Sampling in the Freshwater Reaches of the Lower Delta for Sediment Quality Objectives Measures

CONTAMINANT MONITORING AND RESEARCH PROGRAM

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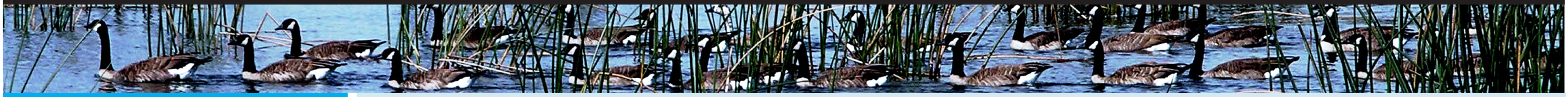

Introduction

The State Water Resources Control Board (SWRCB) recently approved Sediment Quality Objectives (SQO) for Bays and Estuaries. This assessment method utilizes three lines of evidence: benthic community evaluations, chemical condition, and toxic effects in a multiple line-of-evidence approach to evaluate if sediments from a site are potentially impacted.

This SQO-Delta project is collecting environmental data for all three lines-of-evidence in the tidal-freshwater region of the San Francisco Delta. The project plans to develop SQO assessment methods for the lower Delta region through a scientific workgroup process.

In the Fall of 2007, the SQO-Delta project collaborated with the Department of Water Resources - Environmental Monitoring Program to collect benthos, sediment chemistry, and toxicity data.

Project Participants

Southern California Coastal Water Research Project Costa Mesa, CA	Scientific Agency Leading the Development of SQOs for the State
San Francisco Estuary Institute (SFEI) Oakland, CA	SQO-Delta Project Manager & Science Advisor
Department of Water Resources Environmental Monitoring Program (DWR -EMP) Sacramento, CA	Long-term Benthos Sampling Program
Applied Marine Sciences Livermore, CA	Field Logistics
Bureau of Land Reclamation Endeavor	Provided the sampling vessel and operator
Applied Marine Sciences, Inc. League City, TX	Sediment Characteristics
Brooks Rand, Llc. Seattle, WA	Trace Elements
Water Pollution Control Laboratory California Department of Fish and Game Rancho Cordova, CA	Trace Organics
Granite Canyon Marine Laboratory Department of Environmental Toxicology University of California, Davis, CA	Sediment Toxicity
Hydrozoology (Wayne Fields) New Castle, CA	Benthos - Taxonomy & Abundance

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Sampling Design and Analysis Plan

Objective: To collect sediment chemistry, toxicity, and benthos parameters from the tidal-fresh regions of the Delta that represent the full range of sediment condition.

Based on 20 expert opinions on where to sample, we sampled sediments at one hundred stations **(Figure 1)**, and conducted an initial toxicity screening evaluation, using the 10-day amphipod survival test. Based on those results, we selected a subset of 50 stations for the full chemistry and toxicity analyses.

Sampling occurred between September 17th and October 16th 2007.

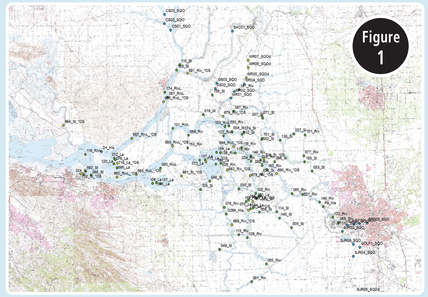
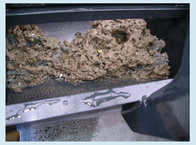


Figure 1. Map of targeted SQO-Delta sampling stations.

- Green dots are the DWR-EMP stations.
- Blue dots are the additional SQO-Delta stations.
- Yellow dots are backup or dropped stations that were initially evaluated for sampling.



Sampling Methods

Sediment samples were collected using a Young-modified Van Veen grab coated with a chemically inert surface.

The top 5 cm of sediment from two to three grabs were composited, homogenized, and refrigerated or frozen for analyses.

Benthic organisms were sampled using a Ponar grab (0.05m^2). The sample is carefully washed through a 0.6 mm mesh screen and the remaining organisms and debris are transferred to a sample container and preserved for taxonomic analyses.

Parameters Measured

Sediment Quality	Method
pH	Shipboard measure of porewater
Conductivity, Temperature, and Depth – CTD water column profile	Seabird
Sediment Grain size	ASTM D422
Total Organic Carbon	EPA 9060A
Total Nitrogen (Kjeldahl)	EPA 351.2
Total Solids	EPA 160.3
Toxicity	
Amphipod: *Hyalella azteca* (10-day survival)	EPA 600/R-99/064
Midge: *Chironomus dilutus* (10-day survival & growth)	EPA 600/R-99/064
Trace Elements	
Al, Cd, Cu, Fe, Pb, Mn, Ni, Ag, Zn	EPA 1638M (ICP-MS)
As	EPA 1638M (ICP-DRC-MS)
Se	BR-0020 (HGAA)
Hg	EPA 1631 Appendix (CVAFS)
Trace Organics	
PAHs (incl. Alk-PAHs)	EPA 8270M (GC-MS (SIM))
PCBs (~48 compounds)	EPA 8082M (GC-MSMS)
OC PEST (~30 compounds)	EPA 8081AM (GC-ECD/GC-MSMS)
Pyrethroids (~ 12 compounds/isomers + PBO)	EPA3645, 3640A, 3620B (GC-MSMS/LC-MSMS/GC-ECD)
Carbamates (Aldicarb, Captan, Carbaryl, Diuron, Methiocarb, etc.)	EPA 3645, 3640A (LC-MSMS)
Misc. Analytes (Fipronil & degradates, metolachlor, Trifluralin)	EPA 3645, 3640A, 3620B (GC-MSMS/LC-MSMS)
Benthos - Taxonomy	
Identification to the lowest practical taxon & abundance	

