Harmful Algal Blooms (HABs) Actionable Research Applied to Support State and Tribal Communities

Tammy L Jones-Lepp, Jade Morgan, and Dan Heggem
ORD - National Exposure Research Laboratory
Las Vegas, NV

Region 10 Technical Assistance Group Annual Meeting:
Roundtable on Nutrients and Harmful Algae
May 25, 2017 Webinar

Overview

- ORD Strategic Research Action Plan (StRAP) for Safe and Sustainable Water Research (SSWR) Program 4.01: Harmful Algal Bloom Project

- ORD National Exposure Research Laboratory (NERL) – Las Vegas HAB direct technical support to Tribes
    - Yurok Tribe - Anatoxin-a
    - Chemehuevi/Colorado River Indian Tribes – Floating Vegetation Islands

Overview of ORD's StRAP
SSWR 4.01 Harmful Algal Bloom Project

- Harmful algal blooms (HABs) from algae, cyanobacteria and golden algae may occur naturally. However, human activities appear to be increasing the frequency of some HABs. HABs can have a variety of ecological, economic and human health impacts.

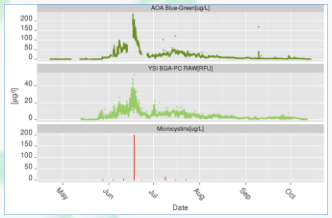
Highlights of StRAP

- Management
- Effects
- Modelling
- Analysis and Monitoring
- Cyanobacteria Assessment Network and Satellite Remote Sensing

Overview cont.

- Management - Research is performed that will result in a greater understanding of the use of appropriate technologies for the management of HAB risk through monitoring, modeling, and treatment during inland freshwater HAB events.

- Modelling – Temperature impacts on bloom modelling. Our ability to manage and mitigate the expected increase in frequency, duration, and severity of harmful algal bloom events (HABs) is directly linked to our ability to describe the interaction between changing temperature and bloom events



- Analysis and Monitoring - (1) Develop or refine chemical, field instrument and biological methods for detection of cyanobacteria, *Prymensium parvum*, and *Anabaena* and their toxins. (2) Application of chemical, biological and instrument methods

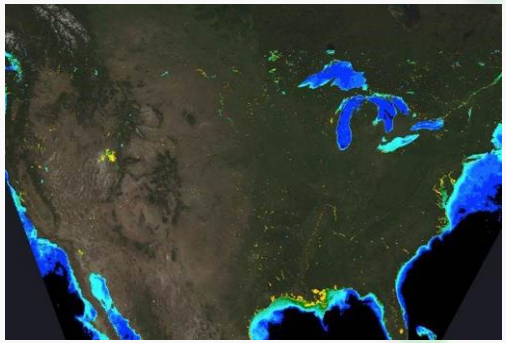
Overview cont.

