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NEW BEDFORD HARBOR PILOT STUDY

PRE-OPERATIONAL MONITORING - PROGRESS REPORT:

SUMMARY OF AMBIENT WATER QUALITY CONDITIONS

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I. INTRODUCTION

Polychlorinated biphenyl (PCB) contamination in New Bedford Harbor was first documented by both academic researchers and the Federal Government between the years 1974 - 1976. Since the initial survey of the New Bedford area, a much better understanding of the extent of PCB contamination has been gained. The entire area north of the Hurricane Barrier, an area of 985 acres, is underlain by sediments containing elevated concentrations of PCB's and heavy metals including copper, cadmium, chromium, zinc and lead. PCB concentrations range from a few parts per million (ppm) to over 30,000 ppm. Portions of western Buzzards Bay sediments are also contaminated, with concentrations occasionally exceeding 50 ppm. The water column in New Bedford Harbor has been measured to contain PCB's in the parts per billion range.

In August 1984 the Environmental Protection Agency (EPA) published a Feasibility Study of Remedial Action Alternatives for the upper Acushnet River Estuary above the Coggeshall Street Bridge. Sediments from this area of the New Bedford Harbor Superfund Project contain much greater PCB concentrations than the remainder of the harbor. The study proposed five alternatives for cleanup of the contaminated sediment. Four of these alternatives dealt specifically with dredging the estuary to remove the contaminated bottom sediments.

Comments received by EPA on these dredging and disposal alternatives prompted them to ask the U.S. Army Corps of Engineers to perform additional studies to better evaluate the engineering feasibility of dredging as a clean-up alternative. A pilot study of dredging and dredged material disposal alternatives was proposed to support this engineering feasibility study. This study is a small scale field test of several dredging and disposal techniques to be carried out on site between March 1988 and August 1988. The need for such a study is particularly great at New Bedford due to our limited knowledge and experience in dredging and disposing of such highly contaminated sediment and where the data base for the impact of site specific factors on design is not available. The study will evaluate three types of hydraulic dredges with the contaminated sediment being placed in two separate disposal sites.

A monitoring program was designed by personnel from the Corps of Engineers Waterways Experiment Station and EPA's Environmental Research Laboratory in Narragansett, Rhode Island (ERLN). The objective of the monitoring program is to provide information that can be used to (1) evaluate the effectiveness of the dredging and disposal techniques employed, (2) predict the magnitude and areal extent of water quality impacts during a full-scale operation, (3) select optimum monitoring protocols, and (4) regulate pilot study operations. Results of this program will be used to evaluate the risks and potential benefits of a full-scale dredging and disposal operation relative to other proposed options for decreasing the contamination effects of PCBs and metals in New Bedford Harbor. The full details of the pilot study objectives, dredging and disposal operations, and the monitoring program may be found in Otis (1987).

This report summarizes the results of the physical, chemical and biological monitoring that was conducted as part of the pre-operational phase. These data were collected to provide an environmental baseline on water quality conditions and to further refine the design of monitoring techniques to be used during the dredging and disposal operations. The physical data presented here include currents, tides, temperature, salinity and suspended solids measurements, with a primary focus on conditions at the Coggeshall St. Bridge. Receiving water toxicity was evaluated using four test methods: the sea urchin, *Arbacia punctulata*, sperm cell fertilization; the red alga, *Champia parvula*, reproduction; the fish, *Cyprinodon variegatus*, growth and survival; and the mysid, *Mysidopsis bahia*, growth and reproduction. The mussel, *Mytilus edulis*, was also deployed and its physiological condition, growth and survival were evaluated. Water column chemical measurements were conducted for PCBs, cadmium (Cd), copper (Cu) and lead (Pb).

II. METHODS

A. FIELD SAMPLING METHODS

Water samples were collected, using hand-operated pumps, at four stations in New Bedford Harbor during two periods, 8-14 July and 22-28 September, 1987, during the pre-operational phase of the NBH Pilot Project. At Stations 1,3, and 4, (Figure 1) daily ebb and flood tide composite samples (6 total per day) were collected by pumping 2 liter aliquots each from just below the surface, from mid-depth, and from one meter above the bottom at each of five hourly intervals during both the ebb and flood tides occurring during daylight hours. Samples were not collected during the hours of slack low and slack high tide. At Station 1, samples were collected at only two depths during the lower half of the tidal cycle when the water depth was less than 2 meters.

At Station 2, similar daily ebb and flood composite samples were collected at three depths but at two cross-stream locations, denoted

