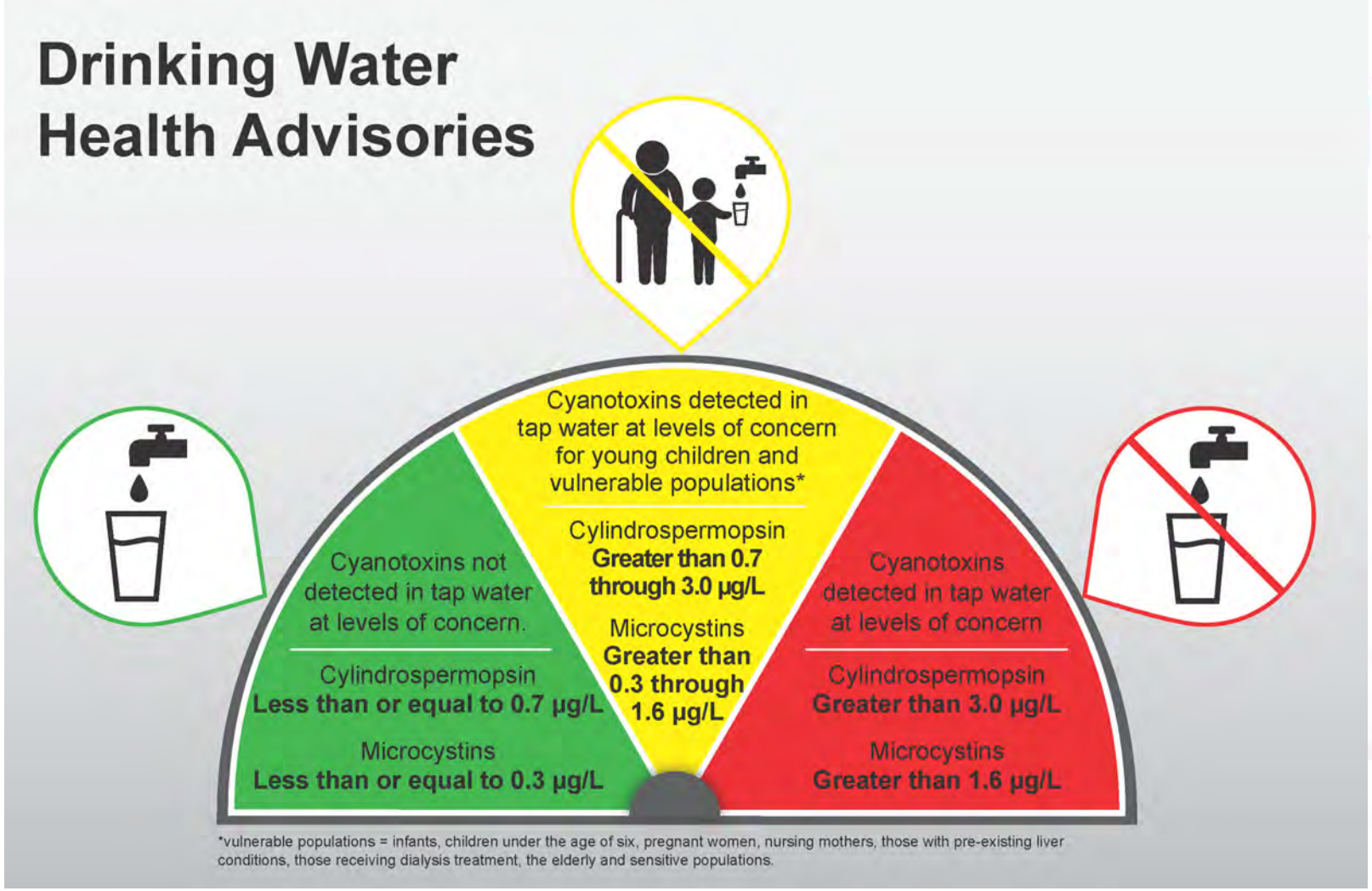
Salem Issues Another Drinking Water Advisory Over Cyanotoxins

by Ericka Cruz Guevarra Follow

UPDATE (1:40 p.m. PT) — Salem has issued yet another drinking water advisory Wednesday for the city's vulnerable populations – just four days after lifting an initial advisory that prompted Gov. Kate Brown to issue an emergency and activate the National Guard.

The new advisory is based off of water samples taken on June 3-4.

