CONTAMINANT DISTRIBUTION IN WHOLE BODY, FILLET AND OFFAL OF FISH AND HUMAN HEALTH EXPOSURE ASSESSMENT OF FISH CONSUMPTION – A PRELIMINARY CASE STUDY OF THE CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE

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Introduction

As part of the Remedial Investigation and Feasibility Study (RI/FS) conducted for the Centredale Manor Restoration Project Superfund site in North Providence, Rhode Island by the U.S. Environmental Protection Agency (USEPA) Region I and the U.S. Army Corps of Engineers (USACE), a Baseline Human Health Risk Assessment (BHHRA) and a Baseline Ecological Risk Assessment (BERA) are being developed. The objectives of the BHHRA in the Remedial Investigation are to:

- evaluate the human health risks associated with contaminants at the Centredale site via exposure pathways such as consumption of fish caught from portions of the Woonasquatucket River at the site, incidental ingestion of and dermal contact with the river bank surface soil, surface water and sediment at the site, and
- develop the preliminary remedial goals for the contaminated media.

A BHHRA would consist of four steps: hazard identification, exposure assessment, toxicity assessment and risk characterization[1]. This paper focuses on the first two steps of the BHHRA: hazard identification and exposure assessment. The next two steps of the BHHRA, toxicity assessment and risk characterization, would be future EPA work and papers.

The hazard identification or data collection and evaluation process has found elevated levels of dioxin (specifically the most toxic dioxin congener 2,3,7,8-tetrachlorodibenzo-p-dioxin or 2,3,7,8-TCDD); 1,2,4,5,7,8-hexachloroxanthene (HCX) and polychlorinated biphenyls (PCB Aroclors) at the site in soil, sediment, groundwater, surface water and biota. Besides these contaminants that were found at elevated levels at the site, a full suite of other chemicals, including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) and inorganics have also been analyzed for samples collected at the site. This paper will include a discussion of data evaluation methods, data summaries of the distribution of the main contaminants (2,3,7,8-TCDD, HCX and PCBs) in sediment and fish at four different exposure areas of the site (Allendale, Lyman Mill, Manton and Dyerville) and two reference areas (Greystone Mill and Assapumpset) and of the correlation between contaminant levels in sediment and in fish[2].

The exposure assessment process presents the pathways by which the human population may be potentially exposed to the main contaminants at the site for current and future scenarios. Contaminated wastes directly released into the soil and into the river were believed to result in high levels of contaminants in soil, sediment, surface water and biota. Through the release

mechanism of infiltration, leaching and direct release to soil, sediment and surface water, it is believed that the contaminants are transported by erosion, runoff or advection and discharge to the contaminated media of bank soil, sediment and surface water. Contaminants can also be taken up from the sediment and surface water and bioaccumulated in biota. The main receptors at Centredale, i.e., residents, visiting anglers, and commercial/industrial workers, can be exposed to contaminants in these media via biota consumption, ingestion of or dermal contact with bank soil, sediment and surface water. This paper will focus only on the fish consumption pathway from available sediment and fish data collected at the site.

