SWAMP
Surface Water Ambient Monitoring Program

SWAMP Newsletter

Sound science for informed water quality management

2017 | Fall Issue

Microcystin Prevalence throughout Lentic Water Bodies in Coastal Southern California

By Carey Nagoda (carey.nagoda@waterboards.ca.gov)

Recent assessments in southern California have indicated that microcystins, a toxin produced by many cyanobacteria, are found in a variety of lentic (still) waterbody types, such as lakes and wetlands. Although low levels of microcystins were found across most of the examined habitats; only a small number of samples exceeded California's voluntary recreational health thresholds for acute toxicity. Furthermore, passive sampler results indicated that dissolved microcystins were widespread throughout lentic waterbodies, and that traditional discrete ('grab') water samples often underestimate toxin presence by missing events. The persistence of detectable microcystins across many years and seasons indicates a low-level, chronic risk through direct and indirect exposures. Multiple cyanotoxins were detected simultaneously in some waterbodies indicating multiple stressors; the risk of which are uncertain because health thresholds are based on exposures to single cyanotoxin. Indicating that cyanobacteria blooms are a more complex stressor than presently recognized and should be included in water quality monitoring programs. Interestingly, the assessment in 2013 found anatoxin-a for the first documented time from Southern California waterbodies.

Figure 1: *Sample taken at Vail Lake*

Microcystins are a class of toxins produced by many genera of freshwater cyanobacteria, most often from Microcystis sp. The toxins are released into the environment when cyanobacteria cells are injured and break open or die. As part of a collaboration with Southern California Coastal Water Research Project (SCCWRP), University of California Santa Cruz (UCSC), and University of Southern California (USC), the San Diego Regional Water Board staff conducted multiple cyanobacteria screening studies over several years. These studies provided an initial investigation into the presence of microcystins in the region's lakes and wetlands, and insight into cyanotoxin sampling techniques (e.g., passive samplers for determining the dissolved fraction of toxins vs. discrete samples used for determining total or particulate, cell-bound, fraction of toxins).

(Continued on next page)

