# Harmful Cyanobacteria and Algae Blooms: Human Dimensions

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**Centers for Disease Control and Prevention**

***Disclaimer***

*The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention/the Agency for Toxic Substances and Disease Registry.*

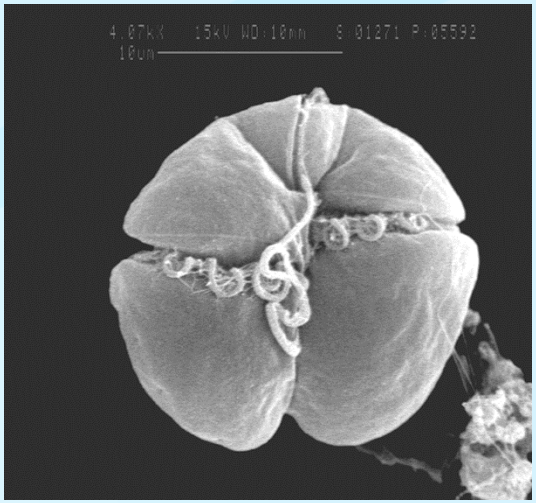
# Overview

- Harmful cyanobacteria and algae blooms (harmful blooms)
- Recent events
- Human dimensions of HABs:  Challenges and opportunities

Caloosahatchee River, at Olga, FL 10-05 Richard Solveson

# Harmful blooms:  What are they?

- Organisms
  - Macro algae
  - Microscopic phytoplankton
- Harms
  - Production of toxins & other chemicals
  - High biomass
  - Oxygen deprivation
  - Light deprivation



*Karenia brevis*, courtesy of Karen Steinberger

# Harmful blooms:  Where do they occur?

- Global distribution
- All aquatic environments

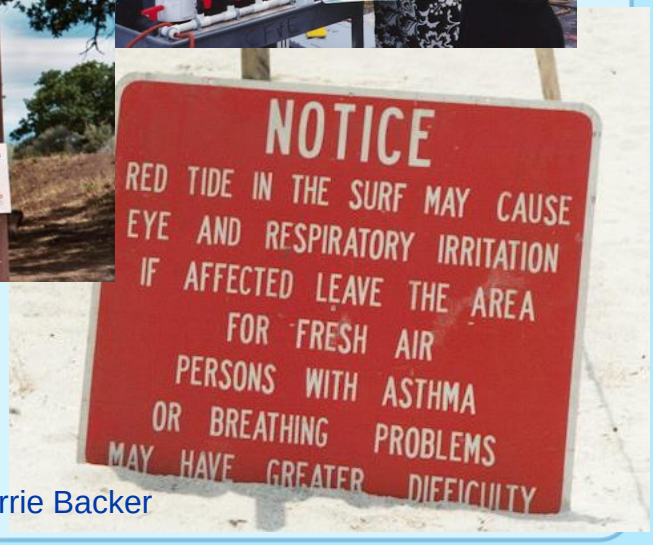
Florida red tide. Photo by Lorrie Backer

http://www.ozcoasts.gov.au/indicators/images/swan_bloom.jpg

# Harmful blooms:  What can they do?

- Damage ecology
- Limit access to recreation, seafood, drinking water
- Cause illness in animals and people

Photo courtesy of Allan Wilson




Photos by Lorrie Backer

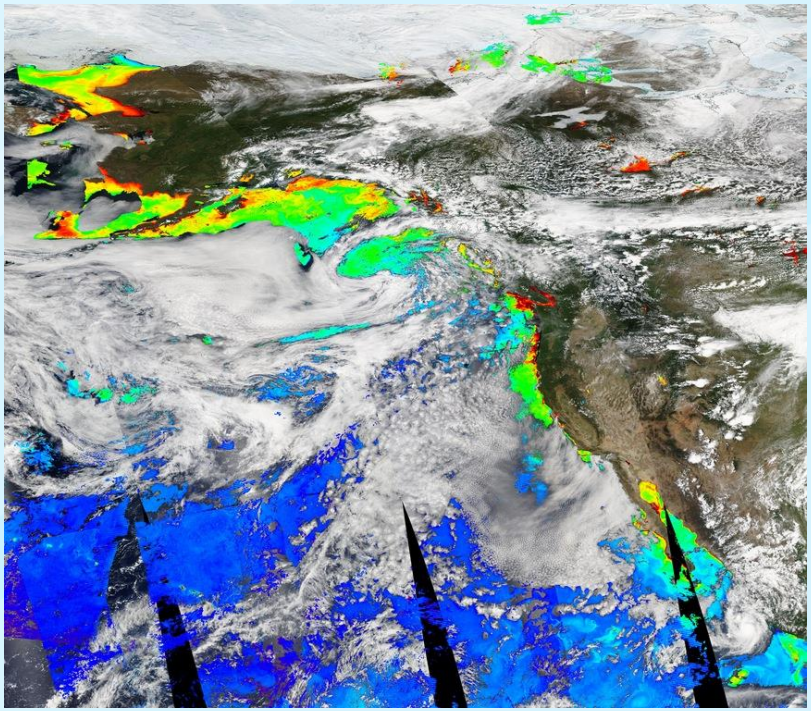
# Recent events: Ohio

- August 2014 *Microcystis* bloom in Lake Erie
  - Near Toledo's water supply intake
  - Do Not Drink & Do Not Boil advisories for about 2 days
  - Increase in visits to emergency rooms for GI distress

*Satellite photo: MODIS 8-13-14*

# Recent events: Pacific Northwest *Pseudo-nitzchia* bloom producing domoic acid

- Unprecedented extent
- California: advisories for recreational fishing and shellfish harvest
- Oregon: closed razor clam harvest
- Washington: closed Dungeness crab fishery
- Vancouver: closed fishery
- Aleutian chain: animal die-offs



Eastern Pacific Chlorophyll-A concentrations as measured by NASA's Terra and Aqua (MODIS) on June 15, 2015. Note: Chlorophyll-A does not necessarily mean HAB, it can indicate both HAB and Non-HAB. Image credit: NASA Aqua&Terra/MODIS. Acquired: June 15, 2015.

# Human dimensions of harmful blooms

- What aspects of society can harmful blooms affect?
  - Socioeconomics
  - Public health
  - Recreational opportunities
  - Drinking water supplies
- How do we address these pressures?
  - Research
  - Risk communication
  - Education and outreach

**Study: Blue-green algae a growing threat to drinking water supply**

The lack of regulations or monitoring poses a risk to the health of animals and humans, researchers said. (Oregon)
By Stephen Feller | Aug. 13, 2015 at 11:37 AM

Bauer, M (ed). 2006. Harmful algal research and response: a human dimensions strategy.

