Bull. Environ. Contam. Toxicol. (1993) 50:626–632

Environmental Contamination and Toxicology

Metal Concentrations in American Lobster and Channeled Whelk from Two Dredge Spoil Dump Sites in Long Island Sound

Richard Greig and Jose J. Pereira

National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, Milford, Connecticut 06460, USA

The National Marine Fisheries Service conducted a field-monitoring project in the early to mid 1970's to determine the impact of dredge spoil disposal at sea on marine animals. As part of that project, we analyzed American lobster (Homarus americanus) and channeled whelk (Busycotypus canaliculatus) collected from two dredge spoil dump sites in Long Island Sound (one off New Haven, CT and the other off New London, CT) for the presence of metals. In 1989, more than a decade later, samples of the same two species were again collected from these locations to determine whether any changes in metal concentrations had occurred in the populations of these organisms over that period of time. Both species are harvested in Long Island Sound for human consumption.

Eisler (1981) reviewed the literature on metal levels in marine organisms but found very little data on copper, cadmium, and silver in lobster and whelk tissue. The Connecticut Department of Environmental Protection (1987) measured copper and cadmium in lobster from Long Island Sound. Lobster and whelk are organisms that can provide valuable information as to whether changes in metal levels in the environment occur over time. These particular organisms, however, can travel considerable distances (Fogarty et al. 1980; Briggs and Mushacke 1984), thereby compounding the interpretation of these trends. Movement patterns for each of these two species were probably similar during both collecting periods so the decadal comparisons of metals in the environment as interpolated by the presence of metals in organisms made here should be valid, but probably on a regional basis and not specifically at the two dumpsites.

Send reprint requests to R. Greig at the above address.

MATERIALS AND METHODS

During the mid-1970's and again in 1989, channeled whelk and lobster were collected in lobster pots at the two dredge spoil disposal sites in Long Island Sound; New London site coordinates were 72°4.5'N and 41°16.3'W and New Haven 72°53.0'N and 41°9.0'W. The samples collected in the 1970's were obtained over several months, mostly in summer, whereas the 1989 samples were collected in October. The animals collected in 1989 were similar in size to those collected in the 1970's. The whelk were heated in hot, deionized water for several minutes to free the body tissue from the shell. The muscular foot was then removed and the remaining tissue saved for analyses. Lobster hepatopancreas was removed with stainless steel utensils. Samples were then frozen at -20°C until analysis. Whelk tissue and lobster hepatopancreas were analyzed for the presence of copper, cadmium, and silver by the method of Greig et al. (1982). Briefly, wet tissues were digested in 250-ml glass beakers with 20 ml concentrated, quartz-distilled nitric acid until most organic material was digested. After cooling, hydrogen peroxide (30%) was added and the samples were evaporated to dryness. This procedure was repeated several times, until the dry residue was white or brownish white. Sample residues were filtered using 5% quartz-distilled nitric acid. Each filtrate was brought to 50 ml volume with 5% nitric acid in polyethylene tubes, then analyzed using graphite furnace atomic absorption spectrophotometry. Results are reported on a wet weight basis. Analyses were on individual animals.

Results were analyzed for normality using the Shapiro-Wilk test appropriate for N = <51. A one-way analysis of variance (ANOVA) of mean metal concentrations was used to investigate temporal differences and differences between the two sampling sites. Duncan's multiple range test was used to determine significant differences.

RESULTS AND DISCUSSION

The concentrations of copper in lobster from the New Haven site were higher ($P < 0.05$) than in those from the New London site for both sample years (Table 1). Mean Cu concentrations ranged from 150 ppm (New London) to 364 ppm (New Haven) in 1989 compared with 558-1490 ppm, respectively, detected in 1974-1975 (Table 1), a significant decrease ($P < 0.05$).

Table 1. Mean (± S.D.) metal concentrations (ppm, wet wt.) in hepatopancreas of lobster (Homarus americanus) obtained from New Haven and New London in 1989 and the early to mid 1970's.

