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Evaluation of New York Bight Lobsters for PCBs, DDT, Petroleum Hydrocarbons, Mercury, and Cadmium

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The New York Bight is routinely exposed to waste from the neighboring urban environments. Nine million metric tons of sewage sludge and industrial waste, and five million tons of dredged materials are dumped into the Bight each year (MacLEOD et al. 1981). The Bight is also a resource for numerous commercial and recreational fisheries. Specifically, the American lobster (Homarus americanus) is regularly harvested from sites in the New York Bight. As a generalized predator of the ocean floor in adult stages and a resident of the water column during larval stages, the lobster has potential to uptake and store those contaminants to which it is exposed. Storage of such compounds in bodily tissue may assume toxicological importance to both the lobster and man as consumer of the lobster. Five potentially toxic compounds were chosen for study which might reflect the impact of disposal operations in the Bight. All lobsters were tested for DDT, petroleum hydrocarbons, total polychlorinated biphenyls (PCBs), mercury (Hg), and cadmium (Cd).

MATERIALS AND METHODS

Test Sites

Four distinct test sites were chosen within the Bight Apex. All sample collection was conducted by the U.S. Army Corps of Engineers New York District (C.O.E.). Descriptions of sampling sites were set forth in maps supplied by the C.O.E. (NOAA maps 12300 and 12326, 1978) and summarized in Figure 1. Those sites comprised the following: a Dredged Materials Disposal site, a site in New York Harbor (Gravesend Bay) chosen for its immediate proximity to the city, a site off the coast of New Jersey where no disposal of dredged material occurs, and a site in Long Island Sound somewhat removed from urban effects and disposal operations.

Test Animals

Ten samples of the American lobster (Homarus americanus) were taken from each of the four sites by the C.O.E. The samples were immediately frozen until analysis. The weight, length, and sex of each sample is presented in Table 1.

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FIGURE 1

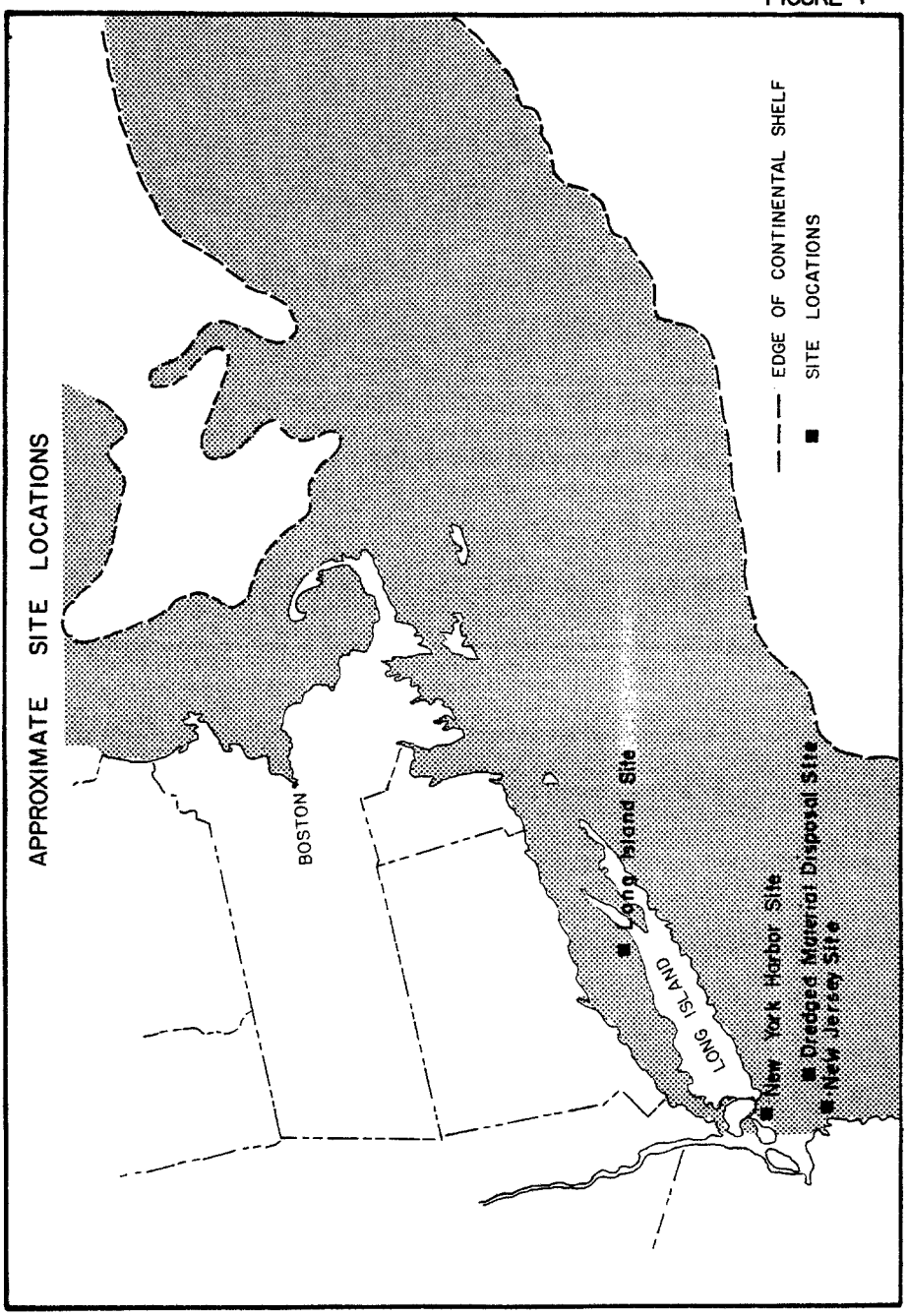
APPROXIMATE SITE LOCATIONS
BOSTON
Long Island Site
LONG ISLAND
New York Harbor Site
Dredged Material Disposal Site
New Jersey Site
EDGE OF CONTINENTAL SHELF
SITE LOCATIONS