Government Response: EPA Health Advisory



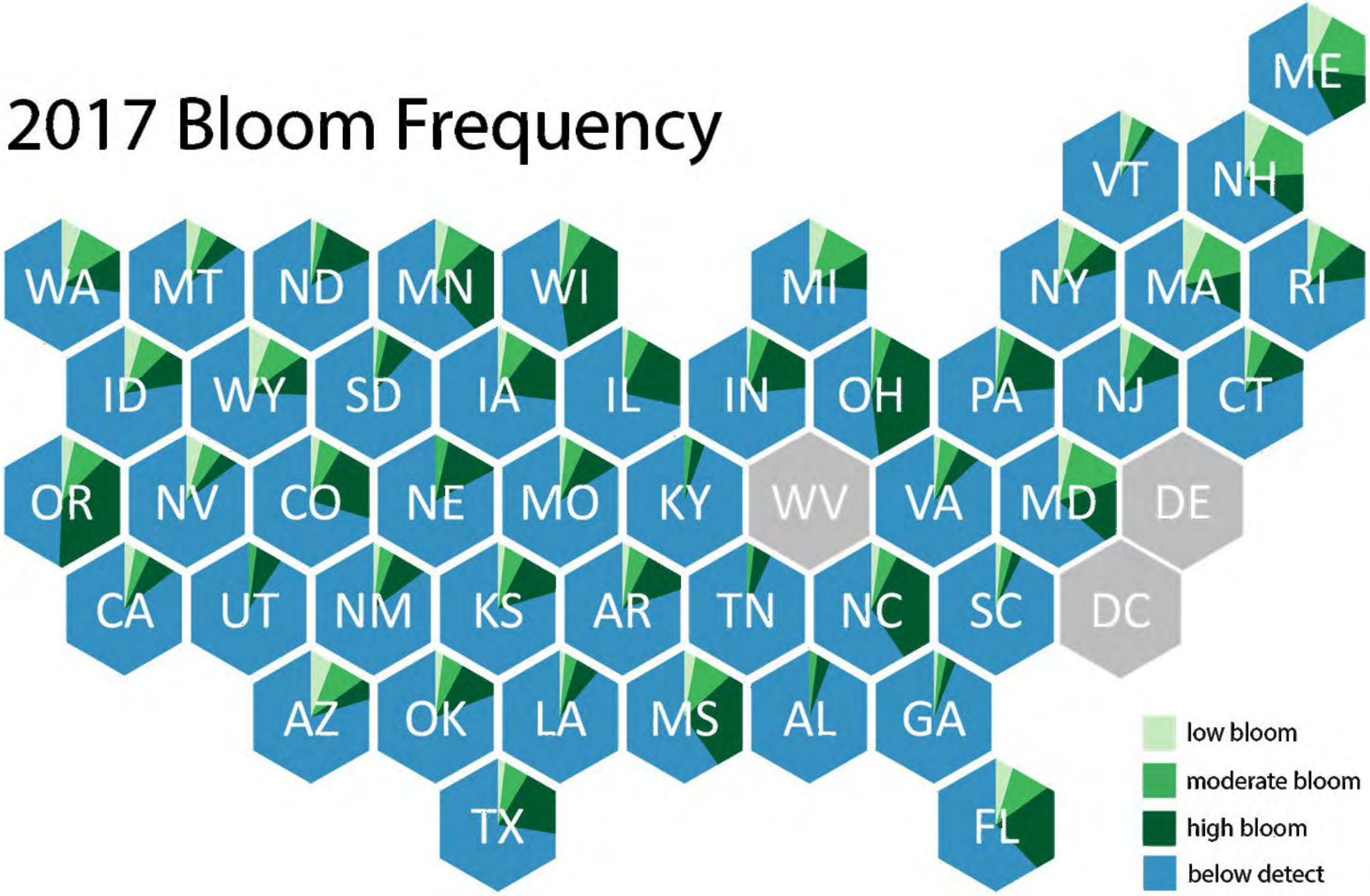
10-DAY HEALTH ADVISORIES	LEVEL
Microcystins	
Children pre-school age and younger (under 6 years old)	0.3 µg/L
School-age children (6 years and older)	1.6 µg/L
Cylindrospermopsin	
Children pre-school age and younger (under 6 years old)	0.7 µg/L
School-age children (6 years and older)	3.0 µg/L

How prevalent are cyanotoxins in drinking water?

- total microcystin
- microcystin-LA
- microcystin-LF
- microcystin-LR
- microcystin-LY
- microcystin-RR
- microcystin-YR
- nodularin
- anatoxin-a
- cylindrospermopsin

https://www.epa.gov/water-research/harmful-algal-blooms-drinking-water-treatment

Cyanobacteria: How Are We Doing in Maine?



Cyanobacteria: How Are We Doing in Maine?

Maine DEP

MAINE DEPARTMENT OF
Environmental Protection

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- Contacts
- Permits, Licenses, Certifications
- Laws
- Monitoring and Reporting
- Programs
- Rules
- Publications and Resources

Maine Lakes at Risk of Having an Algal Bloom

Frequency of blooms

Often: Annually or near-annually
Sometimes: 2-5 years (sometimes more in past)
Rarely: One year on record

Risk of future blooms

Very High: will likely bloom annually
High: will likely bloom again
Moderate: could occasionally bloom
Low: unlikely given other data

Show 25 entries Search:

LAKE	TOWN	LAKE ID#	FREQUENCY	RISK	COMMENTS
ABRAMS P	EASTBROOK	4444	Sometimes	High	
ADAMS P	BOOTHBAY	5366	Rarely	Low	
ANASAGUNTICOOK L	HARTFORD	3604	Rarely	Low	
ANDROSCOGGIN L	LEEDS	3836	Rarely	Moderate	
ANNABESSACOOK L	MONMOUTH	9961	Often	High	Was treated in 1980s
AUBURN L	AUBURN	3748	Rarely	Moderate	
BARKER P	HIRAM	3136	Rarely	Low	
BEAR P	T03 R05 BKP WKR	5140	Rarely	Low	
BEDDINGTON L	BEDDINGTON	4524	Rarely	Low	
BLACK L	FORT KENT	1666	Sometimes	High	
BOYDEN L	PERRY	1404	Rarely	Low	
BRANCH P (EAST)	T07 R11 WELS	2822	Rarely	Moderate	

Cyanobacteria: How Are We Doing in Maine?

