Temporal patterns of the harmful algae toxins microcystins and domoic acid in the San Francisco Estuary mesohaline

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Background

Harmful algae bloom (HABs) events have occurred in the San Francisco Estuary (SFE) with increasing frequency. A multi-investigator study of HABs along the SFE salinity gradient included sampling at four shore stations in Suisun Bay and Carquinez Strait for microcystin (MC) and domoic acid (DA).
Domoic acid is associated with diatoms and represents marine HABs. Microcystins (MC) is produced by freshwater cyanoHABs that commonly occur in the Delta.
Historically, HABs and their associated toxins were low in the SFE, but improved sampling in the estuary now suggests that a variety of HAB toxins exist in the estuary throughout the year.

Objectives

1) Conduct annual sampling for HAB toxins in the mesohaline region of SFE.
2) Compare sampling methods for detecting HAB toxins in the estuary.
3) Determine if HAB toxins are present at a Carquinez Strait shore station and characterize their potential transport between SF Bay and the upper estuary.

Key Findings

- Marine (domoic acid; DA) and freshwater (microcystins; MC) HAB toxins were regularly observed at our study site in the mesohaline SFE.
- Sampling approach was important in detecting toxins, with analysis of tissues yielding the highest concentration. We also detected toxins using SPATT deployments. Discrete water sample analysis yielded lowest toxin concentrations and had the most non-detections.
- SPATT and water filtration suggested seasonality for MC toxins, appearing in late summer and fall, when cyanoHAB blooms occur in the Delta.
- DA and MC toxins are likely being transported from both upstream and seaward habitats into the SF estuary mesohaline region.

Results

- Both marine and freshwater toxins were detected in samples collected between October 2023 and January 2025..
- MC concentrations were higher between August through October.
- DA concentrations were generally highest in late fall and winter.

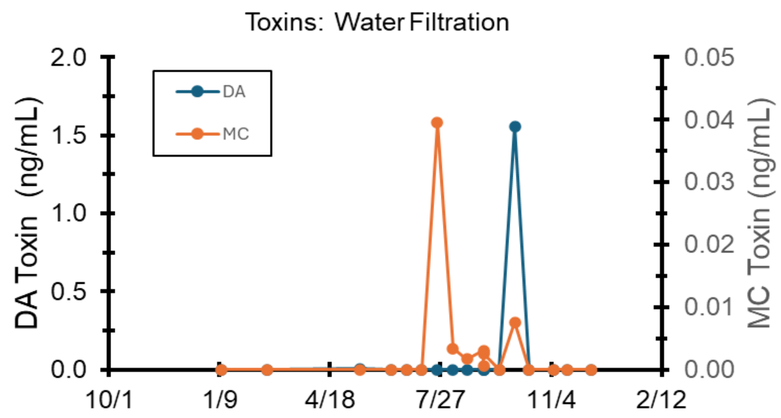


Fig. 1 Toxins in filtered water samples versus time. Toxin concentrations were lowest in filtered water samples. Suggest MC concentrations highest in summer and fall, while DA concentrations increase in late fall. Different scales for DA and MC concentrations.

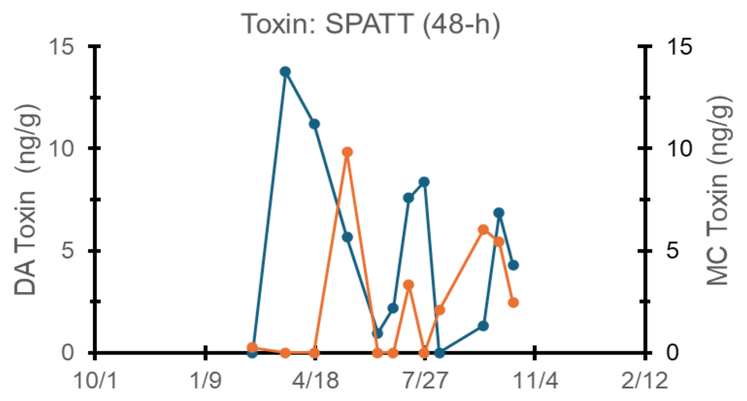


Fig. 2 Toxins in 48-h SPATT deployment versus time. Both DA and MC were routinely detected and at similar concentrations. Different scales for DA and MC concentrations.

