

Recommendations on the Use of Available Data to Evaluate Remedy Effectiveness

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Recommendations for Using Available Data to Evaluate Expected Recovery Prior to Dredging

Two Approaches:

- Compare PCB concentrations in sediment, water and fish to expected concentrations prior to dredging
- Compare rates of recovery in sediment, water and fish during Monitored Natural Attenuation (MNA) and source control period (EPA August 17 presentation focused on this approach)

Outline of Presentation

- Available data and issues for consideration
- Compare data collected prior to dredging to model-predicted concentrations
- Evaluate rate of recovery compared to model predictions
- Potential implications and recommendations

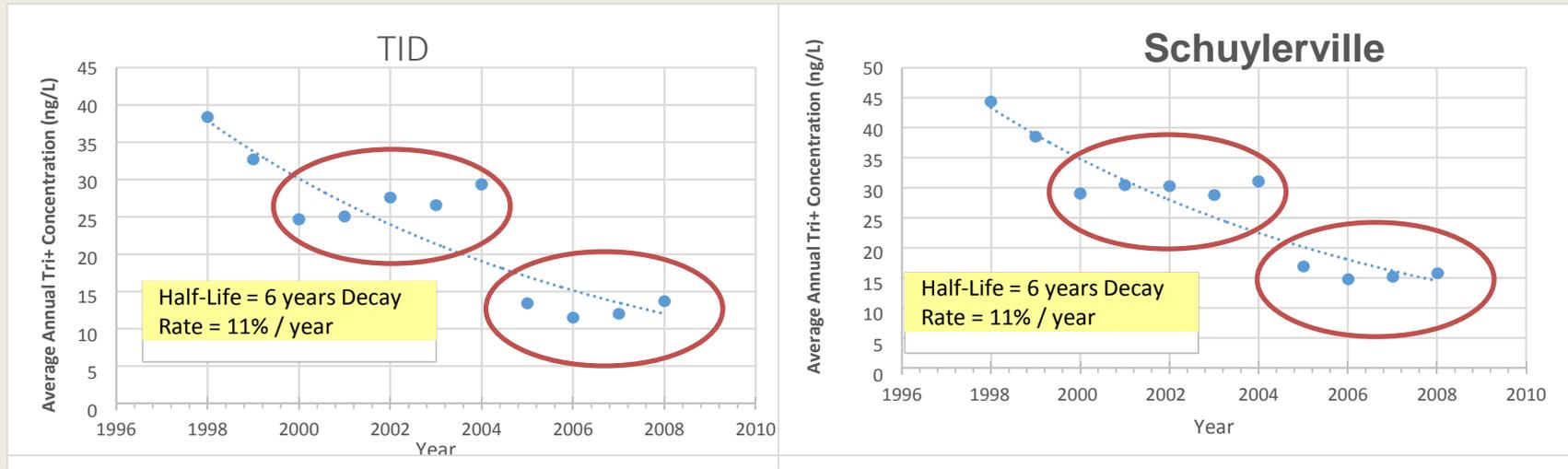
Data Considerations

- MNA period includes major source control
 - Are rates of recovery influenced by source control during the pre-dredge MNA period?
- PCBs in fish fillets biased low to unquantified degree
 - Some uncertainty in year when fillet protocol changed
 - What is the impact of the change in fillet protocol after 2006 on fish fillet PCB concentrations and estimated rate of recovery?
- All analyses shown in this presentation use data at reported value (no homologue adjustment)

“MNA” Period Includes Source Control

- Models incorporated >6-fold reduction in PCB load into Thompson Island Pool between 1998 and 2005
 - EPA Responsiveness Summary: “The upstream source control is characterized in the HUDTOX model by assuming an upstream boundary water column Tri+ PCB load of 0.16 kg/day from 1998 through 2004, followed by a step-down reduction to 0.0256 kg/day on January 1, 2005.”

Water Column Forecasts (Model Output, yr 2000)



Water model forecast for Thompson Island Dam and Schuylerville during source control upstream of Thompson Island Pool between 1998 and 2005.

Regression line spans major source control period in model forecast.

