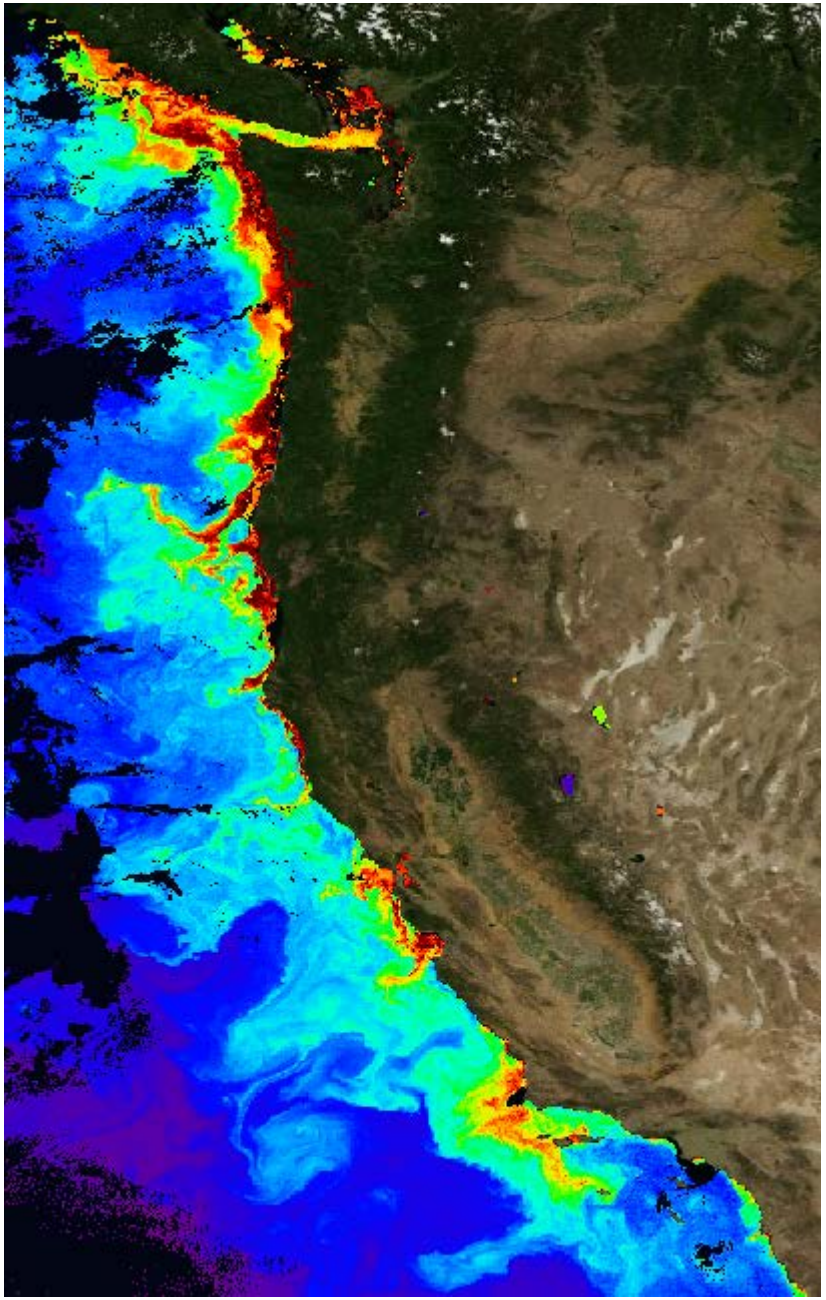
# Harmful Algal Blooms in California: Recent Events and Impacts

