Benthic cyanotoxin production in California streams

Betty Fetscher[1]
Meredith Howard[1]
Rosalina Stancheva[2]
Raphael Kudela[3]
Eric Stein[1]
Martha Sutula[1]
Lilian Busse[4]

[1]*Southern California Coastal Water Research Project;*

[2]*California State University San Marcos;*

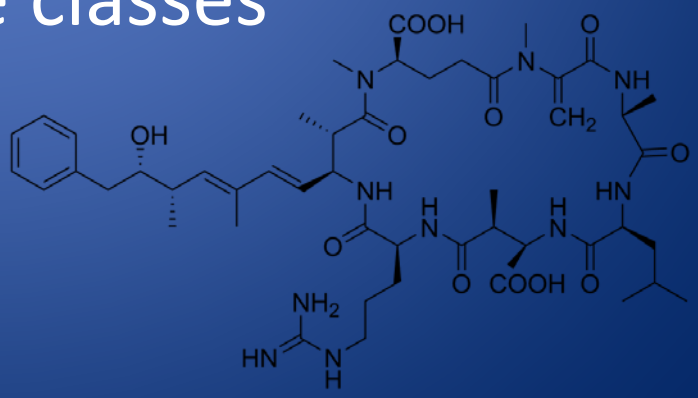
[3]*University of California, Santa Cruz;*

[4]*San Diego Regional Water Quality Control Board*

What are cyanotoxins?

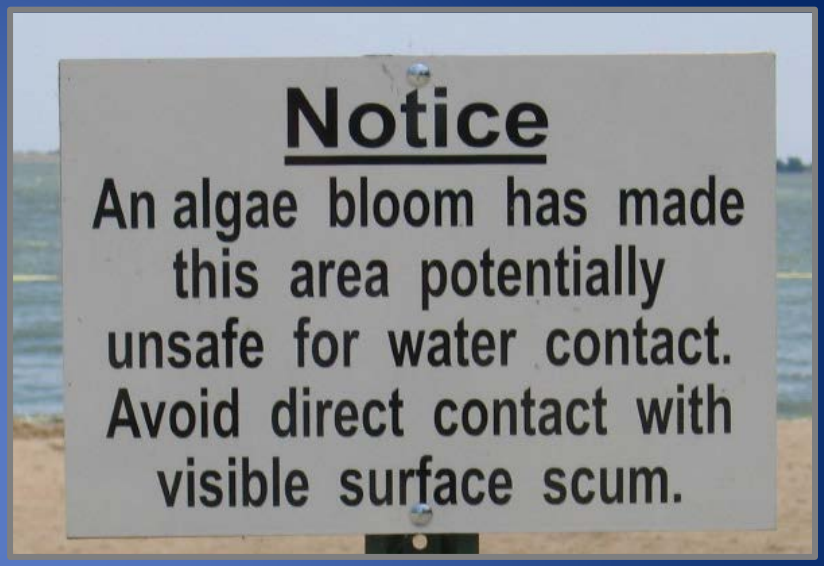
- Naturally occurring; produced by cyanobacteria

- > 90 described, multiple classes
- Persistent
- Bioaccumulate



Why care about cyanotoxins?

