Tribal Water Quality and Cyanotoxins: Leading a Multi-Jurisdictional Monitoring Program

SARAH RYAN, BIG VALLEY BAND OF POMO INDIANS
KAROLA KENNEDY, ELEM INDIAN COLONY
TRIBAL LANDS AND ENVIRONMENT FORUM
AUGUST 16, 2018
Clear Lake, California
Clear Lake Cyanobacteria Monitoring Program

- 2014: Tribes wanted more info on blooms, realized they had to do it.
- Big Valley Band of Pomo Indians, Elem Indian Colony already had established water monitoring programs and QAPPs so added this element.
- Funding used: CalEPA EJ, BIA Water Resources, GAP, US Fish and Wildlife.
What are Cyanobacteria?

- “Blue Green Algae”
- Marine or freshwater.
- Bacteria. Why our atmosphere has oxygen in it.
- Thrives with excess nutrient loads including Phosphorus and Nitrogen.
- Toxin producing—skin, liver and nerve
- “Harmful Algal Blooms”
Cyanobacteria Impacts

- Bloom proliferation $\rightarrow$ reduced sunlight in water column, impacting plant growth
- Dying blooms $\rightarrow$ oxygen depletion $\rightarrow$ fish kills
- Questions about water safety
- Strong odor, visually unpleasing
- Increased filtration and treatment costs for drinking water systems
Lyngbya Cyanobacteria Bloom, Clear Lake 2009
Clear Lake Cyanobacteria Bloom and Fish Kill, September 2014
Clear Lake Cyanobacteria Bloom, August 2017
Dolichospermum, Clear Lake, May 2016
Anabaenopsis, Clear Lake, July 2016
Dolichospermum, Clear Lake, May 2017
Aphanizomenon, Clear Lake, June 2017
Dolichospermum, Clear Lake, July 2017
Synechosystis, Clear Lake, August 2017
Microcystis and Dolichospermum, Clear Lake, August 2018
What Are Cyanotoxins?

- Produced by some cyanobacteria
- Exposure from contact, ingestion of mats/water/fish;
- Can cause illness/death in animals/humans.
- Field kits can detect presence, lab analysis to confirm.
- Blooms don’t always produce cyanotoxins, clear water isn’t always cyanotoxin free.
- Require special treatment to be removed from drinking water.
- Federal and state recommendations for waterbodies with cyanotoxins.
Cyanotoxins’ Impacts

Clear Lake contaminated by algae in potentially hazardous bloom
By James Maynard Tech Times
7 September 2014, 10:12 am EDT

Bag a local news
Toxin known to kill dogs within 30 minutes found in several California lakes, rivers

NOAA Fisheries mobilizes to gauge unprecedented West Coast toxic algal bloom
Offshore survey will measure extent and severity of largest harmful algal bloom in more than a decade
June 2015
Contributed by Michael Milstein

New Diseases, Toxins Harming Marine Life
Dolphins, other marine mammals weakened by pollution, scientists say.
Cyanotoxins’ Impacts
Cyanotoxins’ Impacts

FISH CONSUMPTION

<table>
<thead>
<tr>
<th>INVENTORY NAME</th>
<th>SITE ID</th>
<th>DATE COLLECTED</th>
<th>SPECIES NAME</th>
<th>Microcystin RESULT TISSUE (ng/g)</th>
<th>Microcystin RESULT LIVER (ng/g)</th>
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</thead>
<tbody>
<tr>
<td>83 M4</td>
<td>4/21/2015</td>
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<td>84 609</td>
<td>4/22/2015</td>
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<td>85 762</td>
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</table>

Table 12: Sport Fish and Shellfish Action Levels for Consumption (ng/g, ww⁻¹)

<table>
<thead>
<tr>
<th>Sport fish tissue level</th>
<th>Microcystins</th>
<th>Anatoxin-a</th>
<th>Cylindropermopsin</th>
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<tbody>
<tr>
<td>10</td>
<td>5000</td>
<td>70</td>
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</tr>
</tbody>
</table>
Cyanotoxins’ Impacts

Clear Lake surface water serves 65% of Lake County residents.

