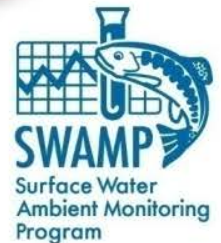


# Harmful Algal Blooms

## North Bay Watershed Association January Meeting



**Naomi Feger**  
**SF Bay RWQCB**  
**January 6, 2017**



# Why are Harmful Algal Blooms (HABs) a Problem in California

- HABs create significant water quality issues
- HABs increasing worldwide, California and Bay Area
  - Increasing water temperatures
  - High nutrient concentrations
  - Drought – less water, low flows



# Freshwater - Cyanobacteria (Blue green algae)

- Most common freshwater HAB in California
- >3 billion years old = very adaptive
- Bacteria that photosynthesize
- Some can produce toxins (skin, liver, nerve)





# Cyanotoxins

**Table 1.** Common genera of planktonic cyanobacteria that contain toxin and taste-and-odor producing strains.

[All data included in this table are based on documented production in laboratory cultures; data based on circumstantial evidence, such as co-occurrence of genera and toxin or taste-and-odor compounds in environmental samples, were not included in this table. LYN, lyngbyatoxin-a; APL, aplysiatoxins; LPS, lipopolysaccharides; CYL, cylindrospermopsins; MC, microcystins; NOD, nodularins; ATX, anatoxins; BMAA,  $\beta$ -N-methylamino-L-alanine; NEO, neosaxitoxins; SAX, saxitoxins; GEOS, geosmin; MIB, 2-methylisoborneol]

Cyanobacterial Genera	Dermatoxins			Hepatotoxins			Neurotoxins				Tastes and odors	
	LYN	APL	LPS	CYL	MC	NOD	ATX	BMAA	NEO	SAX	GEOS	MIB
Colonial/filamentous												
<i>Anabaena</i>			X	X	X		X	X	X	X	X	
<i>Anabaenopsis</i>			X		X							
<i>Aphanizomenon</i>			X	X	X		X	X	X	X	X	
<i>Aphanocapsa</i>			X		X							
<i>Cylindrospermopsis</i>			X	X				X		X		
<i>Microcystis</i>			X		X			X				
<i>Nodularia</i>			X			X		X				
<i>Oscillatoria (Planktothrix)</i>	X	X	X		X		X	X		X	X	X
<i>Pseudanabaena</i>			X		X						X	X
<i>Raphidiopsis</i>			X	X			X					

Source: Graham, Loftin, Meyer, 2008. USGS SIR 2008-5038. <http://pubs.usgs.gov/sir/2008/5038/pdf/SIR2008-5038.pdf>

# Microcystis

- Most common toxic cyanobacteria
- Produces microcystins
- Microcystin human health thresholds
  - OEHHA recreation = 0.8 ug/L
  - USEPA drinking water = 0.3 ug/L
  - *Draft* USEPA recreation = 4.0 ug/L





# Where are they?



Lakes



Wetlands



Rivers and streams



Estuaries



Marine waters



# Beneficial Use Affected Fishing



**Above: Iron Gate Reservoir**



**Right: Pinto Lake**

# Swimming – Contact Recreation





# Non-Contact Recreation



Pinto Lake, Watsonville





# Aquatic Life/Wildlife



**Pinto Lake, Watsonville CA**



# Drinking Water



## Eastern Oaks Arm, Clear Lake

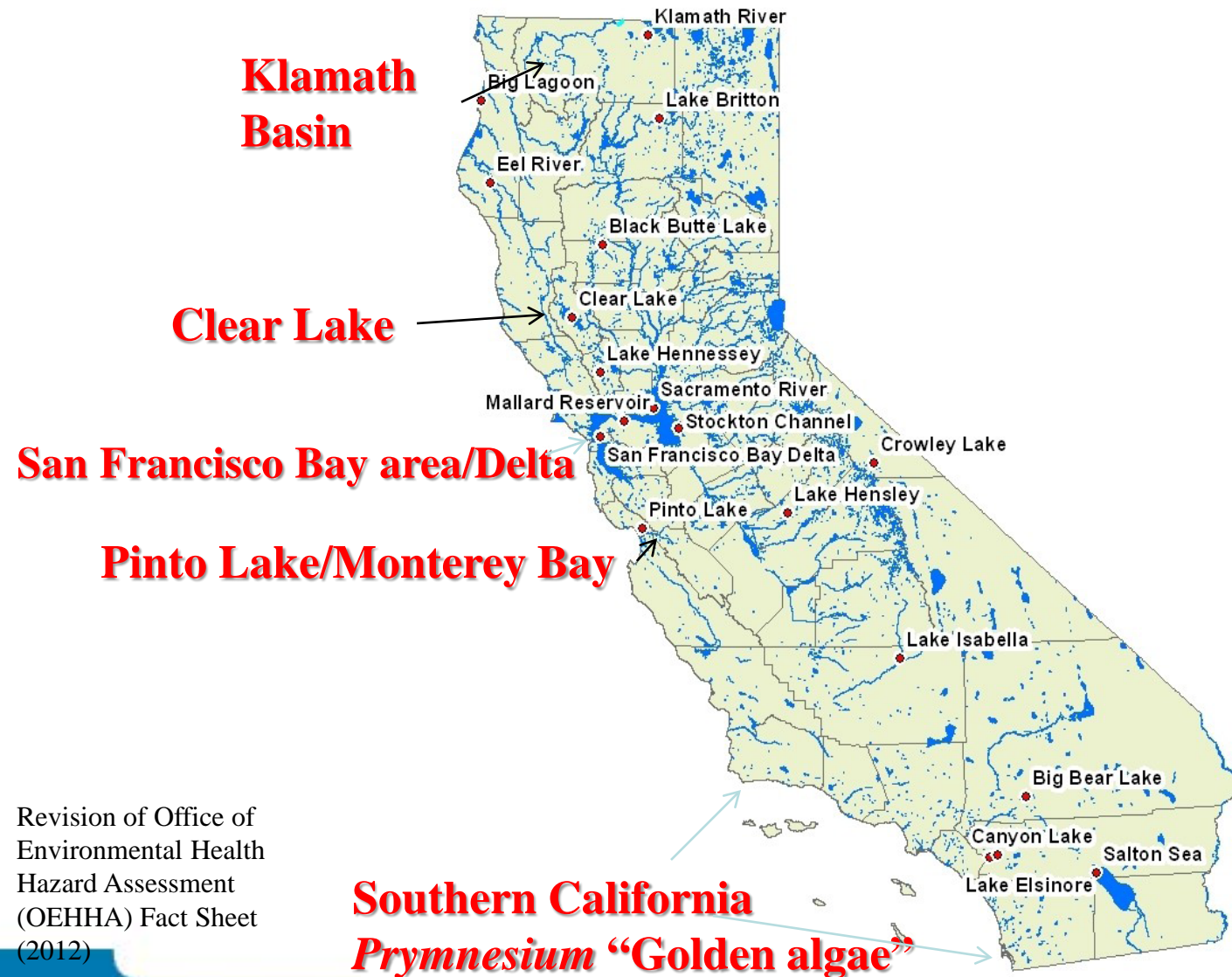
Aerial Image from Google maps; fly in photo from 8/12 presentation by Amy Little, CDPH

