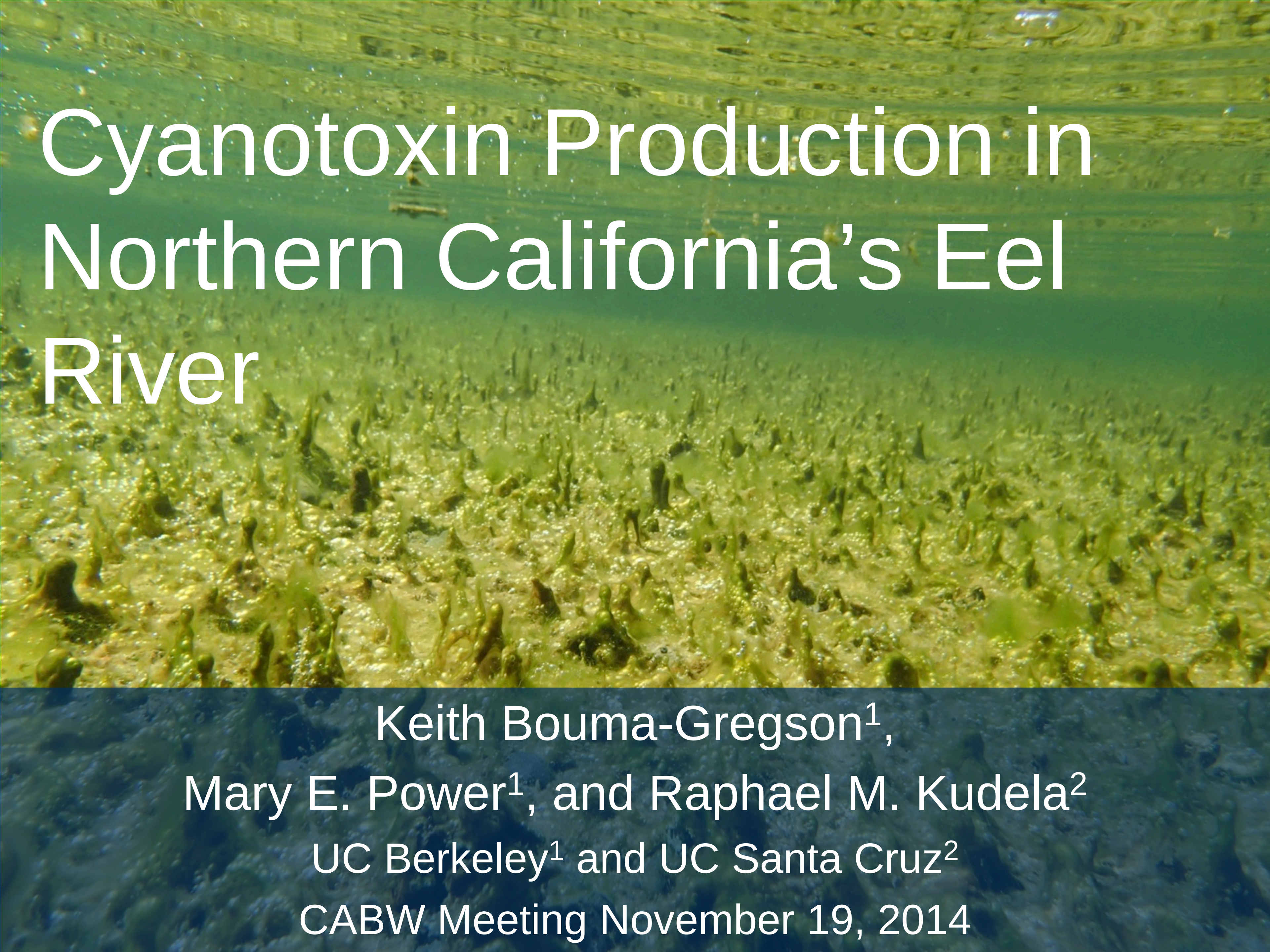
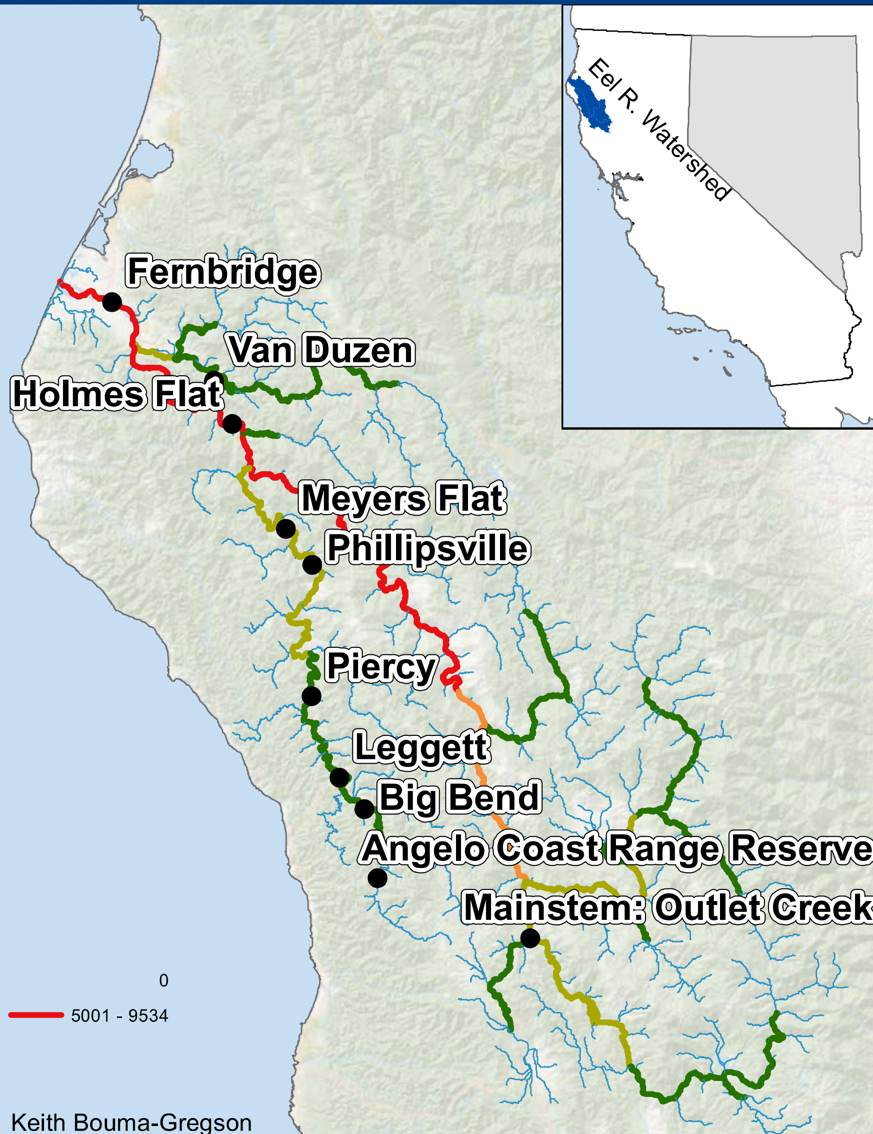
Cyanotoxin Production in Northern California's Eel River