Location	Catch Date	N[a]	Cu	Cd	Ag
New Haven	1974-1976	50	1489.9[b] (829.7)	10.7 (5.87)	23.4[d] (15.95)
New Haven	1989	19	363.5[b] (194.6)	8.8 (4.10)	4.8[d] (5.08)
New London	1974-1975	16	558.4[b] (260.5)	3.5[c] (1.20)	8.8[d] (1.63)
New London	1989	19	150.1[b] (136.0)	3.1[c] (2.60)	2.3[d] (2.42)

[a] Number of individual animals
[b] All significantly different from one another
[c] Significantly different from New Haven, both time periods
[d] All significantly different from one another

Lobster collected by the Connecticut Department of Environmental Protection (1987) in 1985 and 1986 from the New Haven area had Cu concentrations of 280 ppm (wet wt) in the hepatopancreas and lobster from the New London area had concentrations of 39 ppm. These areas were close to our study sites; they also showed higher copper concentrations in lobster from the New Haven than the New London area. Copper concentrations of 400 ppm (wet wt) were reported for hepatopancreas of lobster (Homarus vulgaris) from British waters (Bryan 1968), and 440 ± 65 ppm from lobster (Panulicus japonicus) digestive glands collected in coastal waters of Japan (Ishii et al., 1985).

Mean Cu concentrations in soft tissue of whelk were generally lower than in hepatopancreas of lobster, with means of 80 ppm (New London site) to 780 ppm (New Haven site) (Table 2). Whelk from the New

Table 2. Mean (± S.D.) metal concentrations (ppm, wet wt) in soft tissue of channeled whelk (Busycotypus canaliculatum) obtained from New Haven and New London in 1989 and the early to mid-1970's.

Location	Catch	N[a]	Cu	Cd	Ag
New Haven	1973-1976	70	534.0 (267.9)	9.3[c] (3.72)	6.7[d] (4.12)
New Haven	1989	7	468.5 (147.8)	11.3[c] (6.12)	0.97[d] (0.68)
New London	1974-1975	38	108.1[b] (78.57)	6.0[c] (3.07)	4.6[e] (2.40)
New London	1989	13	253.3[b] (102.2)	5.1[c] (2.14)	1.1[e] (1.12)

[a] Number of individual animals
[b] Significantly different from one another; significantly different from New Haven.
[c] New Haven, both time periods, significantly different from New London, both time periods
[d] Significantly different from one another
[e] Significantly different from one another

Haven site had higher Cu concentrations ($P \leq 0.05$) than whelk from the New London site (Table 2) for all sample years. There were no temporal differences in Cu in soft tissue of whelk from New Haven ($P \leq 0.05$) (Table 2). For New London, 1989 was significantly ($P \leq 0.05$) higher than the 1970's.

Betzer and Pilson (1974) reported lower concentrations of copper in soft tissue of whelk in Narragansett Bay, RI, ranging from 58-116 ppm (wet wt) (mean of 76). Greig et al. (1977) reported a mean concentration of 32.4 ppm (wet wt) in soft tissue of whelk from Chincoteague, VA.

Hepatopancreas of lobster collected from the New Haven site in the 1970's contained a mean Cd concentration of 10.7 ppm. In 1989 the mean was 8.8 ppm, not significantly different. Samples from the New London site in the 1970's had a mean level of 3.5 ppm, while in 1989 the mean level was 3.1 ppm (Table 1); again there was no temporal change.