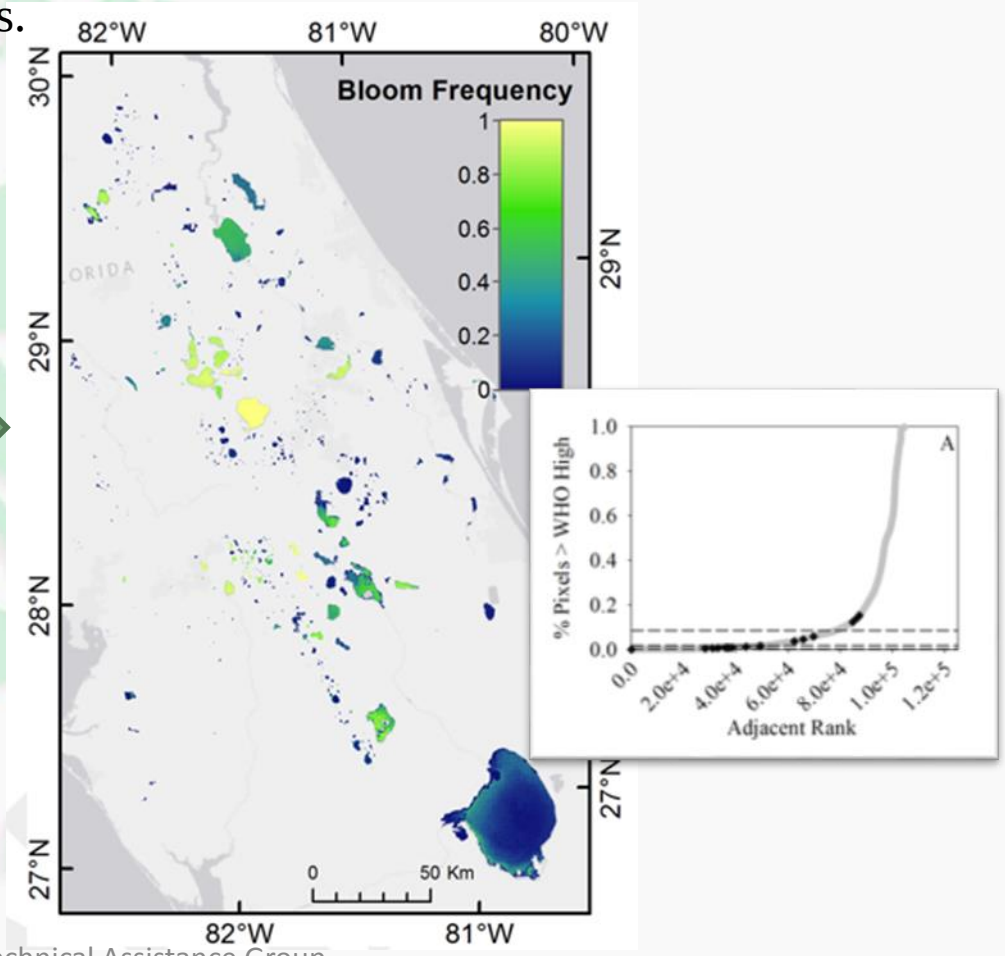
- Effects – Measures of human and animal exposure to ambient cyanotoxin concentrations and associated effects. (1) The effects of cyanotoxins on human cells and cell lines; (2) Toxicity mechanisms as measured by mammalian (rodent) models; (3) Develop measures of cyanotoxin-associated ecological harm using aquatic test organisms

- Cyanobacteria Assessment Network and Satellite Remote Sensing (CYAN):
  - Cyanobacteria, chlorophyll-a, turbidity and temperature indicators can be monitored with satellites.
  - Cross-agency (EPA, NASA, NOAA, and USGS) research to mainstream satellite capabilities for water quality management decisions.
  - New methods to quantify frequency of occurrence and spatial extent of cyanobacteria HABs. With impacts across any geo-political boundary.
  - Potential to prioritize locations for management actions

Quantifying cyanobacteria frequency using satellite imagery

Possible applications for understanding HAB risk at management-relevant sites, e.g. surface water intakes or rec. waters.





Clark et al. (*In Clearance*). Methods for monitoring cyanobacteria harmful algal blooms in recreational waters and drinking source waters with satellites. Ecological Indicators.

Slide courtesy of Dr Blake Schaeffer, ORD, NERL, RTP, NC

HAB StRAP Research Outcomes

- Improve the ability to forecast HABs on State and Tribal lands.
- Devise real-time sensors (e.g., pH, Total N, Total P, salinity, BGA, fluorometers) to monitor identified stressors such that adverse impacts upon susceptible communities can be reduced.
- Research will improve understanding and develop management options (e.g., reduction of nutrients, increase water flows, proper function condition of riparian habitats) between causal environmental relationships and adverse outcomes of HABs.