- Sickness in humans
- Mortality of domestic animals and wildlife



- Increasing problem

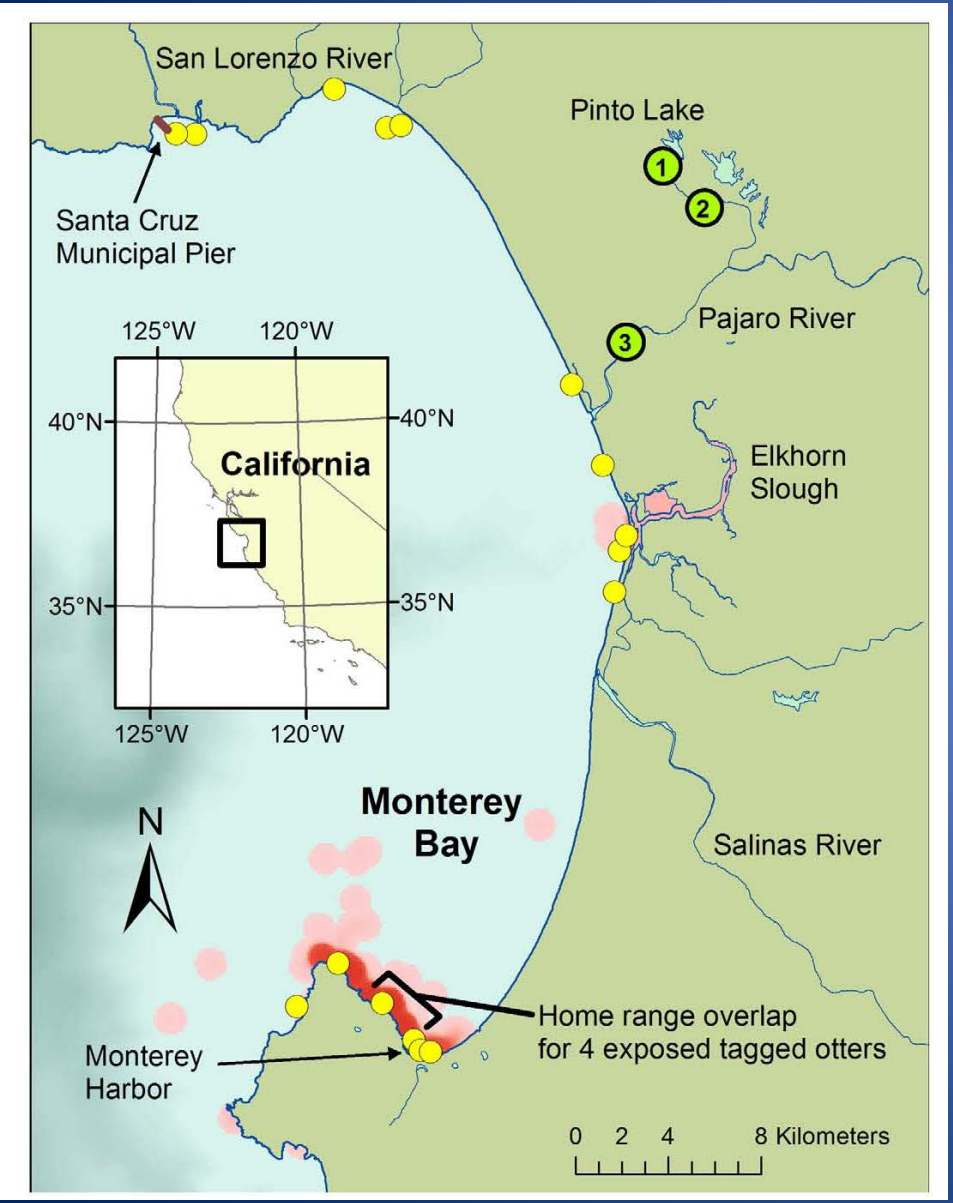
  (Paerl *et al.*, O'Neil *et al.*)

  – expanding distribution

  – more frequent

  – lasting longer

Cyanotoxins: far-reaching effects



Mortality of sea otters due to microcystin intoxication

Miller *et al.*, 2010

Several potentially cyanotoxin-producing taxa recorded in CA streams

15 genera (5 species)