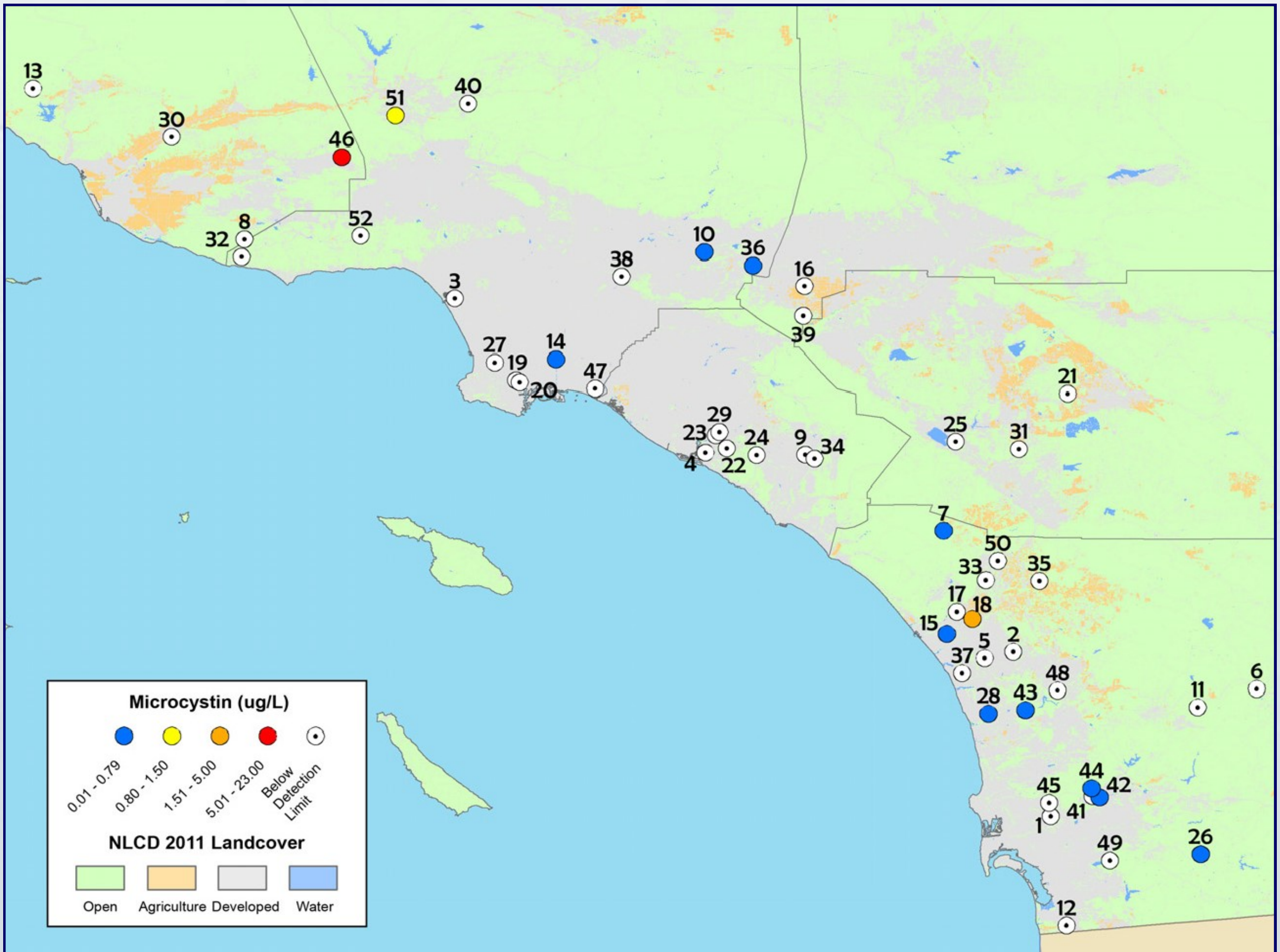

Figure 2. *Map of particulate microcystins concentrations detected from discrete ('grab') samples in the spring depressional wetlands assessment, 2011-2013.*

Staff conducted these studies because cyanotoxins can negatively impact many beneficial uses and pose risks to humans, livestock, pets, and wildlife, causing illnesses or mortality from exposure (e.g. swimming, ingestion). Cyanobacteria blooms and subsequent toxic events are becoming more frequent and geographically widespread due to climate change and other stressors (Paerl and Paul, 2012).

The San Diego Regional Water Board studies focused on depressional wetlands in 2012; lakes/reservoirs and coastal wetlands in 2013; and completed an ad hoc bloom response survey of lakes in 2014. Microcystins were found to be widespread throughout the San Diego region in the water body types each year, but mostly below the California recreational health thresholds, which is 0.8 µg/L for total microcystins.

Twenty-five percent of the depressional wetland sites, located in San Diego, Los Angeles and Riverside Counties, harbored particulate microcystins, ranging from below detection to 22 µg/L, throughout the 2011-2013 sampling period (Figure 2). Because the particulate fraction represents only the cyanotoxins found within cyanobacteria cells, the total toxin concentrations in the depressional wetlands sampled were most likely higher.

(Continued on next page)

Figure 3. A cyanobacteria bloom (of Microcystis and Aphanizomenon), exhibiting the common resemblance to spilled paint or pea soup, at Morena Reservoir on September 18, 2013, when recreational action thresholds

Microcystins were also widespread in the San Diego region's lakes/reservoirs and coastal wetlands in 2013. All study sites, which included 10 lakes/ reservoirs and 9 coastal wetlands, were sampled 3 times throughout the screening period. Dissolved microcystins, measured by passive sampler, were detected in at least 1 of the 3 sample visits from each site. In contrast, particulate microcystin results obtained from the discrete samples suggested that 26% of the sites had measurable particulate microcystins throughout the study period, indicating that discrete samples can miss toxin events that are detected by passive samplers. Two sites in the San Diego region exceeded the recreational action thresholds for California that year. A total of 23.6 µg/L of microcystins were detected in Morena Reservoir (Figure 3), exceeding the Tier II, "Danger" threshold. Vail Lake had 2.1 µg/L, indicating the "Caution" trigger threshold. In 2014, ad hoc study efforts focused on high recreational use areas throughout southern California and found that half of the sites sampled contained cyanotoxins, ranging from below detection to 36,549 µg/L (Figure 4).

