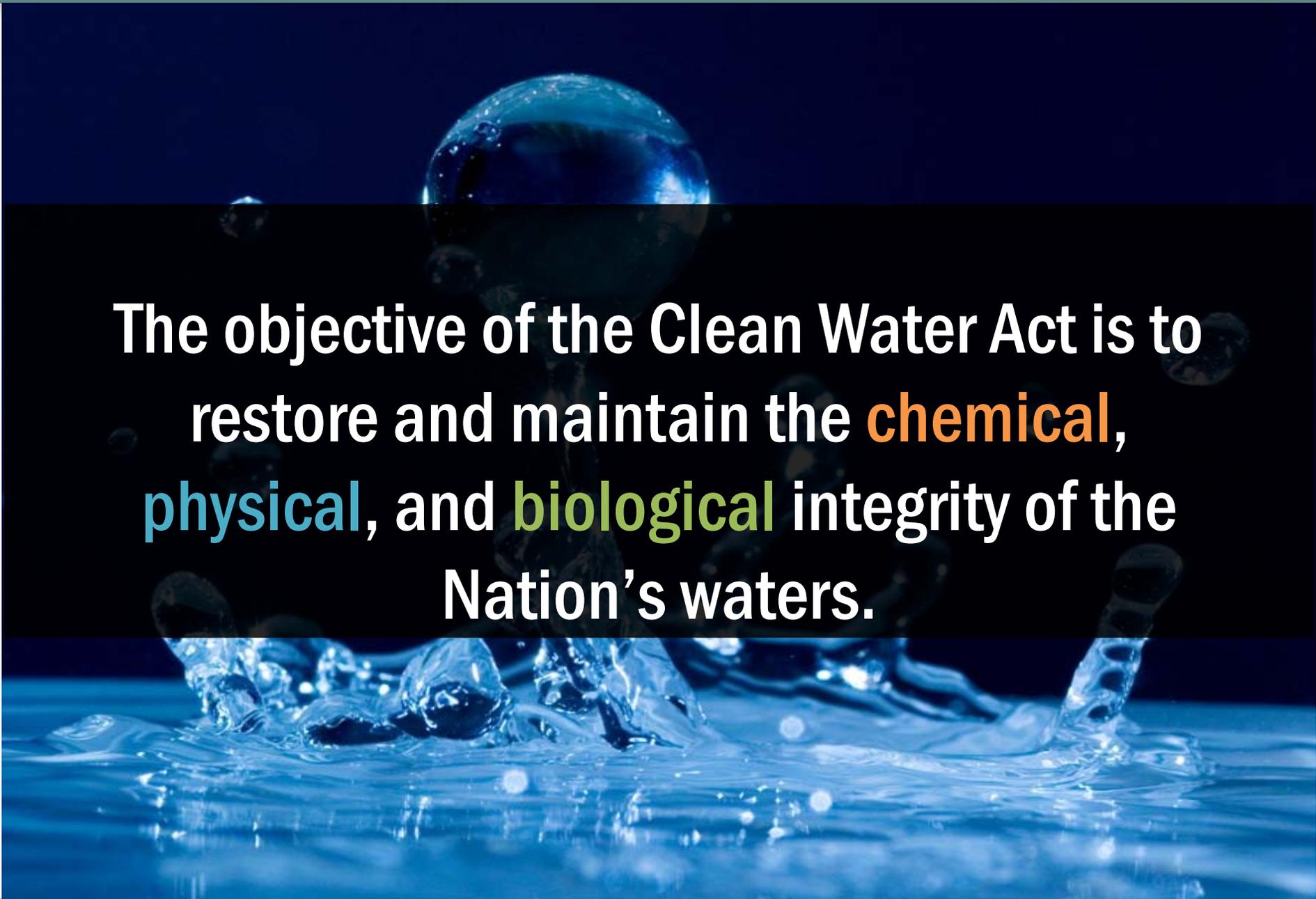


An Introduction to the Clean Water Act in Arizona and How ASU Data Can Help



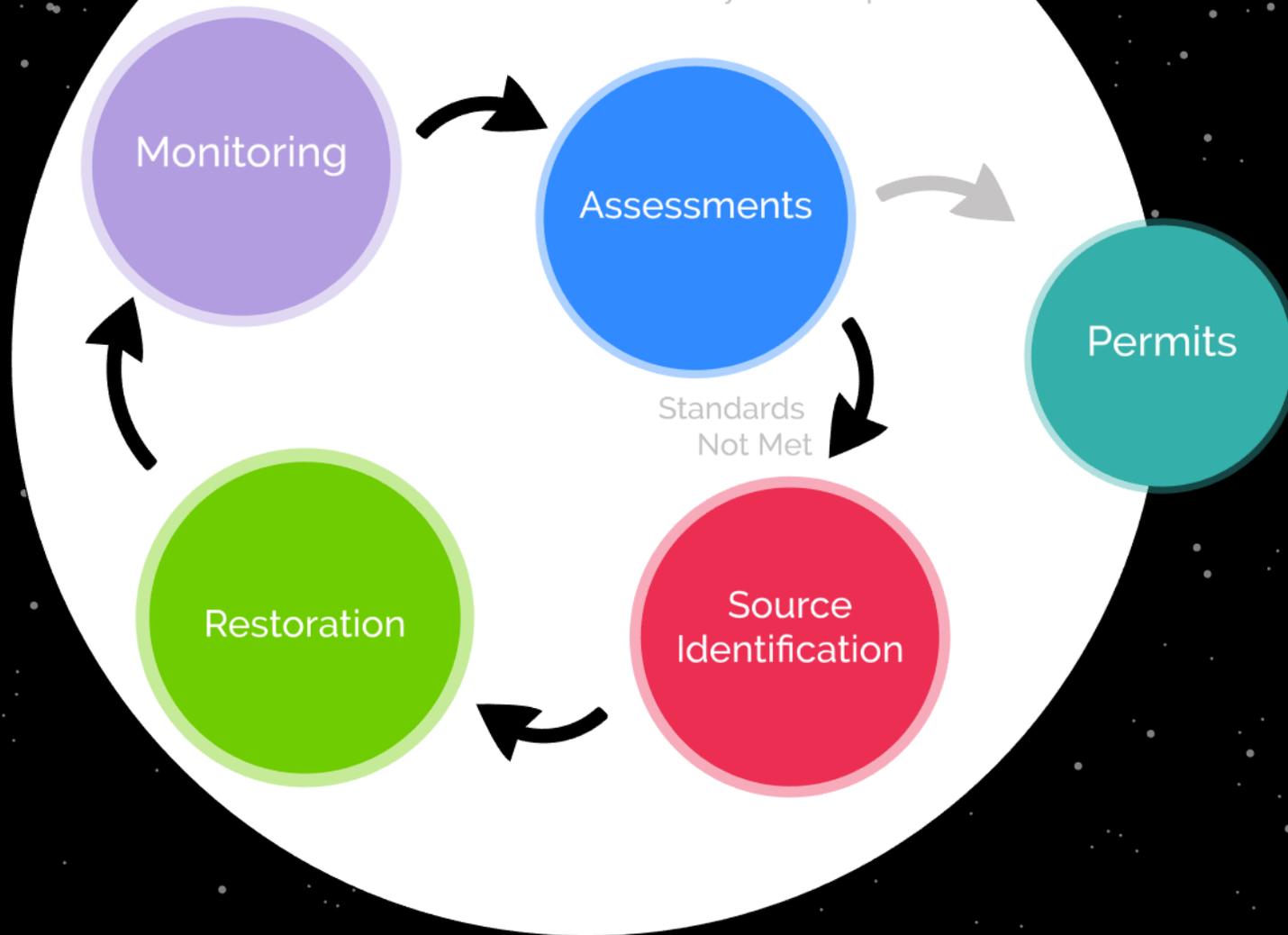
Jason Jones, March 27, 2018



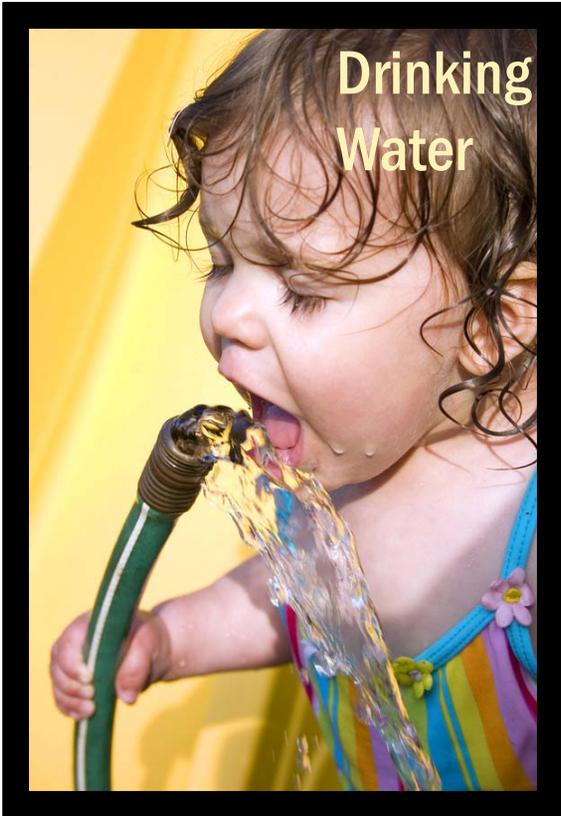
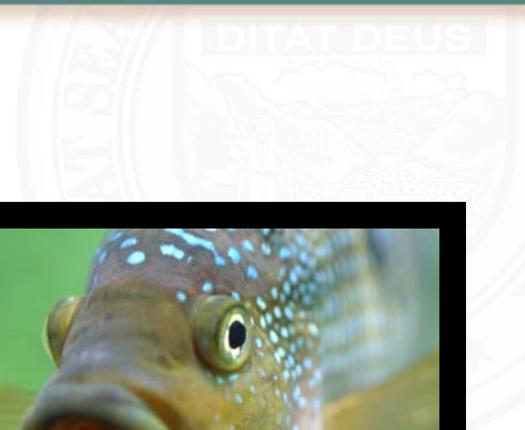
The objective of the Clean Water Act is to restore and maintain the **chemical**, **physical**, and **biological** integrity of the Nation's waters.