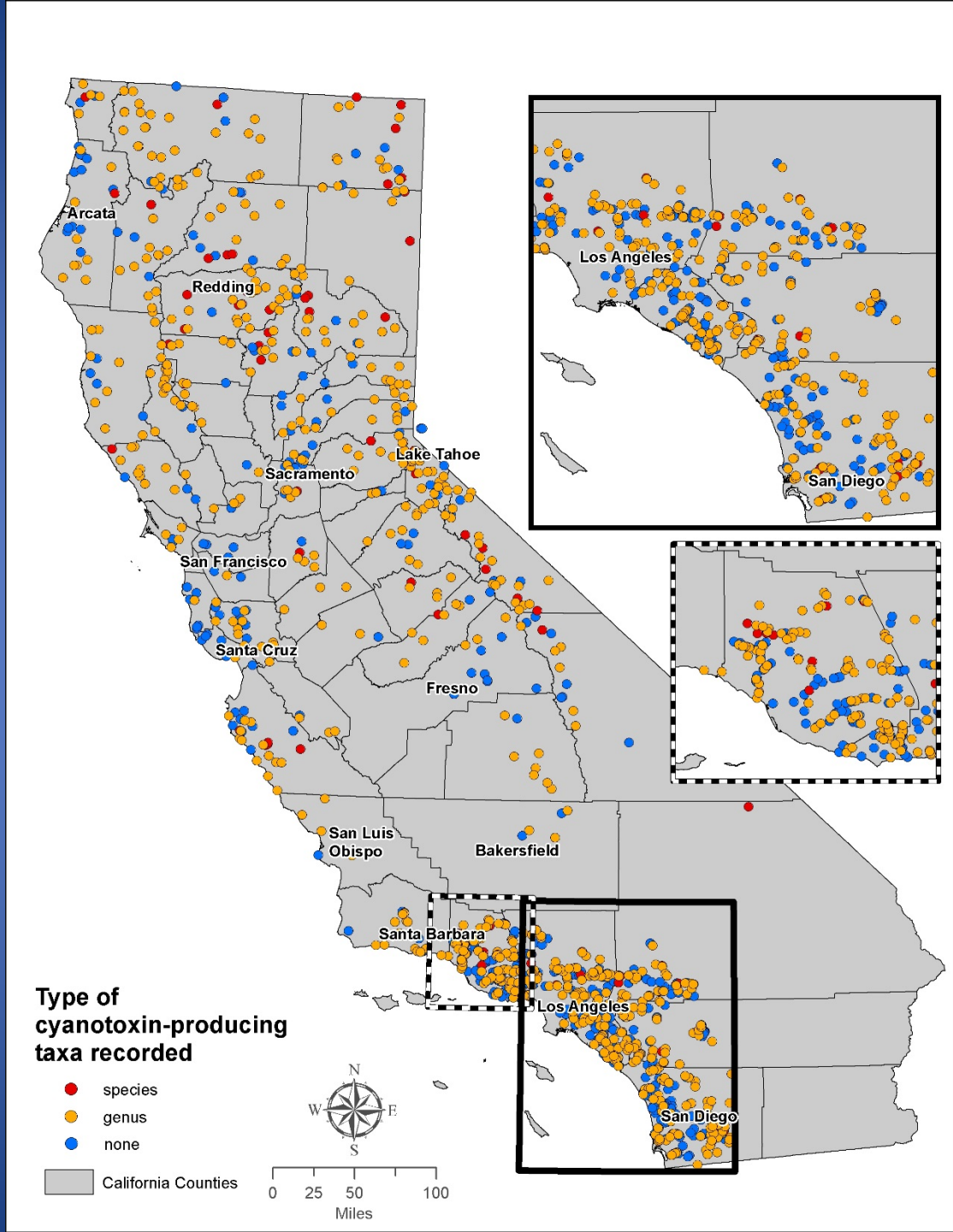
→13+ possible toxins

Genus	anatoxin	aplysiatoxin	B-Methylamino alanine	cylindrospermopsin	debromoaplysiatoxin	dermatotoxins	LPS endotoxins	lyngbyatoxin	microcystins	neosaxitoxins	nodularins	pahayokolide	saxitoxins	Species
Anabaena	X			X					X	X			X	
Anabaenopsis									X					
Arthrospira									X					
Cylindrospermum									X					
Hapalosiphon									**X**					*Hapalosiphon hibernicus*
Lyngbya		X		X	X	X		**X**	X			X	X	*Lyngbya majuscula*
Microcystis									X					
Nodularia									X		**X**			*Nodularia spumigena*
Nostoc									X					
Oscillatoria		X		X		**X**	X		X					*Oscillatoria nigro-viridis*
Phormidium			X	X					X					
Planktothrix			**X**	X					**X**				X	*Planktothrix agardhii*
Schizothrix		X					X							
Snowella									X					
Synechococcus			X											