# Irrigation



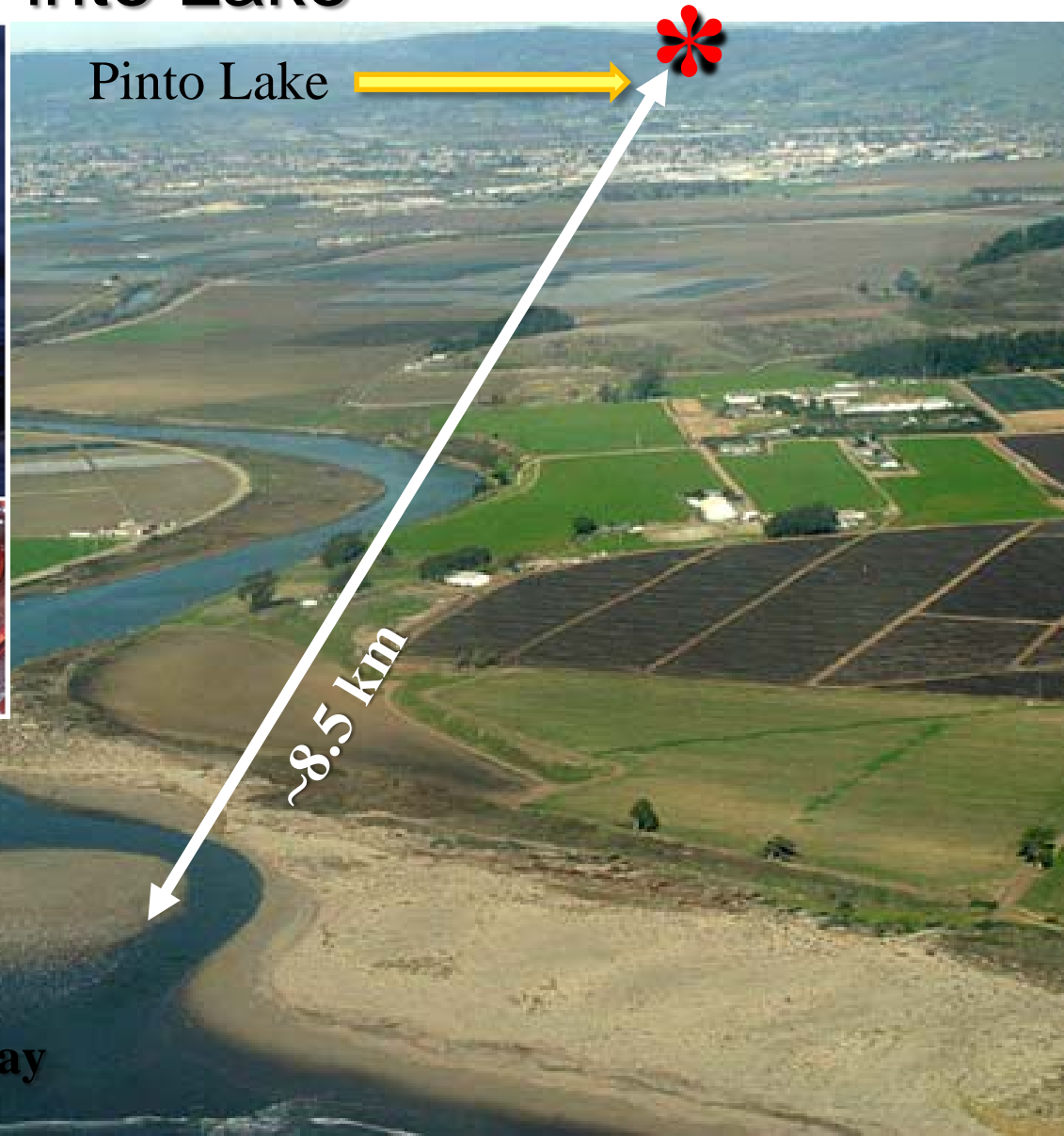


# Areas in California with Recurrent Toxic Algae Blooms



# Freshwater Impacts to Marine Waters

## Pinto Lake





# East Bay Lakes Prior to 2014



2014





2015- 2016

1Dog Death

Closed to Swimming

Closed to Swimming

Closed to Swimming  
2015 150,000 ug/L microcystin

Closed to Swimming

Closed to Swimming  
Drinking BU

East Bay  
Regional Park District

0 10 Miles



# Statewide Strategy to Address Freshwater HABs

- To assess, communicate, and manage freshwater HABs in a collaborative fashion statewide





# California Cyanobacteria and HAB Network (CCHAB)



- Partnership of state, federal, and local agencies, tribes, and non-governmental organizations

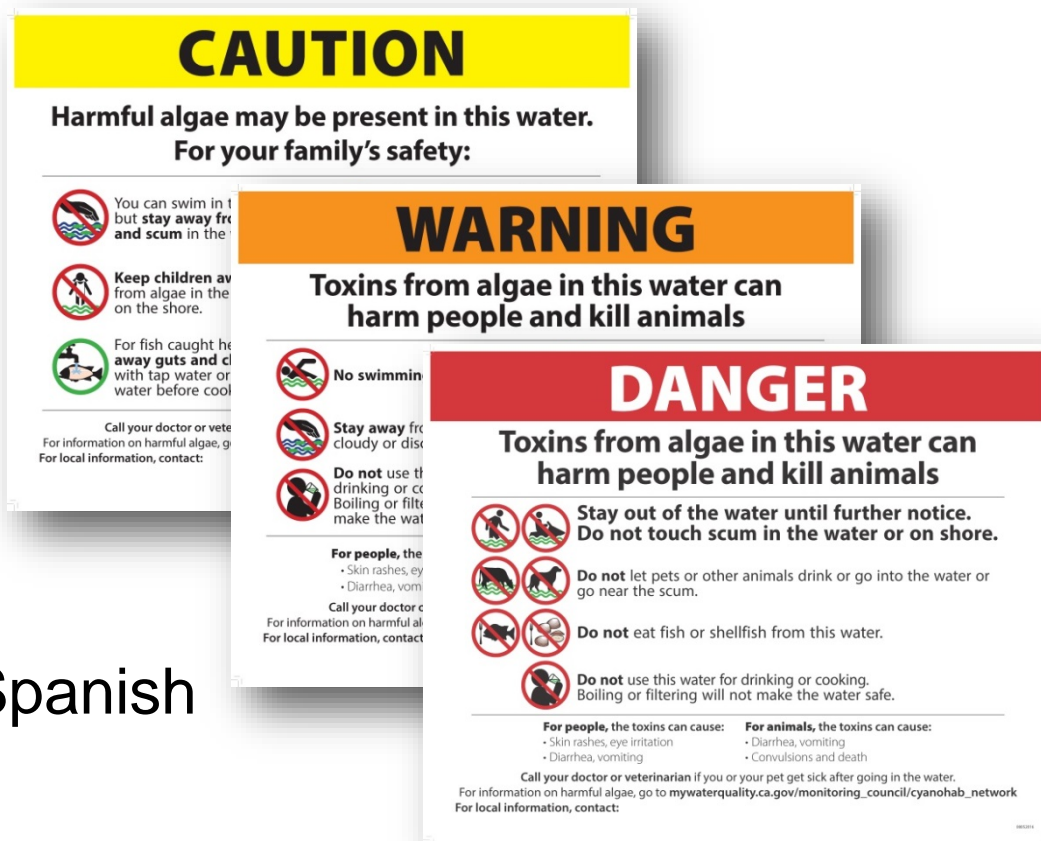


- Under the overarching guidance of the California Water Quality Monitoring Council