Meredith Howard

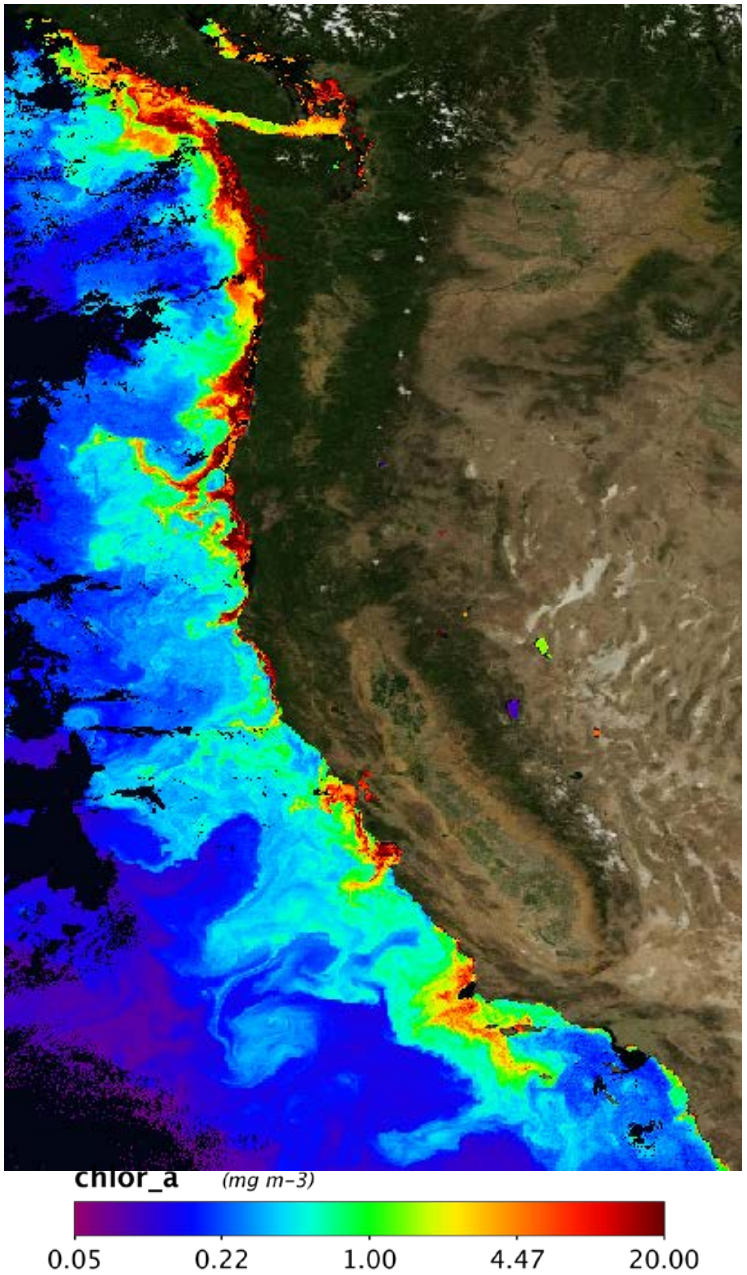
SCCWRP Commission Meeting

June 3, 2016



# 2015: An Unprecedented Year

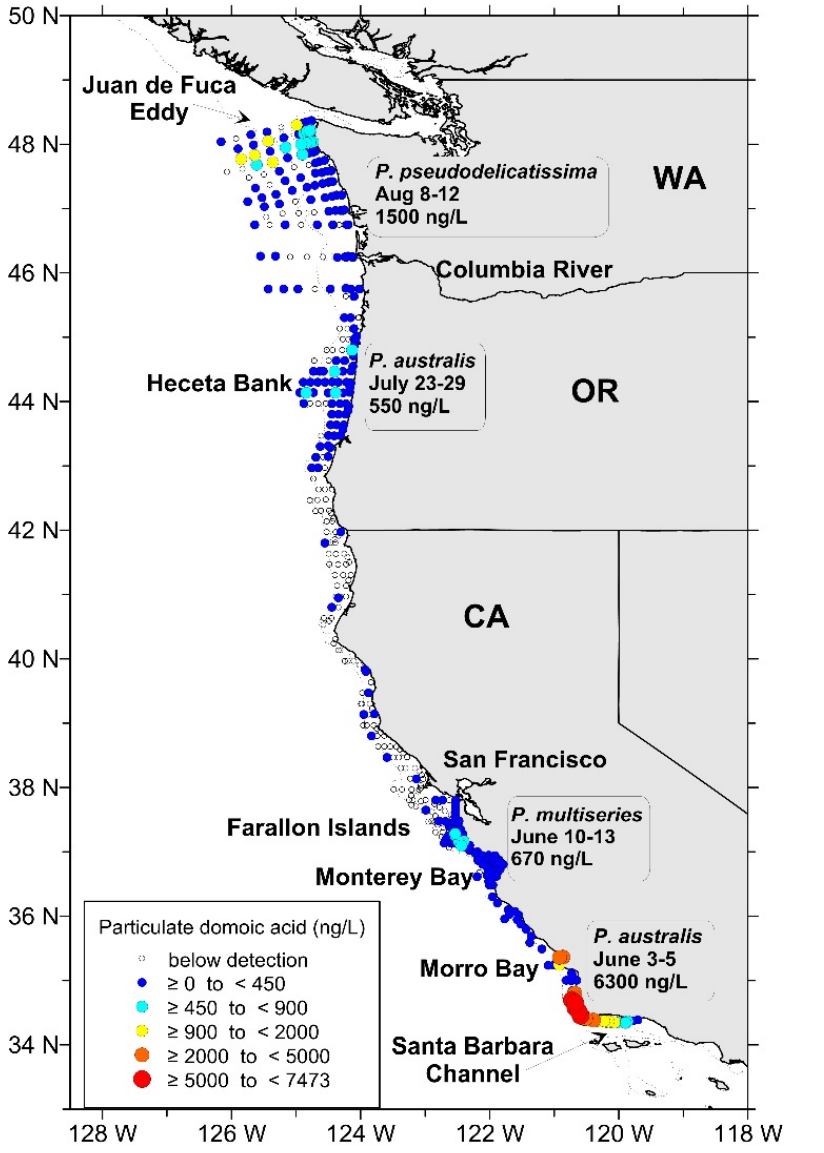
- Geographically most extensive bloom recorded
  - Kodiak Alaska to Santa Barbara
- Long Lasting (months)
- New record of high toxin levels
- Massive impacts
  - Economic losses
  - Shellfish and crab closures
  - Ecosystem impacts
  - Marine wildlife mortalities




MODIS image courtesy of Raphael Kudela

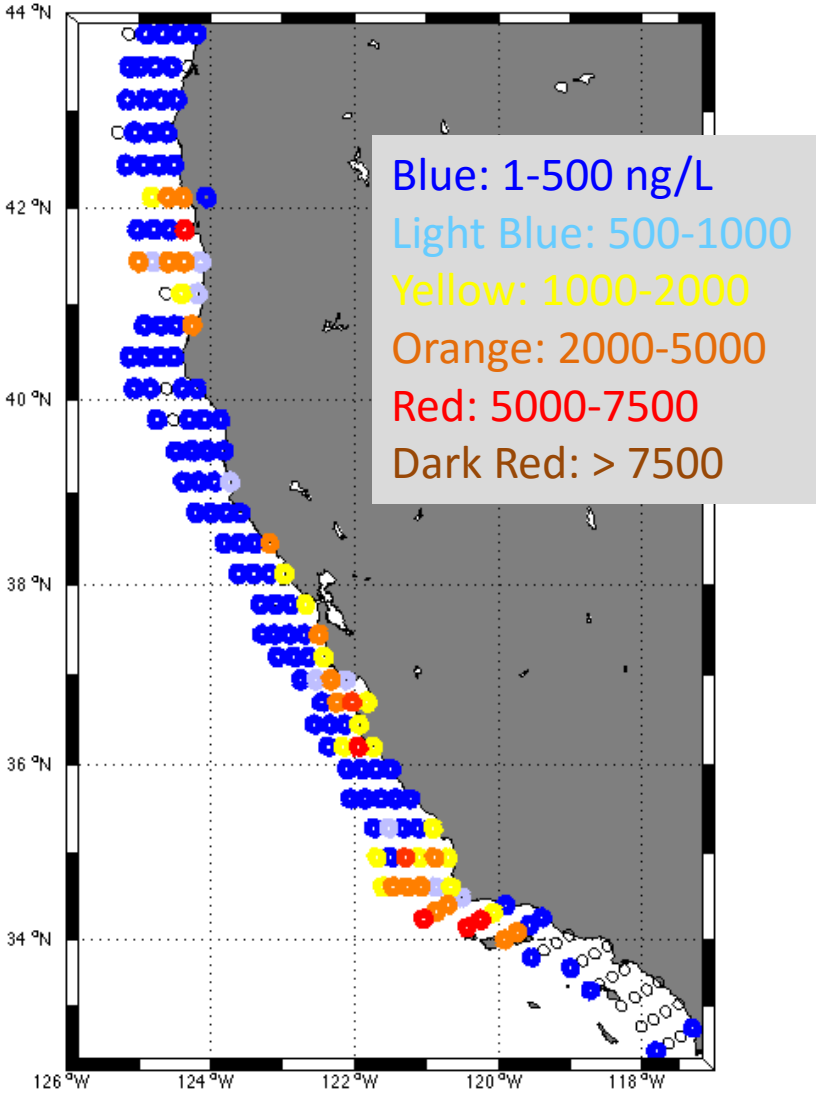
# Geographically Most Extensive Bloom Recorded

## 1998 – Domoic Acid




Trainer et al., 2000

## 2015 – Domoic Acid




*Trainer and Kudela labs*

# Coastwide Closure of Shellfish Harvesting

- Dungeness crabs
- Rock crabs
- Razor clams
- Mussels

**HAB Threatens CA's $256 M Fisheries**

Source: California Sea Grant.


