

PRELIMINARY ASSESSMENT OF RISKS FROM POLYCHLORINATED DIBENZO-*P*-DIOXINS AND DIBENZOFURANS TO FISH AND CRUSTACEANS IN THE TIDAL PASSAIC RIVER, NEW JERSEY, USA

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Introduction

The tidal portion of the Passaic River in northeastern New Jersey (USA) has been adversely impacted by more than 150 years of urbanization and industrialization¹. As a result, water, sediments, and aquatic organisms in the River are contaminated with a large number of organic and inorganic contaminants^{2,3,4}. Data have been collected from the lower six miles of the River (Figure 1) to support an evaluation of the risks that these contaminants pose to ecological and human receptors.

In this paper, we present the results of a preliminary assessment of risks from 2,3,7,8-substituted polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) to fish and crustaceans that reside in the River. Our assessment is based on tissue data that were collected for a variety of species at various trophic levels of the food web, and threshold toxicity values for PCDD/Fs that are available in the scientific literature.

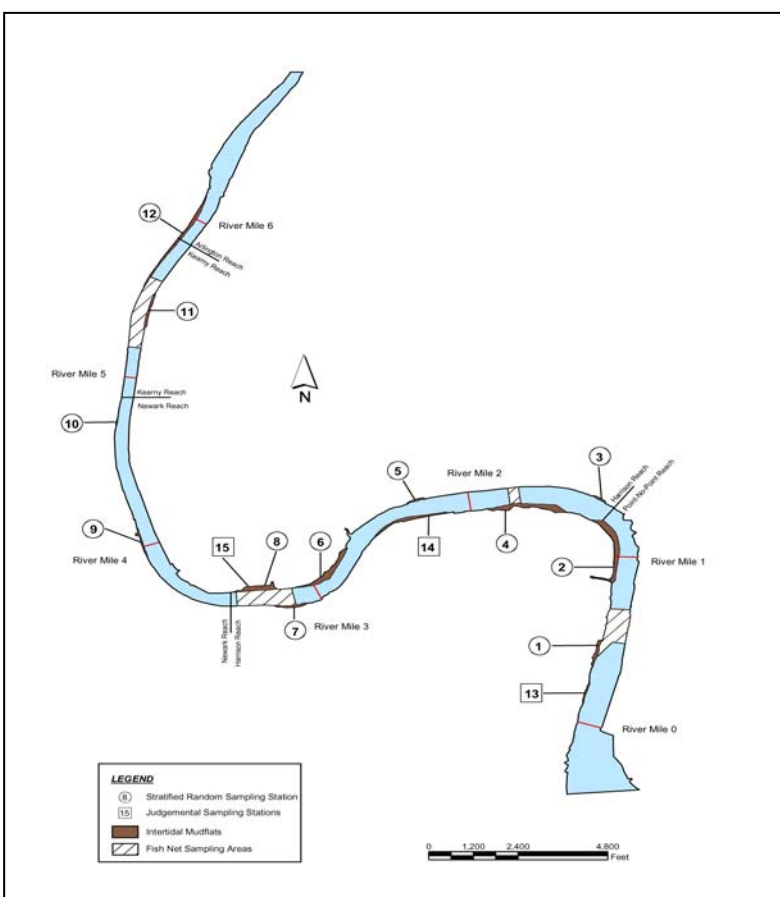


Figure 1. Passaic River Study Area and Sampling Stations

Fish and crustaceans utilizing the River are bioaccumulating chemicals from sediment and/or food sources. Exposure occurs primarily through consumption of contaminated food (prey)⁵. This assessment is focused on risks to the maintenance and survival of populations of these organisms. As such, the toxicological endpoints that we evaluated included reproductive success and survival.

Materials and Methods

Fish and crustaceans were surveyed and sampled as part of a large-scale ecological sampling program conducted in the late summer/early fall of 1999 and spring of 2000. A total of 15 stations were sampled in the lower 6 miles of the River (Figure 1). Several sampling techniques were used including baited minnow, eel, and crab traps; and gill nets. Several samples of the dominant fish species that were captured during the surveys were collected for tissue analyses for PCDD/Fs and other contaminants. Composite whole body samples of fish and blue crab were collected and analyzed for the ecological risk assessment. Each composite sample contained homogenates of at least two individual fish. The exact number of fish per composite was determined based on the necessary mass required to complete the chemical analyses. The samples were analyzed for 2,3,7,8-substituted PCDD/Fs using USEPA Method 1613A⁶.

A literature search was conducted to compile information on toxicity thresholds for effects of PCDD/Fs on fish and crustaceans. The resulting data were tabulated and evaluated for appropriateness relative to the quality of the study, endpoint type, and species.

Results and Discussion

Table 1 provides information and PCDD/F data results for the species included in this risk assessment. The fish community of the lower Passaic River includes several resident and migratory species, of which the six species listed in Table 1 comprised 97.3% of the total amount of fish caught in the 1999/2000 sampling events. The blue crab was the only crustacean that was found in abundance within the River.