# Addressing the Human dimensions of blooms: what's needed?

- Effective risk communication strategies
- Assessment of community vulnerability
- Identification of susceptible populations
- Comprehensive assessment of environmental, sociocultural, and economic effects
- Development of effective decision-support tools
- Improved coordination among agencies and stakeholders
- One Health approach

Bauer, M (ed). 2006. Harmful algal research and response: a human dimensions strategy.

# Challenge:
# We need accurate, clear risk communication

- Available harmful bloom information is not always accurate or up-to-date
- Uncertainty
  - There is much we don’t know about why the organisms produce the toxins, when the toxins are produced, etc.
- Many gaps in understanding health outcomes

# Opportunity:
# Develop communications tool kit

- Fact sheets
- FAQs
- Characteristics
  - Consistent messages across entities
  - Address needs of specific audiences

# Physician Reference

## Blue-green Algae Blooms

When in doubt, it's best to stay out!

Grand Lake Saint Mary's , Summer 2010

**What are blue-green algae?**
Cyanobacteria, sometimes called blue-green algae, are microscopic organisms that live in all types of water.

**What is a blue-green algae bloom?**
•Blue-green algae grow quickly, or bloom, when the water is warm, slow-moving, and full of nutrients.

**What are some characteristics of blue-green algae blooms?**
•Algae usually bloom during the summer and fall. However, they can bloom anytime during the year.
•When a bloom occurs, scum might form on the water's surface.
•Blooms can be many different colors, from green or blue to red or brown.
•As the bloom dies off, you might smell an odor that is similar to rotting plants.

**What is a toxic bloom?**
Sometimes, blue-green algae produce toxins.
•The toxins can be present in the algae or in the water.

**Other important things to know:**
•Swallowing water that has algae or algal toxins in it can cause serious illness.
•Dogs might have more severe symptoms than persons, including collapse and sudden death after swallowing the contaminated water while swimming or after licking algae from their fur.
•There are no known antidotes to these toxins. Medical care is supportive.

**You cannot tell if a bloom is toxic by looking at it.**

## To report a blue-green algae bloom or related health event:

Call your local or state health department

For more information:
http//www.cdc.gov/hab/links.htm
or
Call the National Center for Environmental Health Harmful Algal Blooms Program (HABISS) Centers for Disease Control and Prevention: 866-556-0544

# What we know about exposure to blue-green algae and cyanotoxins and possible health effects

Information about human health effects from exposure to blue-green algae and toxins is primarily derived from a few epidemiology studies of recreational exposures; studies with laboratory animals; reports of extreme human exposure events, such as the use of toxin-contaminated dialysis water; and from animal (e.g., cattle and pet dog) exposures. References are available at: http//www.cdc.gov/hab/links.htm

| Potential exposure route | Information source for possible symptoms and signs | Possible symptoms and signs |
|---|---|---|
| Swallowing water contaminated with blue-green algae (cyanobacteria) or toxins | Data from laboratory animal studies, extreme human exposure events, and animal exposures | **Hepatotoxins and nephrotoxins**<br>Nausea, vomiting, diarrhea<br>Bad taste in mouth<br>Acute hepatitis, jaundice<br>Blood in urine or dark urine<br>Malaise, lethargic<br>Headache, fever<br>Loss of appetite<br><br>**Neurotoxins**<br>Progression of muscle twitches<br>For saxitoxin: high doses may lead to progressive muscle paralysis |
| Skin contact with water that is contaminated with blue-green algae or toxins | Data from human studies | Allergic dermatitis (including rash, itching and blisters)<br>Conjunctivitis |
| Inhaling aerosols contaminated with blue-green algae or toxins | Anecdotal evidence from human exposures and data from human studies | Upper respiratory irritation (wheezing, coughing, chest tightness, shortness of breath) |

Physician Reference card (back)

# Veterinarian Reference

## Blue-green Algae Blooms

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•As the bloom dies off, you might smell an odor that is similar to rotting plants.

**What is a toxic bloom?**
Sometimes, blue-green algae produce toxins, such as microcystins.
•The toxins can be present in the algae or in the water.

**Other important things to know:**
•Swallowing water that has algae or algal toxins in it can cause serious illness.
•Dogs might have more severe symptoms than persons, including collapse and sudden death after swallowing the contaminated water while swimming or after licking algae from their fur.
•There are no known antidotes to these toxins. Medical care is supportive.

**You cannot tell if a bloom is toxic by looking at it.**

## To report a blue-green algae bloom or related health event:

Call your local or state health department

**For More Information:**
Call the National Center for Environmental Health Harmful Algal Blooms Program (HABISS), Centers for Disease Control and Prevention: 866-556-0544

# Exposure and Clinical Information

Information about the health effects from exposure to blue-green algae and toxins is derived from reports of animal poisonings.

| Potential exposure route | Likely Symptoms and signs | Time to symptom onset** | Differential diagnosis includes the following | Possible laboratory or other findings |
|---|---|---|---|---|
| Swallowing water that is contaminated with blue-green algae (cyanobacteria) or toxins or licking it off fur or hair | **Hepatotoxins and nephrotoxins**<br>Excess drooling, vomiting, diarrhea, foaming at mouth<br>Jaundice, hepatomegaly<br>Blood in urine or dark urine<br>Malaise<br>Stumbling<br>Loss of appetite<br>Photosensitization in recovering animals<br>Abdominal tenderness | Minutes to hours | Acetaminophen or NSAID overdose, rodenticide ingestion, aflatoxicosis and other hepatotoxin poisonings | •Elevated bile acids, ALP, AST, GGT<br>•Hyperkalemia<br>•Hypoglycemia<br>•Prolonged clotting tine<br>•proteinuria<br>•Presence of toxin in clinical specimens from stomach contents taken from animals that became ill |
| | **Neurotoxins**<br>Progression of muscle twitches<br>For saxitoxin, high doses may lead to respiratory paralysis and death if artificial ventilation is not provided. | Minutes to hours | Pesticide poisoning, myasthenia gravis, other toxin poisoning | Presence of toxin in clinical specimens from stomach contents taken from animals that became ill |
| Skin contact with water contaminated with blue-green algae or toxin(s) | **Dermal toxins**<br>Rash, hives, allergic dermatitis | Minutes to hours | Other dermal allergens | Blue-green staining of fur or hair |

Veterinarian Reference card (back)

Veterinarian Reference card (back)

Challenge:
There is no comprehensive assessment of environmental, sociocultural, and economic effects from harmful blooms.

# Opportunity:
# Assess community needs during a harmful bloom event using CASPER (Community Assessment for Public Health Emergency Response)

- Enables public health practitioners and emergency management officials to rapidly describe the health status and basic needs of the affected community.
- Uses valid statistical methods to gather information about health and basic needs
- Allows public health and emergency managers to prioritize their response and distribution of resources accurately.
- Can be used to assess preparedness and recovery

Opportunities to contribute real-time environmental data and to create a historical data base.