Using Fish Monitoring Data to Evaluate Model Predictions

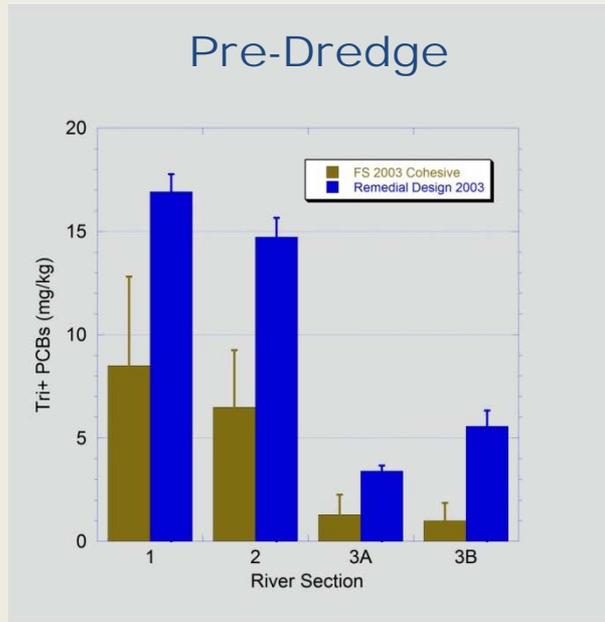
- Post-2006?, fish fillet data collected by GE was biased low due to GE's change in fish processing protocol from "NYS STD (with rib)" to "rib-off"
- Based on a 2014 study of black bass, EPA concluded that lipid-normalized "NYS STD" and "rib-off" for black bass are comparable for evaluating long term trends.
- The degree of low bias for fillets of other fish species (e.g., white perch, yellow perch, brown bullhead, striped bass, channel catfish) is unknown.
- Including post-2006 data can contribute to increased apparent rates of recovery.
- We recommend not using the post-2006 biased low data for trend analysis

PCBs in Post-2006 GE Fish Fillets Biased Low

- EPA preliminary report used 2 approaches to compare rib-in to rib-out fillets in Black Bass
- Regression Approach:
 - “The TPCB regression suggests an approx. 16% bias (16% more TPCB in NYS STD fillets) with a range of 11-21%.”
 - “The LPCB regression suggests an approx. 8% bias (8% more LPCB in NYS STD fillets) with a range of 6-10%.”
- PCB Ratio Approach:
 - TPCB (wet weight) ~ 75% higher PCB concentration for NYS STD fillets
 - Comparable LPCB ratio is ~22% higher with range of 13-31%
 - ~40% of the rib-on fillets were > 20% higher; ~20% were >=40% higher.

Results are inconsistent with EPA’s conclusion “that the lipid normalized data from this period are comparable for evaluation of long term trends.”

Surface Sediment PCBs: Model vs Measured in 2003



Section average Tri+ PCBs (ppm) in surface sediments from the SSAP data exceeded the mean by a factor of 2-3 and the upper bound of model predictions

Olive Green Bar: Model Section average and upper bound for cohesive sediments

Blue Bar: SSAP Remedial Design data

Surface sediment represents top 4 cm for model and top 2 inches (5 cm) for remedial design data. River sections 2 & 3 represent cohesive sediments only.