Clean Water Act

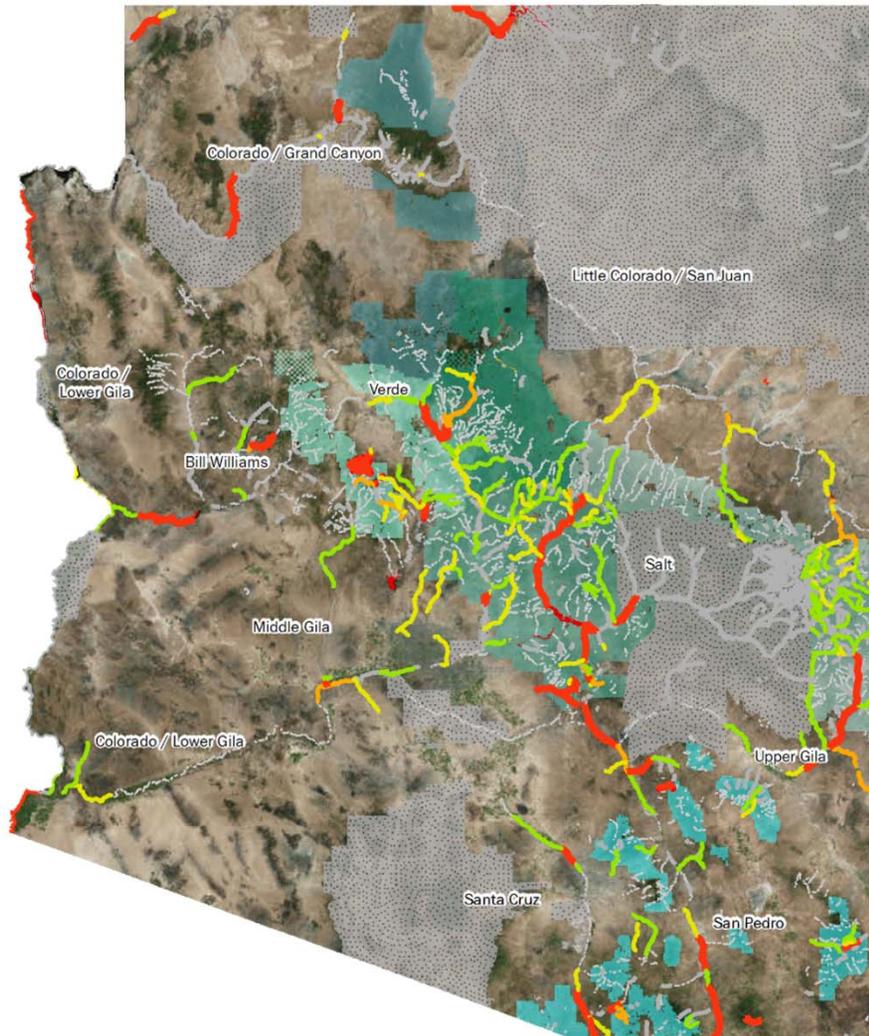
(Drastically Oversimplified)



Arizona's Designated Uses

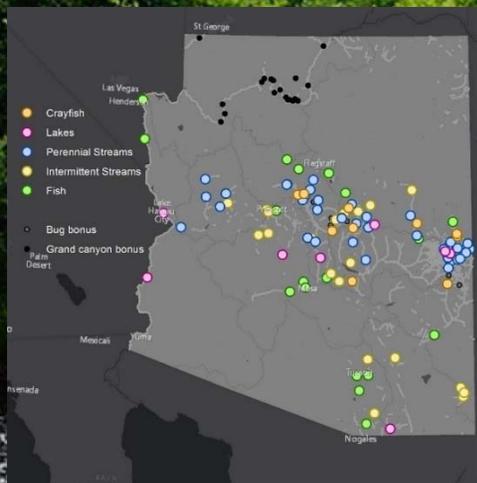


How is the Water?



EPA Category	# of Streams	# of Lakes
1. Attaining All Uses	20	0
2. Attaining Some Uses	89	3
3. Inconclusive	73	22
4. Not Attaining	39	11
5. Impaired	65	21
Not Assessed	934	200
Total	1220	257

Clean Water Act Monitoring and Assessment



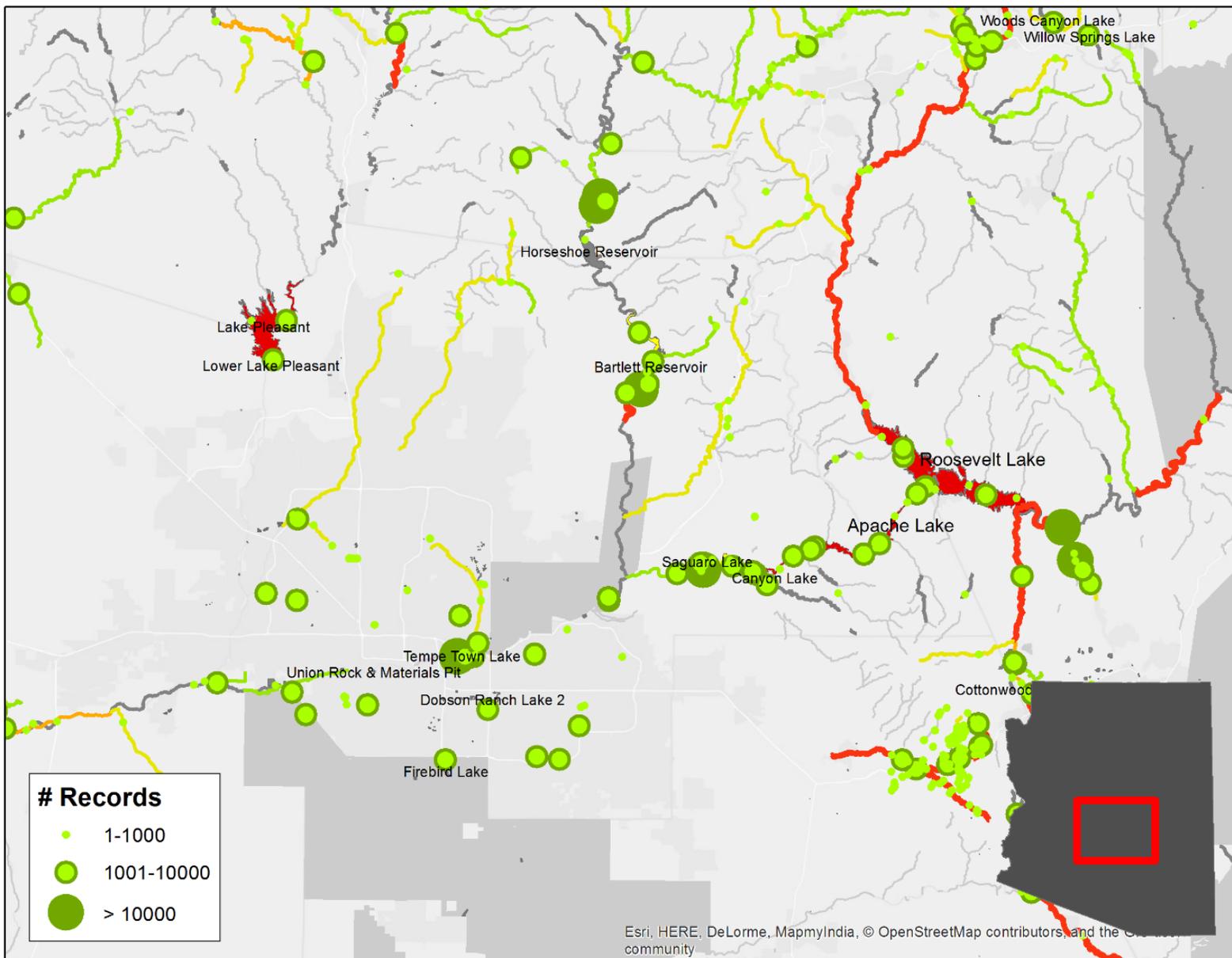
EAT FISH SMART

YOU MAY EAT THE FOLLOWING AT ANYTIME	LIMIT CONSUMPTION: Adults (including pregnant women): not 2.5 oz. per week Children: not 2 oz. per month
 BRYAN TROUT	 SPALLERDUN BASS
 MAYSON TROUT	 DUGWAY BASS

YOUR FISH IS NOT LISTED?
Adults (including pregnant women) may eat 2 oz. per week and children may eat 1 oz. per week

ADEQ Arizona Department of Environmental Quality
The Arizona Department of Environmental Quality is the lead agency for the Clean Water Act in Arizona.

