TROPHIC TRANSFER OF PCB CONGENERS FROM SEDIMENT IN THE DELAWARE RIVER ESTUARY, USA

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Introduction

Estuaries are dynamic systems with great spatial, temporal, and chemical variability. Point and non-point sources provide hydrophobic organic contaminants such as polychlorinated biphenyls (PCBs) to estuaries, resulting in contaminant concentration gradients within urban waters. These chemicals accumulate in sediments, and it is important to understand the processes that transport sediment-bound contaminants into estuarine food webs. Modeling PCB trophic transfer requires extensive data that describe both the physical and biological variability in the estuary. Analysis of top predators and their respective prey items give an overall view of food web dynamics and the transport and accumulation of PCBs (*1*,*2*,*3*). This study explores the efficiency of trophic transfer in an estuarine food web over a PCB concentration gradient. Predator/prey relations are examined to determine if net accumulation of contaminants varies throughout the estuary.

The objective of this study is to determine the efficiency of trophic transfer in a Delaware River estuary food web. The study area is characterized by significant spatial gradients in PCB levels due to elevated urban loadings. Sediments, prey items (epibenthic and macrobenthic invertebrates, and small fish), and two predator species were analyzed to determine if predator/prey PCB ratios are consistent across the estuary. In the present study, white perch (*Morone americanus*) and channel catfish (*Ictalurus punctatus*) were chosen based on their recreational and commercial importance, abundance, and life histories. These two demersal predators reflect differing migration behaviors within the Delaware River Estuary. White perch are a semi anadromous species, migratory within the Delaware River estuary while channel catfish have a small spatial range, and therefore are more closely coupled to local benthos (*4*).

Methods and Materials

The study area was conducted in four zones along an 80-mile stretch of the Delaware River from Trenton, New Jersey to Liston Point, Delaware. Samples were collected under low flow conditions in Fall 2001 and high flow conditions in Spring 2002. Adult white perch (*Morone americanus*), adult channel catfish (*Ictalurus punctatus*), forage fish, and epibenthic invertebrates were collected throughout each of the four zones by balloon trawl. All fish were anesthetized in Tricaine Methanesulfonate (MS-222), and frozen for future analysis. One composite of skinned fillets and one composite of remains from 5 to 8 individuals of the target species within each zone were collected for analysis. White perch and channel catfish otiliths were removed for age determination. Forage fish were separated by species and the whole fish homogenized for analysis. Ekman sediment grabs of surficial sediments (top 5 cm) taken from within each model zone were composited for analysis, sub sampled for bulk chemistry and then sieved for macrobenthic invertebrates. Additional macrobethos were collected using artificial substrate deployed and allowed to soak for 1-3 days. Invertebrates mainly comprised of the amphipod *Leptocheirus plumulosus* were depurated for 6 hours and frozen for analysis. Biota samples were homogenized, extracted and analyzed as reported by Stapleton et al. (*5*).

All samples were analyzed for PCBs using gas chromatography with ^{63}Ni electron-capture detection (GC-ECD) using a Hewlett-Packard 5890 series II GC equipped with a 0.25 µm x 60 m DB-5 capillary column. H_2 was used as the carrier gas at a flow rate of 35 cm/s; injector and detector temperatures are 225 °C and 325 °C respectively (6). PCBs were quantified with the method from Mullin (*6*), congener specific results are totaled to determine "total PCB".

Results and Discussion

PCB levels varied among zones for sediment, benthic invertebrates, forage fish, and predatory fish. High PCB concentrations were found in Zone 3 near Philadelphia Pennsylvania, indicating enhanced inputs in this urbanized stretch of the estuary. Macrobenthic invertebrates contained lower PCB levels in Zone 2, upstream of the urban area (50 ng/g wet weight) relative to those near urban inputs in Zone 3 and 4 (150 ng/g wet weight) and further downstream in Zone 5 (100 ng/g wet weight). Channel catfish had similar spatial patterns, with higher total PCBs in Zone 3. An example of predator/prey PCB ratios in channel catfish fillets and macrobenthic invertebrates is shown in Table 1. These ratios were not constant across the estuary. Although values suggest that net accumulation of contaminants varies across the estuary, the data has not been normalized for lipid content. Future analysis will focus on predator/prey ratios using lipid-normalized data.

Table 1. Total PCB concentrations (ng/g wet weight) and % lipid for epibenthic invertebrates, channel catfish fillet composites, and the ratio of total PCBs for channel catfish to macrobenthic invertebrates in four study zones of the Delaware River, USA.

	Macrobenthic Invertebrates Composites		Channel Catfish Fillet		Channel Catfish/Invertebrates
Study Area	% Lipid	t-PCBs (ng/g wet wt)	% Lipid	t-PCBs (ng/g wet wt)	Ratio of t-PCBs (ng/g wet wt)
Zone 2	0.57	50	3.9	570	11.4
Zone 3	0	140	3.1	890	6.36
Zone 4	1.0	160	4.0	540	3.38
Zone 5	0	90	4.4	550	6.11

Acknowledgements

The Delaware River Basin Committee for providing funding, the Academy of Natural Sciences for collaborative work, as well as Matt Wilhelm, Scott McGuire, and Dave Secor for technical assistance.

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