EXTENDED ANALYSIS OF PCB CONCENTRATIONS IN FISH AND SEDIMENT: NEW INSIGHTS AND DATA

Prepared by: The Friends of Clean Hudson

Hudson River Sloop Clearwater, Hudson Riverkeeper, Scenic Hudson

June 2024

AN ADDENDUM TO THE REPORT TITLED:

THE FRIENDS OF A CLEAN HUDSON:
AN INDEPENDENT REVIEW OF EPA'S
UPPER HUDSON RIVER PCB DREDGING REMEDY

Hudson River PCBs Superfund Site
Operable Unit 2 (Upper Hudson)

Prepared By:
The Friends of a Clean Hudson
Hudson Fishermen's Association,
Hudson River Sloop Clearwater,
Hudson Riverkeeper, Scenic Hudson,
Sierra Club-Atlantic Chapter
November 2023

TABLE OF CONTENTS

I. Abstract

In 2023, the Friends of a Clean Hudson (FOCH) coalition worked with technical experts to conduct an independent analysis of EPA's Upper Hudson River PCB dredging remedy. The FOCH published their findings and recommendations on November 14, 2023 in a report titled "An Independent Review of EPA's Upper Hudson River PCB Dredging Remedy." Since the November 2023 report was published, the FOCH coalition has continued to work with its technical experts to review and analyze publicly available project data to better understand PCB concentrations in Upper Hudson sediment and fish. The FOCH coalition now expands its November 2023 report with additional analysis of PCB concentrations in fish and sediment.

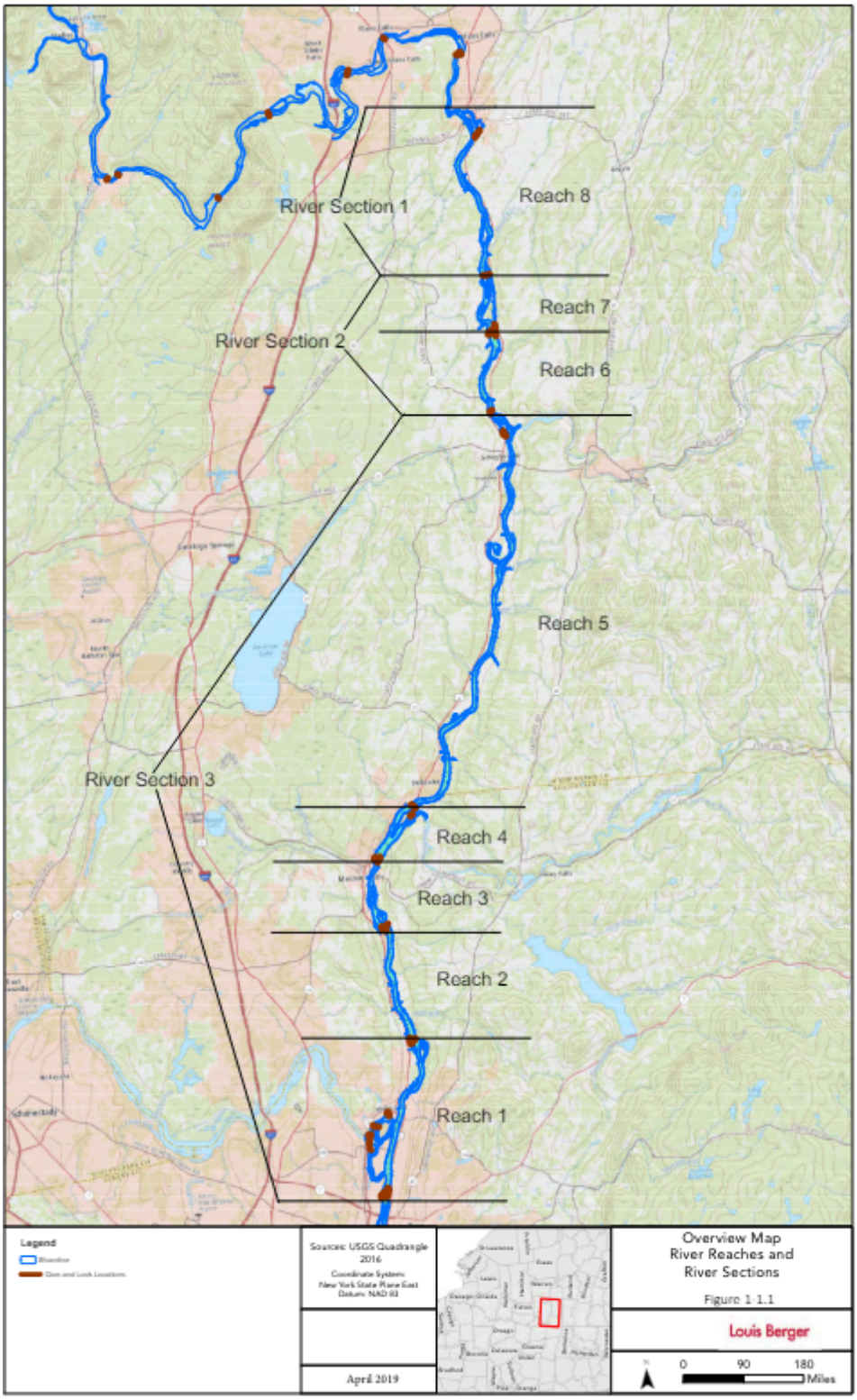
Based on the additional analysis, the conclusions set forth in the November 2023 FOCH report are even more supported: PCB concentrations in Upper Hudson River fish and sediment since dredging ended in 2015 are not decreasing as anticipated by EPA at the time it selected the PCB cleanup remedy 2002. Based on the trends observed, there appears to be little improvement in fish and sediment PCB concentrations after dredging. EPA must take steps to reevaluate the Upper Hudson River cleanup remedy to protect human health and the environment.