# Decision Tree Guides Posting

- Decision Tree and narrative to guide posting and de-posting health advisories at water bodies
- Cyanotoxin Trigger Levels for protection of human health
- Signage for posting water bodies
  - In English and Spanish





# SWAMP Guidance Documents

- Field sampling
  - SOPs for sampling cyanobacteria and cyanotoxins
  - Health and safety recommendations
- Laboratory analysis
  - SOPs analysis of cyanotoxins (anatoxin a, cylindrospermopsin, saxitoxin and microcystins)
  - Performance based QA system for cyanotoxins

August 2016 - DRAFT

*Standard Operating Procedures  
And  
Health and Safety Protocols  
– For –  
Sampling and Monitoring of  
Freshwater Cyanobacterial Harmful  
Algal Blooms and Other Nuisance  
Blooms In California*



Prepared for:  
California State Water Resources Control Board



# Cyanobacteria Assessment Network



## Cyanobacteria Assessment Network (CyAN) Project

EPA, NASA, NOAA, USGS

### What is the CyAN Project?

The Cyanobacteria Assessment Network (CyAN) is a multi-agency project among the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), and EPA to develop an early warning indicator system using historical and current satellite data to detect algal blooms in U.S. freshwater systems. This research supports federal, state, and local partners in their monitoring efforts to assess water quality to protect aquatic and human health.



The project will:

- develop a uniform and systematic approach for identifying cyanobacteria blooms using ocean satellites across the contiguous United States;
- create a strategy for evaluation and refinement of algorithms across satellite platforms;
- identify landscape linkage postulated causes of chlorophyll-a and cyanoacteria blooms in freshwater systems;
- characterize exposure and human health effects using ocean color satellites in drinking water sources and recreational waters;
- characterize behavior responses and economic value of the early warning system using ocean satellites and mobile dissemination platform; and
- disseminate satellite data through an Android mobile application and [EnviroAtlas](#).

### Mission Statement and Objectives of the CyAN Project

- Support the environmental management and public use of U.S. lakes and estuaries by providing a capability of detecting and quantifying algal blooms and related water quality using satellite data records.

#### Objectives

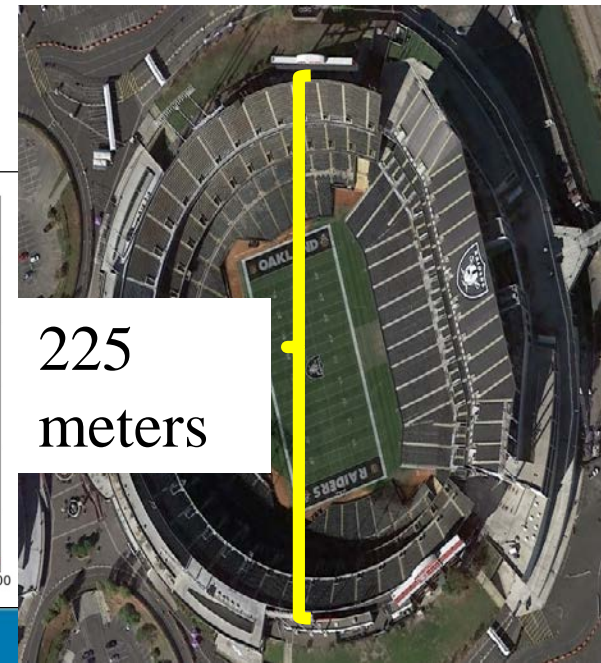
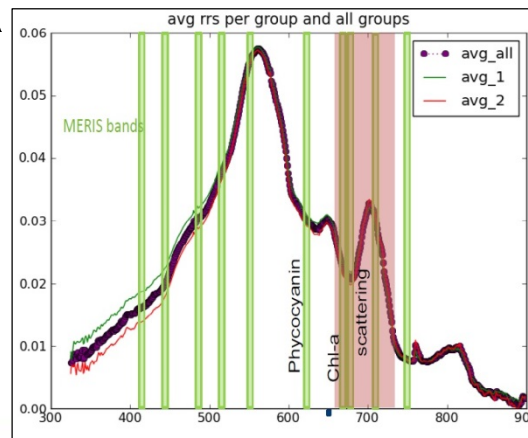
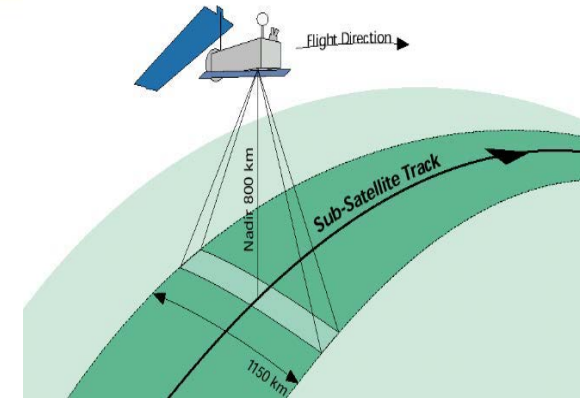
- Create a standard and uniform approach for early identification of algal blooms that is useful and accessible to stakeholders of freshwater systems using the new set of satellites: Ocean Land Colour Instrument (OLCI) on Sentinel-3, Sentinel-2, Landsat and future NASA missions;





