Levels of Polybrominated Diphenyl Ethers (PBDEs) in the Hackensack River and Newark Bay, New Jersey USA

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Introduction

In a relatively short period of time, scientists have come to recognize the widespread occurrence of polybrominated diphenyl ethers (PBDEs) in the environment. At present, the ten most predominant PBDE congeners found in ambient air, soil, sediment, and biota appear to be BDE-28, BDE-47, BDE-66, BDE-85, BDE-99, BDE-100, BDE-153, BDE-154, BDE-183, and BDE-209[1]. Point sources of these and other PBDE congeners in the environment are not well understood, in part due to limited environmental studies and a poor understanding of environmental fate and long-range transport processes. PBDEs have become an ecological concern primarily due to their bioaccumulation in food chains and occurrence in birds, fish, and other aquatic wildlife at levels that may pose potentially adverse effects. The concern for human health focuses primarily on exposure via fish consumption and the potential risks of adverse effects during early stages of development.

Outside the United States, PBDEs have been found in sediment samples collected from rivers, estuaries, and lakes located near industrial plants, sewage treatment plants, and landfills[2,3,4,5]. In general, few environmental data are available describing levels of PBDEs in sediments in U.S. waterways. In this study, PBDE concentrations were measured in surface and buried sediments at several locations in upper Newark Bay and the lower Hackensack River, New Jersey USA. This work was conducted as part of a larger study of sediment contamination in the most heavily industrialized and urbanized estuary in the United States.

Materials and Methods

Fifty-two surface sediment samples (0-6 inches) were collected from the lower Hackensack River, the mouth of the Hackensack River, the mouth of the Passaic River, and in Newark Bay (Figure 1). At 33 locations in the lower Hackensack River, sediment cores were collected using either a piston coring or vibracoring device and polybutyrate plastic liners with 2.25- or 3.5- inch outer diameter (OD) core barrel to a nominal depth of between 8 and 17 feet. Additional surface sediment grab samplers were collected using a Van Veen grab sampler. All field sampling equipment was precleaned prior to each sampling event. Sediments were collected directly from the core barrel using precleaned Teflon®-coated stainless steel spoons and transferred to precleaned amber

glassware and sealed with a Teflon®-coated cap. Sediment samples were analyzed by Alta Analytical Laboratory (El Dorado Hills, CA) for 32 individual PBDE congeners and total mono through deca brominated congeners according to a modified version of USEPA Method 1614.

Results and Discussion

The range and arithmetic mean concentrations of PBDE congeners detected in surface sediments are summarized in Table 1. Total and mean concentrations were calculated assuming that values below the limit of quantification (LOQ) were equal to one-half the LOQ.

BDE-47, BDE-99, and BDE-209 were the predominant PBDE congeners in surface and buried sediments at all sampling locations. The concentrations of BDE-47, BDE-99, and BDE-209 ranged from 34 to 6,500 picograms per gram (pg/g) dry weight, 32 to 6,600 pg/g dry weight, and 97 to 300,000 pg/g dry weight, respectively. In general, the concentrations of PBDE congeners and total PBDEs were lower in the lower Hackensack River at the confluence with Newark Bay than at other locations in Newark Bay. The higher concentrations of PBDEs measured in surface sediment than in buried sediments in the lower Hackensack River suggest recent inputs to the watershed.

While PBDE concentrations in river sediment should not be compared too closely from river to river due to variable sedimentation and hydrodynamic processes, comparisons of PBDE levels in different river systems can be useful to evaluate the relative level of contamination[5]. The levels reported in this study are consistent with PBDE concentrations measured in two U.S. studies: North Carolina and Virginia, and Indiana[6,7]. According to Hale et al.[6], BDE-47, BDE-99, and total PBDE concentrations in sediments downstream from flexible polyurethane foam (FPUF) manufacturing facilities ranged from non-detect to 36,200 pg/g dry weight, non-detect to 86,300 pg/g dry weight, and non-detect to 132,000 pg/g dry weight, respectively. Levels of BDE-47, BDE-99, BDE-209, and total PBDEs measured in Hadley Lake, Indiana, ranged from 800 to 4,700 pg/g dry weight, 1600 to 22,000 pg/g dry weight, 19,000 to 36,000 pg/g dry weight, and 24,000 to 71,000 pg/g dry weight, respectively[7].

