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New Bedford Harbor Pilot Study

Pre-operational Monitoring - Progress Report:

Copper, Cadmium and Lead Concentrations

in the blue mussel, *Mytilus edulis*,

from the First and Second Pre-operational Mussel Deployments

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Warren S. Boothman

Frank A. Osterman

William G. Nelson

United States Environmental Protection Agency

Environmental Research Laboratory

Narragansett, R.I. 02882

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Introduction

The New Bedford Harbor (NBH) Pilot Project is a cooperative effort between the U.S. Environmental Protection Agency's Environmental Research Laboratory in Narragansett, R.I. (ERLN) and the U.S. Army Corps of Engineers (COE) to evaluate a series of remedial action alternatives to clean up NBH. The blue mussel, *Mytilus edulis*, will be used throughout this study as an integrative biological monitor to measure: 1) the effects of each stage of the operation on the release and transport of contaminants, 2) biological availability of released contaminants, and 3) chronic and acute biological effects of released contaminants. The present report describes the results of the trace metal analyses of mussel tissues during the first pre-operational mussel deployment. PCB levels in mussels from the same deployment have been previously reported (Pruell et al., 1988). These data will be used as baseline data against which the effects of future dike construction, dredging, filling and capping operations will be compared.

Materials and Methods

Mussels were collected from a clean area in East Sandwich, Mass., returned to ERLN, and sorted according to length. A total of twenty-five mussels ranging from 5-7 cm were placed into each of 48 baskets. Custody seals were placed on all mussel baskets prior to deployment in NBH to ensure the integrity of the samples

in the field. Mussels were deployed in June and September 1987 one meter above the bottom at 3 locations in NBH (Station NBH-2, Coggeshall St. Bridge; Station NBH-3, opposite the Revere Silverware factory; Station NBH-4, the Hurricane Barrier) and at a reference station. The reference station used for the first deployment (NBH-6) was in Buzzards Bay near Cleveland Ledge (Fig. 1). For the second deployment, a reference station just east of West Island (NBH-5) was used. Each station consisted of four replicate substations with three baskets on each.

Individual baskets were retrieved from each substation on days 3, 7, and 28 and returned to ERLN with custody seals intact. On each retrieval date, subsamples of mussels from each basket were taken for organic and inorganic chemical analysis and frozen at -20° C. Mussels from each subsample were thawed prior to dissection and separated from the shells using stainless steel instruments. As a precaution against cross-contamination, the instruments were cleaned between samples by rinsing with deionized water. The tissue samples were then homogenized using a polytron and portions (approx. 5 g wet weight) of each taken for trace metals analysis. The specimens were placed in tared, acid-cleaned, 100-ml borosilicate glass beakers and covered with borosilicate watch glasses. Wet weights were obtained and the samples are dried by freeze-drying in a Virtis lyophilizer (Model No.#10-145MR-BA) for 48 hr. at -40° C and 24 hr. at 45° C.

After obtaining dry weights for the samples, 10 ml of concentrated HNO_3 (Instra-Analyzed grade) was added to each sample. The tissue was digested for 24 hr. at room temperature,

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then heated to 60° C and maintained at that temperature until digestion was complete. The covers were removed and the solutions heated to evaporate the acid to near-dryness. Residue from each sample was redissolved with 20 ml of 2N HNO_3 and filtered through acid-washed Whatman 42 filter paper into a 50-ml volumetric flask. The sample beaker was rinsed with 2N HNO_3, filtered and combined with the initial solution. The final sample solution was brought to 50 ml by addition of 2N HNO_3 and stored in 60-ml acid-cleaned, polyethylene bottles. ERLN mussel homogenate and procedural blanks were prepared along with the samples.

The sample solutions were analyzed for copper, cadmium and lead by flame atomic absorption (AA) on a Perkin-Elmer 5000 atomic absorption spectrophotometer, using the most sensitive wavelengths for each element, deuterium arc background correction, a lean oxidizing flame, 5x scale expansion and 1.5 second signal integration time. Three separate integrations were measured for each element/sample. Standard solutions in dilute acid were measured along with the samples. The sample and standard absorbance signals from the instrument were collected on a Perkin-Elmer 3600 data station and stored on diskette.

Polynomial regression curves were generated from absorbance data for calibration standards and used to calculate analytical concentrations in the sample solutions. Analytical results were transmitted from the data station to a Perkin-Elmer LIMS system for calculation of metal concentrations in the tissue samples and storage of the calculated data. For approximately every 15 samples processed, one sample was determined by the method of

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standard addition and one procedural blank was analyzed as a quality assurance check. All blanks were below the detection limits for flame AA. Recoveries of standard additions averaged 97±20%.

Statistical analysis was performed on the copper, cadmium and lead tissue concentrations by a general linear models procedure using the SAS statistical package (release 5.16). Mean metal concentrations for 3, 7 and 28-day deployments at the different stations were calculated and compared using Tukey's studentized range test.

Results and Discussion

Copper concentrations in mussels collected from the four NBH stations during the first deployment (June-July 1987) are presented in Table 1. Also presented are the results of statistical comparisons between the stations on each of the sampling dates. Stations with the same letter code were not significantly different from each other at the P=0.05 confidence level. The data are also presented graphically in Figure 2, where each line represents the variation of copper concentrations with sampling station on a given date. Tissue copper concentrations in mussels from the upper NBH stations, NBH-2 and NBH-3, were higher than from the lower harbor station, NBH-4, or the reference site, NBH-6, on all of the sampling dates. After the 28-day deployment, concentrations at NBH-4 were significantly different from the reference site as well. The increase in concentrations from the initial level, however, was not large, ranging from 1.4-1.7 times the concentration in the day-0

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mussels. Comparison of the copper concentrations among days 3, 7 and 28 at each station showed no statistically significant differences (P=.05). The data suggest that slight uptake of copper by the mussels may occur within the harbor, but that the uptake occurs quickly and does not continue throughout the deployment period.