Maine DEP

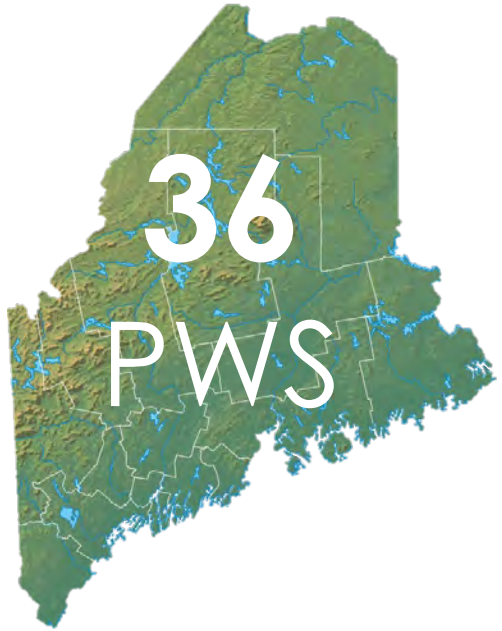
		2014				2015						
	Location	Late August	Early Sept	Late Sept	Early Oct	Late August	Early Sept	Late Sept	Early Oct	Late Oct	Early Nov	Late Nov
Sabattus: 3796	Deep Hole	3.46	21.47	1.60	4.67	0.24	0.66	1.16	0.54	0.49	0.08	0.08
	Deep Area	37.84	3.34	1.82	7.35	0.36	0.86	0.73	0.59	0.84	0.23	0.33
	Near Shore	12.39	5.60	4.46	4.44	0.28	0.57	0.34	1.19	0.6	0.4	0.26
	Surface Scum	619	10605	1674		35.78	3.51	10.21		1.67	4.02	
Unity: 5172	Deep Hole	3.16	7.88	3.14	6.42	0.27	0.28	0.58	0.33	0.21	0.08	
	Deep Area	2.43	1.74	6.44	6.96	0.39	0.6	0.49	0.32	0.08	0.08	
	Near Shore	3.20	2.13	7.44	4.97	0.23	0.26	0.08	0.44	0.31	0.08	
	Surface Scum	22.53	273				30.9	4.14	11.46			
Lovejoy: 5176	Deep Hole	1.38	5.70	3.00	1.19	0.08	0.08	0.08	0.22	0.3	0.18	0.08
	Deep Area	1.83	2.94	1.81	1.68	0.08	0.08	0.08	0.08	0.26	0.23	0.29
	Near Shore	2.48	2.81	1.63	1.68	0.15	0.21	0.23	0.22	0.08	0.48	0.08
	Surface Scum	491	17696	1948	18.46	15.4	17.86	8.55	3.34			60.3
Threemile: 5416	Deep Hole	0.64	1.68	0.33	0.30	5.12	3.49	1.4	0.59			
	Deep Area	1.02	1.51	0.70	0.33	3.43	4.14	1.59	0.53			
	Near Shore	1.48	2.31	0.61	0.27	6.61	5.6	4.9	0.39			
	Surface Scum	9.26	2.70	56.90		17.63	724	710				
North: 5344	Deep Hole	0.08	0.08	0.08	0.08							
	Deep Area	0.08	0.08	0.08	0.08							
	Near Shore	0.08		0.08	0.08							
	Surface Scum	0.08										
East: 5349	Deep Hole	0.08	12.37	0.08	0.08							
	Deep Area	0.08	1.05	0.08	0.48							
	Near Shore	0.08	0.48	0.08	0.42							
	Surface Scum		9.67									
Salmon: 5352	Deep Hole	0.63	0.08	0.35	0.35							
	Deep Area	0.18	1.89	0.08	0.08							
	Near Shore	0.99	0.08	0.27	0.20							
	Surface Scum											

Microcystin Concentration (ug/L) Color Key
<0.3
0.3 - 1.6
1.6 - 10
>10

Cyanobacteria: Are Our Drinking Water Sources at Risk?

THE UNIVERSITY OF MAINE
Senator George J. Mitchell Center for Sustainability Solutions

Algae in Public Water Supply Source Ponds: Occurrence and Potential for Harmful Algae Blooms

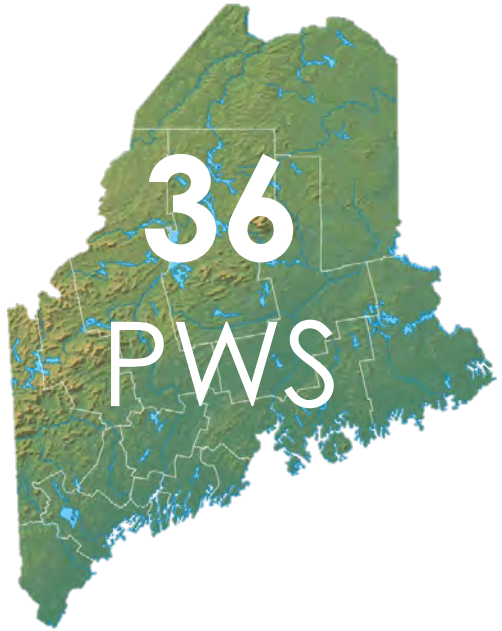


- **Historical blooms**
- **Potential sources of contamination**
- **Microcystin analysis (one sample August 2016)**

What are the risks cyanobacteria pose public water suppliers?