PCB Loads to LHR Higher than Predicted Prior to Dredging

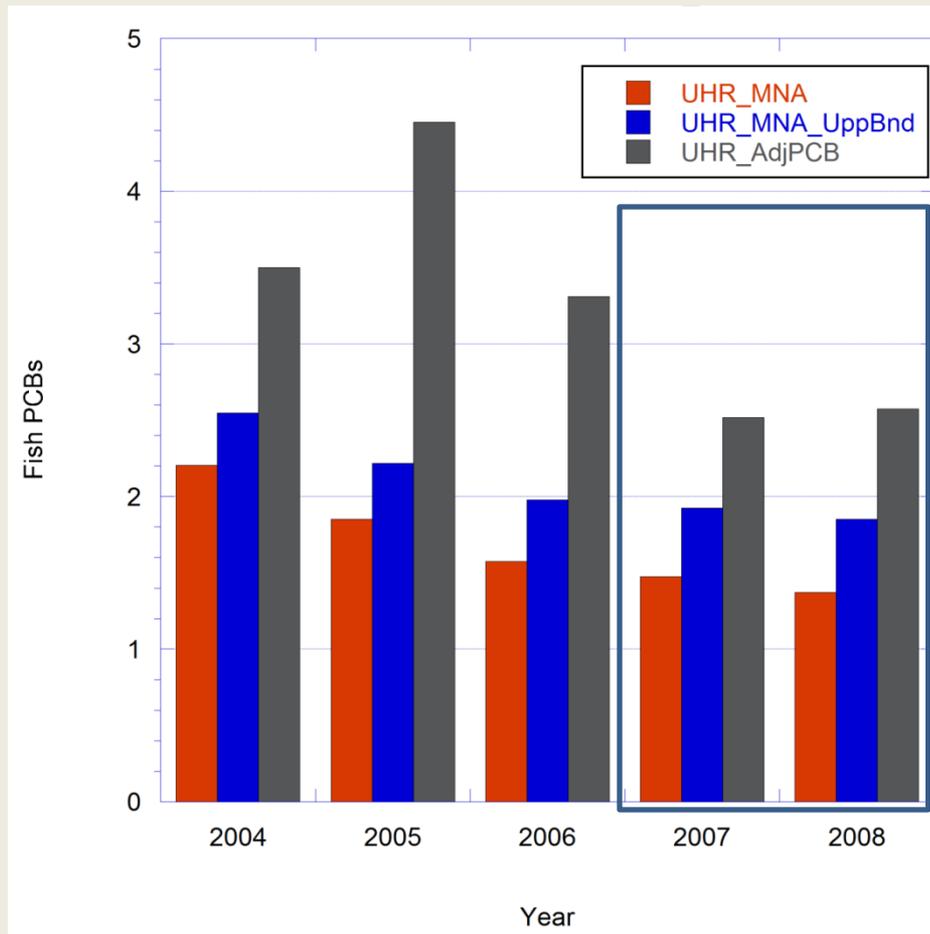
- PCB loads from the upper to the lower river were 3-fold higher than expected prior to the start of dredging and showed little evidence of decline (EPA March 2010; Hydroqual 2010).

USEPA, 2010. Hudson River PCBs Site EPA Phase 1 Evaluation Report, Prepared for: US Environmental Protection Agency, Region 2 and US Army Corps of Engineers, Kansas City District, Prepared by: The Louis Berger Group, Inc., March 2010.

Hydroqual 2010. Evaluation of PCB Concentrations Measured in the Hudson River near Waterford, New York. May 31, 2010, U Appendix A-9. Reports from additional Modeling exercises utilizing the CARP models

UHR Fish: Model vs Data

Model projections of Species-weighted and Section-weighted average and upper bound PCBs (ppm) compared to data from 2004-2008



Total PCBs in fish (2004-2006)
~ 2x higher than model
predicted

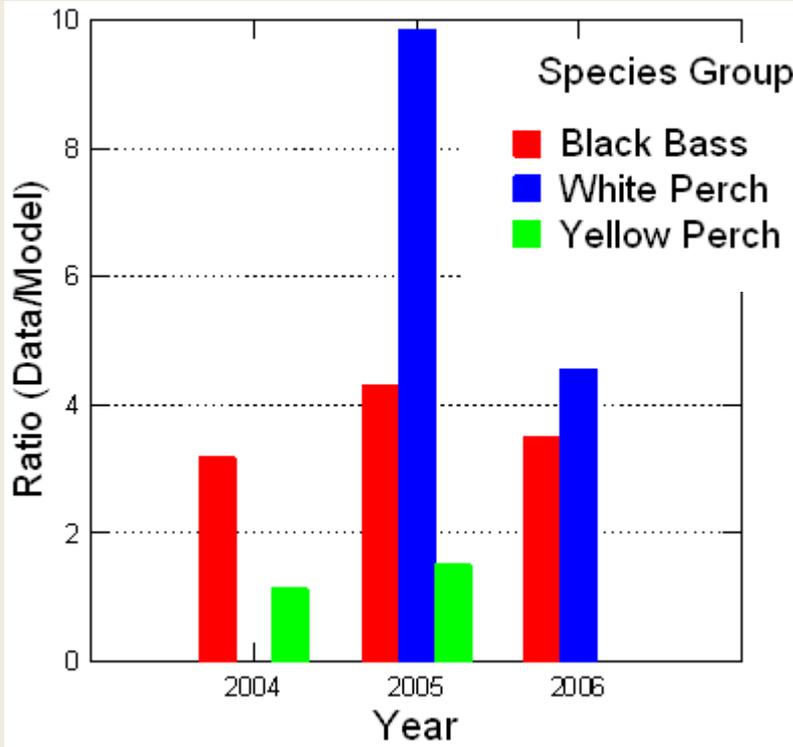
Total PCBs in 2007-2008 fish
have unquantified low bias,
but also higher than model
predicted PCBs

