Got toxins? Get SPATT

Solid Phase Adsorption Toxin Tracking

WHAT IS SPATT?

Solid Phase Adsorption Toxin Tracking (SPATT) is a low-cost monitoring tool used to measure dissolved toxins produced by algae. Simple to deploy and recover, SPATT can be used in all types of waterbodies and measures many different algal toxins. SPATT is easy to assemble using commercially available materials, and one resin is applicable for measurement of many different toxins.

SOP: https://repository.oceanbestpractices.org/handle/11329/1339

WHY USE SPATT?

- SPATT is a time-integrative passive sampler
- SPATT is a method to determine toxin *presence*
- Provides continuous toxin detection, and captures ephemeral events that can be missed by discrete samples
- Useful method for monitoring across the freshwater to marine continuum
- Provides enhanced sensitivity to toxins at low ambient concentrations
- Determines fate of toxins in a system and exposes chronic nature of toxin presence
- Provides toxin data for waterbodies with little or no existing HAB data
- Does NOT provide toxin concentrations that are applicable to health advisory thresholds (ng/g)
- Does NOT measure total toxin, only dissolved toxin

APPLICATION

For best results, SPATT should be used in combination with discrete water grab samples. SPATT is more sensitive to low-level toxins than grab samples, but using multiple methods for toxin detection inreases the chances of detecting toxic events. SPATT can be deployed in lakes, rivers, and estuaries; in depressional wetlands; in shipboard flow-through systems; on offshore buoys or moorings; or on wave gliders and other AUVs.

Assembled SPATT sampler and common method of deployment

INNOVATIVE DEPLOYMENT

The highly flexible nature of SPATT has resulted in varied and creative field deployments.

Images from SPATT SOP, MacKenzie et al 2011, T. Yazzie, M.Roddam.

TOXINS

SPATT has been used around the world for the detection of many different toxins, including:

- Anatoxins (Wood et al, 2011)
- Azaspiracids (Fu et al, 2009)
- Ciguatoxins (Roue et al, 2018)
- Dinophysistoxins (Fu et al, 2008, 2009, Pizarro et al, 2013)
- Domoic acid (Lane et al, 2010)
- Microcystins (Kudela, 2011)
- Okadaic acid (MacKenzie et al, 2004, Fu et al, 2008, 2009)
- Pectenotoxins (MacKenzie et al, 2004, Fu et al, 2009)
- Saxitoxin (Lane et al, 2010)
- Spirolide toxins (Fu et al, 2009)
- Yessotoxins (MacKenzie et al, 2004, Fu et al, 2009)

CASE STUDIES

Monterey Bay Watershed, California

After many dead sea otters on the shores of Monterey Bay were found to have microcystin toxicity, a 3-year time series was conducted throughout the watershed to determine the source of microcystins in the marine environment. Month-long SPATT deployments were used in 21 locations over 6 watersheds in year 1, and in week-long deployments in 4 watersheds during years 2 and 3.

- SPATT provided time-integrative toxin data to be simultaneously collected throughout the watershed
- SPATT methodology uncovered persistent occurrence of microcystins in the watershed and discharged into Monterey Bay
- SPATT provided insight into the temporal and spatial toxin dynamics that was unable to be elucidated using traditional water samples

In summary: SPATT allowed a large watershed to be surveyed for microcystins simultaneously and revealed persistent occurrance of toxins throughout time and space, thereby uncovering an under-recognized and understudied source of microcystins to Monterey Bay.

Pinto Lake, Watsonville, California

Pinto Lake, a known harmful algal bloom “hotspot,” is a shallow, eutrophic lake surrounded by public parks and stocked for recreational fishing. For this 16-month study, SPATT was deployed at weekly intervals and compared to traditional grab samples.

- DIAION HP20 resin was used for SPATT
- SPATT detected microcystins in 100% of samples, as determined by LCMS. Microcystins were below detection limit in 42% of corresponding grab samples.
- There was good correspondence between SPATT and grab sample methods, both statistically and qualitatively.

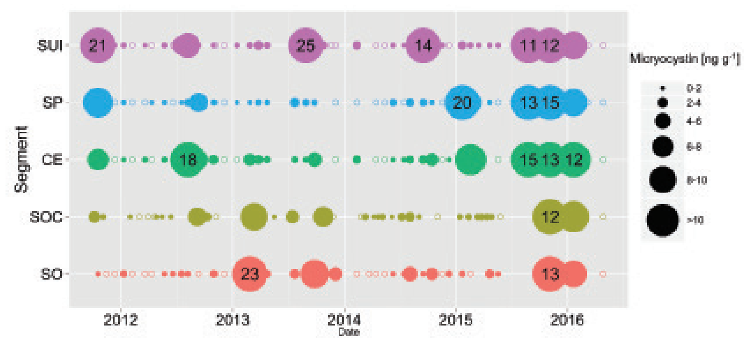
In summary: The resin DIAION HP20, inexpensive and widely used to detect other toxins, can successfully measure microcystins in a freshwater environment. SPATT results in this time series demonstrated that microcystins were present in Pinto Lake year round. The levels were often below the WHO regulatory limits, but little is known about chronic or sub-chronic exposure.

San Francisco Bay, California

As a large eutropic estuary, San Francisco Bay harbors both marine and freshwater toxigenic organisms that can form harmful algal blooms. Though there are few commercial fisheries within the bay, recreational and subsistence harvesting of marine organisms is common. There is no routine testing for marine or freshwater toxins within the bay. SPATT methods showed ubiquitous and year-round toxins throughout San Francisco Bay (figure below) and that multiple toxins are present simultaneously. This insight prompted the analysis of mussel samples, and those results showed the bioaccumulation of multiple toxins.

Traditional water samples were unable to provide this insight into spatial and temporal information. A 2017 study examined the occurrance of 4 different toxins in bay waters and in marine mussels within the bay during a 5-year period.

- From 2011-2016 bi-monthly cruises in the bay collected traditional grab samples, and deployed SPATT samplers in the ship flow-through system. Environmental mussel samples were also collected and analyzed
- 100% of SPATT samples were positive for either domoic acid or microcystins, and 73% were positive for both toxins
- 11% of grab samples contained measurable domoic acid, and 51% had measurable microcystins. 3% contained both.



This figure shows domoic acid (ng/g) and microcystin (ng/g) as detected by SPATT in 5 different segments of San Francisco Bay between 2012 and 2016. Peacock et al, 2018.

RESOURCES

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