Harmful Algal Blooms (HABs) Actionable Research for Tribal Communities

- **Overview** – Tammy L Jones-Lepp, ORD, National Exposure Research Laboratory, Las Vegas, NV – Safe and Sustainable Water Research Program 4.01 - Harmful Algal Blooms, Deputy Project Lead

- **Toxicology of algal toxins** – Dr. Neil Chernoff, Dr. Donna Hill, Dr. Deacqunita Diggs, ORD, National Health and Environmental Effects Research Laboratory, RTP, NC

HABs Overview

- 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.

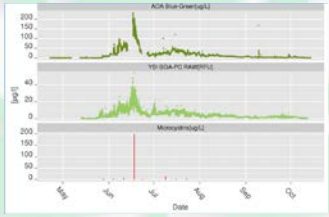
HABS Overview cont.

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

HABs Overview cont.

- Management - Research performed 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.

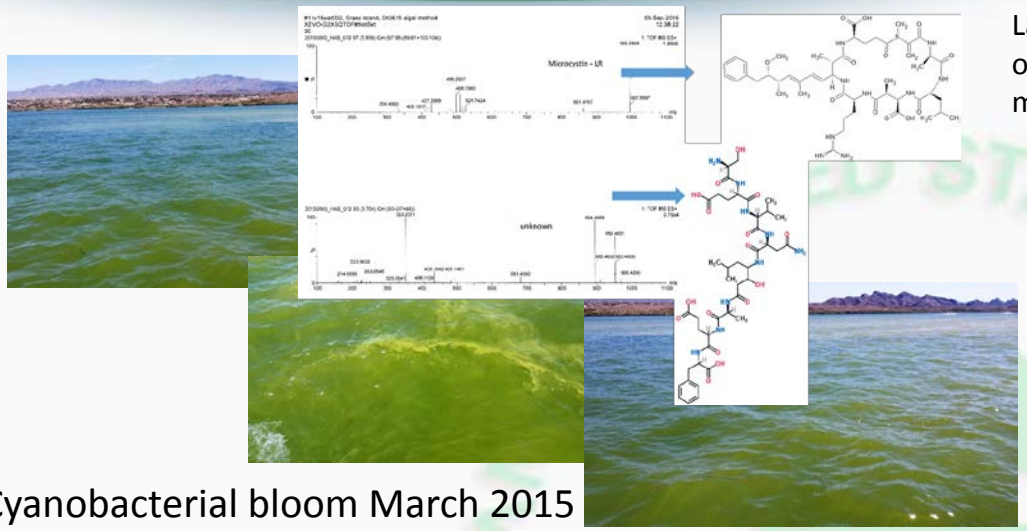
- Modelling – Temperature impacts on bloom modelling. Our ability to manage and mitigate the expected increase in frequency, duration, and severity of harmful algal bloom events (HABs) is directly linked to our ability to describe the interaction between changing temperature and bloom events



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

HAB research to increase capabilities for technical support –

1) Lower Colorado River Basin - City Lake Havasu – CRIT - microcystins
2) Hehlkeek 'We-Roy (Klamath River) – Yurok Tribe – anatoxin-a



Cyanobacterial bloom March 2015

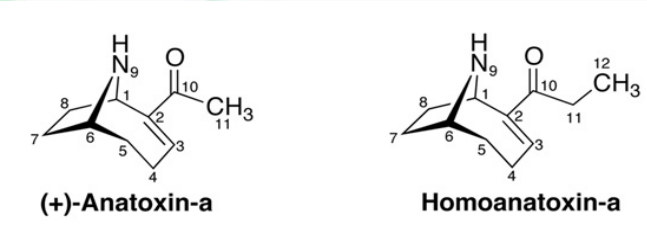
Lake Havasu cyanobacterial bloom pictures courtesy of Dr Doyle Wilson, City of Lake Havasu water manager

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

Unknown algal bloom winter 2013

Hehlkeek 'We-Roy (Klamath River)

Hehlkeek 'We-Roy picture courtesy of NPS website



Structures courtesy of EPA report

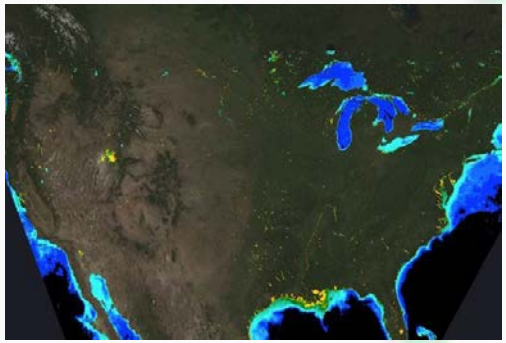
HABs Overview cont.