Graphic: Seattle Times

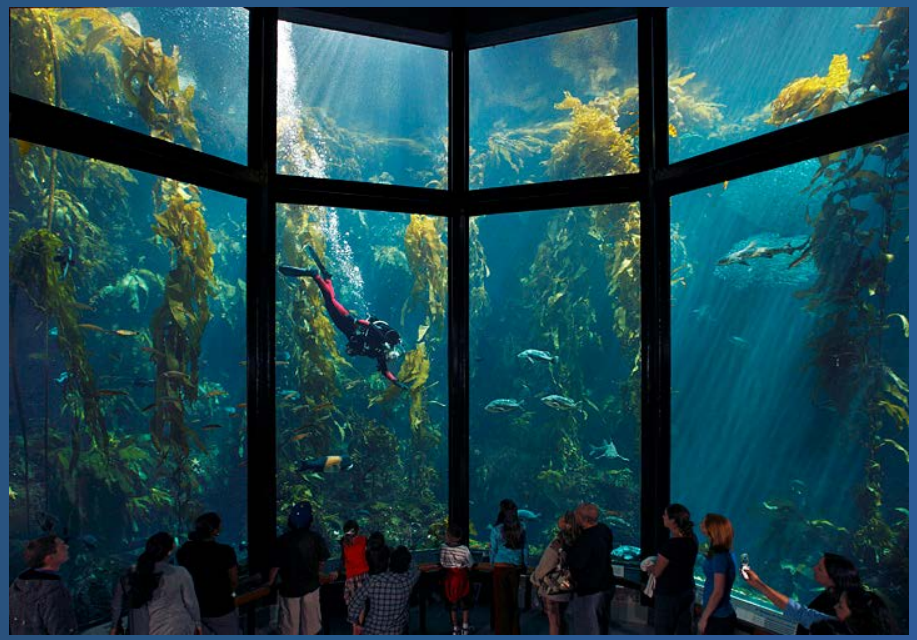
# Impacts: Shellfish and Crabs

- Toxin concentrations exceeded the regulatory safety limits:
  - Mussels were up to 10X higher
  - Dungeness crabs were up to 6X
- New record of toxin concentration in Razor Clams

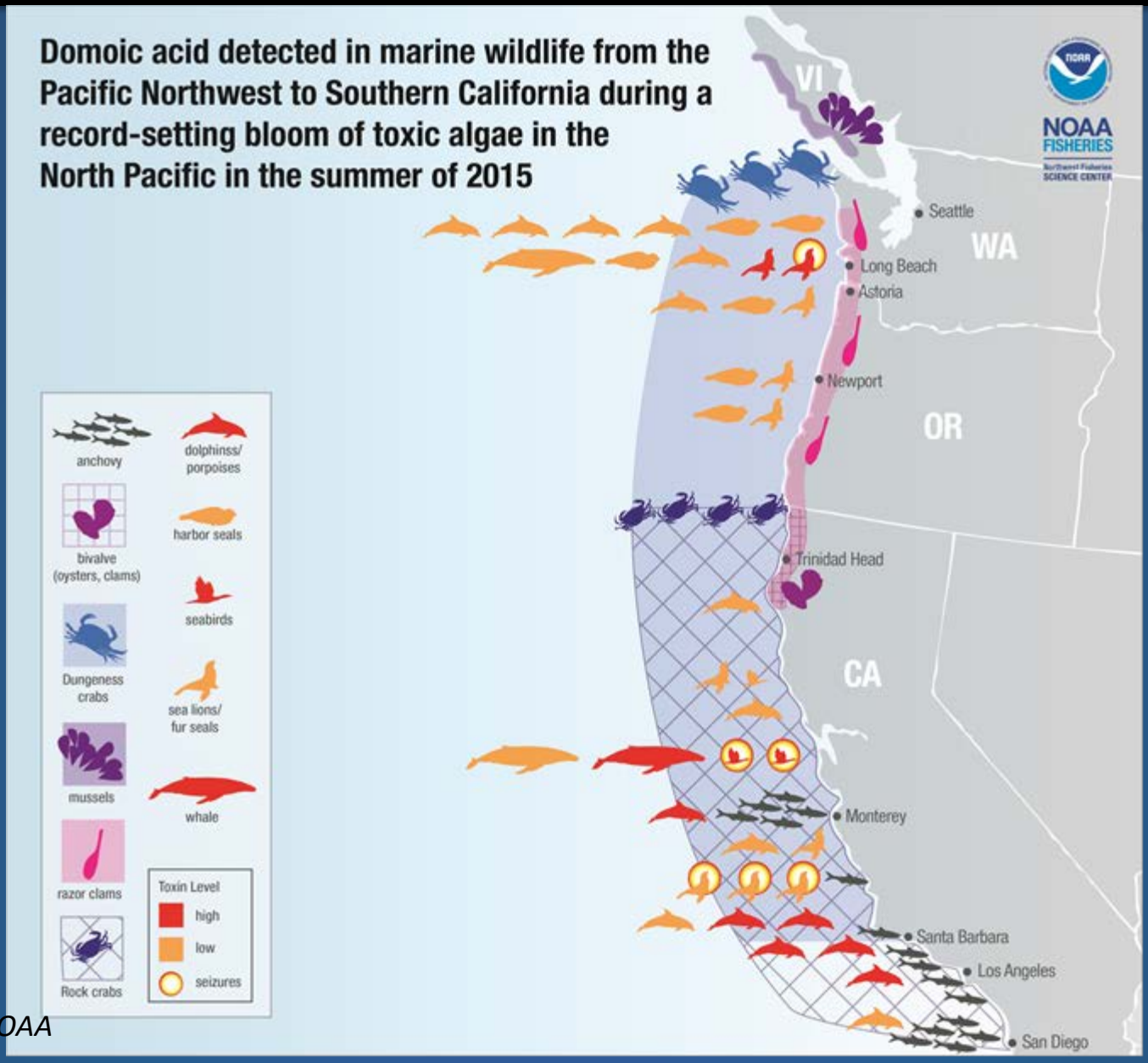

Dungeness crab fisheries closed in multiple states. West coast crab fishery valued at $180 million

