Characterization of sediment toxicity in Newport Bay

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ABSTRACT - Studies of the Newport Bay have identified extensive sediment toxicity and chemical contamination, but the cause of the toxicity has not been determined. The objective of this study was to use various toxicity identification evaluation (TIE) methods to characterize the cause of sediment toxicity. The TIEs were conducted on samples of whole sediment and pore water using amphipod survival and sea urchin fertilization toxicity tests. Tests were conducted using sediment from two locations: a sediment deposition basin in the upper bay, which is influenced by urban runoff; and Rhine Channel in the lower bay, which is surrounded by marina, residential, and industrial uses. The TIE results indicate that multiple sources of toxicity are present in Newport Bay. Toxicity in sediments from the upper bay is associated primarily with unidentified organic compounds, possibly pesticides in current domestic or agricultural use. Sediment toxicity in the Rhine Channel appears to be caused by multiple factors, including metals. The interpretation of the data from this study was limited by variable results between test species and the relative lack of contaminant-specific TIE methods for whole sediments. Development and validation of additional whole-sediment TIE methods is needed in order to facilitate the use of TIEs for guiding environmental management actions.

INTRODUCTION

Newport Bay is a large lagoon in southern California that supports many types of beneficial uses. The ecological reserve in the upper bay protects one of the few remaining estuarine habitats in southern California for coastal wetlands wildlife and estuarine marine life. The developed lower bay is the focus of recreational boating and fishing. The upper bay receives most of its freshwater inputs from San Diego Creek, which flows through a watershed consisting of mostly residential and agriculture land uses. The creek is on the 303 (d) impaired water body list for toxicity and pesticide contamination. The lower bay is surrounded by marinas and has received historical contaminant inputs from industrial sources, such as boat building and cannery operations.

Recent studies have identified extensive and severe sediment quality impairment throughout Newport Bay. Of 11 stations from lower Newport Bay sampled during a regional monitoring survey in 1998, 9 were found to be moderately or highly toxic to amphipods (Bay *et al.* 2000). The California Bay Protection and Toxic Cleanup Program designated the Rhine Channel, in the lower bay, as a "toxic hot spot" due to the presence of high contamination and biological impairment (Phillips *et al.* 1998). Studies conducted in 2000 and 2001 detected sediment toxicity at 7 of 10 locations sampled, with severe toxicity (less than 50% survival) occurring at multiple stations in both the lower and upper portions of the bay (Bay *et al.* 2004).

Extensive analysis of sediment chemistry and toxicity in the Rhine Channel was unable to identify specific contaminants associated with the sediment toxicity present throughout the site (Bay and Brown 2003). Traditional chemical analysis is often not sufficient to identify the cause of sediment toxicity due to uncertainty caused by the interactions of multiple chemicals, variations in chemical bioavailability, and limited information regarding the toxic effects on marine organisms of many chemicals.

Toxicity identification evaluations (TIEs)—consisting of sample manipulations intended to eliminate the activity of specific chemical groups, followed by toxicity tests—are often used to determine the cause of toxicity. Standardized methods are well established for conducting TIEs on aqueous samples (U.S. EPA 1991, 1996). Methods for conducting TIEs on whole sediment are in the development process (Kosian *et al.* 1999, Lebo *et al.* 1999, Burgess *et al.* 2000, Ho *et al.* 2000).

The objective of this study was to characterize the likely cause of sediment toxicity in selected areas of Newport Bay by using TIE methods. Two TIE approaches were used in this study. The first approach used methods under development by the U.S. EPA for treating whole sediment. The second approach applied established effluent TIE methods to samples of pore water from the same sediments. As a secondary objective, the results of the different TIE approaches were compared. This component of the study will ultimately assist in the development of sediment TIE methods that are effective for southern California.

METHODS

Two field sampling efforts for TIE studies were conducted in November 2001 and March 2002. These studies were conducted in two areas (Figure 1), the Rhine Channel (e.g., Station NB3) and the upper bay sedimentation basin (e.g., Station NB10). These areas were selected for study because they have exhibited consistent and strong toxicity to multiple species and they are located in regions of Newport Bay influenced by different sources of contamination (Bay *et al.* 2004). Sediment grab samples were collected from the two areas and pore water was extracted from a portion of the sample. Toxicity of the whole-sediment samples was measured using a 10 d amphipod survival test. Toxicity of the pore water samples was measured using both the amphipod survival test and a sea urchin fertilization test. The TIEs were performed on all pore water and whole-sediment samples, and sediment chemistry was measured. The focus of the March 2002 sampling event was to verify the November 2001 results and to test for small-scale spatial variability. Additional stations were sampled in March 2002 near Stations NB3 and NB10 and tested for pore water and whole-sediment toxicity and chemistry. The TIEs were performed on selected samples of pore water and whole sediment, based on preliminary test results.

