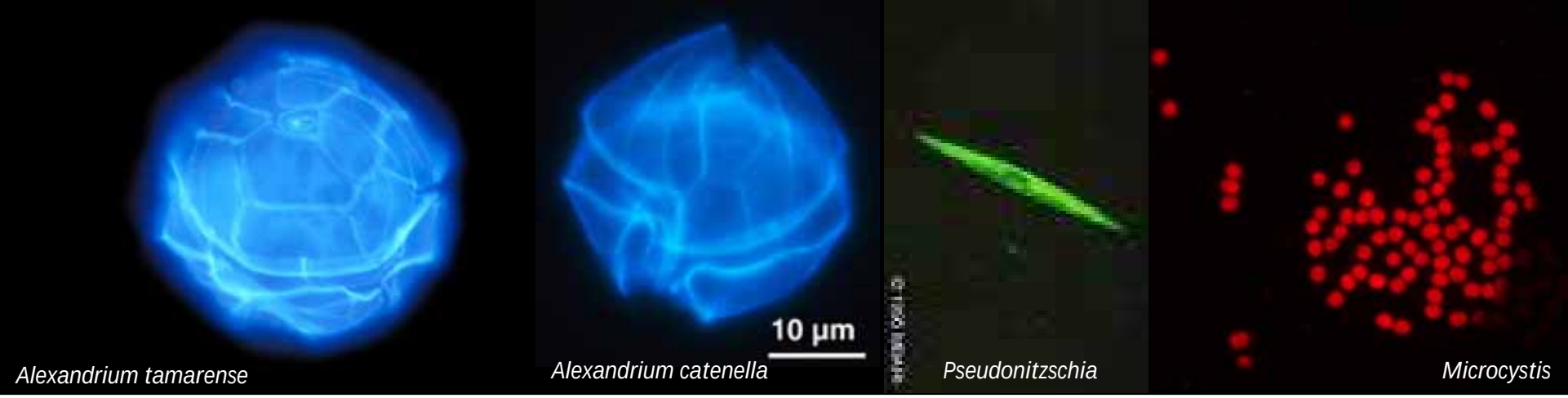


Does Ammonia control harmful algae abundance & toxicity in the San Francisco Estuary, CA?

Cécile E. Mioni & Adina Paytan
University of California, Santa Cruz

Overview

Goals:

- **Establishing a baseline**

- **Identifying drivers**

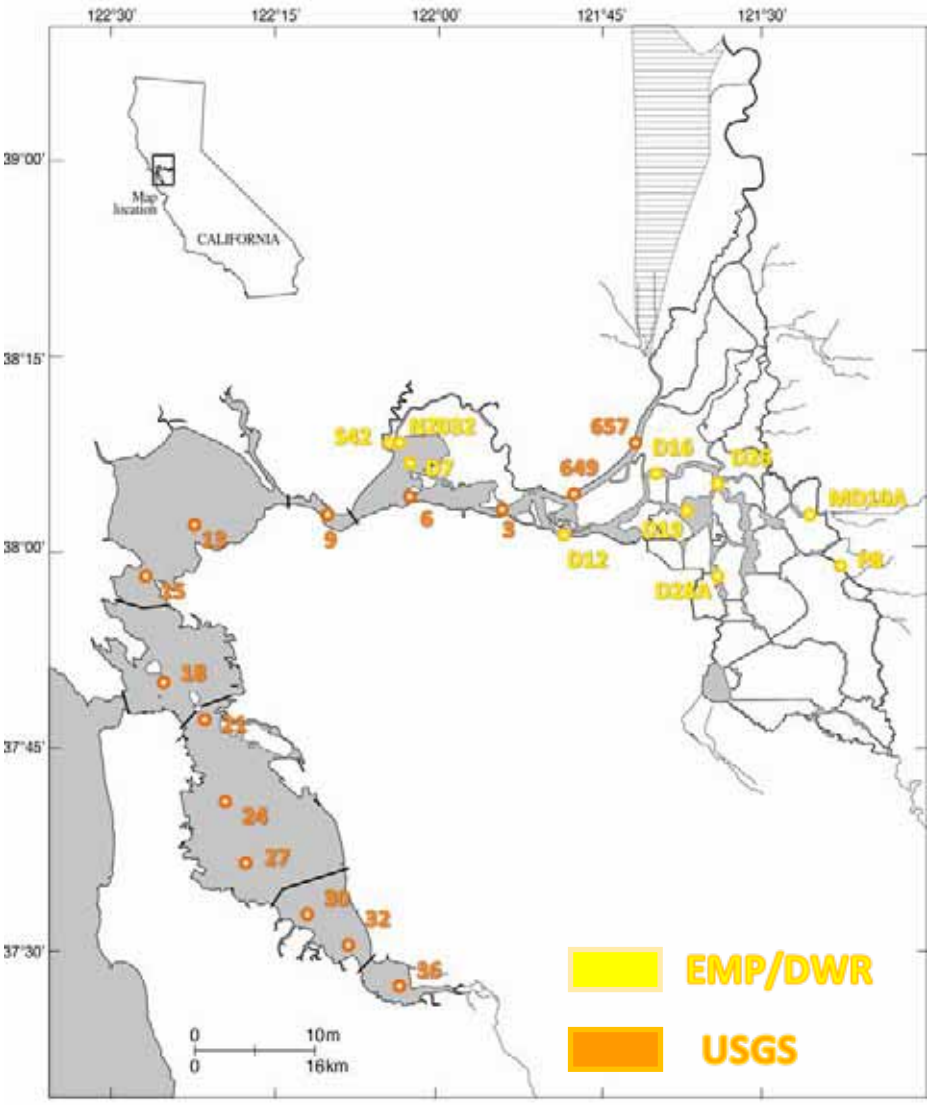
-**Build a predictive model**

Strategy:

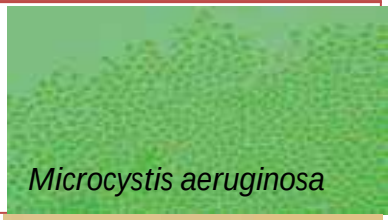
- Monthly monitoring

- 21 stations

- Variables: toxins, HA cells abundance, DOC, nutrients, trace metals, …

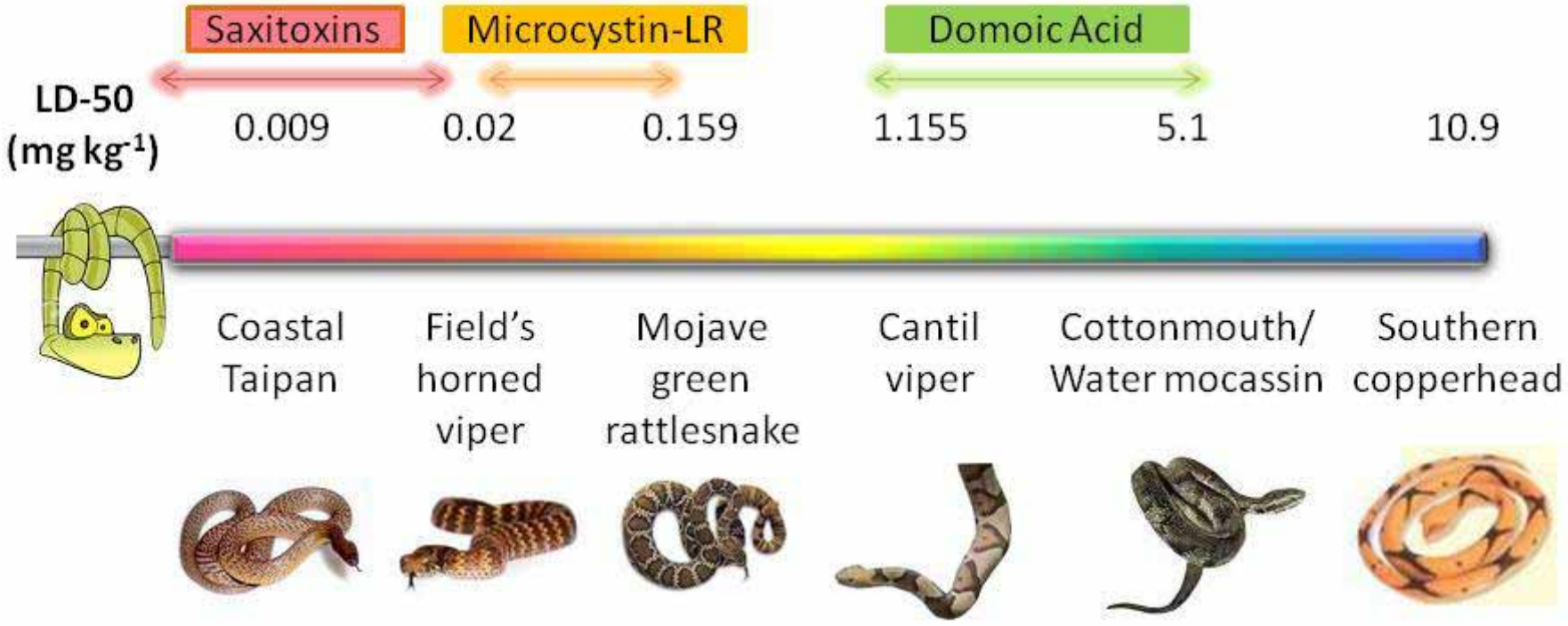


Toxins of interest

Toxin	Vector	Causative organism	
Microcystins (Hepatotoxins)	Drinking & Recreational waters	Cyanobacteria: Microcystis Anabaena Planktothrix	 *Microcystis aeruginosa*
Domoic Acid (Neurotoxin)	Shellfish	Diatoms Pseudo-nitzschia Red Algae (Japan) Chondria armata	 *Pseudo-nitzshia*
Saxitoxins (Neurotoxins)	Shellfish Puffer Fish	Dinoflagellates Alexandrium Gymnodinium Freshwater Cyanobacteria Anabaena Bacteria (?)	 *Alexandrium*  *Anabaena*

The Snake Scale

Comparison of Algal Toxins with some of the most venomous snakes in the world



Note: this comparison based on route of exposure (intraperitoneal). LD-50 can differ among different exposure routes.

(Source of LD-50s: http://www.venomdoc.com/LD50/LD50men.html)

Guidance Values

Table 1. World Health Organization guidancevalues for the relative probability of acute health effects during recreational exposure to cyanobacteria and microcystins, based on information presented in Chorus and Bartram 1999.

Relative Probability of Acute Health Effects	Cyanobacteria[1] (cells/mL)	Microcystin-LR[2] (μg/L)	Chlorophyll-*a*[3] (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

CA Environmental Protection Agency Department of Health Local agencies	Cell counts[1] Microcystin[2] Visual Assessment	40,000 to 100,000 cells/ml Microcystin ≥ 8 µg/L Scum associated with toxigenic species	Advisory/Closure

(Graham et al. 2009)