NOTE: PCB concentrations
adjusted for lipid content used
in EPA FISHRAND model

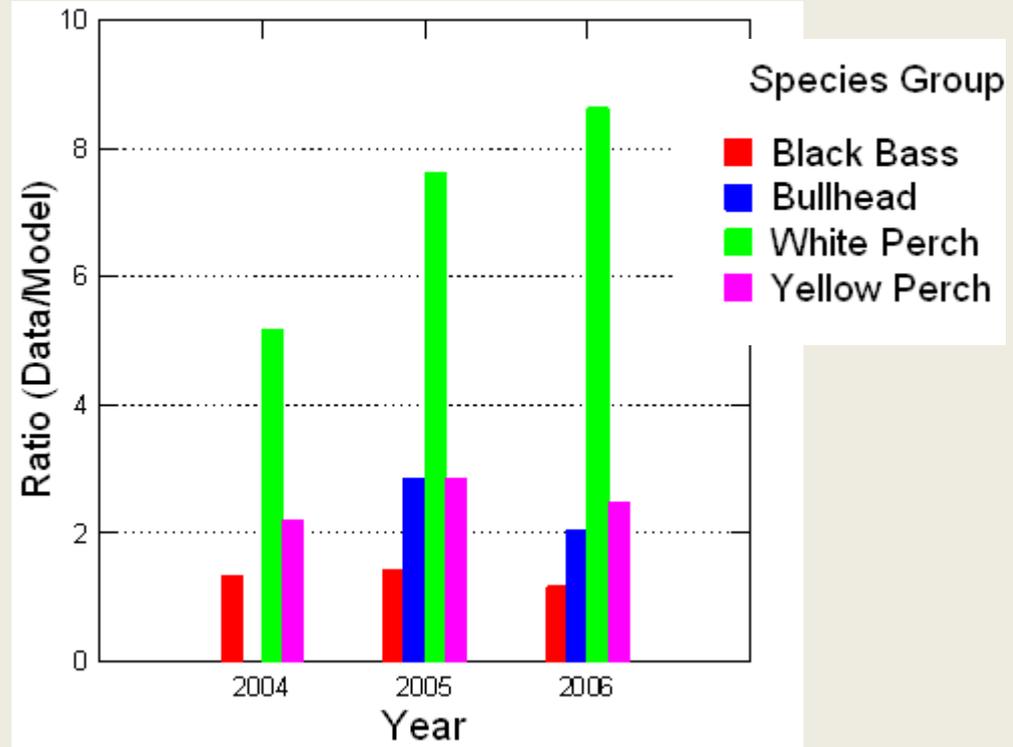
LHR Fish Prior to Dredging

Ratio of Measured PCBs to Model Predictions

Albany/Troy



Catskill



LHR fish PCBs > 2x model predictions

Ratio (Data/Modeled) < 1 Measured PCBs less than model predictions

Ratio (Data/Modeled) > 1 Measured PCBs greater than model predictions 12

Estimates of Rate of Recovery (Decay Rate)