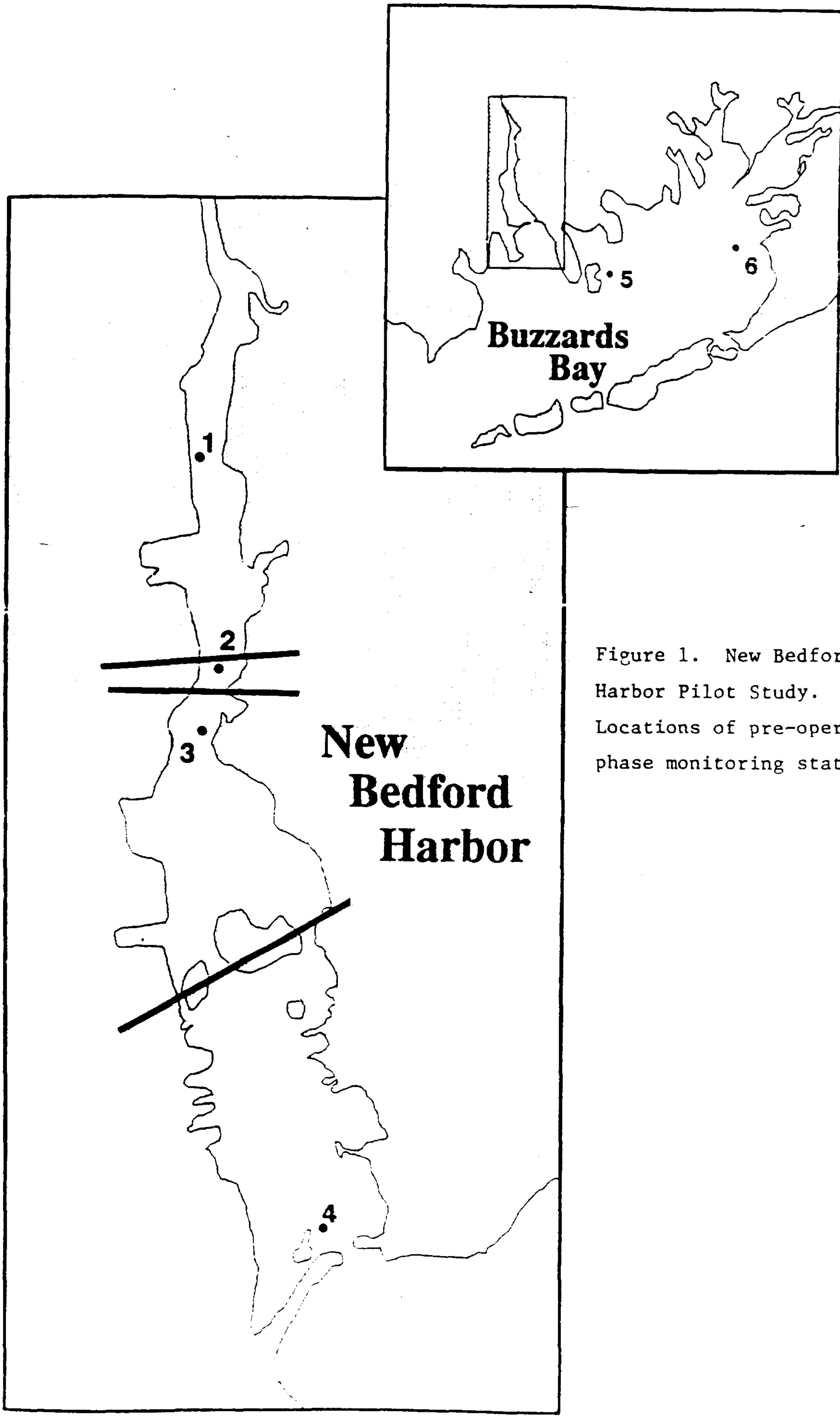

Figure 1. New Bedford Harbor Pilot Study. Locations of pre-operational phase monitoring stations.

"East" and "West". These locations were approximately one-third and two-thirds of the distance from the east to west banks of the channel under the south side of the bridge. At each location, three depths were sampled. During the first pre-operational phase, the "surface" sample was collected 0.6 meters below the water surface. A "bottom" sample was collected 0.6 meters above the bottom of the channel. A "mid-depth" sample was collected at a depth equal to one-half of the total water depth.

During the second pre-operational phase, the "surface" sample was collected 0.5 meters below the water surface, and the "bottom" sample was collected 1.0 meter above the bottom of the channel. The "mid-depth" sample was still collected at a depth equal to one-half of the total water depth. Water depth was determined from the difference in distance between bridge to channel bottom and bridge to water surface. A weighted tape measure was used. These data were also used to determine the variation in tidal height over time.

Current speed data were used to determine the volume of sample collected at each sample location that was incorporated into the station's hourly composite sample. The formula used for sample volume (V_s) determination is as follows;

$$V_s = F_s/F_t \times 6000,$$

where F_s and F_t are the flow rates (cm/sec) at the sample location and the sum total of flow rates at all sampling locations, respectively. The desired volume of the composited sample was 6000 ml.

Current meter measurements were made during the first pre-operational phase, 8,9, and 13 July 1987, using an acoustic current meter (Neil Brown DRMC) equipped with temperature and salinity probes. Samples were composited on these dates using flow-proportional sampling methods. Samples collected for toxicity testing were similarly composited during the intervening days (10-12 July 1987) using current measurements made on 9 July 1987.

During the second pre-operational phase, current meter measurements were made on 24 and 28 September 1987 using an electromagnetic current meter (InterOceans S-4) also equipped with temperature and salinity probes. Samples were composited on these dates according to the flow-proportional method. Samples collected for toxicity testing were not proportionally composited during intervening days (25-27 September 1987). Instead, equal sample volumes were collected at each spatial location (i.e. 1000 ml) for compositing. Appropriate chain-of-custody procedures are followed in the collection process and delivery of all samples to the laboratory.

