PEEIR

Pacific Estuarine Ecosystem Indicator Research Consortium

What PEEIR Data Tell Us about Sediment Quality Objectives

Issue

Sediments have been recognized as the final repository for organic contaminants and trace metals. Toxic chemicals accumulated in sediments, however, can penetrate back into the ecosystem by dispersing and moving up food chains and can cause unanticipated adverse effects. To better assess the quality of sediment, it is desirable to have multiple lines of evidence. The combination of rich chemical and biological datasets is helpful in developing appropriate management strategies for complex ecosystems.

Approach and Rationale

To determine sediment quality, various types of data were integrated, including sedimentary chemical concentrations, tissue body residues, acute porewater toxicity, and benthic invertebrate community profiles. Sedimentary concentrations of toxic chemicals were converted into toxic potentials (mean ER-M quotients, mERMQ) and then were compared to field biological indicators ranging from cellular to community levels according to methods devised by PEEIR (Link to Executive Summary). To determine the bioavailability of sedimentary contaminants, the body burdens of organic contaminants and trace metals in fish, clams, and crabs were measured. Marsh plant exudates were also measured.

Findings and Impact

Sedimentary chemical concentrations and PEEIR indicators showed the impact of land use patterns on the quality of sediment (Table 1 and see Figure 1 for location of PEEIR sampling sites). Toxicity test data and invertebrate community data also showed responses but these were less conclusive. Fish tissue body residue and plant exudates data indicated that sedimentary contaminants are bioavailable and possibly can affect human health and wildlife. Fish indicators uncovered evidence of endocrine disruption, apoptosis, and tumors. Crabs exhibited decreased reproductive performance.

- Sediments from all Stege Marsh (SM) stations had mERMQ higher than 0.5, indicating that SM sediments have elevated potential to cause adverse effects. Mercury, current-use pesticides and other unknown contaminants were not included in this analysis, so actual toxic potential is likely to be higher.
- Crab embryo reproductive impairments showed good correlations with the levels of sedimentary contaminants. TUNEL-positive assay with mudsuckers also indicated sedimentary contaminants in SM caused more apoptosis, and tumors were also more prevalent (Link to Fish Apoptosis).
- Endocrine disruption in fish was also observed at SM and at a lower level at Carpinteria Salt (CS) Marsh (Link to Fish Endocrine Disruption).
- Body burdens of PCBs and DDTs in fish from SM exceeded screening values set to protect human health.
- Macroinvertebrate data revealed that sedimentary toxic chemicals affected the invertebrate community in SM, where pollution-tolerant species accounted for more than 90% of total species abundance. When all northern California marsh data was combined, as toxic potential (mERMQ) increased, pollution-tolerant species also increased. However, measures of benthic invertebrate diversity and abundance showed no consistent variation in relation to site contamination.

A research partnership between **University of California, Davis, Bodega Marine Laboratory** and **University of California, Santa Barbara**
Funded by **U.S. EPA Science To Achieve Results (STAR) EAGLE Program** Grant No. R82867601

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant # R-82867601

Findings, cont.

- Sediment porewater, sea urchin fertilization, and embryological development tests showed significant adverse effects in most samples at SM; however, toxicity of sediment elutriates to echinoderm larvae was negligible. This difference was because of the dilution effect when sediment elutriate samples were collected. Porewater toxicity was attributed to elevated levels of un-ionized ammonia at several stations. A preliminary Toxicity Identification Evaluation (TIE) indicated possible toxic impacts of organic contaminants, which is consistent with PEEIR data.

Table 1. Toxic impacts of sedimentary contaminants in salt marshes.

	Stege Marsh	Carpinteria Salt Marsh	China Camp	Tom's Point	Walker Creek
Land Use Pattern	Urban/Industrial, Highly populated	Urban, Less populated	Rural	Rural	Rural
Sedimentary toxicants	X	△	O	O	O
Crab embryo development	X	NA	NA	O	O
Fish apoptosis/tumors	X	O	NA	O	O
Fish endocrine disruption	X	△	O	O	O
Invertebrate community	X/O	NA	O	O	O
Elutriate toxicity	O	O	O	NA	NA
Porewater toxicity	X/O	NA	X	NA	NA
Toxic Impact	High	Low/Medium	Low	Low	Low

X: impacted, △: moderately impacted, O: not impacted, NA: not available

Applications

- Overall PEEIR data suggest that, instead of single indicator, a "multiple lines of evidence" approach (e.g., a triad approach combined with the Resident Species Portfolio method devised by PEEIR) is desirable to assess sediment quality more accurately.
- A conventional sediment quality triad approach measures acute toxicity, not chronic toxicity. However, PEEIR data indicate that chronic toxicity measurements with residential biota also need to be included.
- Combining sediment and tissue chemistry data with biological indicator data is helpful for evaluation of the disturbance of sediment quality by human activities.
- When Stege Marsh sediments need to be dredged, it is important to note that they are not suitable for beneficial uses, such as habitat restoration.

Contact Names

University of California, Davis,
Hyun-Min Hwang, hmhwang@ucdavis.edu
Peter G. Green, pggreen@ucdavis.edu
Edwin D. Grosholz, tedgrosholz@ucdavis.edu
UCD Bodega Marine Laboratory,
Steven G. Morgan, sgmorgan@ucdavis.edu
Gary N. Cherr, gncherr@ucdavis.edu
Susan L. Anderson, susanderson@ucdavis.edu

Contributing Investigators: Scott Carr, USGS;
Scott Ogle, Pacific EcoRisk

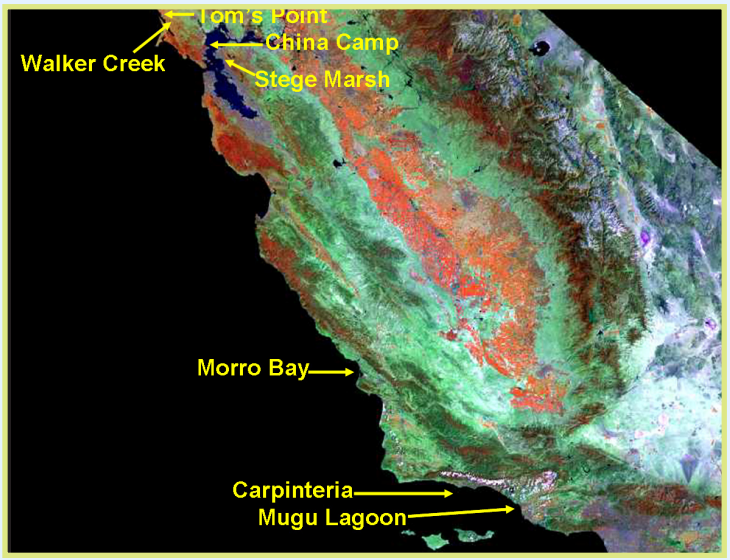

Figure 1. PEEIR Sampling Sites along the California coast.

A research partnership between **University of California, Davis, Bodega Marine Laboratory** and **University of California, Santa Barbara**
Funded by **U.S. EPA Science To Achieve Results (STAR) EAGLE Program** Grant No. R82867601

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant # R-82867601