SWAMP Surface Water Ambient Monitoring Program

SWAMP Newsletter

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Benthic Cyanotoxins Widespread In California Streams

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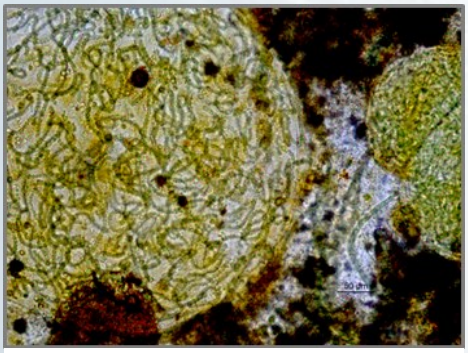
Cyanobacteria are photosynthetic organisms that inhabit a wide variety of aquatic environments. Many are capable of producing toxins (''cyanotoxins''), which can cause illness, and sometimes death in humans, livestock, pets, and wildlife. Although cyanotoxins are naturally occurring, and cyanobacteria have existed for billions of years, toxic "harmful algal blooms" have become an increasing problem in lentic water bodies like lakes and reservoirs, as well as in large rivers, with this proliferation attributed to a variety of human-caused factors.



Photomicrograph of Nostoc, a likely producer of the toxin microcystin found in the bottom of California wadeable streams. This genus of cyanobacteria can fix nitrogen and is commonly found in streams with low nutrient levels and subjected to minimal human disturbance.

Photo by Betty Fetscher

Historically, by far, most cyanotoxin monitoring has been geared toward water-column samples in these water body types. However, ongoing algae-based bioassessment efforts conducted through, or in conjunction with, SWAMP (e.g., the Perennial Stream Assessment (PSA), Reference Condition Management Program (RCMP), the Southern California Stormwater Monitoring Coalition (SMC)), have shown that cyanobacteria are also common in the benthic habitat of wadeable streams. This is an important finding due to potential effects of cyanotoxins on multiple beneficial uses, both locally within streams, and in downstream receiving waters. Starting in 2011, benthic algae "composite samples" were collected from wadeable streams in conjunction with SWAMP, and other monitoring efforts, for the analysis of cell-bound cyanotoxins. Microcystins were detected in one-third of the stream segments (368 samples with a mean concentration of 46 micrograms per square meter of stream-bottom). All ecoregions of the state harbored stream cyanobacteria, and sites where benthic microcystins were detected spanned a variety of surrounding land-use types, from open space (i.e., undeveloped land), to heavily urbanized and agricultural areas. Thus, it is unclear at this point whether human-caused factors are responsible for toxin production in wadeable stream benthos. Lyngbyatoxin (14 samples), saxitoxins (99 samples), and anatoxin-a (33 samples) were also detected, but at lower rates than microcystins.

Recent research in Monterey Bay by Melissa Miller, a Veterinarian Specialist & Pathologist with the California Department of Fish and Wildlife's Office of Spill Prevention and Response, and her collaborators had linked inland-derived microcystins to more than 30 sea otter mortalities in the marine environment. This work illustrated the negative effects cyanotoxins can have on ecosystem services, even far downstream from their origin, due to river transport. Results of the present study have provided strong evidence that wadeable streams throughout the state could be significant sources of cyanotoxin inputs to receiving waters. This finding has implications for the management of drinking water, wildlife, and recreational resources, within both the streams themselves and in downstream rivers, lakes, reservoirs, and the ocean. During the next phase of SWAMP monitoring in the San Diego Region, selected water bodies will be studied to begin to understand whether, and to what extent, stream-produced cyanotoxins are present in receiving waters, and entering aquatic food webs. For more information, please see Fetscher et al., 2015.