Lead concentrations in mussels from the first deployment did show increases with both deployment time and distance up harbor (Table 2, Figure 3). While tissue concentrations of lead did not increase in mussels at the reference station, mussels from NBH-2 showed significantly higher lead concentrations after only 7 days deployment; after the 28-day deployment, lead concentrations were significantly higher in mussels from both NBH-2 and NBH-3. Lead concentrations were also significantly higher after 28 days than after 3 or 7 days at the upper harbor stations; concentrations at NBH-2 and NBH-3 were approximately 13 times the concentrations in the time-zero mussels.

Cadmium concentrations in mussels from the June 1987 deployment (Table 3, Figure 4) varied in a manner similar to those of lead, but to a lesser extent. Only at NBH-2 were tissue concentrations significantly higher than at the other stations, and only on day 28 was there a significant increase. Tissues from mussels at NBH-2 after the 28-day deployment were approximately 4 times higher in cadmium than the initial mussels and only about 2 times higher than mussels deployed at the reference station.

Results of determinations of copper, lead and cadmuim in

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mussels deployed in New Bedford Harbor in September and October 1987, presented in Tables 4, 5 and 6 and Figures 5, 6 and 7, respectively, are very similar to those from the first deployment. No significant differences among stations were observed for copper (Table 4) and cadmium (Table 6) concentrations, although mean concentrations were slightly higher than those from the June deployment. Significant differences among stations were observed in lead concentrations (Table 5), as during the first deployment. However, while all tissue lead concentrations were higher in samples from the second deployment, the differences among stations were only significant at NBH-2 after 28 days (an increase of less than a factor of 5) (Figure 6); mussels from NBH-3 did not have significantly higher lead concentrations from mussels at the reference station. Likewise, the cadmium concentrations in mussels from the second deployment were 50-100% higher than corresponding samples from the first deployment, but due to greater variation in the concentrations at each station during the second deployment, the differences were not statistically significant.

Water column concentrations of total copper, cadmium and lead were measured in New Bedford Harbor during July 1987 (Palmquist et al., 1987). The data showed concentrations were consistently lowest for all metals at NBH-4. The relative concentrations among the other stations was dependant on the particular metal. Copper concentrations were much higher at NBH-3 than at the other stations, with concentrations at NBH-2 generally higher than at NBH-1, whereas lead concentrations were

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generally highest at NBH-1 and higher at NBH-3 than at NBH-2. Cadmium concentrations were usually higher at NBH-1 or NBH-3 than at NBH-2, but the results were much more variable than with copper or lead. The same trends have been observed in the sediment metals concentrations of New Bedford Harbor (Summerhayes et al. 1977, Stoffers et al. 1977, Pruell et al. in prep.), suggesting that there are different sources of copper, lead and cadmium in the New Bedford Harbor and/or that these metals behave differently once released into the harbor. Copper seems to have a primary source near NBH-3, while the source of lead (and possibly cadmium) appears to be further north in the harbor. The concentrations of copper, lead and cadmium in mussels deployed in New Bedford Harbor are consistent with these findings.

Summary

Mussels deployed in New Bedford Harbor in June and September 1987 showed differing degrees of accumulation of copper, cadmium and lead at different stations. The spatial variation in the accumulation of metals by mussels is consistent with metals concentrations in both the sediments and recent water column measurements. The extent of spatial differences, however is dependent on the metal measured. Mussels appeared to accumulate copper and cadmium only slightly, displaying significantly higher tissue concentrations only at stations corresponding with much higher metals concentrations, if at all. Lead, on the other hand, was accumulated somewhat in the mussel tissues to a degree dependent on both location and time of deployment. This is in marked contrast to the rapid and substantial accumulation (2-3

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orders of magnitude) of PCB's observed in mussels from the same deployments.

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References

Palmquist, R., K. Schweitzer, R. Bowen and R. Pruell. 1987. Progress Report: Chemical Analysis Results from the Two Pre-operational Water Samplings Conducted in New Bedford Harbor during July of 1987.

Pruell, R., W. Nelson, R. Palmquist, S. Fluck and R. Bowen. 1988. New Bedford Harbor Pilot Study Pre-operational Monitoring Progress Report: PCB Concentrations in Mytilus edulis from the July and September Mussel Deployments.

Pruell, R.J., C.B. Norwood, R.D. Bowen, W.S. Boothman, P.F. Rogerson, M. Hackett and B.C. Butterworth. In preparation. Geochemical study of sediment contamination in New Bedford Harbor, Massachusetts.

Stoffers, P., C. Summerhayes, U. Forstner and S.R. Patchineelam. 1977. Copper and other heavy metal contamination in sediments from New Bedford Harbor, Massachusetts: A preliminary note. Environmental Science and Technology 11: 819-821.

Summerhayes, C.P., J.P. Ellis, P. Stoffers, S.R. Briggs and M.G. Fitzgerald. 1977. Fine-grained sediment and industrial waste distribution and dispersal in New Bedford Harbor and Western Buzzards Bay, Massachusetts. Woods Hole Oceanographic Institution Technical Report WHOI-76-115, 110 pp.