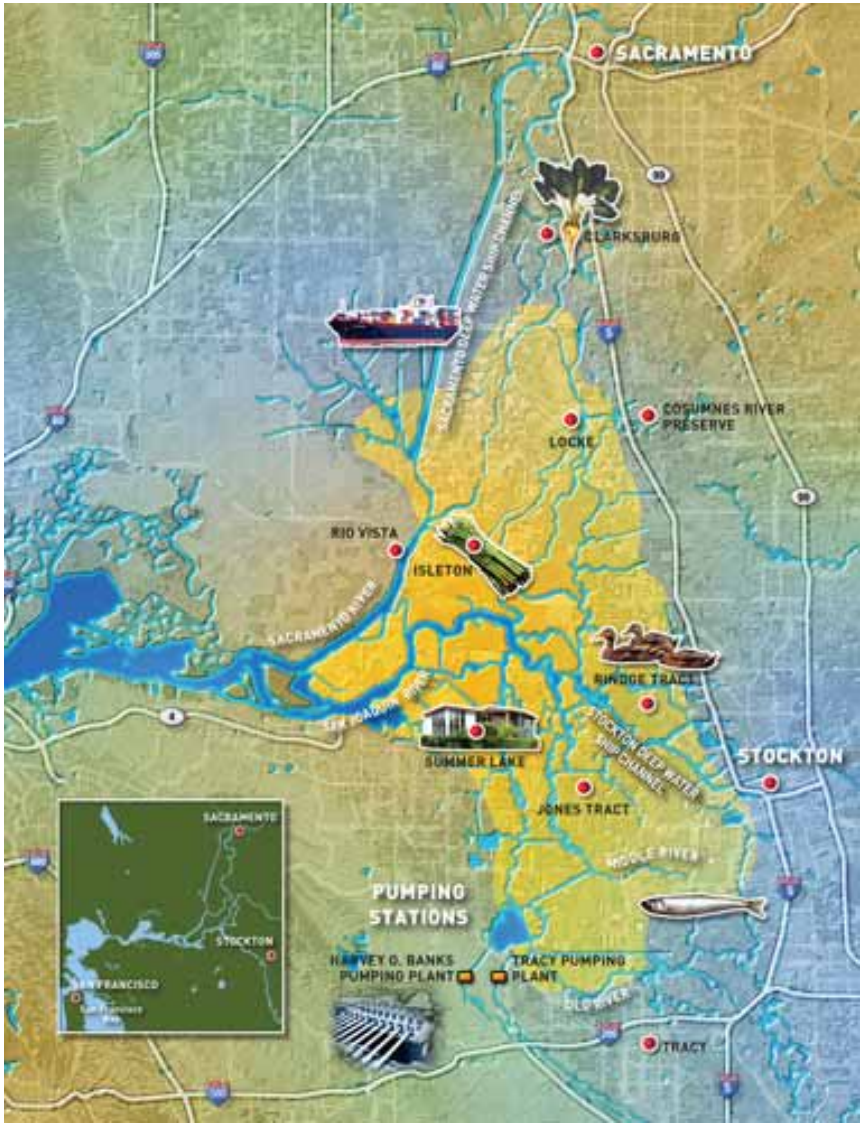
SF Estuary: territory of outsize importance

SF Estuary/Delta

- Water diverted for agricultural, industrial & domestic uses
- Recreational area (fishing, water contact sports)
- Habitat of endangered species (Delta smelt, chinook salmon, sea otters,...)

