

An Overview of the U.S. Army Corps of Engineers, Tulsa District Cyanobacteria Response Efforts

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US Army Corps of Engineers
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Walnut Creek State Park
Keystone Lake, Oklahoma
July 9, 2011



Historical Perspective of HAB's within the Tulsa District

- 2003: Marion Reservoir, Kansas
 - ▶ Initial bloom in July 2003
 - ▶ Blooms of varying degrees have occurred annually since 2003
- 2004: Lake Texoma, Texas and Oklahoma
 - ▶ Cyanobacteria dominance documented since 1996
 - ▶ Reported major cyanobacteria blooms beginning in 2011
 - ▶ Golden algae bloom in Jan 2004 with substantial fish kill in the Red River Arm
- 2004-2009: Big Hill Lake, Kansas
 - ▶ Winter T&O problems reported with increasing frequency
 - ▶ *Anacystis, Microcystis, Merismopedia*
- 2006: R.S. Kerr Reservoir, Oklahoma
 - ▶ Cyanobacteria bloom reported in July 2006
 - ▶ Cyanobacteria bloom reported in August 2012



- 2006: Lake Texoma
 - ▶ Reported dog death in Soldier Creek Marina
 - ▶ Suspected cyanotoxin exposure based upon necropsy
 - ▶ Cyanotoxin sampling not conducted; phytoplankton samples showed little cyanoHAB present but sampled 3-6 days following dog exposure
- In 2004, Tulsa District adopted the WHO guidelines
- Between 2004 and 2011 Advisories and/or Warnings only issued at Marion and R.S. Kerr Reservoirs (based on WHO thresholds)
- In 2011 the Tulsa District experienced an unprecedented level of cyanoHAB's
 - ▶ 7 Oklahoma reservoirs and 1 Kansas with reported blooms in 2011



- In 2011 the Tulsa District incorporated the cyanoHAB response and reporting protocols in its Kansas AOR to those adopted at by the KDHE (2003 WHO guidelines)
- In 2012 the occurrence of cyanoHAB's increased in magnitude relative to historical and 2011 events
 - ▶ 13 Oklahoma and 1 Kansas reservoir(s) with substantial blooms
 - ▶ 2 Kansas and 2 Oklahoma reservoirs with minor, short-lived nuisance blooms
 - ▶ 2 river locations with substantial blooms
 - 16 mile long *Anabaena* bloom in the Cimarron River above Keystone Lake
 - Verdigris River at Rogers Point Recreation Area
- In 2012 the Tulsa District discontinued use of the WHO guidelines in its Oklahoma and Texas AOR.
 - ▶ Implemented provisions of SB 259 signed into law on May 22, 2012 at OK lakes as well as Texas side of Texoma and Pat Mayes lake in Texas
 - ▶ Continue to follow KDHE cyanoHAB policy in KS



Components of SB 259 incorporated into Tulsa District CyanoHAB Procedures

- Advisories issued for cyanoHAB's at reservoirs managed by the Tulsa District when:
 - ▶ $\geq 100,000$ cells/ml total cyanobacteria AND
 - ▶ ≥ 20 ug/l microcystin
- Advisories lifted for cyanoHAB's at reservoirs managed by the Tulsa District when:
 - ▶ $\leq 100,000$ cells/ml total cyanobacteria AND
 - ▶ ≤ 20 ug/l microcystin
 - ▶ SB 259 available from the Oklahoma Secretary of State at:
<https://www.sos.ok.gov/documents/legislation/53rd/2012/2R/SB/259.pdf>



Example of Public Notification in 2011 on District Webpage - www.swt.usace.army.mil

Sign	Lake	Area	Posting	Remarks
Closed	Keystone	Old Mannford	Closed	Contact with water prohibited
		Old Hwy 51	Closed	Contact with water prohibited
Warning	Keystone	Appalachia Bay	Harmful algae present	Considered to have adverse health effects.
			Unsafe for people and pets	Due to test result levels, contact with water prohibited
	Tenkiller	Burnt Cabin Petit Bay	Harmful algae present	Considered to have adverse health effects.
			Unsafe for people and pets	Due to test result levels, contact with water prohibited
Advisory	Eufaula	All areas	Harmful algae present	Considered to have adverse health effects.
			Unsafe for people and pets	Due to test result levels, contact with water prohibited



Public notification in 2012 shifted away from the USACE to Oklahoma Tourism and Recreation Department (OTRD) in the Tulsa District OK-AOR

- SB 259 establishes the OTRD as the responsible agency in OK for reporting cyanoHAB information to the public
- Tulsa District procedures altered with the goal of having a single website for providing cyanoHAB information to the public
- Tulsa District and OTRD partnering to implement a public education campaign
- Tulsa District procedures focus on 3 conditions when responding to cyanoHAB's coordinated through OTRD for recreational areas
- Tulsa District continues to collaborate and share data with OK DEQ for reservoirs which provide PWS
- Advisories and Warnings are no longer posted on-site. USACE is posting a Blue Green Algae Awareness Level sign on site



Tulsa District CyanoHAB Response Conditions

- Condition 1: No cyanoHAB present or reported
 - ▶ Response: CyanoHAB educational material posted at all USACE managed areas
- Condition 2: CyanoHAB \leq 100,000 cells/ml and microcystin \leq 20 ug/l
 - ▶ Response: CyanoHAB educational material posted at all USACE managed areas and data provided to the OTRD for public notification through www.checkmyoklake.com
- Condition 3: CyanoHAB \geq 100,000 cells/ml and microcystin \geq 20 ug/l
 - ▶ Response: Same as response for Condition 2, and lake managers may, under extreme bloom conditions, close designated swim beaches with District Office approval



Blue-Green Algae & Oklahoma Lakes

What you need to know...