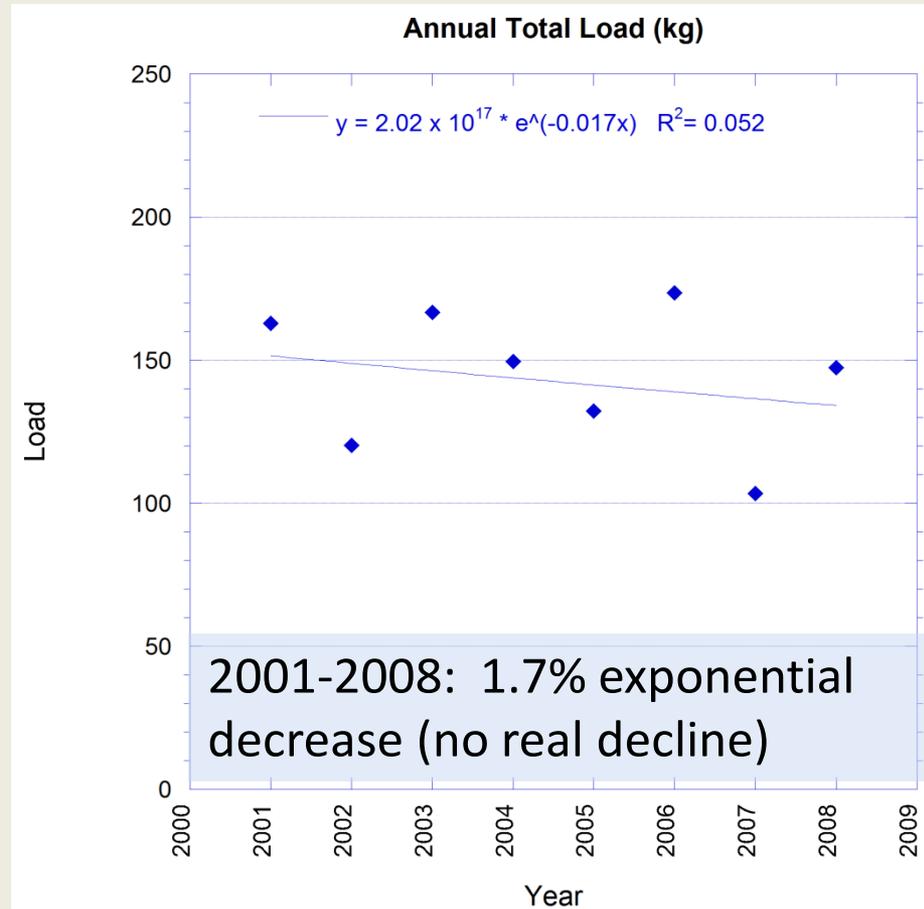
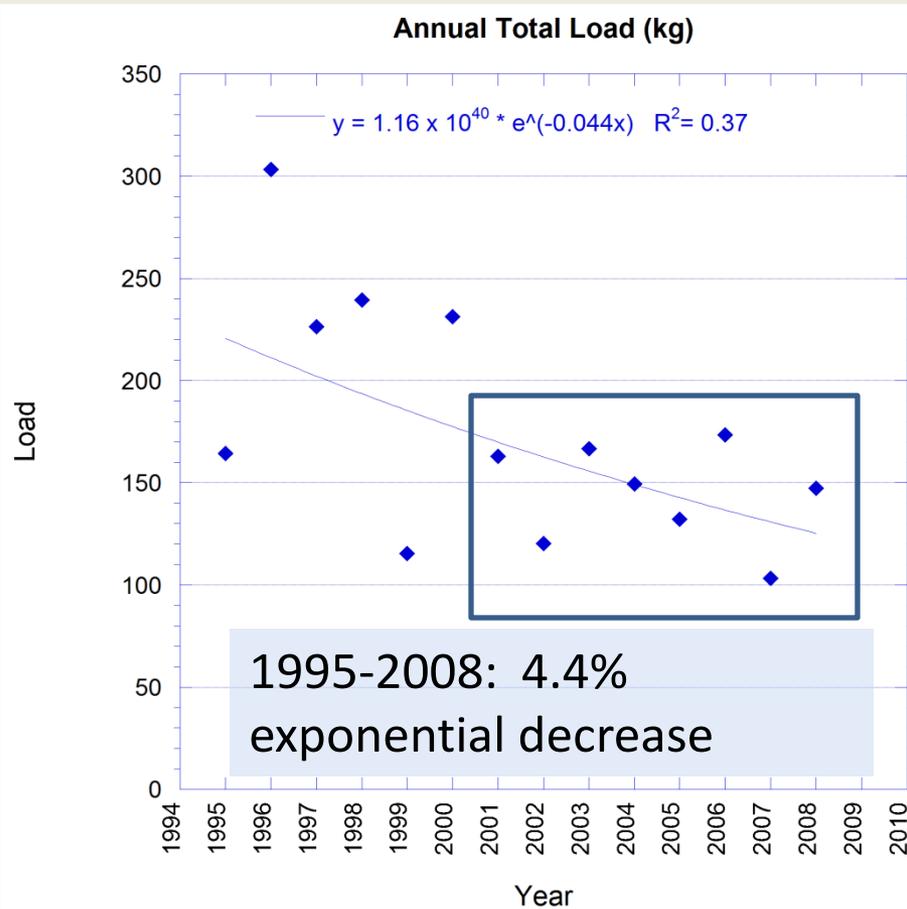
- Surface sediment concentrations from SSAP (~2003) compared to GE 1991 transect survey (only available pre-dredging surface sediment data for RS2 & RS3)
- PCB load to LHR during MNA and source control period
- Fish PCBs in UHR and LHR for primary species and key long-term monitoring stations (part of baseline monitoring plan) between 1997 or 1998 and 2006