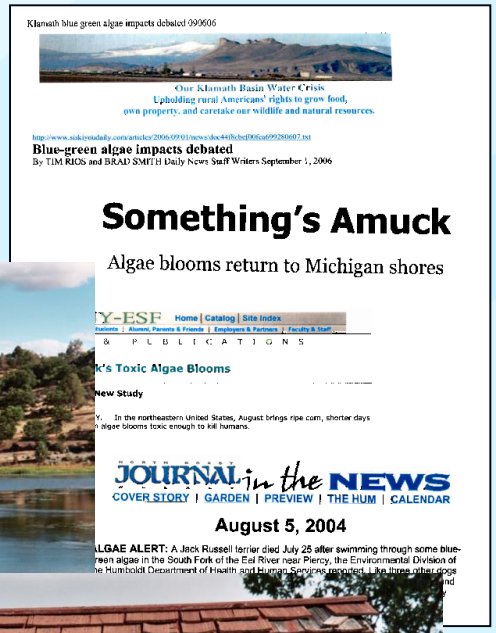
Centers for Disease Control and Prevention (CDC). Community Assessment for Public Health Emergency Response (CASPER) Toolkit: Second edition. Atlanta (GA): CDC; 2012.

Challenge:
Lack of comprehensive assessment of health effects

Opportunity:
Collect new data using epidemiology studies

# Human exposures to cyanobacteria blooms during recreational activities

- Study locations
  - Michigan—Bear Lake
  - California—Klamath River reservoirs
- Exposure
  - Microcystins in blood samples and nasal swabs
  - Microcystins in air and water
- Health effects
  - Self-reported symptoms



Klamath blue green algae impacts debated 090606

Our Klamath Basin Water Crisis
Upholding rural Americans' rights to grow food, own property, and caretake our wildlife and natural resources.

**Blue-green algae impacts debated**
By TIM RIGS and BRAD SMITH Daily News Staff Writers September 1, 2006

**Something's Amuck**

Algae blooms return to Michigan shores

Home | Catalog | Site Index

New Study

JOURNAL in the NEWS
COVER STORY | GARDEN | PREVIEW | THE HUM | CALENDAR

August 5, 2004

Photos by Lorrie Backer

# Collaborators

- National Center for Environmental Health, CDC
- National Center for Emerging Zoonotic and Infectious Diseases, CDC
- Mote Marine Laboratory
- Greenwater Laboratory
- Lovelace Respiratory Research Institute
- Wright State University
- Other Federal Agencies (NOAA)
- State and local public health agencies
- Officials or others at study site
- California Department of Health
- Siskiyou County
- Karuk Tribe
- Pacific Corporation

Photo by Lorrie Backer

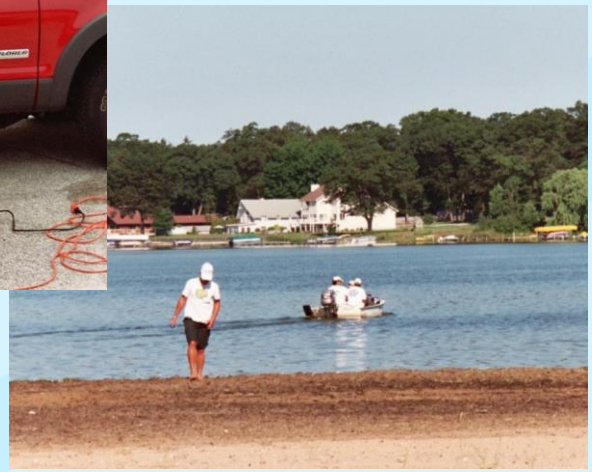
# Epidemiology Study Design

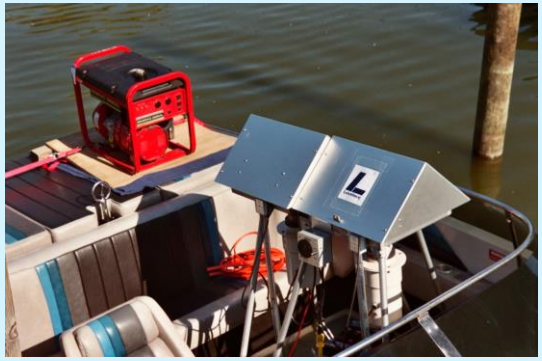
- Study population
  - Planning recreational activities in lake with a cyanobacteria bloom (exposed)
  - Planning recreational activities in lake with no cyanobacteria bloom (control)
- Compared data collected for exposed and control groups

Photos by Lorrie Backer

# Environmental Data Collection

- Water samples
  - Viruses
  - Water quality
  - Algal taxonomy
  - Microcystins
- Ambient air samples
  - High-volume
    - Particle size
    - Mircocystins
- Personal air samples
  - Microcystins





Photos by Lorrie Backer

# Health Data Collection

- Questionnaires
  - Pre-exposure
  - Post-exposure
  - Follow-up (7-10 days later)
- Post exposure plasma samples
  - Microcystins
- Nasal swabs
  - Microcystins

Photos by Lorrie Backer

# Results

- Microcystins detected in lake water and air in both blooming lakes
- Microcystins not detected in blood samples
- No change in symptom reporting
- *Microcystins detected on nasal swabs*

Opportunities to:

- Enhance clinical knowledge
- Improve analytic methods
- Create new techniques
- Sustain collaborations

Backer et al., Harmful Algae, 2003;41:1-10
Backer et al., Marine Drugs, 2008; 6 ISSN 1660-3397

Photos by Lorrie Backer

# Opportunity:
# Public health surveillance

What is public health surveillance?

*The ongoing, systematic collection, analysis, and interpretation of outcome-specific data for use in the planning, implementation, and evaluation of public health practice.*

*….more later*

*Teutsch and Churchill , Principles and Practice of Public Health Surveillance. 2000. Oxford University Press*

# Challenge:
# Incomplete clinical understanding of HAB-related diseases

- Clinical diagnostic tests for algal toxin exposures
- Rapid and affordable water sampling tests for HABs and toxins
- Refined case definitions
- Increased awareness of HAB-related illnesses in the medical community
- Reporting tools to facilitate data collection and analysis

# Opportunity:
# Animal sentinels

- Sea lions exposed to microcystins in Monterey Bay
- Birds exposed to surfactants in the Pacific Northwest
- Cattle deaths in Georgia from drinking water contaminated with microcystins
- …and our pets…

Photo by Lorrie Backer

# Review of canine cyanotoxin poisonings in the US: 1920s to 2012 from three data sources

- Harmful Algal Bloom-related Illness Surveillance System
- Veterinary Medical Teaching Hospital (VMTH) necropsy and biopsy case records, University of California, Davis
- Historical records from scientific publications, media, other electronically-available resources