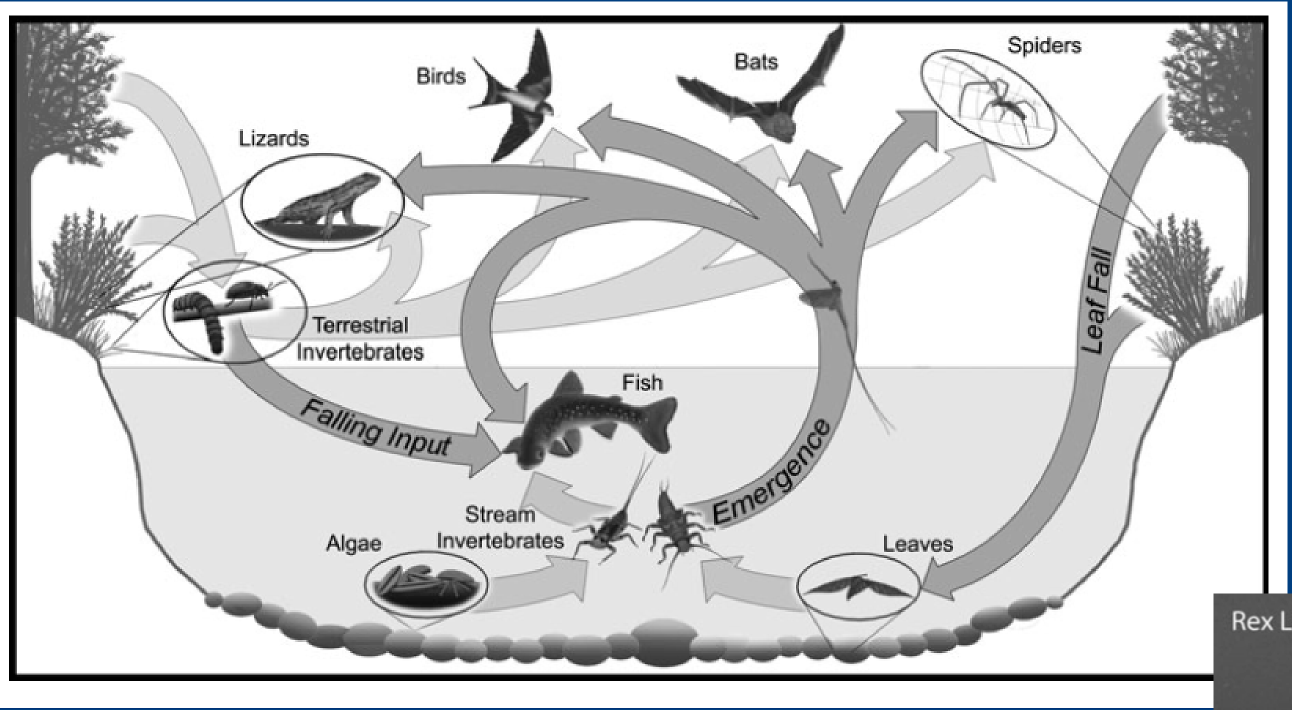
Keith Bouma-Gregson[1],
Mary E. Power[1], and Raphael M. Kudela[2]
UC Berkeley[1] and UC Santa Cruz[2]