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Table 1. Mean (standard error) Cu concentrations ($\mu g/g$) in *Mytilus edulis* deployed in New Bedford Harbor during the first mussel deployment. Four replicate samples were analyzed for each station and date except Day 3 from NBH-2, for which there was only one sample, and NBH-3, for which there was no sample. Means with the same letter group are not significantly different (P=0.05). The mean Cu concentration in the Day 0 mussels collected from the reference site was 5.59 (0.36) $\mu g/g$.

Station	Day 3	Day 7	Day 28
NBH-2	10.6 - A	9.95 (0.27) A	8.23 (0.37) A
NBH-3	10.6 (0.72) A	10.3 (0.88) A	9.68 (0.65) A
NBH-4	7.38 (0.08) B	6.69 (0.77) B	7.72 (0.52) A
NBH-6	- -	6.06 (0.60) B	4.30 (0.47) B

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Table 2. Mean (standard error) Pb concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the first mussel deployment. Four replicate samples were analyzed for each station and date except Day 3 from NBH-2, for which there was only one sample, and NBH-3, for which there was no sample. Means with the same letter group are not significantly different (P=0.05). No significant differences were found among stations on day 3. The mean Pb concentration in the Day 0 mussels collected from the reference site was 0.23 (0.18) μg/g.

Station	Day 3	Day 7	Day 28
NBH-2	0.51 -	1.99 (0.24) A	3.42 (0.64) A
NBH-3	1.32 (0.10)	0.68 (0.37) B	2.79 (0.50) A
NBH-4	0.95 (0.18)	0.15 (0.15) B	1.71 (0.43) A B
NBH-6	- -	0.15 (0.15) B	0.36 (0.36) B

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Table 3. Mean (standard error) Cd concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the first mussel deployment. Four replicate samples were analyzed for each station and date except Day 3 from NBH-2, for which there was only one sample, and NBH-3, for which there was no sample. Means with the same letter group are not significantly different (P=0.05). No significant differences were found among stations for days 3 or 7. The mean Cd concentration in the Day 0 mussels collected from the reference site was 0.34 (0.01) μg/g.

Station	Day 3	Day 7	Day 28	
NBH-2	0.52 -	0.53 (0.03)	0.95 (0.06)	A
NBH-3	0.48 (0.01)	0.58 (0.10)	0.73 (0.04)	A B
NBH-4	0.44 (0.04)	0.37 (0.07)	0.52 (0.05)	B
NBH-6	- -	0.55 (0.10)	0.57 (0.12)	B

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Table 4. Mean (standard error) Cu concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the second mussel deployment. Three replicate samples were analyzed for each station and date except the Day 28 samples from NBH-2, for which there were two replicates. No significant differences were found among stations(P=0.05). The mean Cu concentration in the Day 0 mussels collected from the reference site was 5.90 (0.91) μg/g.

Station	Day 3	Day 7	Day 28
NBH-2	11.5 (1.33)	13.1 (2.86)	17.1 (0.05)
NBH-3	14.3 (2.06)	14.9 (3.73)	22.8 (6.69)
NBH-4	10.1 (2.59)	13.8 (3.32)	13.3 (2.40)
NBH-5	7.14 (1.81)	8.32 (0.54)	8.29 (0.20)

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Table 5. Mean (standard error) Pb concentrations ($\mu g/g$) in *Mytilus edulis* deployed in New Bedford Harbor during the second mussel deployment. Three replicate samples were analyzed for each station and date except the Day 28 samples from NBH-2, for which there were two replicates. No significant differences were found among stations for days 3 or 7; for day 28, means with the same letter group are not significantly different (P=0.05). The mean Pb concentration in the Day 0 mussels collected from the reference site was 2.50 (1.26) $\mu g/g$.

Station	Day 3	Day 7	Day 28	
NBH-2	2.96 (1.67)	3.25 (1.65)	11.0 (0.93)	A
NBH-3	5.12 (0.85)	4.40 (0.39)	8.03 (0.63)	A B
NBH-4	2.89 (1.47)	4.67 (0.33)	5.11 (2.56)	A B
NBH-5	1.43 (1.43)	2.40 (1.20)	1.59 (1.59)	B

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Table 6. Mean (standard error) Cd concentrations ($\mu g/g$) in *Mytilus edulis* deployed in New Bedford Harbor during the second mussel deployment. Three replicate samples were analyzed for each station and date except the Day 28 samples from NBH-2, for which there were two replicates. No significant differences were found among stations(P=0.05). The mean Cd concentration in the Day 0 mussels collected from the reference site was 0.61 (0.11) $\mu g/g$.

Station	Day 3	Day 7	Day 28
NBH-2	0.68 (0.16)	0.69 (0.05)	1.47 (0.25)
NBH-3	1.06 (0.04)	0.81 (0.05)	1.20 (0.14)
NBH-4	0.80 (0.14)	0.70 (0.07)	0.92 (0.12)
NBH-5	0.96 (0.11)	0.86 (0.05)	1.07 (0.09)