# Suspected or confirmed cases of canine cyanobacteria bloom-associated poisonings in the US

| Number reported | HABISS 2007-2011 | Media Search Late 1920s to 2012 | VMTH 1984-2011 |
|---|---|---|---|
| Number of events | 55 | 115 | 44 |
| Reported number of sick or dead dogs | 63 | 260 | 45 |
| Number (%) of cases where exposure biochemically confirmed | 8 (13%) | 20 (8%) | 2 (4%) |
| Number (%) of cases published in the peer-reviewed literature | 63 (100%) | 62 (25%) | 1 (2%) |

*Backer et al. Toxins 2013(5):1597-1628*

# Suspected or confirmed cases of canine cyanobacteria bloom-associated poisonings in the US

| Number reported |
| --- |
| Number of events |
| Reported number of sick or dead dogs |
| Number (%) of cases where exposure biochemically confirmed |
| Number (%) of cases published in the peer-reviewed literature |

Opportunities to:

- Enhance disease surveillance if veterinarians report to a public health system
- Use monitoring data for exposure assessment
- Expand experimental analytic methods to clinical testing
- Share data for diagnosis, treatment
- Provide feedback for ecologic research and monitoring

*Backer et al. Toxins 2013(5):1597-1628*

# Challenge:
# Defining the total costs of harmful blooms

- Societal costs
  - Loss of livelihood
  - Recreation
  - Medical
- Other economic costs
  - Routine monitoring
  - Preparedness
  - Response (increased monitoring, disposal)
  - Recovery

# Opportunity:
# Conduct economic assessments
# Annual costs for cyanobacteria blooms in Australia

- Monitoring and testing
  - $8.7 million
- Treatment
  - $20,000 to $50,000 for algicides
  - $1 million to dispose of copper-contaminated water treatment sludge
- Prevention
  - Covering reservoirs
    - South Australia (3 storages): $7.1 million
  - Environmental improvement
    - Urban sewage control: $121 million
    - Waste water control: $33 million
    - Rehabilitation of land and water: $45 million

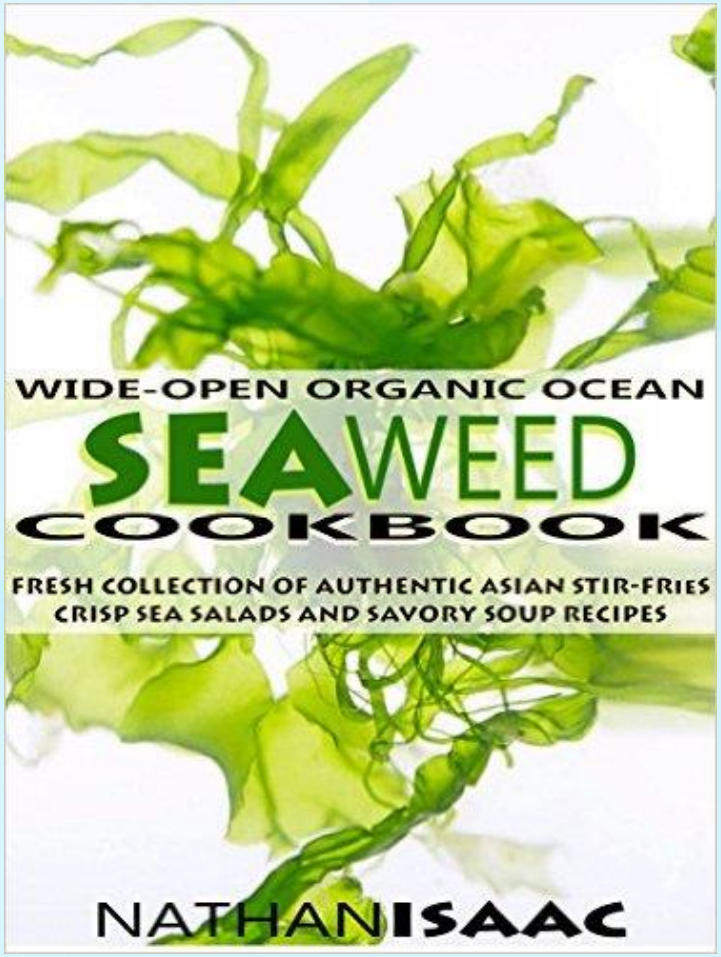
→ $180 to $240 million

Sfeffensen D.A. 2008, Economic costs of cyanobacteria blooms. In: Hudnell, H.K. Cyanobacterial harmful algal blooms: State of the Science and Research Needs. Springer, NY. pp. 855-866.

# Opportunity:
# When prevention fails--New technologies and applications for algae

Utilize algal mass

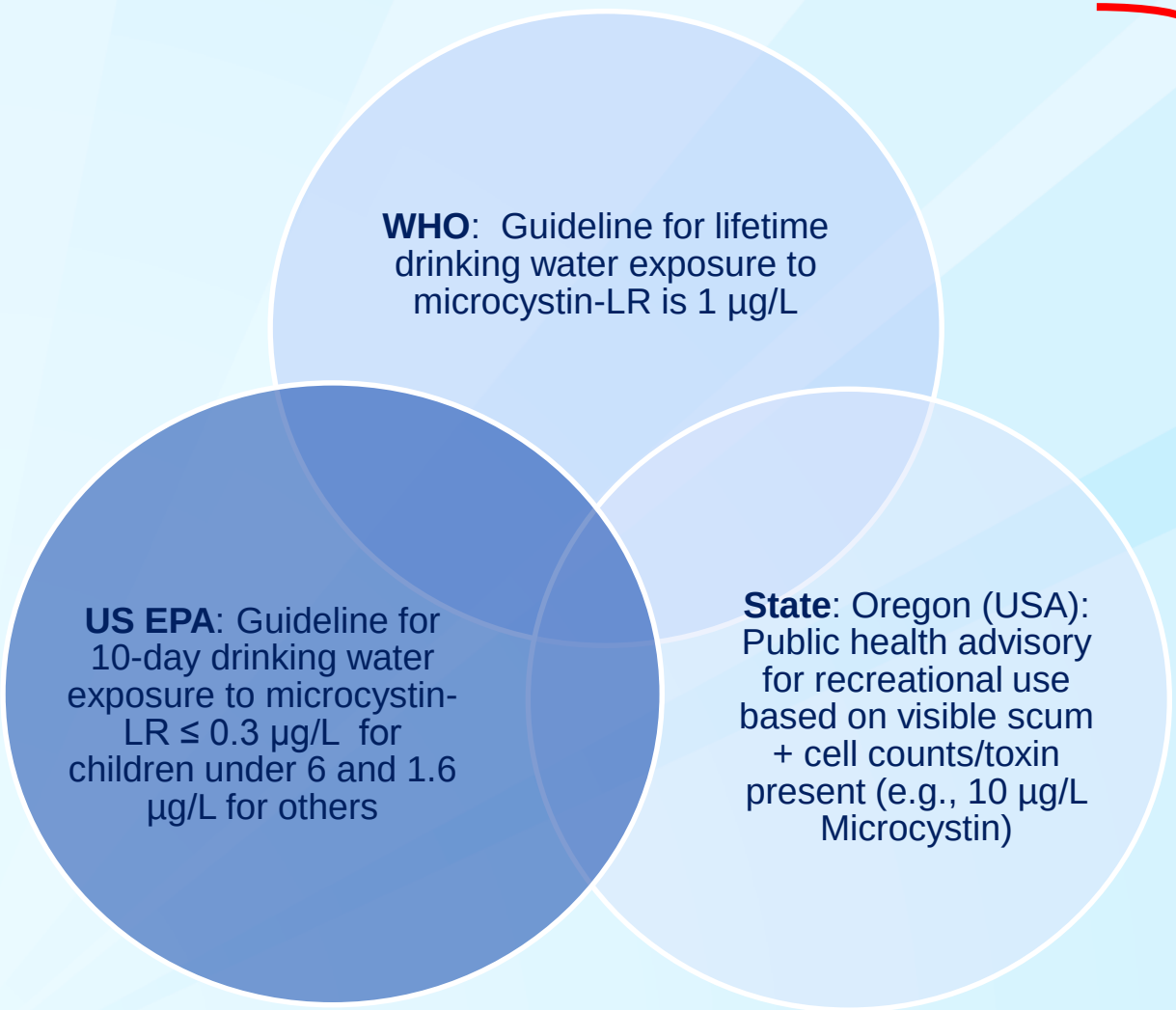
- Biofuels
- Fertilizer
- Food
- Chemicals (cellulose, lipids, agar)