ADEQ Data Around Phoenix in last 10 Years



ASU <https://sustainability.asu.edu/caplter/data/view/knb-lter-cap.617/>

ASU Regional drinking water quali... x

File Edit View Favorites Tools Help

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AZURITE Production WQD Production CI Tracker

Regional drinking water quality monitoring program: long-term monitoring of water quality in select canals, reservoirs, and treatment plants of the greater Phoenix metropolitan area drinking water system, ongoing since 1998

Publication date: 2017-05-17

Author(s):

- Paul Westerhoff, Arizona State University
- Milton Sommerfeld, Arizona State University at the Polytechnic Campus
- Peter Fox, Arizona State University
- Morteza Abbaszadegan, Arizona State University
- Dan Childers

Abstract:

Regional Drinking Water Quality Monitoring Program

Arizona State University (ASU) has been working with regional water providers (Salt River Project (SRP), Central Arizona Project (CAP)) and metropolitan Phoenix cities since 1998 on algae-related issues affecting drinking water supplies, treatment, and distribution. The results have improved the understanding of taste and odor (T&O) occurrence, control, and treatment, improved the understanding of dissolved organic and algae dynamics, and initiated a forum to discuss and address regional water quality issues. The monitoring benefits local Water Treatment Plants (WTPs) by optimizing ongoing operations (i.e., reducing operating costs), improving the quality of municipal water for consumers, facilitating long-

Snap Shot of ASU Data Collected

Row Labels	Count of date
Apache Lake, lower	26
Apache Lake, upper	26
Canyon Lake, lower	26
Canyon Lake, upper	26
Havasu Lake	7
Lake Pleasant integrated sample	12
Roosevelt Lake, lower	26
Roosevelt Lake, upper	26
Salt River below Saguaro (Blue Point Bridge)	13
verde river at beeline highway	13
Waddell Canal	13
Grand Total	214

A	B	W	X	Y	Z	AA	AB	AC	AD	AE	AF
Site Name	Site Location	95Mo	107Ag	111Cd	115In	121Sb	138Ba	202Hg	208Pb	238U	date
APA1A	Apache Lake, upper	1.486	0.004	0.111	NA	0.219	145.8	0.138	0.126	1.128	11/4/2012
APA1B	Apache Lake, upper	1.449	0.006	0.034	NA	0.196	123	0.112	0.12	1.113	11/4/2012
APA2A	Apache Lake, lower	1.42	0.008	0.085	NA	0.187	121.7	0.09	0.072	1.102	11/4/2012
APA2B	Apache Lake, lower	1.427	0.009	0.023	NA	0.171	102.2	0.081	0.044	1.109	11/4/2012
Can1A	Canyon Lake, upper	1.362	0.001	0.046	NA	0.164	153.2	0.071	0.081	1.063	11/4/2012
Can1B	Canyon Lake, upper	1.354	-0.005	0.04	NA	0.18	114.8	0.062	0.059	1.066	11/4/2012
Can2A	Canyon Lake, lower	1.4	0.003	0.021	NA	0.16	122.8	0.058	0.059	1.067	11/4/2012
Can2B	Canyon Lake, lower	1.343	-0.002	0.195	NA	0.163	119.3	0.049	0.062	1.065	11/4/2012
R10	Salt River below Saguaro	1.503	-0.004	-0.004	NA	0.762	132.1	0.043	0.051	1.166	11/4/2012
R25	verde river at beeline hig	2.476	0	0.01	NA	0.287	102.6	0.035	0.018	1.948	11/4/2012
R2A	Lake Pleasant integrated	3.849	-0.001	0.002	NA	0.356	158.9	0.291	0.009	3.504	11/4/2012



Salt

A **PACHE LAKE**
15060106A-0070
2192 Acres

Category 5
Impaired

*Low dissolved oxygen (2006/8)
and mercury in fish tissue (EPA 2016)*

DWS - Inconclusive • FC - Impaired • FBC - Inconclusive
AGI - Inconclusive • AGL - Inconclusive • AWW - Impaired

Core Parameter

DESIGNATED USE	CORE PARAMETERS
Aquatic and Wildlife	Dissolved oxygen (not required if ephemeral) Stream flow (if a stream) Sample depth (if a lake) pH Total nitrogen (if nutrient standards established) Total phosphorus (if nutrient standards established) Dissolved cadmium, copper, and zinc and hardness
Fish Consumption	Mercury in fish tissue (no minimum sample or seasonal distribution requirement). If fish tissue data is not available, use total mercury in water as a core parameter (minimum sample and seasonal distribution requirements apply).
Full Body or Partial Body Contact	Escherichia coli (not required if ephemeral) pH
Domestic Water Source	Nitrate/nitrite or nitrate pH Fluoride Total arsenic, chromium or chromium VI, and lead
Agricultural Irrigation	pH Total boron and manganese
Agricultural Livestock Watering	pH Total copper and lead

www.waterqualitydata.us



National Water Quality Monitoring Council

Working together for clean water

Water Quality Portal

The Water Quality Portal (WQP) is a cooperative service sponsored by the United States Geological Survey (USGS), the Environmental Protection Agency (EPA), and the National Water Quality Monitoring Council (NWQMC). It serves data collected by over 400 state, federal, tribal, and local agencies.

DOWNLOAD DATA

Download water-quality data in Excel, CSV, TSV, and KML formats.

HOW TO USE THE WQP

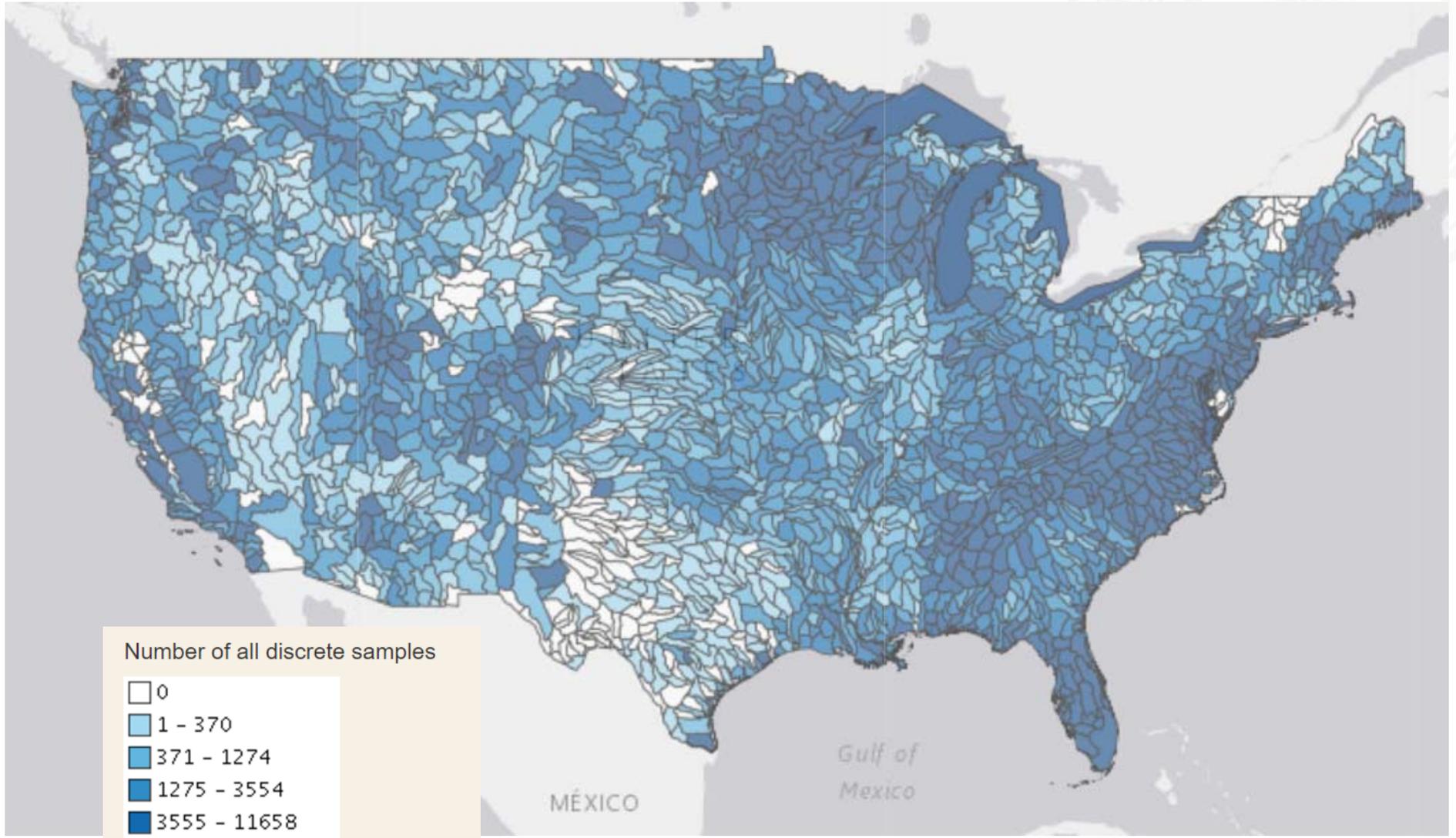
User Guide
Web Services Guide
FAQs
Upload Data

NATIONAL RESULTS COVERAGE

Water-quality data in your state.