Sediment samples were collected using a Van Veen grab. The top 2 cm from multiple grabs were homogenized together. Subsamples for sediment chemistry and whole-sediment toxicity were taken from the homogenized composite sample. The samples for chemistry were frozen at –20°C until analyzed. Samples for sediment toxicity and grain size were stored at 5°C until analyzed. Pore water was obtained from the homogenized whole-sediment sample by centrifuging an aliquot at 3000 X g for 30 min. Pore water was extracted the day before toxicity testing and was stored at 5°C.

The purple sea urchin fertilization test was used to evaluate the pore water samples for toxicity (U.S. EPA 1995). This test measures toxic effects on sea urchin sperm, which are expressed as a reduction in their ability to fertilize eggs. Purple sea urchins (*Strongylocentrotus purpuratus*) used in the tests were collected from the intertidal zone in northern Santa Monica Bay or from the central California coast. The test consisted of a 20 min exposure of sperm to the samples. Eggs were then added and given 20 min for fertilization to occur. The eggs were then preserved and examined later with a microscope to assess the percentage of successful fertilization. Toxic effects are expressed as a reduction in fertilization percentage. The tests were conducted in glass shell vials containing 10 mL of solution at a temperature of 15°C. Three to five replicates were tested for each sample.

The amphipod survival test was used to evaluate the toxicity of pore water and whole-sediment samples. The amphipods, *Eohaustorius estuarius*, were collected from Yaquina Bay near Newport, Oregon. The animals were held in the laboratory on their

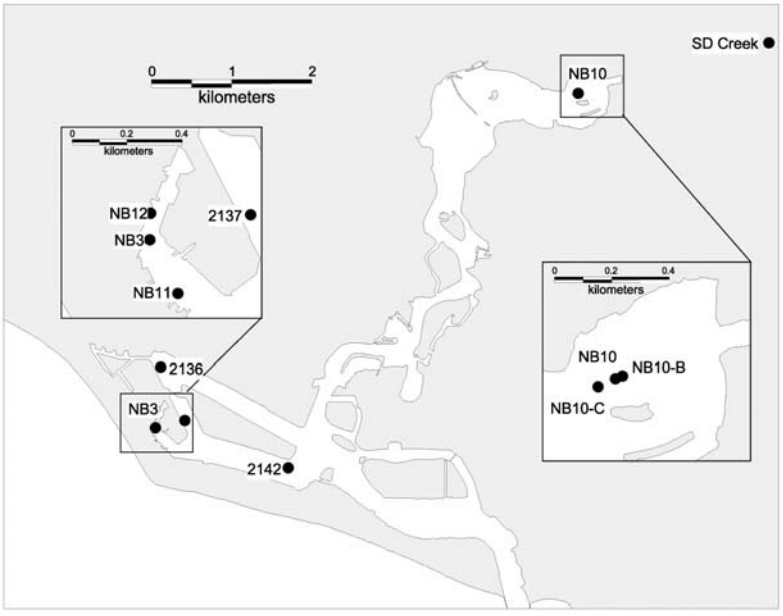

Figure 1. Locations of sediment sampling stations in Newport Bay for November 2001 and March 2002.

native sediment for up to a week before testing began. The pore water tests were conducted in glass vials containing 10 mL of solution at a temperature of 15°C. Five amphipods were added to each vial for an exposure period of 10 d. Three to five replicates were tested for each sample. At the end of the exposure period, the number of amphipods surviving in each vial was counted. Notes on survival were also made after 4 and 7 d of exposure. The samples were tested at the ambient salinity (approximately 30 g/kg); laboratory water samples at both 20 and 33 g/kg salinity were tested as negative controls.

The whole-sediment tests were conducted in 250 mL glass beakers containing approximately 40 mL of sediment and 160 mL of water. Ten amphipods were added to each beaker and were exposed for 10 d. The overlying water had a salinity of 20 g/Kg, the beakers were gently aerated, and the exposures were conducted at 15°C. The beakers were monitored daily for visible changes to the sediment or death of the animals. At the end of the exposure period, the sediment from the beakers was passed through a sieve to recover the animals. The number of surviving animals was then recorded. Samples of amphipod home sediment were tested as negative controls.