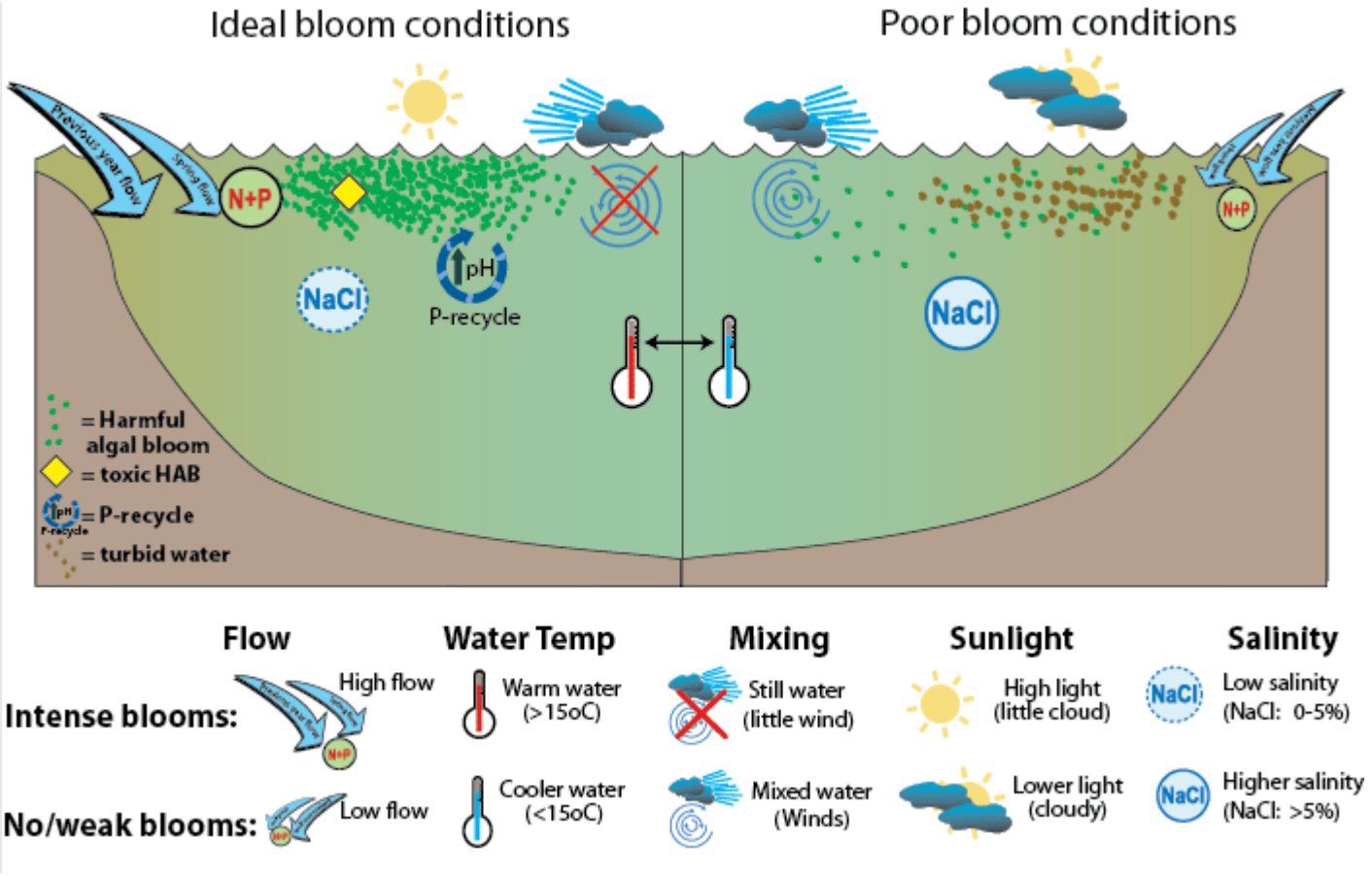
Microcystins exposure

- is linked to cancer in human and wildlife (Carmichael 96, Christoffernsen 96)
- reduce zooplankton feeding success (Kirk & Gilbert, 92)
- Impact fish food quality (Ger et al. 09)
- can kill crops (Allen.Milligan@science.oregonstate.edu)