Distribution of cyanobacterial "toxic taxa" collected in CA wadeable streams

2007 - 2013
(1,280 sites,
mostly 1-time sampling)

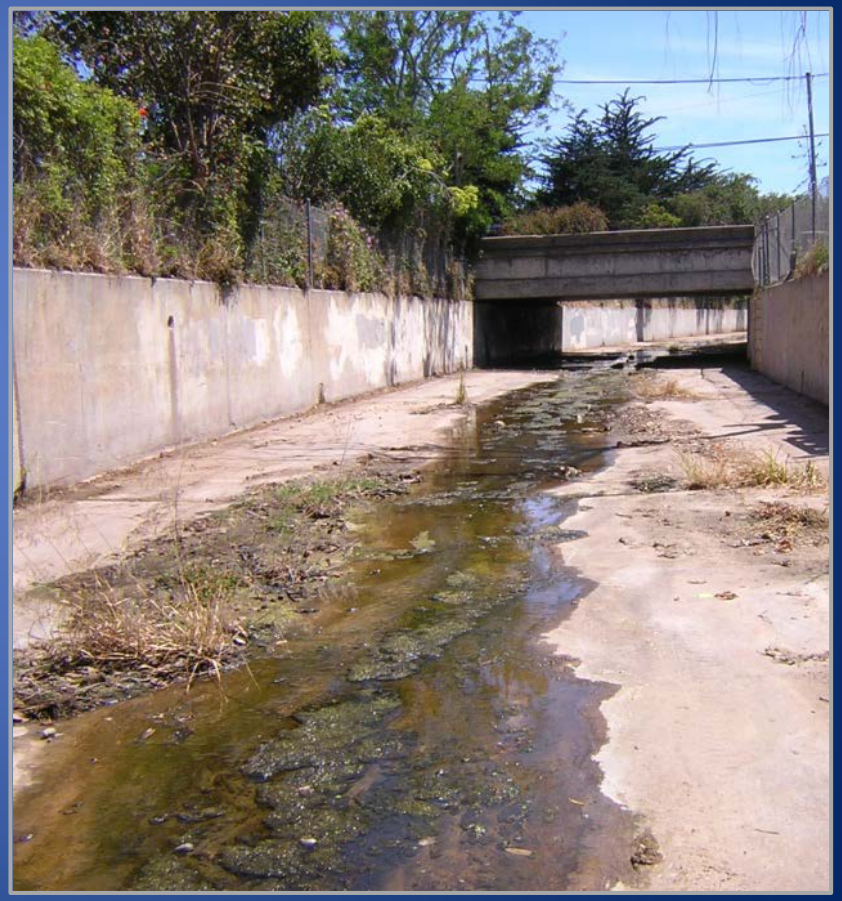
60% of sites support "toxic genera";
of those,
10% support known "toxic species"



Are benthic cyanobacteria producing toxins? Should we be concerned?

- Potential loading source (local, remote impacts)