Phase I TIE procedures were performed on the pore water samples using methods adapted from the (U.S. EPA 1996). The purpose of the Phase I TIE is to characterize the general characteristics of the toxicants (e.g., whether they resemble metals or organics). Pore water from both stations sampled in November 2001 and on selected March 2002 pore water samples were tested.
Ethylenediaminetetraacetic acid (EDTA), a chelator of metals, was added to produce a concentration of 60 mg/L in the test samples. Sodium thiosulfate (STS), a treatment that reduces oxidants such as chlorine and also decreases the toxicity of some metals, was added to a final concentration of 50 mg/L to separate portions of each sample. Both of these treatments were given at least 1 h to interact with the sample before the animals were added. The pore water samples were passed through a Varian Mega Bond Elut C-18 solid phase extraction column to remove nonpolar organic compounds. After treatment, the pore water samples were tested for toxicity using the sea urchin fertilization and the amphipod survival tests.

The effectiveness of the TIE treatments was determined by comparing the test results to the initial toxicity results (usually conducted several days before TIE testing to verify the presence of toxicity) and baseline toxicity results (untreated sample tested concurrently with the TIE treatments). Since the November 2001 samples were collected from two stations that had been identified previously as having consistent toxicity, no initial testing was conducted. The initial test results for the March 2002 samples were used to select a subset of samples for TIEs.

Phase I sediment TIE manipulations were also performed on the whole sediment from each station for both samplings using methods based on recent research (Lebo *et al.* 1999, Burgess *et al.* 2000). While the objective of the sediment TIEs is to remove toxicity, as in the aqueous samples, alternate methods must be used because of the sediment matrix. Three manipulations were performed on each sample. To one aliquot of sediment, cation exchange resin (ResinTech SIR-300) was added at a concentration of 20% by weight to bind metals. To a second aliquot, coconut charcoal was added at a concentration of 15% by weight to bind organics. After addition of the modifying agent for each treatment, the sample was stirred vigorously with a glass rod for 1 min. The final treatment consisted of adding clean home sediment to a third aliquot at a concentration of 20% by weight. This treatment was used to test for any dilution or aeration effect caused by the other treatments. The samples were allowed to equilibrate overnight before the addition of animals. The samples were then tested for toxicity using the amphipod survival method described above.

Trace organic compounds were extracted from the sediment samples using Modified EPA Method 3540, methylene chloride extraction by roller table. The extracts were analyzed by EPA Method 8270 on an HP 6890/5972 GCMS. Trace metals were digested from the sediments using EPA Method 6020, strong acid digestion using microwave. The digested samples were analyzed on an HP 4500 ICPMS.

Acid volatile sulfides (AVS) were measured by taking a 1 to 5 grams aliquot of wet sediment and adding deionized water to make a total volume of 48 mL. Next, 2 mL of 1:1 HCl was added and the sample was immediately capped and centrifuged. A 25 mL aliquot of water was then placed into a cuvet, reagents were added, and the H_2S concentration was measured using a spectrophotometer programmed at 665 nm. Simultaneously, extracted metals (SEM) were measured on the AVS samples. A 10 mL aliquot of water from the acidified sample was centrifuged, spiked with internal standard, and analyzed directly using a Hewlett Packard 4500 ICPMS.

RESULTS

Upper Bay Toxicity

The November 2001 whole-sediment sample from Station NB10 was extremely toxic, with no amphipods surviving in any of the replicates. The cation exchange resin and dilution treatments of the sediment did not reduce the toxicity of Station NB10 sediment (Figure 2). The addition of coconut charcoal was very effective, however; all of the toxicity was removed, with 100% survival of the amphipods in each of the replicates.

Pore water from Station NB10 was not toxic to sea urchin sperm, but a moderate toxic effect on amphipod survival was measured. The only treatment that had any effect on Station NB10 pore water was the C-18 extraction, which increased survival to 87% (Figure 2).

The second sampling was designed to investigate small-scale spatial variability in the upper bay location by testing sediment from Station NB10 and two nearby stations (Stations NB10B and NB10C), as shown in Figure 1.

The initial testing showed that whole-sediment samples from all three stations in the upper bay were again highly toxic to amphipods. No amphipods survived a 10 d exposure to sediment from any of the three stations. Whole-sediment TIEs were performed on all three upper bay stations. The only TIE treatment that removed toxicity was the addition of coconut charcoal, which increased survival to greater than 70% for all three stations (Figure 3).

Pore water from Station NB10C was found to be toxic to the sea urchin fertilization test, with less than 10% of the eggs fertilized. For Stations NB10 and NB10B, fertilization was 100% successful and no TIEs were conducted. When the TIE was performed on pore water from Station NB10C using the sea urchin fertilization test, the toxicity of the baseline sample was much less than had been observed in the initial test. All of the TIE treatments resulted in increased fertilization success at or near 100% (Figure 4).