The Safe Drinking Water Act currently does not have standards on cyanotoxins but does have guidelines.
# California Cyanotoxin Guidelines

## Action levels for selected scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Microcystins</th>
<th>Anatoxin-a</th>
<th>Cylindrospermopsin</th>
<th>Media (units)</th>
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</thead>
<tbody>
<tr>
<td>Human recreational uses²</td>
<td>0.8</td>
<td>90</td>
<td>4</td>
<td>Water (µg/L)</td>
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<tr>
<td>Human fish consumption</td>
<td>10</td>
<td>5000</td>
<td>70</td>
<td>Fish (ng/g) ww³</td>
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<tr>
<td>Subchronic water intake, dog⁴</td>
<td>2</td>
<td>100</td>
<td>10</td>
<td>Water (µg/L)</td>
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<tr>
<td>Subchronic crust and mat intake, dog</td>
<td>0.01</td>
<td>0.3</td>
<td>0.04</td>
<td>Crusts and Mats (mg/kg) dw⁵</td>
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<tr>
<td>Acute water intake, dog⁶</td>
<td>100</td>
<td>100</td>
<td>200</td>
<td>Water (µg/L)</td>
</tr>
<tr>
<td>Acute crust and mat intake, dog</td>
<td>0.5</td>
<td>0.3</td>
<td>0.5</td>
<td>Crusts and Mats (mg/kg) dw⁵</td>
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<tr>
<td>Subchronic water intake, cattle⁷</td>
<td>0.9</td>
<td>40</td>
<td>5</td>
<td>Water (µg/L)</td>
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<td>Subchronic crust and mat intake, cattle⁷</td>
<td>0.1</td>
<td>3</td>
<td>0.4</td>
<td>Crusts and Mats (mg/kg) dw⁵</td>
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<tr>
<td>Acute water intake, cattle⁷</td>
<td>50</td>
<td>40</td>
<td>60</td>
<td>Water (µg/L)</td>
</tr>
<tr>
<td>Acute crust and mat intake, cattle⁷</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>Crusts and Mats (mg/kg) dw⁵</td>
</tr>
</tbody>
</table>

¹ Microcystins refer to cyanotoxin-producing cyanobacteria (CPCP) of the Microcystis genus, which are believed to be the main source of cyanotoxins in California waters.

² Human recreational uses include activities such as swimming, boating, and wading in bodies of water.

³ WW denotes wet weight.

⁴ Dog is a canine animal.

⁵ DW denotes dry weight.

⁶ Acute water intake refers to exposure over a short period of time, typically less than 24 hours.

⁷ Cattle includes bovines such as steers and heifers.

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The content is sourced from ‘Suggested Action Levels and Six Cyanotoxins’, CA OEHHA, 2012.

# Cyanobacteria and Known Toxins

<table>
<thead>
<tr>
<th>Cyanobacteria Genus</th>
<th>CYL</th>
<th>MC</th>
<th>NOD</th>
<th>ATX</th>
<th>SAX</th>
<th>NEO</th>
<th>LYN</th>
<th>BMAA</th>
<th>DAT</th>
<th>APL</th>
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<td></td>
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<tr>
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<td>✓</td>
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<tr>
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<tr>
<td><em>Cylindrospermopsis</em></td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><em>Cylindropermum</em></td>
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<td>✓</td>
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<td>✓</td>
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<tr>
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<td>✓</td>
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</tbody>
</table>

**Neurotoxins**

**Dermatoxins**

**Hepatotoxins**

[https://drive.google.com/file/d/0B40pxPC5g-D0RWtJZVloUnhnWm8/view](https://drive.google.com/file/d/0B40pxPC5g-D0RWtJZVloUnhnWm8/view)
Continually Developing Program

2014
- Formed Clear Lake Cyanobacteria Task Force, has continued to meet quarterly
- Focused on Microcystin levels at 8 shoreline sites—lab analysis and field Abraxis Algal Toxin strips

2015
- 18 shoreline sites
- Cyanobacteria cell identification
- Lab analysis for Microcystin, Anatoxin-a, Cylindrospermopsin, Saxitoxin
Continually Developing Program

2016

- Monitoring toxins in drinking water systems
- Chlorophyll-a and phycocyanin for TMDL
- Microcystin analysis at every site

2017

- Other waterbodies in County
- qPCR analysis (toxin producing genes)
Continually Developing Program