II. Hudson River PCBs Superfund Site Background

The Hudson River PCBs Superfund Site (the Site) includes a nearly 200-mile stretch of the Hudson River from the Village of Hudson Falls, NY, to the Battery in New York City. In 2002, the U.S. Environmental Protection Agency (EPA) issued a Record of Decision (ROD) to address the ongoing environmental and human health risks posed by the discharge of millions of pounds of polychlorinated biphenyls (PCBs) by General Electric (GE) from its capacitor production facilities in Hudson Falls and Fort Edward, NY (referred to herein as the 2002 ROD). The cleanup plan selected in the 2002 ROD called for targeted environmental dredging in the Upper Hudson River followed by a period of monitored natural recovery.

The Upper Hudson River includes 40 miles of the river between Hudson Falls, NY and the Federal Dam at Troy. The Upper Hudson River was further divided into three river sections. River Section 1 extends from the former location of the Fort Edward Dam to Thompson Island Dam (approximately 6.3 river miles); River Section 2 extends from the Thompson Island Dam to the Northumberland Dam near Schuylerville (approximately 5.1 river miles); and River Section 3 extends from below the Northumberland Dam to the Federal Dam at Troy (approximately 29.5 river miles). The Upper Hudson River was also divided into eight river reaches or "pools." Each reach represents an isolated ecosphere which could offer potentially different results than those found through aggregating the data by "River Section."

Upper Hudson River Overview Map with River Sections and River Reaches[1]



[1] Louis Berger US, Inc. & Kern Statistical Services, Inc. Hudson River PCBS Superfund Site, Technical Memorandum, Evaluation of 2016 EPA/GE and 2017 NYSDEC Surface Sediment Data (April 2019), https://www.epa.gov/sites/default/files/2019-04/documents/hudson_technical_memorandum_part_1_of_2.pdf

With the completion of dredging in 2015, the cleanup has transitioned from the dredging phase to the monitoring natural recovery phase. During the monitoring phase, EPA will track the long-term recovery of the river over time to determine if the cleanup is functioning as intended. This includes monitoring of sediment, fish, water, and reconstructed habitats.

Under the Superfund law, five-year reviews are required when hazardous substances, pollutants, or contaminants remain at a site that would not allow for unrestricted use. The purpose of the five-year review is to ensure that implemented remedial actions are working as intended and are protective of human health and the environment. Five-year reviews are performed by the EPA following the start of a Superfund response action and are repeated every succeeding five years so long as future uses remain restricted. Even after dredging, PCBs remain in the river at levels that remain unsafe to humans and the environment, restricting the use of the Hudson River.