In addition, individual water samples, taken 24 September at Station 2 at 3 hours after high and low tides at 3 depths, both east and west of the channel (12 samples total), were examined for spatial variability using chemical, suspended solids and sperm cell test measurements. Likewise on 28 September, each of the individual hourly samples at Station 2 (10 total) were examined for temporal variability.

Scope for growth and tissue residue measurements were made using the caged mussel, <u>Mytilus</u> <u>edulis</u>. For mussel deployments, organisms were collected from a reference population, appropriately characterized chemically and deployed at Stations 2, 3, 4, 5 (or 6) (Figure 1), at two time intervals, 5 June - 7 July and 14 September - 10 October 1987. Details of the deployment procedures may be found in Appendix IX. For all water and tissue samples, appropriate chain of custody procedures were followed in the collection, processing and delivery to the laboratory.

B. LABORATORY METHODS

Table 1 shows the sampling dates and the corresponding analyses that were performed on water samples collected during the pre-operational studv. The daily ebb and flood tide water samples were used in the seven day static renewal bioassays on *Cyprinodon* and *Mysidopsis*. Individual tests using the daily water samples were performed on the remaining species. Water samples collected from sites at West Island in Buzzards Bay and Narragansett Bay were as control treatments for the toxicity tests.

The methodologies for conducting the various physical, chemical and biological meausrements are described in detail or by reference in the attached appendices. A list of the measurements and where a description of the methodology may be found follows:

Suspended Solids	-	Appendix II
PCBs and Metals in Water	-	Appendix IV
PCBs and Metals in Tissue	-	Appendix VI
Receiving Water Tests	-	Appendix VII, Addenda 1-4
Mussel Scope for Growth	-	Appendix IX

III. RESULTS

A. METEOROLOGICAL CONDITIONS

July was considered to be a dry month, having only 0.01" of rain during the sampling period. The weather was mostly warm and humid with an overnight low temperature of 64°F on 8 July and a daytime high of 90°F on 10 July (Table 2). September, on the other hand, was much wetter

Table 1. Pre-operational water column analyses conducted on New Bedford Harbor receiving water samples.

SAMPLE DATE	Cyprinodon	Mysidopsis	Arbacia	Champia	Suspended Solids	Chemical
07/08	X	X	X	X	X	X
07/09	X	X	X		X	
07/10	X	X				
07/11	X	X				
07/12	X	X	X	X		
07/13	X	X	X		X	X
07/14	X	X	X	X		
09/22	X		X	X		
09/23	X					
09/24	X		X*	X	X	X*
09/25	X					
09/26	X					
09/27	X		X			
09/28	X		X*	X	X	X*

* indicates tests performed on both individual and composite water samples.

Table 2. New Bedford weather observations collected by the City of New Bedford Department of Public Works.

JULY

DAY	TEMP °F MAX	MIN	0800		PRECIP.	
1	86	66	66			
2	77	63	68	RAIN	.52"	
3	78	60	61	RAIN/DRIZZLE	.12"	
4	82	66	67	DRIZZLE/FOG	Trace	
5	82	64	71			
6	80	61	68	CLEAR		
7	76	58	62	CLEAR		
8	73	64	66	CLOUDY		
9	87	66	69	AM FOG/CLDY/HAZY		
10	90	68	78	AM FOG/CLR/HAZY		
11	82	68	70	AM FOG/HAZY		
12	75	68	70	AM FOG/OVERCAST		SAMPLING PERIOD
13	74	68	68	RAIN/DRIZZLE	.01"	
14	77	70	72	FOG/SHOWERS/TS	Trace	
MONTH TOTAL					1.13"	

SEPTEMBER

DAY	TEMP °F MAX	MIN	0800		PRECIP.	
13	70	64	65	HEAVY RAIN	1.26"	
14	81	64	70	RAIN	.16"	
15	79	56	58			
16	80	60	61			
17	76	65	68	RAIN	.23"	
18	65	55	60	SHOWERS	.28"	
19	59	56	56	SHOWERS	.72"	
20	61	55	58	RAIN	1.36"	
21	63	54	54	MIST	.03"	
22	72	57	58	CLOUDY		
23	72	54	54	CLDY/CLR		
24	77	58	58	CLR/CLDY/RAIN	.03"	
25	67	49	50	CLEAR		
26	68	46	49	CLEAR		SAMPLING PERIOD
27	68	49	49	CLEAR		
28	73	55	61	CLEAR		
MONTH TOTAL					5.49"	

overall but still had only .03" of rain during the sampling period. There was, however, a significant rainfall during the preceding week. Temperatures ranged from 46°F on 26 September to 77°F on 24 September.

B. PHYSICAL MEASUREMENTS

Temperature, Salinity, Currents, Tides

Details of results of the hydrographic measurements discussed in this section are described in Appendices I and II. During the first pre-operational phase, seawater temperature varied between 21.5 and 23.5°C at Station 2. During the second pre-operational phase, temperature varied between 18.5 and 19.5°C. Profiles of temperature for each of the five sampling periods on the flood and ebb tides were generally similar over depth and between east and west locations. Although only minor differences (< 0.5-1.0°C) were observed, they are probably real, since each data point represented the cumulative mean of the large number of determinations (n = 120).

