PCBs in Fish Tissues at the Hudson River PCBs Superfund Site:

Results of Remedial Action and Early Post-Construction Monitoring

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Summary and Background

Long term monitoring of PCBs in fish from the Hudson River since the 1970s is important for understanding the status of risks to humans and wildlife that may consume contaminated fish and establishing a useful database for future remedy effectiveness evaluations. Overall, results obtained on the Hudson River PCB Superfund Site since 2009 generally indicate that fish tissue PCB levels decreased following increases due to dredging activities, but the magnitude and timing of dredging-related impacts vary across stations, river sections (RS1,2,3), and species. Risk from fish consumption by humans and/or wildlife was a key decision driver for the remedy selected in the 2002 Record of Decision (ROD). Since 2003, the monitoring of PCBs in Hudson River fish included sampling designs to provide statistical power capable of addressing both short- and long-term needs, specifically the evaluation of:

- annual (short term) changes in order to establish long-term trends;
- remedy effectiveness, considering NYSDEC Fish Consumption advisories; and
- risk reduction during the monitored natural attenuation (MNA) period after dredging.

Since 2003, fish have been collected annually each spring and fall throughout the pre-dredging Baseline Monitoring Program (BMP; 2004-2008), Remedial Action Monitoring Program (RAMP; 2009-2015), and post-remedy Operation, Maintenance and Monitoring period (OM&M). The OM&M will continue into the foreseeable future. Hudson River fish monitoring stations are located on both the Upper (freshwater) and Lower (tidal and brackish/saline) river segments.

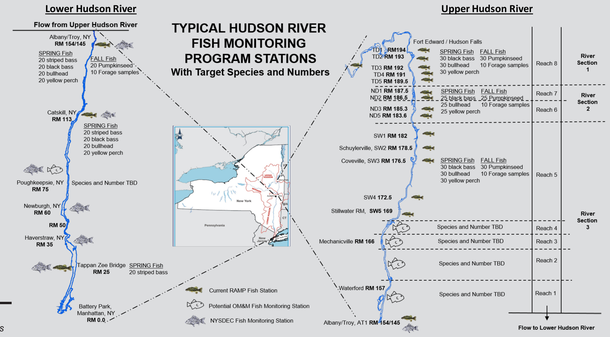

Figure 1

Typical Lower (left) and Upper (right) Hudson River Fish Monitoring Stations with River Miles

Results and Discussion

The potential effects of episodic dredging on fish lipid-normalized PCB (LPCB) concentrations in the Upper Hudson River were evaluated by comparing the BMP average concentrations with the results from samples collected in species annually under the RAMP from multiple stations that were dredged between 2009 and 2015. Upper Hudson fish tissue PCB concentrations have approached or fallen below pre-dredging levels (see Table 1, 2017 v 2008) and are exhibiting relatively consistent recovery trends (Figure 3). The 2002 ROD anticipated temporary and localized fish-tissue PCB increases due to dredging. EPA continues to anticipate that dredging-related, localized body burden increases of PCBs in fish will return to baseline levels, and will continue to decline post-construction. Modeling scenarios were generated to compare the results of different remedial approaches under simulated conditions in support of remedy selection for the 2002 ROD. EPA did not suggest that the exact results of the model runs would, in fact, be realized when the dredging was completed. However, EPA did expect that modeling results would be approximated in nature when monitoring data are viewed over a longer time frame.

Table 1

Upper Hudson River Total Aroclor PCB [mg/kg] Fish Species and River Section (RS) / Reach Weighted Averages 2004-2017.

Monitoring Period	Year	Upper River Average[1]	River Section 1	River Section 2		River Section 3[2]
			Reach 8	Reach 7	Reach 6	Reach 5
Baseline (Pre-Dredging) Monitoring Period (BMP)	2004	2.5	5.1	4.7	3.5	1.7
	2005	2.6	2.7	5.5	3.2	2.3
	2006	2.8	3.0	3.0	2.9	2.7
	2007	2.1	2.9	3.4	2.2	1.9
	2008	1.2	1.8	NA[3]	3.0	1.0
Dredging (2009, 2011-2015) Remedial Action Monitoring Program (RAMP)	2009	1.5	1.9	2.9	2.1	1.2
	2010[4]	1.8	3.4	2.5	1.8	1.4
	2011	1.6	1.9	2.9	2.2	1.4
	2012	2.8	3.7	6.7	2.6	2.3
	2013	2.1	3.1	3.1	3.4	1.7
	2014	2.7	2.9	4.2	3.6	2.5
	2015	1.4	2.1	2.1	1.9	1.1
O&M Monitoring (on-going)	2016	1.4	1.5	2.2	1.7	1.3
	2017	1.2	1.2	2.3	1.5	1.1

NOTES:
1. Reach and River Section fish tissue PCB concentrations are weighted by species. Black bass = 47%, bullhead = 44%, yellow perch = 9%.
2. Upper Hudson River average is weighted by both species and river reach length. River Reach 8: = 6.3 miles (15.4%); River Reach 7 = 2.2 miles (5.4%); River Reach 6 = 2.9 miles (7.1%); and River Reach 5 = 29.5 miles (72.1%). There are not currently fish sampling locations in river reaches 4-1. Reach 5/River Section 3 is weighted to reflect all 29.5 miles of River Section 3, while the fish monitoring stations representing River Section 3 are all located in Reach 5, which is 14 miles long.
3. Fish data were not available for Reach 7 in 2008.
4. Dredging was not performed in 2010 so that a planned peer-review of the project could be convened for the purpose of refining the selected remedy