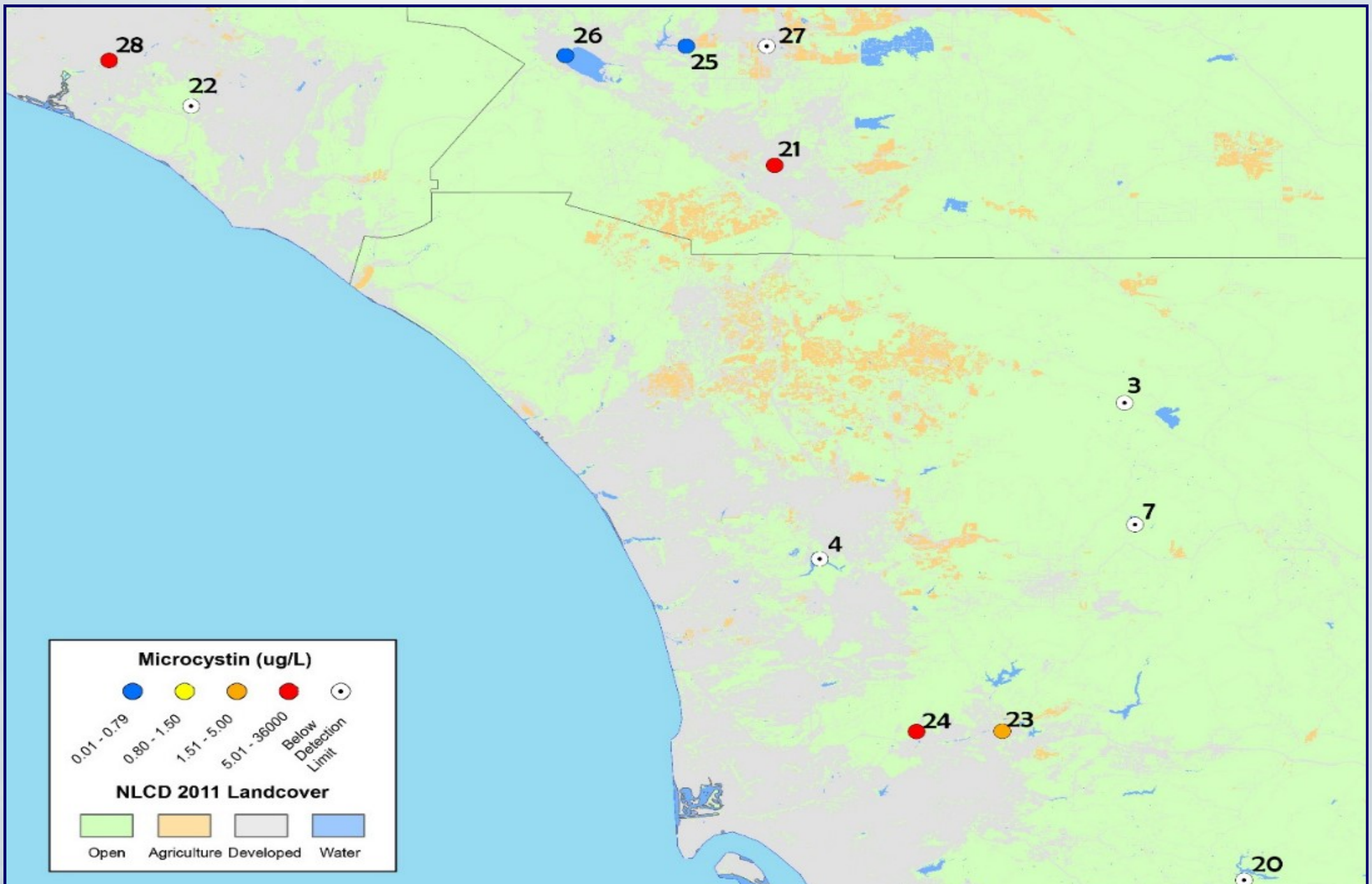

Figure 4. Map of discrete ('grab') sample results collected from the ad hoc bloom response survey in 2014 in San Diego, Riverside and Orange Counties (including one sample collected in 2015 from San Joaquin Marsh).