Source ://www.amazon.com/s/ref=nb_sb_noss?url=search-alias%3Dstripbooks&field-keywords=wide+open+oganic+ocean+seaweed+cookbookhttp

Challenge:
Need guidance for public health protection

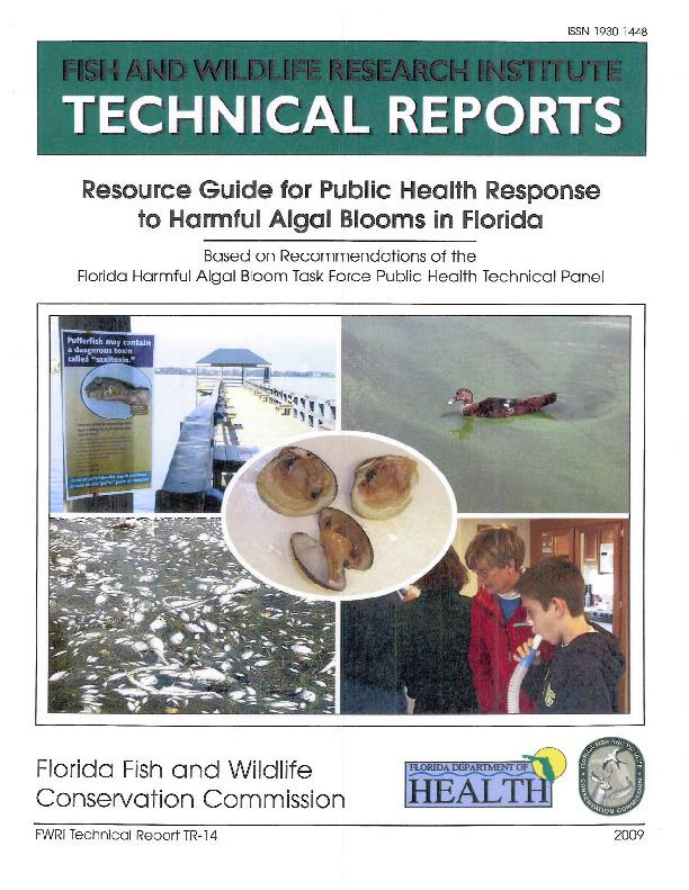
# Opportunity:
# Water exposure guidance




Opportunities to create consistent guidance for drinking water and recreational waters.

# Opportunity: Guidelines for response

- Create response plans
  - Resource Guide for Public Health Response to Algal Blooms in Florida
    - http://myfwc.com/research/redtide/research/scientific-products/resource-guide/
- Create best practices for data collection
  - SWAMP (Surface Water Ambient Monitoring Program) in CA
    - Quality Control and Sample Handling Guidelines
    - http://www.waterboards.ca.gov/water_issues/programs/swamp/mqo.shtml


ISSN 1930-1448

FISH AND WILDLIFE RESEARCH INSTITUTE
TECHNICAL REPORTS

Resource Guide for Public Health Response to Harmful Algal Blooms in Florida

Based on Recommendations of the Florida Harmful Algal Bloom Task Force Public Health Technical Panel