During the first pre-operational phase, salinity varied between 24 and 29 ppt. During the second pre-operational phase, salinity varied between 29 and 33 ppt. The relatively lower salinities observed during the first pre-operational phase cannot be explained by rainfall data. Profiles of salinity for each of the 5 sampling periods on the flood and ebb tides were generaly similar over depth and between east and west locations. Although only minor differences (< 1-2 ppt) were observed, they again are probably real, given the large number of samples (n = 120) used to determine each data point. Salinity tended to be lower in surface waters and on the ebb tide.

Temperature and salinity were measured concurrently at Stations 1-4 on 28 September (t=H+4) to elucidate scales of variability in these parameters. Mean temperature (averaged over depth) increased with distance from offshore waters (17.8° to 18.6° C). Mean salinity (averaged over depth) decreased with distance from offshore waters (29.8 to 32.4 ppt.). Variability (standard deviation) over depth for temperature (0.05-0.15°C) and salinity (0.06-0.33 ppt) was small. However, temperature consistently decreased with depth, and salinity consistently increased with depth at each station. These data most likely reflect a source of warmer, less saline water in the upper harbor.

During the first pre-operational phase, current speeds varied between 0 and 50 cm/sec. During the second pre-operational phase, current speeds varied between 0 and 90 cm/sec. The reason for the relatively lower current speeds observed during the first pre-operational phase are not clear at this time. Profiles of current speed for each of the five sampling periods on the flood and ebb tides were generally uniform over depth with only minor differences (5-10 cm/sec) being observed. Significant (two-fold) variations in current speed were often observed between east and west sampling locations.

The pattern of water depth in the channel over time was used to determine tidal variation. Tidal fluctuation on all dates was about 1.6 meters. This estimate was conservative since water depth was not measured during slack tide periods. In addition, windy conditions often impeded accurate measurements. More accurate tide data would require the deployment of tide gauges.

The results of physical measurements during the two pre-operational phases suggest that the variables of interest were fairly constant over depth. However, significant differences were observed between the east and west sampling locations, which may indicate cross channel differences in water mass. It is not known whether these differences are time or spatially dependent, since available instrumentation would not allow synoptic measurements. Instead, a delay of 20-25 minutes between sampling activities between locations was necessary. The acquisition of new instumentation under the Inter-agency agreement will resolve this problem.

Suspended solids

A summary of the suspended solids concentrations at the four sampling stations in New Bedford Harbor is shown in Table 3. Detailed results are presented in Appendix III. Mean suspended solids concentrations ranged from a low of 4.4 mg/l to a high of 15.0 mg/l over the whole study site. Within station ranges, however, were not as great. Values at Station 1 ranged from 5.6 to 8.6 mg/l, at Station 2, from 6.4 to 10.2 . The greatest variability was observed at Station 3 where values ranged from 6.1 to 15.0. Station 4 concentrations ranged from 4.4 to 7.9. Differences were twofold or greater only at Station 3.

Since the data were not subjected to statistical analysis, no definitive statements can be made regarding suspended solids distribution. There was a trend in the data, however, suggesting the ebb concentrations were lower than those during the flood tide, especially during the dry period sampling in July. Concentrations tended to be more evenly distributed during the September wet period sampling.

No trends were apparent in the hourly samples at any of the stations (Appendice III), nor were there any differences between stations. Station

Table 3. Mean ebb and flood suspended suspended solids concentrations at four stations in New Bedford Harbor during July and September, 1987. N = 5 for all means unless otherwise noted.

STATION	DATE	CONCENTRATION (mg/l) MEAN ± SD EBB	FLOOD
1	7/8	5.6 ± 1.8	8.4 ± 1.9 (4)
	7/9	6.1 ± 1.3	7.9 ± 1.8
	9/24	8.6 ± 0.8	7.8 ± 1.1 (4)
	9/28	6.5 ± 0.8	6.5 ± 2.0
2	7/8	7.9 ± 1.9 (4)	10.2 ± 1.7
	7/9	7.8 ± 0.8	9.4 ± 1.1
	7/13	8.3 ± 1.3	7.4 ± 1.0
	9/24	7.5 ± 1.1	6.8 ± 1.1 (4)
	9/28	6.4 ± 0.4	7.0 ± 2.0
3	7/8	10.1 ± 2.0	11.4 ± 4.5
	7/9	8.5 ± 1.1	15.0 ± 6.4
	9/24	8.2 ± 0.9	10.4 ± 3.3
	9/28	6.1 ± 1.0	6.5 ± 1.0
4	7/8	5.4 ± 1.6	6.6 ± 1.9
	7/9	5.5 ± 0.8 (4)	7.1 ± 1.0
	9/24	7.9 ± 1.5	7.8 ± 3.4
	9/28	4.4 ± 1.2	7.1 ± 1.3

4 did tend to exhibit the lowest values, however. The sampling to determine the degree of spatial variability at Station 2 also revealed no apparent trends.

C. CHEMICAL MEASUREMENTS

Water

Polychlorinated Biphenyls:

The temporal mean values for PCB concentrations are shown in Table 4. These means were based on the data for each sampling date (Appendices IV,V). There is a distinct trend showing the highest concentrations at Station 1. Stations 2 and 3 exhibit intermediate and similar values.