The pore water from all three of the upper bay stations was very toxic to amphipods, with no animals surviving in any of the replicates after 10 d of exposure. The TIEs were conducted on pore water from Stations NB10 and NB10C using the 10 d amphipod survival test. The C-18 extraction was the only treatment that reduced toxicity for Station NB10 (Figure 3). None of the treatments reduced toxicity for Station NB10C. Amphipod survival for

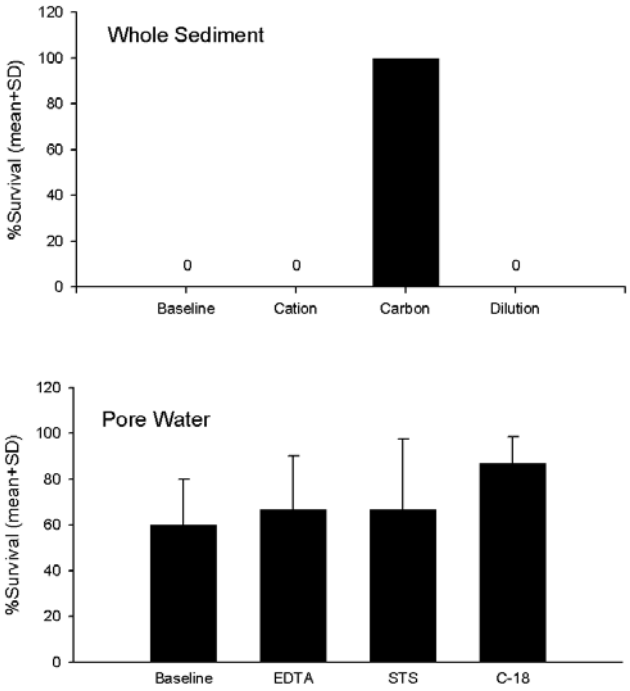

Figure 2. Results of toxicity identification evaluation treatments for November 2001 sediment and pore water samples from upper Newport Bay.

the pore water TIE was also recorded after 4 d of exposure and showed a somewhat different response pattern. The baseline samples for Stations NB10 and NB10C still showed no survival. However, C-18 extraction greatly improved survival for both stations and the STS treatment produced a small increase in survival for Station NB10C.

Rhine Channel Toxicity

The whole-sediment sample from Station NB3 was not toxic to amphipods. The concurrent TIE treatments produced similar results to the baseline sample, indicating that the sediment manipulation did not increase toxicity of the sediment (Figure 5).

Similar to the results for Station NB10, pore water from Station NB3 was not toxic to sea urchin sperm, but a moderate toxic effect on amphipod survival was measured. Each of the TIE treatments reduced toxicity for Station NB3, resulting in a mean amphipod survival of 93% (Figure 5).

The March 2002 sampling in Rhine Channel collected additional sediment from Station NB3 and also sampled two other locations (Stations NB11 and NB12), as shown in Figure 1.

Sediment from all three of the Rhine Channel stations produced toxicity to amphipods. The mean survival for these stations ranged from 30 to 56%.

