PERSISTENT ORGANIC POLLUTANTS IN SEDIMENTS AND AQUATIC ORGANISMS FROM INTERTIDAL HABITATS IN AN URBAN RIVER

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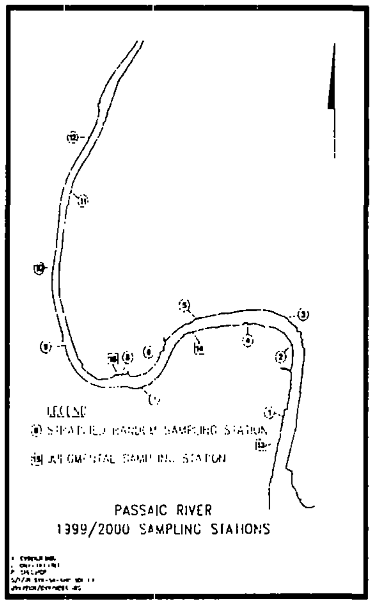
Introduction

The Passaic River in northeastern New Jersey, USA is part of the New York/New Jersey Harbor Estuary, one of the most heavily industrialized and populated estuaries in the world. Elevated concentrations of hundreds of chemicals from many sources have been detected in surface and buried sediments of the River[1,2,3,4,5]. Intertidal areas (i.e., mudflats) within the lower six miles of the River are of particular concern, as they represent the only shallow water estuarine habitats within the river and, therefore, are the areas with the greatest potential for biological exposure to contaminated sediments. For this reason, a sampling program was conducted in 1999 and 2000 to quantify the present extent of contamination in shallow water areas (including mudflats and adjacent subtidal areas), and assess the bioaccumulation and trophic transfer of persistent organic pollutants (POPs) through the food web within these habitats.

Methods and Materials

Composite surface sediment and biological tissue (fish and blue crab) samples were collected concurrently from 15 individual mudflat stations along a six mile stretch of the River (Figure 1). Two samples were collected per River mile under a stratified random design. Three additional stations on the River were sampled based on known sources of particular POPs.



A modified stainless steel VanVeen grab sampler was used to collect sediment for analysis. Each composite sample consisted of 10 discrete grab samples that were combined and homogenized using a core-and-quarter method. Resident fish and crab species, including mummichog (*Fundulus heteroclitus*) and blue crab (*Callinectes sapidus*), among others, were collected using a variety of traps. Each composite sample consisted of whole body soft tissues from several individuals.

Sediment and tissue samples were analyzed for the following POPs (as well as a variety of other contaminants not reported in this paper): pesticides/herbicides, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins/dibenzofurans (PCDD/Fs), and polycyclic aromatic hydrocarbons (PAHs). Analyses were performed using high resolution gas chromatography followed by high or low resolution mass spectroscopy[6,7].

Results

Sediment and tissue results for representative POPs are summarized in Table 1. Compounds were grouped and summed by chemical class. The 2,3,7,8-tetrachlorodibenzo-*p*-dioxin toxic equivalents (TEQ) were calculated for each of the 17 PCDD/F congeners and summed into a Σ PCDD/F TEQ. Similarly, individual PCBs and PAHs were summed into totals for their respective classes. DDT and its metabolites (DDE and DDD), presented as Σ DDT, was the only pesticide that was detected in most of the sediment and tissue samples.

Variability in chemical concentrations among stations was generally low with few exceptions. This is not unexpected given that samples were composited. These composites are likely reflective of average exposure conditions on each mudflat. Biota-sediment-accumulation factors (BSAFs—μg/kg lipid tissue/μg/kg organic carbon sediment) were calculated for forage fish and blue crab that live in close association with sediments on the mudflats (Table 2). BSAFs for most organic compounds were similar across stations for the POPs investigated. In general, the BSAFs for blue crab are higher than the BSAFs for mummichog for Σ PCDD/F TEQs, Σ DDTs, and Σ PAHs while the BSAFs for blue crab and mummichog are about the same for Σ PCBs.