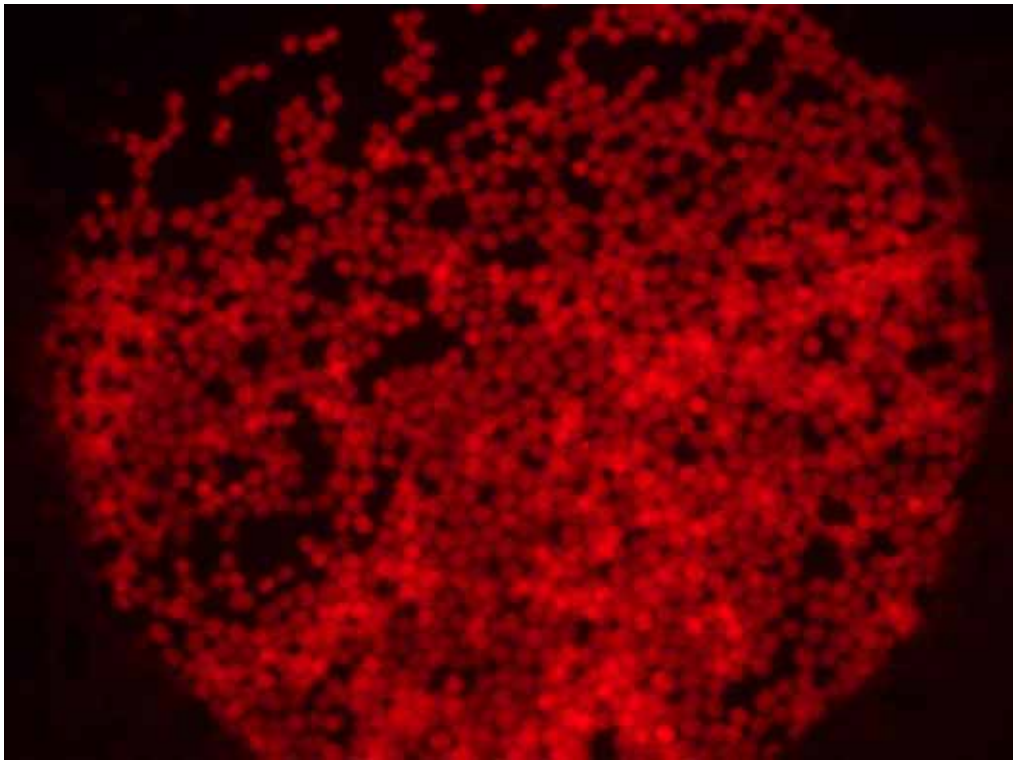


http://www.onearth.org/files/onearth/article_images/08fal_sacramento_f_slideshow.jpg