The first five-year review for the Hudson River PCBs Superfund site was completed in June 2012 while the selected remedy was under construction. At that time EPA determined that the remedy for the in-river sediments of the Upper Hudson River "will be protective of human health and the environment" upon completion of dredging. The Second Five-Year Review report was finalized and released in April 2019. EPA concluded therein that a protectiveness determination of the Upper Hudson River cleanup remedy could not be made until further information was obtained. EPA determined that there was not enough data available to determine if the remedy will be protective within the time frames anticipated in the 2002 ROD, and to assess whether the interim targets identified in the ROD would be reached in the time frames estimated.[2]

EPA initiated its third five-year review in the spring of 2022 and is expected to release its most recent review this summer. Since EPA initiated its third five-year review, the FOCH coalition has been asking EPA to use the best available science and analysis to acknowledge in the upcoming report that the cleanup is "not protective of human health and the environment." The human health and ecological risks are well in excess of EPA's acceptable risk ranges, and based on current trends in fish and sediment PCB levels will not be in the acceptable range for the foreseeable future.

[2] In the 2002 ROD, EPA established two interim remediation targets: 0.2 mg/kg PCBs in fish fillet (which is protective at a fish consumption rate of one half-pound meal per month) and 0.4 mg/kg PCBs in fish fillet (which is protective at a consumption rate of one half-pound meal every two months). EPA projected that for the Upper Hudson River as a whole, a target level of 0.4 mg/kg wet weight could be achieved in about 5 years after completing dredging and after about 16 years for the 0.2 mg/kg wet weight target level.

III. Introduction

In November 2023, the FOCH coalition released a new report titled, "An Independent Review of EPA's Upper Hudson River PCB Remedy," in which available sediment, water, and fish PCB data were evaluated by technical experts to provide EPA and the public with analyses of publicly available data in advance of EPA's third Five-Year Review (FYR) of the Upper Hudson River remedial program (referred to as Operable Unit 2 or OU2).

In the FYR finalized in 2019, EPA stated the following concerning remedy protectiveness:

> A protectiveness determination of the remedy at OU2 cannot be made until further information is obtained. There is not enough data available since the completion of dredging and related project activities in 2015 to determine if the remedy will be protective within the time frame anticipated by the Record of Decision (ROD). There is also not sufficient data available to assess whether the interim targets identified in the ROD will be reached in the time frames estimated at the time the ROD was issued in 2002. A critical factor needed for the protectiveness determination is a reliable calculation of the rate of decline in post-dredging fish tissue PCB levels. It is necessary to examine the annual record over a longer period of time in order to calculate this rate with statistical certainty. EPA estimates that as many as eight or more years of post-dredging fish tissue data are needed. This information will be obtained through the collection and evaluation of fish tissue data along with the water and sediment data collected as part of the long-term monitoring program. Once statistically relevant rates of decline in post-dredging fish tissue PCB levels can be established, EPA will estimate the rates of recovery and determine if they are reasonably consistent with those predicted in the ROD. It is anticipated that this additional information will be obtained with the results of the 2024 fish data. (Emphasis added).

In the November 2023 FOCH report, preliminary evaluations of available sediment and fish PCB data were presented which illustrated how the concentrations of PCBs in these media were higher than EPA expected and were not declining as anticipated by EPA at the time of remedy selection, which means that the time to recovery in the Upper Hudson River will take much longer than EPA projected in the ROD. Further evaluations of fish data (presented below) conducted since November 2023 by the FOCH's technical experts illustrate the need to evaluate the fish PCB data on a "lipid basis," meaning that the amount of lipids (fats) in the sample needs to be taken into account in determining the change (or lack thereof) in fish PCB concentrations over time. The FOCH coalition also conducted a detailed analysis of the PCB concentrations in (a) pumpkinseed, which represent an interim trophic level between sport fish and the primary source of PCB to Upper Hudson fish (and terrestrial piscivores such as mink and kingfisher), and (b) the remaining PCB contaminated sediments in the Upper Hudson. These two analyses, of lipid-based PCBs in fish and PCBs in pumpkinseed, support the conclusion that the remedy is not performing as anticipated and that the appropriate protectiveness determination in the third FYR should be "not protective."