2018

- Analysis of fish and shellfish for Microcystin
- Began collaboration with CA DWR to get water samples from interior of lake
- Tribal data URL is installed on county signs, county press releases

www.bvrancharia.com/clearlakecyanotoxins
Clear Lake Cyanobacteria Task Force

- Local Tribes: Big Valley, Elem, Scotts Valley, Upper Lake, Robinson
- County agencies: Lake County Water Resources, Environmental Health, Public Health
- City agencies: City of Lakeport, City of Clearlake
- Local elected officials: Lake County, Cities of Lakeport and Clearlake
- US EPA: Region 9 Water and Tribal Programs, Research Triangle
- CalEPA: SWRCB, OEHHA, Division of Drinking Water
- Regional water quality: Central Valley Regional Water Quality Control Board
- California Dept of Public Health
- California State Parks, Clear Lake
Clear Lake Cyanotoxin Monitoring Locations

- Included locations that are Tribally important
- Monitoring to coincide with important dates of Tribal uses of the water
- Communicate with Tribes and the public about the results
Use a multiprobe meter to get water quality parameters

Fluorometer to get chlorophyll-a and cyanobacteria pigment data (results are important with some nutrient TMDLs)

Screening kits like Abraxis will detect specific cyanotoxins


http://www.abraxiskits.com/products/algal-toxins/
Planning - Choosing Labs

- What type of equipment do they use and is the detection limit of the equipment low enough?
- How long does it take to get results back?
- Cost of analysis?
- Supply your own bottles, which ones does the lab recommend?
- Prep requirements such as freezing (for lysing cells first)?
- Shipping requirements?

http://www.mywaterquality.ca.gov/habs/resources/index.html#laboratory
Processing the Water Samples

Testing for presence of microcystin with Abraxis recreational test strips (measures to 10ppb)
Educating the Public About Water Quality Conditions

Dolichospermum cyanobacteria at Horseshoe Bend

Clear Lake Water Quality added 5 new photos.
Published by Pago Likod - July 25, 2017

LAB UPDATE ON CLEAR LAGE AND BLUE LAKES CYANOTOXIN LEVELS: 14 of our 20 sites came back with levels of MICROCYSTIN toxins from our last lakewide sampling event which was 9/25/17. One of those sites are above the Action Level set by the state - the site at Clearlake Keys had elevated results and are at the CAUTION LEVEL threshold set by the state. The results were as follows:
Clearlake Keys 4.0 ug/L (CAUTION LEVEL)
Jago Bay 0.30 ug/L
Austin Park 0.28 ug/L

Harmful algae may be present in this water. For your family’s safety:
- You can swim in this water, but stay away from algae and scum in the water.
- Do not let pets and other animals go into or drink the water, or eat scum on the shore.
- Keep children away from algae in the water or on the shore.
- For fish caught here, throw away guts and clean fillets with tap water or bottled water before cooking.
- Do not drink this water or use it for cooking.
- Do not eat shellfish from this water.

Call your doctor or veterinarian if you or your pet get sick after going in the water.
For information on harmful algae, go to mywaterquality.ca.gov/monitoring.directives/yenoha_network
For local information, contact:

nanoHAB Trigger Levels for Hu

4,469 people reached
Big Valley Band of Pomo Indians

UPDATE ADVISORY, BIG VALLEY MEMBERS
FRIDAY JULY 14, 2017, 4:30PM:
CYANOBACTERIA (BLUE GREEN ALGAE) BLOOM AT THE POINT CONTINUES.

BIG VALLEY EPA HAS IDENTIFIED CYANOBACTERIA ALONG BIG VALLEY’S SHORELINE AND AT OTHER LOCATIONS ON CLEAR LAKE. LAB TESTING OF BIG VALLEY’S SHORELINE SHOWED LOW DETECT FOR 1 TOxin - Microcystin, AT 0.21 ug/L. THE state has set a level of 0.8 ug/L, TO be protective of kids swimming. THE lab results at the Point are below the level of concern.

TAKE CAUTION IF YOU ENTER THE LAKE. UNLESS YOU CAN KEEP YOURSELF AND CHILDREN FROM SWALLOWING LAKE WATER WHILE PLAYING, IT IS BEST TO STAY OUT OF THE LAKE AT THIS TIME. DO NOT SWALLOW LAKE WATER OR ALLOW CHILDREN TO SWALLOW ANY LAKE WATER. KEEP DOGS FROM THE LAKE BECAUSE THEY WILL LICK THEIR FUR AND CONSUME ANY TOXINS THAT MIGHT BE PRESENT.