# Impacts: Fish

- Anchovy and sardine fisheries health advisory in California due to high toxins
- New record for toxin concentration in anchovies
- Detectable toxin in filet of many fish
  - halibut, salmon, ling cod, whole body of mackerel, squid, smelt
- Contaminated Monterey Bay Aquarium tanks



# Impacts: Marine Wildlife




*Kathi Lefebvre, NOAA*

# The Bloom is Over But the Impacts Remain

**Bill aims to give crab industry $138 million in disaster relief**

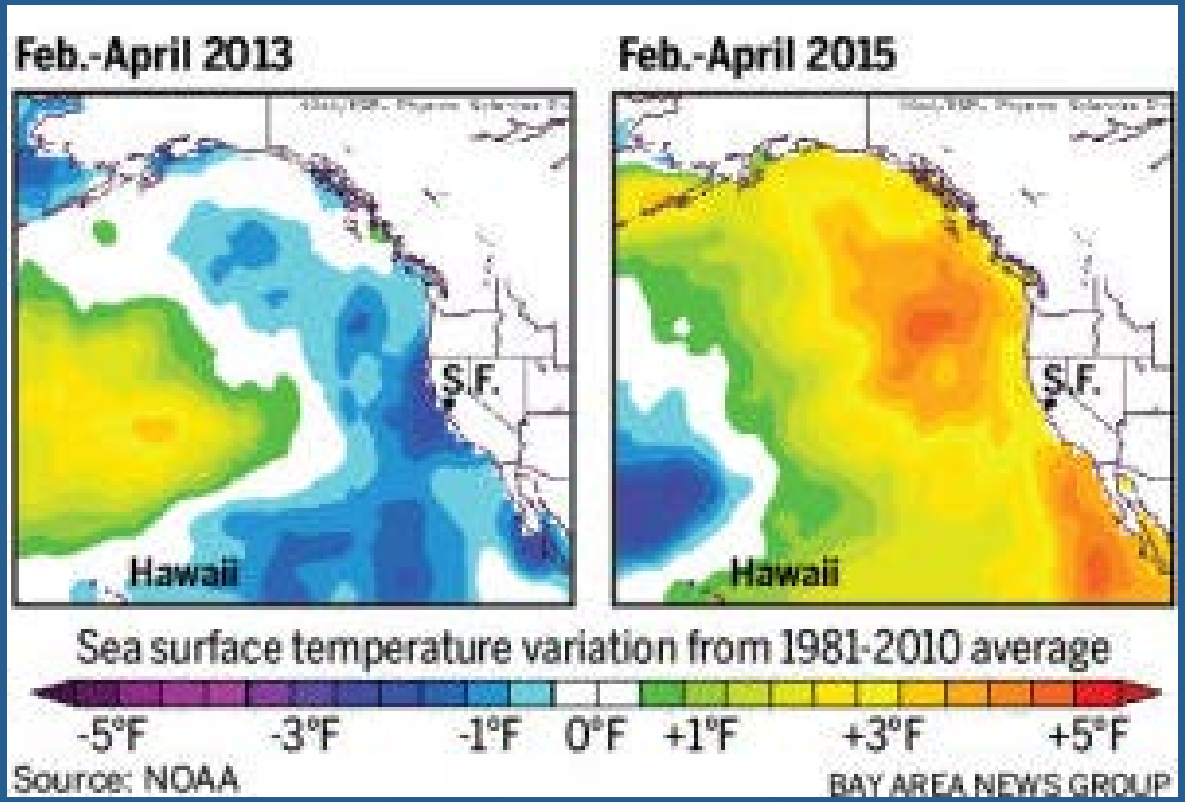
By Kimberly Veklerov Updated 7:50 pm, Friday, March 4, 2016

- Fishery disaster related to closure of the Dungeness crab and rock crab fisheries
  - Direct economic losses - estimated **$49 million** in the foregone California catch alone
  - Crab Emergency Disaster Assistance Act of 2016