Cyanobacteria: Are Our Drinking Water Sources at Risk?

THE UNIVERSITY OF MAINE
Senator George J. Mitchell Center for Sustainability Solutions



- **Historical blooms**
  - 5 known blooms (high)
  - 4 past blooms (moderate)
- **Potential sources of contamination**
  - 2 high (same source)
  - 2 medium-high
  - 15 medium
- **Microcystin analysis (one sample August 2016)**
  - All samples contained microcystin
    - Below the health advisory (0.035-0.197 µg/L)
    - Three systems had levels >0.100 µg/L

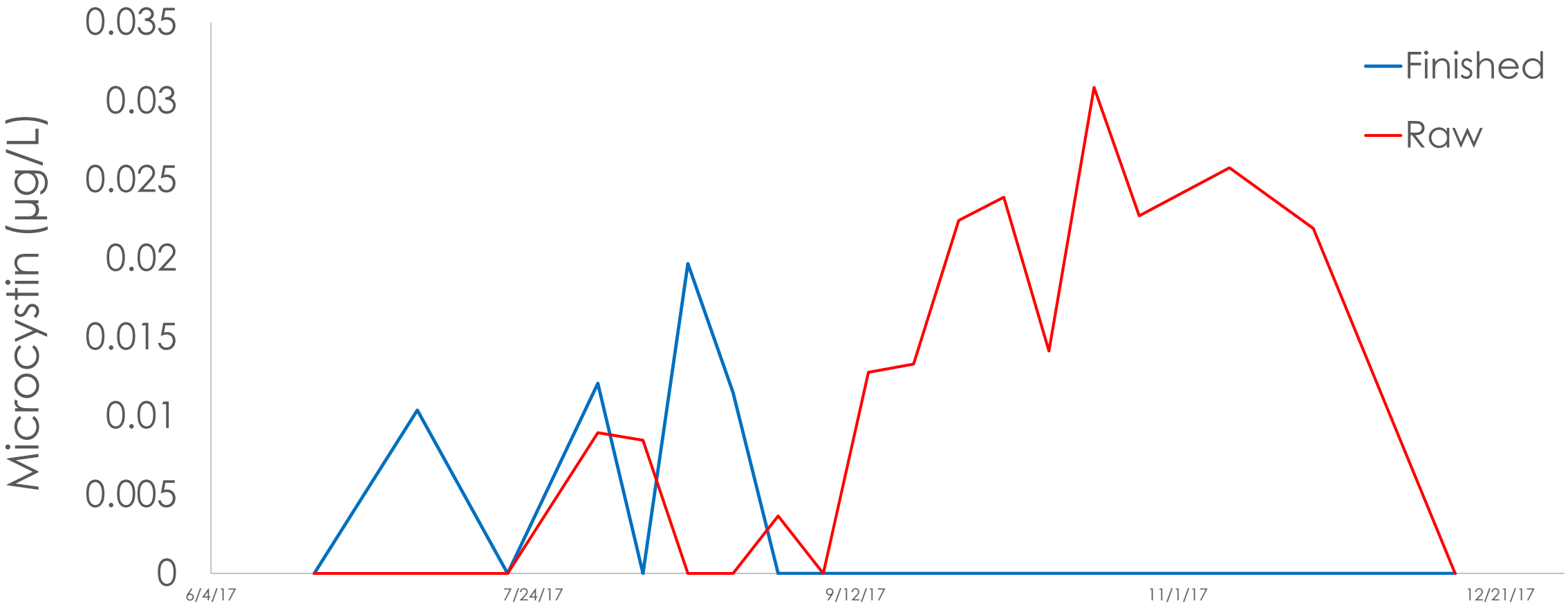
Cyanobacteria: Are Our Drinking Water Sources at Risk?

- 7 public water system sources
- Raw and finished water
- June-December: 310 samples collected
  - June, December – monthly
  - July, November – biweekly
  - August-October – weekly