IV. PCB Concentrations in Fish After Dredging

A. Analysis of Fish Data on a Lipid Basis

EPA has developed a composite metric to evaluate sport fish PCB concentrations over time. This metric, a species-weighted and river section-length-weighted average PCB concentration, is used by EPA to represent the changes in PCB concentrations over time.

This composite metric uses black bass, bullhead, and perch, weighted as follows[3]:

Black Bass – 47%; Bullhead – 44%; Perch – 9%

There are three discrete stretches of river from Fort Edward to Thompson Island Dam (River Section 1), Thompson Island Dam to the Northumberland Dam (River Section 2), and from the Northumberland Dam to the Federal Dam at Troy (River Section 3). These river sections are weighted according to their length as follows:

River Section 1 – 15.4%; River Section 2 – 12.5%; River Section 3 – 72.1%

This metric is presented by EPA using the total PCB data from individual fish collected at fourteen locations in the Upper Hudson, averaged by species and river section length using the weighting described above.

While using the total PCB data informs evaluations of potential exposure to humans and wildlife who consume fish from the Upper Hudson, the use of total PCB without accounting for the changes in fish lipid (fat) content can confound evaluations of the changes (or lack thereof) in exposure over time. Apparent declines in fish PCB concentrations using the total PCB data need to be evaluated in the context of changes in lipid content in the fish collected from year to year, as changes in lipid content will cause changes in PCB concentration even though there may not be changes in the amount of PCB exposure to the fish from sediment and water. It is therefore necessary, when evaluating changes in conditions over time, to account for the changes in fish lipid content.

PCBs are lipophilic (tending to accumulate in the fatty portion of the fish), therefore the more lipid in the sample, the more PCB tends to accumulate; less lipids means less PCB accumulation in the fish. Thus, PCB concentrations in fish are highly correlated with lipid content. Fortunately, this has been recognized and lipid content has been included as a key data point in the monitoring program for Upper Hudson fish. EPA has recognized this and used lipid-based PCB concentrations as the basis for the modeling work done to understand the anticipated reductions in PCB concentrations after dredging during the monitored natural recovery phase of the remedy.

Evaluation of fish PCB data on a lipid basis is a straightforward exercise. The total PCB concentrations in fish, typically expressed as milligrams PCB per kilogram of sample (mg/kg, or

[3] U.S. EPA, Phase 2 Report, Further Site Characterization and Analysis, Volume 2F-Revised Human Health Risk Assessment Hudson River PBs Reassessment RI/FS, p. 14. (November 2000), https://www3.epa.gov/hudson/revisedhhra-text.pdf

parts per million) are divided by the percentage of lipid in the sample. The resulting lipid-based PCB concentration is expressed in mg/kg/percent lipid.

The lipid-based PCB concentrations can be evaluated for each species at each location, averaged over river sections, and weighted by species and river section length to present the data over time. In this way, a river section and species weighted average, on a lipid basis, can be evaluated over time to understand the actual changes in PCB concentrations without the confounding factor of changing lipid content in the fish samples.

B. Comparison of Total PCB and Lipid-Based PCB

In the two figures below, the Total PCB and Lipid-Based PCB weighted average concentrations during the period of monitored natural recovery after dredging are presented.

In Figure No. 1, the weighted average total PCB concentrations are presented. While there is an apparent decline in total PCB concentrations, this decline is much less significant than the decline EPA anticipated it would see at the time of remedy selection, and the targeted reductions in PCB concentrations identified in the ROD have not occurred. Specifically, the weighted average PCB concentration was targeted by EPA to achieve a reduction to 0.4 mg/kg five years after dredging was completed. Under that model, the average PCB concentration in fish should have been 0.4 mg/kg by 2020.