ABOUT THE WQP

What is the WQP?
Contributing organizations
Other Water Quality Portals
Explore WQP Sites



Number of all discrete samples

- 0
- 1 - 370
- 371 - 1274
- 1275 - 3554
- 3555 - 11658
- 11659 - 1028397

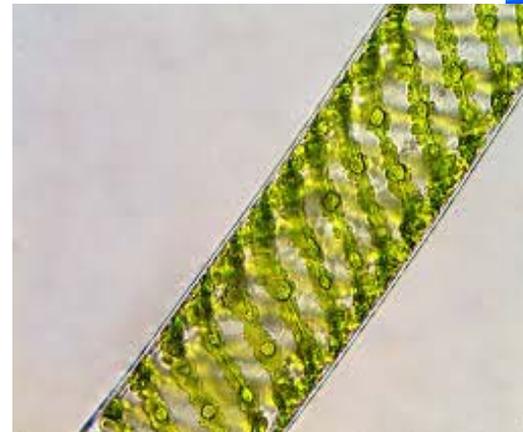
Arizona's Strategy for Protecting the Public from Harmful Algal Blooms



Catherine Gullo and Jason Jones | March 27, 2018

Algae Facts

- Algae produces more than **half** of Earth's oxygen
- Algae is everywhere
- Algae is broadly defined:
 - Can be single celled or multicelled (kelp)
 - Prokaryote / eukaryote
- Symbiotic:
 - Lichen
 - Sea sponge
 - Sloth



Algae Facts

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What is an Algal Bloom?

Blooms form when environmental conditions that promote excessive growth of **algae** in surface waters can lead to situations with high cell density