There were, however, statistically higher ($P \leq 0.05$) levels of Cd in lobster hepatopancreas samples collected from the New Haven site in the 1970's and 1989 than in samples collected from the New London site in the same years (Table 1). Lobster hepatopancreas examined by the Connecticut DEP (1987) had mean Cd levels of 7.5 ppm in samples collected from both the New Haven and the New London areas of Long Island Sound. Uthe et al. (1986) reported Cd concentrations of 172 and 223 ppm, wet wt, in hepatopancreas of lobster collected near a lead smelter in Belledune Harbor, New Brunswick, Canada, in 1981 and 1982, respectively. In 1984 Cd concentrations in lobster from the same area decreased to 75.4 ppm presumably because the lead smelter had ceased operation. Lobster from an unimpacted area in Canada had concentrations of 3.3 to 4.8 ppm for this same time period. Ray et al. (1981) reported concentrations of Cd in hepatopancreas of lobster from Maine of 22 ppm dry wt (about 3.7 ppm wet wt), similar to our findings for the New London site. Ishii et al. (1985) reported Cd concentrations of 19 ± 7 ppm (wet wt) in hepatopancreas of lobster from Japan; they were somewhat higher than our findings for the New Haven site.

Mean concentrations of Cd in soft tissue of channeled whelk collected from the New Haven site in the 1970's were 9.3 ppm and 11.3 ppm in 1989. Samples from the New London site had mean concentrations of 6.0 ppm in the 1970's and 5.1 ppm in 1989 (Table 2). There were no statistically significant temporal differences at either site. There were significant differences ($P \leq 0.05$) between Cd concentrations in whelk from the New Haven site and those from the New London site (Table 2). Greig et al. (1977) reported Cd concentrations of 7.4 ppm wet wt. in soft tissues of whelk collected from Chincoteague, VA; these were similar to values found at our New London site. As with lobster, Cd concentrations in whelk collected from Long Island Sound were similar to those reported elsewhere.

Mean silver concentrations in hepatopancreas of lobster collected from the New Haven site were 23.4 ppm in the 1970s and were 4.8 ppm in 1989 (Table 1), a significant ($P \leq 0.05$) decrease. Lobster from the New London site had a mean concentration of 8.8 ppm in the 1970's; concentrations dropped to 2.3 ppm in 1989. New Haven lobster examined in the 1970's had statistically higher ($P < 0.05$) concentrations of silver in hepatopancreas than those collected in

1989, and those from the New London site. Lobster collected from New London in the 1970's had a significantly higher ($P < 0.05$) concentration of Ag in hepatopancreas than those collected in 1989. Like Cu and Cd, Ag concentrations were generally higher in lobster from the New Haven site than in those from the New London site.

Mean silver concentrations in soft tissue of whelk collected from the New Haven site ranged from 6.7 ppm in the 1970s to 0.97 ppm in 1989 (Table 2), a significant temporal decrease ($P \leq 0.05$). Mean values in whelk from the New London site ranged from 4.6 ppm in the 1970's to 1.1 ppm in 1989, also a significant temporal decrease. There were no significant differences between sites in any single year.

O'Connor (1990), reporting on the NOAA National Status and Trends Program, which has been monitoring metals in mussels, oysters, and sediments since 1984, described trends for copper, cadmium, and silver levels on a national scale. He reported that levels of these three metals have not changed "overwhelmingly" in either direction over that time.

The Long Island Sound Study Annual Report (1991) reported several statistically significant trends in contaminant levels in the Sound, using mussels and bottom sediment as markers. Silver, cadmium, and copper levels decreased at all nine sites sampled from 1986 to 1989. The study reported here, using lobster and channeled whelk as markers, showed no statistical change in cadmium levels in either lobster or whelk samples between the 1970's and 1989. Silver, on the other hand, decreased from the 70's to 1989 in both lobster and whelk, whereas copper decreased in lobster but not whelk during those years. This study, therefore, underscores the importance of using multiple markers, both biological and physicochemical, to assess the comparative contamination of various sites on a temporal basis.

Both species reported on here may move considerable distances from the collection site, but the movement patterns are likely to be similar for similar sized animals caught 13-16 years apart. These animals probably travel over clean and "dirty" locations in similar fashion from year to year.

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Received October 1, 1992; accepted December 10, 1992.