The analyses of the dissolved and particulate phases of the samples at stations 1, 2, and 3 generally showed that the concentrations were higher in the dissolved phase than in the particulate phase for Aroclor 1242 (A1242). For Aroclor 1254 (A1254) the levels were similar in both phases. The concentrations of A1242 were higher than those of A1254 at Stations 1, 2, and 3. At Station 4 the concentrations of these two formulations were similar.

The spatial heterogeneity sampling in September (Appendix V), showed that A1242 was most concentrated in the surface water samples on both the east and west, Station 2 locations. Composite samples collected each hour were also analyzed to examine temporal heterogeneity. There was a significant trend in the distribution of total PCBs, primarily reflecting the high proportion of A1242. PCB concentrations appeared to increase as the tide ebbed to slack low tide and decrease as the flood tide approached slack high tide. These data and those provided in Table

Table 4. Whole water concentrations of PCBs, Cd, Pb and Cu measured on samples collected at four stations in New Bedford Harbor in July and September, 1987. Means and standard deviations are based on values for each date for ebb (E) and flood (F) tidal conditions. N=4 unless otherwise noted.

		CONCENTRATION (ug/l)			
STATION/TIDE		PCB	Cd	Pb	Cu
1	E	1.147 ± 0.560	0.22 ± 0.10	4.0 ± 0.2	7.8 ± 3.6
	F	1.009 ± 0.353	0.29 ± 0.06	3.9 ± 0.4	8.0 ± 1.8
2	E	0.607 ± 0.099 (5)	0.20 ± 0.04	3.4 ± 0.3	6.5 ± 1.0
	F	0.531 ± 0.130 (5)	0.13 ± 0.02	3.1 ± 1.2	8.5 ± 1.1
3	E	0.578 ± 0.113 (3)	0.22 ± 0.06	3.5 ± 0.8	9.4 ± 2.7
	F	0.405 ± 0.188	0.24 ± 0.10	2.7 ± 0.4	9.1 ± 0.8
4	E	0.114 ± 0.013	0.11 ± 0.05	2.3 ± 1.1	2.9 ± 0.9
	F	0.106 ± 0.009	0.14 ± 0.06	1.8 ± 0.9	2.5 ± 1.0

4 definitely indicated the source of PCBs in the water column to be in the upper harbor.

Metals - Cadmium, Lead, Copper:

Mean concentrations for the metals, Cd, Pb and Cu are also shown in Table 4 and are presented in detail in Appendices IV and V. There were no consistent trends or differences in concentrations of any metal for the ebb and flood samples. Likewise, no station differences were evident except that Station 4 consistently showed the lowest concentrations. One other exception is that Cu concentrations were usually highest at Station 3.

Analysis of the particulate and dissolved phases for each metal showed that Cd was predominantly in the dissolved phase and that Cu was equally distributed between each phase. Interestingly, Pb concentrations were approximately equal in each phase during the dry period sampling but were at least twofold higher in the paticulate phase during the wet period sampling. These data may reflect the input of Pb-associated particulates characteristic of urban surface runoff.

There were no trends in the data examining spatial heterogeneity at Station 2. In the temporal heterogeneity sampling, Cd showed the same hourly differences as were seen for PCBs; lowest concentrations were found near slack high tide and the highest concentrations near slack low tide.

Mussel Tissue Residue

The results for mussel tissue residues are presented in Appendix V. During both periods of exposure in July and September, uptake of total

PCB's was very rapid. After 7 and 28 days, total PCB values were comparable for equal exposure times during both July and September, reaching slightly greater than 100- and 200-fold increases, respectively, over day 0 values at Station 2 for example. After three days of exposure, levels concentrated by mussels at Station 2 during the second exposure period were significantly higher than during the first. The uptake of total PCB's during the July three-day exposure period was roughly a 30-fold increase over time 0 values, while for the same period of exposure in September the increase was roughly 100-fold. Because of the extraordinarily rapid rate of uptake during the first three days, the use of total PCB's may not be a good early warning measure for use in the Decision Criteria. A difference of only a few hours deployment time between three-day exposure periods may result in very significant differences in uptake.

An evaluation of Aroclor 1242 and Aroclor 1254 separately indicates that mussels deployed within the harbor accumulated relatively higher levels of Aroclor 1242 (Appendix VI, Table 2-2). The converse is true for mussels at the two reference sites located outside of the harbor and in Buzzards Bay. There was a significant increase in the ratio of Aroclor 1242 to 1254 as one progresses from the Hurricane Barrier up to Stations 3 and 2. There was roughly three times more Aroclor 1242 than 1254 at Station 2 compared to less than two times 1242 to 1254 at the Hurricane Barrier.

The examination of the individual congeners shows that the lower molecular weight congeners were taken up much more rapidly than the higher molecular weight congeners. Due to the less rapid uptake of congeners in the " mid-level" molecular weight range (i.e., CB128 and

CB180) these congeners may be useful as the three day indicators of bioaccumulation for the purposes of the Decision Criteria.

D. BIOLOGICAL MEASUREMENTS

Receiving Water Tests

Arbacia punctulata Sperm Cell Test:

No toxic effects were detected by the sea urchin sperm cell test in July. Moderate toxicity was noted on one day (22 September) during the September preoperational study for the Station 1 flood and Station 2 ebb samples (Table 5). Toxicity was marginal and not repeated, however, and was not evident after the first day of testing; it is not considered environmentally significant. No other toxicity was observed, including no significant spatial or temporal variation among individually examined samples at Station 2.