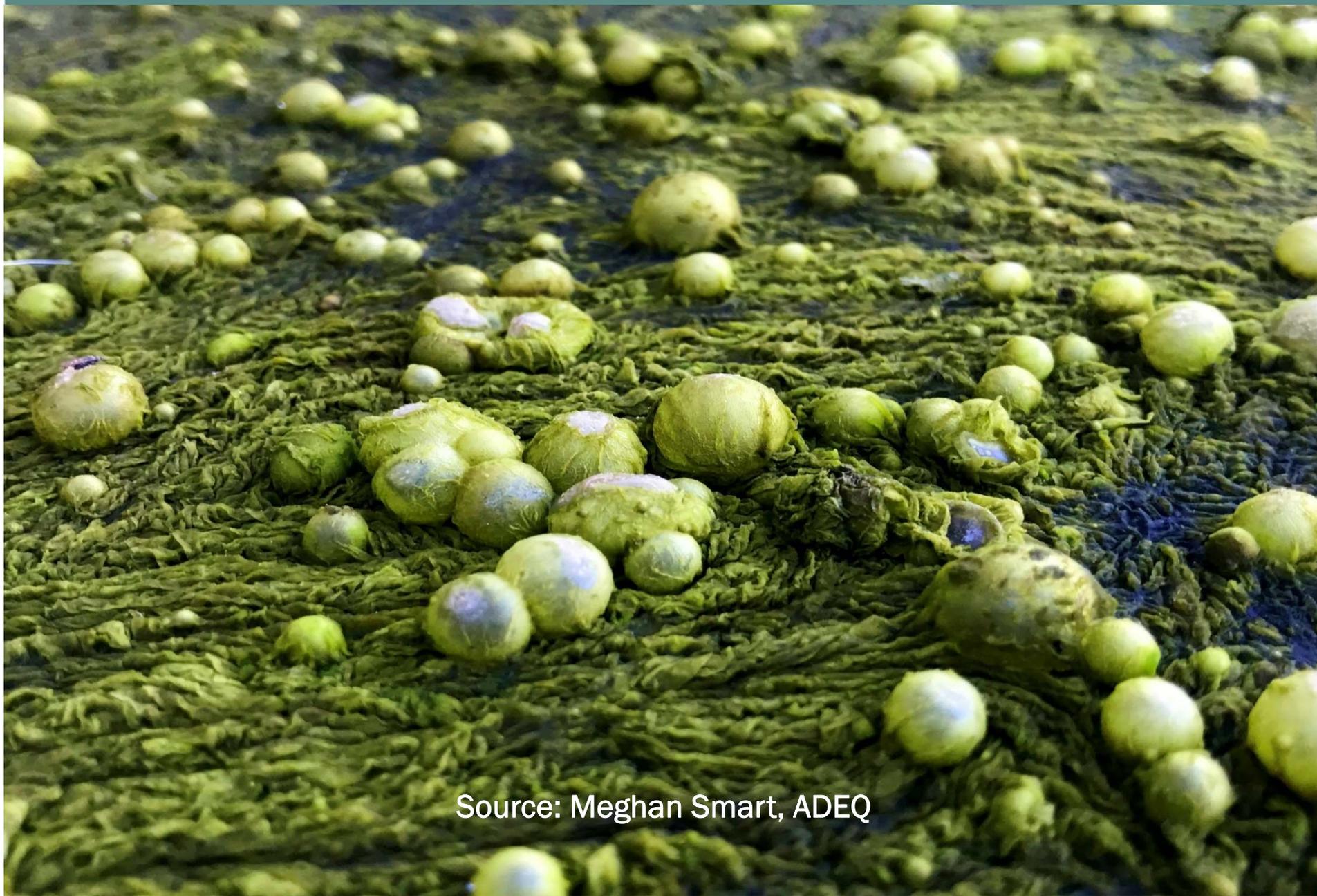


Source: USGS Open-File Report 2015-1164

Not all blooms are from Cyanobacteria



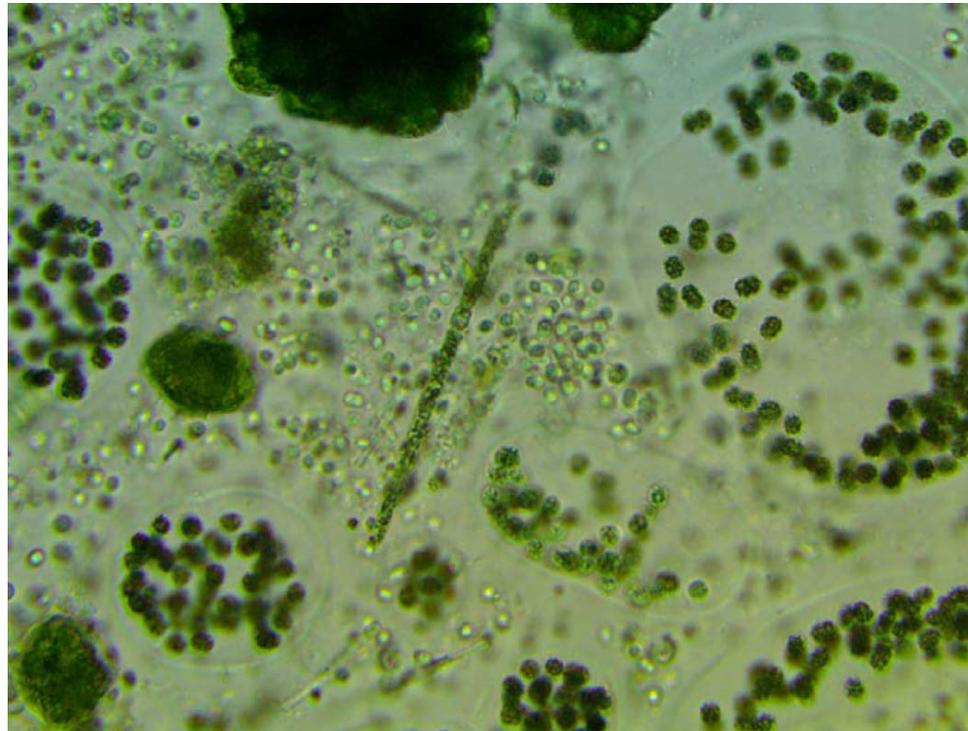
Source: Doug Von Gausig



Source: Meghan Smart, ADEQ

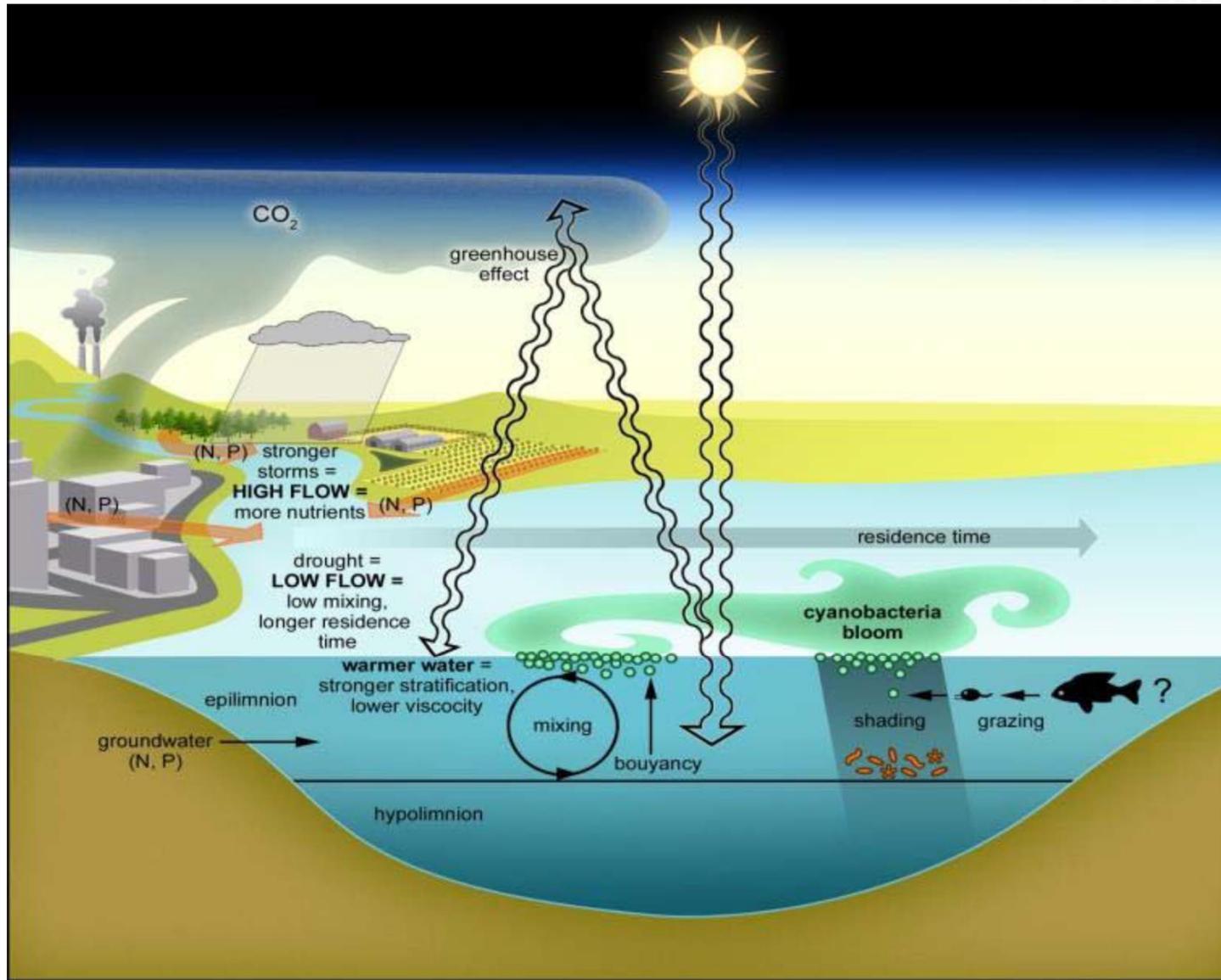
What are cyanobacteria?

Cyanobacteria, also known as blue-green algae, are tiny, plantlike organisms that live in lakes, streams, and reservoirs and use sunlight to grow.



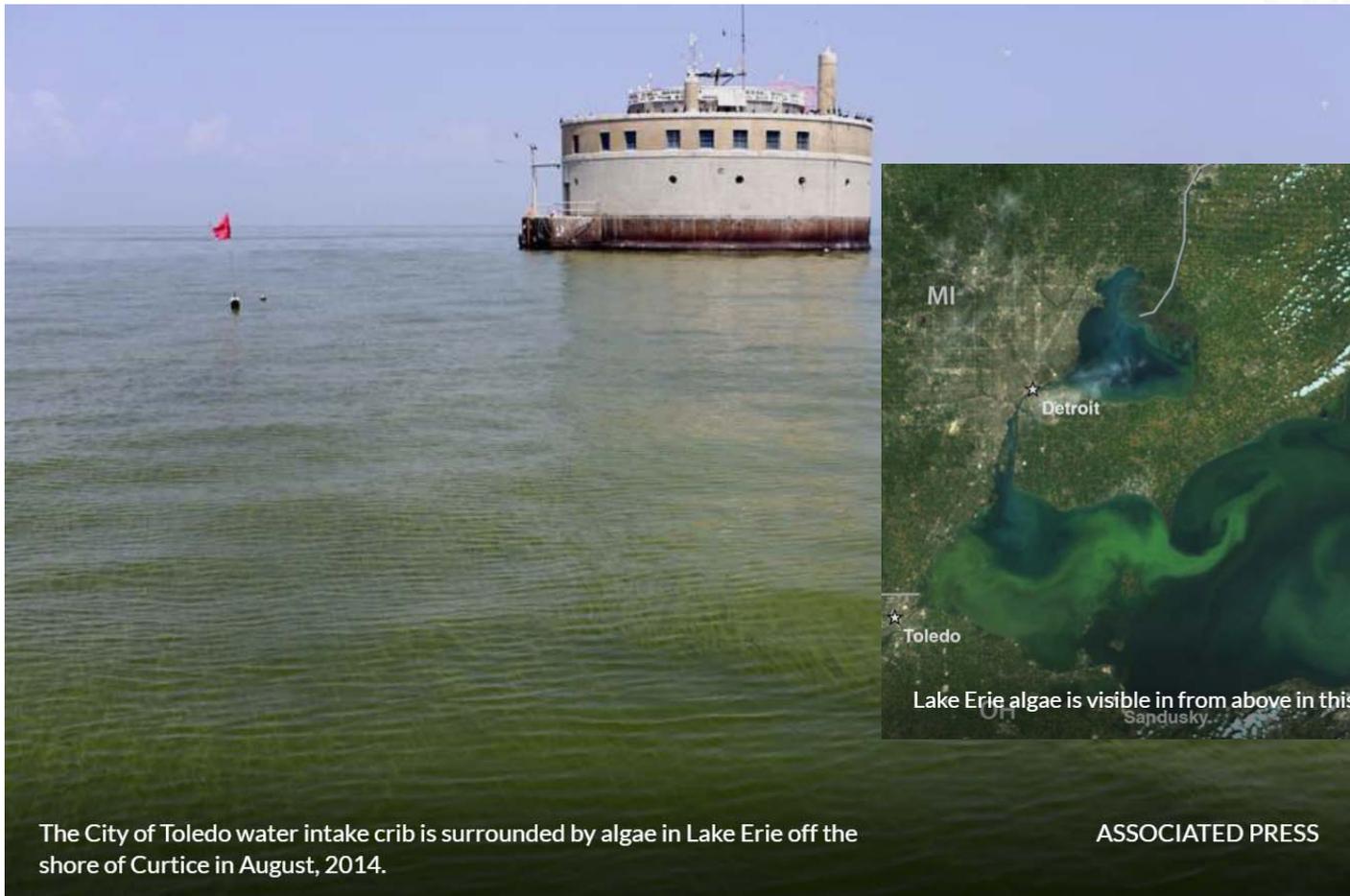
Source: Dr. David Walker University of Arizona

What Causes Algal Blooms?



Source: Hans W. Paerl HABS Presentation

Toledo, Ohio in 2014: Toxic algae bloom leaves **500,000** without drinking water for three days



The City of Toledo water intake crib is surrounded by algae in Lake Erie off the shore of Curtice in August, 2014.



ASSOCIATED PRESS

Health Affects from Algal Toxins

For **people** algal toxins can cause:

- Skin rashes
- Eye irritation
- Diarrhea
- Vomiting



For **animals** algal toxins can cause:

- Skin rashes
- Vomiting
- Convulsions
- Death (in severe cases)



Toxic Algae is Harmful

- National statistics on harmful algal bloom illnesses are **poor**
- New York Pilot Study in 2015 looked at 16 of 62 counties.
 - 32 reported human cases; **17 required hospitalization**
 - 3 dog cases; **2 required hospitalization**
- Kansas 2010 Study
 - 7 confirmed human cases; **2 required hospitalization**
 - 7 dog cases; **5 fatalities; 1 hospitalization**

Algal blooms can contain **toxins** that are harmful to people and animals.

The Environmental Protection Agency (EPA) established Health Advisory criteria for algal toxins in **drinking water** in 2015.