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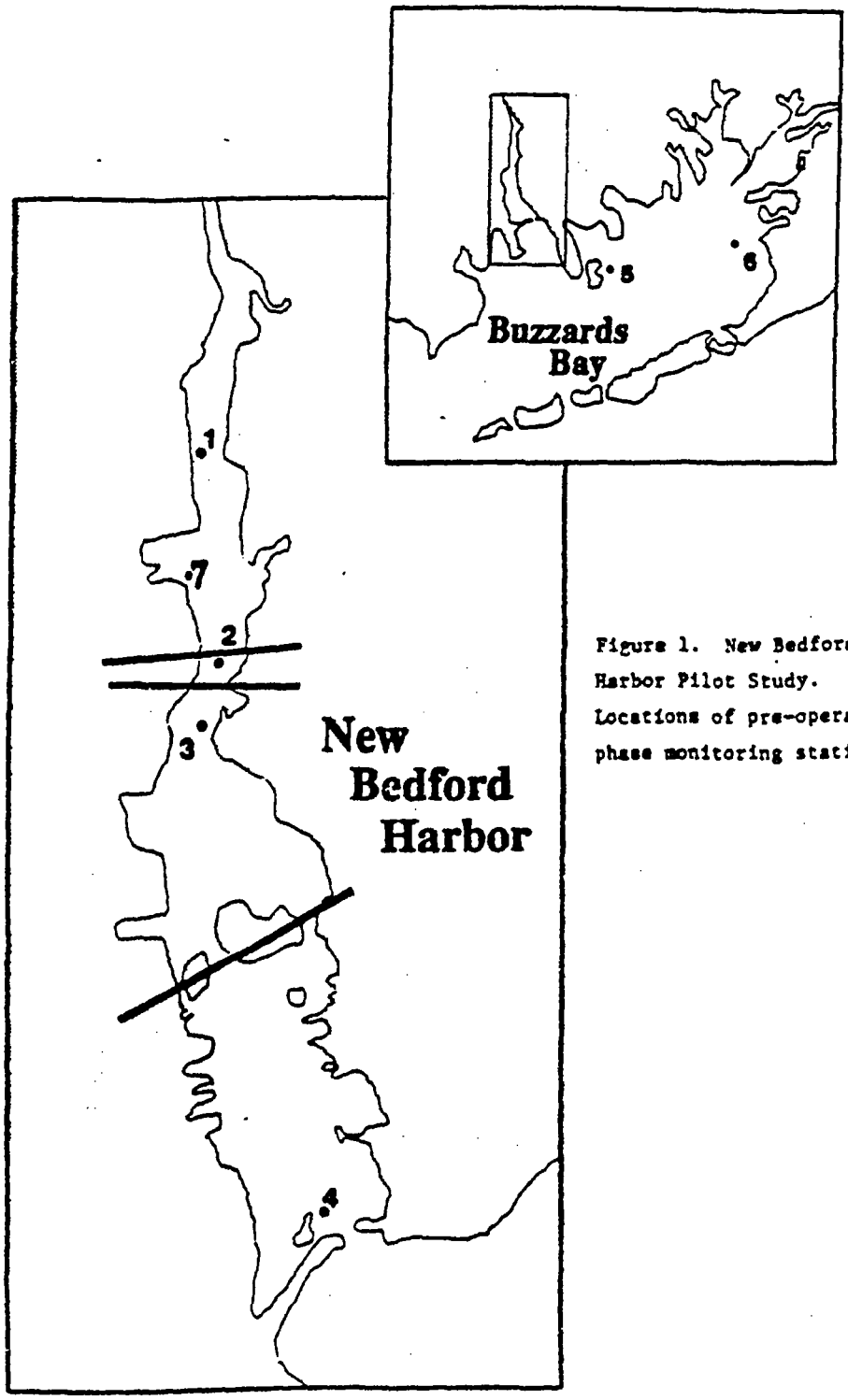

Figure 1. New Bedford Harbor Pilot Study. Locations of pre-operational phase monitoring stations.

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Figure 2. Mean (± standard error) copper concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the first mussel deployment. Day 0 concentration provided for comparison.