TABLE 1
CONTAMINANT VALUES

Site	Sex	Length mm	Weight g	Petroleum Hydrocarbons Aliphatic ug/g	Petroleum Hydrocarbons Aromatic ug/g	PCBs ug/kg	DDT o,p-DDT ug/kg	DDT p,p-DDT ug/kg	Heavy Metals Hg ug/kg	Heavy Metals CD ug/kg
New	M	105	342.5	N.D.*	N.D.	70	N.D.	N.D.	190	14
Jersey	M	106	402.9	N.D.	N.D.	320	N.D.	N.D.	120	24
site	M	109	413.4	N.D.	N.D.	200	N.D.	N.D.	180	18
	M	110	430.5	N.D.	N.D.	230	N.D.	N.D.	130	15
	M	109	431.0	N.D.	28.0	120	N.D.	N.D.	80	17
	F	85	263.7	N.D.	N.D.	160	N.D.	N.D.	80	15
	F	95	326.4	N.D.	N.D.	130	N.D.	N.D.	170	23
	F	100	387.0	N.D.	N.D.	70	N.D.	N.D.	310	24
	F	100	390.5	N.D.	15.0	94	N.D.	N.D.	130	11
	F	113	504.5	N.D.	N.D.	83	N.D.	N.D.	140	17
Dredged	M	89	233.0	N.D.	N.D.	100	N.D.	N.D.	200	18
Material	M	101	345.5	N.D.	N.D.	79	N.D.	N.D.	130	17
Disposal	M	109	455.5	N.D.	N.D.	220	N.D.	N.D.	340	18
	M	112	459.0	N.D.	N.D.	95	N.D.	N.D.	160	21
	M	107	460.0	N.D.	N.D.	260	N.D.	N.D.	150	23
	M	113	468.8	N.D.	N.D.	210	N.D.	N.D.	260	16
	M	112	474.5	N.D.	N.D.	140	N.D.	N.D.	230	17
	M	110	574.4	N.D.	N.D.	150	N.D.	N.D.	260	12
	F	109	454.3	N.D.	N.D.	62	N.D.	N.D.	150	12
	F	113	462.5	N.D.	N.D.	190	N.D.	N.D.	370	20

TABLE 1 (cont'd)