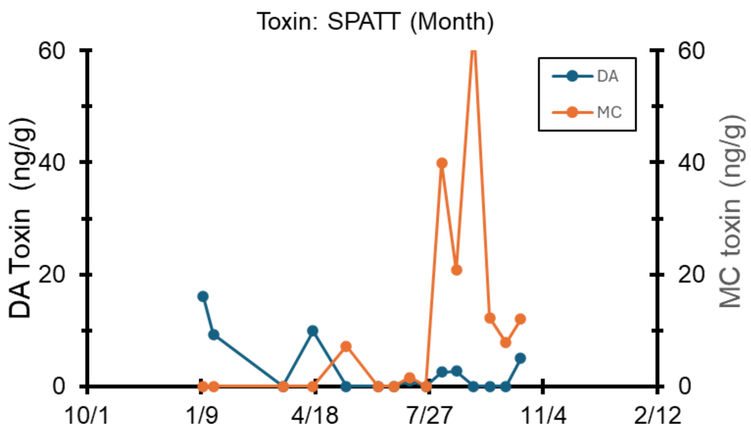


Fig. 3 Toxins in monthly SPATT deployment versus time. MC concentrations increased in late summer to fall. DA concentrations elevated in winter/ spring and late fall. Different scales for DA and MC concentrations. Note: scale of Y-axis is 4X compared to Fig. 2.

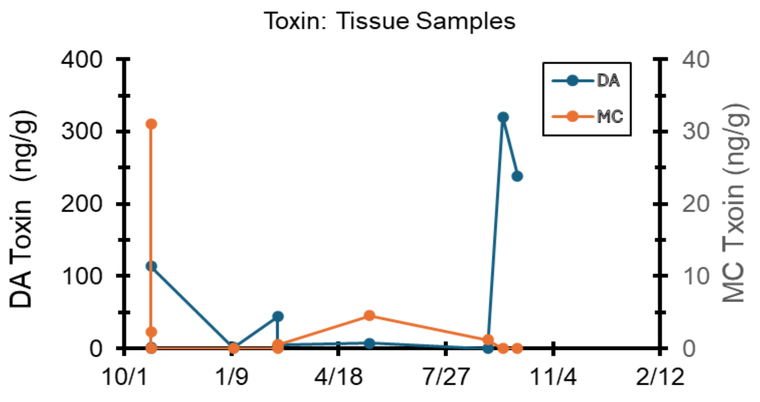


Fig. 4 Toxins in tissue samples versus time. This sampling approach yielded the highest concentrations compared to SPATT. Highest concentrations found in invertebrate tissues occurred in late fall. Note: on some dates multiple samples were analyzed and individual concentrations shown. Different scales for DA and MC concentrations.

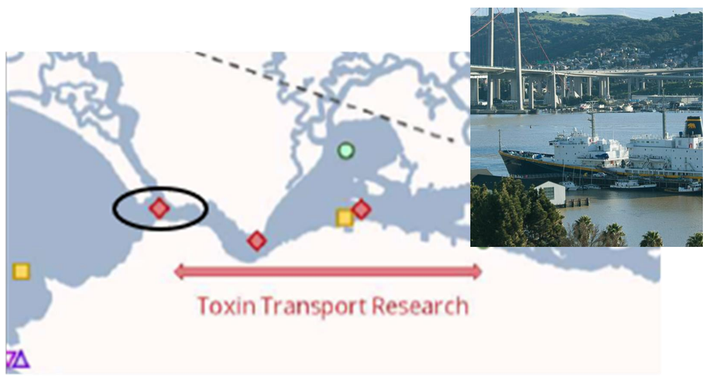
Methods

Samples were collected from shore using the methods at right, between October 2023 and December 2024 and a frequency of 2 weeks in summer and 3 to 4 weeks in all other seasons.

Toxin analysis was completed using liquid chromatography - mass spectrometry (LC-MS) at UC Santa Cruz.

Study Site

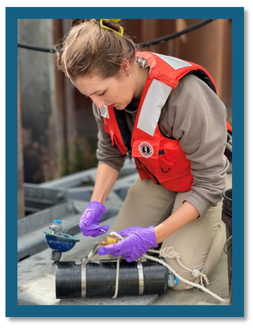
Sample collections for HAB toxins were made at the waterfront at CSU Maritime Academy at the western end of Carquinez Strait. This mesohaline region of the SFE may experience salinities between 0 and 20 (pss).



Sampling Approaches

1) **Invertebrate Tissue** Baited minnow traps were deployed for 48 h. All invertebrates (commonly, *Palaemon macrodactylus* and *Metacarcinus magister*) were counted, measured and frozen until analysis

2) **Solid Phase Adsorption Toxin-Tracking (SPATT)** Samplers were deployed for 48 h and 2 to 4 weeks. SPATT was frozen until analysis



3) **Discrete Water Sampling** Water was collected by Van Dorn bottle within 1 m of surface. 150-200mL water was filtered onto 47mm GF/F for analysis.

Acknowledgements
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