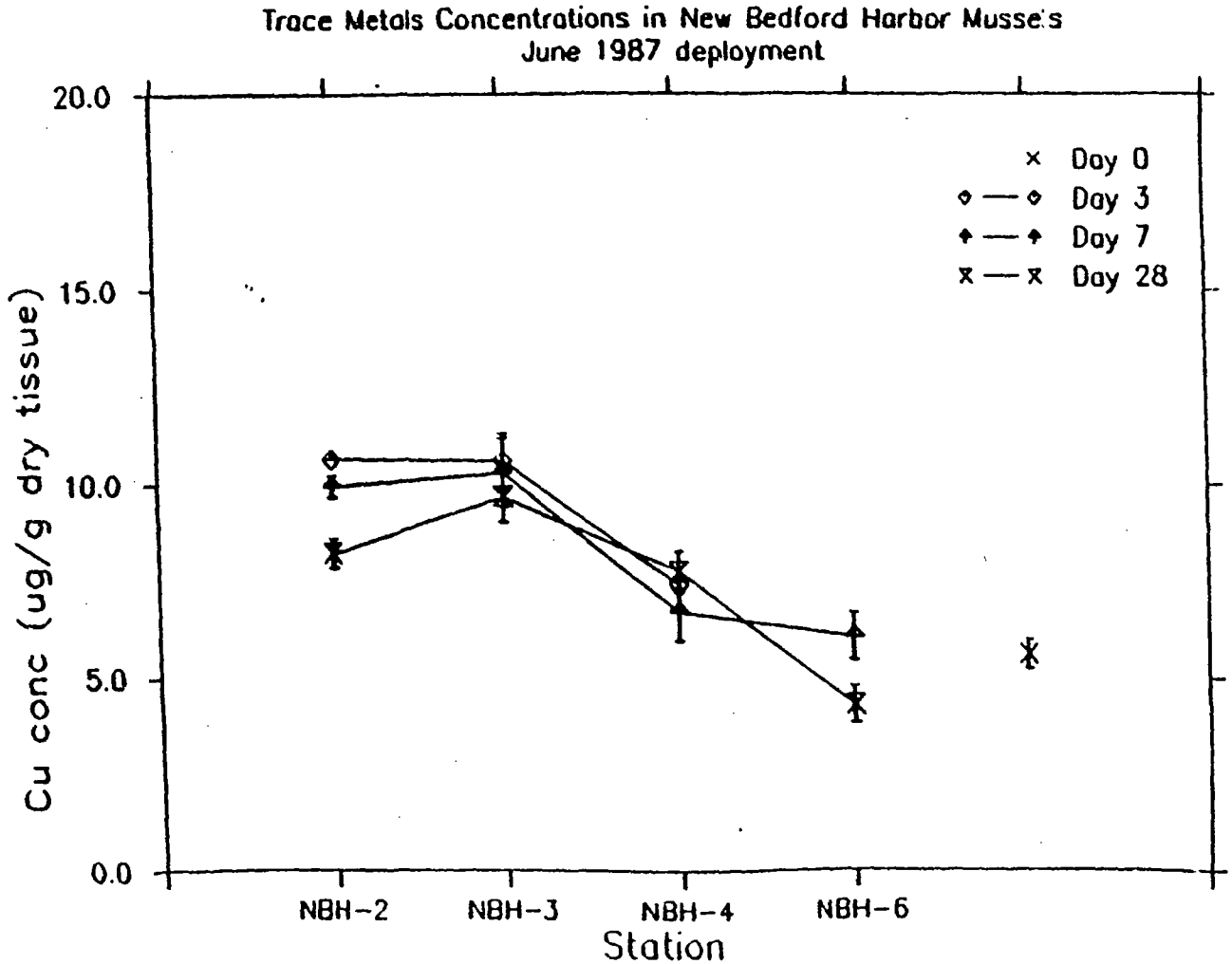

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Figure 3. Mean (± standard error) lead concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the first mussel deployment. Day 0 concentration provided for comparison.

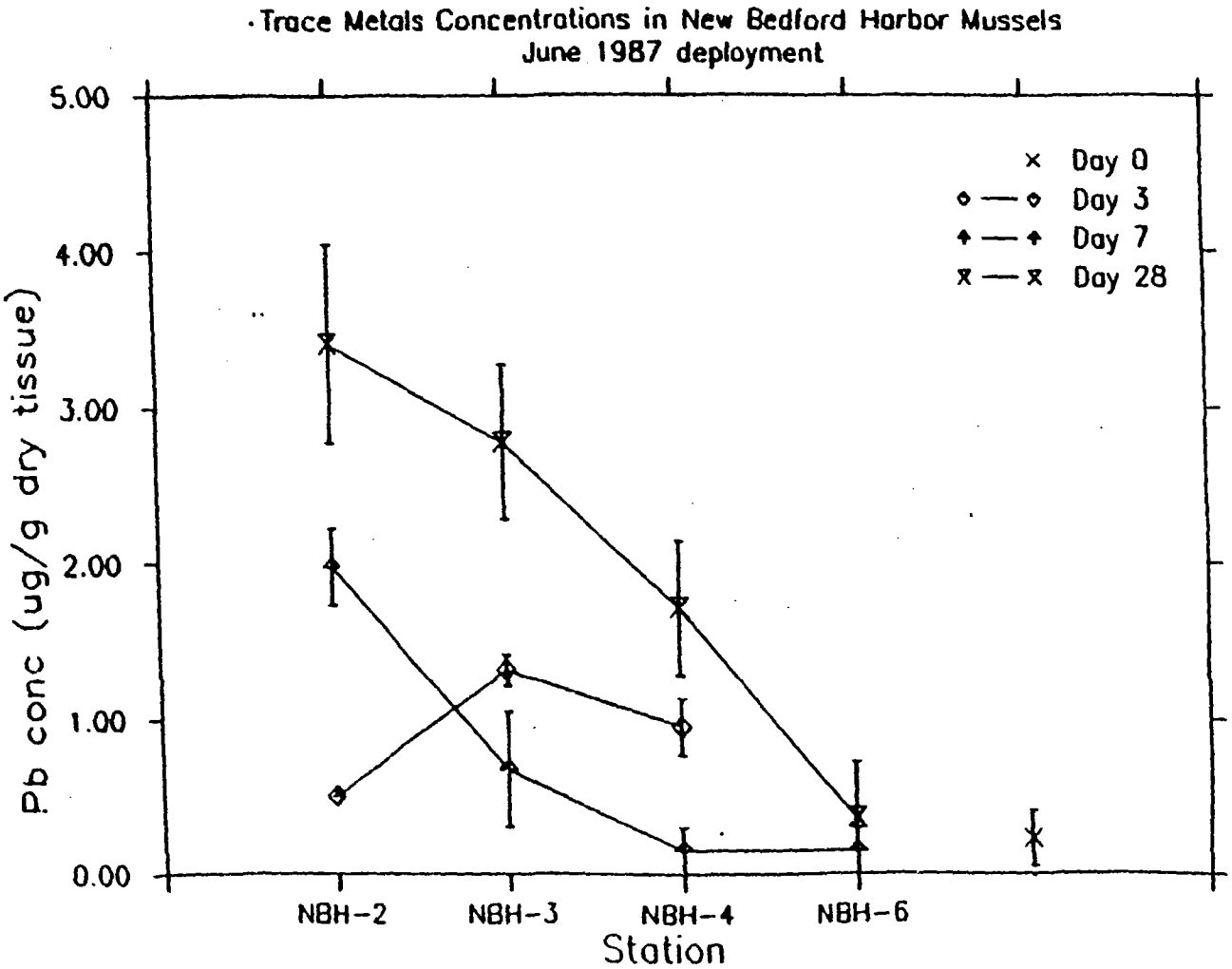

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Figure 4. Mean (± standard error) cadmium concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the first mussel deployment. Day 0 concentration provided for comparison.