CABW Meeting November 19, 2014

The Eel River



Algae fuel aquatic summer food webs

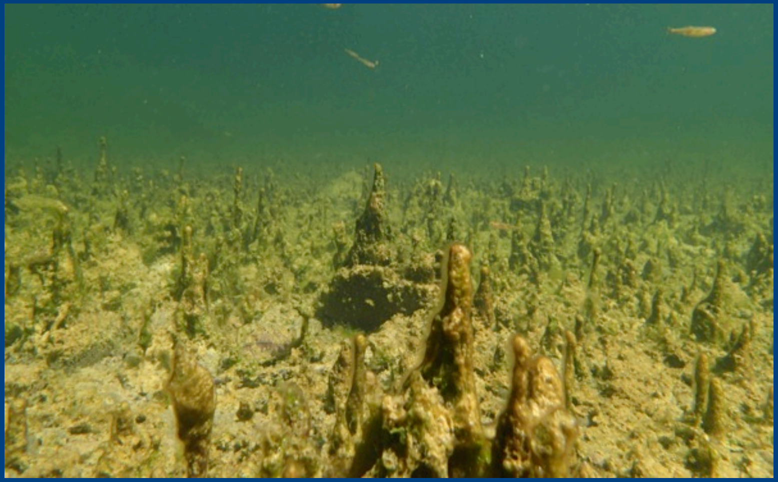


Baxter et al. 2005, *FW Bio.*

Power et al. 2009, *FW Bio.*

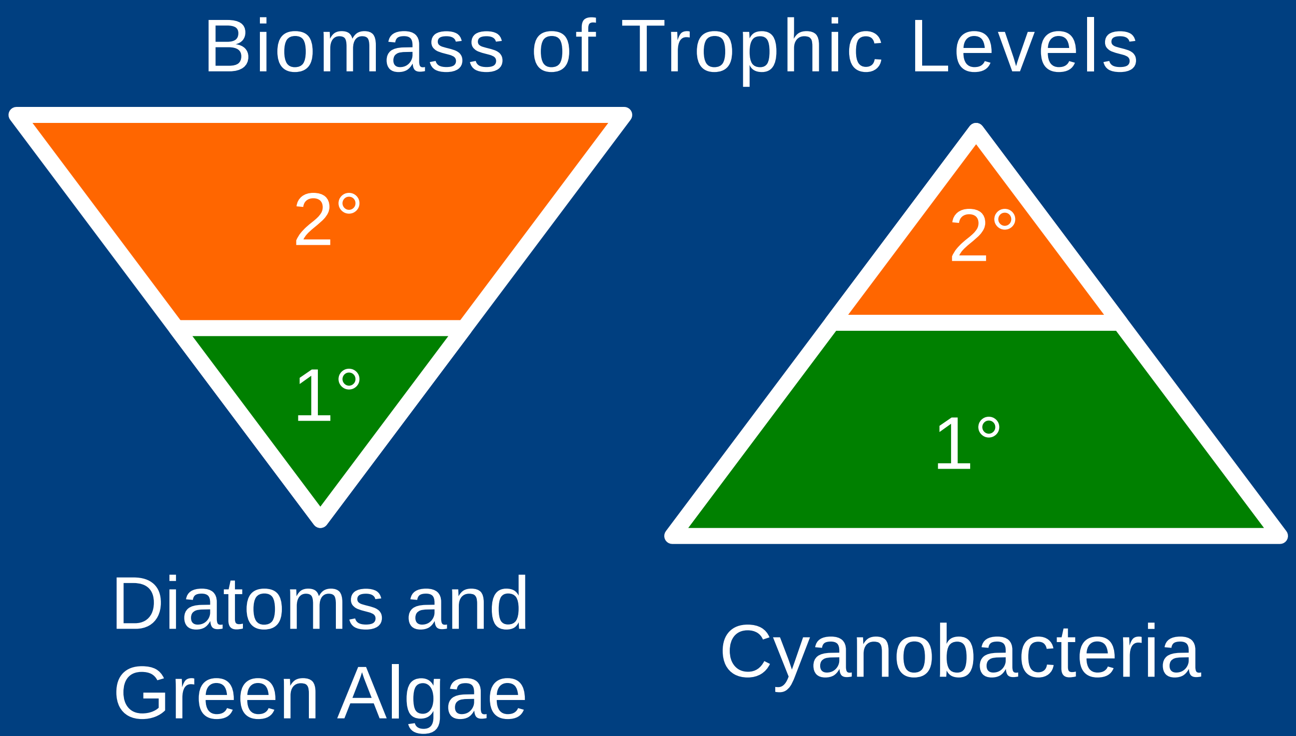
Algae kills dogs in the Eel river

Algal assemblages can tip towards toxic cyanobacteria



Potential consequences of cyanobacteria blooms

1. <u>Altered aquatic food webs and reduced secondary production</u>



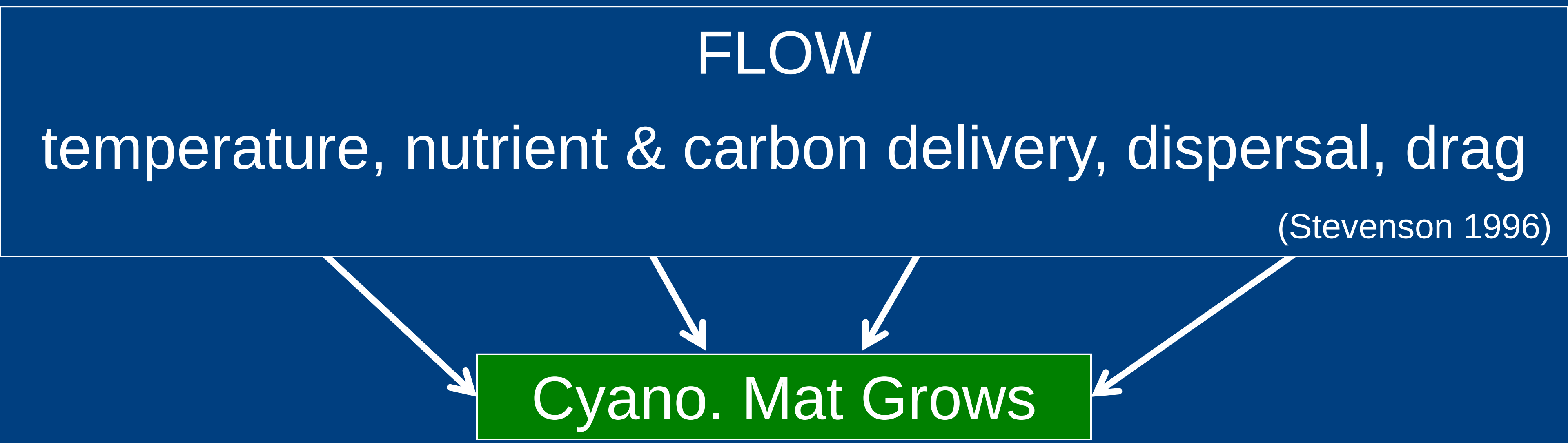
Lamberti and Resh 1983, *Ecology* Scott and Marcarelli 2012

Potential consequences of cyanobacteria blooms

2. <u>Cyanotoxin production and public health threats</u>

- Focal cyanotoxins:
    - Microcystins: liver toxins
    - Anatoxin-a: neurotoxin
- Swimming warnings posted by Humboldt Co.
- 11 dog deaths (Backer et al. 2013, *Toxins*)

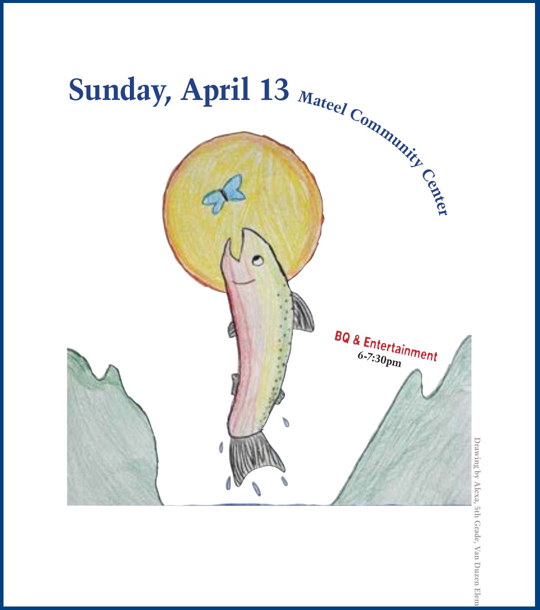
Factors associated with cyanobacteria blooms



Citizen science and outreach

Eel River Recovery
PROJECT

www.eelriverrecovery.org



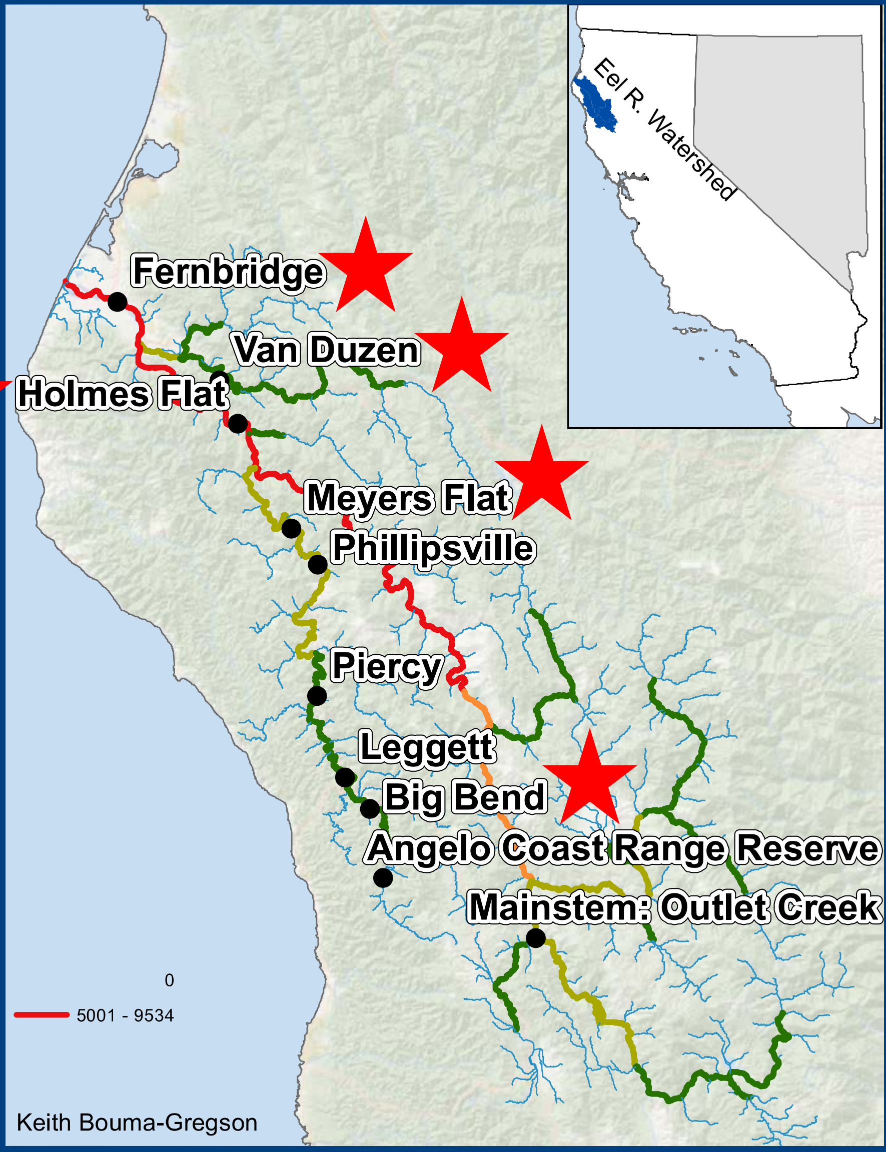
Phillipsville Sep-2013

Angelo Jun-2013

What is the temporal and spatial distribution of cyanobacteria in the Eel River?

Monitoring sites:

- Visited weekly June – Sep. 2013 and 2014
- Collected algal samples
- Cyanotoxin concentrations, temperature, TDN, and TDP