Florida Fish and Wildlife Conservation Commission

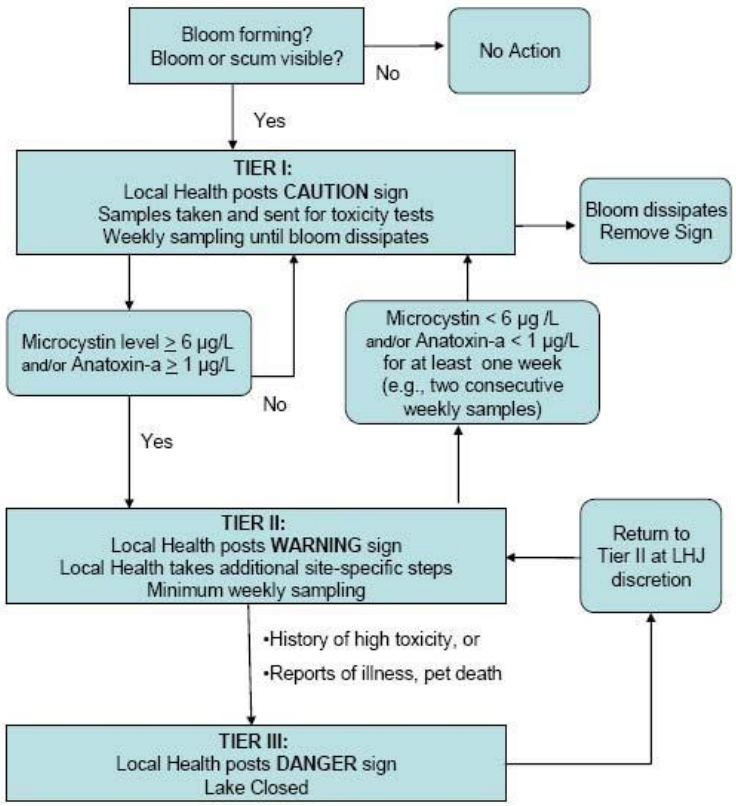
FLORIDA DEPARTMENT OF HEALTH

FWRI Technical Report TR-14 2009

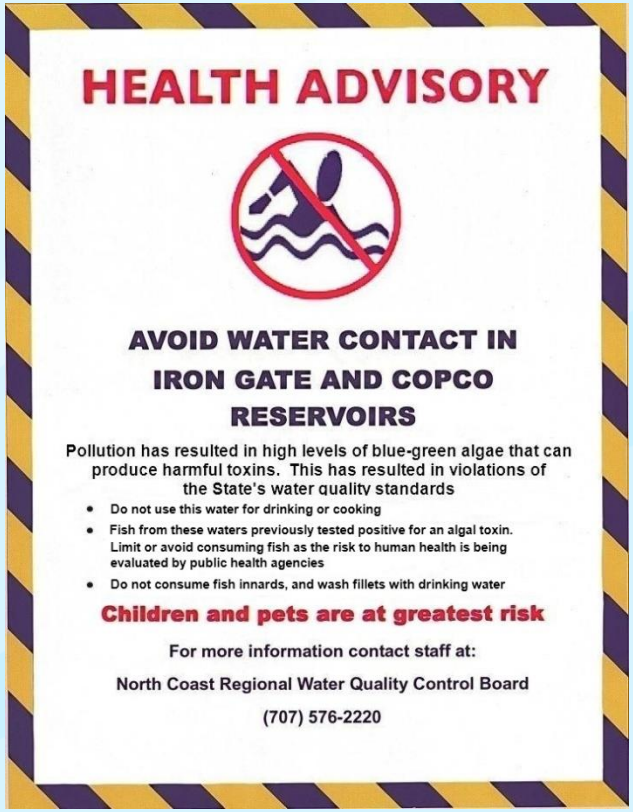
# Opportunity: Guidelines for response

## Washington State

**Figure 1.** Three-tiered approach to managing Washington water bodies with cyanobacterial blooms.




## California




Opportunities for:

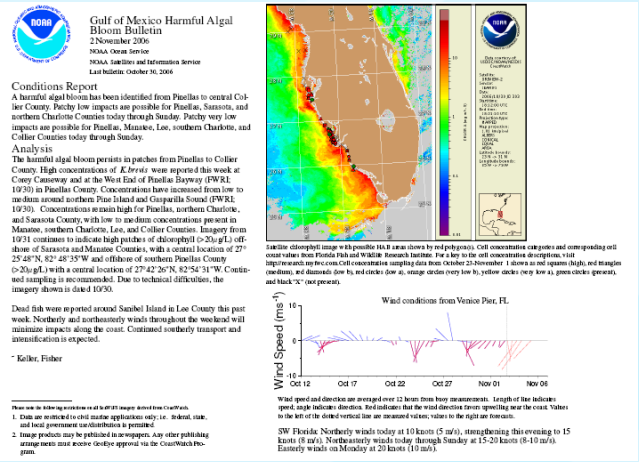
- Information sharing
- Consensus on guidance

# Opportunity: HAB Forecast

- Data
- Analysis
- Forecast

Opportunities to integrate data on environment, health

## NOAA GOM HAB Bulletin



Gulf of Mexico Harmful Algal Bloom Bulletin
2 November 2006
NOAA Ocean Service
NOAA Satellites and Information Service
Last bulletin: October 30, 2006

Conditions Report
A harmful algal bloom has been identified from Pinellas to central Collier County. Patchy low impacts are possible for Pinellas, Sarasota, and northern Charlotte Counties today through Sunday. Patchy very low impacts are possible for Pinellas, Manatee, Lee, southern Charlotte, and Collier Counties today through Sunday.

Analysis
The harmful algal bloom persists in patches from Pinellas to Collier County. High concentrations of *K.brevis* were reported this week at Coney Causeway and at the West End of Pinellas Bayway (FWRI; 10/30) in Pinellas County. Concentrations have increased from low to medium around northern Pine Island and Gasparilla Sound (FWRI; 10/30). Concentrations remain high for Pinellas, northern Charlotte, and Sarasota County, with low to medium concentrations present in Manatee, southern Charlotte, Lee, and Collier Counties. Imagery from 10/31 continues to indicate high patches of chlorophyll (>20µ/gL) offshore of Sarasota and Manatee Counties, with a central location of 27° 25'48"N, 82° 48'35"W and offshore of southern Pinellas County (>20µ/gL) with a central location of 27°42'26"N, 82°54'31"W. Continued sampling is recommended. Due to technical difficulties, the imagery shown is dated 10/30.

Dead fish were reported around Sanibel Island in Lee County this past week. Northerly and northeasterly winds throughout the weekend will minimize impacts along the coast. Continued southerly transport and intensification is expected.

- Keller, Fisher

Please note the following restrictions on all SeaWiFS imagery derived from CoastWatch.
1. Data are restricted to civil marine applications only; i.e. federal, state, and local government use/distribution is permitted.
2. Image products may be published in newspapers. Any other publishing arrangements must receive dedipe approval via the CoastWatch Program.

Satellite chlorophyll image with possible HAB areas shown by red polygon(s). Cell concentration categories and corresponding cell count values from Florida Fish and Wildlife Research Institute. For a key to the cell concentration descriptions, visit http://research.myfwc.com. Cell concentration sampling data from October 23-November 1 shown as red squares (high), red triangles (medium), red diamonds (low b), red circles (low a), orange circles (very low b), yellow circles (very low a), green circles (present), and black "X" (not present).

Wind conditions from Venice Pier, FL

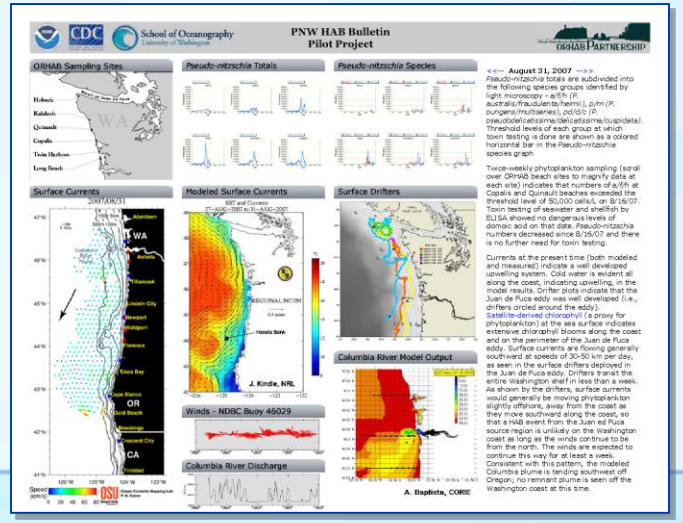
Wind Speed (ms$^{-1}$)

Oct 12 Oct 17 Oct 22 Oct 27 Nov 01 Nov 06

Wind speed and direction are averaged over 12 hours from buoy measurements. Length of line indicates speed; angle indicates direction. Red indicates that the wind direction favors upwelling near the coast. Values to the left of the dotted vertical line are measured values; values to the right are forecasts.