NYSDEC Standard Fillet Approach Not Used 2007-2013

While the levels of PCBs in Upper Hudson River fish since 2015 have generally exhibited recovery toward pre-dredging levels (Table 1 and Figure 2), sport and forage fish tissue concentrations appear to indicate varying responses to proximal dredging activities within and between river sections. Most species-station combinations indicate responses to dredging (2009-2015); and data from the immediate post-dredging period (2016-2017) show variable trends. Thus, while River Section or reach-scale data (Table 1) may indicate gross recovery, some populations may still be recovering from ROD-anticipated temporary and localized increases due to dredging. Continued monitoring is needed to demonstrate statistically that fish tissue concentrations have fallen below pre-dredging levels and when they have attained interim project target concentrations.

Figure 2

Hudson River black bass (RS1; Reach 8) and pumpkinseed (RS2; Reaches 7 & 8) tissue responses to dredging

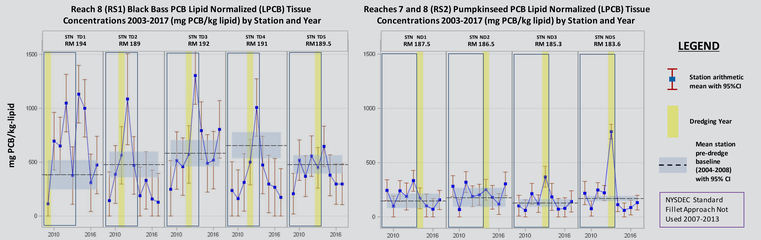

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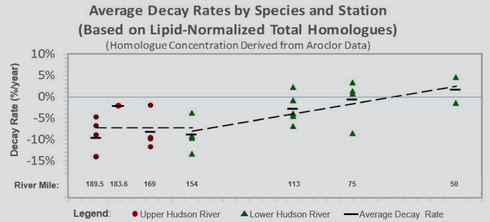
Figure 3

Fish Tissue Recovery Rates as a Function of River Mile Stations with 8+ years of Data and at Least 100 Samples for Upper Hudson (RM200-154) and Lower Hudson (Rm154-RM20) River

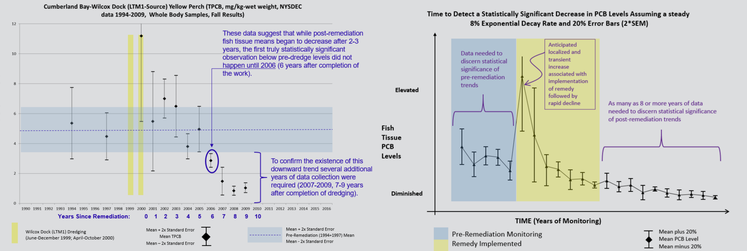


In general, Lower Hudson River fish recovery trends do not reflect Upper Hudson River results (Figure 3). Upper Hudson (River Miles 194-154) fish tissue levels exhibit varying recovery rates (Avg. decay rates 5% to 10% per year). Lower Hudson fish tissue levels south of River Mile 120 are recovering more slowly and the rates of decay diminish with increasing distance from Upper River dredging areas. These differentially variable trends are one of the reasons for the on-going monitoring and additional data collection to be performed under the supplemental monitoring of the Lower Hudson River. Variability in fish tissue contaminant levels is not unique to the Hudson River PCBs Superfund Site.

Similar responses following environmental dredging have been observed at another PCB site (Cumberland Bay/Wilcox Dock) in Plattsburgh, NY (Figure 4, left panel). These data show that while fish tissue levels decreased in the 5 years following remediation, they also exhibited significant variability and required 6 years to statistically fall below pre-remediation levels at this site. Figure 4 (right panel) also illustrates conceptually the time it may require a fish population recovering at 8% (with +/- 20% variability) to fall below initial levels. This figure, adapted from an analysis presented in Greenberg et al (2005), suggests that populations exhibiting lesser recovery rates or greater variability will need even more annual monitoring data cycles to demonstrate recovery to concentrations below pre-remediation levels.

Figure 4

Fish tissue PCB data from the NYSDEC Wilcox Dock Remediation Site (left panel) and a conceptual representation (right panel) of the years of monitoring data needed to discern data trends.



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AECOM. 2012. Cumberland Bay Sludge Bed – Wilcox Dock Site # 5-10-017 Removal and Disposal Project Pre-to Post-Dredging Monitoring (Volume I of II) Ten Year Review. Prepared by AECOM, 40 British-American Blvd, Latham, NY. Prepared for NY State Department of Environmental Conservation. June 2012.

Conclusions and Lessons Learned

EPA continues to anticipate that dredging-related, localized body burden increases of PCBs in fish will return to baseline levels, and will continue to decline post-construction. While available data from the Upper River project area suggest trends toward pre-dredging levels and interim project target concentrations, only 2 years of post-dredging data have been collected and evaluated. Data from another PCB site suggest that 2 years may not be a long enough period to discern post-dredging trends. In addition, Lower Hudson fish tissue concentrations further downstream from the location of dredging activities are exhibiting differential responses. It is too early to determine the rates at which fish tissue PCB concentrations are declining in the post-construction period as a result of the combined effects of upstream source control and the benefits of remedy implementation. EPA anticipates that it will take as many as eight or more years of data to identify fish-tissue trends with a reasonable degree of scientific certainty.