Cyanotoxins and Blooms Detected in Multiple Water Body Types Throughout the San Diego Region

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Introduction

Cyanotoxins are:

- toxins that can be released from many species of cyanobacteria (a.k.a. blue-green algae)
- contaminants of emerging concern that can have far-reaching impacts on public health, water supply, recreation, and natural resources management

There is no statewide cyanobacteria monitoring program in California, so the San Diego Regional Water Quality Control Board conducted screening studies in several water body types over several years.

Screening Studies

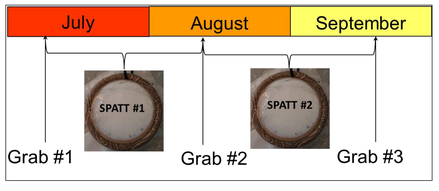
2011: Streams and Depressional Wetlands (P)
2012-2013: Depressional Wetlands (P)
2013: Lakes/Reservoirs and Coastal Wetlands (T)
2014: Lakes with high recreational use (T)
2015: Emergency funds for bloom notifications (T)
P = Probabilistic, T = Targeted

Screening efforts ranged from:

a one-time grab sample

to

grab and SPATT samples



Sampling and Analyses

A decision tree framework for toxin analysis was developed for efficient use of limited resources. Passive samplers, SPATT (Solid Phase Adsorption Toxin Tracking), provided valuable initial microcystin screening.

Grab samples were analyzed for:

- Microcystins (particulate and whole water)
- Additional Cyanotoxins (small subset of samples)
- Chlorophyll *a*
- Pigments
- Nutrients
- Species Identification

What have we learned?

1. Microcystins are widespread in southern CA water bodies.

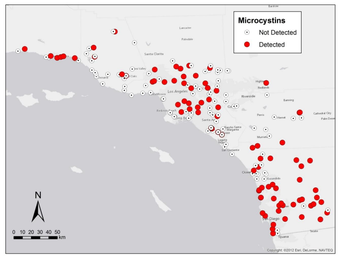


Figure 1. Microcystins detected in southern CA water bodies (Howard et al., in progress).

2. Grab samples can miss toxic events.

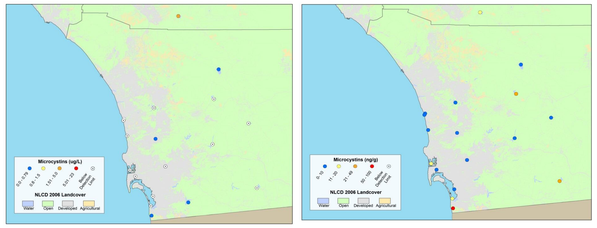


Figure 2. Maps of microcystin concentration results from grab samples (left) and SPATT bags (right) collected in the summer, 2013. The highest concentration is reported, as sites were visited multiple times (Howard et al., in progress).

3. Looks can be deceiving.

Depressional Wetland (904EMISG)

8/31/2012 (grab)
Visible bloom, but no pMCY detected.

10/12/2012 (grab)
No visible bloom, but pMCY detected.

SPATT deployed 8/31 -10/12/2012
dMCY-RR = 0.37 ng/g

Reservoir (907PEC062)

7/23/2013 (grab)

8/27/2013 (grab)

No visual blooms.
No pMCY detected in grab samples July-August.
However, dMCY detected in SPATT!

July - August
pMCY-RR = 1.63 ng/g

- Very clear reservoir water
- Quagga mussels present
- Rarely receives imported water

Microcystin source?

MCY = microcystin, pMCY = particulate microcystins, dMCY = dissolved microcystins

Coastal Wetland (908SDBNTC)

7/2/2013

8/7/2013

9/5/2013

No visual blooms.
No pMCY detected in grab samples July-August.
However, dMCY detected in SPATT!

July - August
pMCY-RR = 3.29 ng/g

August - September
pMCY-LR = 1.61 ng/g
pMCY-RR = 4.4 ng/g

High Recreational Use Lakes/Reservoirs

7/30/2015: Morena Reservoir
Visible bloom minimal, but microcystins off the chart!
(MCY > 5.25 µg/L)

6/23/2015: Lake Hodges
Visible bloom obvious, but low concentration of microcystins detected.
(MCY = 0.11 µg/L)

Results and Conclusions

1. Microcystins were detected in all of the water body types and were extremely prevalent in lakes, reservoirs and coastal wetlands.

STATION	NAME	SPATT #1	SPATT #2
902TV0111	Vail Lake	No	Yes
903PLH214	Lake Henshaw	Yes	Yes
904SNELLG	San Elijo Lagoon	Yes	Yes
904SNELPD	San Elijo Pond	Yes	Yes
905PLH070	Lake Hodges	Yes	Yes
905PLS198	Lake Sutherland	Yes	No
906O6MISS	Mission Bay	No	Yes
906LSPNLG	Los Penasquitos Lagoon	No	Yes
906PLM142	Lake Miramar	Yes	Yes
907CUYRES	Cuyamaca Reservoir	Yes	Missing
907LKMURR	Lake Murray	Yes	No
907PEC062	El Capitan Reservoir	Yes	No
907SDRVES	San Diego River Estuary	No	Yes
908SD8NTC	San Diego Bay near NTC	Yes	Yes
908SD8YSS	San Diego Bay Silver Strand	Yes	No
908SD8TSW	San Diego Bay Sweetwater	No	Yes
910PLO182	Lower Otay Reservoir	Missing	Damaged
911PMR110	Morena Reservoir	Missing	Yes
911TJRVES	Tijuana River Estuary	Yes!	Yes

2. Toxin concentrations detected from grab samples were above recommended recreational use action levels* at some sites, but overall underestimated the prevalence of microcystins in most water bodies.

* CA Action Levels for Human Recreation
0.8 µg/L Microcystins
90 µg/L Anatoxin-a
4 µg/L Cylindrospermopsin

3. In some cases, microcystins were detected in water bodies not visually indicative of having cyanobacteria blooms. Conversely, microcystins were not detected at some water bodies exhibiting excessive bloom conditions.

4. Our findings are important for development of an effective monitoring program and suggest that sampling based solely on visual observations of blooms may underestimate toxin prevalence and miss toxic events.

Future Studies

The San Diego Regional Water Quality Control Board has developed a SWAMP-funded plan to investigate the potential cyanotoxin transport from lentic to lotic systems and bioaccumulation in shellfish (Monitoring Plan for Watershed Dynamics of Cyanotoxin Transport and Bioaccumulation). This plan is part of a larger project funded by National Oceanic and Atmospheric Administration (NOAA), Monitoring and Event Response for Harmful Algal Blooms (MERHAB).