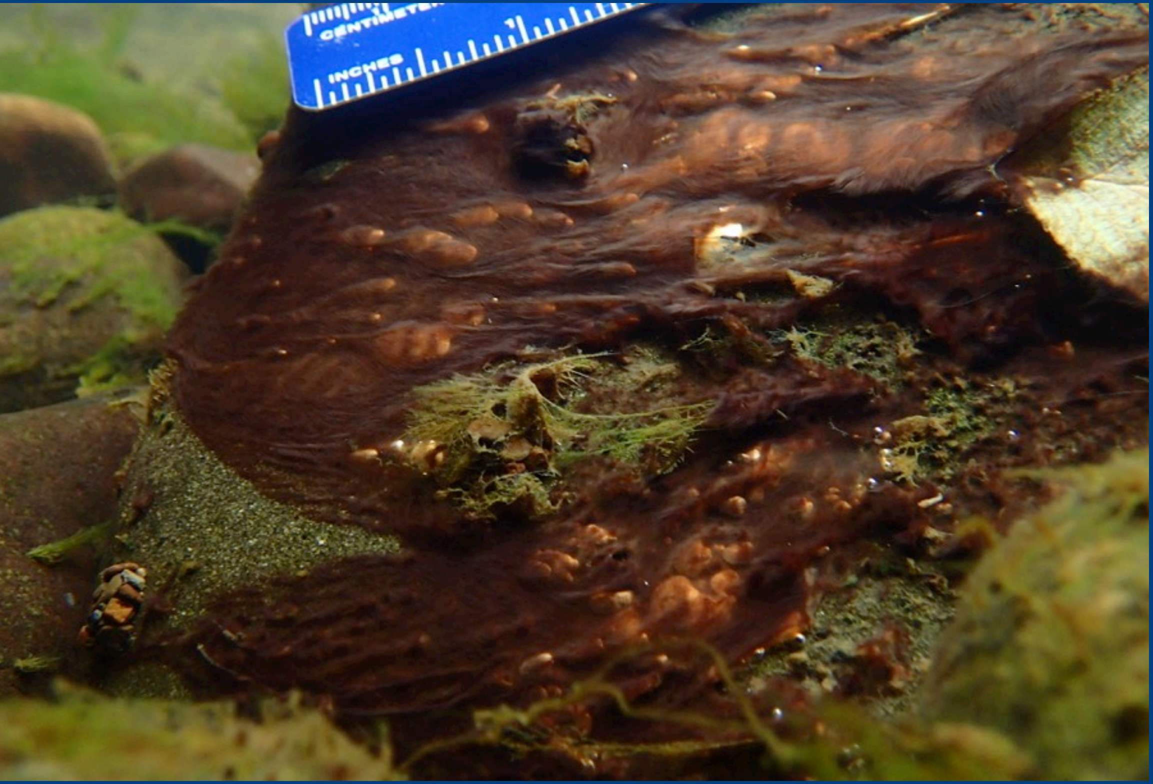
Observed cyanobacterial taxa

Anabaena spp.

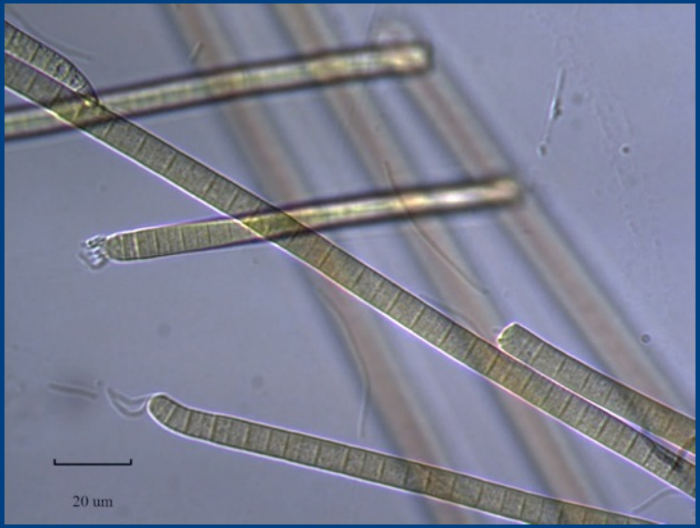
Cylindrospermum spp.

Nodularia spp.

Observed cyanobacterial taxa



Phormidium spp.



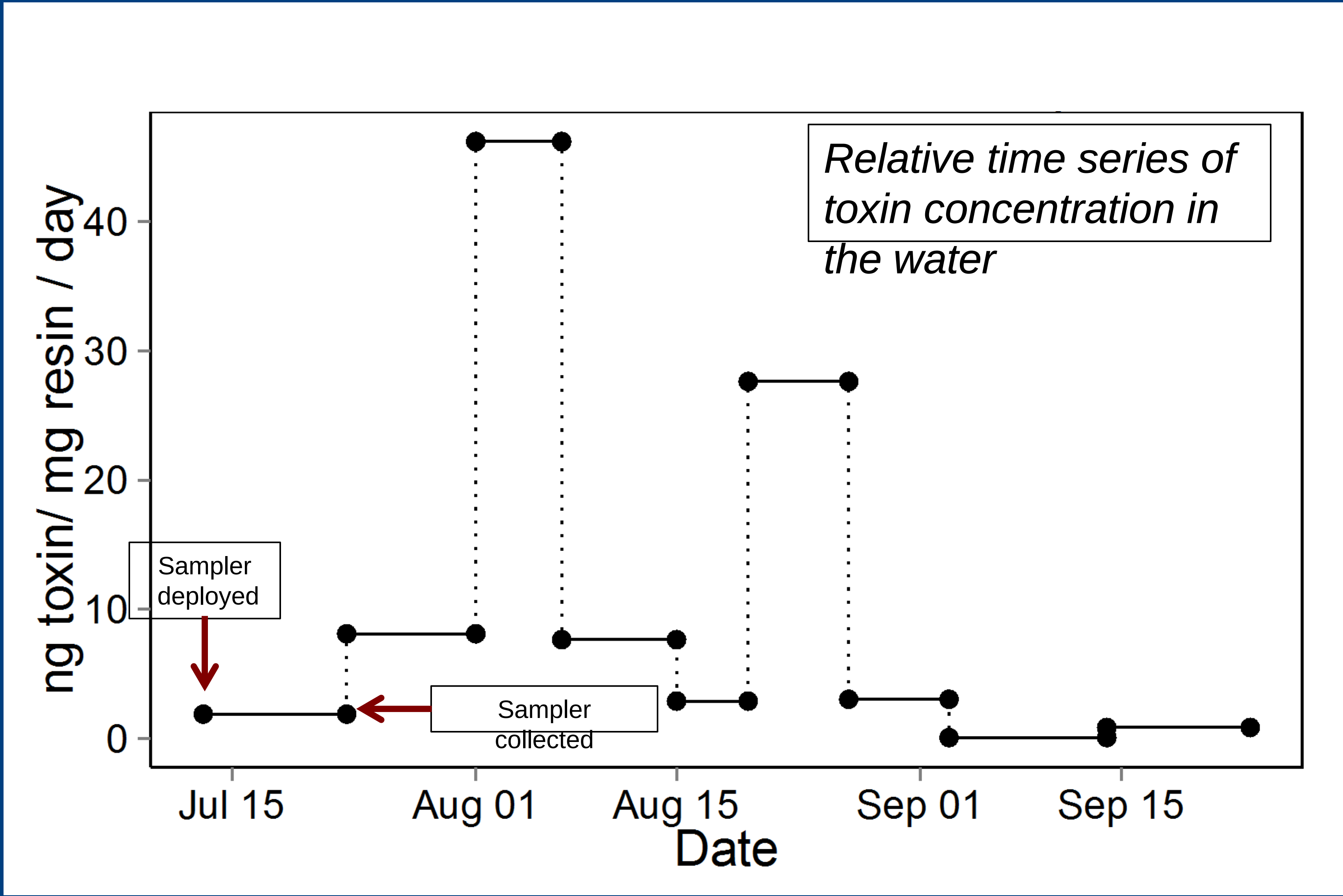
Nostoc spp.