(Continued on next page)

Samples were also collected from each site for cyanobacteria taxonomic identification, marking an initial effort toward identifying freshwater cyanobacteria species in the San Diego region (Table 1). Three sites within the region harbored particulate microcystins above the California recreational health thresholds: Harveston Lake in the City of Temecula, Lindo Lake in Lakeside, and Santee Lakes in the City of Santee (concentrations of 10 µg/L, 2.5 µg/L, and 11.7 µg/L, respectively). These values may be conservative, as total microcystins concentrations are most likely higher than the particulate concentrations.

Name	Site Number on Map	Cyanobacterial Genera and Species Identification	MCY
Barrett Lake	20	*Cylindrospermopsis raciborskii, Cylindrospermopsis* spp., *Anabaena* spp.	bd
Canyon Lake	25	*Anabaena* sp., *Raphidopsis* sp.	0.01
Chollas Reservoir		Low abundance of non-nitrogen fixing filaments	NA
Discovery Lake		*Planktothrix* sp., *Anabaena variabilis, Anabaena spiroides, Cylindrospermopsis* sp.	NA
Guajome Lake		*Cylindrospermopsis* sp., *Planktothrix* sp.	NA
Harveston Lake *,¥	21	Sparce *Microcystis* sp.	10.0
Lake Barbara	22	no cyanobacteria observed	bd
Lake Elsinore §	26	*Anabaena* sp., *Cylindrospermopsis* spp.	0.01
Lake Hodges	4	*Anabaena* sp.	bd
Lake Henshaw, outflow	3	*Microcystis* sp.	bd
Lake Menifee §	27	*Cylindrospermopsis* sp. *Raphidopsis* sp.	bd
Lake Morena		Mainly eukaryotes, shoreline dominated by *Microcystis* spp.	NA
Lake Poway		Sparse *Microcystis* sp. colonies	NA
Lake Sutherland	7	*Microcystis* sp.	bd
Lindo Lake *	23	*Planktothrix* spp., *Anabaena variabilis, Anabaena* spp. *Cylindrospermopsis* spp., *Microcystis* sp.	2.5
San Joaquin Marsh	28	*Microcystis* sp.	36,549
Santee Lake #5	24	*Microcystis* sp., *Cylindrospermopsis* sp. *Cylindrospermopsis raciborskii* and *Anabaena spiroides*	11.7

NA = not analyzed; bd = below the method detection limit. * = Sampled in both June and August. ¥ = toxin results for June only; cyanobacteria identification genera results for August only. § = sites exceeded CA health advisory thresholds for either cylindrospermopsin or anatoxin-a concentrations.

Table 1. *List of study sites from the ad hoc bloom response survey in 2014, and discrete sample results for cyano-bacterial identification and total microcystins (MCY) reported in µg/L. Sites in bold exceeded the California health advisory thresholds for recreational exposures.*

For More Information:

- *Paerl H.W. and Paul V.J. Climate change: links to global expansion of harmful cyanobacteria. Water Res. 2012 Apr 1;46(5):1349-63. doi: 10.1016/j.watres.2011.08.002*
- *"Microcystin Prevalence throughout Lentic Waterbodies in Coastal Southern California" recently published in the Journal Toxins and featured in the July issue of EPA's Freshwater Harmful Algal Blooms Newsletter. The full-text article is available at: http://www.mdpi.com/2072-6651/9/7/231/pdf*
- *San Diego Regional Water Board Executive Officer's Report, December 14, 2016, Part C.1 (pg. 29)*
- *The monitoring plan for the San Diego Water Board lakes/reservoirs and coastal wetlands cyanotoxin screening study is available here.*
- *Visit the California Harmful Algal Blooms (HAB) Portal*