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Table 1. Mean Concentrations of persistent organic pollutants in the lower Passaic River, New Jersey

	Σ PCDD/F TEQ[a] (ng/kg)			Σ PCBs (ug/kg)[b]			Σ DDT (ug/kg)[c]			Σ PAHs (ug/kg)		
Station	Sediment	MC[d]	BC[e]	Sediment	MC[d]	BC[e]	Sediment	MC[d]	BC[e]	Sediment	MC[d]	BC[e]
1	448	29	63	1,318	852	978	114	71	63	40,093	305	265
	(164)	(6)	(42)	(169)	(172)	(456)	(39)	(46)	(7)	(5,839)	(57)	(57)
2	351	45	78	1,657	963	1,330	88	39	53	33,765	298	323
	(171)	(5)	(NA)	(1,509)	(67)	(NA)	(22)	(5)	(NA)	(6,299)	(25)	(NA)
3	313	37	83	950	1,423	914	115	77	87	30,318	269	365
	(107)	(2)	(NA)	(310)	(257)	(NA)	(65)	(62)	(NA)	(5,700)	(28)	(NA)
4	399	62	80	1,418	1,230	1,070	180	140	41	40,026	250	293
	(90)	(1)	(NA)	(245)	(148)	(NA)	(77)	(63)	(NA)	(4,866)	(11)	(NA)
5	425	44	66	1,172	965	797	97	87	67	47,446	272	304
	(136)	(2)	(NA)	(248)	(94)	(NA)	(91)	(82)	(NA)	(6,478)	(24)	(NA)
6	1,419	52	64	1,315	1,320	825	113	82	116	46,679	289	536
	(1,988)	(4)	(NA)	(44)	(82)	(NA)	(33)	(85)	(NA)	(4,825)	(14)	(NA)
7	564	57	86	1,113	987	763	251	131	222	42,693	290	315
	(137)	(4)	(NA)	(287)	(862)	(NA)	(96)	(61)	(NA)	(2,853)	(34)	(NA)
8	441	61	75	1,113	1,240	1,013	126	49	120	48,871	271	278
	(99)	(16)	(9)	(112)	(360)	(39)	(9.3)	(10)	(83)	(2,980)	(28)	(44)
9	368	62	63	871	1,012	699	405	48	158	49,114	299	292
	(77)	(5)	(NA)	(146)	(43)	(NA)	(537)	(12)	(NA)	(7,156)	(41)	(NA)
10	328	62	96	1,560	1,550	965	79	75	71	39,349	393	334
	(61)	(3)	(NA)	(356)	(70)	(NA)	(31)	(47)	(NA)	(6,562)	(86)	(NA)
11	826	65	72	1,333	995	969	142	101	79	90,099	281	384
	(1,073)	(14)	(50)	(191)	(79)	(228)	(77)	(41)	(11)	(62,090)	(31)	(162)
12	346	74	106	1,371	1,029	963	93	81	74	57,771	350	273
	(112)	(9)	(NA)	(391)	(28)	(NA)	(15)	(40)	(NA)	(29,967)	(97)	(NA)
13	316	33	96	1,613	1,317	1,030	166	56	223	48,362	446	245
	(52)	(2)	(NA)	(283)	(101)	(NA)	(73)	(17)	(NA)	(7,215)	(82)	(NA)
14	781	445	119	1,376	909	1,252	379	155	114	34,318	202	270
	(117)	(312)	(43)	(265)	(93)	(591)	(250)	(59)	(5)	(4,566)	(135)	(41)
15	357	70	80	1,578	1,233	1,060	79	34	63	47,928	322	316
	(35)	(4)	(NA)	(469)	(85)	(NA)	(38)	(3)	(NA)	(1.384)	(53)	(NA)

Notes:

[a] ΣPCDD/F toxic equivalents (TEQs) were calculated using the World Health Organization toxic equivalency factors (TEFs) for fish (Van den Berg et al., 1998).

[b] Individual PCB congeners were summed into a measure of total PCBs, using the NOAA National Status and Trends Program method (NOAA, 1989).

[c] Σ DDT was calculated as the sum of 4,4'-DDE, 4,4'-DDD and 4,4'-DDT.

[d] MC - mummichog

[e] BC - blue crab

Numbers in parentheses represent one standard deviation of the mean.

NA - Not available.