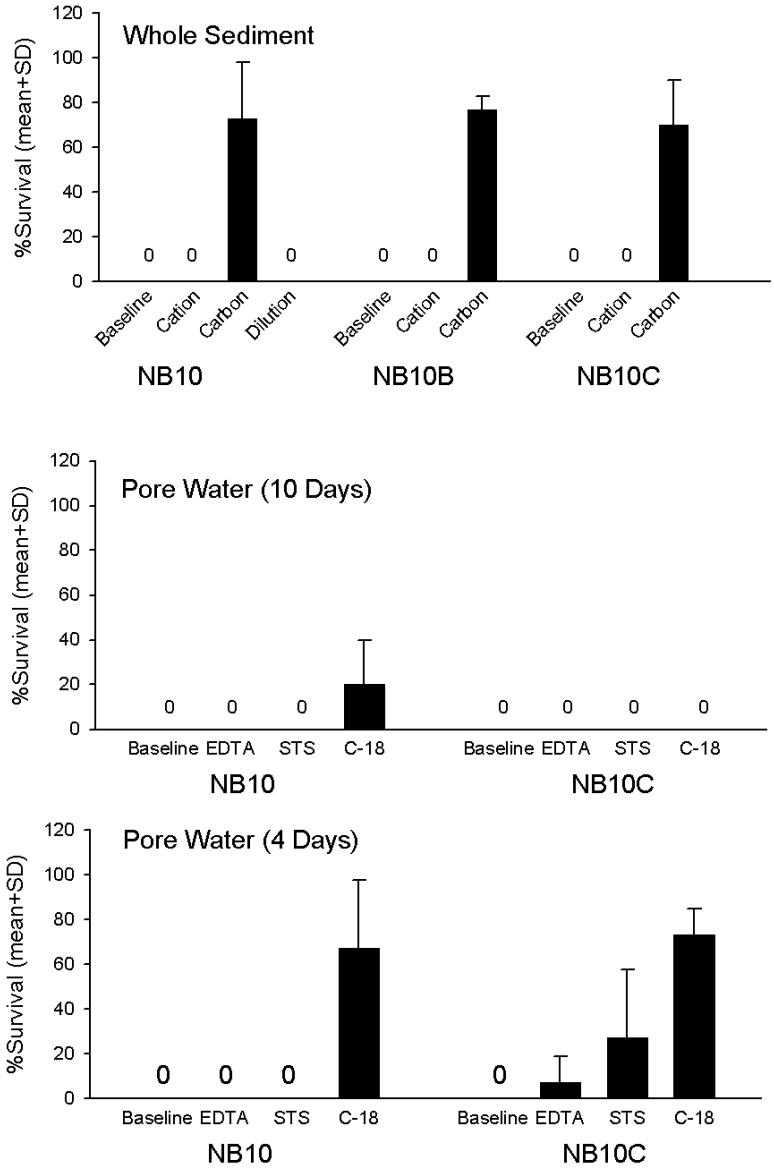

Figure 3. Results of toxicity identification evaluation treatments for March 2002 sediment and pore water samples from upper Newport Bay. Data for the pore water tests are shown for the final 10 d exposure endpoint and for observations made after 4 d of exposure.

Between-replicate variability was higher than usually observed for these stations, with standard deviations ranging from 19 to 34. Sediment TIE treatments were conducted on all three Rhine Channel stations. The cation exchange resin removed some of the toxicity from Station NB11, but had little effect on the other two stations (Figure 6). Addition of carbon increased amphipod survival for both Stations NB11 and NB12, but did not completely remove the toxicity. None of the treatments improved amphipod survival for Station NB3 sediment.

Pore water from both Stations NB3 and NB11 was very toxic to sea urchin sperm in the initial tests, with less than 15% of the eggs successfully fertilized. Station NB12 pore water was not toxic (97% fertilization). The TIEs conducted using the sea urchin fertilization test on pore water from Stations NB3 and NB11 showed that toxicity had completely disappeared from the baseline samples during storage of 11 d. All of the TIE treatments also produced high fertilization, as expected.

Moderate toxicity of pore water to amphipods was measured for all three Rhine Channel stations, with mean survival ranging from 35 to 60%. A TIE was performed on pore water from Station NB11 using the amphipod survival test (pore water extracted after 11 d storage). None of the TIE treatments were successful at removing toxicity (Figure 6). The baseline survival for this test was similar to that measured in the initial toxicity test.

Sediment Chemistry

Sediment trace metal analyses revealed relatively high levels of mercury, copper, zinc, and lead at Station NB3 in the Rhine Channel for both the November 2001 and March 2002 samplings (Table 1). Copper and mercury exceeded the National Oceanic and Atmospheric Administration (NOAA) effects range median (ERM) sediment quality guidelines (Long *et al.* 1995). The concentrations of arsenic, zinc, and lead fell between the effects range low (ERL) and ERM values for those constituents. The concentrations of copper and mercury were substantially lower at Station NB10 in the upper bay. The sediment concentrations of nickel, cadmium, and selenium were higher in Station NB10 sediment samples than in the Rhine Channel (NB3), possibly reflecting inputs of these metals from San Diego Creek discharge.

Results of the AVS and simultaneously extracted metals (SEM) analyses indicated that there was a large excess of sulfide binding capacity for metals. Sediment from Stations NB3 and NB10 contained 37-67 μmoles/g of AVS, which was 5 to 10 times

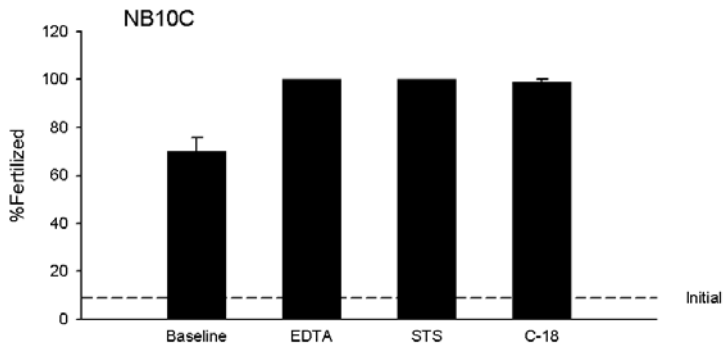

Figure 4. Results of TIE treatments for the March 2002 sediment pore water sample from upper Newport Bay. The sea urchin fertilization test results are expressed as mean ± standard deviation.