Champia parvula Reproduction:

Results of the *C. parvula* reproduction test during the July sampling were marginally acceptable due to problems in quality of stock cultures. Difficulty was experienced in September with the quality of the Narragansett Bay control water samples; hence, only site control water was used for comparison. Tests on samples collected on two days (24 and 28 September) were successful and showed significant degrees of toxicity at several stations, especially Station 3 (Table 6). These data do not correlate well with the observed trend of decreasing PCB concentrations in the water from Station 1 to Station 4 (Appendices IV and V); however, they do correlate with the available copper data (Station 2) which is sufficiently high to elicit the observed response.

Table 5. Results of New Bedford Harbor receiving water evaluation using the sea urchin, Arbacia punctulata. Results are presented as percent fertilized on each day of testing. Controls included in the test are a Narragansett Bay control (NSW), an autoclaved Narrgansett Bay control (ANSW), and a site control from Buzzard's Bay.

SITE/ TIDE	EFFECT, PERCENT FERTILIZED 09/23/87	09/25/87	09/28/87	09/29/87
CONTROL (NSW)	91.5±2.1	93.5±2.1	94.0±1.4	94.0±5.7
CONTROL (ANSW)	90.8±4.5	92.6±2.2	95.5±0.7	97.0±1.4
CONTROL (SITE)	64.9±17.7 a	92.0±2.9	95.0±1.4	93.5±0.7
1 EBB	81.7±5.9	94.0±1.4	94.0±1.4	94.5±0.7
1 FLOOD	56.5±23.4 a	93.0±1.5	93.0±1.4	96.5±0.7
2 EBB	65.4±9.7 a	92.5±3.6	94.0±4.2	94.5±2.1
2 FLOOD	81.6±5.8	90.0±1.5	94.5±0.7	93.5±2.1
3 EBB	95.9±0.6	92.5±0.7	94.5±2.1	95.0±1.4
3 FLOOD	74.6±7.6	94.0±1.4	93.0±1.4	95.0±2.8
4 EBB	90.7±0.1	93.1±2.6	94.0±4.2	95.2±4.3
4 FLOOD	92.6±4.8	95.0±1.4	93.5±2.1	96.5±0.7

a Significantly lower than the lab and test controls.

Table 6. The effect of receiving waters from New Bedford Harbor on the sexual reproduction of *Champia parvula*. Results are expressed as the mean number of cystocarps formed per plant. Samples were collected on September 24 and 28, 1987, and the tests begun the following day. Temperature was 22 to 24 C, salinity was 30 parts per thousand, and light density was ca 75-100 uE m-2 s-1 of cool-white fluorescent light on a 16:8 L:D cycle.

Site/ Tide	No. of Cystocarps ± S.D. 9/24	9/28
Control (Site)	12 ± 4	10 ± 1
1 Ebb	6 ± 2	4 ± 1
1 Flood	4 ± 3 a	4 ± 1
2 Ebb	4 ± 4 a	3 ± 1 a
2 Flood	5 ± 3	5 ± 5
3 Ebb	8 ± 3	4 ± 2
3 Flood	dead	0 ± 0 a
4 Ebb	6 ± 5	5 ± 3
4 Flood	3 ± 5 a	6 ± 7

a) Statistically different from the site control.

Cyprinodon variegatus Growth and Survival:

No toxic effects were observed in the C. variegatus tests in either July or September.

Mysidopsis bahia Growth and Reproduction:

No differences with respect to growth (weight gain) were observed in July; however, significant mortality was observed at Station 2, and egg production was below acceptable values in the control samples. Tests were not conducted in September.

Mussel Scope For Growth

Results of scope for growth measurements on mussels deployed in New Bedford Harbor are presented in Appendix IX. During the periods of mussel deployments, water temperature ranged between 17 and 22°C during both exposures, except during the latter part the September-October period when temperatures dropped to between 13 and 14°C. During both exposure periods dissolved oxygen and salinity remained nearly constant among stations and between sampling times.

During the first time interval, SFG demonstrated an inverse relationship with PCB levels in the water column and mussel tissues. There were significant differences among stations in SFG after seven days (Table 7). Although not significantly different, the pattern of SFG among stations at day 28 was similar to that at day 7, therefore, the seven day results were indicative of what would be expected at day 28 (Figure 2). Significant differences among stations in shell growth after 28 days of exposure (Figure 3) were inversely correlated with PCB tissue concentrations. Response patterns shown by SFG after seven days

Table 7. Mean (standard error) scope for growth values (J/h) of mussels from four stations during the first pre-operational deployment.

Station	Scope for growth	
	Day 7	Day 28
NBH-2	-4.9(2.5)A*	-3.5(1.7)A
NBH-3	-1.1(1.6)A,B	0.0(2.4)A
NBH-4	3.7(2.0) B,C	2.7(3.6)A
NBH-6	8.2(1.5) C	2.2(1.6)A

* Means with the same letter group are not significantly different (P=0.05).