HAB research to increase EPA capabilities for technical support

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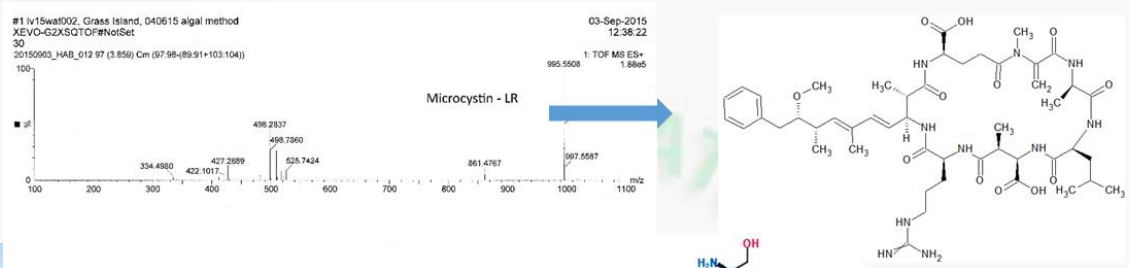
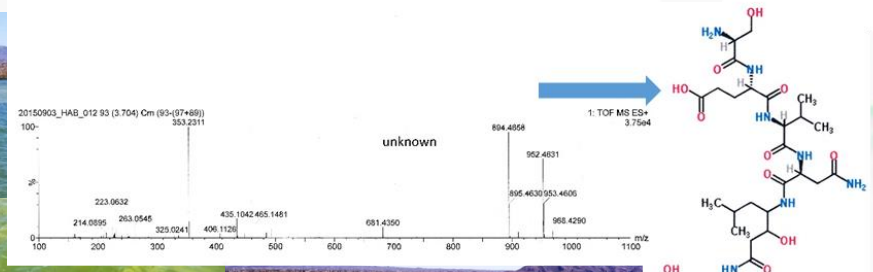
Lower Colorado River Basin - City Lake Havasu – Colorado River Indian Tribes - microcystins





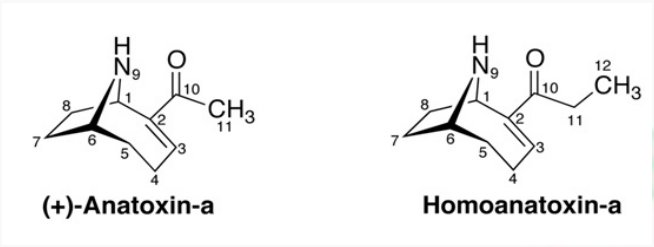
Cyanobacterial bloom March 2015

Lake Havasu cyanobacterial bloom pictures courtesy of Dr Doyle Wilson, City of Lake Havasu water manager

Unknown algal bloom winter 2013

Lower Colorado pictures courtesy of Terry Dock, CRIT, Lake Havasu

1) Hehlkeek 'We-Roy (Klamath River) – Yurok Tribe – anatoxin-a



Structures courtesy of EPA

Hehlkeek 'We-Roy (Klamath River)