Estimated Pre-Dredge Decay Rate in Surface Sediment

Model Subsection	GE 1991 (ppm)	SSAP 2003 (ppm)	Calculated Exponential Decay Rate
1	20	16.9	1.4%
2	18	15.7	1.7%
3A	4.3	3.4	2.0%
3B	5.7	5.6	0.1%
Average			1.3%
95% CI			-0.1% – 2.6%

Rate of sediment recovery much slower than 7-9% in modeling projections

Measured PCB Load to LHR (MNA) 1995-2008 and 2001-2008 (NOAA Analysis of Load data provided by EPA)



Note: MNA predicted load in 2008 was ~50 kg

Pre-Dredge Fish Recovery Rate (1997/8-2006)

Station	Species Group	1997_2006	1998_2006	Average Decay Rate	Station Average
Thompson Island Pool	Black Bass	-0.101	-0.120	11.0%	7%
	Bullhead	-0.045	-0.058	5.1%	
	Yellow Perch	-0.133	-0.150	14.1%	
	Pumpkinseed (age 1+)	0.048	0.034	-4.1%	
Stillwater	Black Bass	-0.044	-0.075	6.0%	6%
	Bullhead	-0.056	-0.114	8.5%	
	Yellow Perch	-0.019	-0.044	3.2%	
	Pumpkinseed (age 1+)	-0.059	-0.083	7.1%	
Albany/Troy	Black Bass	-0.047	-0.046	4.6%	4%
	White Perch	-0.038	-0.018	2.8%	
	Yellow Perch	-0.041	-0.040	4.0%	
Catskill	Black Bass	-0.081	-0.109	9.5%	3%
	Bullhead	-0.043	-0.043	4.3%	
	White Perch	0.056	0.041	-4.9%	
	Yellow Perch	-0.013	-0.013	1.3%	
	Pumpkinseed (age 1+)	-0.037	-0.037	3.7%	
Poughkeepsie	Black Bass	-0.067	-0.067	6.7%	3%
	Bullhead	-0.015	-0.015	1.5%	
	White Perch	-0.007	-0.007	0.7%	
	Yellow Perch	-0.012	-0.012	1.2%	
	Pumpkinseed (age 1+)	-0.056	-0.056	5.6%	

Decay rate may differ with interval selected

UHR data show highly variable decay rates

LHR decay rates mostly <5%

Decay Rate	Color Coding
>8%	Red
4-8%	Blue
<4%	Green

Negative decay rate indicates no change or increase in PCBs

Summary: Pre-Dredging PCB Concentrations and Rate of Recovery

- Model-Data Comparisons

- Surface Sediment PCBs ~2-3x higher than predicted
- PCB Load to LHR in 2008 ~3x higher than predicted
- UHR Fish PCBs ~2x higher than predicted
- LHR Fish PCBs >2x higher than predicted

- Rate of Recovery

- Estimated pre-dredge sediment rate of recovery < 3%
- Pre-dredging PCB load to LHR shows little evidence of decline between 2001 and 2008 (post major source control)
- UHR fish highly variable with many species/locations < 8% (6-7% station averages)
- LHR fish mostly < 5% (3-4% station averages)