Results

Data from the Fall-2007 sampling event are just being received from the analytical laboratories. Preliminary toxicity and a subset of contamination results are presented.

Toxicity Results

Only three out of one hundred stations screened, were significantly toxic **(Figure 2)**.

Figure 2. Initial sediment screening results from 100 stations, using the 10-day amphipod survival test (*Hyalella azteca*). Based on those results, we selected a subset of 50 stations for the full chemistry, toxicity, and benthos analyses (TRIAD Stations). Only three stations were toxic to amphipods.

- Green dots indicate the 50 TRIAD stations: sediment samples were analyzed for all sediment chemistry, toxicity, and benthic community measures.
- Yellow dots indicate the remaining 50 stations screened for amphipod toxicity but not analyzed for the full suite of measures (not TRIAD stations).
- Blue circles indicate the three TRIAD stations that were significantly toxic in the 10-day midge growth test (Chironomus dilutus).

Sediment Chemistry

Preliminary results indicate that several persistent legacy contaminants of concern and current use pesticides were detected in sediments from many of the 50 stations sampled in the lower Delta.

Comparison of *median* concentrations of select contaminants between the SQO-Delta samples and the RMP-Status and Trends program samples from the northern estuary (Suisun Bay and the Sacramento and San Joaquin Rivers stations; 2005 & 2006 (n=22)) indicate that:

- Sum of PCB and PAH concentrations are similar in the lower Delta region as in the northern Estuary.
- Sum of DDT and Chlordane concentrations are about ten times higher in the lower Delta than the northern Estuary.
- Except for PAHs, the highest concentrations of these contaminants were 30 to 70 times higher in the lower Delta sample area than the northern Estuary.

	Sum of PCBs		Sum of PAHs		Sum of DDTs		Sum of Chlordanes	
	RMP	SQO	RMP	SQO	RMP	SQO	RMP	SQO
% Detected concentrations	100%	88%	100%	98%	95%	90%	100%	96%
Avg MDL	0.001	0.2	0.9	1	0.001	0.4	0.001	0.7
Median	0.8	0.5	285	257	1.3	9	0.08	0.7
Min	0.001	ND	18	ND	0.1	ND	0.02	ND
Max	2.4	156	5170	1833	2.5	72	0.22	16

Units = µg/kg dry weight units

Other organic compounds detected in the SQO-Delta study (but not analyzed by the RMP) include Chlorpyrifos, Carbamates and Pyrethroid pesticides.

- Pyrethroids were detected in about 30% of the samples (Bifenthrin, Permethrin, and Cyfluthrin were the most often detected compounds on the targeted list), and Piperonyl butoxide (PBO, a synergist added to pyrethroid pesticide mixtures was detected in about 90% of the samples).
- Several current use carbamate pesticides were detected in 10 to 90% of the samples including Aldicarb, Carbaryl, Carbofuran, Diuron, and Linuron. Diuron was detected in over 90% of the samples.

				Carbamates				
	Chlorpyrifos	Sum of Pyrethroids	Piperonyl butoxide	Aldicarb	Carbaryl	Carbofuran	Diuron	Linuron
% Detected concentrations	50%	32%	92%	32%	66%	10%	96%	8%
Avg MDL	0.4	1.8	0.1	1	0.1	0.1	0.2	0.2
Mean	0.9	5.9	1.8	1.6	0.2	0.08	17	0.7
Median	0.6	5.1	1	1.4	0.1	0.05	8	0.4
Min	0.4	0.5	0.1	1	0.1	0.1	0.3	0.2
Max	5	25	18	4	1	0.2	97	2

Next Steps

The SQO-Delta project is preparing for another sampling event with the DWR-EMP's benthic sampling team in late May-2008. We will be collecting sediment at 50 DWR-EMP stations for toxicity screening and will conduct additional toxicity and chemistry analyses at 25 of those stations.

By sampling the lower Delta in both the Fall and Spring seasons we hope to get a snapshot of sediment conditions during different run-off periods and seasonal agricultural practices.

Results from all three lines-of-evidence (chemistry, toxicity, and benthos) from both sampling events (75 stations) will be compiled, validated, and presented to the scientific workgroup for use in the development of SQOs for the tidal-fresh region of the Delta.

While it is encouraging that there doesn't appear to be widespread toxicity in the sediments of the lower Delta, it may be a challenge to develop SQO methods for this region without more data that include clearly impacted sediments based on all three lines of evidence.