In Figure No. 2, the weighted average lipid-based PCB concentrations are presented. Taking into account the changes in fish lipid concentrations, it appears that the apparent decline in fish PCB concentrations observed in the first figure is not due to changes in the exposure of fish to PCBs in water and sediment, but rather due to changes in fish lipid content. In the period since the dredging ended and the remedy entered the monitored natural recovery phase, there have been very limited declines in fish PCB concentrations that are not due to changing lipid content.

FIGURE 1.

Total PCB Concentrations (Weighted Average) in Upper Hudson River Fish

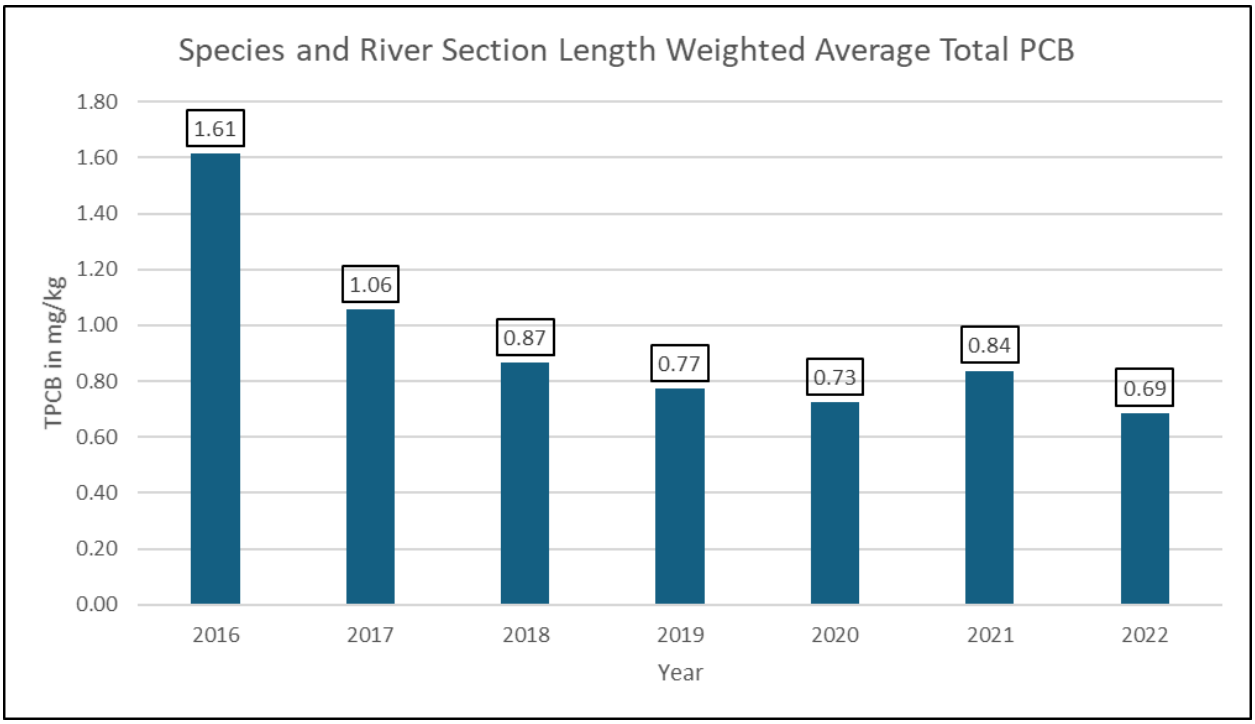
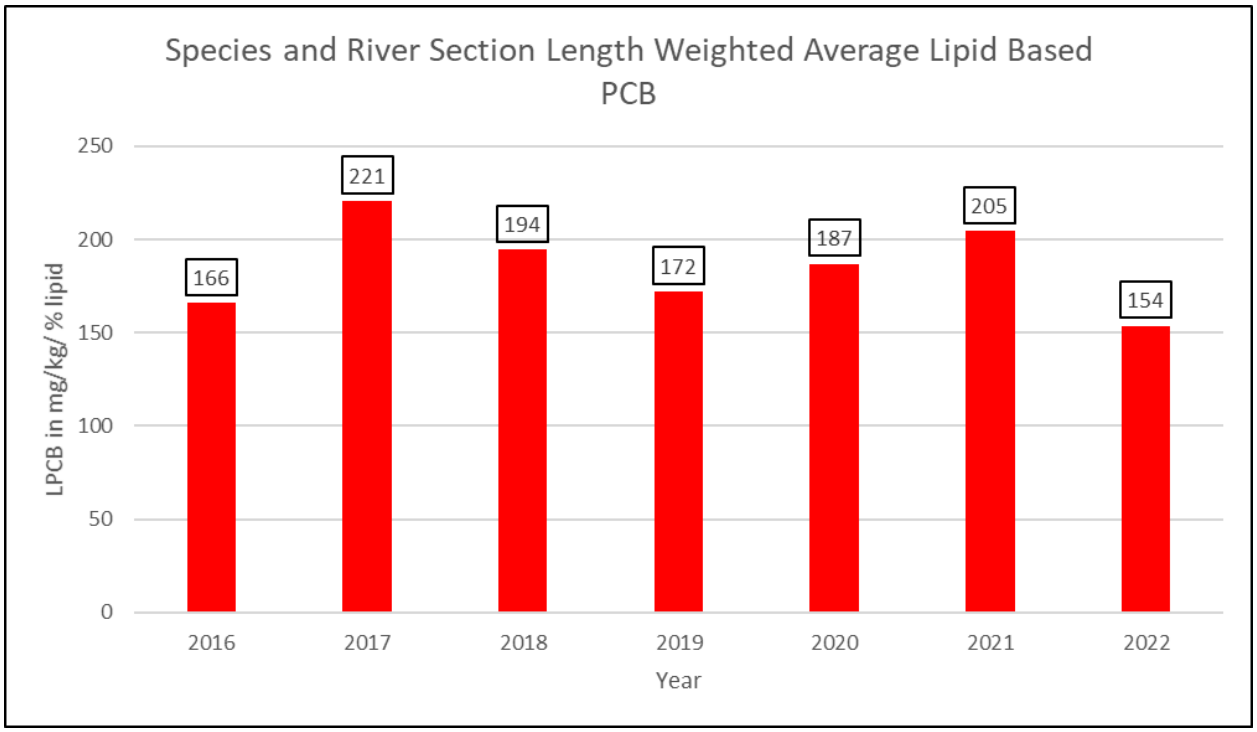