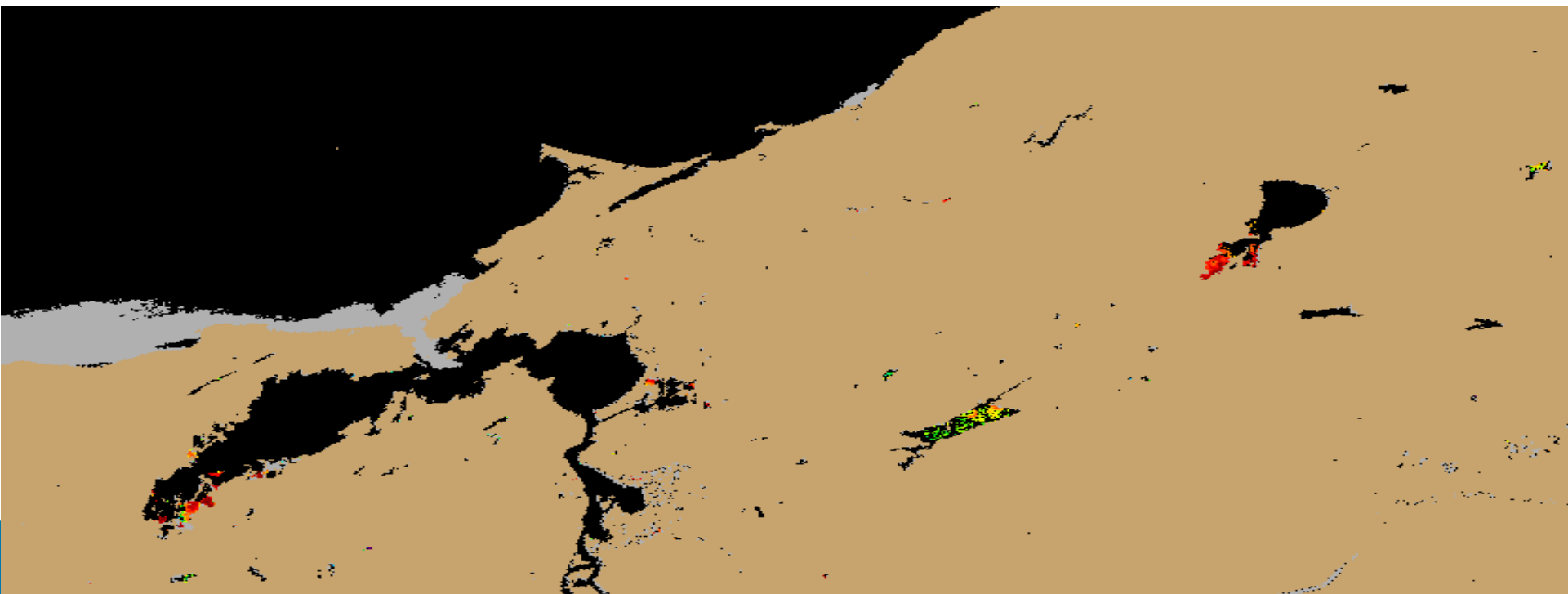
# Satellite Basics

- Flyover every few days
  - Swath 1,150 km wide
- Spatial resolution is 300m x 300m (per pixel)
- Satellite analyzes light absorption signature in each pixel at key spectral bands
- Can estimate concentrations separately for:
  - Total algal biomass
  - **Cyanobacteria**
  - Non-cyanobacteria
- All cyanobacteria
- Not toxins



# Satellite imagery and real time notification (SFEI)

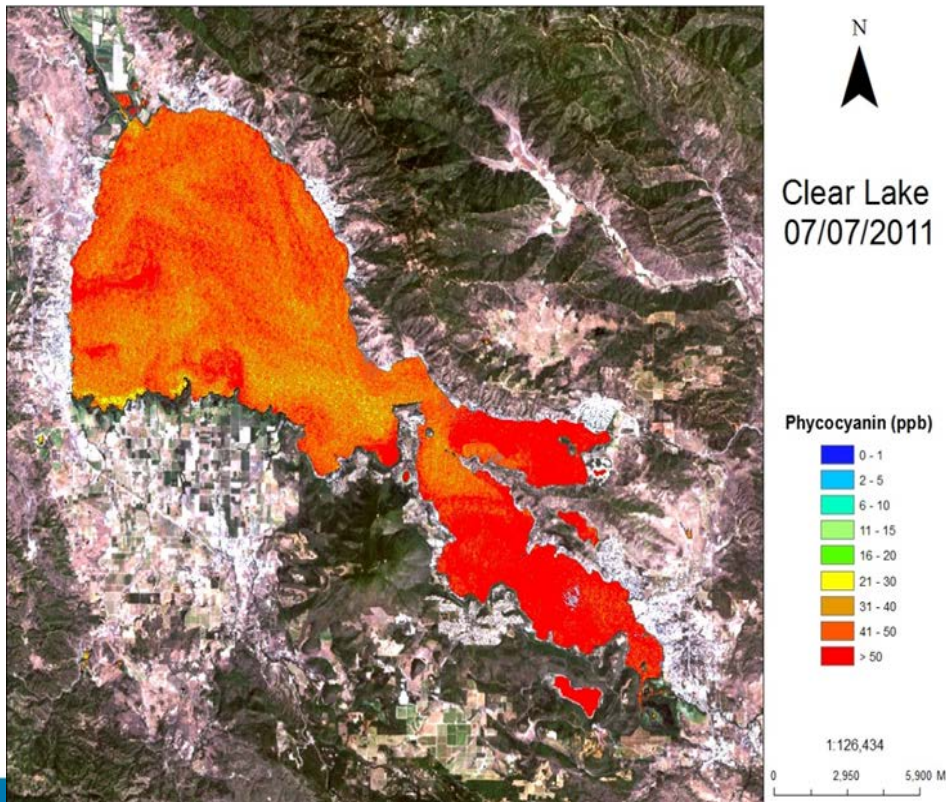
- Retrieve and process imagery created by satellite
- Notify contacts in real time when imagery indicates a bloom
- Respond to requests for follow-up information