Drinking Water Cyanotoxin Health Advisory Criteria

Cyanotoxin	Bottle-fed infants and pre-school children	School-age children and adults
Microcystin	0.3 ug/L	1.6 ug/L
Cylindrospermopsin	0.7 ug/L	3 ug/L

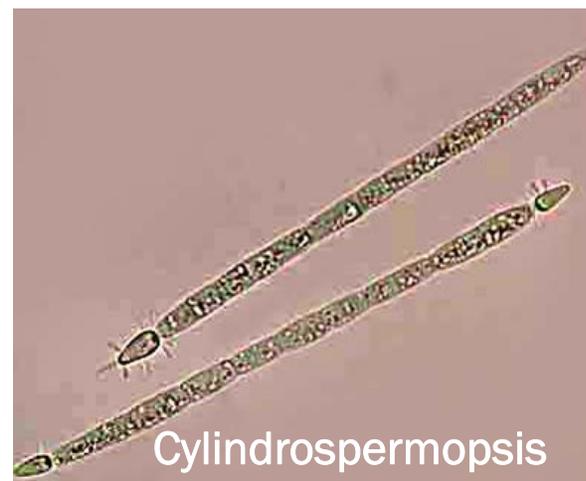
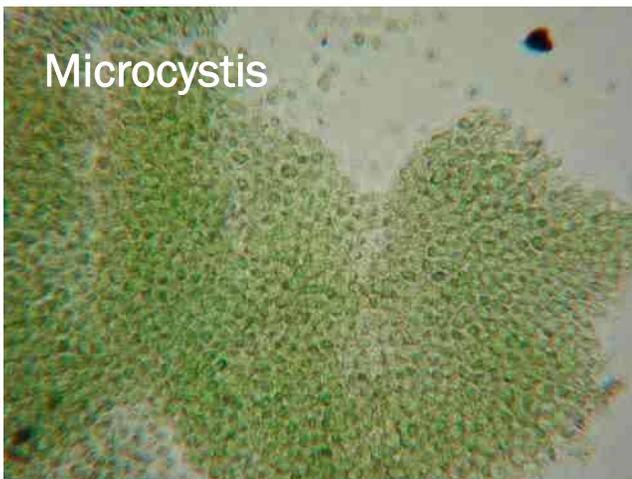
[Source](#)

Algal Toxins

The EPA proposed Health Advisory criteria for algal toxins in **recreational waters** in 2016.

Recreational Water Quality Criteria

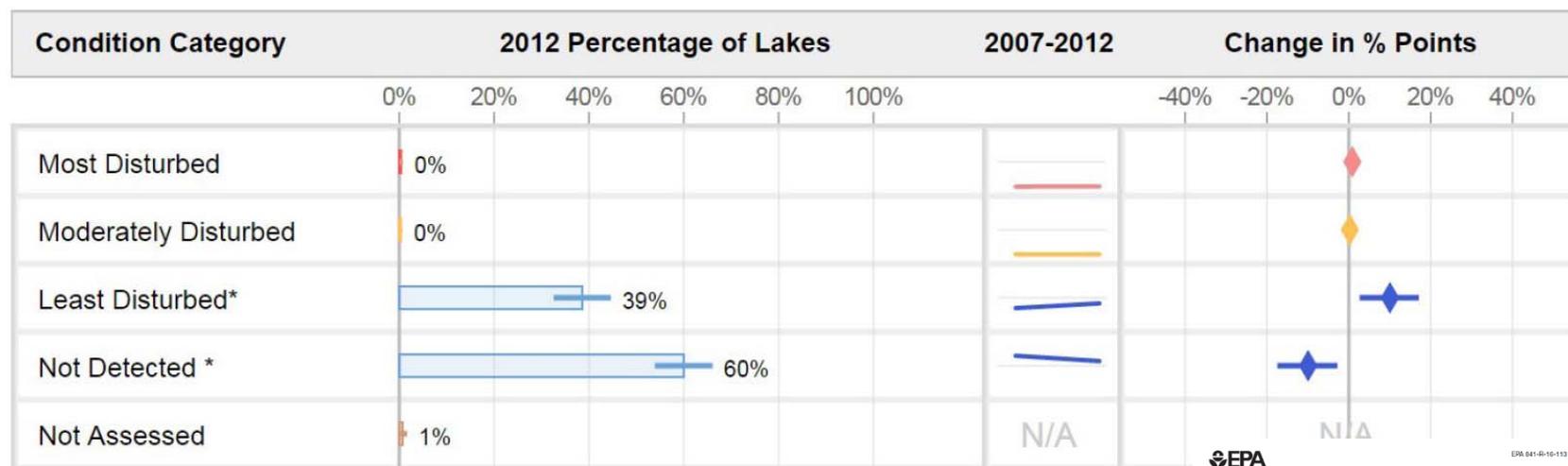
Cyanotoxin	Proposed Recreational Criteria
Microcystin	4 ug/L
Cylindrospermopsin	8 ug/L



[Source](#)

EPA's National Lake Survey – Microcystin

Figure 4.14: Microcystin (Risk) | National Condition Estimates



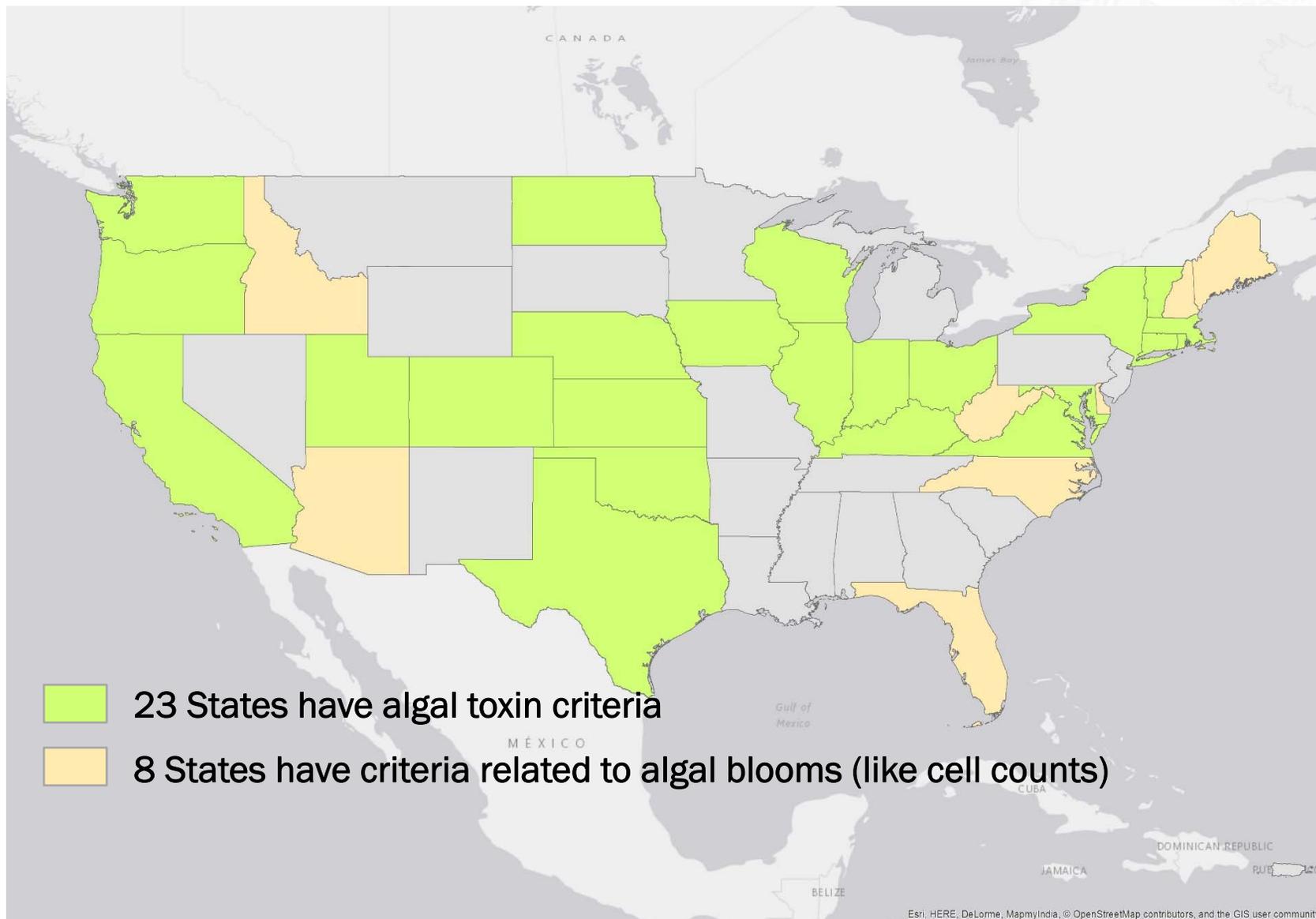
* Reflects a statistically significant change between 2007 and 2012 (95% confidence).

- **Microcystin** is detected in 39% of the nation's lakes (111,818 total lakes in the US).
- Concentrations **rarely** reach moderate or high levels of concern established by the World Health Organization (< 1% of lakes).