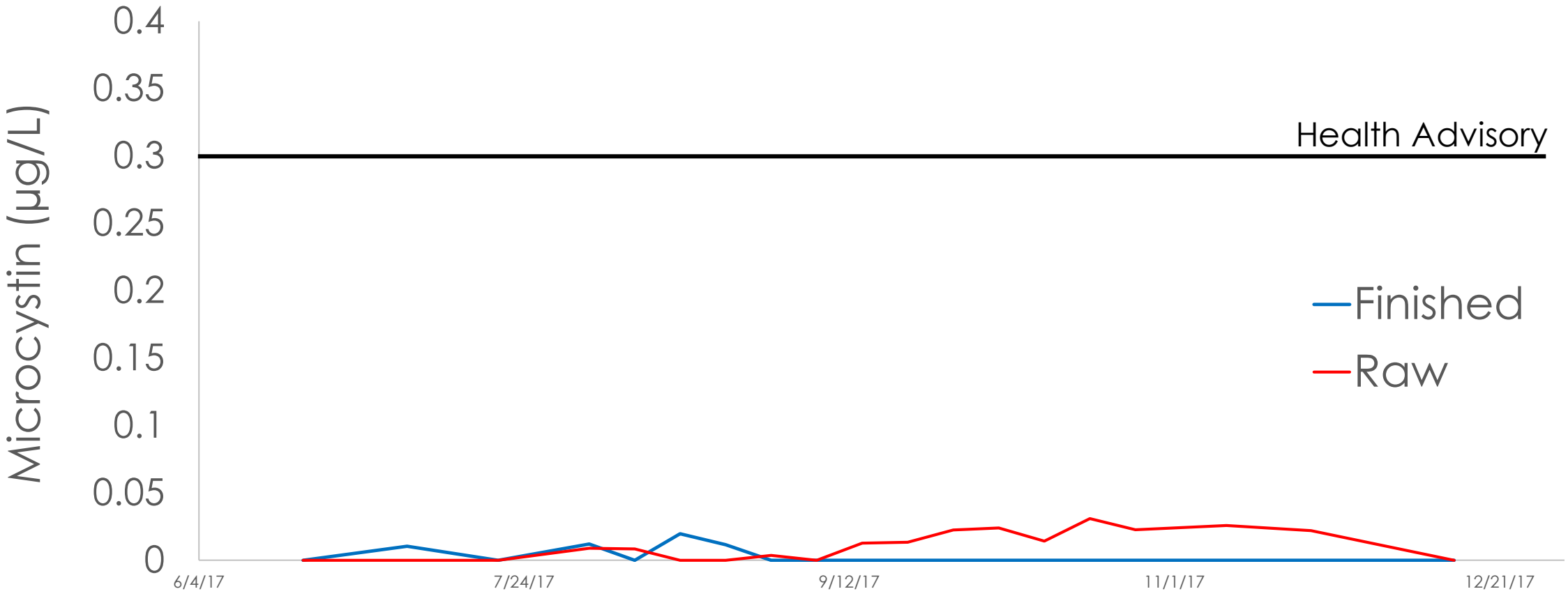
Microcystin is well below the health advisory (0.3-1.6 µg/L)

PWS	Number of Detections raw/finished	Highest Raw µg/L	Highest Finished µg/L	Treatment
1	3/1	0.016	0.013	*
2	1/1	0.010	0.009	
3	5/0	0.021	BDL	
4	16/6	0.020	0.009	*
5	12/4	0.031	0.020	*
6	9/0	0.036	BDL	
7	10/6	0.035	0.032	*

Water System 5 – Microcystin Concentrations



Microcystin: Well Below the Health Advisory



This is great news!

Cautiously celebratory

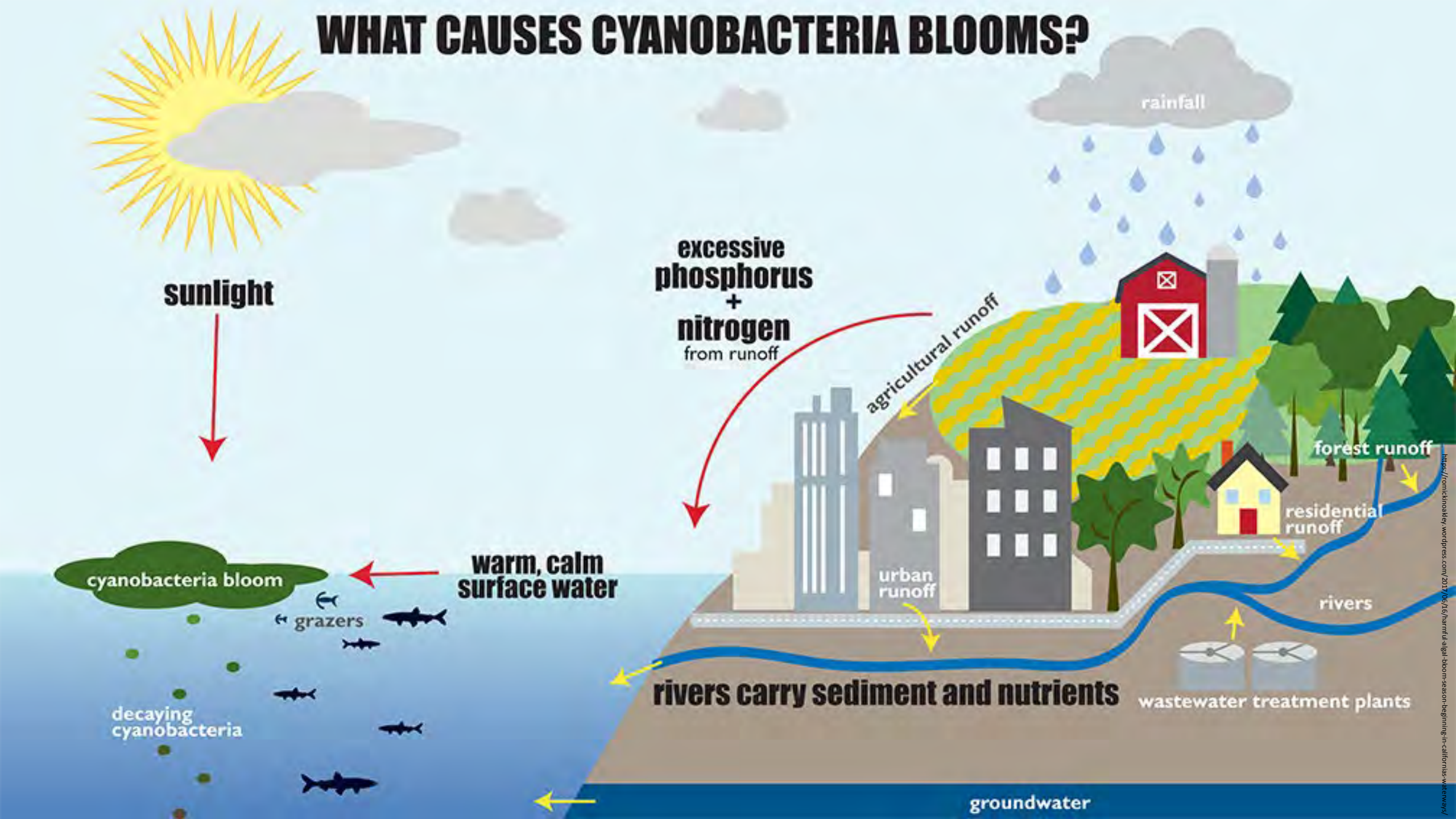
- This is only **one year** and only **seven systems**