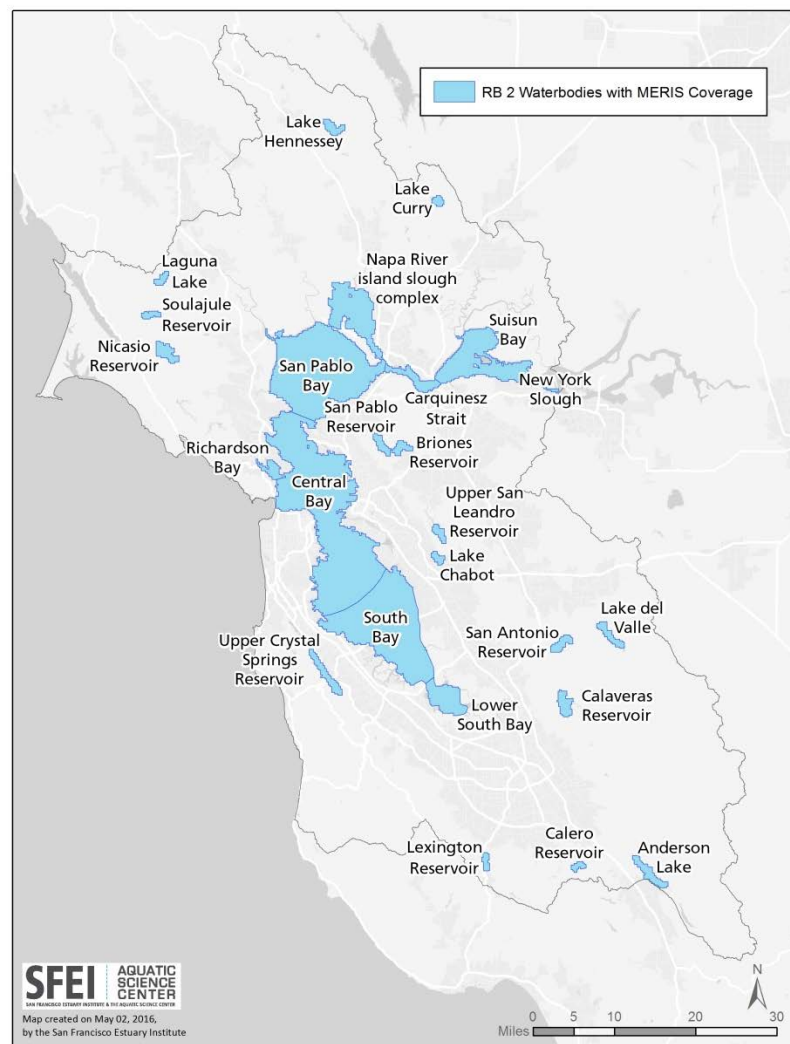


# Satellite Imagery

- Large lakes – OLCI (launched February 2016)
  - Previous satellite MERIS with same resolution (2002 – 2012)
- Small waterbodies – Sentinel-2 and Landsat 8



# Lakes with MERIS Satellite Coverage



# Harmful Algal Bloom Portal



[www.MyWaterQuality.ca.gov](http://www.MyWaterQuality.ca.gov)







Portals

About Us

Work Groups

These web portals, supported by a wide variety of public and private organizations, present California water quality and aquatic ecosystem monitoring data and assessment information that may be viewed across space and time.

1 2 3 II

## Welcome to My Water Quality

### Is Our Water Safe to Drink?



Safe drinking water depends on a variety of chemical and biological factors regulated by a number of local, state, and

federal agencies. *[Future Portal]*

### Are Our Aquatic Ecosystems Healthy?



The health of fish and other aquatic organisms and communities depends on the chemical, physical, and

biological quality of the waters in which they live.

[Learn more >>](#)

### Is it Safe to Swim in Our Waters?



Swimming safety of our waters is linked to the levels of pathogens that have the potential to cause disease. [Learn more >>](#)

### Are Harmful Algal Blooms Affecting Our Waters?



Harmful algal blooms can make water unsafe for swimming and other recreational activities. The toxins they produce can harm pets, livestock, and people. [Learn more >>](#)

### Is it Safe to Eat Fish and Shellfish From our Waters?



Aquatic organisms are able to accumulate certain pollutants from the water in which they live, sometimes reaching

levels that could harm consumers. [Learn more >>](#)

### About Us

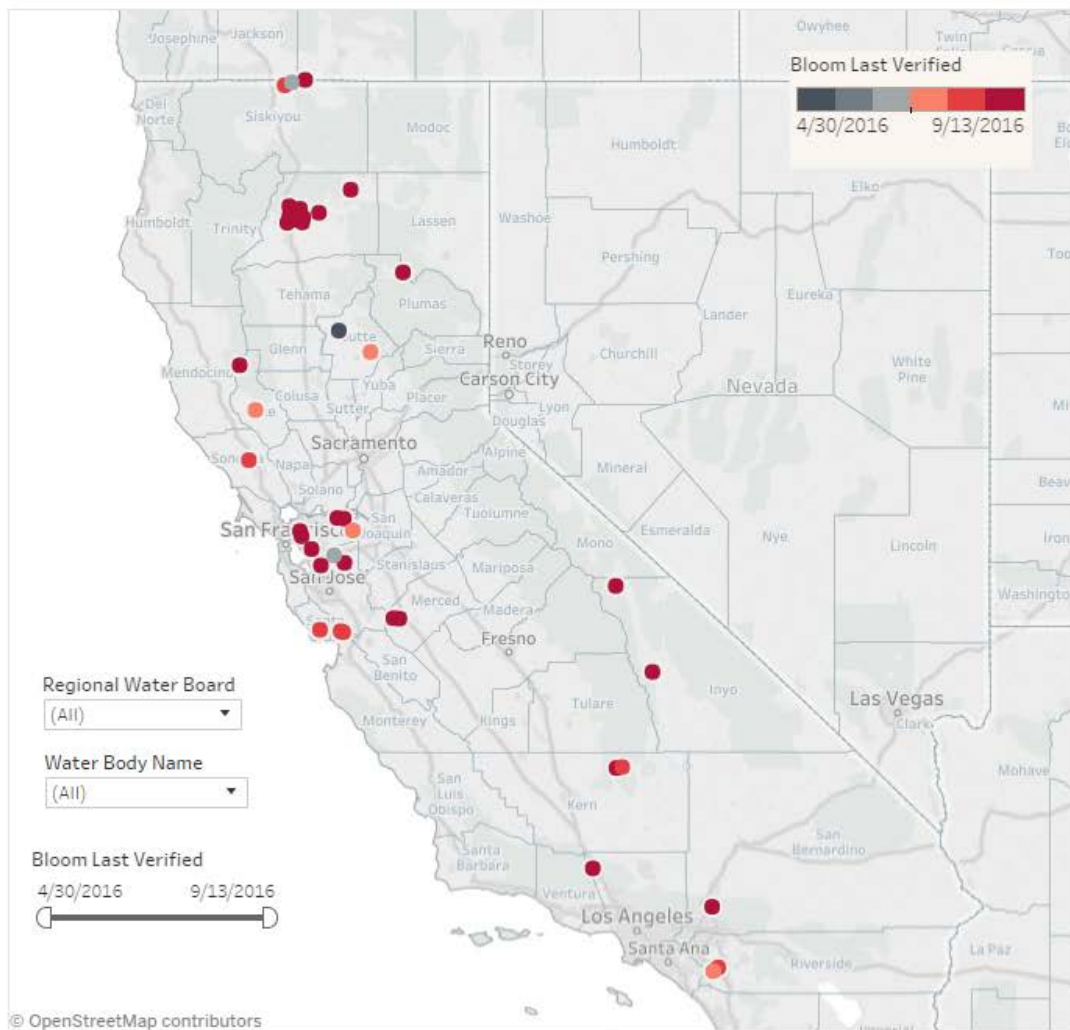


The Monitoring Council seeks to provide multiple perspectives on water quality information and to highlight existing data gaps and inconsistencies in data collection and interpretation. [Learn more >>](#)

# California Harmful Algal Blooms (HABs)

HAB events represented below are [voluntarily reported](#) to the State Water Board's Surface Water Ambient Monitoring Program. Data provided are for general information purposes only and may contain errors. The exact location, extent and toxicity of the reported bloom may not be accurate and may not be affecting the entire waterbody. The data are subject to change as new information is received. Please check back for updates.