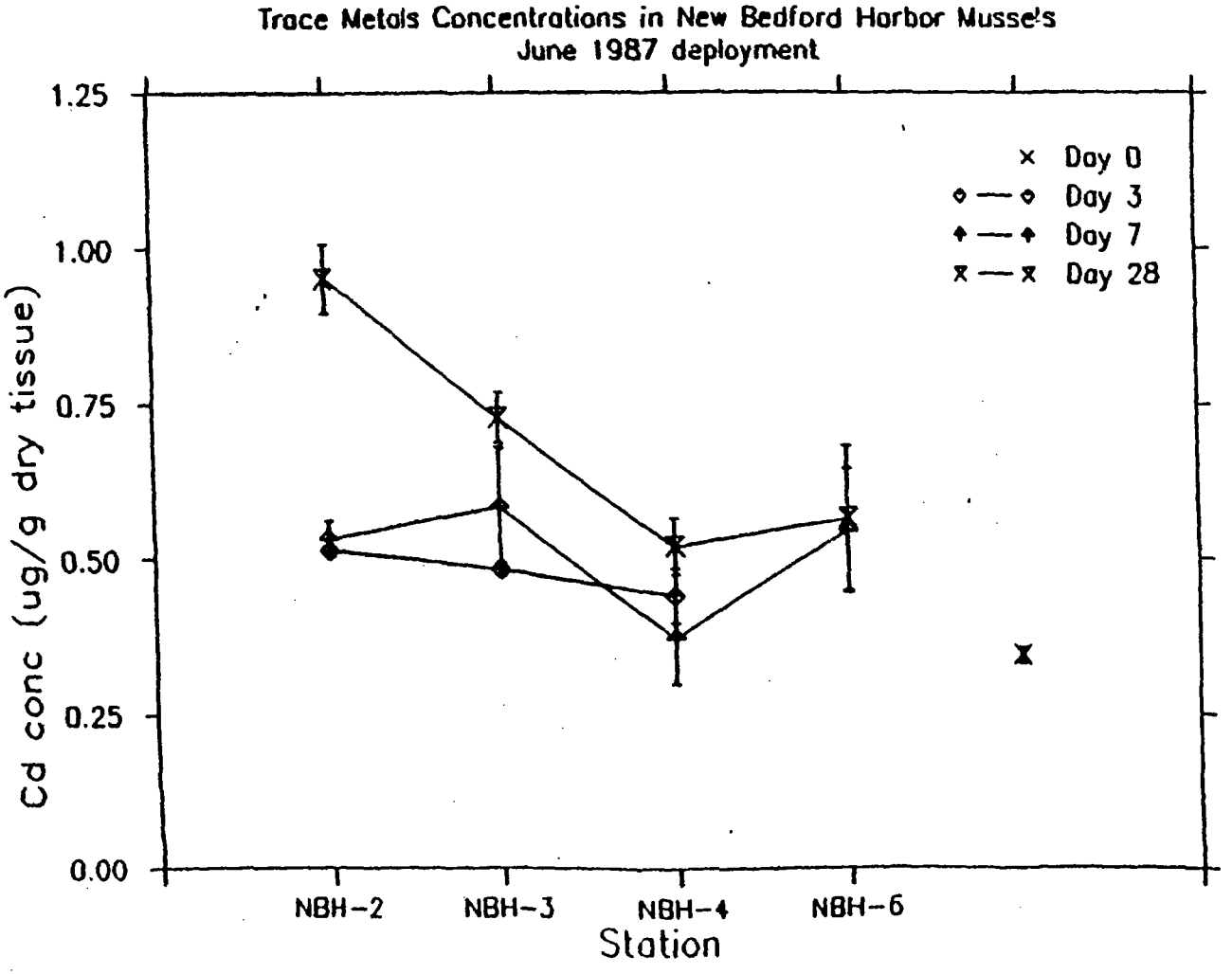

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Figure 5. Mean (± standard error) copper concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the second mussel deployment. Day 0 concentration provided for comparison.

