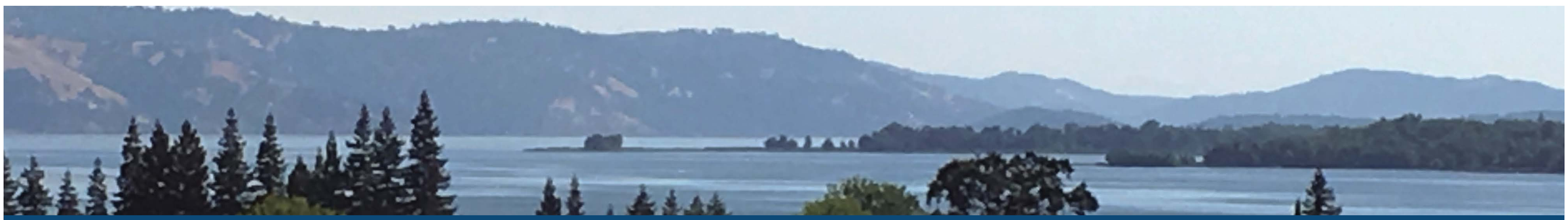

Exposure Characterization at a Cyanobacteria Harmful Algal Bloom (CHAB): Data Collection Methodology

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ABSTRACT

Description Potentially harmful freshwater algal blooms of cyanobacteria (CHAB) are increasingly reported among US surface waters, including recreational and drinking waters, as well as industrial settling ponds and commercial fish farm ponds. A number of anecdotal reports have intimated blue-green algae as the source of respiratory illness and sometimes death in dogs and livestock exposed to CHAB-infested waters. Exposure assessment has been limited and a variety of approaches have been employed. This poster presents the methodology for one study conducted at Clear Lake, CA.

Situation/Problem Clear Lake, CA is regularly impacted by CHABs during the spring through fall. As part of the USEPA's effort to characterize such exposures, air and water samples were collected adjacent to the shore at a public beach on five consecutive weekends.

Methods Air samples were collected for eight hours at 4-5 LPM; 20 Button samplers with fiberglass filters were collected in duplicate for endotoxin analysis; 20 closed-face, 25-mm MCE filters were collected in replicate for cyanotoxin analysis. Water samples were collected three times during each sampling day. A bucket was dropped from the pier to collect surface water from the top 10 inches; individual samples for analysis were collected from the bucket sample. Water samples were submitted to laboratories for analysis of endotoxin, phytoplankton, cyanotoxins, phycocyanin and chlorophyll-a. Water characteristics (temperature, pH, turbidity, dissolved oxygen) and weather condition (temperature, humidity, wind direction, wind velocity, rainfall) were recorded immediately following each sample collection period. Observations of human activities were made every hour throughout the sampling period, characterized by type of contact with water (no contact, hands/feet in water, partial submersion, full submersion, in boat, or on watercraft. The number of people engaging in each activity were counted by age group category (infants, toddlers, pre-adolescents, adolescents, adults). Dogs were counted due to recent reports of respiratory illness and death among dogs swimming in a CHAB.

Results/Conclusions Initial results indicate that the sampling protocols allow for quantitation of cyanotoxins and endotoxin, and associated human activity. This abstract does not necessarily reflect EPA policy.

How will this help advance the science of IH/OH? As freshwater algal blooms increase in recreational waters and commercial settling and fish farm ponds, monitoring will need to be conducted and standardized. Research is needed to determine the best methods to use, and how results correlate with human health.

BACKGROUND

Cyanobacteria are a broad group of photosynthesizing prokaryotes that inhabit fresh and marine waters worldwide. Some genera are known to produce potent toxins that have been associated with human health effects such as skin, eye and respiratory irritation, gastroenteritis and neurological impairment.

Potentially harmful freshwater algal blooms of cyanobacteria (CHABs) are increasingly reported among US surface waters. Although there is a growing body of toxicological literature that describes the effects of a few of the cyanotoxins in rodent models, there are fewer reports of well characterized sub-lethal human and animal health effects, particularly in the US where ambient CHAB exposures are uncommonly reported.

