NATURAL RECOVERY OF PCB CONTAMINATION AT THE SANGAMO-WESTON/TWELVEMILE CREEK/LAKE HARTWELL SUPERFUND SITE

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Introduction

Previous natural recovery studies conducted by the United States Environmental Protection Agency (EPA) and Battelle have focused on the characterization of polychlorinated biphenyls (PCBs) in deposited sediments in Lake Hartwell, SC (Battelle, 2002; Magar et al., 2002). The goal of this study was to combine information on natural recovery processes responsible for the recovery of PCB-contaminated sediments with data from fish and invertebrate studies at Lake Hartwell. The previous sediment studies showed that natural capping of contaminated sediments with progressively cleaner sediments over time resulted in gradual surface sediment recovery, from peak concentrations of approximately 40 mg/kg to concentrations below the 1 mg/kg total PCB (t-PCB) cleanup goal. Reductive dechlorination activity resulted in the transformation of higher-chlorinated PCB congeners (congeners with 4 or more chlorines) to *ortho*-saturated mono-, di-, and trichlorobiphenyl congeners with sediment depth and time. This paper compares the fish and invertebrate PCB concentrations to surface sediment concentrations in Twelvemile Creek and upstream portions of Lake Hartwell. Excerpts of this paper were also presented by Ickes et al. (2003) at the 2003 *In Situ and On-Site Bioremediation Symposium*, Orlando, Florida.

This study compares the results of the Lake Hartwell sediment Natural Recovery studies (Magar et al., 2002) with fish and invertebrate data collected by EPA Region 4 under their annual monitoring program, to examine the extent to which surface sediment recovery has measurably impacted the recovery of fish in the lake.

Site Description

The 730-acre Sangamo Weston/Twelvemile Creek/Lake Hartwell site is located in Pickens County, SC (EPA, 1994). The Sangamo-Weston plant was used for capacitor manufacturing from approximately 1955 to 1978. The plant used a variety of dielectric fluids in its manufacturing processes, including ones containing PCBs. Waste disposal practices included land burial of off-specification capacitors and wastewater treatment sludge on the plant site and at six satellite disposal areas. PCBs were released into Town Creek, a tributary of Twelvemile Creek, which is a major tributary of Lake Hartwell, between 1955 and 1977 (EPA, 1994).

Materials and Methods

Surface sediment and water samples were collected at six locations. Sampling locations corresponded with former *Corbicula* clam sample locations previously deployed by the EPA Region 4 (RMT Inc., 1999). Two surface sediment samples were collected from each of the C-0, C-1, C-2, C-3, C-4, C-5, and C-6 locations and labeled with the sample location and A or B for consecutive samples.

Fish and *Corbicula* clam sampling were conducted by EPA Region 4 between 1995 and 2002, according to procedures described in the EPA Final Record of Decision (ROD) (EPA, 1994). Fish samples were collected at six locations; only two locations, SV-106 and SV-107, are discussed in this paper, due to their proximity to sediment coring locations. SV-107 is located just downstream from EPA Region 4's Transect L, discussed in previous studies (Battelle, 2002). SV-106 is further downstream from Battelle's previous sampling locations, but is discussed in this paper as a comparison to location SV-107. Game fish (i.e., hybrid bass, largemouth bass, and channel catfish) were prepared for analyses in accordance with the standard FDA fillet method and were analyzed by EPA SW-846 Method 8082 PCBs Aroclor method. *Corbicula* clams were placed in baskets for 28 days, then were removed and analyzed for PCBs using EPA SW-846 Method 8082.

Results and Discussion

Surface sediments were collected and analyzed for PCB concentrations at seven locations (C-0 through C-6) (Figure 1); multiple sediment samples were taken from 0- to 30- cm depth at locations C-3 and C-6. Total-PCB (t-PCB) concentrations were determined as the sum of 107 PCB congeners.