- [More detailed information on freshwater HAB events](#)



Map Updated 09/15/2016

## News and Announcements

- [Report a Bloom](#)
- [Current Advisories](#)
- [Bulletins & Newsletters](#)
- [California CyanoHAB Network](#)

## Questions Answered

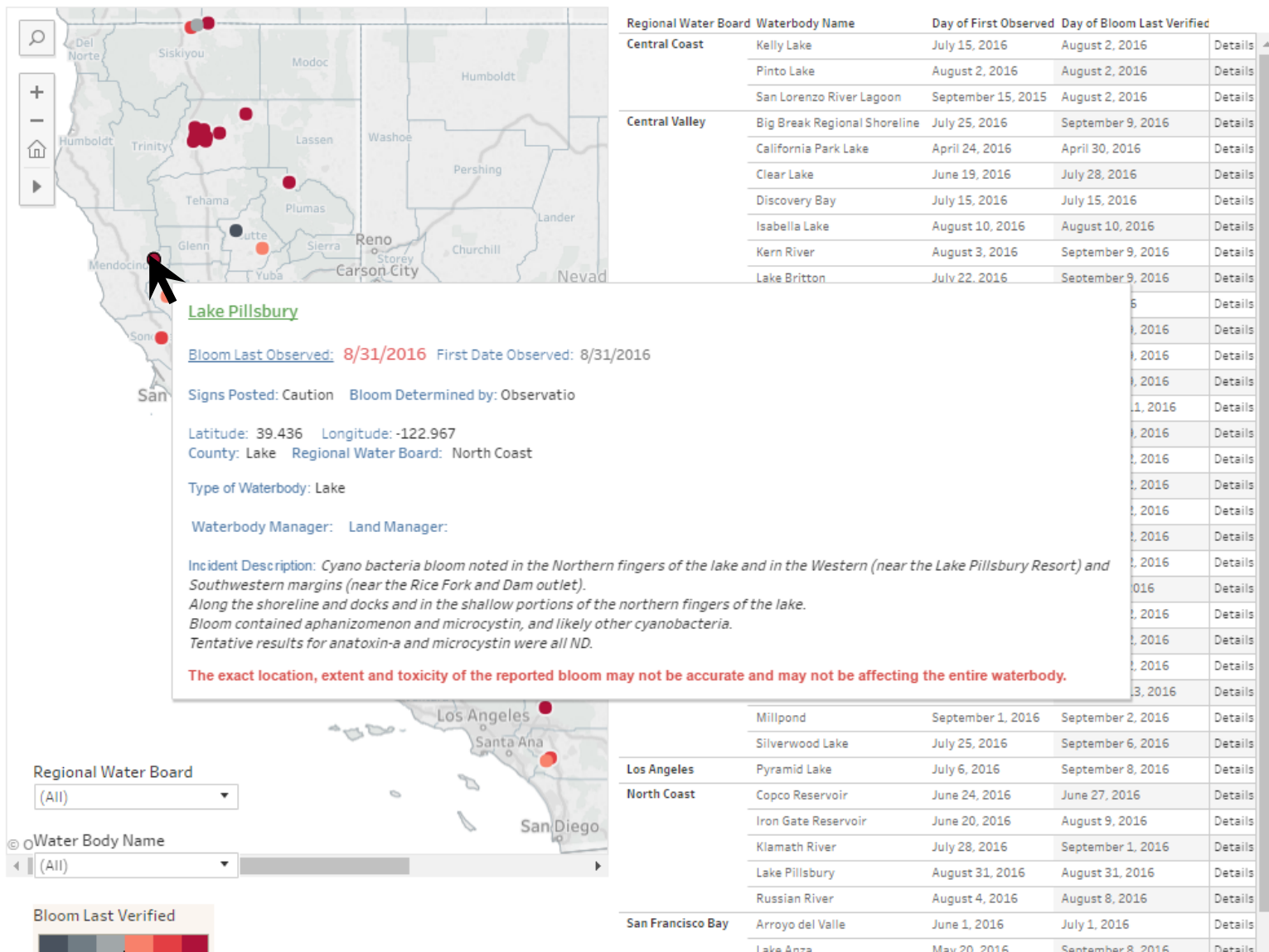
- [What are harmful algal blooms?](#)
  - What are harmful algae?
  - Why are they important?
  - Where do they come from?
  - Why should I be concerned?
  - What are the impacts?
    - Swimming & recreation
    - Drinking water
    - Fish & shellfish harvesting
    - Domestic animals
    - Wildlife
- [Where are harmful algal blooms occurring?](#)
  - HABs event maps
    - Freshwaters
    - Marine waters
  - Satellite map
- [What can I do about a bloom?](#)
  - How do I identify harmful algae?
  - How can I report a bloom, or a related animal illness or human illness?
- [What resources and guidance are available to address harmful algal blooms?](#)
  - Recreational Water Uses
  - Drinking Water
  - Shellfish Harvesting
  - Monitoring
  - Laboratory Resources
  - Freshwater Assessment and Support Strategy
  - Freshwater Incident Response and Interagency Coordination
  - Informational Presentations
  - Other Resources



# Where are freshwater harmful blooms occurring in California?

HAB events represented below are [voluntarily reported](#) to the State Water Board's Surface Water Ambient Monitoring Program. Data provided are for general information purposes only and may contain errors. The exact location, extent and toxicity of the reported bloom may not be accurate and may not be affecting the entire waterbody. The data are subject to change as new information is received. Please check back for updates.

- [View California HAB event data](#)
- [Download California HAB event data as an Excel file](#)