		2014				2015						
	Deep Hole	1.38	5.70	3.00	1.19	0.08	0.08	0.08	0.22	0.3	0.18	0.08
	Deep Area	1.83	2.94	1.81	1.68	0.08	0.08	0.08	0.08	0.26	0.23	0.29
	Near Shore	2.48	2.81	1.63	1.68	0.15	0.21	0.23	0.22	0.08	0.48	0.08
Lowejoy: 51.76	Surface Scum	4.91	176.96	19.48	18.46	15.4	17.86	8.55	3.34			60.3

Microcystin Concentration (ug/L) Color Key
<0.3
0.3 - 1.6
1.6 - 10
>10

2018 – Algaecide
2019 – Alum treatment (planned)

https://www.westfargopioneer.com/sports/outdoors/4284191-taking-starry-stoneworts-opening-act


WHAT CAUSES CYANOBACTERIA BLOOMS?
sunlight
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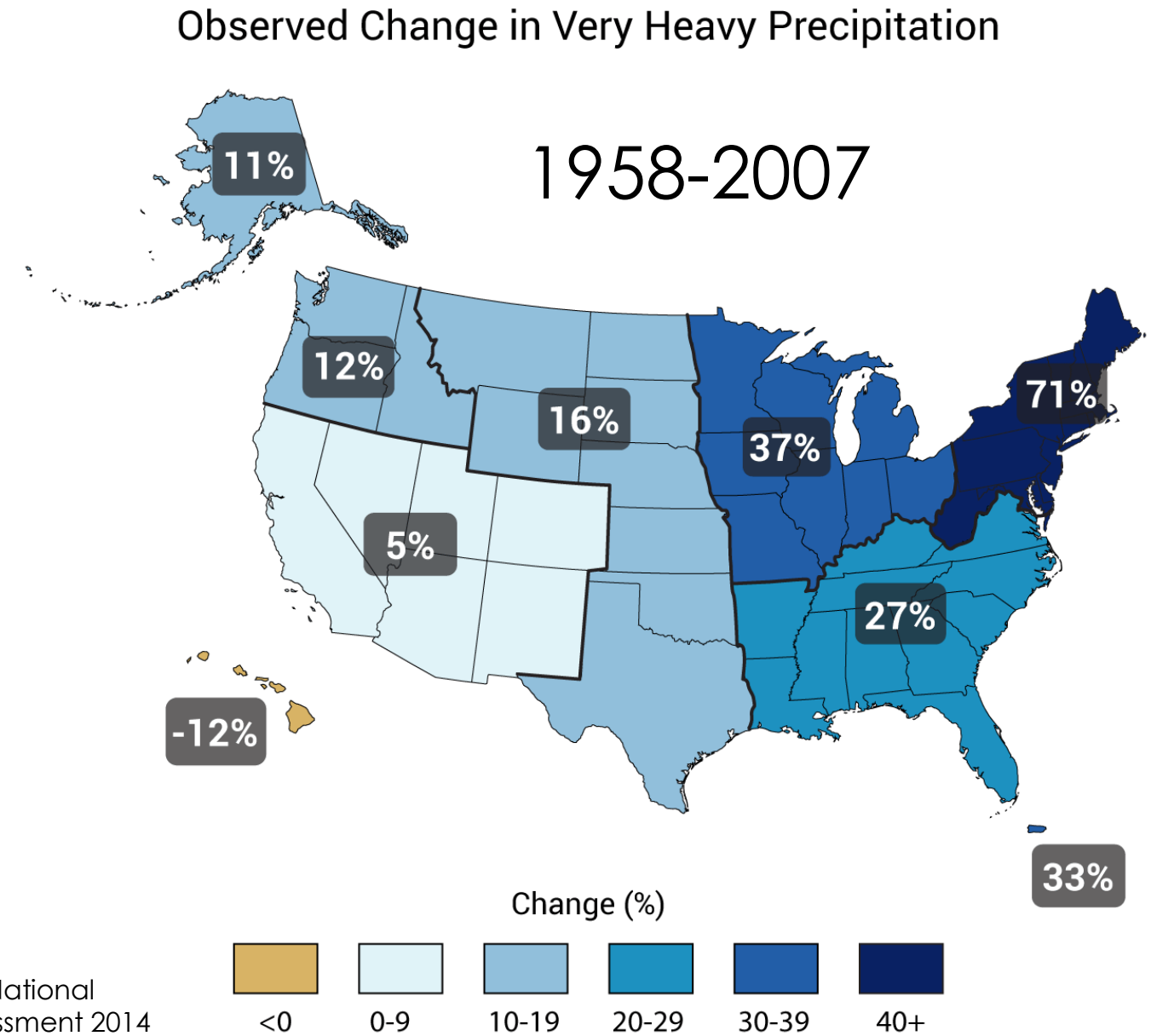
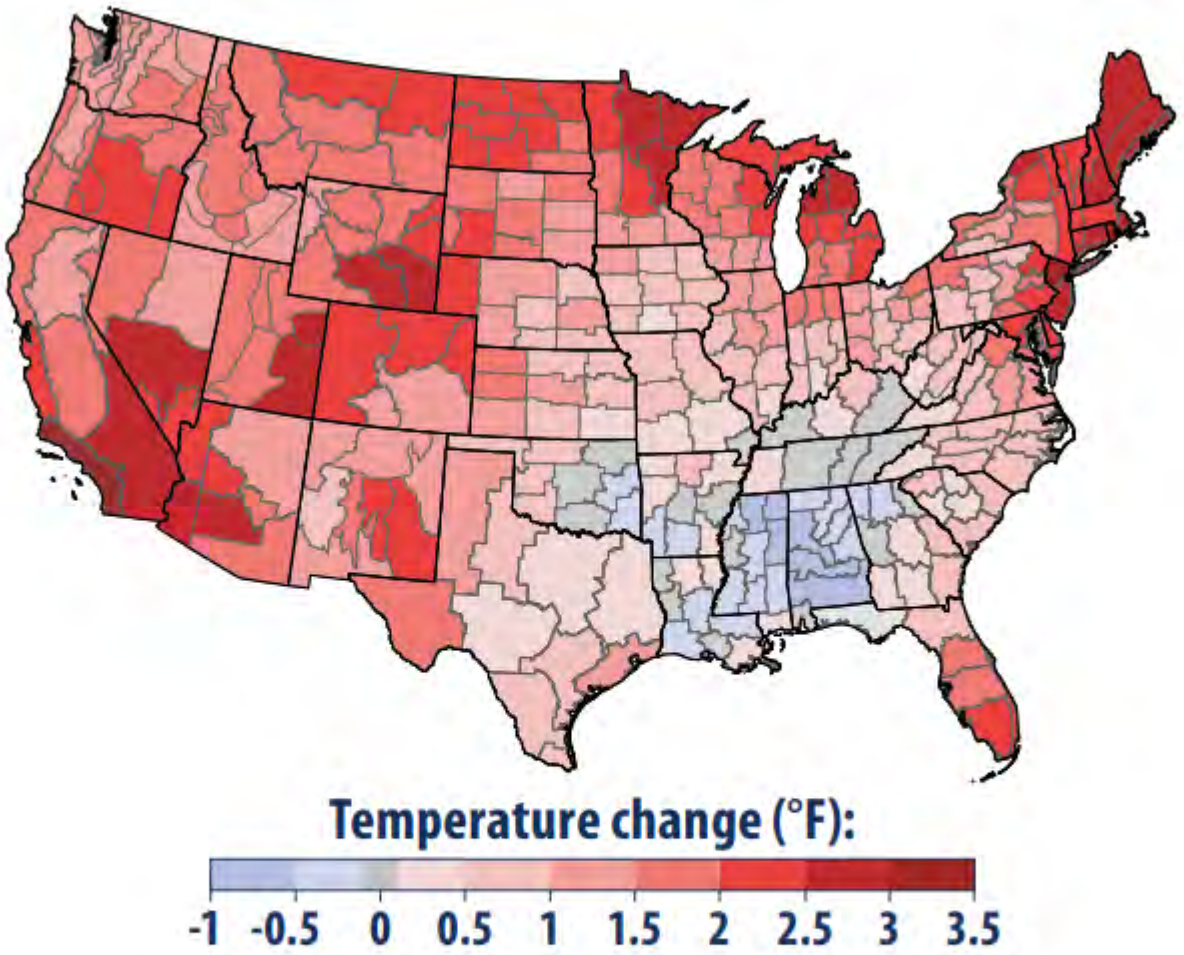
Will Climate Change Impact Cyanobacteria Blooms?



