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Wadeable streams as widespread sources of benthic cyanotoxins in California, USA

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ABSTRACT

Lentic water bodies and large rivers have long been recognized as being susceptible, under certain conditions, to toxin-producing (‘‘toxigenic’’) planktonic cyanobacterial blooms. Although benthic cyanobacteria commonly inhabit wadeable (i.e., shallow) streams, little has been published on the potential for cyanotoxin (e.g., microcystin) production in this water body type. Recent research in Monterey Bay, California, USA has linked inland-derived microcystins to numerous sea otter mortalities in the marine environment, a finding that illustrates the negative effects cyanotoxins can have on ecosystem services, even far downstream from their origin, due to fluvial transport. For the present study, surveys of >1200 wadeable stream segments were conducted throughout California during the spring and summer of 2007 through 2013, and revealed a high occurrence of potentially toxigenic benthic cyanobacteria. In addition, benthic microcystins were detected in one-third of sites, where tested (N = 368), based primarily on one-time sampling, from 2011 to 2013 (mean concentration was 46 $\mu g/m^2$ of stream-bottom). Sites where microcystins were detected spanned a variety of surrounding land-use types, from open space (i.e., undeveloped land) to heavily urbanized/agricultural. Lyngbyatoxin (n = 14), saxitoxins (n = 99), and anatoxin-a (n = 33) were also measured, at subsets of sites, and were also detected, albeit at lower rates than microcystins. Results of this study provide strong evidence that wadeable streams could be significant sources of cyanotoxin inputs to receiving waters, a finding that has implications for the management of drinking water, wildlife, and recreational resources, within both the streams themselves and in downstream rivers, lentic water bodies, and the ocean.