Why PCB Concentration in Sediment & Fish are the Most Relevant Metrics

- ROD used the number of years to reach human health and ecological risk concentration based thresholds in comparison of remedial alternatives as a basis for selection of the remedy.
- Higher than expected post-dredging surface sediment concentrations over model predictions likely extends time to reach risk thresholds in fish PCBs.
- Time to recovery is determined by both the magnitude of the post-dredging sediment concentration and the rate of recovery.
- Given higher-than-expected pre- and post-dredging concentrations, a higher percent reduction or longer time is required to achieve the expected concentrations in fish

Additional Information

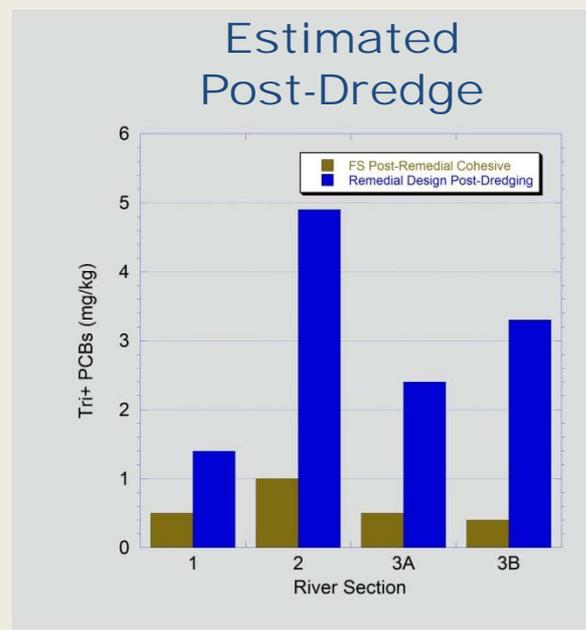
- More PCBs in UHR than the ROD anticipated
 - Mass removed greater than expected
 - Surface sediment post-dredging estimated to be much higher than the models used in the ROD predicted

Mass of PCBs Removed

- Mass of PCBs removed (~65%) was more than 2X the original estimate (150,000 lbs) within the same dredge footprint, which implies that a greater mass of PCBs remain in the river post-dredging than EPA originally expected would be removed by the remedy.
- Some of the underestimate was due to the amount of PCBs found at depth, but PCBs in the surface sediment were also higher, more widespread, and shallower than expected.
- Not reasonable to assume that the increase in mass was confined to within the dredge footprint
- More mass and higher PCBs remaining than expected post-remedy contributes to on-going risk

Surface Sediment PCBs: Model Predicted vs Estimated From SSAP Data

- Estimated post-remediation PCBs for the selected remedy were 3-5X higher than model predictions.
- Differences are greater for River Sections 2 & 3



Olive Green Bar: Model Section average and upper bound for cohesive sediments

Blue Bar: SSAP Remedial Design data

Implications

- ROD expected that the target cleanup levels for RS2 and RS3 would result in post-dredging surface sediment PCBs comparable to RS1
- Estimated post-dredging surface PCBs are ~5X higher than expected in RS2 and RS3 and ~3X higher than expected in RS1
- Using the EPA model projected 8% decay rate (equivalent to a 10 year half-life), achieving expected initial post-dredging sediment concentrations would be delayed by 25 years due to higher post-dredging surface concentrations. A slower rate of recovery would extend considerably the time to recovery.

Recommendations

- Source control is mostly complete and PCB load into the Thompson Island Pool should no longer influence the observed rate of MNA recovery. Going forward, use more realistic rates of recovery for MNA
- Change in fish processing protocol results in unquantified low bias in adult fish PCBs, which makes apparent recovery rates faster: recommend evaluating magnitude of effect in other species (see federal trustee 7/21/16 recommendations)
- Post-remedy concentrations are driven by both recovery rate and initial concentrations: should consider impact of both
- Develop and implement a robust sediment sampling plan to characterize the surface sediment concentrations to provide a strong basis for evaluation and prediction (see federal trustee 2/26/16 recommendations)