National Lakes
Assessment 2012
A Collaborative Survey of
Lakes in the United States



United States - Harmful Algal Bloom Criteria



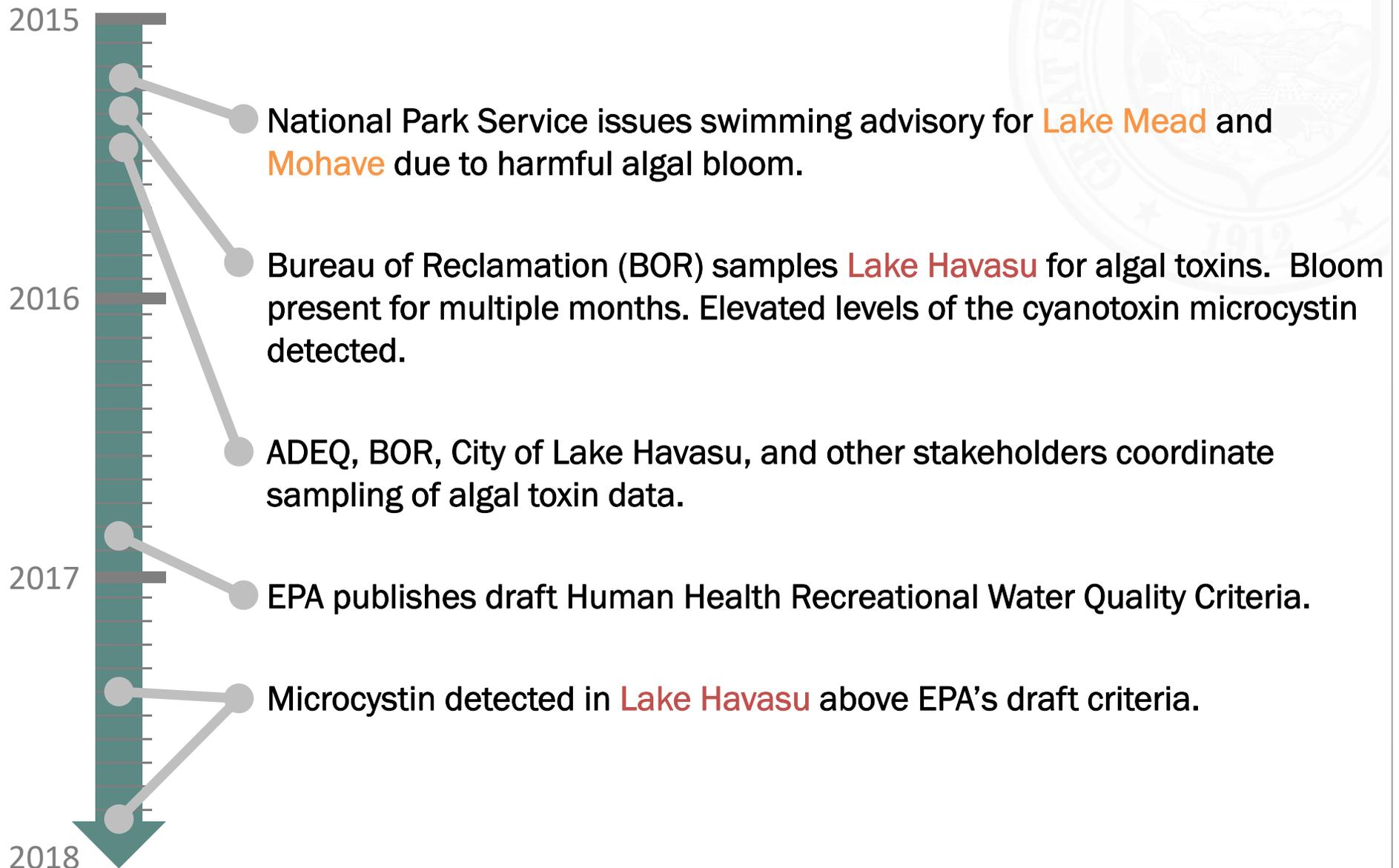
-  23 States have algal toxin criteria
-  8 States have criteria related to algal blooms (like cell counts)

NUMERIC TARGETS FOR LAKES AND RESERVOIRS

Designated Use	Lake Category	Chl- <i>a</i> (µg/L)	Secchi Depth (m)	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Total Kjehldal Nitrogen (TKN) (mg/L)	Blue-Green Algae (per ml)	Blue-Green Algae (% of total count)	Dis-solved Oxygen (mg/L)	pH (SU)
FBC and PBC	Deep	10-15	1.5-2.5	70-90	1.2-1.4	1.0-1.1	20,000			6.5-9.0
	Shallow	10-15	1.5-2.0	70-90	1.2-1.4	1.0-1.1				
	Igneous	20-30	0.5-1.0	100-125	1.5-1.7	1.2-1.4				
	Sedimentary	20-30	1.5-2.0	100-125	1.5-1.7	1.2-1.4				
	Urban	20-30	0.5-1.0	100-125	1.5-1.7	1.2-1.4				
A&Wc	All	5-15	1.5-2.0	50-90	1.0-1.4	0.7-1.1		<50	7 (top m)	6.5-9.0
A&Ww	All (except urban lakes)	25-40	0.8-1.0	115-140	1.6-1.8	1.3-1.6			6 (top m)	
	Urban	30-50	0.7-1.0	125-160	1.7-1.9	1.4-1.7				
A&Wedw	All	30-50	0.7-1.0	125-160	1.7-1.9	1.4-1.7			6.5-9.0	
DWS	All	10-20	0.5-1.5	70-100	1.2-1.5	1.0-1.2	20,000			5.0-9.0

Source: Arizona Administrative Code R18-11-108.03

Timeline of Harmful Algal Blooms in Arizona



Drinking Water

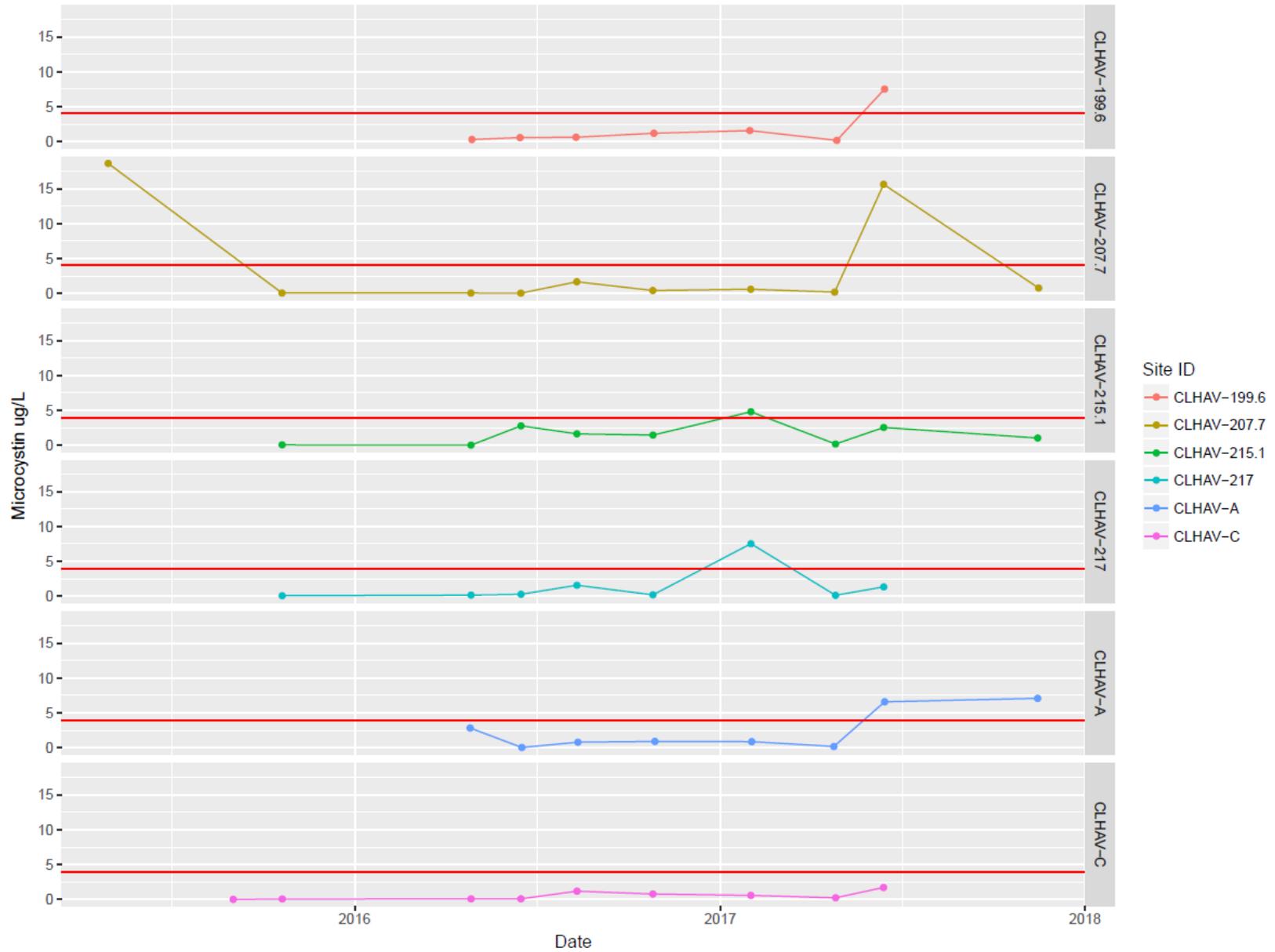
8 Drinking Water intakes located on Lake Havasu or immediately downstream; over 5,000 people served