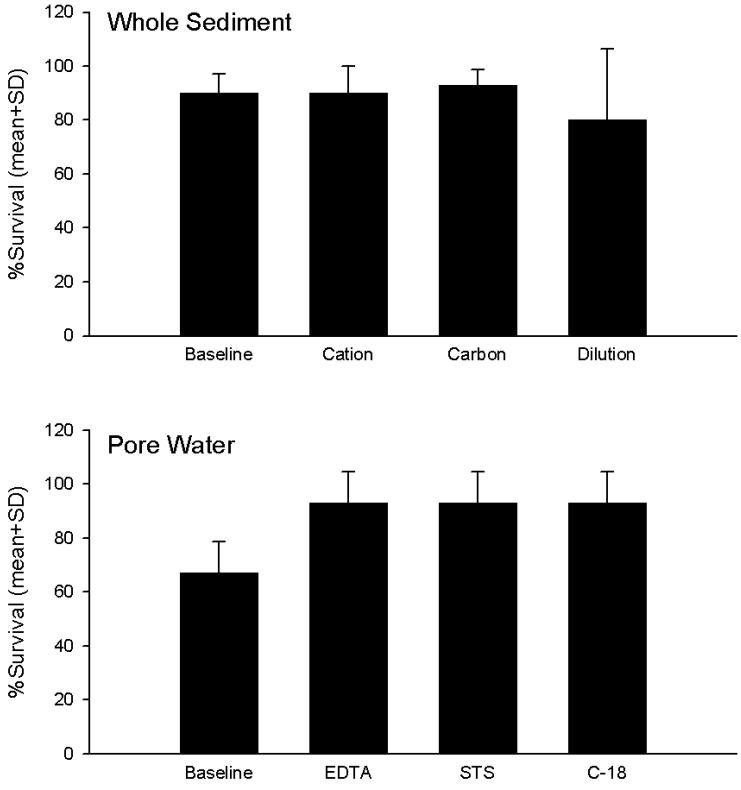

Figure 5. Amphipod survival test results for toxicity identification evaluation treatments on November 2001 sediment and pore water samples from the Rhine Channel (NB3).

greater than the concentration needed to bind the potentially bioavailable quantities of cadmium, copper, lead, nickel, and zinc (Table 2).

The Rhine Channel sediment samples contained higher concentrations of PAHs and total PCBs relative to Station NB10; however, all concentrations were below the ERM values (Table 3). The upper bay stations contained 2 to 3 times higher concentrations of total DDTs relative to the Rhine Channel. The upper bay DDT concentrations exceeded the ERM value.

The concentrations of most trace organics were similar among the three upper bay stations (Table 3). However, the concentration of total PAHs for Station NB10 in March 2002 was about a factor of two higher than the concentration for the other two stations (NB10B and NB10C), which were sampled at the same time.

Discussion

Toxicity characterization analyses were conducted on 18 samples from the upper bay and Rhine Channel. As observed in previous studies (Bay *et al.* 2004), toxicity was consistently prevalent at stations in both areas of the bay. Initial characterization of toxicity was successful at some of the stations in both the sediment and pore water phases and using more than one species.

Relatively consistent results from the toxicity characterization tests of whole sediment from the upper Bay (Stations NB10, 10B, and 10C) were obtained (Table 4). In all cases, the addition of powdered carbon to the sediment was highly effective at reducing toxicity to amphipods, suggesting that nonpolar organic constituents were the dominant type of toxicant present. Though carbon is a relatively nonspecific treatment that has the capacity to bind many types of constituents including metals, the lack of effectiveness of the concurrent cation exchange resin treatment suggests that metals were not a principal cause of the observed toxicity. The acid volatile sulfide and simultaneously extracted metals analyses conducted during the study also provide evidence that metals are not likely to be the cause of the toxicity to the amphipods. There was an excess of sulfide present in all of the upper bay samples that should have bound most of the cadmium, copper, lead, nickel, and zinc in the sediments, rendering them biologically unavailable to cause acute toxicity.

The concentrations of DDTs, PCBs, and PAHs in the upper bay sediment samples were less than the concentrations associated with consistent toxicity in other regions (Long *et al.* 1995). In addition, the