IF IT IS GREEN ON TOP

Oklahoma's more than 200 lakes and miles of rivers are a water-lovers' paradise, but they are also complicated ecosystems susceptible to environmental and weather conditions. The nation's bodies of water, including some Oklahoma lakes and rivers, have experienced an increase in the growth of bacteria known as Blue-Green Algae. Blue-Green Algae (BGA) are free-floating, microscopic organisms naturally present in reservoirs, lakes and streams. They are usually found in low numbers, but in very warm, shallow and undisturbed waters that receive a great deal of sunlight, BGA can become abundant.

WHAT ARE BLUE-GREEN ALGAE?

- Blue-Green Algae, or cyanobacteria, are an ancient group of algae. BGA may reproduce rapidly in lakes and ponds with adequate amounts of sunlight and nutrients (phosphorus and nitrogen).
- Within a span of just days, a clear lake or pond can become cloudy or deep green with algae growth. This is called a bloom.
- Although a nuisance, most BGA blooms are not toxic.

HOW CAN I TELL IF BGA ARE PRESENT IN A BLOOM?

- BGA may look like:
 - Thick pea soup, Green paint,
 - Bluish, brownish or reddish green paint.
- When BGA washes up on shore, it may form a thick mat on the beach. BGA are made up of extremely small organisms that are difficult to pick up and hold. Green algae are stringier and made up of grass-green strands. Green algae are harmless.

WHY BE CONCERNED ABOUT BGA?

- The toxins produced by BGA may cause a variety of reactions, most commonly upper respiratory problems, eye irritation, vomiting and diarrhea.
- Adults are not often affected by BGA since they are less likely to be exposed; however, the consumption or inhalation of BGA can be unsafe.
- Any contact with BGA can be harmful. Please use caution when boating, waterskiing, swimming, fishing, etc.
- Children are more vulnerable than adults for several reasons:
 - They tend to play in the water and are not as cautious as adults.
 - Children are more likely to drink or accidentally swallow water when swimming.
- Children usually weigh less than adults, so a smaller quantity of toxins may trigger a more severe effect.
- Pets and livestock are particularly susceptible to the harmful effects of BGA.



Photo: Oklahoma Department of Environmental Quality



Photo: Oklahoma Department of Environmental Quality


To find out more information, please visit www.CheckMyOKLake.com.

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:

- Life jackets float, you don't.
- Be sober or pull over. Remember, only beer with 3.2% alcohol is legal on Oklahoma lakes.
- Where BGA is concerned, IF IT IS GREEN ON TOP 

To find out more information, please visit www.CheckMyOKLake.com.



Photo: US Army Corps of Engineers



Photo: US Army Corps of Engineers



Blue-green Algae Awareness Level

Elevated Risk of Adverse Health Effects

BLUE-GREEN ALGAE BLOOMS ARE PRESENT

For Your Safety, The U.S. Army Corps of Engineers, Tulsa District
Recommends the Following:

- Children and pets are more likely to get sick because of blue-green algae.
- Use caution when swimming, water skiing and coming into contact with water.
- DO NOT drink untreated lake water.
- Keep pets/livestock off of the beach and out of the water.
- Avoid areas with visible algae accumulation.

Symptoms from exposure may include nausea, vomiting, diarrhea, skin rash, eye irritation, respiratory problems or other unexplained illness.

For more information go to:



www.TravelOK.com/checkmyoklake
or
www.swt.usace.army.mil

To Report Illness Due to Exposure, Please Contact Your Doctor or
the Oklahoma Poison Control Hotline at: **1-800-222-1222**



OTRD Main Page at
www.checkmyoklake.com

OKLAHOMA LAKE CONDITIONS



With more than 200 lakes and over one million surface acres of water for boating and swimming, Oklahoma has always been a haven for water recreation. In recent years, Oklahoma and other states have been impacted by the spread of blue-green algae. Learn how to keep you and your family safe on Oklahoma's waterways and find answers to all of your questions about blue-green algae and water safety here.

Simply browse this section for frequently asked questions, water safety tips, lake updates, blue-green algae identification tips and more. Before you pack up the car and head to your lakeside destination, choose your lake from the drop-down menu below to view the most up-to-date lake conditions and testing results.