Solid **P**hase **A**dsorption **T**oxin **T**racking (SPATT) Samplers

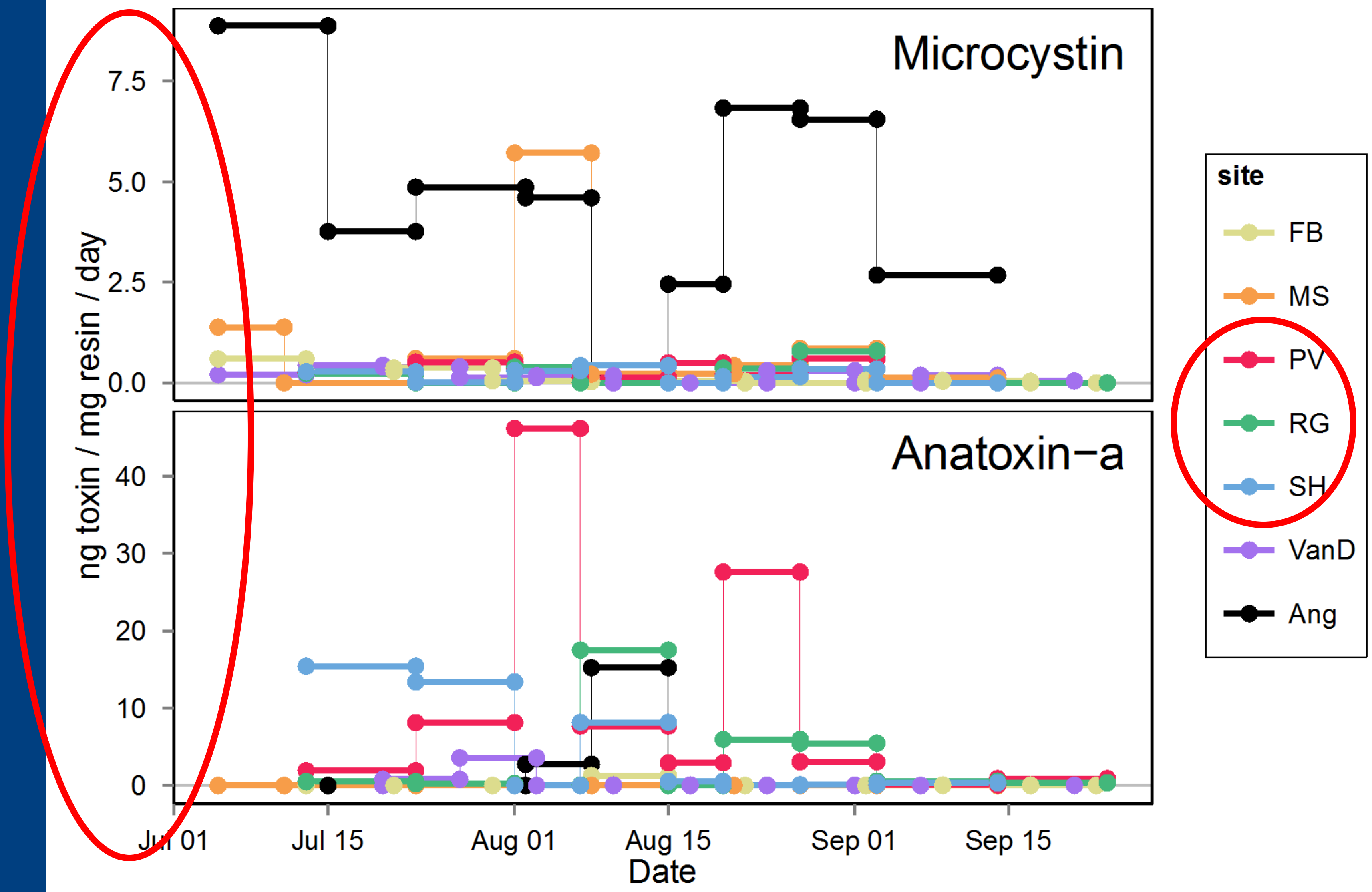
- 3 g HP20 DIAION™ resin
- Cyanotoxins microcystin and anatoxin-a measured with LC-MS

Lane et al. 2010, *Limnology and Oceanography: Methods*
Kudela 2011, *Harmful Algae*