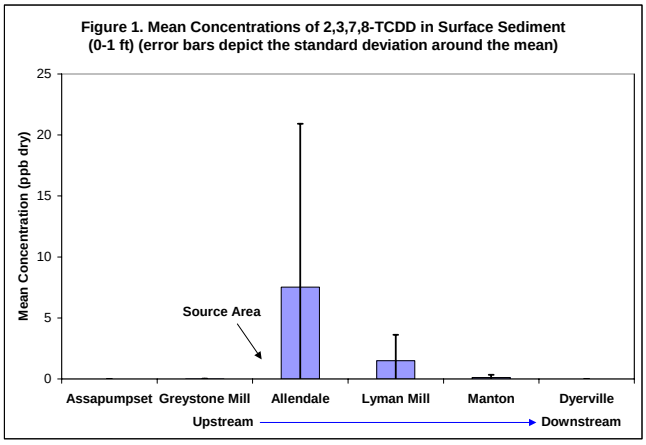
Methods and Materials

Samples for characterization include surface sediments (0-1 foot), American eel (*Anguilla rostrata*), white sucker (*Catostomus commerson*), and largemouth bass (*Micropterus salmoides*)[3]. American eel and white sucker were analyzed as whole body. Largemouth bass were analyzed as separate fillet (skin-on) and offal tissue samples; with the reconstituted whole body (RWB) concentration calculated based on the proportional sum of the fillet and offal data. Samples were analyzed by high-resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) for dioxins, furans, and HCX following U.S. EPA Method 1613 (Revision B)[4]. Samples were also analyzed by gas chromatography/electron capture detection (GC/ECD) for PCB, as Aroclor, following methods comparable to U.S. EPA Method 8082[5].

The distribution of contaminants in sediment and in fish at the site was evaluated by comparing either mean (sediment) or individual (fish) concentrations at each of the exposure areas. Because of the large datasets (e.g., over 100 samples analyzed for Allendale), sediment data within a sampling location were averaged. However, fewer fish data were available (10 or fewer samples, by species and location), thereby allowing for comparison on an individual sample basis. The correspondence between contaminants in sediment and fish was evaluated by linear regression using normalized, mean concentrations of contaminants in sediment and fish, by sampling area and species. Sediment data were normalized to the fraction of Total Organic Carbon (TOC) and then averaged by sampling location. Similarly, fish data were normalized to the fraction of lipid and then averaged by sampling location and species. Wherever data were averaged, a value of one-half the detection limit was used in cases of non-detects.

Results and Discussion

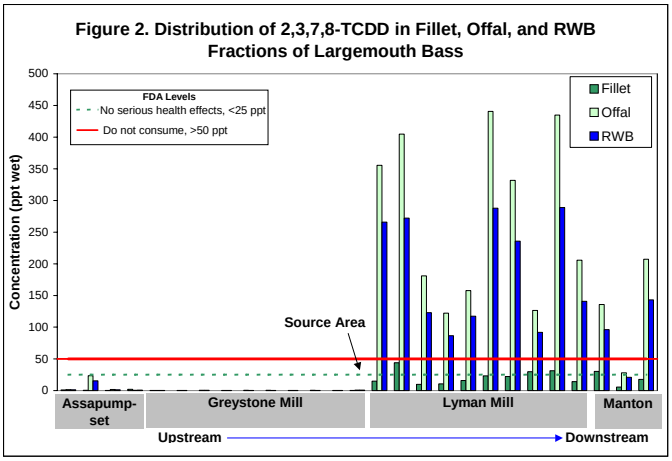
Contaminant concentrations were among the highest, and were by far the most variable, in sediment nearest to the source area, i.e., the Allendale sampling area (Figure 1). The magnitude and variability in contaminant concentrations generally decreased downstream of the source area. Mean concentrations of 2,3,7,8-TCDD at reference locations (Assapumpset and Greystone Mill) and areas downstream of Lyman Mill (Manton



and Dyerville) were well below mean concentrations of 2,3,7,8-TCDD at Allendale and Lyman Mill (Figure 1). Similarly, the highest concentration of HCX in sediment was measured at Allendale, followed by Lyman Mill. Concentrations of HCX at the reference areas and areas downstream of Lyman Mill were one or more orders of magnitude lower than those at Allendale and Lyman Mill. However, PCB detection was more complicated than the other contaminants, with the highest detection still at Allendale but also some high levels at Greystone Mill, Lyman Mill and Dyerville.