FIGURE 2.

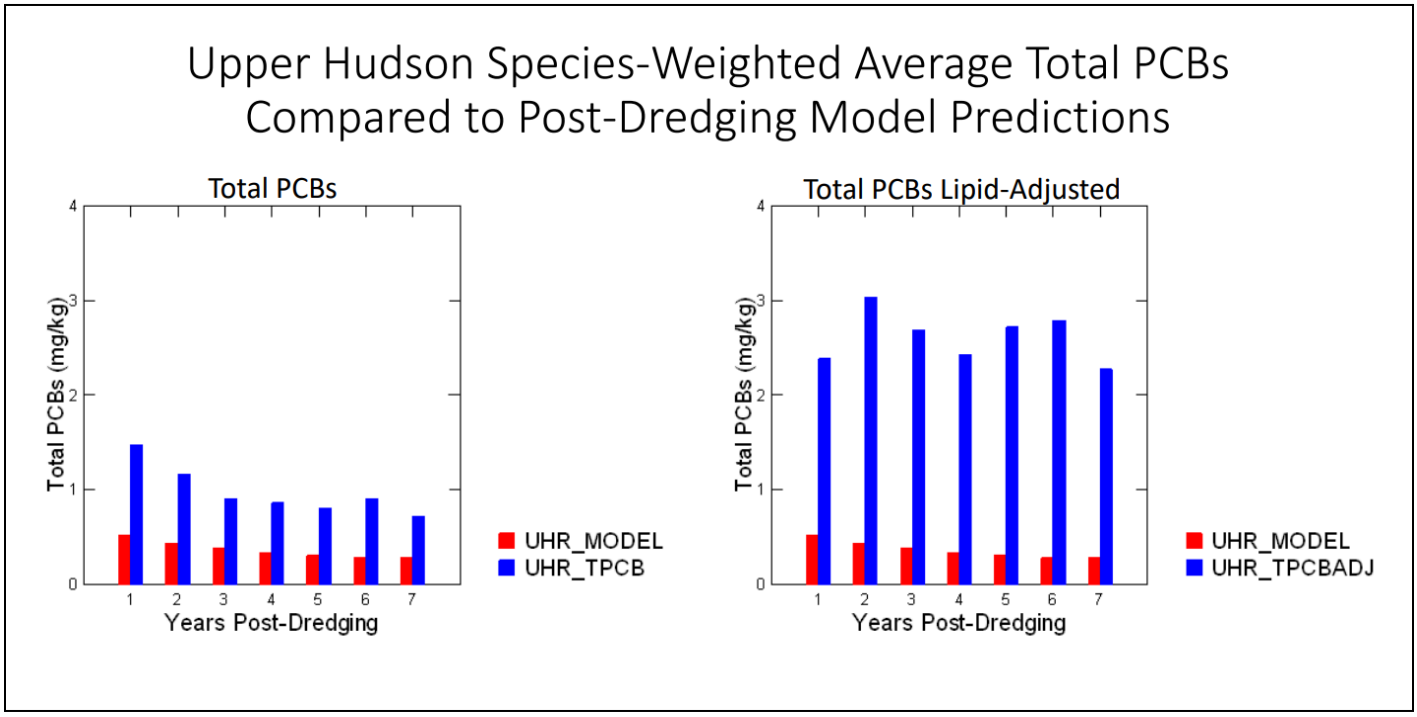
Lipid-Based PCB Concentrations (Weighted Average) in Upper Hudson River Fish