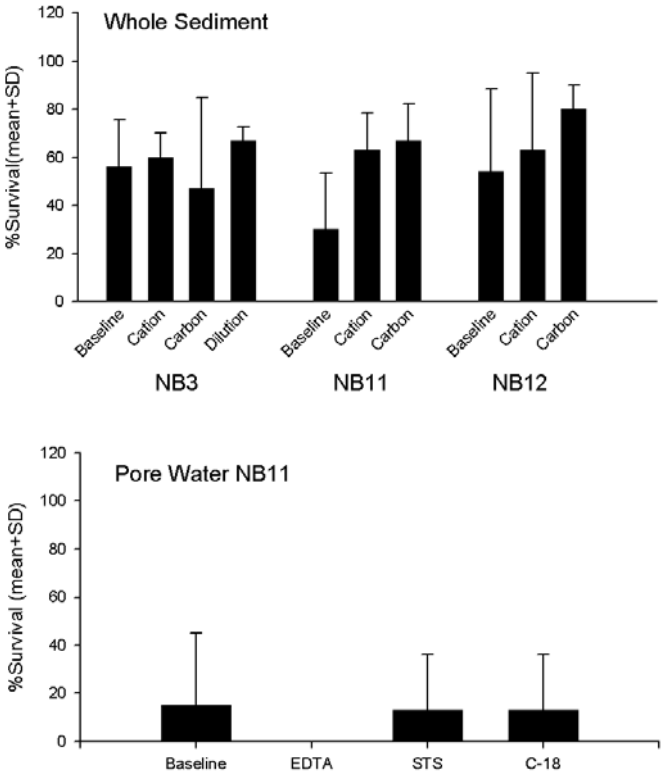

Figure 6. Amphipod survival test results for TIE treatments of March 2002 sediment and pore water samples from the Rhine Channel.

very strong toxic response by the amphipods at this site (<5% survival) has not been observed at other locations throughout Newport Bay having similar concentrations of these constituents, nor in samples from the Palos Verdes Shelf, where historical contamination by DDTs, PCBs, and PAHs is much greater. An unmeasured contaminant with a source related to runoff discharge may be responsible for the whole-sediment toxicity in the upper bay. An organic pesticide in current use, such as an organophosphorus or pyrethroid compound, is a likely candidate since these pesticides have been detected in San Diego Creek, which receives runoff from residential and agricultural areas. Additional sediment chemistry analyses are needed to confirm this hypothesis.

Results from the TIE analyses of pore water from the upper bay stations are consistent with the results for bulk sediment and indicate that the toxicity to amphipods is due to a nonpolar organic compound. This conclusion is based upon the results of a total of three TIE analyses, conducted on two dates and at two different locations (Table 4). Extraction of the pore water using a C-18 column was the only effective treatment in each case. A single TIE analysis of a pore water sample using the sea urchin fertil-

Table 1. Newport Bay selected metals chemistry concentrations from the sediment TIE sampling efforts. All data are presented as mg/dry kg.

	November 2001		March 2002				
Metal	NB3	NB10	NB3	NB10	ERL	ERM	MDL
Arsenic	8.61	6.13	10.2	7.14	8.2	70	0.05
Barium	80.9	160	125	184	NA	NA	0.05
Cadmium	0.505	1.53	0.635	1.90	1.2	9.6	0.01
Chromium	38.8	41.2	53.0	50.0	81	370	0.05
Copper	540	38.5	532	60.0	34	270	0.01
Iron	27,950	33,100	36,050	38,850	NA	NA	1
Lead	57.0	15.8	85.0	21.4	46.7	218	0.01
Manganese	200	326	251	351	NA	NA	0.05
Mercury	4.95	0.24	6.69	0.295	0.15	0.71	0.005
Nickel	15.1	19.6	19.8	23.4	20.9	51.6	0.01
Selenium	1.28	1.75	1.52	2.36	NA	NA	0.05
Silver	0.30	0.35	0.39	0.405	1.0	3.7	0.01
Tin	7.20	2.87	9.66	3.74	NA	NA	0.05
Zinc	238	160	294	219	150	410	0.05

Table 2. Newport Bay sediment simultaneously extracted metals (SEM) and acid volatile sulfide (AVS) values from samples collected for TIE analysis. All data are expressed as μmoles/g.

Constituent	Nov. 2001 NB10	March 2002 NB10	Nov. 2001 NB3	March 2002 NB3
SEM				
Cadmium	0.00512	0.00483	0.00126	0.0014
Copper	0.000755	0.0016	0.00464	0.0349
Lead	0.0151	0.0191	0.0516	0.0709
Nickel	0.0273	0.0230	0.0125	0.0104
Zinc	0.489	0.703	1.22	1.28
Total SEM	0.54	0.75	1.29	1.40
AVS	54.9	66.7	60.2	36.8

Table 3. Newport Bay selected organic chemistry concentrations from the sediment TIE sampling efforts. All data are presented as μg/dry kg. Method detection limit for all organic compounds was 1 μg/dry kg.