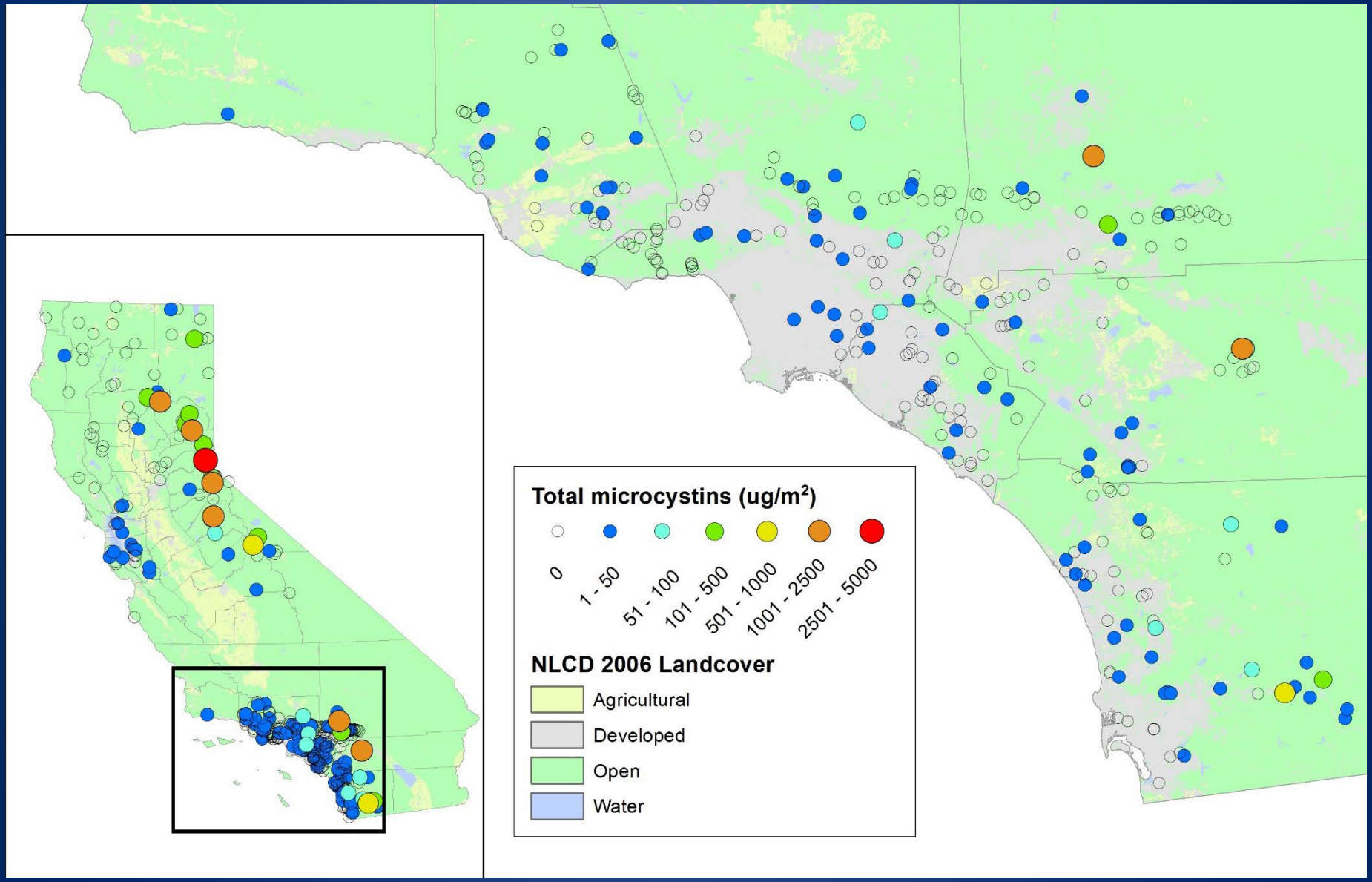
- Toxin production possibly exacerbated by :
  - Loss of riparian habitat/shading
  - Hydromodification; stagnation
  - "Perennialization" of intermittent streams by nuisance flows