[Check Current Conditions >>](#) --Choose a Lake--



<http://www.travelok.com/checkmyoklake/>

Example of OTRD web notification from www.checkmyoklake.com

Lake Texoma

- Updated: Sunday October 7th, 2012
- **September 1, 2012: Blue-green Algae Update** - Testing was performed on 8-29-12 at several areas of Lake Texoma including Sheppard Annex, Johnson Creek, Little Glasses Creek, Lakeside PUA, Burns Run East, Little Mineral Arm, Treasure Island and the Highway 377/99 bridge. While blue-green algae cell counts were elevated, toxicity levels reported on 9-1-12 are below the World Health Organization threshold. If you or your pet swim in water that may have blue-green algae present, rinse off with soap and fresh water.
- **October 7, 2012:** Elevation is currently 3 ft. below normal, water temperatures are around 83 degrees and the water appears clear.
- **October 7, 2012: Fishing Report** - Largemouth and smallmouth bass are fair to good at 5-15 ft. in creek channels on plastic worms, spinnerbaits and shad colored crankbaits. Striped and white bass are fair to good from 10-30 ft. in the river channels on surface lures, live bait and sassy shad. Channel and blue catfish are fair to good from 10-20 ft. deep from Little Glasses Creek to Johnston Creek on live bait, worms and stink bait. Crappie are fair to good from 5-20 ft. deep in the upper creeks and brush piles on minnows and jigs and small lures. Sunfish are fair to good 5-15 ft. deep around the fishing docks on worms, small tube jigs and shrimp.



Example of OTRD web notification at www.checkmyoklake.com

- [Lake Eufaula](#)
- Updated: Monday October 8th, 2012
- **September 21, 2012: Blue-green Algae Update** - Due to elevated blue-green algae cell counts, contact with the water in the Porum Landing, Brooken Cove and Highway 9 Landing areas is discouraged until toxicity tests can be completed. Visitors should not drink untreated water or let themselves or pets come in contact with areas of discolored water. If you or your pet swim in water that may have blue-green algae present, rinse off with soap and fresh water. Although swimming is discouraged, visitors can still enjoy boating and many land activities at Lake Eufaula State Park, Arrowhead State Park and at other locations around the lake.
- **October 8, 2012:** Lake elevation is currently 4 ft. below normal. The Frisbee boat ramp at Lake Eufaula State Park is currently closed due to low water. The boat ramp at Deep Fork near the marina remains open.
- **October 8, 2012: Fishing Report** - Black bass are good on plastic and crank baits in rocky areas and windy points. White bass are good trolling in shallow flats and windy points. Blue catfish are good on shad in shallow flats. Crappie are fair on minnows and jigs in standing timber and riprap.



Copan Lake, OK - 2012

- Bloom reported in on August 7, 2012
 - ▶ Copan Point Swim Beach: 1,442,397 cells/ml
- Bloom reported on August 21, 2012 (*Microcystis*)
 - ▶ Copan Point Swim Beach: 78,134 cells/ml; 6.99 ug/l microcystin
 - ▶ Post Oak Camp Ground: 66,968 - 56,811,116 cells/ml; 10.38 – 3,455 ug/l
 - ▶ Re-sampled on September 18, 2012
 - ▶ Copan Point Swim Beach: 4,693 cells/ml; 0.26 ug/l microcystin
 - ▶ Post Oak Camp Ground: 25,790 cells/ml; <0.15 ug/l microcystin
- Closed signs were posted at Post Oak Camp Ground in accordance with OK State Law



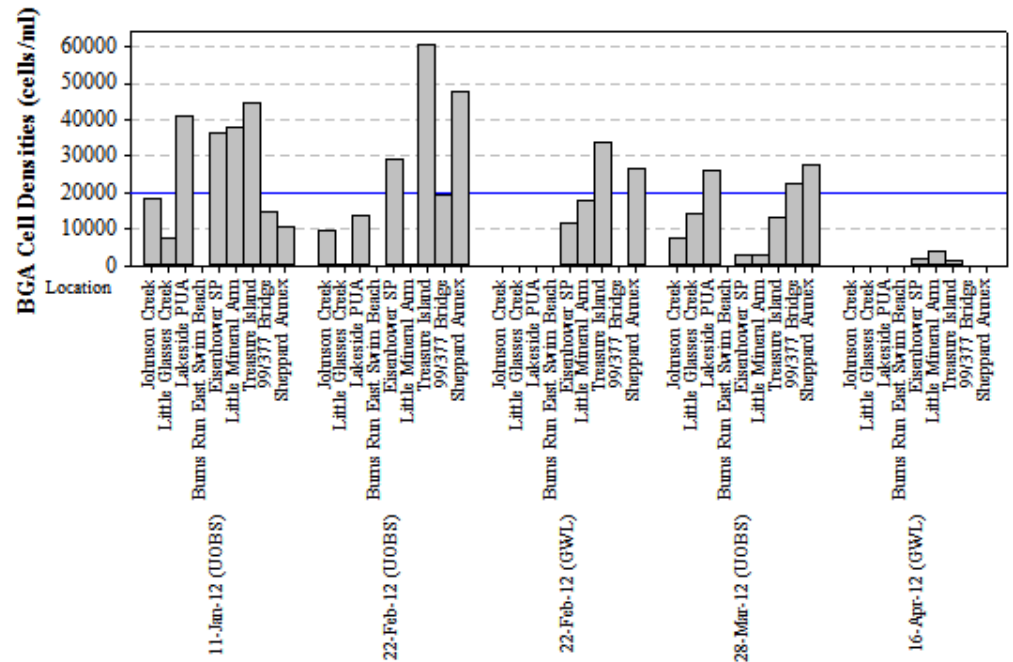
Eufaula Lake, OK

- Isolated blooms continued throughout the winter of 2011-2012 at $> 20,000$ cells/ml
- As early as March 2012, cell densities $> 100,000$ cells/ml present in some areas
- In June 2012 blooms began forming at other locations across the lake
 - ▶ Cell densities ranged from 4,268 to 51,515 cells/ml
- In July 2012 blooms increasing in intensity
 - Cell densities ranged from 10,393 to 141,905 cells/ml
- In September 2012 blooms continue to be present at multiple locations
 - ▶ Cell densities ranged from 9,074 to 699,729 cells/ml