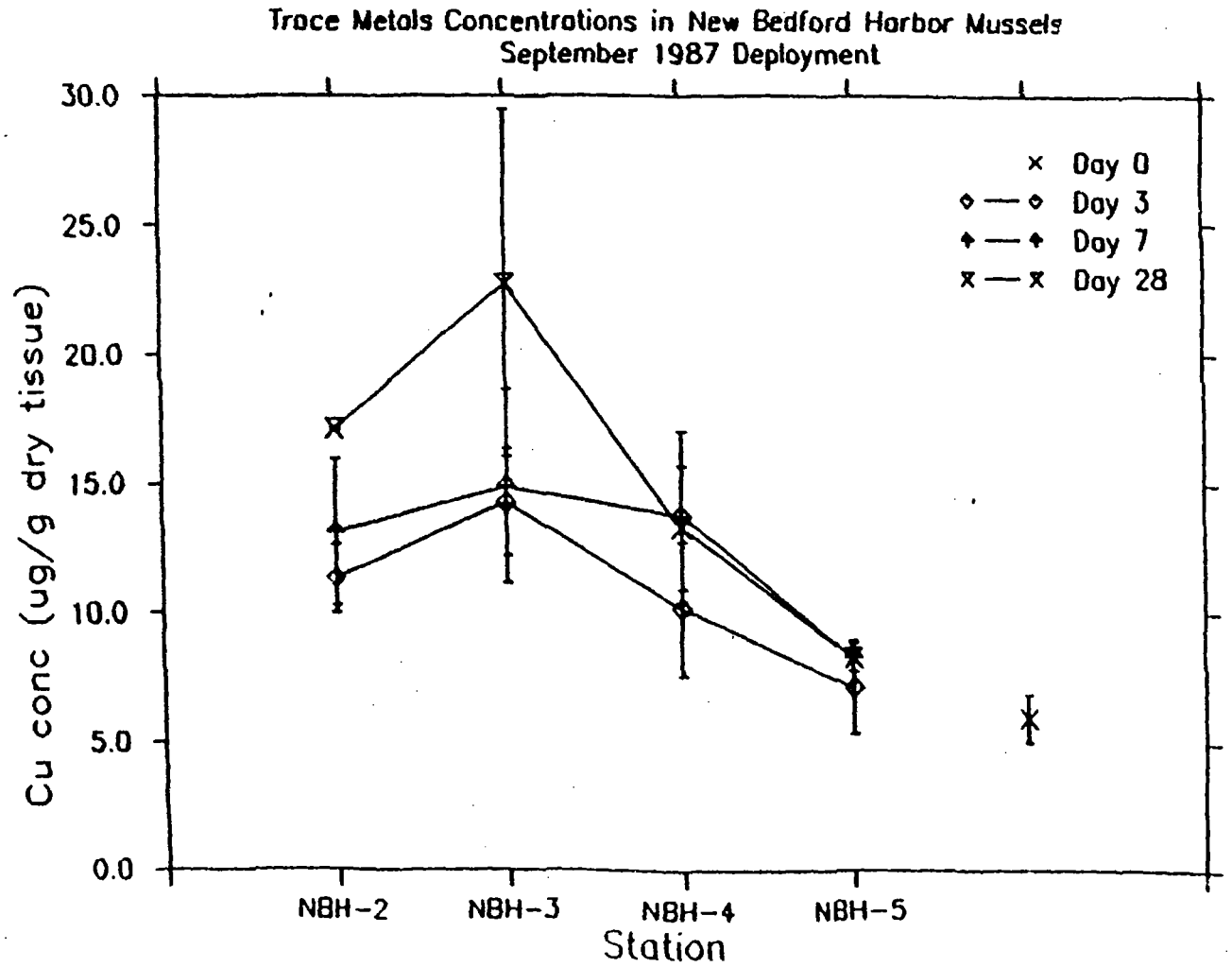

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Figure 6. Mean (± standard error) lead concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the second mussel deployment. Day 0 concentration provided for comparison.