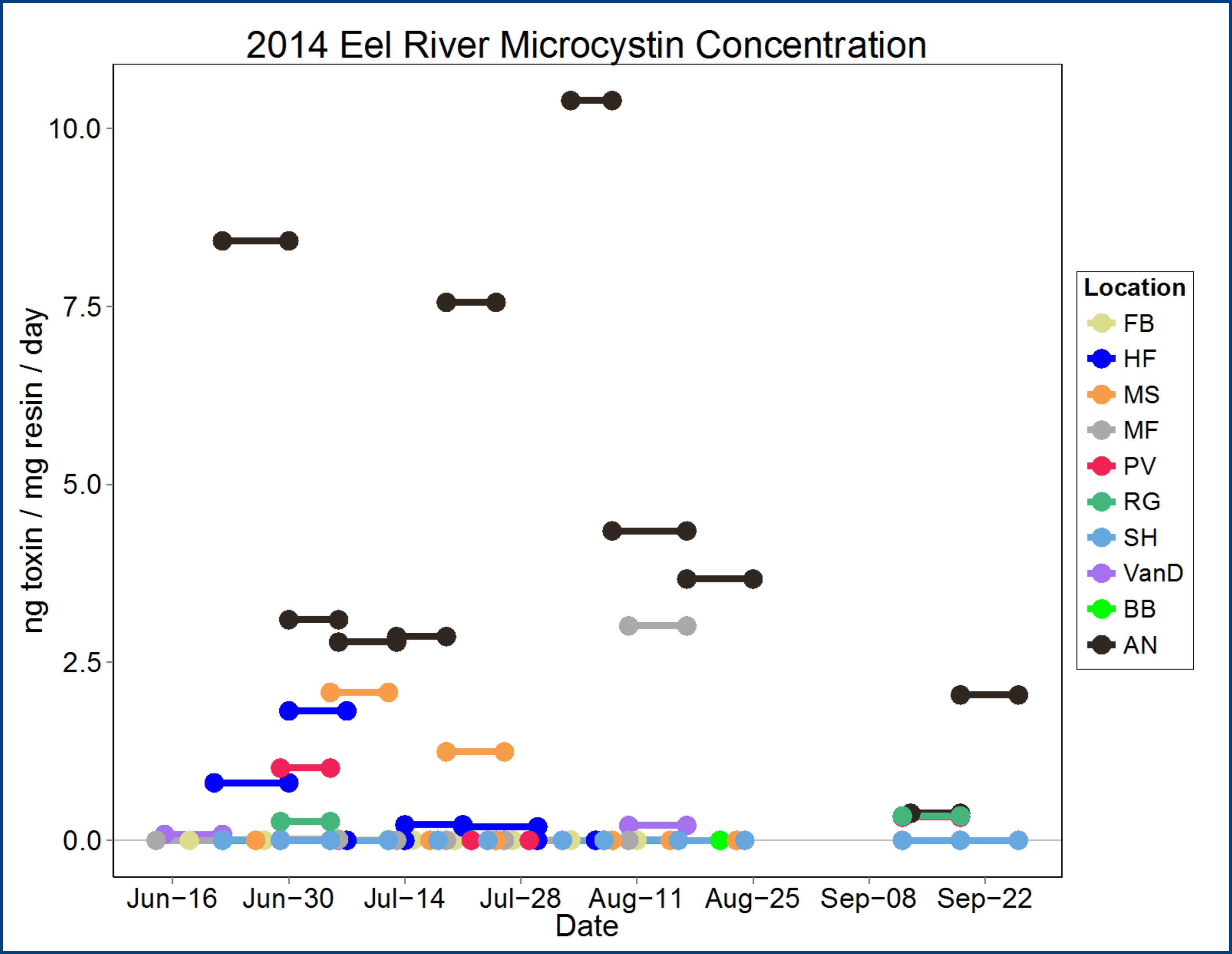
Visualizing SPATT data



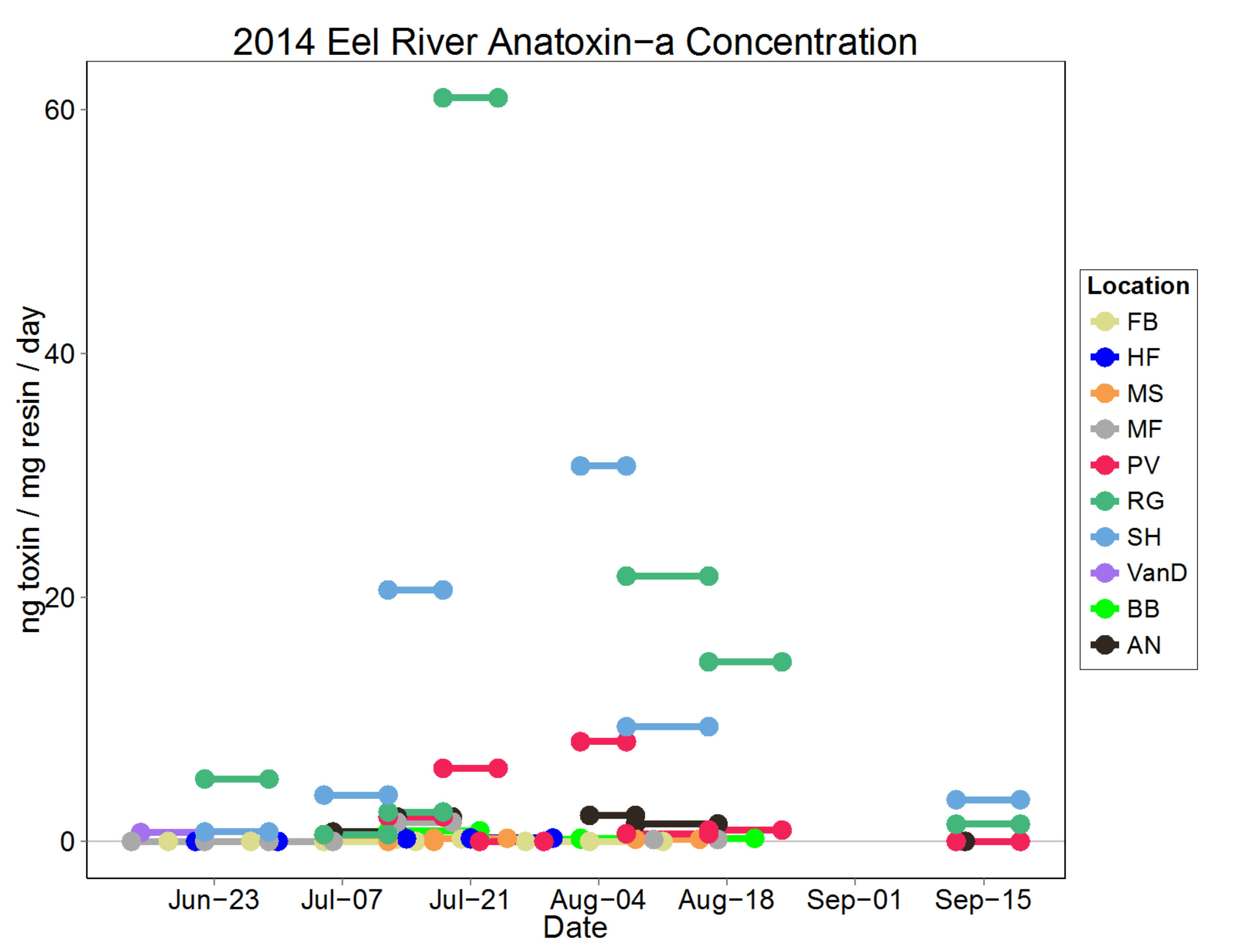
SPATT results 2013



SPATT MCY results 2014



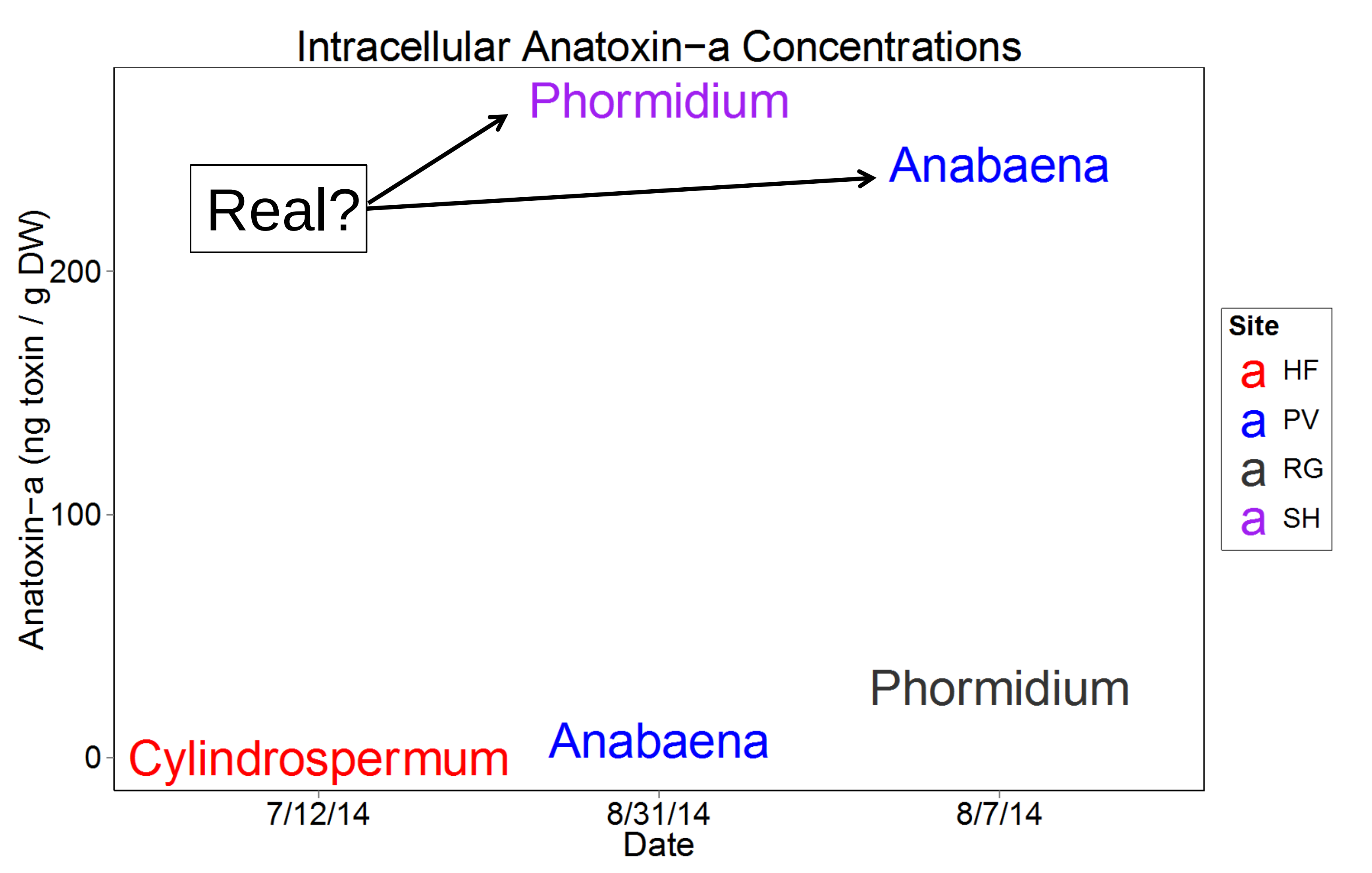
SPATT ATX results 2014



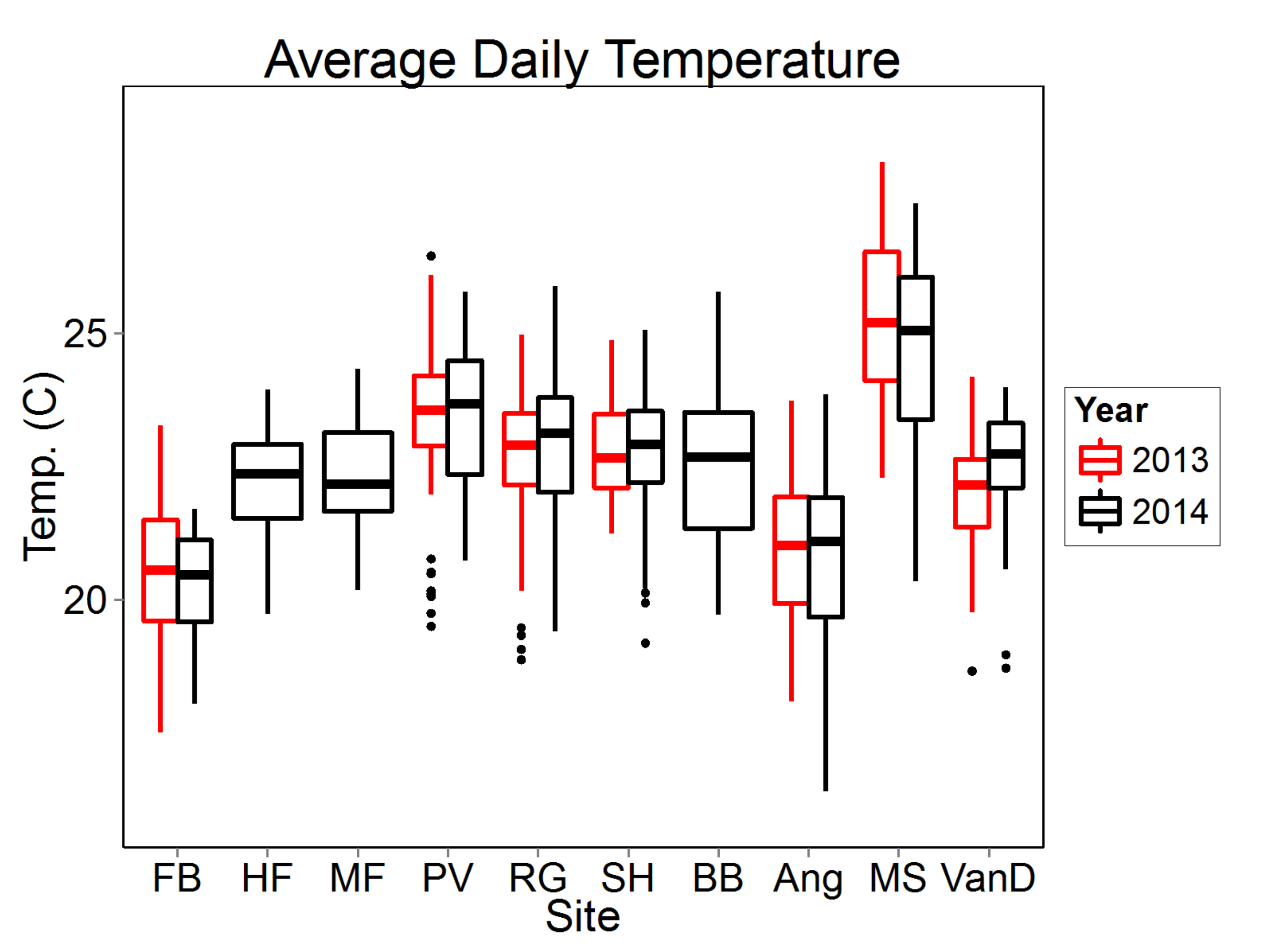
Intracellular cyanotoxins

Date	Site	Taxa	MCY	ATX
7-Aug	RG	Phormidium	--	+
31-Aug	SH	Phormidium	+	+
12-Jul	PV	Anabaena	+	--
7-Aug	Pville	Anabaena	--	+
7-Aug	Pville	Anabaena	+	+
31-Aug	Pville	Anabaena	+	+
12-Jul	MF	Nostoc ears	--	+
31-Aug	SH	Nostoc ears	--	+
12-Jul	HF	Cylindrospermum	+	--
26-Aug	Farm	Oscillatoria	--	--