**2016 Advisories still in effect in some areas for:**

- **Razor clams**
- **Dungeness crabs**
- **Rock crabs**

# Why Did The Bloom Occur?



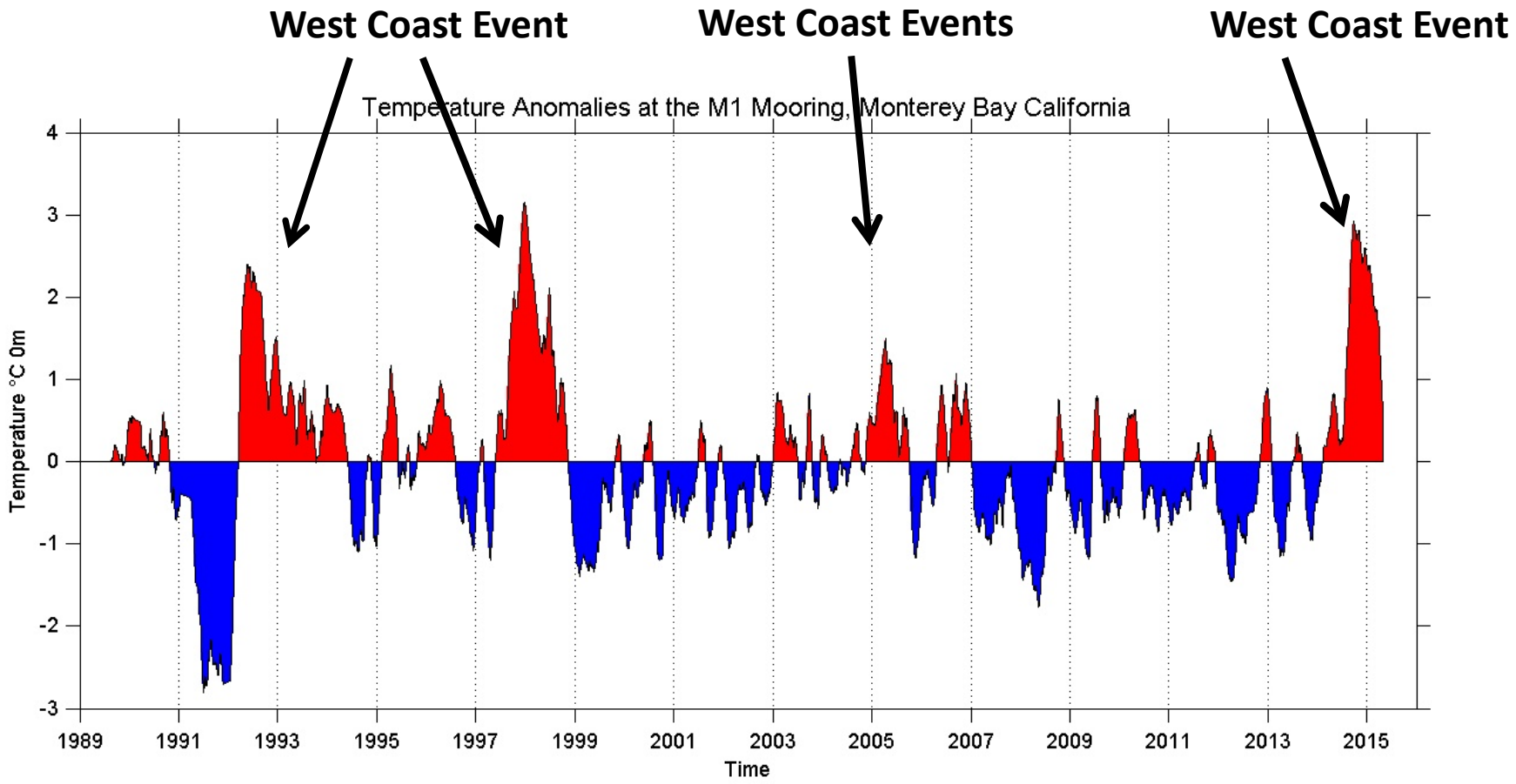

- Warm sea surface temperatures, called the “warm blob”
- Bloom corresponded with spring transition and the coastward propagation of the Pacific Warm Anomaly (“blob”)
- Interaction of the blob with coastal upwelling appears to have created the DA event

CLIMATE

# Blooms Like It Hot

A link exists between global warming and the worldwide proliferation of harmful cyanobacterial blooms.

Hans W. Paerl[1] and Jef Huisman[2]




*Note: 60 point moving average applied to daily averaged values.*

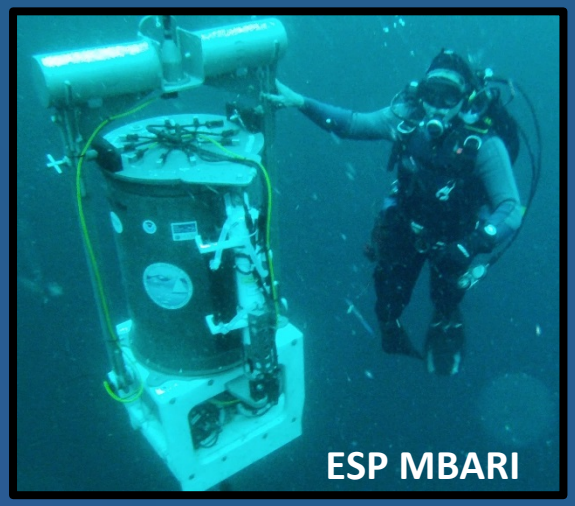
*Monterey Bay Aquarium Research Institute*

*Updated:20-Jul-2015*

Slide courtesy of Raphael Kudela, UCSC

# What are Scientists Doing To Better Understand and Predict HABs?

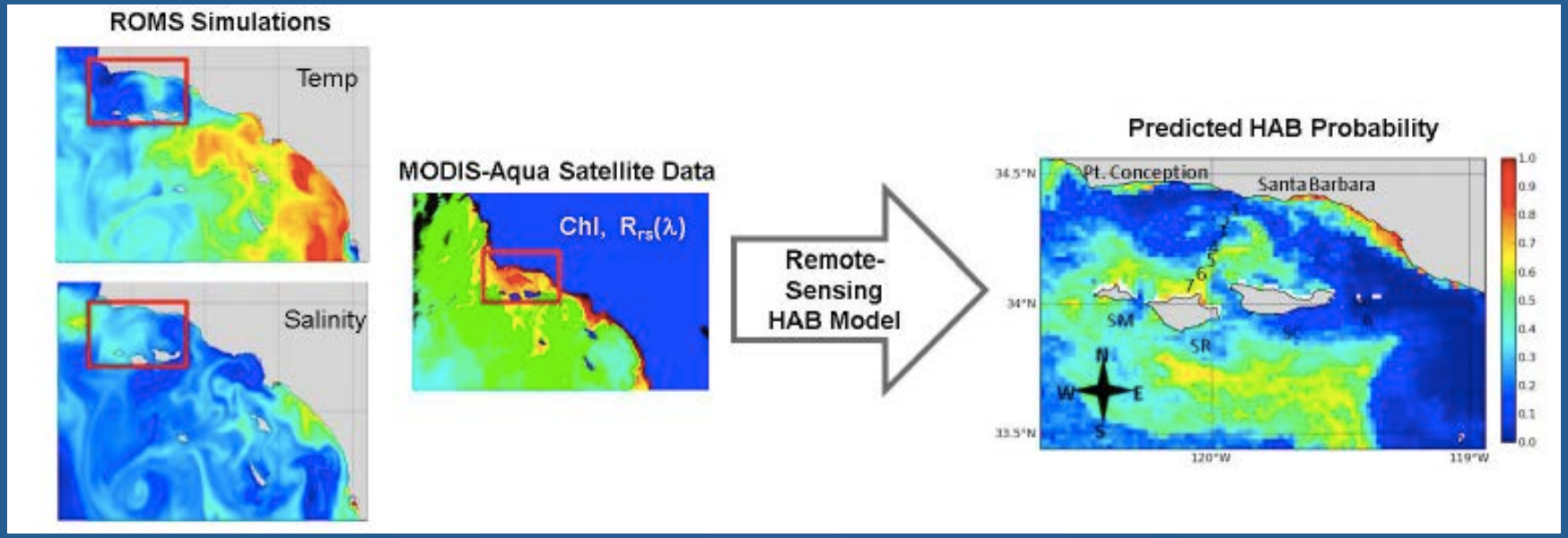
- Observations to understand bloom development
- New monitoring tools
  - Multiple types of autonomous underwater vehicles
  - Moored instruments
- Modeling



# Modeling to Forecast HABs

- Nowcasts and forecasts of the probability of cells or toxin through combination of :
  - Satellite observations of chlorophyll, reflectance and historical HAB data
  - Ocean circulation models (temperature, salinity and ocean currents)