August 20, 2012



Courtesy Univ. of Oklahoma, Grayson County Health Department

Lake Texoma, Oklahoma-Texas

- Blooms continued through much of the winter of 2011-2012
 - ▶ Advisories lifted in April 2012
- Blooms returned in May 2012
 - ▶ Cell densities ranged from:
 - 27,811 – 42,545 cells/ml in May
 - 3,058 – 408,759 cells/ml in June
 - 571,415 – 909,172 cells/ml in July
 - 629,289 – 1,334,902 cells/ml in Aug
- Significant cyanotoxin production remains minimal
 - ▶ Microcystin documented from <0.15 to 3.2 ug/l; sporadic occurrence
 - ▶ Saxatoxin present on one date, 0.027
 - ▶ Cylindrospermopsin from 0.05 to 0.5 ug/l; continuously present
 - ▶ Multiple analytical methods/analysts: LC/MS/MS; ELISA



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Marion Reservoir, KS



Date	Cell Densities (cells/ml)	Microcystin (ug/l)
6-18-12	493 - 14458	<0.5 – 2.0
6-25-12	241,290 – 22,648,500	40.0 – 5,000
7-16-12	28,980 – 262,521	10.0 – 18.0
7-23-12	0 – 12604	2 – 3

Courtesy KDHE





Cimarron River-Keystone Lake, OK – July
24, 2012; 16 mile long bloom
16,109,275 cells/ml (*Anabaena*)



Hulah Lake, OK – August 29, 2012
No samples collected



R.S. Kerr Lake, OK – August 29, 2012
482,144 cells/ml

Lakes and Rivers Division (LRD), USACE

- LRD implemented the use of the 2003 WHO guidelines in June 2012
 - ▶ Advisory Level $\geq 20,000$ cells/ml – public awareness
 - ▶ Caution Level $\geq 100,000$ cells/ml – contact discouraged
- Issues with cyanoHAB's began increasing in 2010
 - Human illnesses and dog deaths attributed to HABs at Burr Oak and Deer Creek Lakes, OH



Dillon Lake, OH
Euglena bloom – emerging HAB



Kinzua Dam, Allegheny River, PA

Ohio River Region

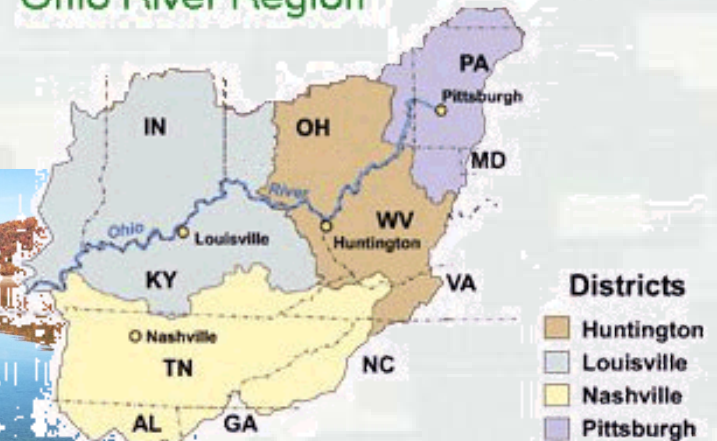
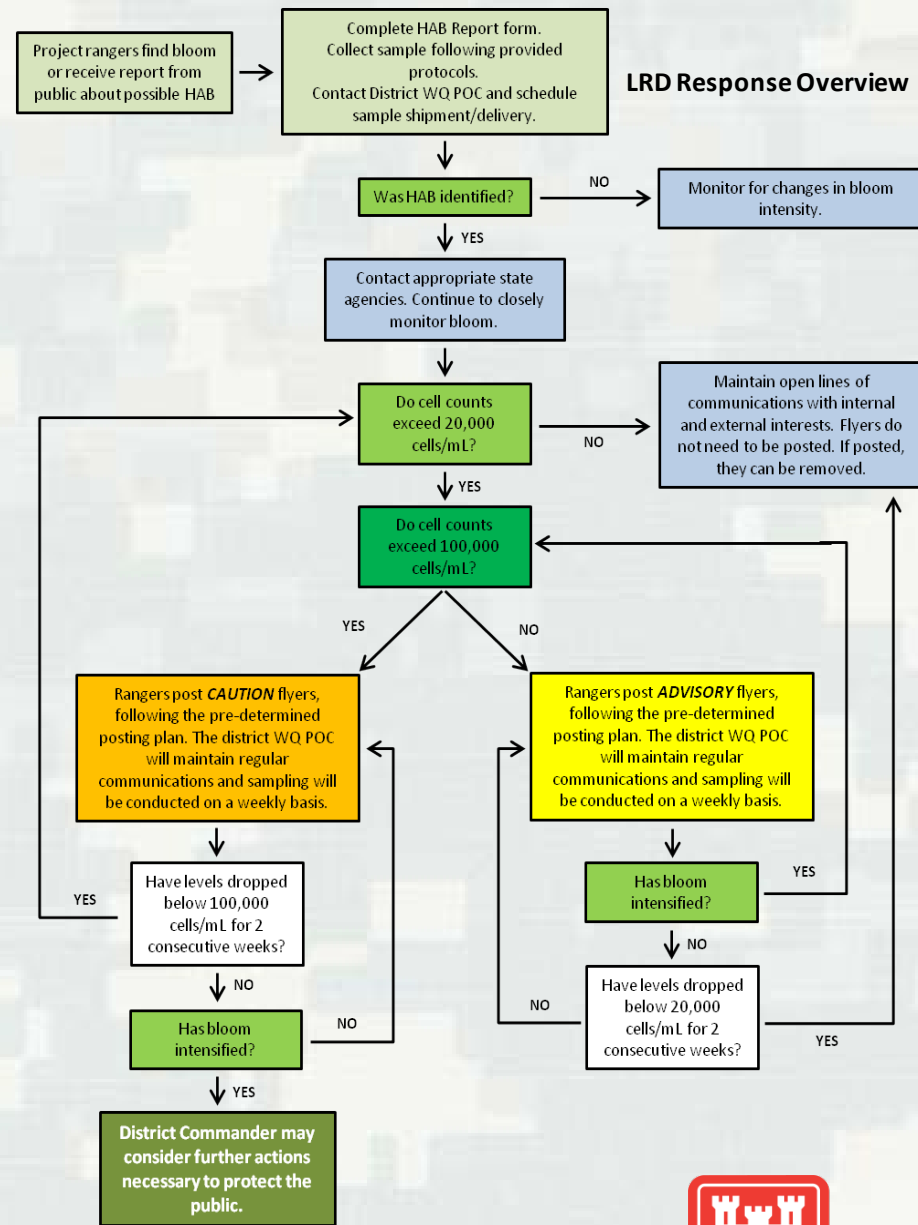