SW Florida: Northerly winds today at 10 knots (5 m/s), strengthening this evening to 15 knots (8 m/s). Northeasterly winds today through Sunday at 15-20 knots (8-10 m/s). Easterly winds on Monday at 20 knots (10 m/s).

## Pacific Northwest HAB bulletin



PNW HAB Bulletin
Pilot Project

ORHAB Sampling Sites
Pseudo-nitzschia Totals
Pseudo-nitzschia Species
Surface Currents
Modeled Surface Currents
Surface Drifters
Columbia River Model Output
Winds - NDBC Buoy 46029
Columbia River Discharge

<<< August 31, 2007 >>>

Pseudo-nitzschia totals are subdivided into the following species groups identified by light microscopy - a/f/h (P. australis/fraudulenta/hemii), p/m (P. pungens/multiseries), pd/d/c (P. pseudodelicatissima/delicatissima/cuspidata). Threshold levels of each group at which toxin testing is done are shown as a colored horizontal bar in the Pseudo-nitzschia species graph.

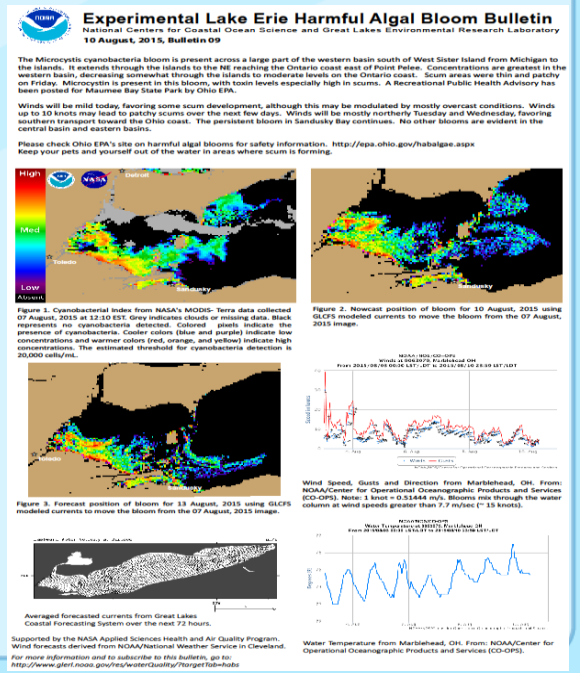
Twice-weekly phytoplankton sampling (scroll over ORHAB beach sites to magnify data at each site) indicates that numbers of a/f/h at Copalis and Quinault beaches exceeded the threshold level of 50,000 cells/L on 8/16/07. Toxin testing of seawater and shellfish by ELISA showed no dangerous levels of domoic acid on that date. Pseudo-nitzschia numbers decreased since 8/26/07 and there is no further need for toxin testing.

Currents at the present time (both modeled and measured) indicate a well developed upwelling system. Cold water is evident all along the coast, indicating upwelling, in the model results. Drifter plots indicate that the Juan de Fuca eddy was well developed (i.e., drifters circled around the eddy).
Satellite-derived chlorophyll (a proxy for phytoplankton) at the sea surface indicates extensive chlorophyll blooms along the coast and on the perimeter of the Juan de Fuca eddy. Surface currents are flowing generally southward at speeds of 30-50 km per day, as seen in the surface drifters deployed in the Juan de Fuca eddy. Drifters transit the entire Washington shelf in less than a week. As shown by the drifters, surface currents would generally be moving phytoplankton slightly offshore, away from the coast as they move southward along the coast, so that a HAB event from the Juan de Fuca source region is unlikely on the Washington coast as long as the winds continue to be from the north. The winds are expected to continue this way for at least a week. Consistent with this pattern, the modeled Columbia plume is tending southwest off Oregon; no remnant plume is seen off the Washington coast at this time.

J. Kindle, NRL
A. Baptista, CORIE

## *Microcystis* Demonstration: Lake Erie summer 2015

**(National Centers for Coastal Ocean Science and Great Lakes Environmental Research Laboratory)**



Experimental Lake Erie Harmful Algal Bloom Bulletin
National Centers for Coastal Ocean Science and Great Lakes Environmental Research Laboratory
10 August, 2015, Bulletin 09

The Microcystis cyanobacteria bloom is present across a large part of the western basin south of West Sister Island from Michigan to the Islands. It extends through the Islands to the NE reaching the Ontario coast east of Point Pelee. Concentrations are greatest in the western basin, decreasing somewhat through the Islands to moderate levels on the Ontario coast. Scum areas were thin and patchy on Friday. Microcystin is present in this bloom, with toxin levels especially high in scums. A Recreational Public Health Advisory has been posted for Maumee Bay State Park by Ohio EPA.

Winds will be mild today, favoring some scum development, although this may be modulated by mostly overcast conditions. Winds up to 10 knots may lead to patchy scums over the next few days. Winds will be mostly northerly Tuesday and Wednesday, favoring southern transport toward the Ohio coast. The persistent bloom in Sandusky Bay continues. No other blooms are evident in the central basin and eastern basins.

Please check Ohio EPA's site on harmful algal blooms for safety information. http://epa.ohio.gov/habalgae.aspx
Keep your pets and yourself out of the water in areas where scum is forming.

High
Med
Low
Absent
Detroit
Toledo
Sandusky

Figure 1. Cyanobacterial index from NASA's MODIS- Terra data collected 07 August, 2015 at 12:10 EST. Grey indicates clouds or missing data. Black represents no cyanobacteria detected. Colored pixels indicate the presence of cyanobacteria. Cooler colors (blue and purple) indicate low concentrations and warmer colors (red, orange, and yellow) indicate high concentrations. The estimated threshold for cyanobacteria detection is 20,000 cells/mL.

Figure 2. Nowcast position of bloom for 10 August, 2015 using GLCFS modeled currents to move the bloom from the 07 August, 2015 image.

Figure 3. Forecast position of bloom for 13 August, 2015 using GLCFS modeled currents to move the bloom from the 07 August, 2015 image.

Wind Speed, Gusts and Direction from Marblehead, OH. From: NOAA/Center for Operational Oceanographic Products and Services (CO-OPS). Note: 1 knot = 0.51444 m/s. Blooms rise through the water column at wind speeds greater than 7.7 m/sec (~ 15 knots).