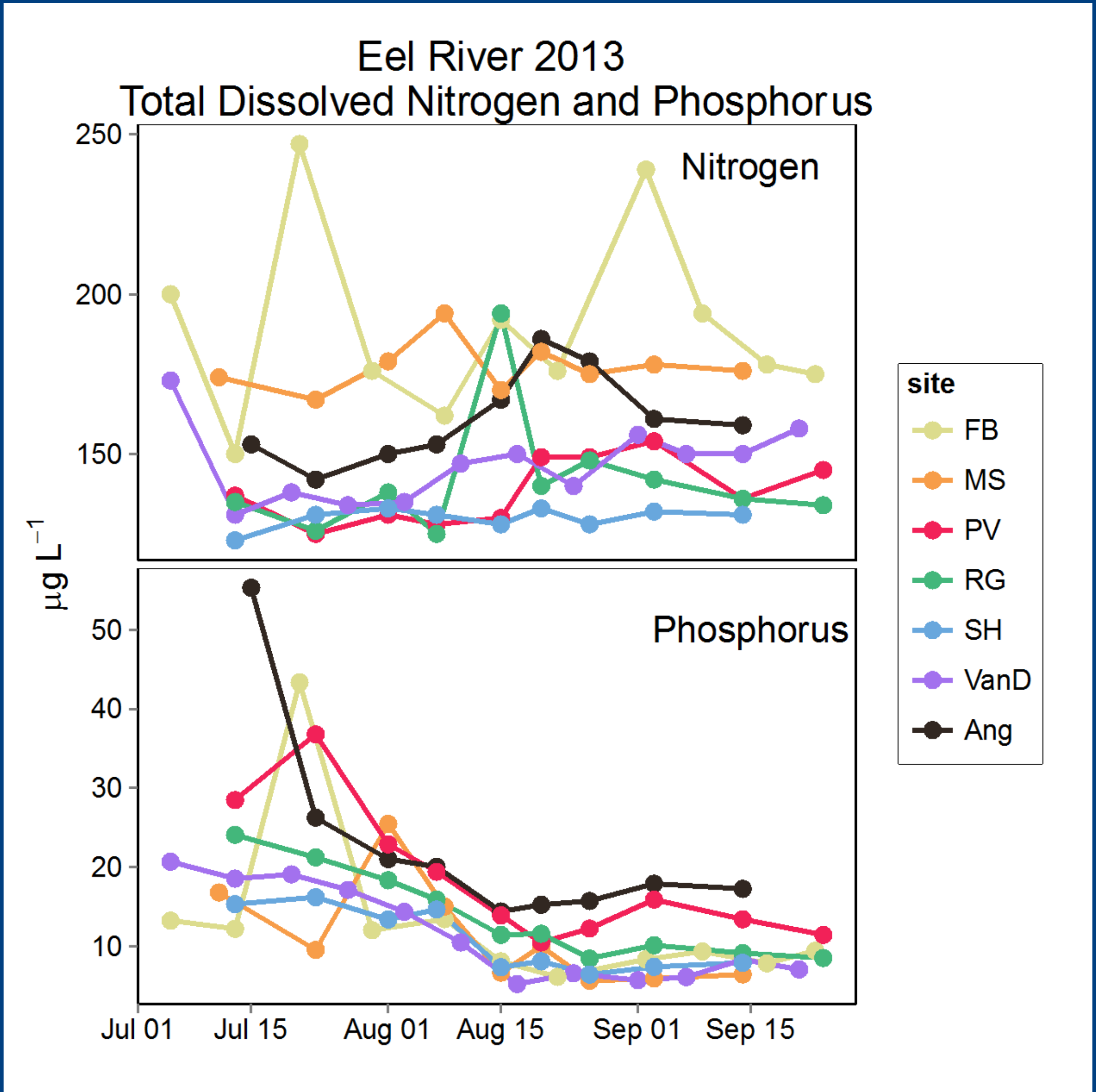
Intracellular cyanotoxins



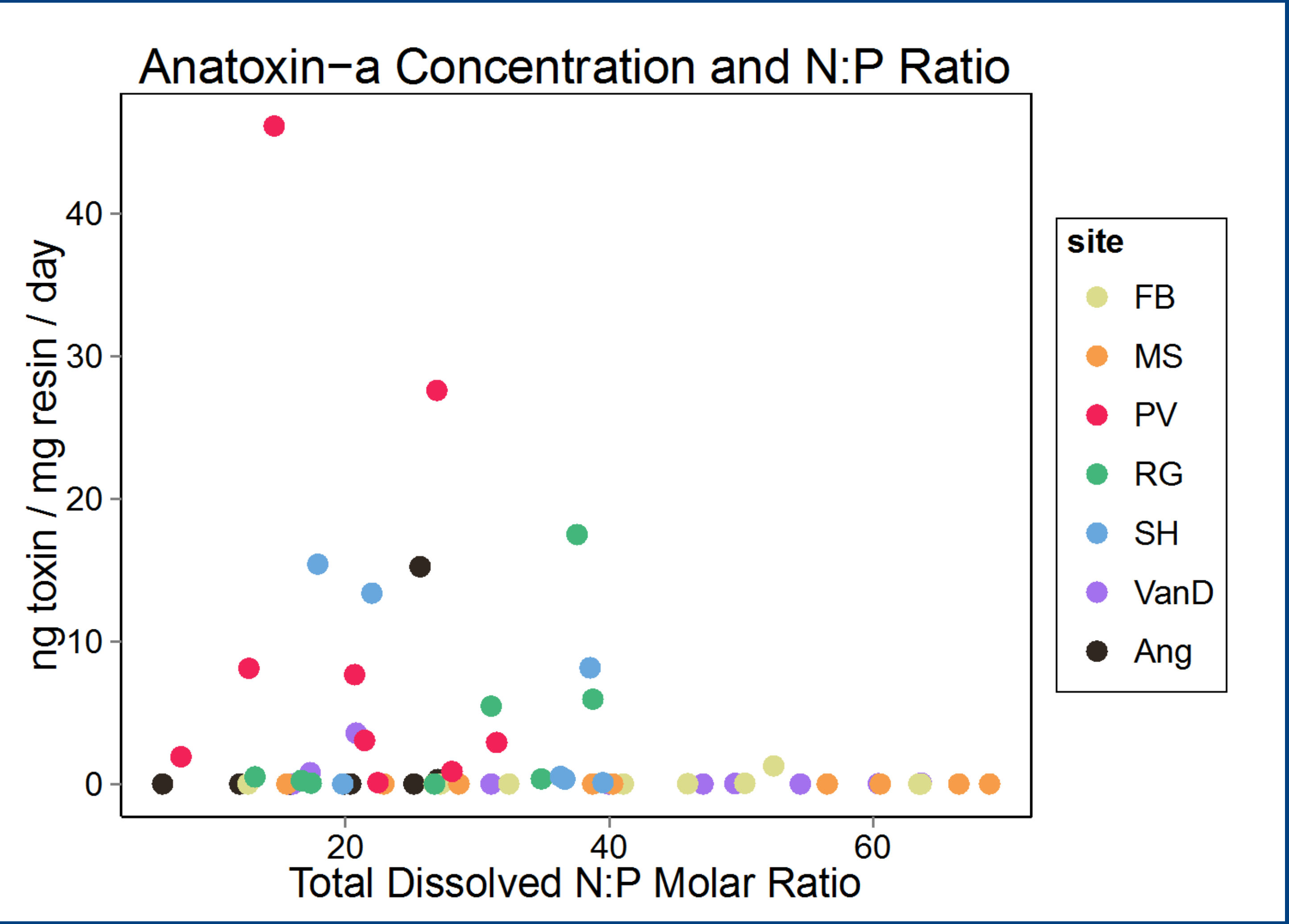
Temperature



Water chemistry 2013



Water chemistry 2013



Possible processes resulting in increased cyanobacteria

Scouring floods: exports invertebrate grazers
(Power and Dietrich 2008)

High green algal biomass

Cyanobacteria Growth

Higher temperatures: climate change?
(Paerl and Huisman 2009)

Water withdrawals: decrease summer base flows

Acknowledgements

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Questions?

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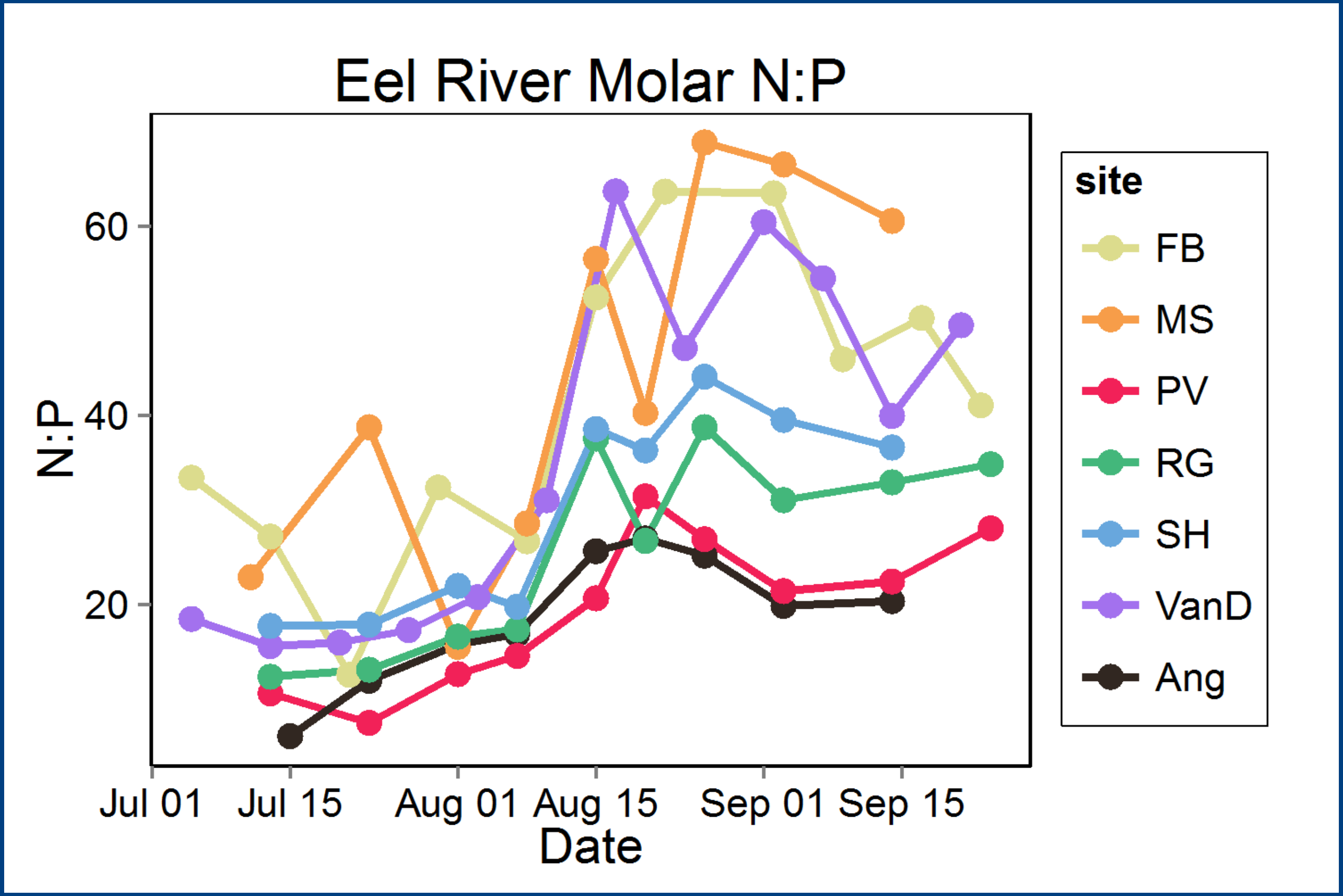
Water Chemistry Results



OEHHA Action Levels

Action levels for selected scenarios

	Microcystins[1]	Anatoxin-a	Cylindro-spermopsin	Media (units)
Human recreational uses[2]	0.8	90	4	Water (µg/L)
Human fish consumption	10	5000	70	Fish (ng/g) ww[3]
Subchronic water intake, dog[4]	2	100	10	Water (µg/L)
Subchronic crust and mat intake, dog	0.01	0.3	0.04	Crusts and Mats (mg/kg) dw[5]
Acute water intake, dog[6]	100	100	200	Water (µg/L)
Acute crust and mat intake, dog	0.5	0.3	0.5	Crusts and Mats (mg/kg) dw[5]
Subchronic water intake, cattle[7]	0.9	40	5	Water (µg/L)
Subchronic crust and mat intake, cattle[7]	0.1	3	0.4	Crusts and Mats (mg/kg) dw[5]
Acute water intake, cattle[7]	50	40	60	Water (µg/L)
Acute crust and mat intake, cattle[7]	5	3	5	Crusts and Mats (mg/kg) dw[5]

[1] Microcystins LA, LR, RR, and YR all had the same RfD so the action levels are the same.
[2] The most highly exposed of all the recreational users were 7- to-10-year-old swimmers. Boaters and water-skiers are less exposed and therefore protected by these action levels. This level should not be used to judge the acceptability of drinking water concentrations.
[3] Wet weight or fresh weight.
[4] Subchronic refers to exposures over multiple days.
[5] Based on sample dry weight (dw).
[6] Acute refers to exposures in a single day.
[7] Based on small breed dairy cows because their potential exposure to cyanotoxins is greatest. See Section VI for action levels in beef cattle.

CA OEHHA, Toxicological Summary and Suggested Action Levels to Reduce Adverse Health Effects of Six Cyanotoxins, May 2012