RESULTS FROM OTHER SITES ON THE LAKE:

<table>
<thead>
<tr>
<th>Site</th>
<th>Concentration (ug/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soda Bay Cove</td>
<td>3.5</td>
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<tr>
<td>Sulphur Bank</td>
<td>2.4</td>
</tr>
<tr>
<td>Mercury Mine</td>
<td>1.3</td>
</tr>
<tr>
<td>Buckingham</td>
<td>1.2</td>
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<tr>
<td>Richmond Park</td>
<td>0.38</td>
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<tr>
<td>Elem shoreline</td>
<td>0.35</td>
</tr>
<tr>
<td>Horseshoe Bend</td>
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<tr>
<td>Keeling Park</td>
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<tr>
<td>Austin Park</td>
<td>0.22</td>
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<tr>
<td>Clearlake Oaks</td>
<td>0.21</td>
</tr>
<tr>
<td>Big Valley shoreline</td>
<td>0.11</td>
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<tr>
<td>Redbud Park</td>
<td>No Detect</td>
</tr>
<tr>
<td>Jago Bay</td>
<td>No Detect</td>
</tr>
<tr>
<td>Lakeside County Park</td>
<td>No Detect</td>
</tr>
<tr>
<td>Lakersport 5th Street Ramp</td>
<td>No Detect</td>
</tr>
<tr>
<td>Rodman Slough</td>
<td>No Detect</td>
</tr>
<tr>
<td>Lucerne Alpine Park</td>
<td>No Detect</td>
</tr>
<tr>
<td>Cache Creek</td>
<td>No Detect</td>
</tr>
<tr>
<td>Upper Blue Lakes</td>
<td>No Detect</td>
</tr>
<tr>
<td>Lower Blue Lakes</td>
<td>No Detect</td>
</tr>
</tbody>
</table>

4 SITES ABOVE LEVEL OF CONCERN ARE HIGHLIGHTED BLUE. BIG VALLEY SHORELINE AT THE POINT HIGHLIGHTED YELLOW. BELOW LEVEL OF CONCERN BUT TOXINS ARE PRESENT.

THIS ADVISORY IS IN EFFECT UNTIL FURTHER NOTICE. NEXT SAMPLING DATE IS JULY 17, 2017 AND WE WILL PROVIDE RESULTS SOON AFTER. IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT ENVIRONMENTAL DIRECTOR SARAH RYAN AT 707-340-4040.

Additional information can be found at www.mywaterquality.ca.gov

One of several advisories issued by Clear Lake Tribes in 2017.
Evidence of bloom and low toxin levels

No evidence of bloom and caution toxin levels

Toxins can be present with no obvious bloom. Widespread blooms don’t always have elevated toxin levels. We have many pictures of instances of this.
Reviewing bloom conditions and toxins against phycocyanin/chlorophyll-a ratios

<table>
<thead>
<tr>
<th>Cyanotoxin Monitoring Sites</th>
<th>Cell ID</th>
<th>Dominant Genus</th>
<th>Chlorophyll-a (µg/L)</th>
<th>Phycocyanin (µg/L)</th>
<th>phyco/chloro-a ratio</th>
<th>Total Microcystins (EPA)</th>
<th>Site ID</th>
<th>Dates</th>
<th>Lab Results (in ppb)</th>
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<tbody>
<tr>
<td>BVCL6</td>
<td>6/14/2016</td>
<td>anabaencpsis</td>
<td>26.45</td>
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<td></td>
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### How Often Did Clear Lake Cyanotoxin Monitoring Sites Exceed the Microcystin Threshold for Potential Health Risks?

0.8 micrograms per Liter ($\mu$g/L) is the CCHAB recommendation for public notification of microcystin cyanotoxins at potential health risk levels.