Microcystis blooms : Environmental drivers

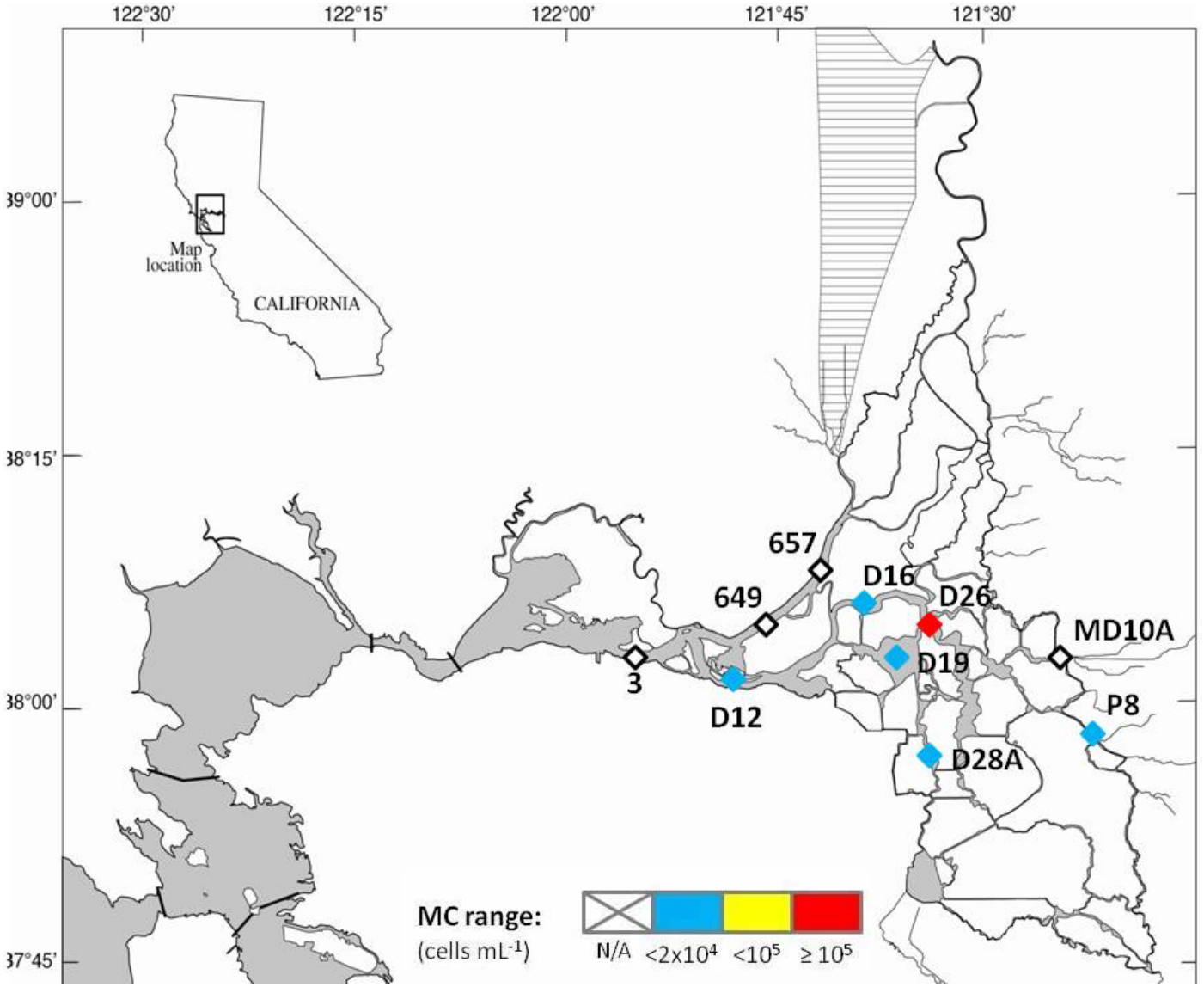


http://www.eco-check.org/forecast/chesapeake/2009/methods/



DOES NH_4^+ INFLUENCE MICROCYSTIS ABUNDANCE?

June 2009


122°30'
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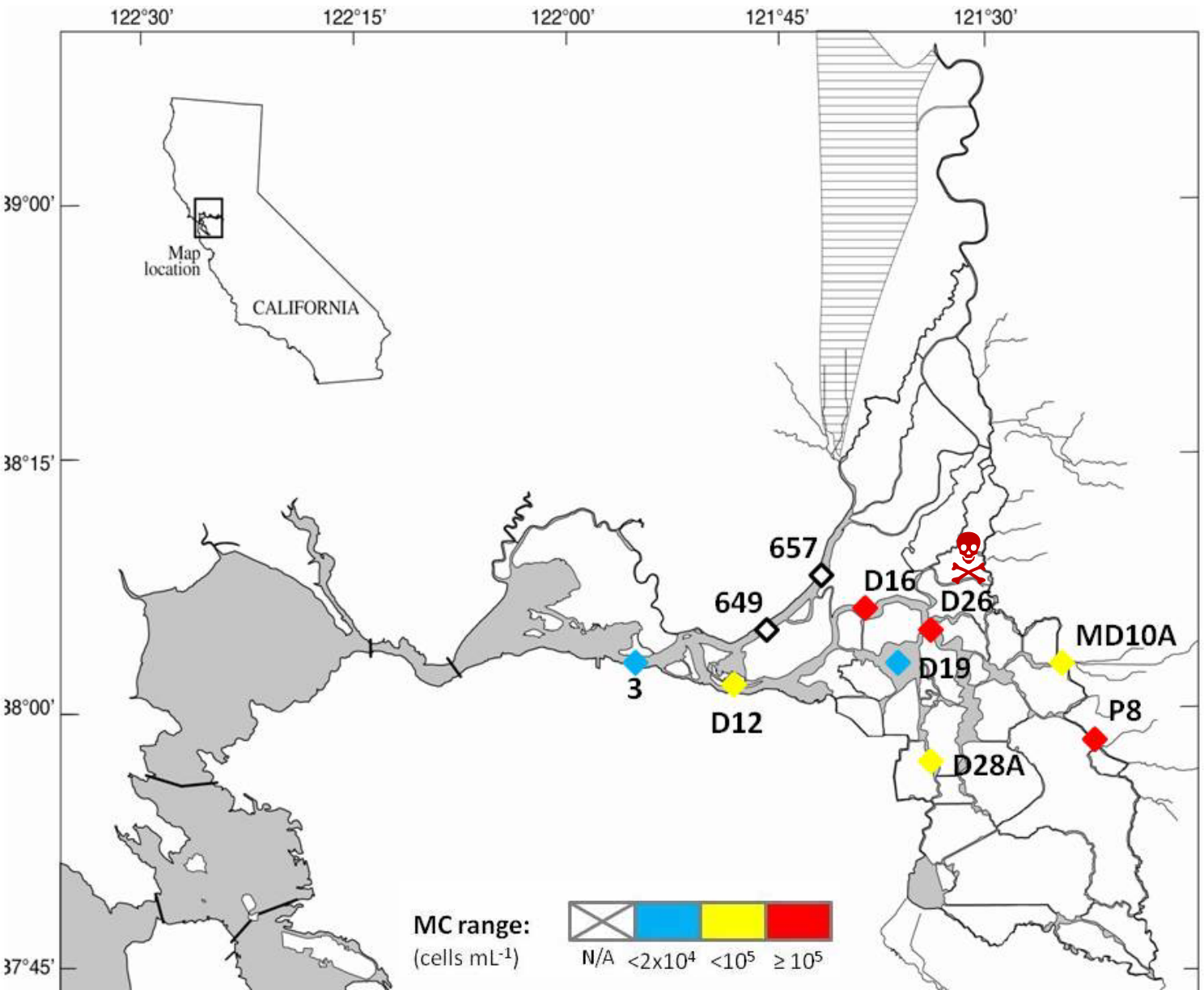
39°00'
38°15'
38°00'
37°45'
Map location
CALIFORNIA
657
649
3
D12
D16
D26
D19
MD10A
P8
D28A
MC range:
(cells mL-1)
N/A
<2x10⁴
<10⁵
≥ 10⁵