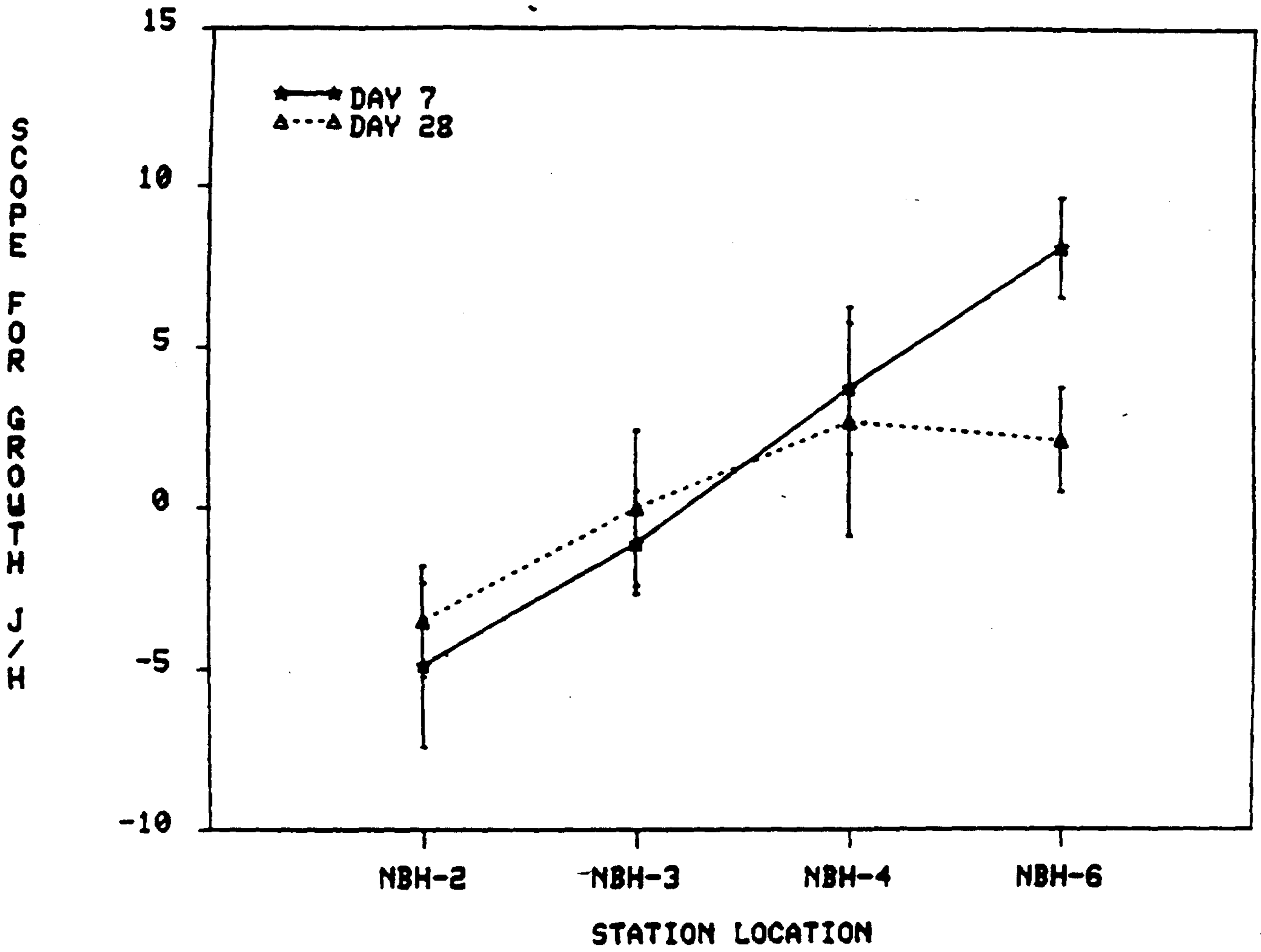

Figure 2. The mean scope for growth (± standard error) values of mussels collected from New Bedford Harbor after 7- and 28-day exposures during the first pre-operational deployment.