Consistent with sediment findings, fish collected from Allendale and Lyman Mill areas generally contained higher concentrations of contaminants than fish collected at reference areas and areas downstream of Lyman Mill. Among the fish species analyzed, white sucker generally contained the highest concentrations of 2,3,7,8-TCDD and PCBs compared to American eel and largemouth bass. This might be usual with white sucker being a bottom feeding fish. The concentrations of 2,3,7,8-TCDD and PCBs measured in the offal tissues of largemouth bass were generally one order of magnitude higher than those concentrations measured in the corresponding fillet tissues, suggesting that 2,3,7,8-TCDD and PCBs are lipophilic and mainly stored in the fatty tissues (offal) instead of the muscle tissues (fillet) (Figure 2). HCX was also measured at higher concentrations downstream of the source area than the reference areas, and was similar between American eel and white sucker. For largemouth bass, however, HCX was generally undetected in the fillet, and when detected in the offal, concentrations were near the detection limit.

Figure 2. Distribution of 2,3,7,8-TCDD in Fillet, Offal, and RWB Fractions of Largemouth Bass

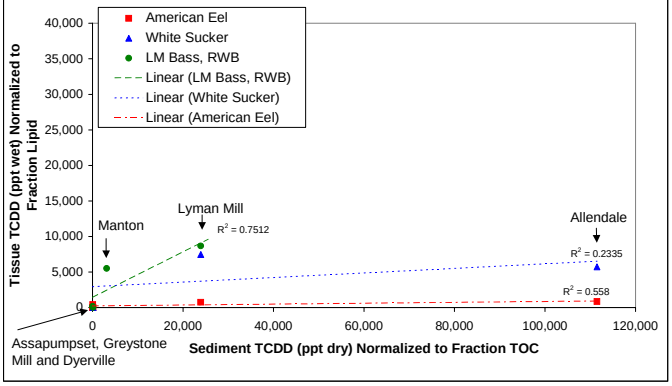


2,3,7,8-TCDD concentrations in fish collected at Allendale and Lyman Mill areas frequently approached or exceeded FDA “Do Not Consume” levels of 50 ppt by one order of magnitude, suggesting the receptors at the site not eat the offal parts or whole body of fish from these two areas (representative fish, largemouth bass, shown in Figure 2). Exceedences of the FDA Tolerance Level for PCBs were less widespread, with no observed and limited exceedences for American eel and largemouth bass, respectively. However, PCB concentrations in white sucker consistently exceeded the FDA Tolerance Level at Lyman Mill (10 out of 10) and to a less extent at Allendale (3 out of 10). There is no advisory or tolerance level for HCX available at this time. A fish consumption advisory recommending not eating fish caught from the Woonasquatucket River in North Providence issued by the Rhode Island Department of Health is currently in effect.

Based on the limited data available (n = 5 for American eel; n = 3 for white sucker; and n = 4 for largemouth bass), there is a positive correlation between mean concentrations of 2,3,7,8-TCDD in sediment (normalized to fraction TOC) and fish (normalized to fraction lipid) for largemouth bass

and American eel, whereas the correlation is considerably weaker for white sucker (Figure 3). These findings show that largemouth bass has a relatively stronger correlation between sediment and fish 2,3,7,8-TCDD concentrations than American eel and white sucker. Yet interestingly, the data showed that white sucker contained the highest concentrations of 2,3,7,8-TCDD compared to largemouth bass and American eel. Some potential reasons for this are: 1) the differences in diet, habitat, and lipid contents among the species, 2) the differences in age of the fish sampled, or 3) the potential for chemical disequilibrium in the river. The correlation between sediment and fish HCX concentrations was also fairly good among all species analyzed, except for largemouth bass where HCX was undetected for the most part. Results from the correlation analysis between sediment and fish for PCBs are more convoluted, suggesting that there is no clear point source of PCB contamination, as for 2,3,7,8-TCDD and HCX.

Figure 3. Correlation Between Sediment and Fish Normalized, Mean 2,3,7,8-TCDD Concentrations



Acknowledgements
The authors would like to thank MACTEC Engineering and Consulting, Inc. for sample collection and data management and Battelle scientists for the dioxin/furan, HCX and PCB analyses.

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