picture courtesy of NPS website

- ***An EPA Drinking water Method 545 was modified for Anatoxin-a analysis***

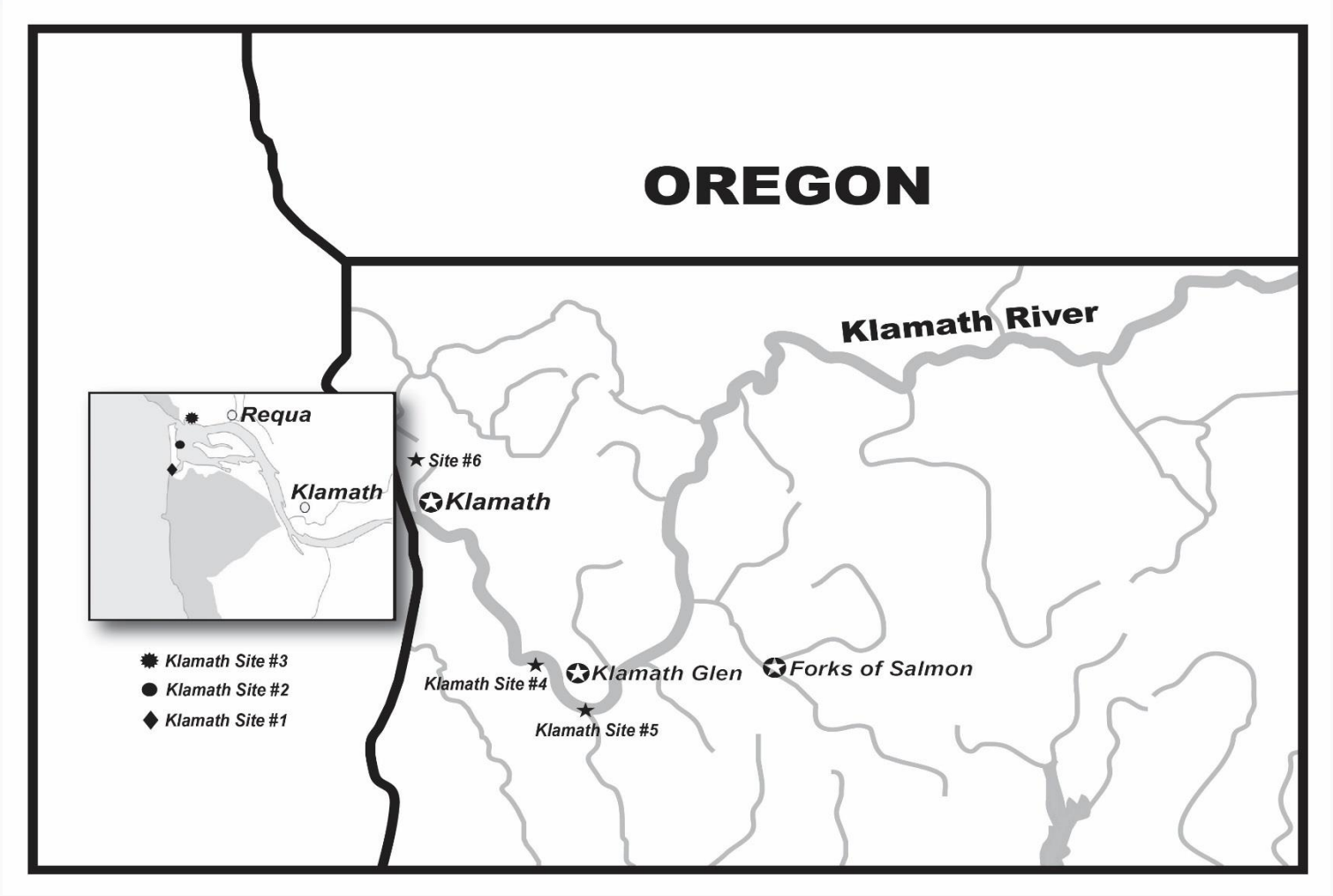
  Briefly, 5 mL aliquots of sample were transferred to 15 mL glass vials and placed in the freezer (-30°C) for 1 hour, then thawed at 40°C, in a warm water bath. This process was repeated two more times. If necessary, sample was filtered through 0.2 µm filter. The 1 mL sample was transferred to a autosampler vial, 20 µl internal standards were added before LC/MS/MS analysis.

- ***Mass Spectrometric Detection***. Analyses were performed using an Agilent 6490 LC/MS-QqQ.

Results from *Anabaena* HAB along the Klamath Fall 2016

Klamath river sample for Anatoxin-a	Collection date	Anatoxin-a LC/MS/MS ng/mL	Time (days) from collection to LC/MS/MS analysis	Microcystin ELISA ‡ ug/L	Phytoplankton Anabaena sp. ‡ cells/mL
Site 1	8/23/2016	ND	28	0.11**	ND
Site 2	8/30/2016	<LOD*	21	0.13**	1696
Site 2	9/13/2016	6.6	9	0.18	184116†
Site 2	9/27/2016	ND	9	0.11**	ND
Site 3	9/13/2016	4.4	9	ND	
Site 3	9/27/2016	<LOD*	9	0.1	
Field blank	9/13/2016	1.1	9		
Field blank	9/27/2016	ND	9		
Site 4	9/13/2016	4.4	9	ND	ND
Site 4	9/27/2016	ND	9	ND	ND
Site 5	9/14/2016	4.7	8	ND	
		*Detected but < LOD		**Detected but < LOQ ‡Data courtesy of Yurok Tribe and Region 9	†Also present Limnothrix sp 12989 cells/mL ‡ Data courtesy of Yurok Tribe and Region 9