Site	Sex	Length mm	Weight g	Petroleum Hydrocarbons Aliphatic ug/g	Petroleum Hydrocarbons Aromatic ug/g	PCBs ug/kg	DDT o,p-DDT ug/kg	DDT p,p-DDT ug/kg	Heavy Metals Hg ug/kg	Heavy Metals CD ug/kg
New	M	89	197.2	N.D.*	N.D.	380	N.D.	N.D.	270	30
York	M	89	227.7	N.D.	N.D.	410	N.D.	N.D.	290	16
Harbor	M	88	232.2	N.D.	N.D.	200	N.D.	N.D.	290	20
	M	92	253.3	N.D.	N.D.	160	N.D.	N.D.	260	18
	M	102	313.0	N.D.	N.D.	170	N.D.	N.D.	260	24
	M	103	325.2	N.D.	N.D.	180	N.D.	N.D.	440	21
	M	103	326.7	N.D.	N.D.	320	N.D.	N.D.	350	36
	M	119	440.0	N.D.	N.D.	160	N.D.	N.D.	330	25
	M	132	479.1	N.D.	N.D.	210	N.D.	N.D.	500	33
	F	78	186.2	N.D.	N.D.	140	N.D.	N.D.	90	13
Long	M	108	340.0	N.D.	N.D.	48	N.D.	N.D.	360	15
Island	M	109	443.5	N.D.	N.D.	17	N.D.	N.D.	110	19
Sound	F	113	403.4	N.D.	N.D.	26	N.D.	N.D.	250	14
	F	113	404.5	N.D.	N.D.	87	N.D.	N.D.	180	14
	F	116	457.5	N.D.	N.D.	96	N.D.	N.D.	140	18
	F	115	537.8	N.D.	N.D.	9	N.D.	N.D.	180	23
	F	116	539.5	N.D.	N.D.	100	N.D.	N.D.	160	13
	F	126	572.0	N.D.	N.D.	61	N.D.	N.D.	90	13
	F	127	673.8	N.D.	N.D.	200	N.D.	N.D.	180	10
	F	127	687.4	N.D.	N.D.	140	N.D.	N.D.	130	11

*N.D. - not detected
detection limits: petroleum hydrocarbons - 5 ug/g
DDT - 50 ug/kg

Test Methods

Once thawed, the tissue to be tested was removed from the exoskeleton. Only tissue from the two chelipids and the abdomen was excised for analysis. Once removed, the tissue was thoroughly homogenized in a Cuisinart Food Processor, model CFP-5A (Cuisinarts, Stamford, CT). The tissue homogenate was then divided into three portions: one each for heavy metals, PCBs and DDT, and petroleum hydrocarbon analysis.

Briefly described, the procedure (adapted from various EPA, DEC, procedures) for PCBs and DDT begins with the blending of tissue in the presence of the solvent acetonitrile. Blending was performed with a Virtis "23" tissue homogenizer, model number 7-109AF (Virtis Co., Gardner, NY). The acetonitrile was centrifuged to segregate tissue and washed with 2% (W/V) aqueous sodium sulfate. The acetonitrile phase was then extracted with hexane. Interferences were removed from hexane extracts during passage through anhydrous sodium sulfate and florisil packed columns. The cleaned extract was concentrated to 1 ml via Kuderna Danish evaporation. Concentrates were analyzed for PCBs and DDT on a Tracor 550 gas chromatograph equipped with a linearized electron capture detector and interfaced with a Hewlett Packard Model 3380S integrator. A 6' x 1/4" O.D. 4 mm I.D. packed column of 3% OV-1 on 80/100 chormosorb W-HP at 200°C was used for separation. The carrier gas was 95% argon/5% methane (All solvents used were nanograde quality from Mallinkrodt Co.).

The Hatch and Ott technique (HATCH and OTT 1968) was used in the determination of mercury. Homogenized tissue was digested with sulfuric acid, hydrogen peroxide, and potassium permanganate (HARRIS et al. 1978). Hydroxalamine and stannous chloride were used to liberate mercury from digested tissue which was subsequently analyzed via atomic absorption spectrophotometry (Varian 575).

In preparation for cadmium analysis, homogenized tissue was dried for four hours at 100°C, ashed at 450°C, dissolved in nitric acid, and diluted with water for analysis by atomic absorption spectrophotometry (PERKIN ELMER 1973).

Petroleum hydrocarbons were analyzed according to WARNER (1978). Prior to extraction, homogenized tissue was digested at 90°C with sodium hydroxide. The digested sample was extracted with ethyl ether. Subsequent to centrifugation the ether layer was removed and the sample reextracted. The combined extracts were dried with sodium sulfate and concentrated to 1 ml by Kuderna-Danish evaporation. The ether was replaced with hexane by addition and reconcentration. Interferences were removed with silica gel (MCB 200 mesh and finer) column chromatography. Extracts were added to columns under 2-3 psi of ultrapure nitrogen and eluates collected. Petroleum ether was used to elute the aliphatic hydrocarbon fraction. A 20% mix of methylene chloride in petroleum ether (V/V) was used to elute the aromatic hydrocarbon fraction. Eluates were concentrated and analyzed on a Tracor 550 gas chromatograph equipped with a flame ionization detector and interfaced to a Hewlett Packard Model 3380S integrator. One quarter inch OD dual stainless steel columns packed

with 10% OV-101 on 80/100 Mesh Chromosorb W-HP were utilized in the gas chromatograph. Columns were programmed from 60°-200°C at 10°C/min. The carrier gas was ultrapure nitrogen. Aliphatic hydrocarbons were quantited against a hexadecane standard. Aromatic hydrocarbons were quantitated against a biphenyl standard. Quantitation against representative standards was necessary as petroleum hydrocarbons is a general term that comprises the several thousand compounds in crude oil.