*Operational HAB Forecasting System by 2018/2019*



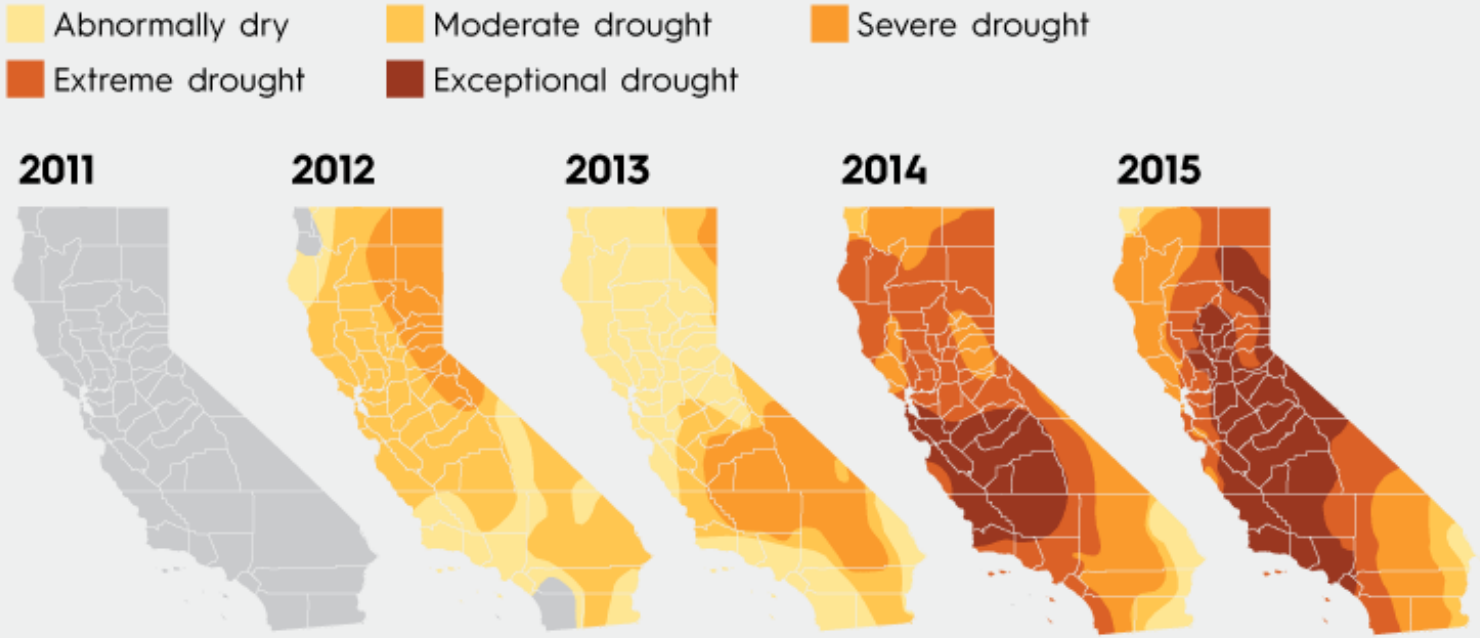

***Opportunity to link with causal ocean acidification and hypoxia modeling***

# Freshwater Toxins
# Record Breaking Years
# 2014 – 2015


- First time several lakes closed due to cyanotoxins
- Extremely high toxin concentrations recorded
- Several dog deaths attributed to toxins
- Multiple toxins detected simultaneously

# A Record-Breaking Drought

41% of the state is facing “exceptional drought” (the most severe kind).




VISUAL NEWS


CLIMATE

## Blooms Like It Hot

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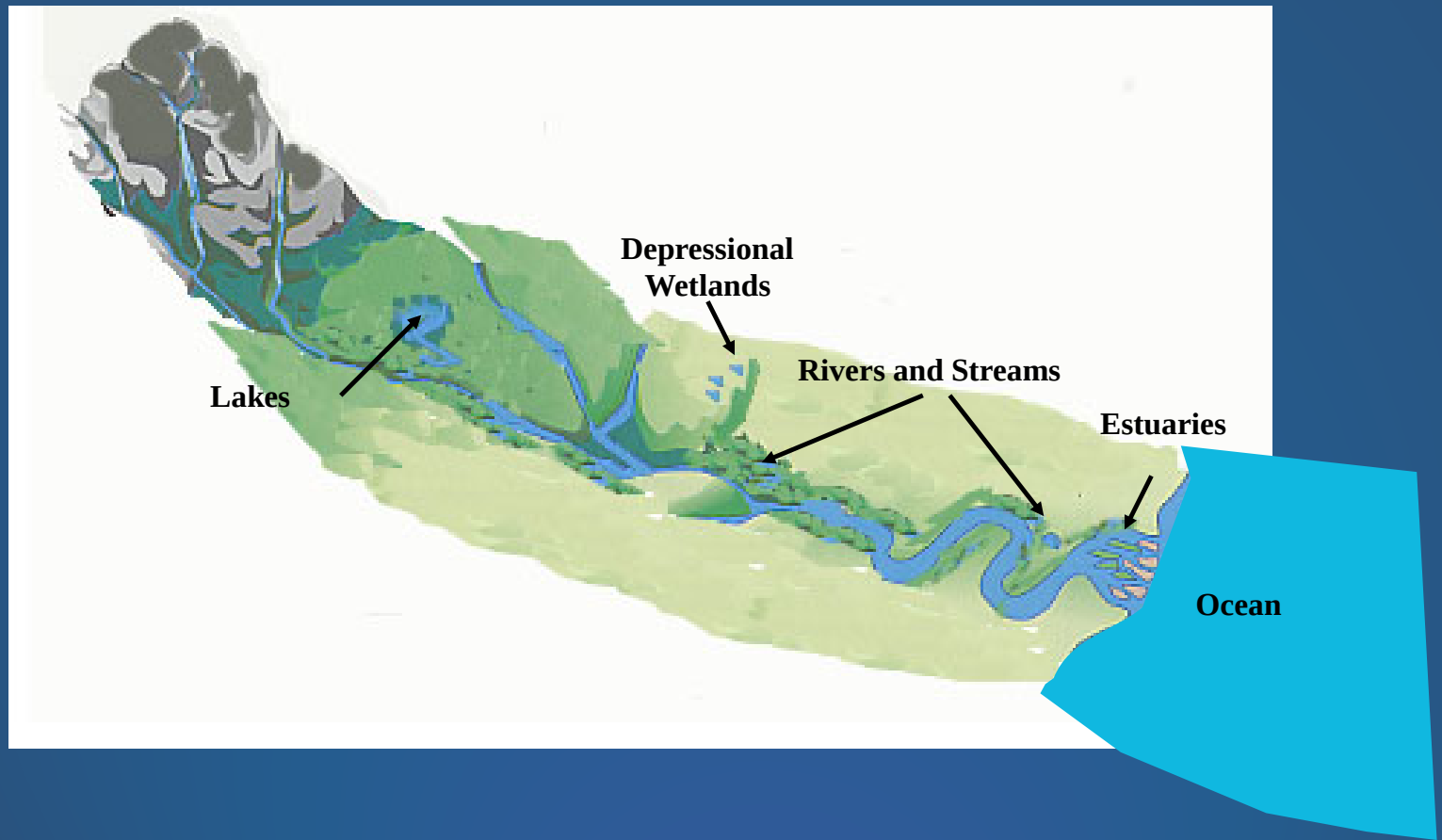
Hans W. Paerl[1] and Jef Huisman[2]

