CHLORINATED DIOXIN/FURANS IN NEW YORK HARBOR WATER, WASTEWATER, BIOTA, AND SEDIMENTS

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Introduction

Contaminants in New York Harbor sediments increase the costs for maintaining the Port of New York/New Jersey. Sediment disposal criteria include chlorinated dioxins/furans as well as PCBs, DDT, and toxicity to marine organisms. This work reports dioxin concentrations and fingerprints from different media at sites throughout the system.

Methods and Materials

Large volumes of water, from 200 to 6,000 L, were pumped through pre-fired glass fiber cartridge filters to concentrate suspended sediments. Bottom sediments were collected by Ponar or from sectioned cores. Striped bass (*Morone saxatilus*) and ribbed mussel (*Modiolus demissus*) were collected by rod and reel and hand picking respectively. Analyses for suspended and bottom sediments were by USEPA Method 1613. Biological materials were analyzed using USEPA Method 8290.

Data were evaluated against conventional quality control criteria of method blanks, duplicates, field blanks, and surrogate recovery. Use of WHO 98 Toxic Equivalency Factors (TEFs) makes some of the 17 congeners more important than others. The 505 samples noted here had total TEQs differing by less than 10% if non-detections were assigned values of zero or half the detection limit.

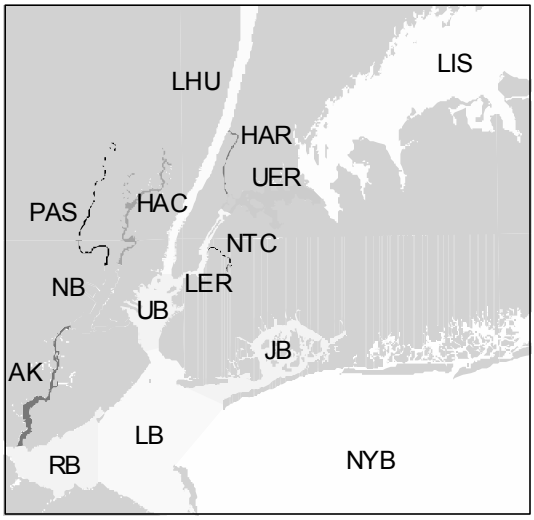

Figure 1. Harbor Areas.

Map	Name	Map	Name
AK	Arthur Kill	NB	Newark Bay
HAC	Hackensack R.	NTC	Newtown Creek
HAR	Harlem R.	NYB	New York Bight
JB	Jamaica Bay	PAS	Passaic R.
LB	Lower Bay	RB	Raritan Bay
LER	Lower East R.	UB	Upper Bay
LHU	Lower Hudson	UER	Upper East R.
LIS	Long Island Sound		

Specific locations of wastewater treatment plants (POTWs), combined sewer overflows (CSOs) treated landfill leachates, and tributaries are not indicated.

Results and Discussion

Tables 1 to 4 show summary statistics by harbor area the number of samples, average total TEQ (WHO98), the standard deviation for the total TEQ, and the percent of total TEQ contributed by 2,3,7,8-TCDD for striped bass, ribbed mussel, sediments, and water. Not all harbor areas are equally represented. Since Table 3 (sediments) includes both surficial and core samples, the average depth is also indicated. Rows are ordered by average TEQ.

Table 1. Striped Bass, standard fillets

Harbor Area	Count	TEQ, Avg. pg/g	TEQ, StDev, pg/g	Avg. % TCDD
Long Island Sound	7	1.9	0.88	42
Lower Hudson R.	12	3.4	2.2	61
New York Bight	9	3.5	3.6	52
Raritan Bay	8	4	3.8	61
Mid Hudson R.	6	5.4	1.6	51
Upper Bay	27	7.6	14	59
Newark Bay	5	29	30	87

Table 2. Ribbed Mussel

Harbor Area	Count	TEQ, Avg. pg/g	TEQ, StDev, pg	Avg. % TCDD
Raritan Bay	18	1.5	0.45	65
Upper Bay	17	2.2	0.48	64
Newark Bay	24	16	7.3	93
Passaic R.	22	38	11	97