RESULTS AND DISCUSSION

Of the five target pollutants, DDT (o,p-DDT and p,p-DDT) and the petroleum hydrocarbon (excluding two samples), concentrations were below the detection limits of the analytical procedures. Quantifiable levels of PCBs, Hg, and Cd were found in the tissues of all lobsters analyzed in Table 1.

Mean values calculated for contaminant concentrations lend an overview of data when grouped by sample site (Table 2). PCBs, Hg, and Cd levels were found to be highest in those lobsters taken from New York Harbor. The lowest mean concentrations were found in those samples from Long Island Sound. Analysis of variance between sample sites showed only New York Harbor lobsters to have significantly elevated levels of PCBs, Hg, and Cd in comparison to the other sites. This fact is not surprising as the proximity of the site to New York City is taken into consideration.

TABLE 2

MEAN CONTAMINANT VALUES
ug/Kg wet weight

	New York Harbor Site	Dredged Materials Disposal Site	Coastal New Jersey Site	Long Island Sound Site
PCBs	233	151	148	78
Hg	308	225	153	178
Cd	24	17	18	15

As seen in Table 1, the concentration of PCBs found in the forty test lobsters ranged from 9 to 410 ug/kg wet weight. In comparison, Atlantic tomcod (Microgadus tomcod) samples taken from the Hudson River Estuary were found to have PCB concentrations in body tissues ranging from 10 to 670 ug/kg wet weight (KLAUDA 1981). Horn et al. (1979) found total PCB concentrations in tomcod ranging from 440 to 4480 ug/kg (edible flesh). Mean concentrations of 1500 ug/kg and 1300 ug/kg were found for Aroclors 1242/1016 and 1254 in the edible flesh of tomcod by SPAGNOLI and SKINNER (1977). In another study the highest concentrations of PCBs in ocean fishes from Long Island Sound ranged from 1200 to 3200 ug/kg wet weight (RISEBROUGH and

deLAPPE, 1972). Stripped bass from the Bight displayed concentrations from 1000-7000 ug/kg in muscle tissue (U.S. DEPT. COMMERCE 1979).

The concentration of Hg in the tissues of the American lobster samples ranged from 80 to 500 ug/kg wet weight (Table 1). Concentrations of Hg and related compounds in the New York Bight are unknown (U.S. Dept. of Commerce, 1979). Coastal waters, however, are known to have Hg concentrations of approximately .05 ug/kg (U.S. DEPT. of COMMERCE, 1979). Also referenced here are Hg concentrations of 900 to 1100 ug/kg in bluefish and stripped bass from Long Island Sound and concentrations as high as 2300 ug/kg in lobster muscle from samples of the New York Bight.

A range of 10 to 36 ug Cd/Kg was found in the test lobsters of this study (Table 1). SEGAR and CANTILLO (1976) found an average concentration of .8 ug/kg in the New York Bight Apex. Concentrations greater than 1 ug Cd/Kg have been found in the near bottom waters of the Dredged Material Disposal site (U.S. DEPT. of COMMERCE, 1979). Also reported is an average concentration of less than 100 ug/kg in fish and shell fish from the Bight.

Regression analysis was performed to test the relationship of lobster weight to tissue concentration of measured contaminants. No significant correlations were found to exist. Of interest, however, was the total lack of correlation between female lobster weight and PCB concentration ($r = .0005$).

Finally, it should be noted that none of the tissue contaminant concentrations of PCBs and Hg exceed action levels established by the U.S. FOOD and DRUG ADMINISTRATION (1978) and the EPA. The action level for PCBs in fish and shell fish is 5 ppm. The Environmental Protection Agency lowered this action level to 2 ppm in the spring of 1979 and recinded that level the same fall (ZABIK et al. 1982). The action level for Hg has been set at .5 ppm in edible flesh by the same agencies. No official limit exists for Cd in fish and shellfish.

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