July 2009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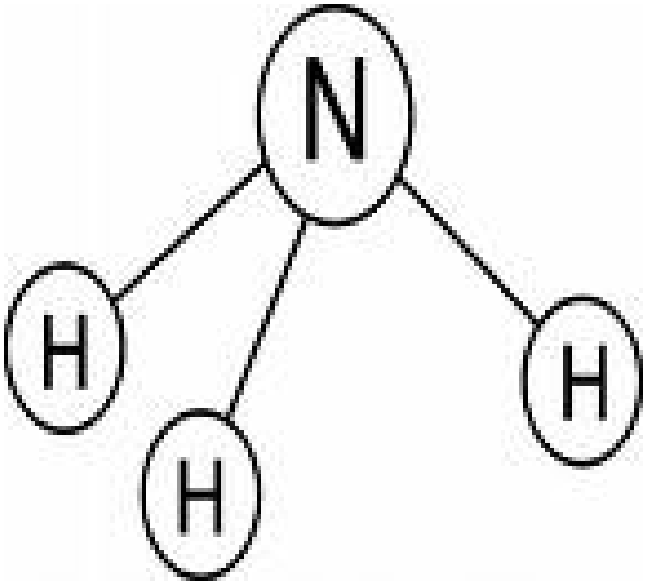

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DOES AMMONIA INFLUENCE THE PRODUCTION OF OTHER TOXINS?

Conclusion

- Microcystis abundance appears to be positively correlated with NH_4^+
- Microcystins levels do not appear to be correlated with NH_4^+
- Previous work suggest that :
  - non N-fixing cyanobacteria success depends on the form of inorganic N present (Blomqvist et al. 1994, Jacoby et al. 2000)
  - *M. aeruginosa* prefers NH_4^+-N over NO_3^--N as N source (Kappers 1984)
  - NH_4^+-N availability stimulate buoyancy in cyanobacteria (Spencer & King, 1985, 1987)
  - Dominance of *M. aeruginosa* is associated with low N:P (Smith 1983; <30: Jacoby et al. 2000)
  - Microcystins production is reduced under N-limitation (Downing et al. 2005)

Acknowledgements

UCSC
Paytan Lab
Rob Franks & Marine Analytical Lab
Kudela Lab
Silver Lab
Zehr Lab
Brandon Carter - MEGAMER facility
Pia Moissander & Rachel Foster

Department of Water Resources
Environmental Monitoring Program staff
** Scott Waller, Gregg Schmidt, Eric Santos, Rich Breuer, & Karen Gehrts **

CALFED-IEP
Anke Mueller-Solger

USGS
SF Bay Water Quality Monitoring
** Cloern Lab, Lisa Lucas**

Department of Fish & Game
Gloria Blondina & Dave Crane

MBARI
Tim Pennington, Chavez lab

Funding:

CALFED BAY-DELTA PROGRAM

Postdoctoral Fellowship
California Bay-Delta Authority Agreement No. U-04-SC-005

SRCSD
Sacramento Regional County Sanitation District

Postdoctoral Fellowship
Sacramento Regional County Sanitation District Agreement No. 93597