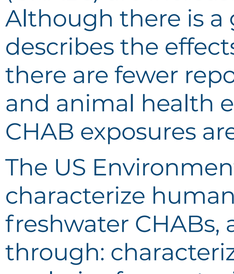
The US Environmental Protection Agency (EPA) seeks to characterize human and animal health effects associated with freshwater CHABs, and to characterize cyanotoxin exposure through: characterizing CHAB exposure, associated illness, and analysis of cyanotoxins in biological specimens from exposed and ill individuals to inform the exposure to effect association.

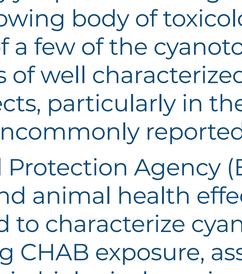
In addition, as algal blooms are complex aquatic communities with associated bacteria, protozoa, and true algae, EPA is interested in characterizing bacterial endotoxin to help distinguish cyanobacteria-associated endotoxin.

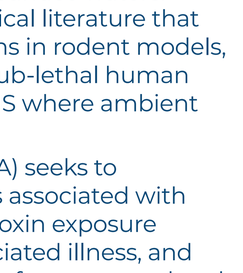
EPA has partnered with State, County and Regional officials who have been monitoring lakes for the presence of CHABs and cyanotoxins. One preliminary study site was identified: Clear Lake in Lake County, California.

WATER SAMPLING

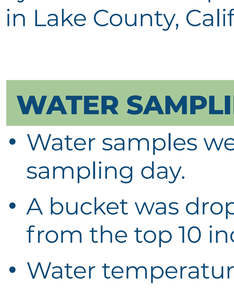
- Water samples were collected three times during each sampling day.
- A bucket was dropped from the pier to collect surface water from the top 10 inches.
- Water temperature was measured in the bucket sample.
- Individual samples for analysis were then collected from the bucket sample.

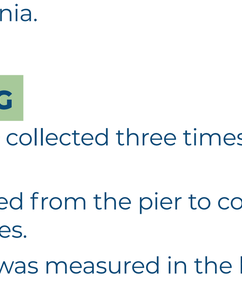


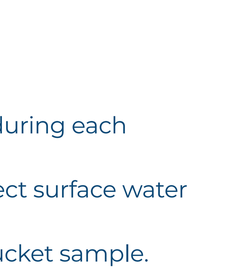




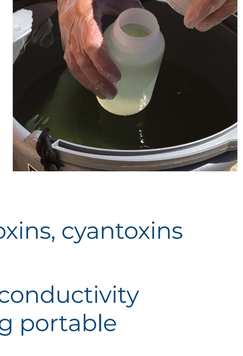
- Duplicate samples were collected for endotoxins, cyantoxins and algal identification.
- Samples collected for dissolved oxygen, pH, conductivity and turbidity were analyzed in the field using portable field equipment.
- Samples collected for phycocyanin and chlorophyll-a analysis were filtered after collection.







- Samples were refrigerated or frozen after collection and preservation per the protocol.



- Water and air samples were shipped overnight on ice packs to laboratories for analysis of endotoxins and cyanotoxins. Water filters were submitted for analysis of phycocyanin and chlorophyll-a.

STUDY LOCATION

Clear Lake is a natural freshwater lake approximately 19 miles long and 8 miles wide with an average depth of 27 feet. It is used for recreation and for drinking water for the surrounding communities of Clearlake, Lakeport, Upper Lake, Nice, Lucerne, and Lower Lake, CA. Clear Lake experiences chronic cyanobacteria blooms throughout the spring through fall most years. Blooms vary spatially and temporally. Due to the regular occurence of blooms, a local cyanotoxin monitoring program is conducted by community members.

Air and water samples were collected at a pier adjacent to the shore at Austen Beach, a public beach on the southern end of Clear Lake, on five consecutive weekends during September-October, 2017. Human activity patterns were recorded along the entire public area shoreline, which included a northern tree-lined shore area and a southern open gravel beach area.

Aerial View of Austen Beach

X air and water sample location,

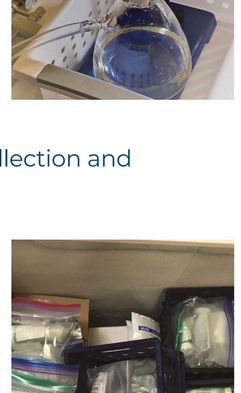
O boundaries of human activity recorded.