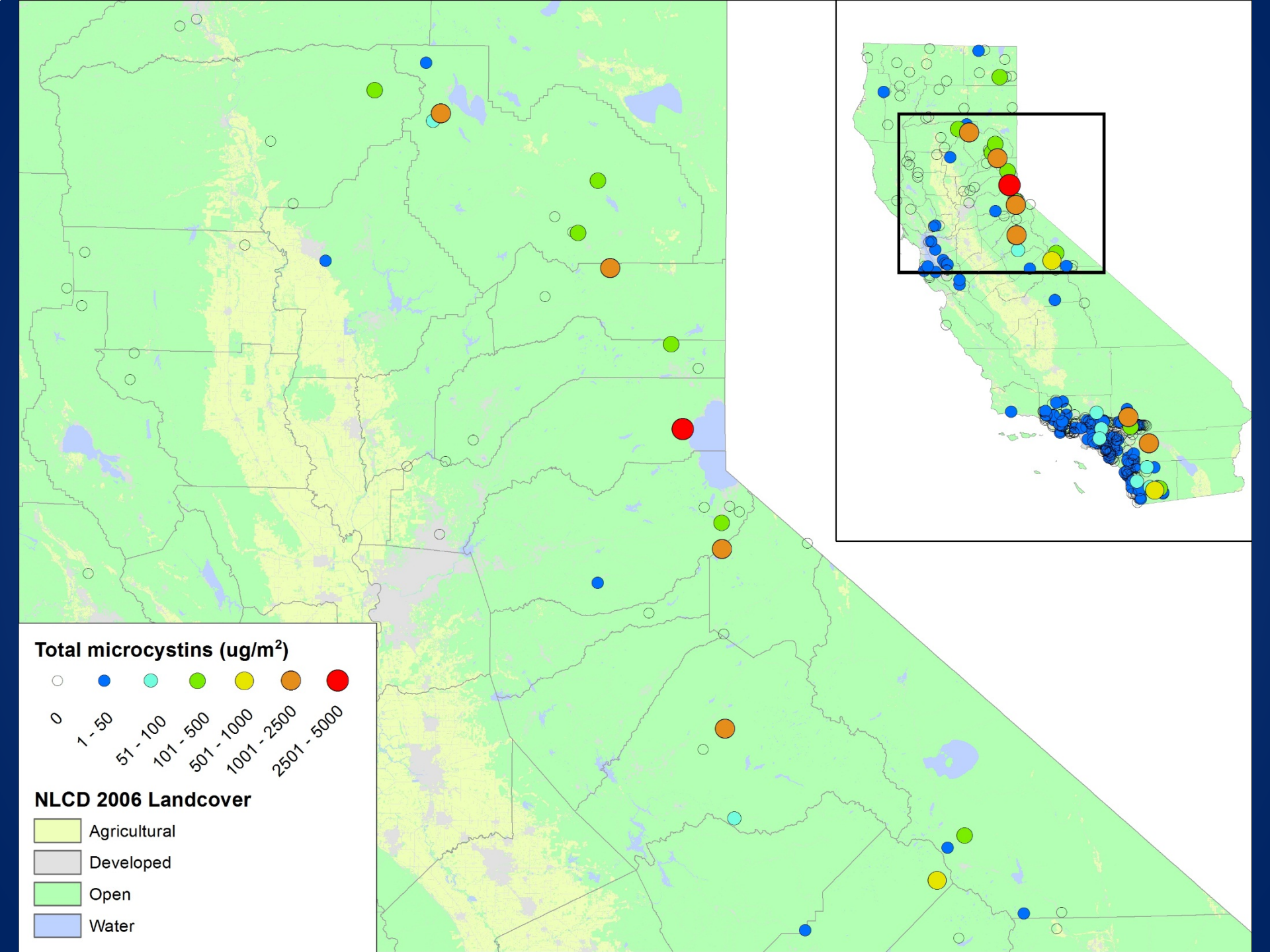


Benthic cyanotoxin detection rates in CA streams (2011-2013)

	Total Microcystins	Lyngbya-toxin	Saxitoxin	Anatoxin	Cylindro-spermopsin	Nodularin
% detects	33	21	5	3	0	0
# sites analyzed	368	14	101	33	14	14