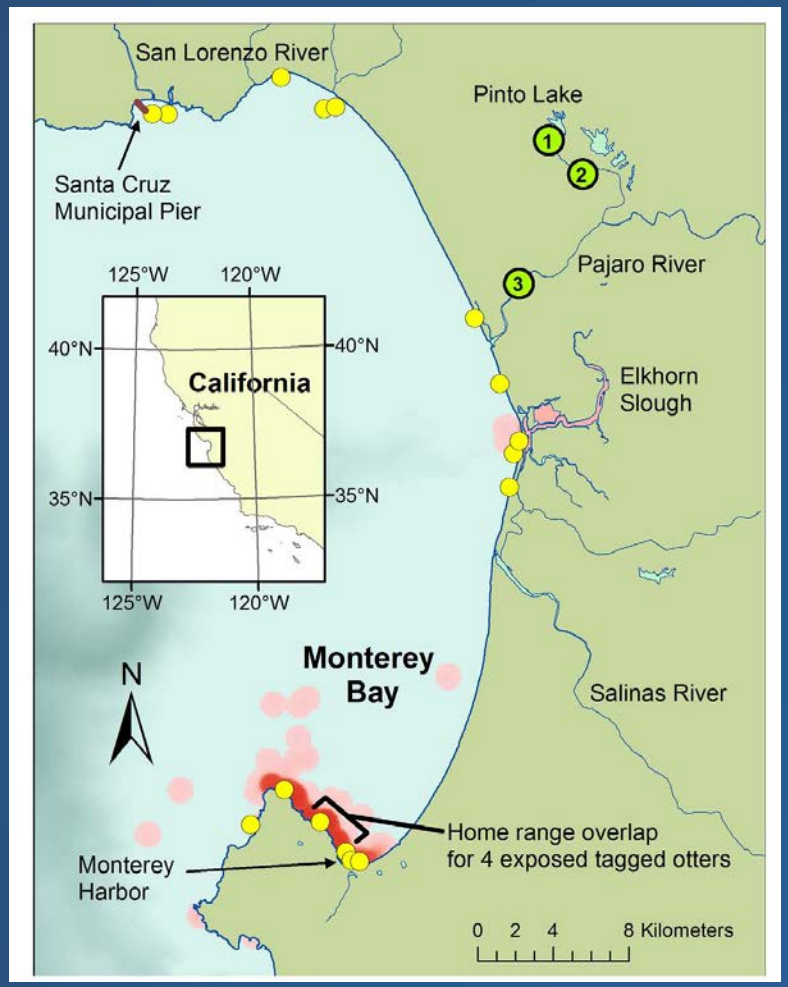
Paerl et al. 2009

# Freshwater Toxins Flow Downstream Through The Land-Sea Interface

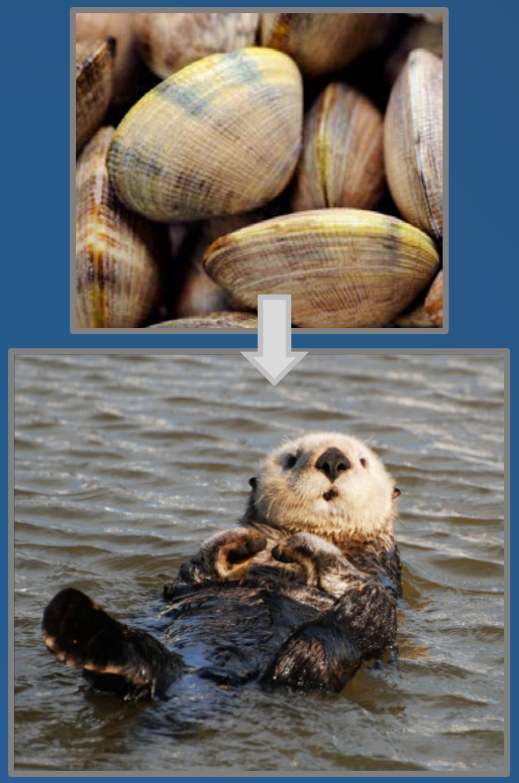
***Are Freshwater toxins a marine issue?***



# Far-Reaching Effects of Freshwater Toxins to Marine Waters




***Mortality of sea otters due to microcystin intoxication***



**Miller *et al.*, 2010**

Microcystins are persistent in the major watersheds that flow into the ocean in Monterey Bay (Gibble and Kudela, 2014)