<table>
<thead>
<tr>
<th>SAMPLING SITE ID</th>
<th>ARM OF LAKE</th>
<th>PERCENTAGE OF TIMES EACH SITE EXCEEDED 0.8 $\mu$g/L EACH YEAR (PUBLIC NOTIFICATION THRESHOLD FOR MICROCYSTIN)</th>
<th>HIGHEST MICROCYSTIN LEVEL RECORDED AT EACH SITE EACH YEAR *</th>
</tr>
</thead>
<tbody>
<tr>
<td>BVCL6</td>
<td>U</td>
<td>17%, n=6</td>
<td>0%</td>
</tr>
<tr>
<td>CLV7</td>
<td>U</td>
<td>86%, n=7</td>
<td>0%</td>
</tr>
<tr>
<td>M4</td>
<td>U</td>
<td>33%, n=6</td>
<td>0%</td>
</tr>
<tr>
<td>LPTNT</td>
<td>U</td>
<td>83%, n=6</td>
<td>0%</td>
</tr>
<tr>
<td>RODS</td>
<td>U</td>
<td>not sampled</td>
<td>0%</td>
</tr>
<tr>
<td>CP</td>
<td>U</td>
<td>not sampled</td>
<td>0%</td>
</tr>
<tr>
<td>LS</td>
<td>U</td>
<td>not sampled</td>
<td>0%</td>
</tr>
<tr>
<td>LS2</td>
<td>U</td>
<td>not sampled</td>
<td>not sampled</td>
</tr>
<tr>
<td>LUC01</td>
<td>U</td>
<td>67%, n=6</td>
<td>0%</td>
</tr>
<tr>
<td>HB</td>
<td>U</td>
<td>not sampled</td>
<td>0%</td>
</tr>
<tr>
<td>KP01</td>
<td>U</td>
<td>not sampled</td>
<td>0%</td>
</tr>
<tr>
<td>ELEM01</td>
<td>O</td>
<td>50%, n=4</td>
<td>29%</td>
</tr>
<tr>
<td>SBMMEL01</td>
<td>O</td>
<td>100%, n=7</td>
<td>20%</td>
</tr>
<tr>
<td>CLOAKS01</td>
<td>O</td>
<td>100%, n=7</td>
<td>31%</td>
</tr>
<tr>
<td>GH</td>
<td>O</td>
<td>not sampled</td>
<td>not sampled</td>
</tr>
<tr>
<td>BP</td>
<td>L</td>
<td>not sampled</td>
<td>27%</td>
</tr>
<tr>
<td>RP</td>
<td>L</td>
<td>not sampled</td>
<td>33%</td>
</tr>
<tr>
<td>SHADY01</td>
<td>L</td>
<td>not sampled</td>
<td>40%</td>
</tr>
<tr>
<td>RED01</td>
<td>L</td>
<td>not sampled</td>
<td>33%</td>
</tr>
<tr>
<td>AP01</td>
<td>L</td>
<td>100%, n=9</td>
<td>41%</td>
</tr>
<tr>
<td>JB</td>
<td>L</td>
<td>not sampled</td>
<td>not sampled</td>
</tr>
</tbody>
</table>

* $n =$ number of times sampled

* $*= \text{in } \mu\text{g/L}$
Additional Work

- Providing support for ground truthing at Clear Lake for the CyAN (Cyanobacteria Assessment Network), a joint EPA, NASA, NOAA, and USGS project.
- Early warning indicator using historical and current satellite data to detect algal blooms in freshwater.
Implementing Non Point Source Management to Control Cyanobacteria Levels

Nonpoint Source control to reduce cyanobacteria levels
Cyanotoxins in Drinking Water

OVERVIEW

• Cyanotoxins – A drinking water concern
• Guidance and Standards for Cyanotoxins
• Incidents of Cyanotoxin detects in drinking water
• Effective treatment systems
• Monitoring for microcystin in drinking water
• Projects that have come from the monitoring
Cyanotoxins – A drinking water concern

- Drinking water community has traditionally focused on taste, odor, impact on treatment processes – with background awareness of toxicity issues
- Worldwide increase in bloom occurrence
- Recent media and regulatory attention
- Limited occurrence data
- EPA guidance, rather than regulation
# Guidelines for Cyanotoxins