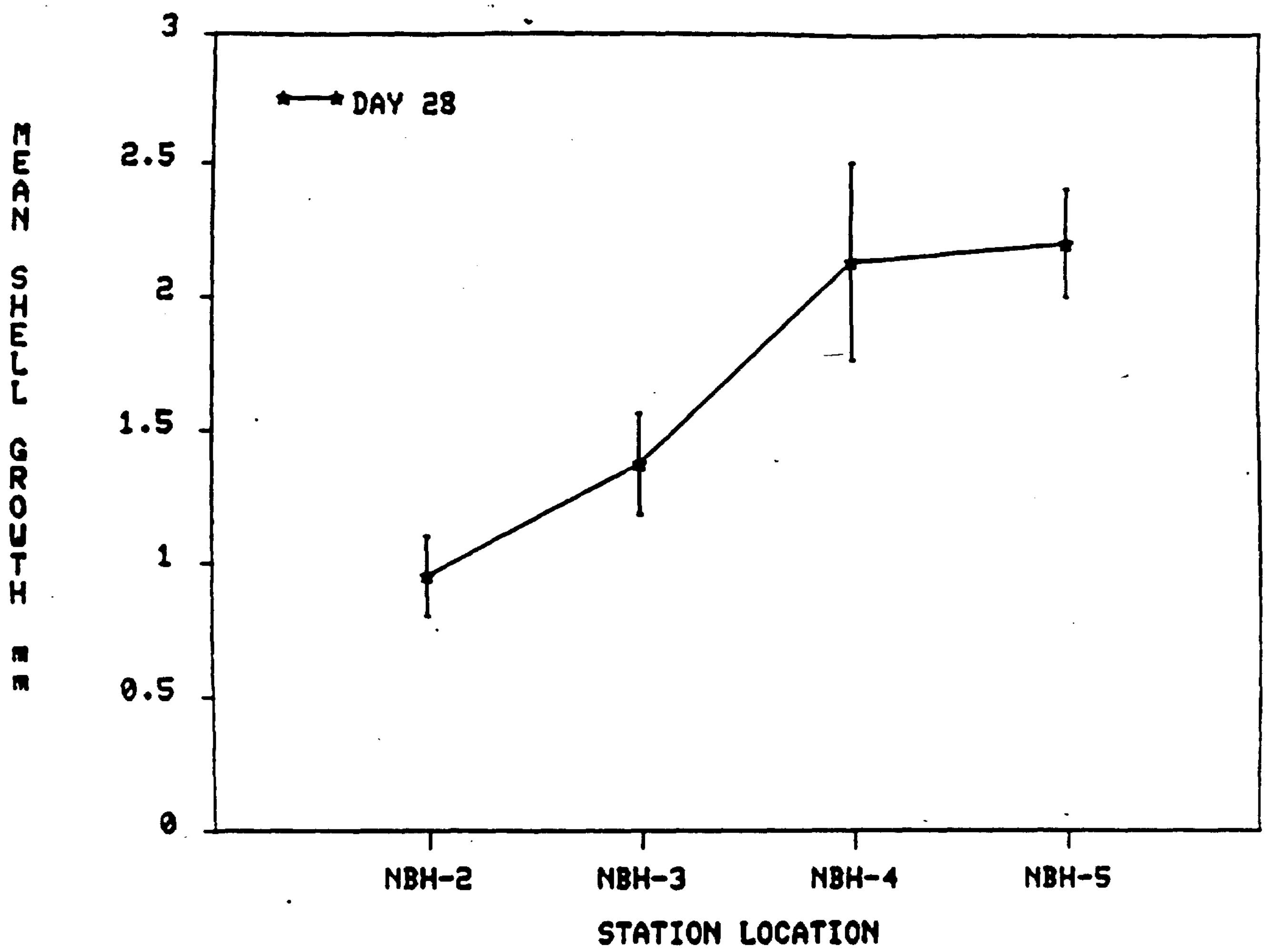

Figure 3. The mean (± standard error) increase in mussel shell length after a 28-day exposure in New Bedford Harbor during the first pre-operational deployment.

and shell growth after 28 days were very similar. In that sense, the seven day SFG results were also indicative of the 28-day shell growth data. Scope for growth and shell growth were lowest and the PCB levels highest (in the water column as well as mussel tissue) at the Coggeshall Street Bridge. Scope for growth and shell growth were highest and PCB levels lowest (in the water column as well as mussel tissue) at the Hurricane Barrier and control site. Day three samples were not analyzed for SFG after the first exposure period. There were no significant mortalities among stations during this exposure period.

There were no significant differences among stations in SFG or shell growth during the second deployment period in September. Water column chemical analyses during the September pre-operational study showed that chemical concentrations were the same as those observed during the July chemical analyses. Again, there were no significant mortalities within or among stations during this exposure period.

VI. SUMMARY

1a) Water sampling and mussel deployments were conducted during two periods, July and September, 1987, dry and wet months, respectively. Mussels were deployed for 28-day periods and water samples were collected over a seven-day period during each month on the spring phase of the tidal cycle.

b) Current velocities at Station 2 ranged up to 90 cm/sec and were fairly constant over depth. Significant variations in velocity were often observed between east and west sampling locations.

2a) Flood tide concentrations of suspended solids in July were usually higher than ebb tide levels, indicating a net inward transport of material into New Bedford Harbor. Station 3 samples tended to be highest.

b) There were no statistically significant differences in suspended solids concentrations during September with respect to station location, individual hour of sampling, tidal phase, or horizontal or vertical spatial distribution at Station 2.

3a) Total PCB concentrations decreased form about 1 ug/l to about 0.1 ug/l with distance downbay on all four sampling dates in July and September.

b) Aroclors 1242/1016 and 1254 were detected in both the dissolved and particulate phases of the seawater. Aroclor 1242/1016 concentrations were higher in the dissolved phase relative to the particulate phase.

c) Trace metal concentrations were lowest at Station 4. The levels measured at the other stations were variable but tended to be highest at Station 3.

4a) Deployed mussels rapidly accumulated PCBs reaching concentrations near 100 ug/g dry weight at Station 2. The results were similar for both deployments.

b) During both deployments, a significant down-harbor gradient in PCB uptake was observed.

5a) Receiving water tests (*Champia*, *Arbacia*, *Mysidopsis* and *Cyprinodon*) generally showed no consistent toxicity response to New Bedford Harbor receiving waters. The *Champia* reproduction test did show responses which were not consistent with station or tidal differences.

6a) Significant reduction in scope for growth and shell growth were observed during the first pre-operational deployment which were inversely related to PCB tissue residue consentrations. There were no significant differences in either parameter during the second pre-operational deployment.

b) No significant mortality occurred at any station during either pre-operational deployment period.