Table 1. Harmful Algal Bloom thresholds for public health advisories.

<u>Cyanobacterial cell counts/ml</u>	<u>Health Risk</u>	<u>Actions Taken</u>
Counts greater than 4,000 and Less than 20,000	-Low risk of short-term health outcomes	-Monitor bloom -Notify Health Department about the presence of a HAB
Relatively low probability of adverse health effects		
Counts between 20,000 and 100,000	-Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	-Contact Health Department -Post Advisory signs at public access points.
Moderate probability of adverse health effects		
Counts greater than 100,000	-Potential for long-term illness with some cyanobacterial species -Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	-Watch for scums or conditions conducive to scums. - Discourage swimming - Post Advisory signs -Coordinate with Health Department and develop a plan of action for area 'No Contact Advisory' if it becomes necessary.
High probability of adverse health effects		
Cyanobacterial scum formation in areas where whole-body contact and/or risk of ingestion/aspiration occur	-Potential for acute poisoning -Potential for long-term illness with some cyanobacterial species -Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	-Coordinate with Health Department and develop a plan of action for area No Contact Advisory if it becomes necessary. -If HAB is in an area with a high probability of skin contact (beach), a No Contact Advisory may be issued by the Health Department at that time.



What can you do?

- Follow instructions found on posted signs and avoid contact with any questionable waters or floating scum that may have an odd green or sometimes blue or brown color.



YELLOW – Advisory signs will be posted when cyanobacteria concentrations reach levels that may potentially cause irritative or allergic effects.

ORANGE – Caution signs will be posted when higher concentrations are found. At these higher levels, cyanotoxins are more likely to be present and increase the risk of more pronounced health effects.

- Do not let livestock or pets drink from any waters posted with an advisory.
- Immediately rinse off after swimming in natural waters.
- If anyone becomes ill after swimming, seek medical attention immediately. Seek veterinary assistance if a pet appears ill.
- Please report possible HAB sighting or fish kills to the appropriate USACE office.

Please help reduce the risk of HABs

Measures you can take:

- Limit fertilizer use near streams and ditch lines
- Maintain septic tanks
- Do Not treat possible HABs with algicides
- Promote native plant growth along streams and shorelines that may act as a “bufferzone” and reduce potential runoff.

Additional HAB Resources

Ohio EPA:

<http://www.epa.state.oh.us/dsw/HAB.aspx>

National Oceanic and Atmospheric Administration:

<http://www.glerl.noaa.gov/res/Centers/HABS/>

Centers for Disease Control and Prevention:

<http://www.cdc.gov/nceh/hsh/hab/default.htm>

U.S. Geological Survey:

http://toxics.usgs.gov/highlights/algal_toxins/algal_faq.html

To report a HAB please call the local project office at () -

For more general information concerning HABs contact the _____ District Water Quality Office at () -

Harmful Algal Blooms (HABs)

What are they?

What do I need to know?



U.S. Army
Corps of Engineers
Great Lakes & Ohio River Division



Harmful Algal Blooms (HABs)

U.S. Army
Corps of Engineers
Great Lakes & Ohio River Division



What are HABs?

Harmful **A**lgal **B**looms are microscopic cyanobacteria or "blue green algae" colonies that resemble green algae. HABs can have a bluish appearance and can often times be seen as scums, foams or mats anywhere on the surface of a lake or stream. The area effected by a "bloom" can range from the size of a basketball to half the lake.

Anabaena

Planktothrix

Why are they harmful?