<table>
<thead>
<tr>
<th>Authority/Country</th>
<th>Microcystin</th>
<th>Cylindrospermopsin</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO (1998 provisional guidelines): Adopted by many countries</td>
<td>1 ug/L</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Health Canada</td>
<td>1.5 ug/L</td>
<td>NA</td>
<td>Anatoxin-a 3.7 ug/L</td>
</tr>
<tr>
<td>Australia</td>
<td>1.3 ug/L</td>
<td>1 ug/L</td>
<td>Saxitoxin 3.0 ug/L</td>
</tr>
<tr>
<td>EPA Health Advisory: Based on 10 day exposure (May 2015)</td>
<td>0.3 ug/L infants and preschool children</td>
<td>0.7 ug/L infants and preschool children</td>
<td>3.0 ug/L school age children and adults</td>
</tr>
</tbody>
</table>
Cyanotoxin Standards in Drinking Water

In June 2015, US EPA issued 10-day Drinking Water Health Advisories (HAs) for two cyanobacterial toxins: total microcystins and cylindrospermopsin.

Per US EPA: Health advisories are non-regulatory concentrations at which adverse health effects are anticipated to occur over specific exposure durations (e.g., one day, ten days, and lifetime).

At this time Microcystin-LR, Cylindrospermospin, and Anatoxin-a are included in EPA’s drinking water contaminant candidate list 4 (CCL 4) – draft.

Also proposed in the draft UCMR 4, 2018-2020.
Outbreak of 100 patients have acute liver failure occurred at a dialysis center in Caruaru, Brazil from treatment during February 13\textsuperscript{th} – 20\textsuperscript{th}, 1996

76 people died and 52 could be linked to the hepatotoxin microcystin and cylindrospermopsin

Microcystin level of 19.5 ug/L
Toledo, Ohio

- July 31, 2014 issued a two day ban on drinking and cooking tap water for more than 400,000 residents
- Detected level of 2.5 µg/L in finished water
Salem, Or

- May 30, 2018 City of Salem issued a do not drink water
- Criticized because results were known on Friday May 25th and no warning to public till Tuesday May 30th
- Low levels of microcystin and cylindrospermopsin
Water Treatment Systems

- Treatment systems must be fine-tuned based on source water, treatment train, technical ability, analytical ability
- Growing amount of tools to help PWSs optimize treatment
In-Plant Treatment Alternatives

- **Physical Removal**
  - Most effective for intracellular toxins
  - Need strategy to remove settled solids to prevent cells from lysing and releasing toxins

- **Adsorption**
  - Activated carbon (PAC or GAC)

- **Utilities can effectively respond to cyanotoxin-producing algal bloom events**
  - Best if SOP is in place prior to the event
Monitoring

- Lake County 64,000 people and 65% get it from Clear Lake.
- 6 of the 17 systems participate in bi-weekly sampling.
- Microcystin analysis on raw and finished water.
Clearlake Oaks County Water District

- Serves drinking water to Elem Indian Colony
- Intake is 100 ft from shoreline
- Highest shoreline values from this beach of 16,900 µg/L in 2014
Microcystin Strip Test - Drinking Water

1. Collect Sample
   - Collect 1 to 2 mL of sample.

2. Transfer/QuickLyse™
   - Using the graduated pipette provided, transfer 1 mL of SAMPLE to the lysate vial containing the dried lysate reagent.

3. Add Reagent Paper/QuickLyse™
   - Using the reagents provided, add 1 reagent paper to the lysate vial.

4. Transfer
   - Using the pipette provided, add 7 drops of SAMPLE to the conical, tip-top tube.

5. Shake and Incubate
   - Close the conical, tip-top tube and shake for 30 seconds.

6. Test
   - Insert test strip into conical, tip-top tube with arrow pointing down (sample end down).

7. Dry
   - Incubate for 10 minutes.

8. Interpret
   - Remove test strip. Lay flat and allow to continue developing for 5 minutes.

<table>
<thead>
<tr>
<th>PPB</th>
<th>Microcystin</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>&gt;=10 ppb</td>
</tr>
<tr>
<td>5</td>
<td>&gt;20 ppb</td>
</tr>
<tr>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 ppb</td>
</tr>
<tr>
<td>0</td>
<td>0 ppb</td>
</tr>
</tbody>
</table>

Sample date: 7/17/18
Test date: 7/17/18

Cloaksol: >10 ppb
Cloaksol Diluted 1/2: >20 ppb
Elemo: 1 ppb
Kpo: 0 ppb
Hb: 10 ppb
Microcystin-ADDA ELISA Kit
Procedure