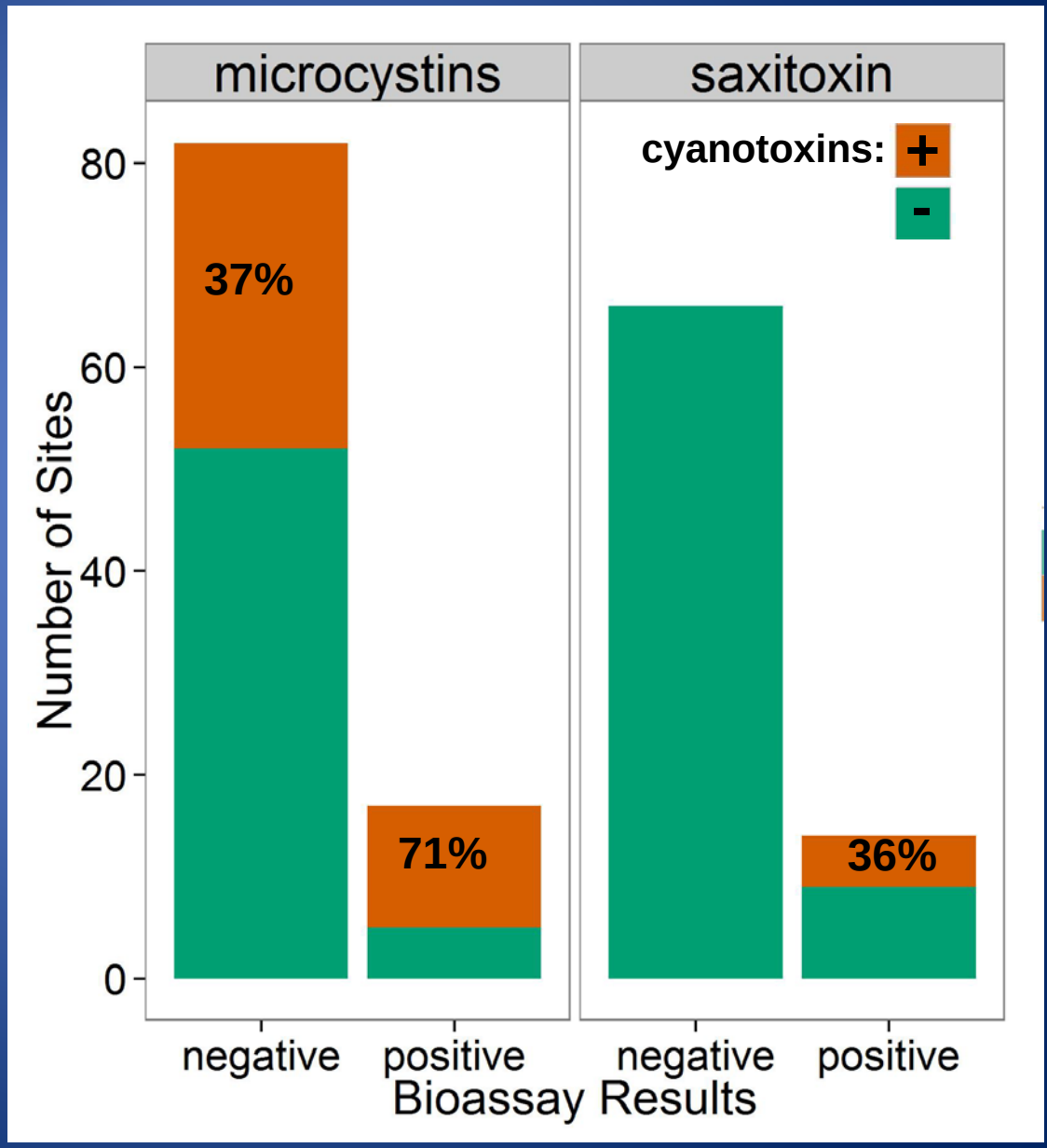
Distribution of [total microcystins] in California wadeable streams (2011-2013)




Total microcystins (ug/m²)
0
1 - 50
51 - 100
101 - 500
501 - 1000
1001 - 2500
2501 - 5000
NLCD 2006 Landcover
Agricultural
Developed
Open
Water

Could cyanotoxins help explain toxicity in undeveloped catchments?

Higher frequency of cyanotoxin detection among sites positive for toxicity based on bioassay



Burning Questions

- Do cyanotoxins (or cyanobacterial extracts) influence bioassay results?
- How do cyanotoxins affect stream food webs, aquatic life?
  - Study (Aboal et al.) found evidence for cyanotoxin impacts to benthic macroinvertebrates
  - Influence IBI interpretation
- What is significance of stream cyanotoxin loading to receiving waters?
- Do anthropogenic factors influence cyanotoxin production in streams?