HABs can generate toxins that can potentially impact human, pet, livestock, and fish health. The toxins can cause:

- Allergic type reactions
- Skin irritation
- In severe cases liver or nervous system damage could occur
- Unexplained pet/livestock sickness

If an unknown illness occurs after water contact seek medical attention!

Microcystis

Good or bad?

Not all "scums" or floating mats are harmful! Healthy lakes produce many species of aquatic vegetation and algae that are beneficial to the environment and pose no threat to human or animal health. When in doubt, err on the side of caution and avoid contact.



What can you do?

Follow instructions found on posted signs and avoid contact with any questionable waters or floating scum that may have an odd green or sometimes blue or brown color. Do not let livestock or pets drink from any waters posted with a advisory. Please report possible HAB sighting or fish kills to the local USACE office.

Please help reduce the risk of HABs

Measures you can take:

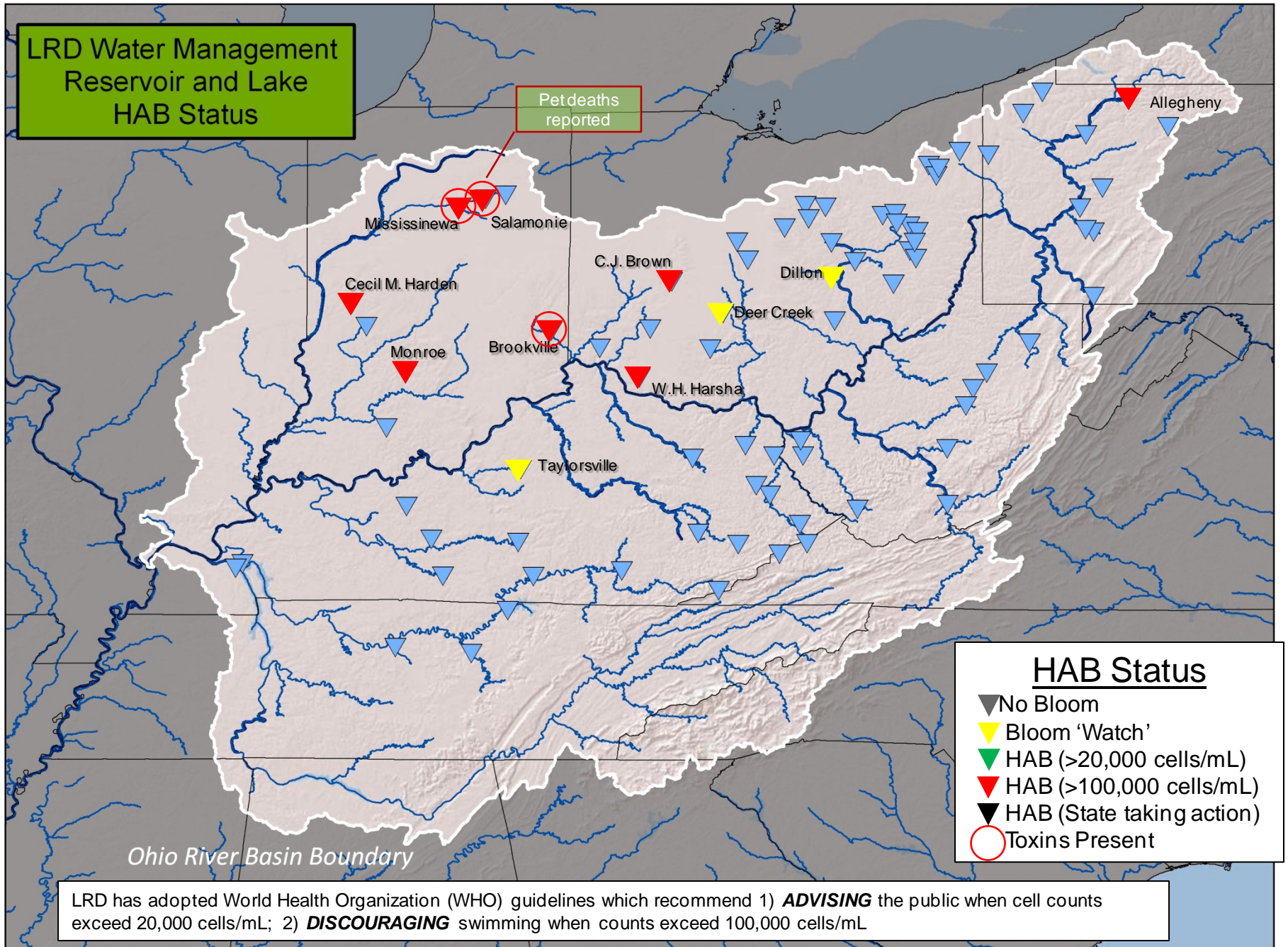
- Limit fertilizer use near streams or ditch lines
- Maintain septic tanks
- Do not treat possible HAB blooms with algicides
- Promote native plant growth along streams and shorelines that may act as a "buffer zone" and reduce potential runoff.

To report a HAB please call the local project office at () - .

For more general information concerning HABs contact the District Water Quality Office at () - .