An alternative way to look at the data is to compare the weighted average fish PCB concentration with the fish PCB concentrations anticipated by EPA using modeling during remedy selection. In Figure No. 3 below, one can compare the PCB concentrations anticipated by EPA in the 2002 ROD to the actual measured concentrations. The anticipated concentrations in red are compared to the measured concentrations in blue, both for total PCB and for lipid-adjusted PCB, taking into account changes in lipid content. In both comparisons, the actual PCB concentrations are higher than anticipated by EPA.

FIGURE 3.

Total PCB Concentrations (Weighted Average) in Upper Hudson River Fish[4] Compared to Total PCB Concentrations (Weighted Average) in Upper Hudson River Fish Predicted by EPA's Models in 2002[5]



[4] Total PCB Concentrations (Weighted Average) in Upper Hudson River Fish ("UHR_TPCB")

[5] Total PCB Concentrations (Weighted Average) in Upper Hudson River Fish Predicted by EPA's Models in 2002 ("UHR_Model"); Lipid-Adjusted Total PCB Concentrations (Weighted Average) in Upper Hudson River Fish ("UHR_TPCBADJ")

C. Changes in Lipid Content

The following figures depict changes in lipid content over time at three selected sampling sites in the Upper Hudson. To illustrate how lipid content has changed over time since the start of the monitored natural recovery phase of the remedy, Figures No. 4, No. 5, and No. 6 below evaluate data collected from 2016 to 2022 after the end of dredging in 2015. Bass and bullhead are presented as they make up the largest portion of the EPA's species-weighted average metric.

FIGURE 4.