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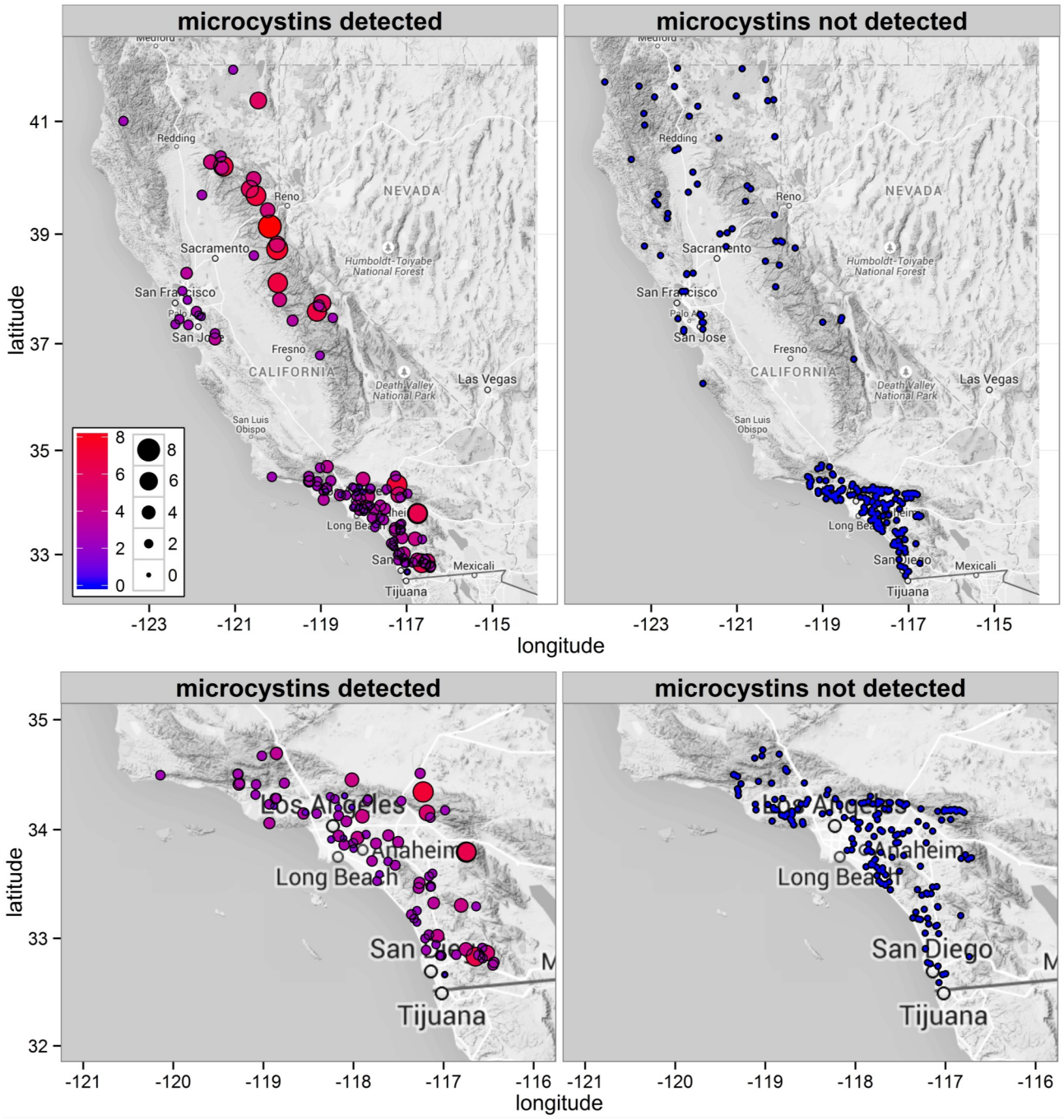

Wadeable stream sites where benthic microcystin concentrations were assessed. Left panel shows all sites where microcystins were detected; icon size and shading indicate relative concentrations (ug/m^{-2}) on a natural-log scale, with larger/red corresponding to higher values (see legend). Right panel shows all sites where microcystins were tested for, but not detected.