LRD Water Management Reservoir and Lake HAB Status



Pet deaths reported

Allegheny

Mississinewa

Salamonie

Cecil M. Harden

C.J. Brown

Dillon

Deer Creek

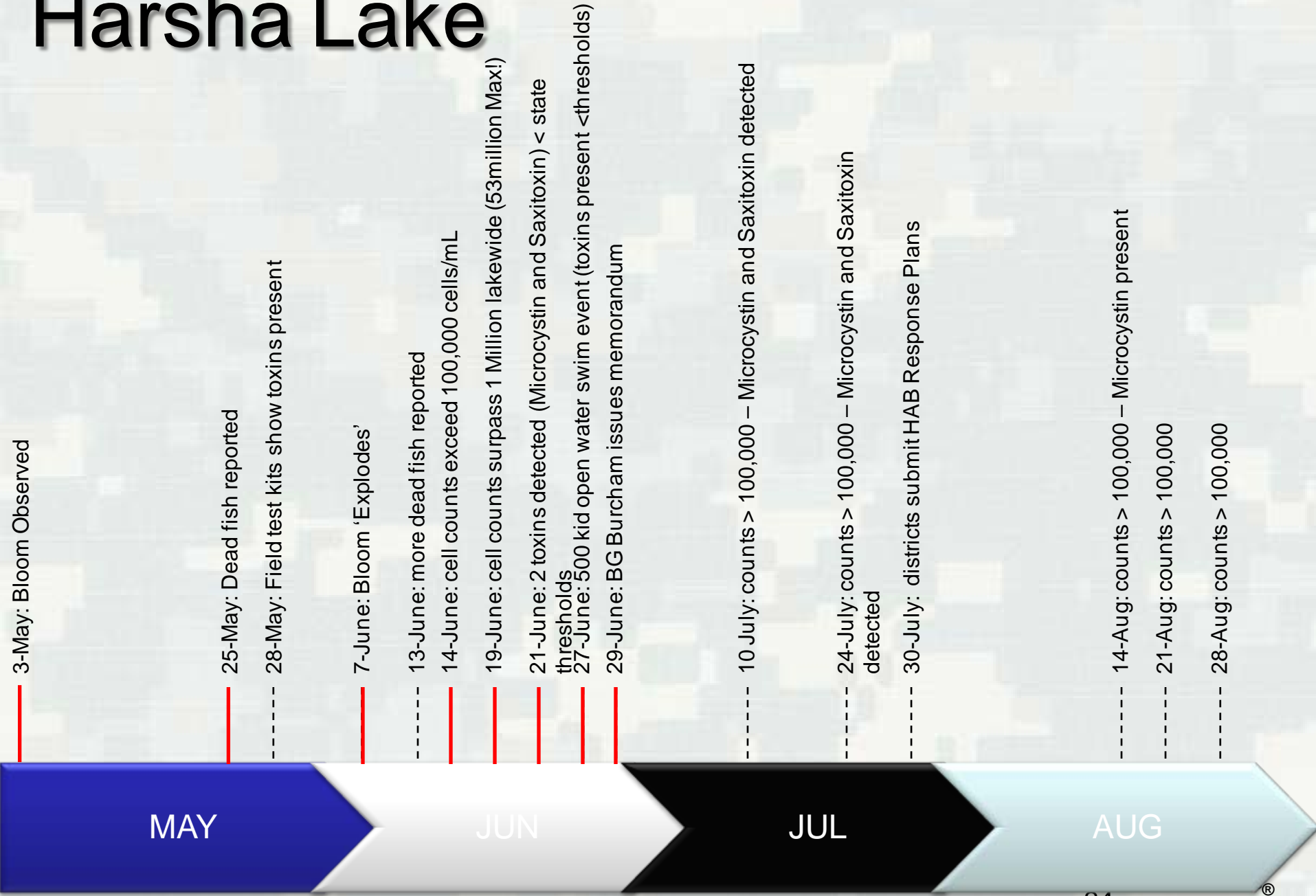
Monroe

Brookville

W.H. Harsha

Taylorsville

Harsha Lake



Historical USACE CyanoHAB Activities

Table 3. HAB occurrence and impact summary table.

District	HAB Occurrence	HAB Impact
Louisville	Blooms occur at multiple Corps projects every summer, late in the season. Blue-green algae blooms have become a larger issue in the Louisville District in the past three years, most often in Indiana lakes, but also in Ohio and Kentucky bodies of water. Associated factors are thought to include eutrophication, oxygen depletion, high temperatures, and drought conditions.	Multiple projects have reported fish kills. Anecdotal reports of dogs that died after jumping into/drinking water high in algal toxins. Blooms have necessitated an increase in filtration and application of carbon to remove taste and toxins in the water supply. Beaches have been closed down due to blooms, and some people have reported skin rashes.
Norfolk	Large bloom occurred at the Craney Island Dredged Material Management Area in the summer of 2005.	Algal toxin effects are negligible, as the toxins dissipate in the wide mixing area of Norfolk Harbor and recreational activities do not take place in the region.
Buffalo	The Buffalo District manages and maintains many harbors along the south shore of Lake Erie, which currently faces multiple problems and concerns with algal blooms. Blooms have occurred on Lake Erie every summer, with a peak of 2-3 weeks, for at least the past 5 years.	No documented human health impacts have resulted thus far. Beaches have been closed as a precautionary measure.
Portland	Most of the Portland District projects have experienced algal blooms at one time or another. Blooms begin in June and last through the summer. In 2005, large blooms occurred at three of the 17 district projects; typically up to two-thirds of the district's projects experience a large bloom in a given year.	Despite bloom prevalence, health and property impacts were not specified.
Jacksonville	Blooms occurred at several of the district's biggest projects in 2005. Blooms seem to be associated with heavy rainfall periods.	Anecdotal reports of dead manatees. Many human health concerns, especially relating to potable water. Concerns will likely impact the design of a costly project where a downstream water quality treatment installation could increase costs.
Tulsa	Blooms occurred at six of the district's 36 projects in 2005. Marion Reservoir in Kansas blooms annually.	A dog is thought to have gotten sick from Microcystin at Marion Reservoir, Kansas. A golden algae bloom at Lake Texoma in January 2004 killed 25-30,000 fish. Golden algae threaten the striped bass fishery on the lake, which is a \$40 million/year economic asset as reported by Paul Mauk, Oklahoma Department of Wildlife Conservation.

