

Progress Report

Title of the project: Magnitude and extension of copper pollution effects on benthic faunal communities in San Diego Bay

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Progress report on activity Nov, 2009 – July 30, 2010

Summary of the whole activity

Main results

This period of work has focused on (1) the production of a second paper for publication on benthic faunal communities and their relationships to copper pollution in SIYB, and (2) conducting a field experiment exposing two mussel species of the family Mytilidae to waters with differing Cu levels in SIYB.

The first paper describing the spatial distribution of copper species concentrations in SIYB and its relation to boat number and distance was recently published in the journal *Chemistry & Ecology* (Vol. 25: 417-433, 2009) (please see pdf attached).

(1) This detailed determination of Cu levels provided the basis for further sampling efforts to determine the effects of Cu on benthic macrofaunal communities. The results are described in the second paper. We tested the hypothesis that variation in macrobenthic community structure is associated with changes in Cu concentrations. Because the benthic animals are permanently associated with their sediments, the question arises whether faunal assemblages inhabiting sediments with higher Cu differ of those associated with sediments with low Cu levels. We also evaluated the concentration of Cu in tissue of invertebrates in relation to surrounding sediments with differing background Cu concentrations. Through multivariate community analysis, stepwise forward selection and classification methods, we addressed the following questions:

- a) Are changes in macrobenthic community structure (density, biomass, composition, diversity) associated with Cu concentration gradients and or with other identifiable factors such as sediment organic matter, grain size, chl *a*, Cu species?
- b) Which feeding modes and lifestyles prevail at different Cu concentrations?
- c) What are the actual Cu concentrations in macrobenthic invertebrates?
- d) Do Cu concentrations in tissue follow Cu concentrations in sediment?
- e) Are there macrofaunal species more tolerant or sensitive to Cu?

Main results are:

-Macrofaunal assemblages significantly differ between sites with “high”, “medium”, and “low” environmental Cu in SIYB.

-At sites with “high” background Cu contamination macrofaunal assemblages exhibited lower total biomass and individual biomass (body size), and were less diverse, relative to “low” Cu and reference sites.

-Peracarid crustacean species richness was lowest at “high” Cu sites, and greatest at “low” Cu and reference sites, with the gammarid amphipods the most affected.

-Cu concentration in invertebrate tissues varied between species and within the same species. Several species showed higher Cu concentrations in tissue than in the surrounding environment, whereas other species had lower concentrations. This may

reflect species variations in assimilation efficiencies of Cu sorbed to sediment and detritus.

-Cu concentrations in tissue suggest that there are some species able to “regulate” their body load through mechanisms that need further investigation, most likely associated with detoxification, storage and excretion abilities.

(2) In February 2010 in SIYB, we started an experiment on the exposure of mussels to waters with differing Cu levels. The objective of this study was to evaluate potential effects of Cu bioaccumulation on mussel growth and on relationships between Cu toxicity and Cu complexation capacity. Target species are *Mytilus galloprovincialis* and *M. californianus*. Cu bioaccumulation is analyzed in different tissues, including gills, gonads, muscle, and hepatopancreas.

Results: Samples for Cu in tissue are currently being analyzed.

Additional work in others marinas, i.e., America’s Cup, and Harbor Island West and East is in progress. We have completed the titrations using increasing CuSO₄ concentrations to estimate the Cu complexation capacity (CuCC) in selected sites of these marinas. Also we have measured the total dissolved Cu in surface and bottom water and porewater.

Macrofaunal data from these marinas are being analyzed.

For each task we carried out the following activities:

Laboratory: analysis of Cu in different tissues of mussels. Measurements of total dissolved Cu, free Cu⁺⁺, CuCC. Macrofaunal biomass.

Desk: Preparation of second manuscript for publication. This is focused on macrofaunal response to Cu pollution in SIYB. Literature research to obtain historical records of Cu pollution in the bay. Available data are being analyzed and integrated. Paper on Cu spatial distribution at Shelter Island Yacht Basin published in Chemistry & Ecology is attached to this report in a separate file.

Table of activity - percentage carried out

Task	Field	Laboratory	Desk
	Previous/this period	Previous/this period	Previous/this period
Focused sampling	% 100 / 80%	% 80 / 70%	% 100 / 50%

Task in progress:

- field: Ongoing field experiments of toxicity in SIYB.
- laboratory: Cu in tissue, CuCC, free Cu⁺⁺.
- desk: Paper on community response to Cu in final revision phase prior to submission.

Deliverables

Report produced

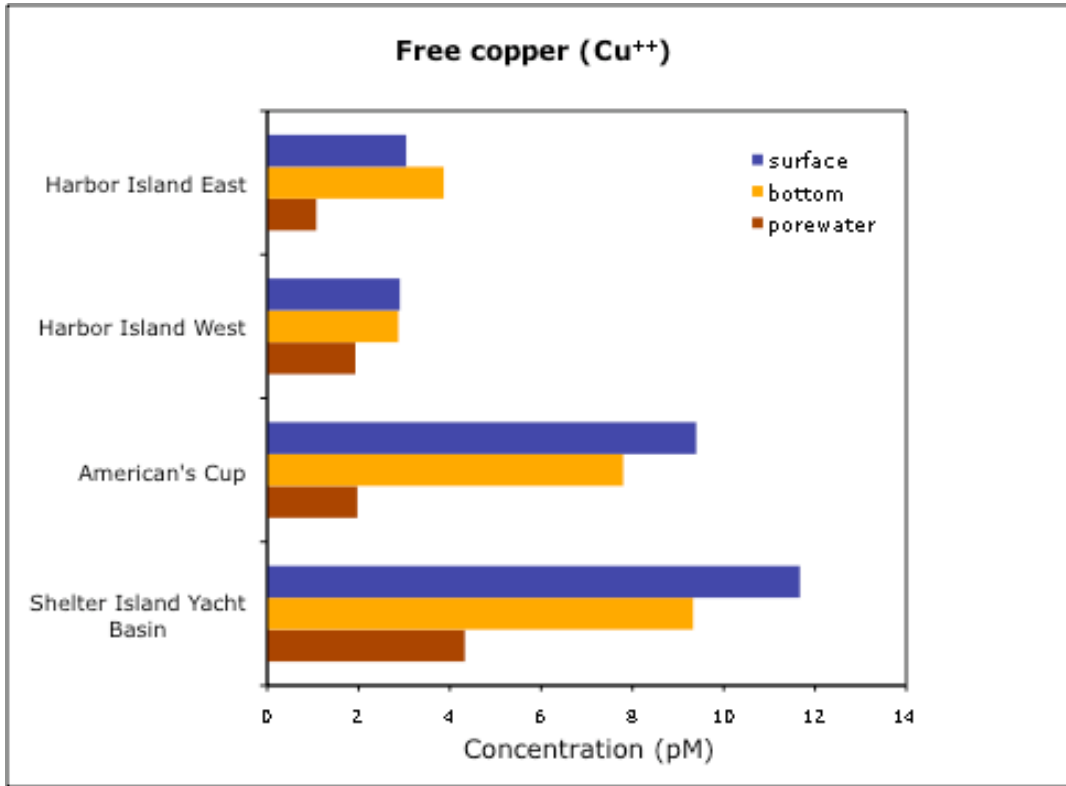


Fig. 1. Comparison of free Cu⁺⁺ concentrations within marinas in three vertical zones (surface water, bottom water, and sediment porewater), and among marinas. Free Cu was measured with an Orion 94-29 Cu-Ion Selective Electrode in unfiltered water samples.

Fig. 2. Mini-gravity core to collect sediment samples