- Add 50 μL of sample then 50 μL of antibody solution, incubate for 90 minutes
- Wash out wells
- Add 100 μL of enzyme conjugate, incubate for 30 minutes
- Wash out wells
- Add 100 μL of substrate / color solution, incubate 20-30 minutes
- Add 50 μL stopping solution
Read Absorbance
Analyzing for Microcystin in Drinking Water
## 2016 Clear Lake Microcystin Concentrations (μg L) for Public Water Systems

<table>
<thead>
<tr>
<th></th>
<th>RAW WATER</th>
<th>FINISH WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ROUND 1</td>
<td>ROUND 2</td>
</tr>
<tr>
<td>Lake County CSA 20 - Soda Bay</td>
<td>0.16</td>
<td>0.18</td>
</tr>
<tr>
<td>Clearlake Oaks County Water District</td>
<td>0.73</td>
<td>0.38</td>
</tr>
<tr>
<td>Lake County CSA 21 - North Lakeport</td>
<td>0.33</td>
<td>0.21</td>
</tr>
<tr>
<td>Buckingham Park Water District</td>
<td>0.12</td>
<td>0.27</td>
</tr>
<tr>
<td>Clearwater Mutual Water Company</td>
<td>0.3</td>
<td>0.21</td>
</tr>
<tr>
<td>Highlands Mutual Water Company</td>
<td>0.38</td>
<td>0.27</td>
</tr>
<tr>
<td>Konocti County Water District</td>
<td>0.27</td>
<td>0.28</td>
</tr>
<tr>
<td>California Water Service - Lucerne</td>
<td>0.4</td>
<td>&lt;0.1</td>
</tr>
</tbody>
</table>
Automated ELISA Assay System
### Abraxis products

<table>
<thead>
<tr>
<th>Toxin</th>
<th>Microplate</th>
<th>Test Strips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcystin / Nodularins</td>
<td>Yes – EPA Method 546</td>
<td>Yes</td>
</tr>
<tr>
<td>Anatoxin-a</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cylindrospermopsin</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Saxitoxin</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

- $500 for 20 test strips
- $500 for 96 microplate
- Automated System $22,000
- Manual system $6,000
Shoreline vs. Raw Water Intake

CSA 21 North Lakeport

Clearlake Oaks

Buckingham Park
Resources to help Water Operators

- US EPA - Jun 15 - 2015 Drinking Water Health Advisory for Two Cyanobacteria Toxins
- US EPA - Jun 15 - Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water
- USW EPA - Nov 15 - Algal Toxin Risk Assessment and Management Strategic Plan for Drinking Water
Projects That Have Grown from Our Program – Drinking Water

- 2016 EPA funded an Engineering Firm to write a cyanotoxin monitoring and customer response plan for Clear Lake Water Purveyors
- 2017 Drinking Water Division funded a firm to write the Sanitary Survey co-joined with a nutrient management grant proposal
- 2018 EPA funded a project looking at DBP and Cyanotoxins
Projects That Have Grown from Our Program - Health

- Conceptual Grant Proposal - Joint Project with CDPH – reviewing ER and clinic visits and correlating with spikes in toxins at Clear Lake
- Fish and Shellfish Tissue analysis funding
- Contract between EPA and CA Fish and Wildlife to review wildlife deaths at Clear Lake for cyanotoxin poisoning
Additional Areas of Interest/Concern

- Ongoing evaluation of cyanotoxin impacts on Tribal traditional uses of the lake
- Crop irrigation and presence of cyanotoxins
- Aerosolization of cyanotoxins in shower, recreation, swamp coolers
- Cyanobacteria and mercury interactions
- Implications of phosphorus fire retardant use on nutrient impaired waterbodies
- Potential interactions of aquatic weed treatments and cyanobacteria blooms/toxin production
Summary

- Be proactive to protect your waters if you suspect blooms
- Federal and some state agencies have funding that can help develop monitoring programs
- Tribes in Northern and Central California have strong monitoring programs, reach out for assistance
- Conduct research, collaborate, educate the public, take action on watershed management and help create policy to protect your waters
- Developing and leading the program ensures a Tribal centric program that reflects Tribal values
Questions?

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sryan@big-valley.net

Karola Kennedy, Environmental Director
Elem Indian Colony
707-994-3400
kkarolaepa@gmail.com