Table 3. Sediments

Harbor Area	Avg. Depth, cm	Count	TEQ, Avg, pg/g	TEQ, StDev, pg/g	Avg % TCDD
Long Island Sound	4.1	21	23	10	11
Lower Hudson R.	4.1	10	35	19	19
Raritan Bay	8.7	15	40	20	28
Harlem River	7.8	7	52	7	20
Lower Bay	7	11	53	43	36
Upper East R.	5.7	10	54	26	26
Jamaica Bay	11.7	17	63	64	26
Arthur Kill	10.8	13	120	126	31
Upper Bay	9	35	276	880	20
Passaic R.	5	3	454	66	77
Newark Bay	8.7	23	591	1320	71
Newtown Creek	10.4	11	876	474	6

Newtown Creek flows through an old industrial area in Queens and Brooklyn, NY. Two cores and a surficial sample all show three dominant congeners: 1,2,3,7,8-PeCDD; 2,3,4,7,8-PeCDF; and 1,2,3,4,7,8-HxCDF.

With certain exceptions (Newtown Creek for sediments and CSOs for water), the highest TEQ concentrations were seen in the western harbor areas of Passaic/Hackensack Rivers and Newark Bay. These areas were also those with the greatest contributions from 2,3,7,8-TCDD to total TEQ. The variability between harbor areas in average TCDD contribution was greatest in water samples and least in biological material. Table 6 relates the percent contribution of 2,3,7,8-TCDD by media to western harbor areas and all others.

Table 4. Water

Harbor Area	Count	TEQ, Avg, pg/L	Avg StDev, pg/L	Avg % TCDD
New York Bight	6	0.0049	0.0015	23
Long Island Sound	5	0.039	0.0052	6
Lower Bay	3	0.11	0.051	32
Jamaica Bay	3	0.11	0.049	8
Upper East R.	3	0.15	0.024	14
Raritan Bay	3	0.17	0.03	30
POTWs*	60	0.24	0.47	5
Urban tributaries*	11	0.28	0.53	9
Major tributaries*	13	0.3	0.25	4
Upper Bay	4	0.31	0.1	33
Treated landfill leachate	4	0.32	0.29	18
Lower East R	5	0.33	0.1	15
Lower Hudson R.	12	0.55	0.26	19
Mid Hudson R.	9	1.1	0.89	3
Newark Bay	3	1.3	0.5	68
Arthur Kill	3	1.6	1.1	53
Hackensack R.	7	2.8	2.1	68
Passaic R.	12	11	14	82
CSO	8	11	6	4

Table 5. Final POTW Effluents, water

POTWs	Count	Avg. TEQ, pg/L	StDev, pg/L	Avg % TCDD
Low TEQ samples	52	0.15	0.088	8
High TEQ samples	8	1.0	0.65	2

Table 6. Average percent contributions of TCDD to total TEQ.

Harbor Area	Water	Sediments	Striped Bass	Ribbed Mussel
Western harbor	68	60	87	95
All others	15	21	56	65
Total means	26	31	60	80

Water samples show the greatest variability from site to site in 2,3,7,8-TCDD contributions. TEQ fingerprints from ribbed mussels had the least. Striped bass and mussels also show greater relative dominance of 2,3,7,8-TCDD. Stated another way, elimination of 2,3,7,8-TCDD would have more impact on total TEQ in biota than in water.

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Figures 2-4 illustrate congener patterns. The ordinates are the relative contributions of each congener to total TEQ and the abscissa is an ordering of congeners identified in Table 7.