Table 1. PCDD/F TEQ concentrations ($\mu\text{g}/\text{kg}$) in fish and crustaceans from the lower Passaic River, New Jersey, USA

Species	Status	N	FOD (%)	Min.	Max.	Avg.	SD
American Eel (<i>Anguilla rostra</i>)	M	6	100	0.0051	0.023	0.011	0.0068
Atlantic Menhaden (<i>Brevortia tyrannus</i>)	M	6	100	0.028	0.085	0.050	0.026
Inland Silverside (<i>Menidia beryllina</i>)	M	9	100	0.023	0.061	0.042	0.012
Mummichog (<i>Fundulus heteroclitus</i>)	R	49	100	0.020	0.84	0.085	0.13
Striped Bass - Adult (<i>Morone saxatilis</i>)	M	6	100	0.0056	0.11	0.076	0.038
Striped Bass - Juvenile (<i>Morone saxatilis</i>)	R	3	100	0.080	0.099	0.087	0.011
White Perch (<i>Morone americana</i>)	R	18	100	0.084	0.37	0.23	0.082
Blue Crab (<i>Callinectes sapidus</i>)	M	19	100	0.033	0.15	0.081	0.026

Notes:

Average calculated using 1/2 detection limit values for any non-detects.

FOD - frequency of detection

M - migratory

N - number of samples

R - resident

SD - standard deviation

The PCDD/F data are provided in 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) toxic equivalent (TEQ) concentrations for ease of presentation. The World Health Organization toxicity equivalence factors (TEFs)⁶ for fish were used to calculate the TEQs in this study. The data that are used to assess risk to fish and blue crab were generated from the combined 1999 and 2000 datasets. For the purposes of this assessment, the data were combined by species for the entire six-mile study area.

Toxicity thresholds are concentrations in the tissues of organisms above which adverse effects have been reported. If these thresholds are based on endpoints associated with population parameters such as reproductive success and survival, they can be used as indicators of potential population-level risk. While this approach does not consider the natural compensatory mechanisms of fish populations to adapt to fluctuations in population and recruitment levels, it is a conservative means to assess the risks of contaminants to fish using site-specific measures of direct environmental exposure (i.e., tissue levels).

Seventeen whole body PCDD/F toxicity thresholds were identified for fish, 14 of which were for survival (12) and reproduction (2) endpoints. The lowest threshold reported for these endpoints was 0.30 $\mu\text{g}/\text{kg}$, which was based on decreased survival in mummichog (see Figure 2)⁷. Only one crustacean threshold was identified—3.0 $\mu\text{g}/\text{kg}$ which is based on reduced survival in crayfish⁸.

Figure 2. PCDD/F TEQ concentrations (min., max., avg.) and toxicity threshold comparison in fish species from the tidal Passaic River

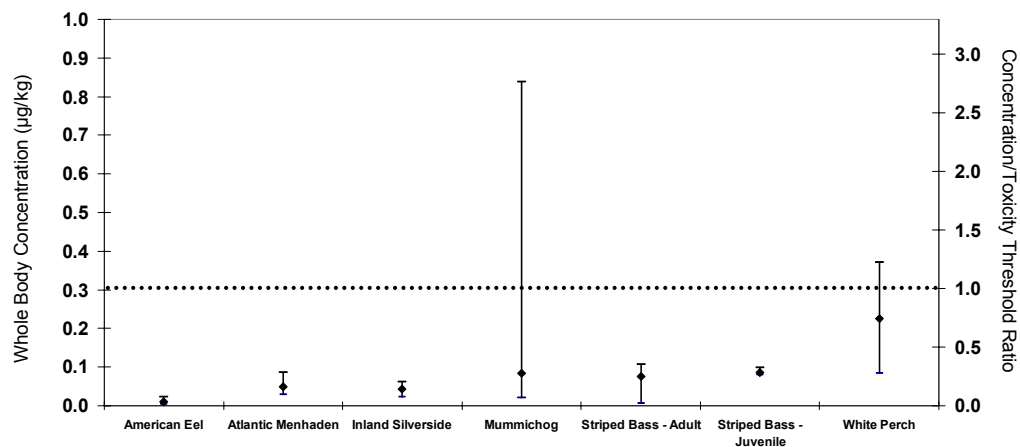


Figure 2 provides a comparison of the Passaic River fish data to the lowest reported toxicity threshold. Only the maximum concentrations reported for two of the six species, mummichog and white perch, exceeded this threshold. The concentrations of PCDD/F TEQ in blue crab were well below the reported threshold of 3.0 µg/kg (Table 1). These results, being based on very conservative estimates of toxicity to fish, suggest that the PCDD/Fs do not pose a substantial risk to fish and blue crab in the Passaic River.

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