Individual States have set recreational water limits: CA = 20 ug/L (warning trigger); OH = 80 ug/L (PHA); OR = 20 ug/L (PHA); WA = 1 ug/L

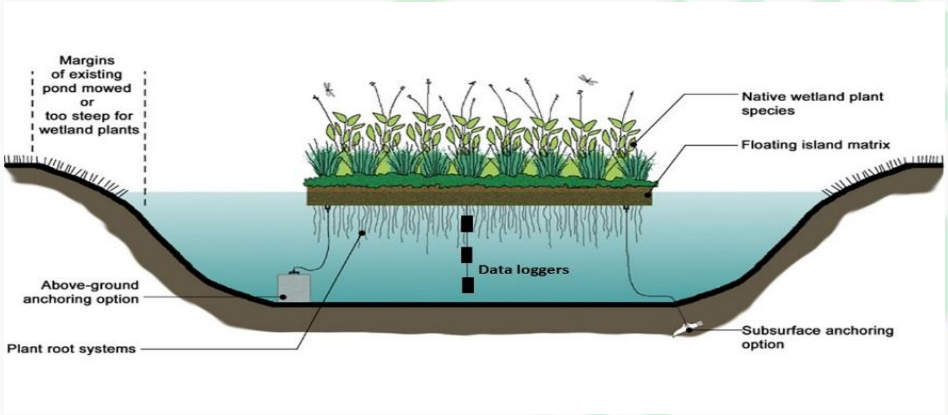

OREGON
Klamath River
Requa
Klamath
Site #6
Klamath
Klamath Site #3
Klamath Site #2
Klamath Site #1
Klamath Site #4
Klamath Glen
Forks of Salmon
Klamath Site #5

2) Floating Vegetation Island Project
Colorado River Indian Tribes

– Chemehuevi – Hopi - Mojave - Navajo

No Name lake is an area on tribal lands where EPA and the CRIT (The Colorado River Indian Tribes) have worked together in the past few years using PFC (proper functioning condition) analysis to re-establish shoreline vegetation.

CRIT and EPA collected baseline water samples in the Fall 2016 in No Name Lake. The purpose of this sampling effort will be to establish water quality baseline criteria before the floating islands are placed. Investigating simple water quality parameters, as well as screening for a variety of algal toxins.



Stylized diagram of a floating vegetation island. Diagram is from the Texas Coastal Watershed Program where they used a dense mesh of polyethylene terephthalate (PET) fibers which have been recycled from plastic waste such as soda bottles (http://tcwp.tamu.edu/floating-wetland-islands/). Data loggers will be placed down column, and up and down flow of the island.

No Name Lake – CRIT – Chemehuevi – Lower Colorado River

Floating islands will improve the shoreline habitats that are degraded by extreme flow regime; cool warming waters, and potentially decrease rising salinity due to drought.

All pictures are courtesy of Terry Dock, CRIT, Lake Havasu, Lower Colorado

No Name Lake – CRIT – Chemehuevi – Lower Colorado River

Final Thoughts

- Chronic/acute exposure to natural toxins will become increasingly important in a water commodity-based future.
- Scarce clean source water, water reuse, and recycling will play an ever-increasing role along with the probability of increasing natural toxins.
- Managing our ecosystems for function is paramount and just plain common sense.

Contact information

Tammy L Jones-Lepp, MSc
Branch Chief, Environmental Chemistry Branch
U.S. Environmental Protection Agency
P.O. Box 93478
Las Vegas, NV 89193-3478
Ph: 702-798-2144
E-mail: jones-lepp.tammy@epa.gov