			November 2001		March 2002					
Constituent	ERL	ERM	NB3	NB10	NB3	NB11	NB12	NB10	NB10B	NB10C
Total PCBs	22.7	180	158	ND	157	183	126	ND	7	6
Total PAHs	4022	44792	1970	847	1810	4460	1360	1220	791	558
Chlordane-a	NA	NA	ND	ND	ND	ND	ND	ND	2	3
Chlordane-g	NA	NA	ND	ND	ND	ND	ND	ND	2	3
Total DDTs	1.58	46.1	36.1	76.3	41	88	48	73	106	112
TOC (%)	NA	NA	1.4	0.7	1.6	1.6	1.7	1.1	2.1	2.3

MDL = Method detection limit
ND = Not detected

ization test yielded a different pattern of response; the EDTA, sodium thiosulfate, and C-18 treatments were all effective. This pattern of response is suggestive of a trace metal or a mixture of toxicant types, which indicates that the sea urchin sperm are responding to a different class of toxicant than the amphipods.

TIE analyses of whole sediments in the Rhine Channel were less effective at characterizing the likely toxicants. Sediments from three stations within Rhine Channel produced different patterns of response to the TIE treatments. The addition of the cation exchange resin was partially effective at two stations, suggesting that metals may be a contributing factor. Neither carbon nor cation exchange resin addition reduced the toxicity at Station NB3, however. These different patterns of TIE treatment effectiveness suggest that multiple toxicants may be present within the Rhine Channel. Prior studies at multiple sites within the Rhine Channel were unable to identify a correlation between specific contaminants and sediment toxicity, suggesting either that unmeasured contaminants are present or that conventional sediment chemistry analytical methods do not adequately represent the biologically available contaminant fraction.

The TIE results for pore water samples from the Rhine Channel sediments were less consistent than those from the upper bay. The toxicity of one pore water sample from Station NB3 was reduced by both EDTA and C-18 column extraction, suggesting that the predominant cause of toxicity was either a metal that was also removed by the C-18 column or a mixture of toxicants. Laboratory studies have demonstrated that extraction by a C-18 column can reduce the toxicity of seawater spiked with copper or zinc, presumably by nonspecific adsorption to the resin particles (Schiff *et al.* 2003). The inability of the

Table 4. Summary of effectiveness of TIE treatments on whole-sediment and pore water samples from Newport Bay. The main presumed contaminant types indicated by each treatment are shown in parentheses. Some treatments may to a lesser extent also be effective on other contaminant types.

Station	Test	Date	Whole Sediment		Pore Water		
			Carbon (organics)	Cation (metals)	EDTA (metals)	STS (oxidants)	C-18 (organics)
NB10	Amphipod	Nov. 2001	+	0	0	0	+
NB10	Amphipod	Mar. 2002	+	0	0	0	+0
NB10B	Amphipod	Mar. 2002	+	0	NA	NA	NA
NB10C	Amphipod	Mar. 2002	+	0	0	0	+0
NB10C	Fertilization	Mar. 2002	NA	NA	+	+	+
NB3	Amphipod	Nov. 2001	?	?	+	+	+
NB3	Amphipod	Mar. 2002	0	0	NA	NA	NA
NB3	Fertilization	Mar. 2002	NA	NA	?	?	?
NB11	Amphipod	Mar. 2002	+0	+0	0	0	0
NB11	Fertilization	Mar. 2002	NA	NA	?	?	?
NB12	Amphipod	Mar. 2002	0	+0	NA	NA	NA

NA = Not analyzed
+ = Treatment effective
+0= Treatment slightly effective
? = Effectiveness could not be determined
0 = Treatment ineffective

TIE treatments to reduce the toxicity of the pore water sample from Station NB11 suggests that the toxicant in this sample was not a trace metal, as the EDTA treatment is usually highly effective at neutralizing the toxicity of dissolved metals at the concentrations likely to be encountered in the field. The nature of the toxicant in the Station NB11 sample cannot be discerned without further testing, but it is possible that a polar organic compound may be responsible; such a compound would be poorly retained by the C-18 column and would not be neutralized by EDTA treatment.

Toxicity characterization of two Rhine Channel pore water samples from the March 2002 collection were not successful due to the loss of toxicity upon storage of the sediment. The loss of toxicity from samples during storage indicates either a change in the partitioning of the toxicant between particle and dissolved phases or a loss of contaminant. These results underscore the difficulty of working with stored sediments in TIE programs. Other researchers have found that availability of metals in pore water is changed after the pore water is extracted from the sediment (Simpson and Batley 2003).

The complex nature of sediment contamination and toxicity in Newport Bay and other locations where toxicity has been observed suggests that as many tools as possible must be used to determine the specific chemicals responsible. Chemical analyses for all classes of pesticides currently in use are necessary, including organophosphorus and pyrethroids in areas influenced by urban or agricultural runoff discharge. These constituents are not typically analyzed in sediments, and specialized methods may be needed. Chemical analysis of the pore water for both metals and organics would help determine which constituents are biologically available to the organisms. Finally, innovative whole-sediment TIE treatments need to be developed to add more specificity than is available from those methods currently in use.

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