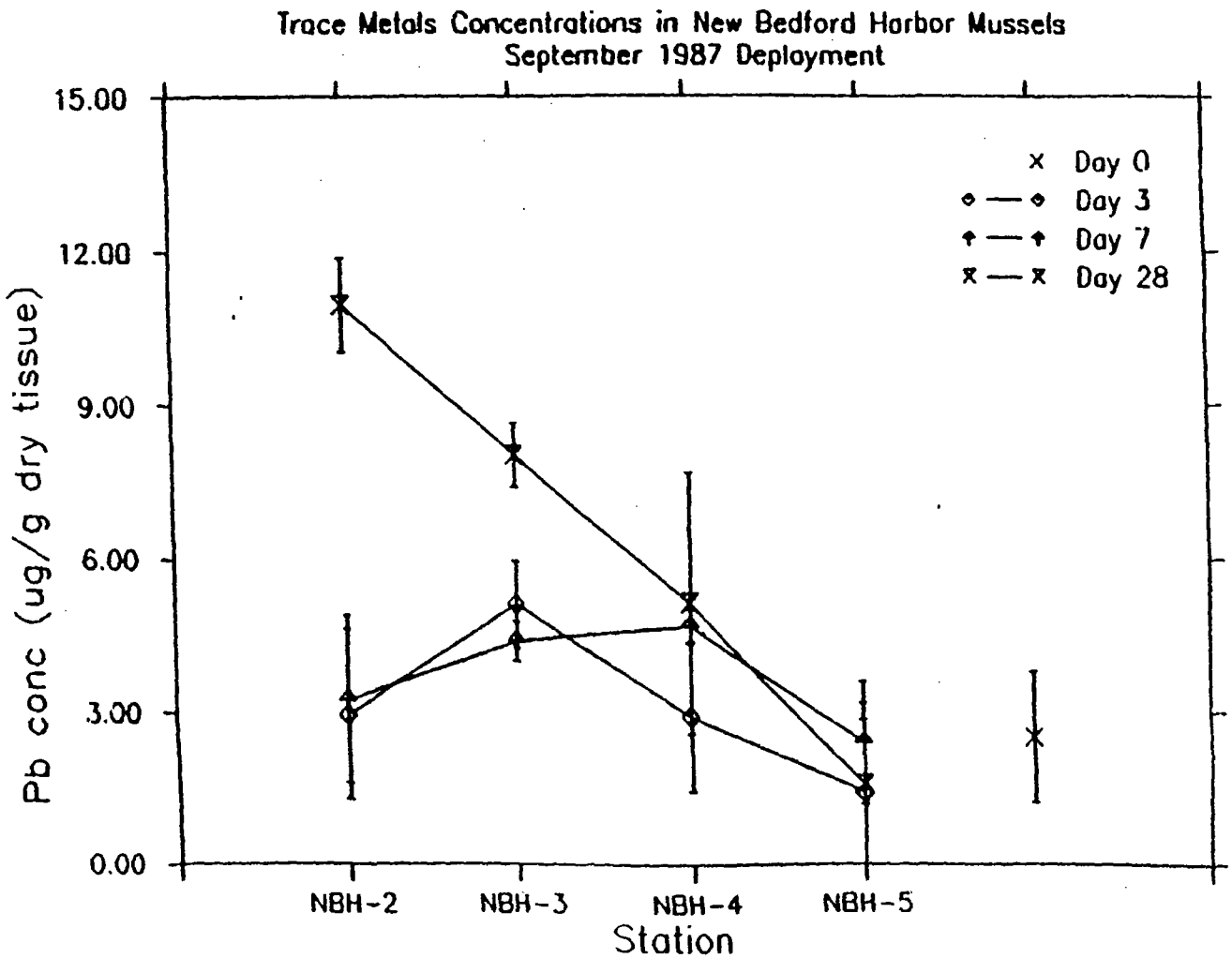

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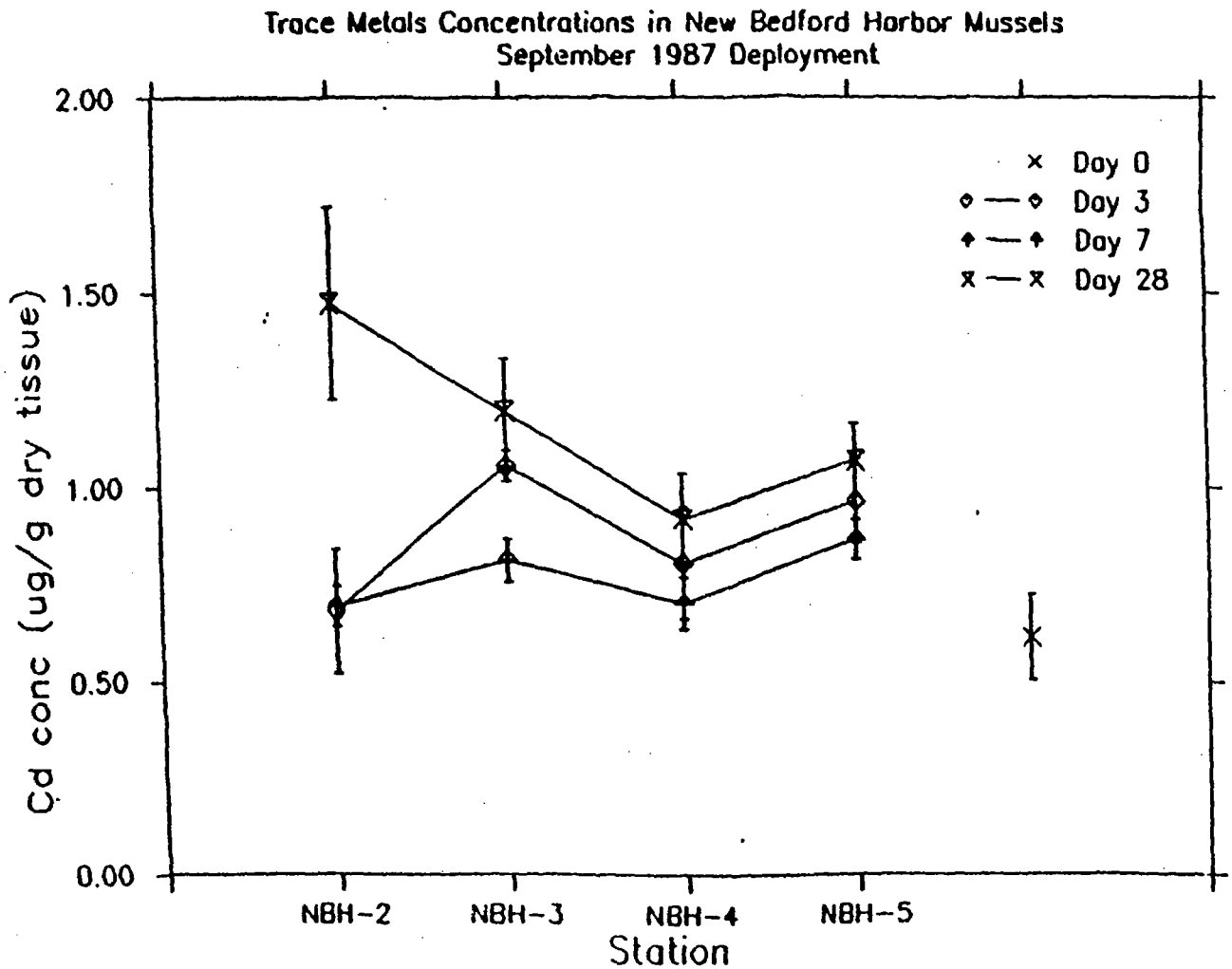
Figure 7. Mean (± standard error) cadmium concentrations (μg/g) in *Mytilus edulis* deployed in New Bedford Harbor during the second mussel deployment. Day 0 concentration provided for comparison.



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