Table 5. HAB monitoring summary table.

District	HAB Monitoring
Louisville	The Louisville District collects data from each of their reservoir projects, from the inflows and from the tail waters. At Harsha Lake the District conducted a modeling study, collecting data on a weekly basis through the summer of 2005. Sampling included five locations within the lake every four weeks at different depths. Measurements included metals, nutrients, phytoplankton, chlorophyll, and physical parameters. However, the budget only contains enough money to monitor other locations once a year (in August or September). The Corps collects water for analysis from different depths at tail waters, dam sites, and major tributaries. Special circumstances may warrant a closer look at other places. Other agencies, such as the Division of Water, Fish & Wildlife, and USGS, also collect data in Kentucky, as well as many Indiana agencies.
Norfolk	The Norfolk District has recently measured chlorophyll A levels at Craney Island. USACE noticed these levels increasing over the summer of 2005. Levels started fairly low (i.e. levels the previous winter were around 1-2 ug/L), but levels in the spring and summer were 15-20 ug/L. USACE does not have past summer background measurements and has not done testing until the last few years.
Buffalo	The Buffalo District does not collect data related to algal blooms.
Portland	For the past ten years, the Portland District has taken comprehensive measurements at three projects: the Willow Creek Reservoir (which often experiences algal blooms), Lost Creek Lake, and Applegate Dam. Sample analysis consists of organism ID, cell counts, cell density, and biovolume, as well as environmental factors (including temperature, pH, turbidity, dissolved oxygen, dissolved solids, etc.). Samples are generally 500 mL to 1 L, taken from the top layer of water. Due to budget constraints, samples are not taken regularly at other projects and often include analysis for fewer factors. The interviewee estimated that monitoring all projects on a weekly basis would take over \$100,000 per year, which is much larger than the District's entire water quality budget.
Jacksonville	Rather than USACE, the Florida DEP and South Florida Water Management District often sample for algal blooms. The Jacksonville District has, however, collected data about cyanobacteria at sites connected with the Aquifer Storage & Recovery Project. These data are taken from four sites (Lake Okeechobee, Kissimmee River, Hillsboro Canal, Caloosahatchee River), quarterly for one year. Sampling is expensive.
Tulsa	In 2005, the Tulsa District took measurements at the Marion and Fort Gibson reservoirs. Microcystin levels ranged from 2.9 to 9.6 ppb at Marion (June 8th to July 13th, samples taken every two weeks, possibly 60 or 70 samples); 2.8 to 3.6 ppb at Fort Gibson (July 6th, possibly 40 samples). Samples were also taken at Tenkiller Reservoir in 2005, and Skiatook Lake samples were taken on a day at peak of cylindrospermopsin bloom near a swim beach. All told, approximately 360 samples were taken during the year. Data include nutrient levels, total phosphorous, nitrate/nitrite, ammonia, organic carbon, chloride, and total calcium in some lakes, as well as vertical profiles of turbidity, oxygen, pH, conductivity, temperature, chlorophyll, and some light data. Most samples are surface samples; others are a half meter below surface or a meter above the bottom, taken in 1-L amber bottles, split between microcystin and cylindrospermopsin analysis. Historically, the District has had chlorophyll data, but now Dr. Bob Lynch at OU is doing phytoplankton analysis for them.

Excerpted from ERDC/TN ANSRP09-1, The Impact of Harmful Algae Blooms on USACE Operations:

<http://el.ercd.usace.army.mil/elpubs/pdf/ansrp09-1.pdf>



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Conclusion-Discussion

- Nationally, the intensity and frequency of cyanoHAB's at USACE managed reservoirs is increasing
- Currently, the USACE is responding to cyanoHAB's specifically, and HAB's generally, within a local regional context
 - ▶ Individual local/county and state policies, procedures, and statutes
 - ▶ Lack of national guidelines/policies with regard to HAB's
 - ▶ Stakeholders in different jurisdictions within any given USACE District/Division Office AOR are not provided consistent environmental health risk assessments and information to make informed decisions for themselves and their families
 - The USACE manages 422 lakes in 43 states
 - > 90% of USACE recreation areas are within 50 miles of a major metropolitan center
 - 55,000 miles of shoreline; 4,500 miles of trails; 90,000 campsites; 3,400 boat ramps
 - The USACE provides PWS storage capacity of 329.2 million ac-ft
- The scope of the USACE recreation and water supply missions necessitates a national approach to cyanoHAB guidance