Portals

About Us

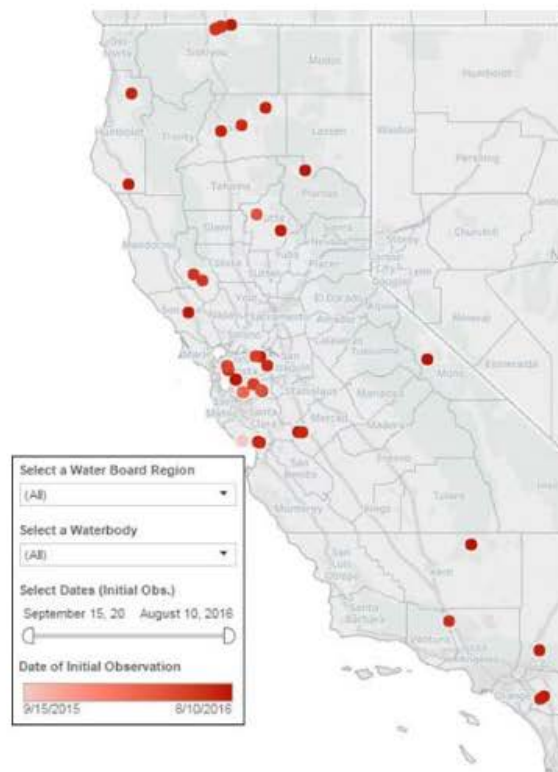
Work Groups

HABs Links

## Where are harmful algal blooms occurring?

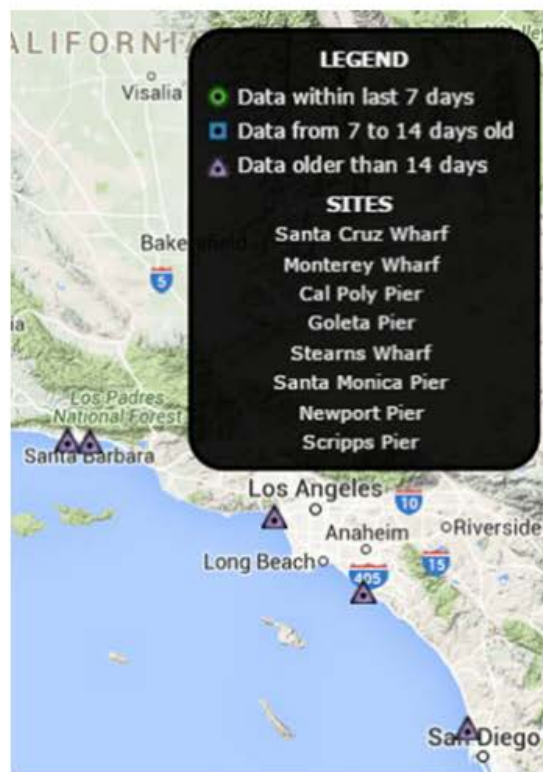
### Freshwater HABs Event Map

Recreational closures and advisories



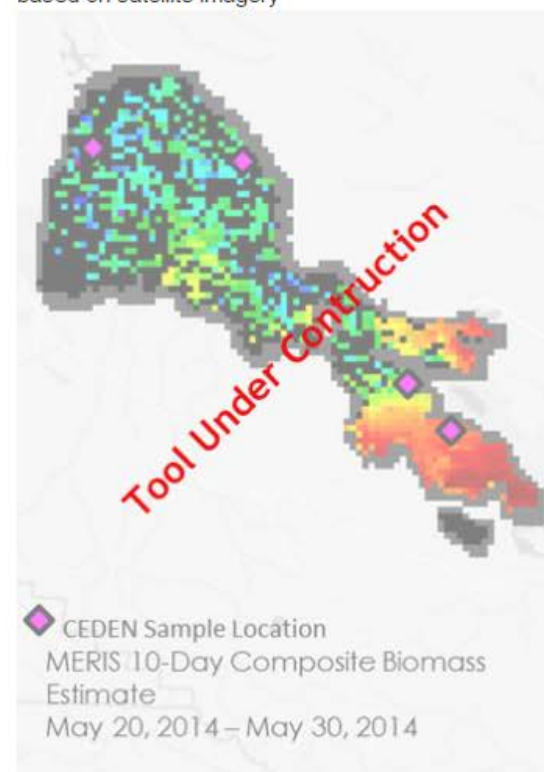
### CalHABMAP

Marine HABs information



### Satellite Maps

Where HABs are occurring in larger water bodies based on satellite imagery



- Klamath Basin Monitoring Program, [Blue-Green Algae Tracker](#)

# What can I do about a harmful algal bloom?

If you see a harmful algal bloom, there are things you can do to help.

## How do I identify harmful algae?

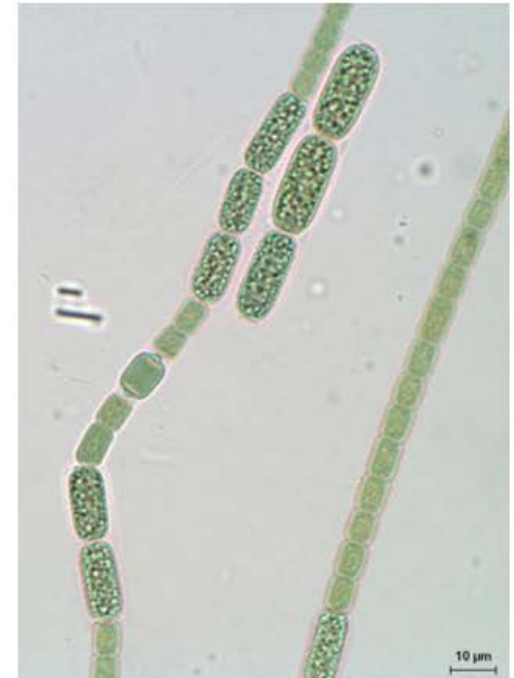
There are many kinds of algae. Only some are capable of producing toxins.

- These are harmful algae (*under development*)
- These are **not** harmful algae (*under development*)
- US Geological Survey, [Field and Laboratory Guide to Freshwater Cyanobacteria Harmful Algal Blooms](#)  
Pages 4 through 15 provide photos of harmful algae and of non-harmful green algae and aquatic plants.  
Microscope images are also included.
- [Key to Algal Phyla/Classes](#)
- Western Washington University, [Freshwater Algae in Northwest Washington, Volume I, Cyanobacteria](#)

## How can I **report a bloom**, or an animal illness or human illness related to a bloom?

Reporting a harmful algal bloom or an animal or human illness associated with exposure to a bloom helps authorities understand where problems are occurring and to respond appropriately

- [Freshwater Bloom Incident Form](#)
  - Human Illness Incident Form (*under development*)
  - Animal Illness or Mortality Incident Form (*under development*)
- [Report a red tide or other unusual marine sighting](#)
- **Bloom reporting and information**
  - Call: 1 (916) 341-5357
  - Call toll free: 1 (844) 729-6466
  - Email: [CyanoHAB.Reports@waterboards.ca.gov](mailto:CyanoHAB.Reports@waterboards.ca.gov)



# California Freshwater Harmful Algae Bloom Report Form

Please provide information about the harmful algae bloom observed. Click the submit button at the end of the form to send the information to the State Water Resources Control Board. Please submit one report per water body.

For more information on harmful algae blooms, visit:

[What are harmful algal blooms?](#)

For more information about the state's activities to address harmful algae blooms, visit:

[CA Cyanobacteria and Harmful Algal Bloom \(CCHAB\) Network](#)

This form will not support the upload of photographs or other files directly. Please send photographs of the incident and any additional informational documents to the email address provided after the form has been submitted. You will be provided an Incident Tracking ID to include in your email to link the attachments to this report. If you have questions or concerns please email [CyanoHAB.Reports@waterboards.ca.gov](mailto:CyanoHAB.Reports@waterboards.ca.gov) or call 1-844-729-6466.