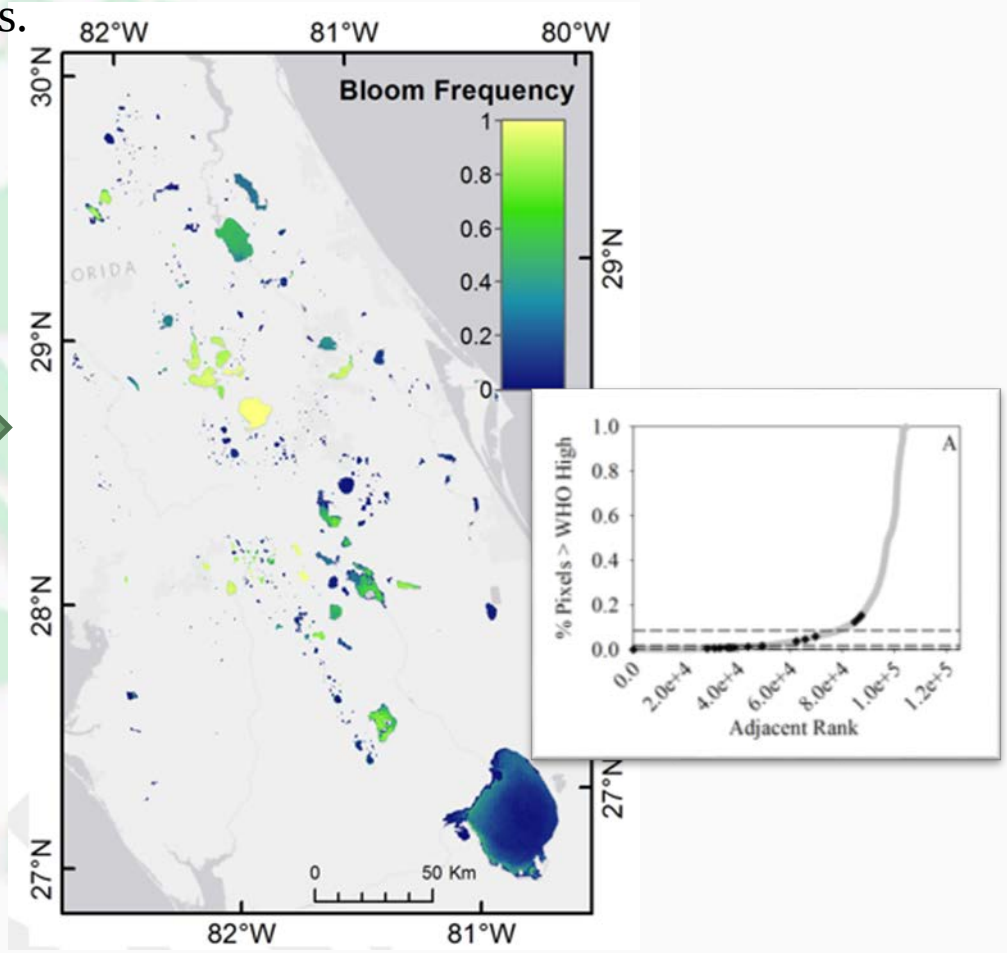
- Effects – Measures of human and animal exposure to ambient cyanotoxin concentrations and associated effects. (1) The effects of cyanotoxins on human cells and cell lines; (2) Toxicity mechanisms as measured by mammalian (rodent) models; (3) Develop measures of cyanotoxin-associated ecological harm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

The Toxicological Effects of HAB Toxins

Dr. Neil Chernoff – ORD, National Health and Environmental Effects Research Laboratory
Dr. Donna Hill – ORD, National Health and Environmental Effects Research Laboratory
Dr. Deacqunita Diggs – ORD, National Health and Environmental Effects Research Laboratory

Harmful Algal Blooms

Harmful effects without toxins

- Unpleasant appearance
- Taste and odor problems
- Block photosynthesis in bottom-dwelling plants
- Deplete dissolved O_2 as bloom material dies
- Physical effects to animals

Harmful Algal Blooms

Harmful Effects Due to Toxins

- Illness and deaths in humans, wildlife, livestock, and pets
- Skin and airway irritation

Exposure is usually through ingestion of contaminated water and shellfish

Fundamentals of Toxicological Research with Cyanotoxins and Algal Toxins

- Animal model
- Available and reliable sources of toxin
- Funding
- Analytical chemistry
- Study design

Study Parameters Used to Evaluate Toxicity

- Behavior and appearance observations
- Body weight/body composition changes
- Organ appearance and weights
- Blood tests
- Histopathology
- Gene expression tests
- Toxin levels in organs

Study Example

Table 1							
Organ weights and organ/body weight ratios							
Dose ug/kg			No.	Necropsy Wt	Liver Wt	L/BW	Kidney Wt
0	male		10	40.3±1.3	1.94±0.07	**0.048**±0.002	0.64±0.03
		%cv		3.2	3.5	3.5	5.2
	female		9	33.5±1.7	1.64±0.11	**0.049**±0.001	0.38±0.015
		%cv		5.2	6.5	2.0	3.9
75	male		10	40.4±0.9	2.37±0.08[a]	**0.059**±0.001[a]	0.88±0.03[a]
		%cv		2.1	3.3	2.2	3.1
	female		10	31.8±1.1	1.66±0.07	**0.052**±0.001	0.39±0.01
		%cv		3.5	4.0	1.9	1.8
150	male		8	38.1±0.7	2.36±0.05[a]	**0.062**±0.001[a]	0.89±0.04[a]
		%cv		1.9	2.2	2.3	4.2
	female		10	30.5±0.6	1.88±0.09[b]	**0.062**±0.003[a]	0.40±0.02
		%cv		2.0	5.0	4.8	5.0
300	male		10	39.3±0.7	2.70±0.06[a]	**0.069**±0.001[a]	0.84±0.05[a]
		%cv		1.8	2.1	1.2	6.3
	female		10	29.8±0.7[b]	1.87±0.05[b]	**0.063**±0.001[a]	0.39±0.01
		%cv		2.4	2.8	1.6	1.5