In general, PBDE concentrations in sediment appear to be higher in Nordic and European countries than in the United States. In a study conducted by Nylund et al.[2], laminated sediment cores were analyzed to measure the concentration of PBDEs in the Baltic Sea. In surface sediment, BDE-47, BDE-99, and total PBDEs were detected at mean concentrations of 363 pg/g dry weight, 153 pg/g dry weight, and 500 pg/g dry weight[3], respectively. In Osaka, Japan, total PBDEs measured in surface sediment were as high as 57,200 pg/g dry weight[3].

The results of this study suggest that additional work is warranted to evaluate body burdens in fish and other aquatic organisms in the Hackensack River and Newark Bay.

Adopting the ratio approach used by Sellstrom et al.[8], there may be at least 20-40 fold higher concentrations of BDE-47, BDE-99, BDE-100 and possibly other PBDE congeners in fish tissues relative to the concentrations that occur in sediment. If true, fish body burdens in the estuary may occur at levels approaching those associated with potentially adverse effects, and any disturbance of the sediments that facilitate bioaccumulation should be avoided in the River and the Bay.

References

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Figure 1. Surface and buried sediment sampling locations in upper Newark Bay and the lower Hackensack River, New Jersey USA.

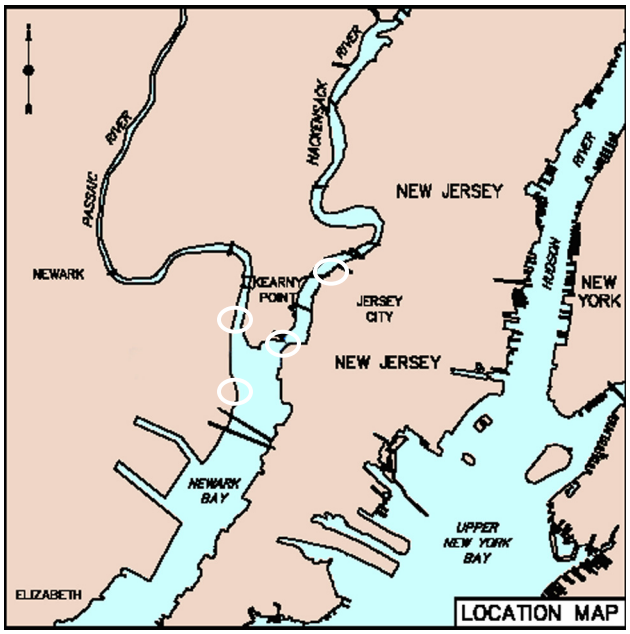

Table 1. The concentrations (pg/g dry weight) of PBDEs in surface and buried sediments collected from upper Newark Bay and the lower Hackensack River Concentrations.

PBDE Congener	Lower Hackensack River		Lower Passaic River Confluence		Northern Newark Bay		Lower Hackensack River Confluence		
	(n=4)		(n=3)		(n=3)		(n=78)	(n=51)	(n=27)
	Range	Mean (0-0.5')	Range	Mean (0-0.5')	Range	Mean (0-0.5')	Range	Mean (0-0.5')	Mean (0.5'-4')
BDE-28	5-22	11	360-680	530	93-150	130	1 - 320	70	40
BDE-47	150-390	260	4,400-16,000	9,100	620-1,600	1,000	34 - 6,500	830	310
BDE-66	7-9	8	200-530	340	11-72	40	1 - 240	42	21
BDE-85	4-14	7	140-670	340	14-47	30	1 - 190	26	11
BDE-99	140-390	280	4,800-19,000	11,000	500-1,500	900	32 - 6,600	800	270
BDE-100	30-86	58	1,300-4,100	2,400	140-370	230	5 - 1,500	200	73
BDE-153	19-49	30	930-3,400	1,900	350-650	460	4 - 1,200	200	120
BDE-154	13-55	30	750-2,200	1,400	300-490	370	2 - 940	160	80
BDE-183	11-60	25	1,800-13,000	5,400	940-5,000	2,500	3 - 5,000	510	430
BDE-209	1,900-6,800	3,900	330,000-700,000	500,000	140,000-380,000	240,000	97 - 300,000	60,000	30,000
Total PBDEs	2,400-8,300	4,800	370,000-840,000	580,000	160,000-470,000	290,000	200 - 360,000	71,000	36,000