Figure 1 includes t-PCB data for surface sediment, water, and tissue samples. Three of the surface sediment sample locations were collected upstream from the Sangamo-Weston Plant and represent background samples (C-0, C-2, and C-4). All of the samples from these three locations had low PCB concentrations ranging from below detection to 12.5 μg/kg. All three of these locations had correspondingly low *Corbicula* PCB concentrations of <0.05 mg/kg (Schlumberger, 2002).

Two samples collected at C-1, located directly downstream from the former Sangamo-Weston plant, had the highest PCB concentrations of the surface sediment samples. These were the only surface sediment samples with concentrations exceeding the 1 mg/kg target clean-up concentration. Moving downstream from the Sangamo-Weston plant, the sediment t-PCB concentration decreased at C-3, then increased again at C-5; the reason for the apparent increase in concentration between Stations C-3 and C-5 is unclear but likely reflects heterogeneity in sediment PCB concentrations. Core samples of sandy sediments collected at C-3 also had low sediment t-PCB concentrations at deeper depths.

The surface sediment samples collected furthest downstream, before Lake Hartwell, were collected in Twelvemile Creek at Highway 337 (Maw Bridge). The two surface sediment samples collected at this location, C-6A and C-6B, had t-PCB concentrations of 3.84 and 147 μg/kg, respectively. Samples at C-6 also were collected at 5 – 12 cm (442 μg/L), 20 – 27 cm (11 μg/kg), and 40 – 52 cm (73 μg/L). The potential for sediment mixing within Town Creek and Twelvemile Creek would suggest that the t-PCB concentration profile is not necessarily reflective of typical vertical concentration gradients in the creek, but rather indicates that the sediments are contaminated at low levels throughout the beds.

The C-1 *Corbicula* clam samples also had the highest t-PCB concentration (2.52 mg/kg) of the seven caged *Corbicula* deployments (Schlumberger, 2002). The *Corbicula* samples collected at C-3, C-5, and C-6 had t-PCB concentrations of 0.973, 0.758, and 1.27 mg/kg, respectively (Schlumberger, 2002). It is unclear why the C-5 clam concentration was lowest, when it had among the highest sediment concentration. The clam concentrations may not be directly correlated with sediment concentrations at the low-concentration range in the river sediments; also, the clam deployments and sediment samples were not collected at the same time period.