Averaged forecasted currents from Great Lakes Coastal Forecasting System over the next 72 hours.

Supported by the NASA Applied Sciences Health and Air Quality Program. Wind forecasts derived from NOAA/National Weather Service in Cleveland.

Water Temperature from Marblehead, OH. From: NOAA/Center for Operational Oceanographic Products and Services (CO-OPS).

For more information and to subscribe to this bulletin, go to: http://www.glerl.noaa.gov/res/waterQuality/?target=habs

# Opportunity:
# Expand HAB forecasting

- NCCOS is funding research in support of pilot regional HAB forecasts in the following areas
  - The Gulf of Maine (Alexandrium)
  - The Pacific Northwest (Pseudo-nitzscha) including Puget Sound (Alexandrium)
  - Southern California (Pseudo-nitzschia).

- Data
- Analysis
- Forecast

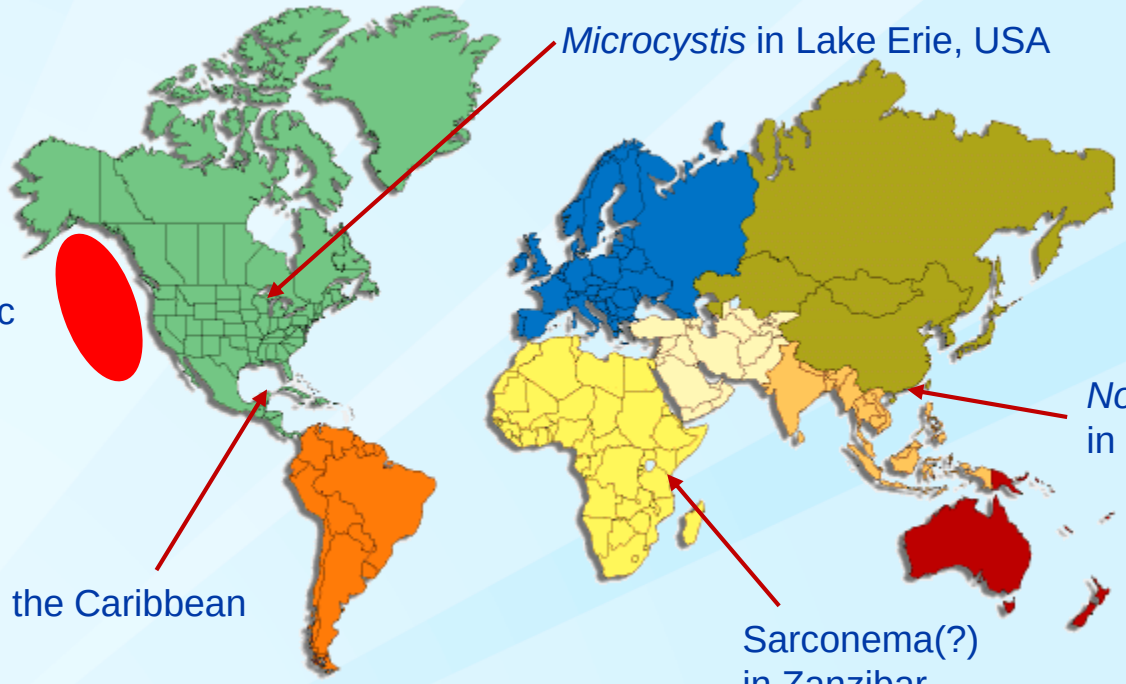
Opportunities to integrate data on environment, health.

- Expand globally?
- Integrate other sources of environmental data (e.g. local coastal sampling—monitoring and response)

Challenge:
Need improved communication and coordination among agencies and stakeholders to develop consistent messaging and response.

# Opportunity:
# Events of summer 2015

## A few examples…



# Opportunity:
# Extensive communication among agencies and stakeholders (Algae-L and others)

Opportunities

- Share knowledge
- Extend communication to coordination
- Build on HARRNESS (Harmful Algal Research & Response National Environmental Science Strategy)
  - Create global monitoring network
  - Create global access to resources for taxonomy, toxin analysis
    - Global Ciguatera Strategy (UNESCO)
  - Demonstrate need for toxin standards

# Opportunity:
# This meeting!

- Important environmental issue with human dimensions components
  - One Health
  - Social well-being
  - Coastal community economies
- Need a multidisciplinary approach to identify, assess, and respond to mitigate “harm”
  - Strengthen existing and build new multidisciplinary partnerships

Current challenges = future opportunities

# Thank you.

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# Results

| Parameter | Bear Lake, Minnesota | | Klamath River, California | |
|---|---|---|---|---|
| | **Unexposed**<br>**N = 7** | **Exposed**<br>**N = 97** | **Unexposed**<br>**N = 7** | **Exposed**<br>**N = 88** |
| **Microcystin in water (µg/L)** | < LOD<br>LOD = 0.15 | 3-5 | < LOD | 23 -357 |
| **Microcystins in air (ng/m$^3$)** | NA | < LOD – 0.14<br>LOD = 0.0037 | NA | 0.2 – 0.4 |
| **Microcystins in blood (µg/L)** | <LOD<br>LOD = 0.147 | < LOD | < LOD | < LOD |
| **Microcystins on nasal swabs (ng)** | NA | NA | NA | <LOD - 1<br>LOD=0.4 |
| **Symptoms** | No change | No change | No change | No change |

# Opportunity
# Create consistent exposure guidelines

- WHO

| Relative probability of acute health effects | Cyanobacteria (cells/mL) | Microcystin-LR (µg/L) | Chlorophyll-a (µg/L) |
|---|---|---|---|
| Low | < 20,000 | < 10 | < 10 |
| Moderate | 20,000 – 100,000 | 10 - 20 | 10 - 50 |
| High | 100,000 – 10,000,000 | 20 – 2,000 | 50 – 5,000 |
| Very high | > 10,000,000 | > 2,000 | > 5,000 |

# Opportunity
# Create consistent exposure guidelines

- Federal (US EPA) Guidelines for microcystins and cylindrospermopsin in drinking water
  - Microcystins (µg/L in drinking water)
    - ≤ 0.3 for children under 6
    - 1.6 for older children and adults
  - Cylindrospermopsin (µg/L in drinking water)
    - 0.7 for children under 6
    - 3.0 for older children and adults
  - Additional suggestion that vulnerable populations follow the guidance for young children

# Opportunity
# Create consistent exposure guidelines

- State (Oregon, USA)
  - Issue public health advisory when one of the following conditions is observed:
    - Visible scum and cell count or toxicity
    - Toxigenic species >100,000 cells/ml
    - Microcystis or Planktothrix > 40,000 cells/mL
    - Toxin Testing Microcystin: 10µg/L Anatoxin-a: 20 µg/L Cylindrospermopsin: 6µg/L Saxitoxin: 100 µg/L