Table 7

Order	PARAM	Order	PARAM	Order	PARAM
1	2,3,7,8-TCDD	7	OCDD	13	2,3,4,6,7,8-HxCDF
2	1,2,3,7,8-PeCDD	8	2,3,7,8-TCDF	14	1,2,3,7,8,9-HxCDF
3	1,2,3,4,7,8-HxCDD	9	1,2,3,7,8-PeCDF	15	1,2,3,4,6,7,8-HpCDF
4	1,2,3,6,7,8-HxCDD	10	2,3,4,7,8-PeCDF	16	1,2,3,4,7,8,9-HpCDF
5	1,2,3,7,8,9-HxCDD	11	1,2,3,4,7,8-HxCDF	17	OCDF
6	1,2,3,4,6,7,8-HpCDD	12	1,2,3,6,7,8-HxCDF		

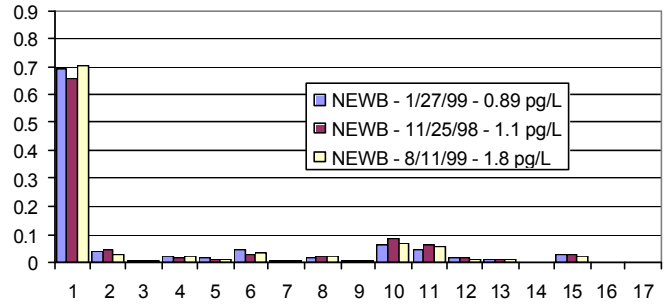

Figure 2. Relative abundances of dioxin/furan congeners from three Newark Bay suspended sediment samples. While total TEQ concentrations are variable, the patterns of congener abundances are stable. Congener # 1 (2,3,7,8-TCDD) is seen in the wastes of chemical manufacturing. Agent Orange was made in the vicinity.

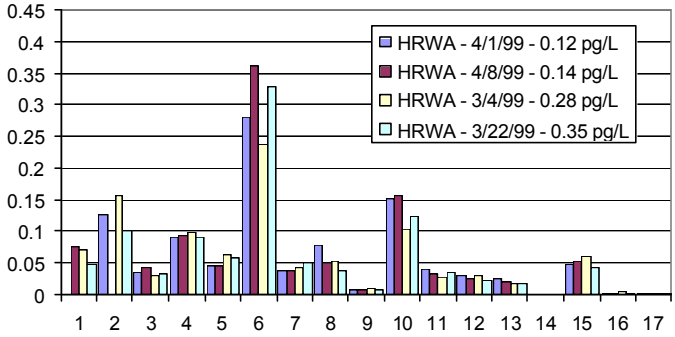

Figure 3. Low TEQ levels occur in the upper Hudson at Waterford (150 miles north of NYC) during spring freshets. A 1,2,3,4,6,7,8-HpCDD dominated pattern appears. A similar pattern occurs in the Bronx River.

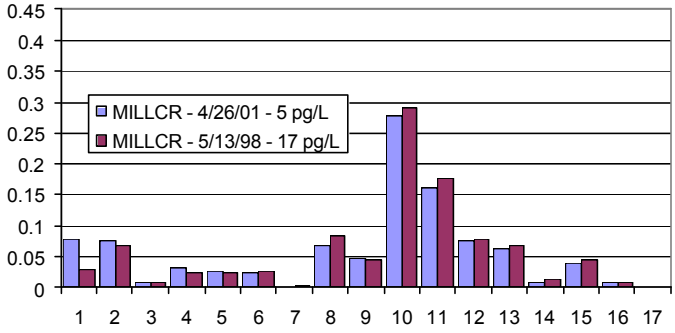

Figure 4. TCDD was relatively unimportant in suspended sediment from Mill Creek, a tidal tributary to the Arthur Kill. A nearby industrial incinerator ashed obsolete electronics to recover precious metals. Congener # 10, 2,3,4,7,8-PeCDF, is important here and it becomes increasingly significant while moving down the Hudson. It may be an incineration product.

There are numerous sources of dioxin TEQ in the New York Harbor area. Some of the different sources have reproducible signatures and may have forensic use. If fingerprints are specific to sources and not functions of environmental degradation, they suggest a multiplicity of source types.

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