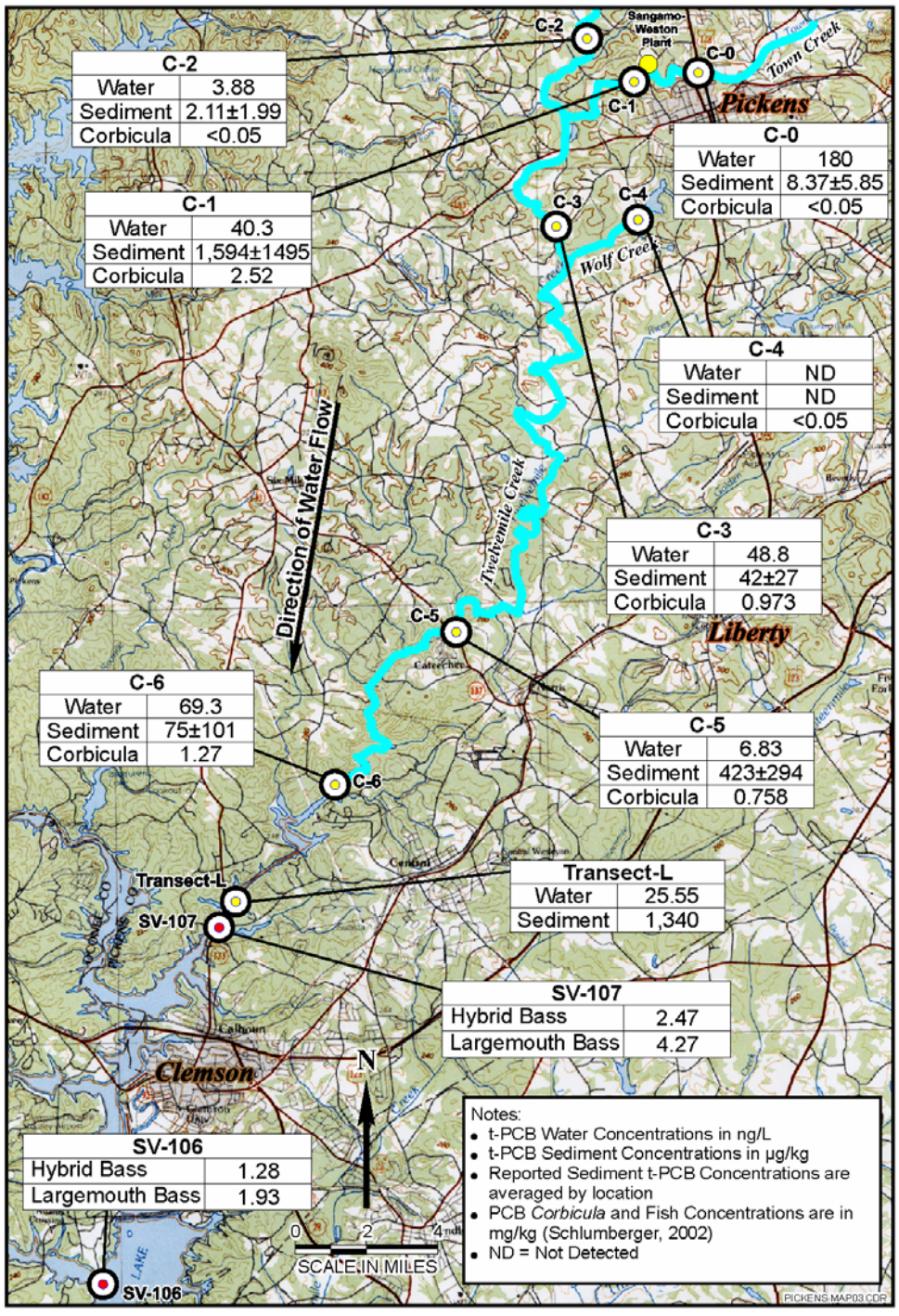

Figure 1. Sangamo-Weston/Lake Hartwell/Twelvemile Creek superfund site map showing sample locations and t-PCB concentrations.

Largemouth Bass and Hybrid Bass were collected by the State since 1992, for determination of 5-PCB concentrations. Sample location SV-107, located close to *Corbicula* clam sample location C-6, and location SV-106, located in Lake Hartwell, historically had average t-PCB concentrations above the FDA tolerance level of 2 mg/kg. Sediment core samples collected by Battelle in 2000 and 2001 at Transect L, in the vicinity of Stations SV-107, saw reduced surface sediment concentrations from approximately 40 mg/kg (30-35 cm depth) to between 1 and 2 mg/kg surface sediment concentrations (Battelle, 2002). The average fish concentrations at both Stations SV-106 and SV-107 did not exhibit corresponding concentration decreases. However, this may be due to variations in fish age (and size), sex, time year for fish catches.

Conclusions

Surface sediment samples taken from Twelvemile Creek generally have low t-PCB concentrations. The *Corbicula* clam t-PCB concentrations appear to generally correspond to the surface sediment t-PCB concentrations with the lowest t-PCB levels at locations C-0, C-2, and C-4 and the highest concentrations at C-1.

Despite the reduction in surface sediment concentrations over time, from ~20-40 mg/kg in buried sediments to ~1-5 mg/kg in surface sediments (data not shown, but reported in Magar et al., 2002), fish collected from Twelvemile Creek and Lake Hartwell continued to have t-PCB concentrations above the FDA tolerance level of 2 mg/kg, and also showed no apparent decreasing concentration trends. Whether the forage fish are impacted solely, or primarily, from surface sediment concentrations, upward advection or diffusion from buried contaminated sediments, or influx of PCBs from an upgradient, cannot be deciphered from the data. Further research is being conducted to elucidate these parameters and their potential impact on forage fish PCB concentrations, and to collect smaller fish that may better reflect reduced surface sediment PCB concentrations over time.

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