The Prevalence of Cyanotoxins in Southern California Waterbodies

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Microcystins Detected in California 2010-2012

UC Santa Cruz
SCCWRP
USGS
Coastal Confluences
Regional Board 9
CalFED
Stormwater Monitoring Coalition
• Other Cyanotoxins detected
  – Anatoxin-a
  – Cylindrospermopsin
  – Lyngbyatoxin
  – Saxitoxin
Microcystins Detected In a Variety of Waterbodies

- Wetlands
- Lagoons
- Lakes
- Ponds
- Streams
- Rivers
- Estuaries
- Seawater
Microcystins Detected Across Many Land Use Types
Cyanotoxins: Considered to be “Contaminants of Emerging Concern”

- Dedicated session held at 2012 national meeting of Society of Environmental Toxicology & Chemistry (SETAC)
- Special cyanotoxins issue under consideration in *Environmental Toxicology*
Multiple Cyanotoxins Detected in Coastal Waterbodies

- Grab Samples Collected in August 2009

100% samples positive for 3 cyanotoxins:
  - Microcystins
  - Anatoxin-a
  - Cylindrospermopsin

3 Sites Exceeded CA Action Levels
Cyanotoxins Detected in Depressional Wetlands

Probabilistic study that collected one time grab samples in Spring 2012
Percentage of Depressional Wetlands Sites Where Cyanotoxins Detected

Spring 2012

- Microcystin:
  - No Toxin: 53%
  - Microcystin: 47%

- Saxitoxin:
  - No Toxin: 95%
  - Saxitoxin: 5%
Expanded Study in San Diego Region: Toxin Results Across Multiple Seasons

**Spring 2012**
- Microcystins: Microcystin 29%, No Toxin 71%
- Saxitoxin: No Toxin 90%

**Summer 2012**
- Microcystins: Microcystin 29%, No Toxin 71%
- Saxitoxin: No Toxin 86%

**Fall 2012**
- Microcystins: Microcystin 29%, No Toxin 71%
- Saxitoxin: No Toxin 100%
San Diego: SPATT Results Show Double The Number of Sites With Toxin

Spring 2012
Microcystin 60%
No Toxin 40%

Summer 2012
Microcystin 29%
No Toxin 71%

Fall 2012
Microcystin 29%
No Toxin 71%

SPATT Samples
Summer through Fall
No Toxin 17%
Microcystin 83%
Cyanotoxins in Wadeable Streams

• Potentially important source of toxin loading

• Toxin production in streams may be exacerbated by increased heat & alterations to flow regimes:
  – Loss of riparian habitat for shading
  – Hydromodification; stagnation
  – “Perennialization” of intermittent streams by anthropogenic nuisance flows
Cyanotoxins in Wadeable Streams

- Cyanotoxins may help explain “mystery toxicity” in undeveloped catchments (*w/ atm. dep. of nutrients?*)
- Potential effects on food web, aquatic life uses
  - Some evidence (Spain) for cyanotoxin impacts to benthic macroinvertebrates (incl. EPT taxa)
  - Role in causal assessment (CA biological-objectives framework)
  - Biotic index interpretation
Locations of California stream bioassessment sites where benthic algae were sampled, 2007 - 2011 (N = 928 sites)

Sites where cyanobacterial genera known to have toxin-producing species were recorded

Sites where such taxa were not recorded
Methods: 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
• LC-MS/ELISA
Stream Pilot Study (MCY & ATX) – Yr 1

- LA/San Gabriel Rivers watersheds (N=20 samples)
- Microcystin hits at **75%** of urban sites, **57%** of open
- 4 microcystin congeners detected; no anatoxin-a
Multiple Cyanotoxins Analyzed & Detected in Streams – Yr 2

Cyanotoxins evaluated at the subset of sites with positive toxicity bioassay results:

- Microcystins
- Lyngbyatoxin
- Anatoxin-a
- Saxitoxin
- Cylindrospermopsin
- Nodularin
Any Evidence for Relationship between Detection of Stream Benthic Cyanotoxins and Toxicity Bioassay Results?

Total Microcystins (N = 99 sites)  Saxitoxin (N = 81 sites)

- Positive toxicity (bioassay)
- Negative toxicity (bioassay)

Total Microcystins:
- 71% MYC+
- 37% MYC+

Saxitoxin:
- 40% STX+
Summary of Yr 1 & 2 Stream Benthic Cyanotoxin Results

<table>
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<th>Sites tested</th>
<th>Total microcystins</th>
<th>Lyngbya-toxin</th>
<th>Saxitoxin</th>
<th>Anatoxin</th>
<th>Cylindrospermopsin</th>
<th>Nodularin</th>
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<td>%</td>
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</table>

* Sites were preferentially selected for these additional cyanotoxin analyses based on positive results in toxicity bioassays.
Numerous & Varied Loading Sources for Cyanotoxins

Cyanotoxins prevalent throughout California--detected in:

- streams, rivers, depressional wetlands, coastal lagoons, lakes
- plankton, benthos, dissolved
- across many land use types
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