AIR SAMPLING

- Air samples were collected for eight hours at 4-5 liters per minute (LPM).
- Pumps were pre- and post-calibrated.
- Pumps were placed in a cooler for ease of placement, security, and protection from the elements. Samplers extended out of the cooler over the edge of the pier.

The following samples were collected on each day:

- **Cyanotoxins**
  Three or four closed-face, 25-mm MCE filters.
- **Endotoxins**
  Two side-by-side Button samplers with precleaned fiberglass filters.



- **Field blanks**
  One field blank was collected each weekend for each analysis.

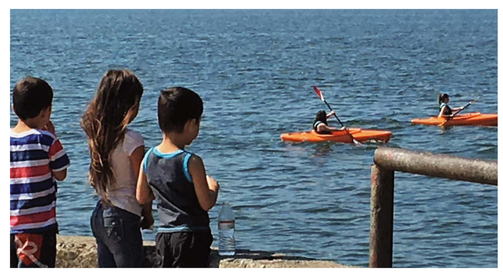
WEATHER CHARACTERISTICS

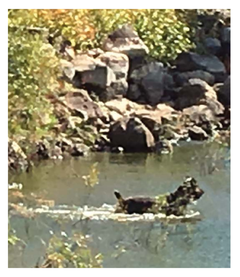
Weather conditions were measured and recorded immediately following each water sample collection period.

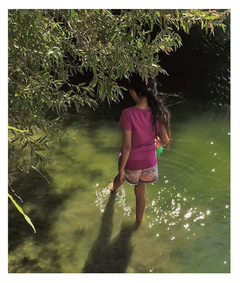
- Air temperature
- Humidity
- Wind direction
- Wind velocity
- Rainfall

HUMAN ACTIVITY MONITORING

Observations of human activities were made every hour throughout the sampling period, characterized by type of contact with water (no contact, hands/feet in water, partial submersion, full submersion, in boat, or on watercraft. The number of people engaging in each activity were counted by age group category (infants, toddlers, pre-adolescents, adolescents, adults). Dogs were counted due to recent reports of respiratory illness and death among dogs swimming in a CHAB.







CLEAR LAKE ANCILLARY DATA COLLECTION FORM - EXPOSURE INFORMATION

Beach Name	Austin Beach, Clear Lake, CA											
Date of Sampling	____/____/ 2017						Collector's Name					
Collection Time (military time)	_____ AM PM						Photographs (circle one)	YES NO	Description			
Beach section	Pier area (North end - shrubs, rocks, picnic area)						Beach area (South end - beach, playground, picnic area)					
Location, Activity/ Attribute	Infants (can't walk)	Toddlers (unsteady walkers)	Pre-adolescents (no obvious puberty anatomy)	Adolescents/ teens	Adults	Dogs	Infants (can't walk)	Toddlers (unsteady walkers)	Pre-adolescents (no obvious puberty anatomy)	Adolescents/ teens	Adults	Dogs
On beach, no water contact	M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:		M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:	
Edge of water, hands/feet in water	M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:		M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:	
In water, partial submersion	M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:		M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:	
In water, submersion/ swimming	M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:		M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:	
In boat (motor boat, canoe)	M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:		M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:	
On watercraft (kayak, jet-ski, paddleboard)	M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:		M: F: U:	M: F: U:	M: F: U:	M: F: U:	M: F: U:	
Comments (notes on people, activities)	F=female, M=male, U=unknown											

CONCLUSIONS

Initial laboratory results of air and water samples indicate:

- All samples had detectable levels of the analytes of interest.
- Sampling protocols allow for quantitation of cyanotoxins and endotoxins in water. Analysis of air samples is being evaluated.
- Variability in replicate samples reflect real world variability and should be considered in future sampling of these toxins in the environment.

Observation data

- The observation form was simple to use.
- Data allows for quantitation of human activity by age, gender, and type of contact with water.
- Humans were using the water in multiple ways despite warning signs placed around the area.

ACKNOWLEDGEMENTS

The authors wish to thank the County of Lakeport, City of Clear Lake, Elem Indian Colony and Big Valley Band of Pomo Indians for their support of this field study.

This work was funded under contract EP-D-12-050 with the US Environmental Protection Agency. The content of this poster does not necessarily reflect EPA policy.