Acknowledgements

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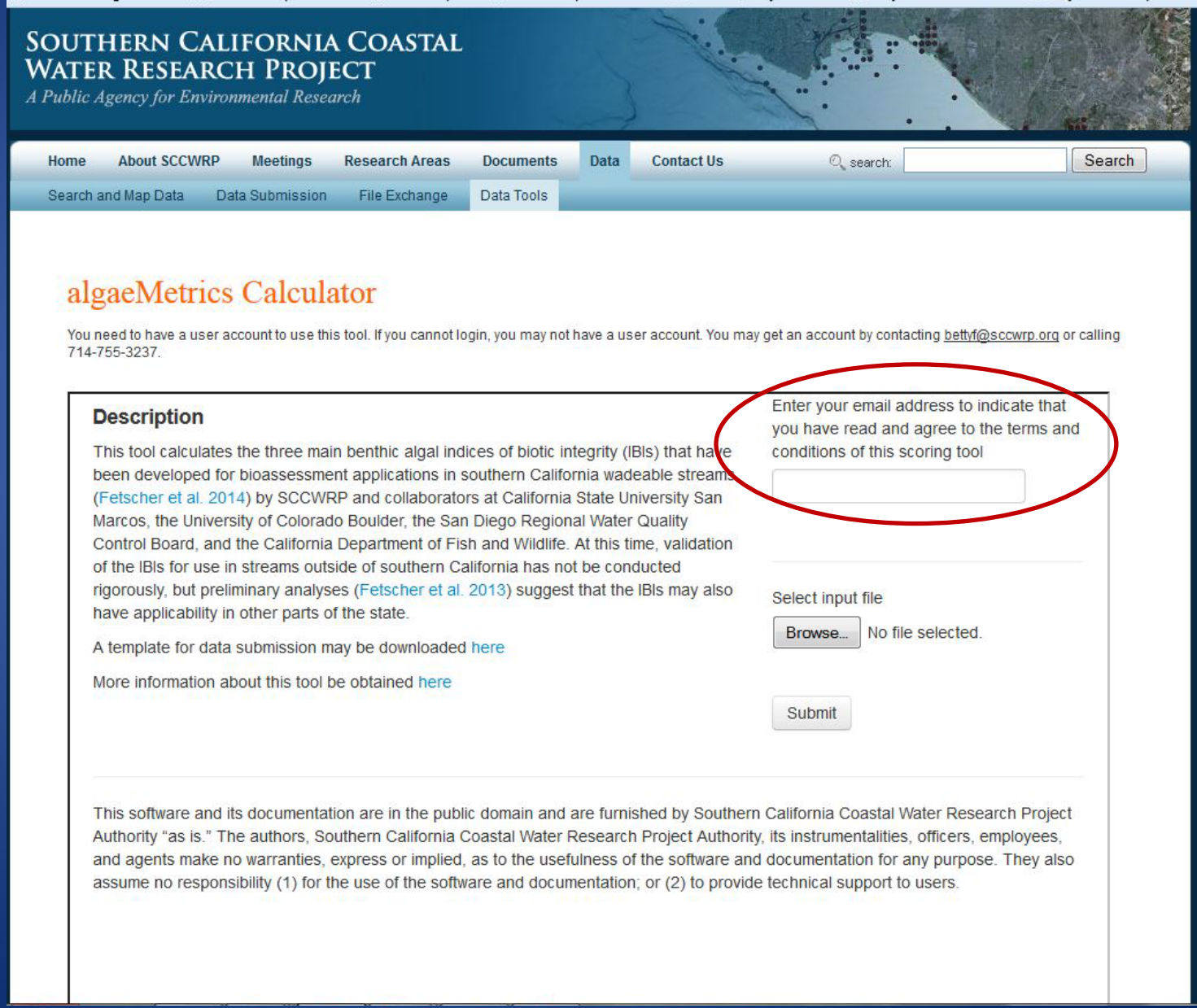
- Analyses: David Tsukada, Kendra Negrey, Becky Schaffner, Abel Santana

Public Service Announcement:

online algae IBIs calculator now available

… for non-SWAMP users …



More information:

Betty Fetscher

bettyf@sccwrp.org

714-755-3237

Stream benthic cyanotoxin sampling

- Quantitatively scrape/brush biofilms from substrata & take cuttings from algal mats
- Homogenize into slurry
- Filter measured amount on glass-fiber filter; store frozen
- ELISA (LC-MS)