## Waterbody Information

Report Type (\*): ☐ New Report  
☐ Follow Up from Previous Report

Incident ID from previous report, if known:

Waterbody Name and Type (\*):

County:

Latitude (decimal) ☐ :

Longitude (decimal):

Datum ☐ :

☐ GPS  
Coordinates were taken from: ☐ Online Map  
☐ Other

Or Nearest Landmark:

## Contact Information

Name:

Organization:

Email ☐ :

Phone:

May we contact you for more information? (\*)  
☐ Yes  
☐ No

Would you like to receive a follow-up message  
regarding this incident? ☐ Yes  
☐ No

## Algae Bloom Information

Date of Algae Bloom Observation (\*):

Will you be sending pictures? (\*)  
☐ Yes  
☐ No



# Remediation methods

- Cyanobacteria specific algaecide
- Reduce nutrients (primarily P, N can also be important)
  - Source reduction
  - Wetlands – “Floating Islands”
  - Inhibit nutrient fluxes from sediment
- Mix and destratify water column
  - Temp goes down, eliminates thermocline
  - Oxygen in sediment goes up binds phosphorus
  - Algae mixed out of photic zone
- Reduce residence time/flushing

# The End



## NOTICE

**Blue Green Algae is Present  
in Lake Del Valle**



During summer and fall, the presence of blue green algae in lakes can result in a buildup of toxins. While near-water activities such as picnicking, biking, and hiking are safe, take the following precautions to help protect yourself, your family (including pets), and your friends:

- No bodily contact with the water. Supervise children and pets at all times—they are particularly vulnerable.
- Keep pets, especially dogs, out of the water.
- Skin in contact with blue green algae should be rinsed with tap water.
- Fish may be consumed after removing guts and liver, and rinsing fillets in tap water.

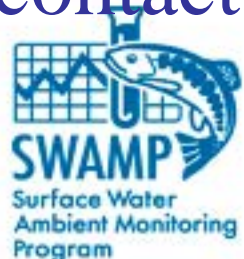
For more information, contact East Bay Regional Park District at (510) 544-2328 or visit the California Department of Public Health online [www.cdph.ca.gov/healthinfo/communicable/diseases/BlueGreenAlgae.aspx](http://www.cdph.ca.gov/healthinfo/communicable/diseases/BlueGreenAlgae.aspx)



Region 2: Point of contact  
for bloom events

Carrie Austin

[caustin@waterboards.ca.gov](mailto:caustin@waterboards.ca.gov)



## Table 3. CyanoHAB Thresholds for Human Health

	Action Trigger	Warning TIER 1	Danger TIER 2
Primary Thresholds <sup>a</sup>			
Total Microcystins <sup>b</sup>	0.8 µg/L	6 µg/L	20 µg/L
Anatoxin-a	Detection <sup>c</sup>	20 µg/L	90 µg/L
Cylindrospermopsin	1 µg/L	4 µg/L	12 µg/L
Secondary Thresholds			
Cell Density ( <i>Toxin producing cells</i> )	4,000 cells/mL	--	--
Site Specific Indicators of Cyanobacteria	Blooms, scums, mats	--	--

a. The primary thresholds triggered when ANY toxin exceeds criteria

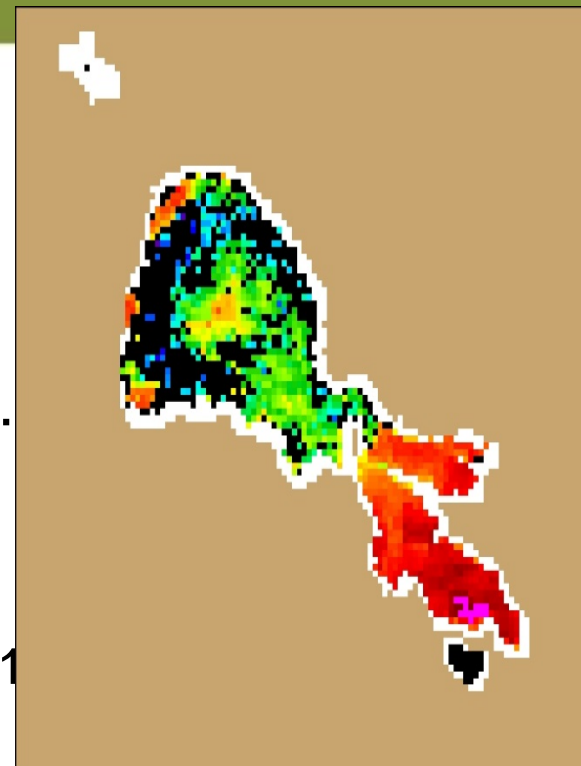
b. Microcystins refers to the sum of all measured microcystin variants. (See Box 3)

c. Must use an analytical method that detects ≤ 1µg/L Anatoxin-a



# Satellites- What They Can't Do

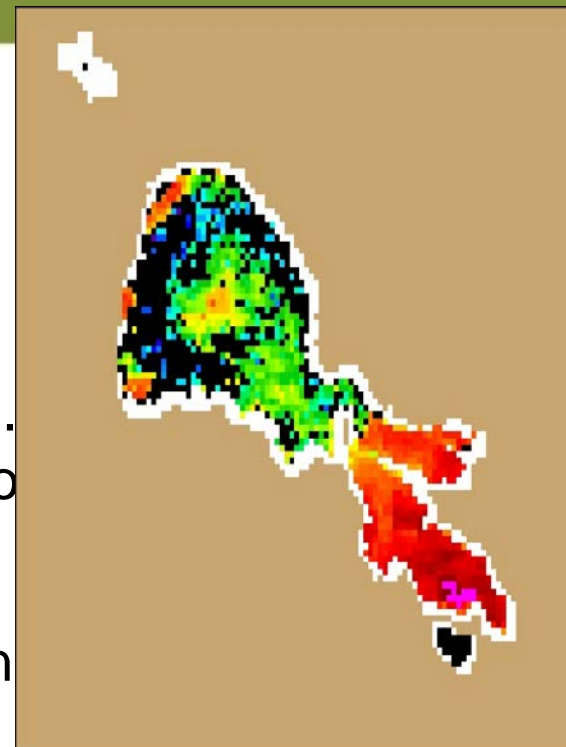
- Cyanobacteria blooms can be detected but..
  - Clouds block images
  - Screening tool
    - No direct comparisons to HAB thresholds
    - Values are estimates (NOAA recommends  $\pm 1$  uncertainty)
  - Estimates all cyanobacteria (including non-toxin producers)
  - Doesn't measure toxin levels
  - Less confidence with data for lowest algal densities
  - False positives can occur
  - Limited to large lakes (currently)



# Satellites- What They Can Do

- Cyanobacteria blooms can be detected and...
  - Provide understanding of bloom conditions from 2012
    - Identify trends and severity of blooms
  - Data can help understand bloom drivers, management
  - Monitor ~150 waterbodies in CA at once
  - Inform public about changing bloom status and location
  - Communicate data to help guide event response monitoring by:
    - Waterbody managers
    - County public health officials
    - Regional Board of SWAMP

**Bev needs YOUR  
contact  
information!**



# CCHAB MISSION



## ➤ Mission

- Work towards
  - A comprehensive, coordinated program
  - To identify and address
  - Causes and impacts of HABs

## ➤ Cyanotoxin Voluntary Guidance

- Framework
- Interpret monitoring data
- Communicate risk