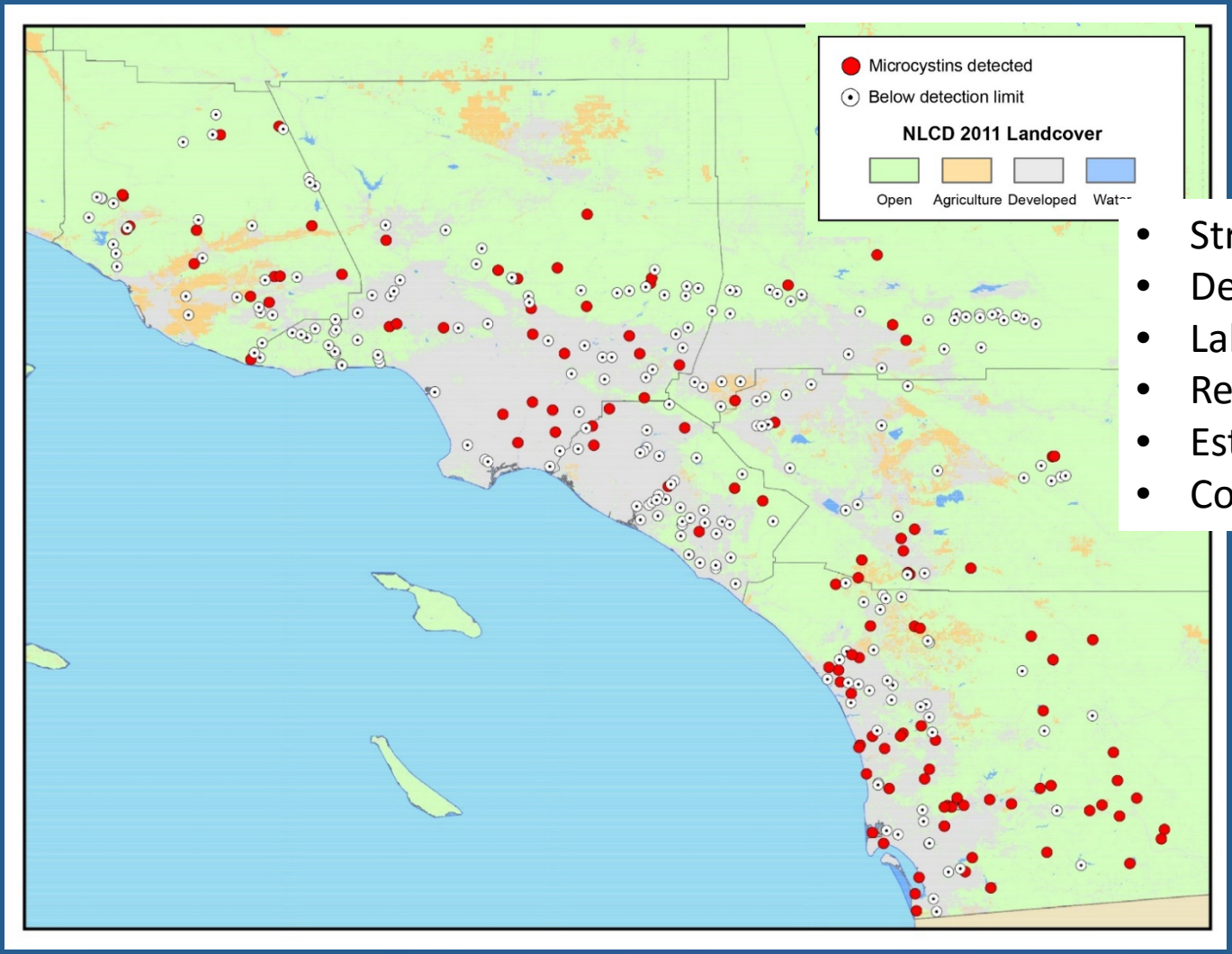
# SCCWRP's HAB Initiatives

- Marine
  - Observational studies on bloom development
- Freshwater
  - Regional survey in Southern CA
  - Statewide HAB strategy and method standardization
  - Development of new methods

# Southern CA Assessments for Cyanotoxins

- Regional Assessments
  - Wadeable streams
  - Depressional wetlands
- Targeted Assessments
  - Lakes and reservoirs
  - Estuaries and coastal lagoons

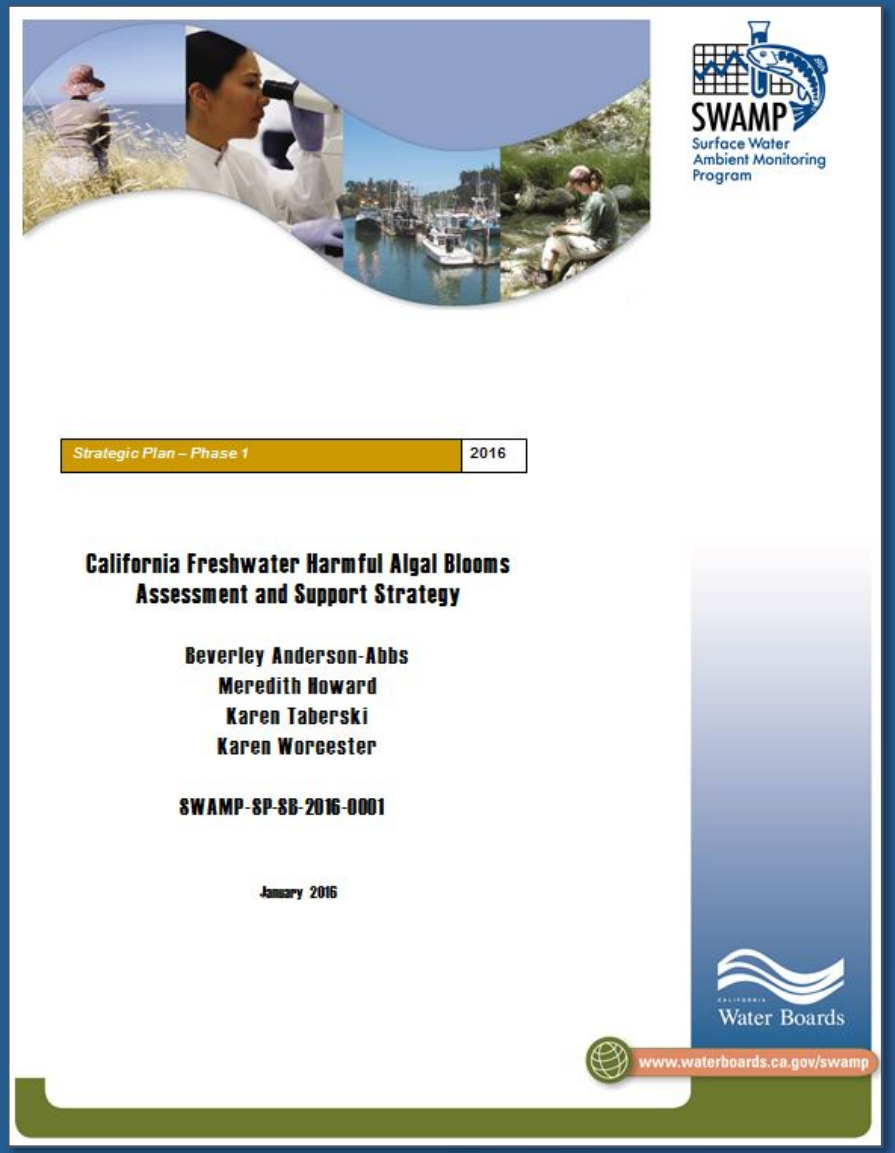
# Toxin Production Widespread Across Multiple Waterbody Types




- Streams
- Depressional Wetlands
- Lakes
- Reservoirs
- Estuaries
- Coastal lagoons

***Many loading sources of toxin to coastal waters in S. CA***

# California Freshwater HABs Strategy




- Currently, no routine monitoring programs for freshwater HABs
- Coordinated long-term program to assess, communicate, and manage freshwater HABs
- SWAMP investing resources to build infrastructure to support strategy

# Newly Developed Monitoring Tool for Toxins: SPATT

Solid Phase Adsorption Toxin Tracking (SPATT)

- Passive Sampler that is time-integrative
- Provides continuous toxin detection to capture ephemeral events
- Applicable to both marine and freshwater toxins
- Determines the prevalence and persistence of toxins

# Potential Future Initiatives

- Methods standardization and quality assurance
- HAB mitigation workshop
- Link HAB Models with nutrient and ocean models


Questions?
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