Lake Havasu Microcystin Sites



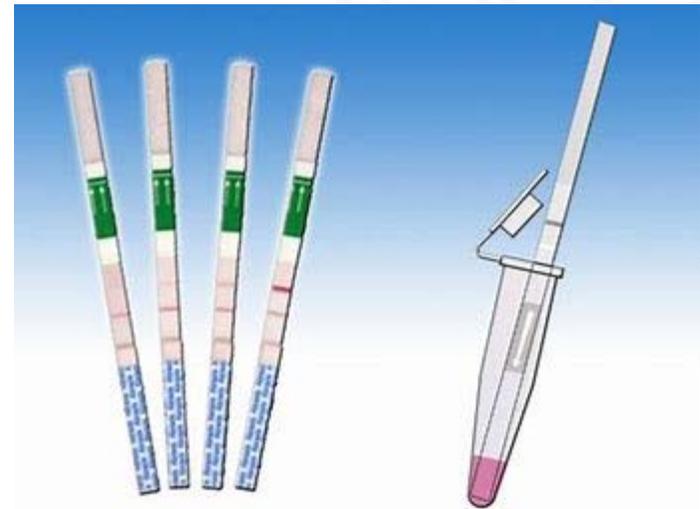
Lake Havasu Microcystin Results - Red line = Proposed EPA Health Limit



Tools for HABs Monitoring

Abraxis test strips – screening tool to detect common algal toxins

- Anatoxin-a (0-2.5 ppb)
- Cylindrospermopsin (0-10 ppb)
- Microcystins - Finished Drinking Water (0 – 0.3 ppb)
- **Microcystins** - Recreational Water (0-10 ppb)





Enjoying the outdoors is an important part of an active, healthy lifestyle. ADEQ recommends following these simple, healthy habits in waters with visible algae:

- **STAY AWAY** from algae and scum in the water – AND – keep children and pets away from algae in the water or on the shore.
- **DO NOT DRINK** or use this water for cooking.
- [Visit ADEQ's Healthy Beach Habits Webpage](#)

Problem Identified...Now What?

- No numeric standard. Cannot apply Clean Water Act tools (impairment, enforcement, permits)
- ADEQ is working with landowners and stakeholders for Lake Havasu (30 plus entities) → **Complicated**
- Resistance to communicating risk to the public because of possible impact on local economy

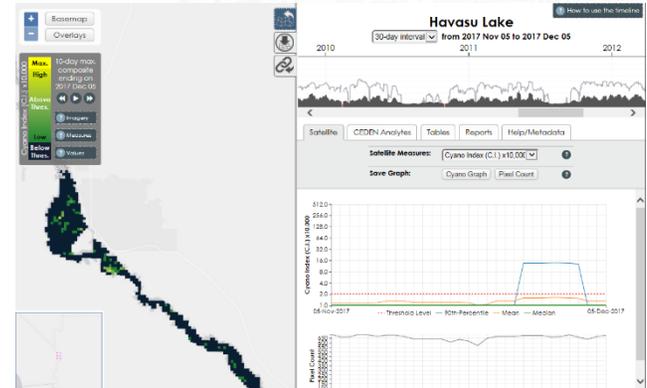


Stakeholders

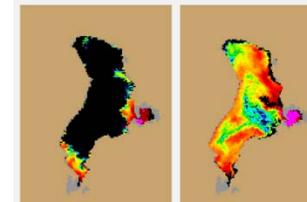


Satellite Tools for HABS Monitoring

- EPA and California both have **early** satellite tools that include Arizona Lakes
- Both relate pixel values to cyanobacteria cell density
- Neither are related to toxicity



Utah DEQ Case Study



June 18, 2017

July 3, 2017

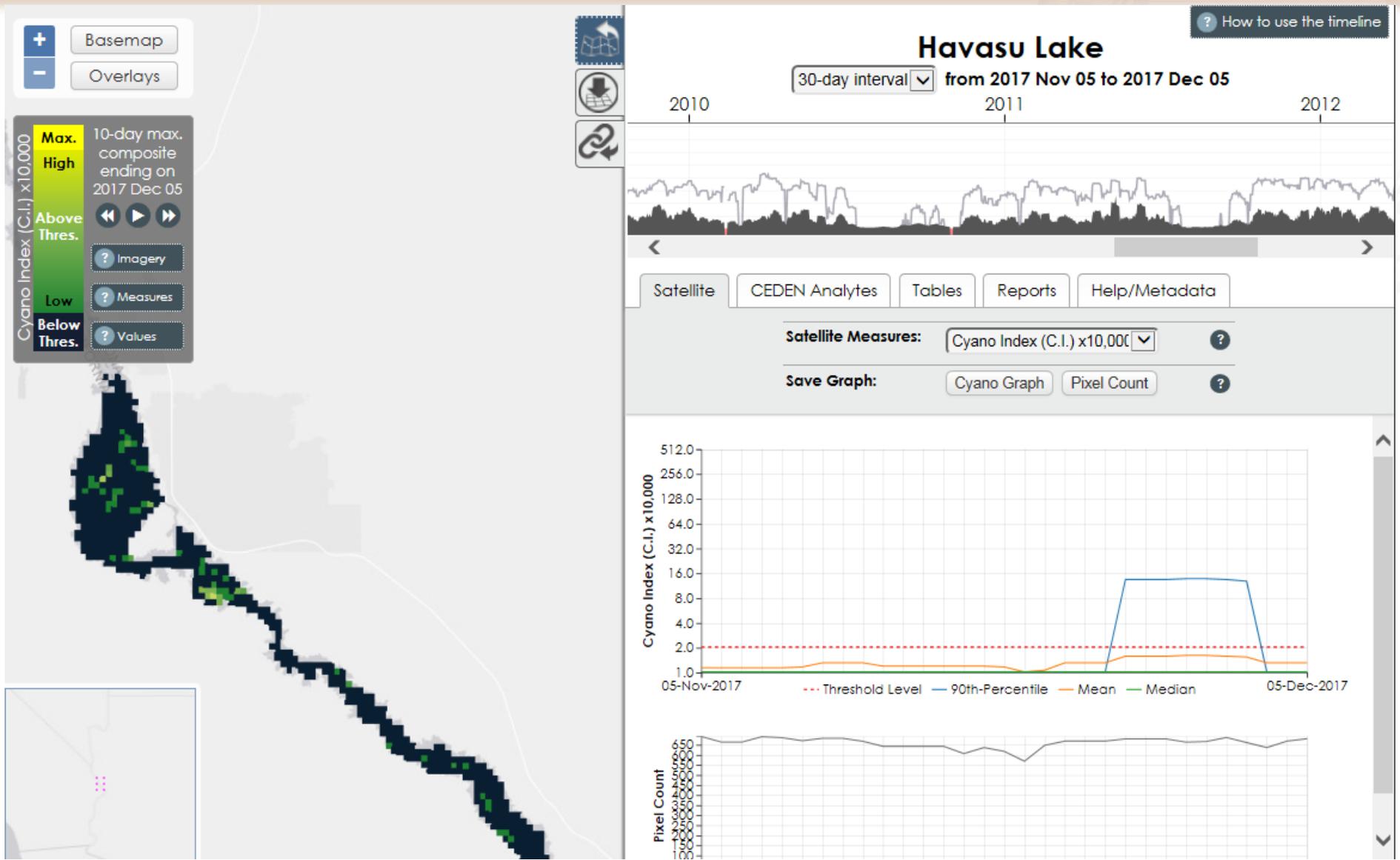
- UT DEQ and Department of Water Quality (DWQ) conducted routine monthly sampling, June 12, 2017
- Satellite imagery the following week indicated a bloom was developing
- DWQ scientists returned to the area, June 22, 2017
- June 29, DEQ issued an advisory, warning the public and pets to stay out
- Ben Holcomb, Utah DEQ statement:
 - "...provides UDWQ confidence that our in-situ, bloom-response data are representative..."
 - "...better target field sampling and more efficiently use our limited resources."
 - "...images are easily shared with response agencies as a useful visual communication aid."

16 Sentinel-3 OLCI imagery from ESA and processed by NOAA

EPA CYaN Info - https://www.epa.gov/sites/production/files/2017-11/documents/cyan_presentation_schaeffer.pdf

California Tool - <https://cchab.sfei.org/?w=73&d=20171126>

Satellite Tools for HABS Monitoring



California Cyano Index - <https://cchab.sfei.org/?w=73&d=20171126>