Maine is getting wetter

The Third US National Climate Assessment 2014

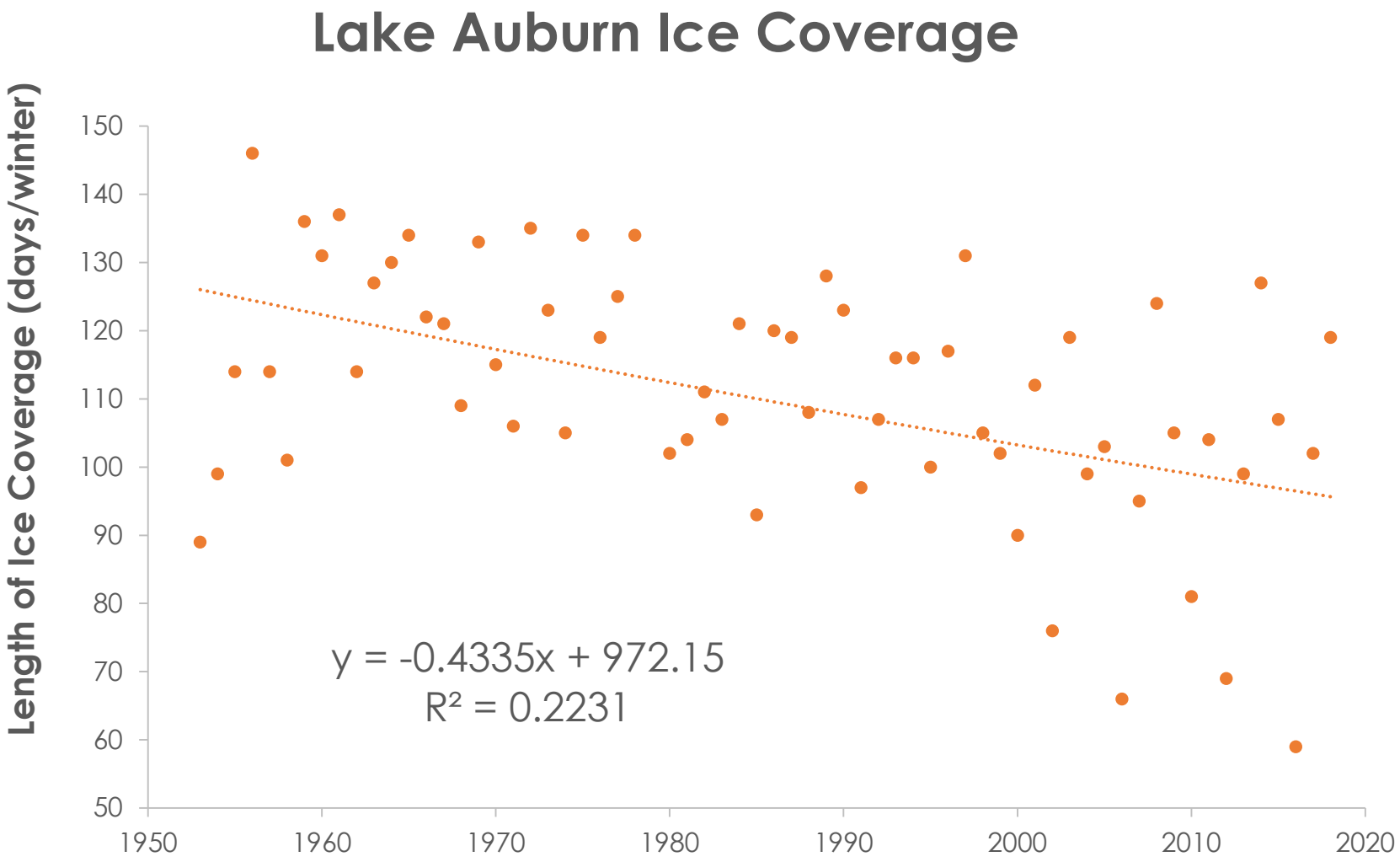
Will Climate Change Impact Cyanobacteria Blooms?



Rising temperatures in the last century. Maine has warmed twice as much as the rest of the contiguous 48 states. Source: EPA, Climate Change Indicators in the United States. US EPA 2016

Maine is getting warmer

Lake Ice Coverage is Decreasing



22%

Reduction in ice coverage!

Changing Climate Impacts Cyanobaterial Blooms

ELSEVIER

Water Research

Volume 46, Issue 5, 1 April 2012, Pages 1349-1363

Climate change: Links to global expansion of harmful cyanobacteria

Hans W. Paerl [a], Valerie J. Paul [b, 1]

Show more

https://doi.org/10.1016/j.watres.2011.08.002

Abstract

Cyanobacteria are the Earth's oldest (~3.5 bya) oxygen evolving organisms, and they have had major impacts on

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Carola Wagner, Rita Adrian

First published: 16 November 2009 | https://doi.org/10.4319/lo.2009.54.6_part_2.2460 | Cited by: 158

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Hans W. Paerl, Jef Huisman

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Summary

What can we do?

Invest in source protection.

Questions?

Sophia Scott, Source Water Protection Coordinator
Maine CDC Drinking Water Program