Percent Lipid in Bullhead Samples Collected in River Section 1 From 2016-2022

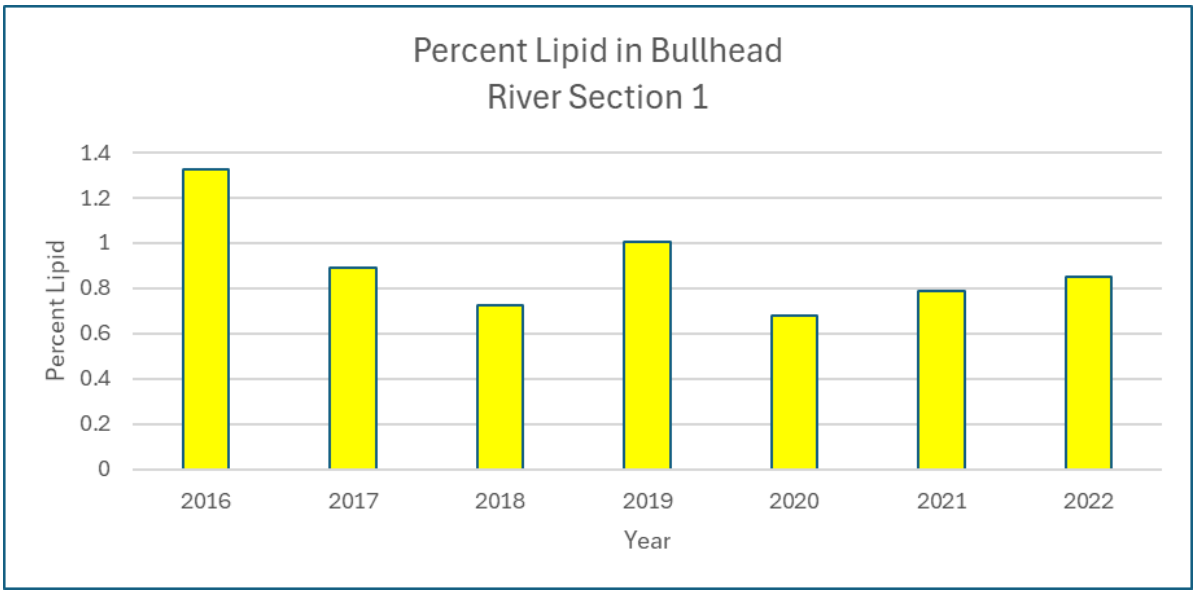


FIGURE 5.

Percent Lipid in Black Bass Samples Collected in River Section 2 From 2016-2022

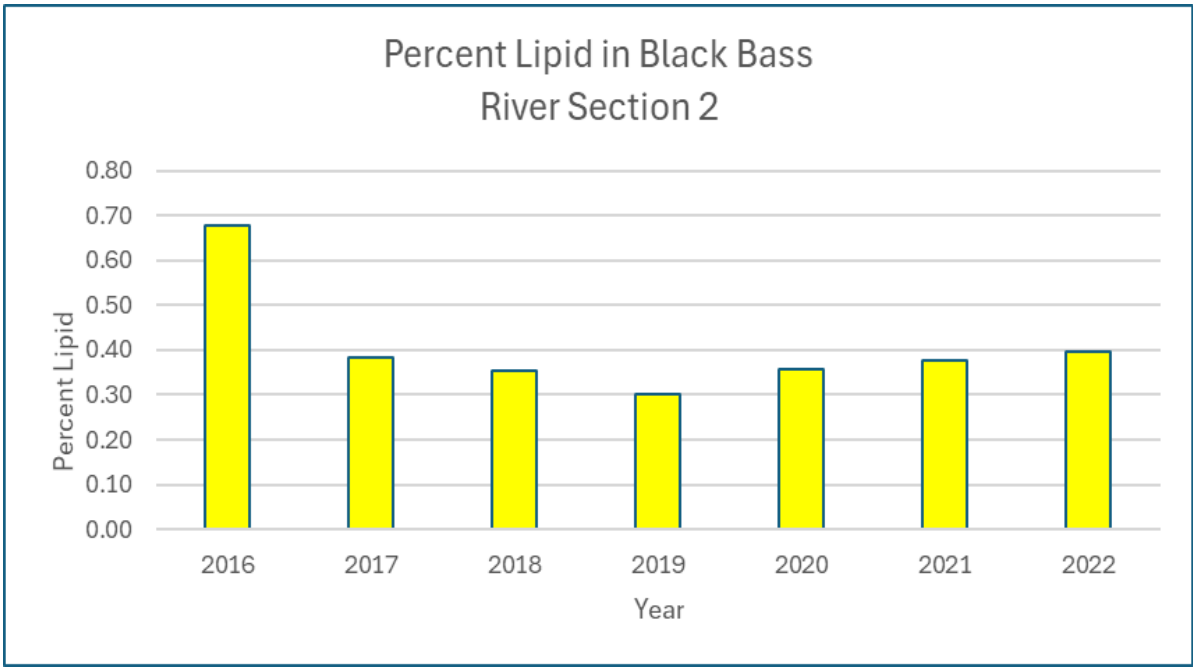
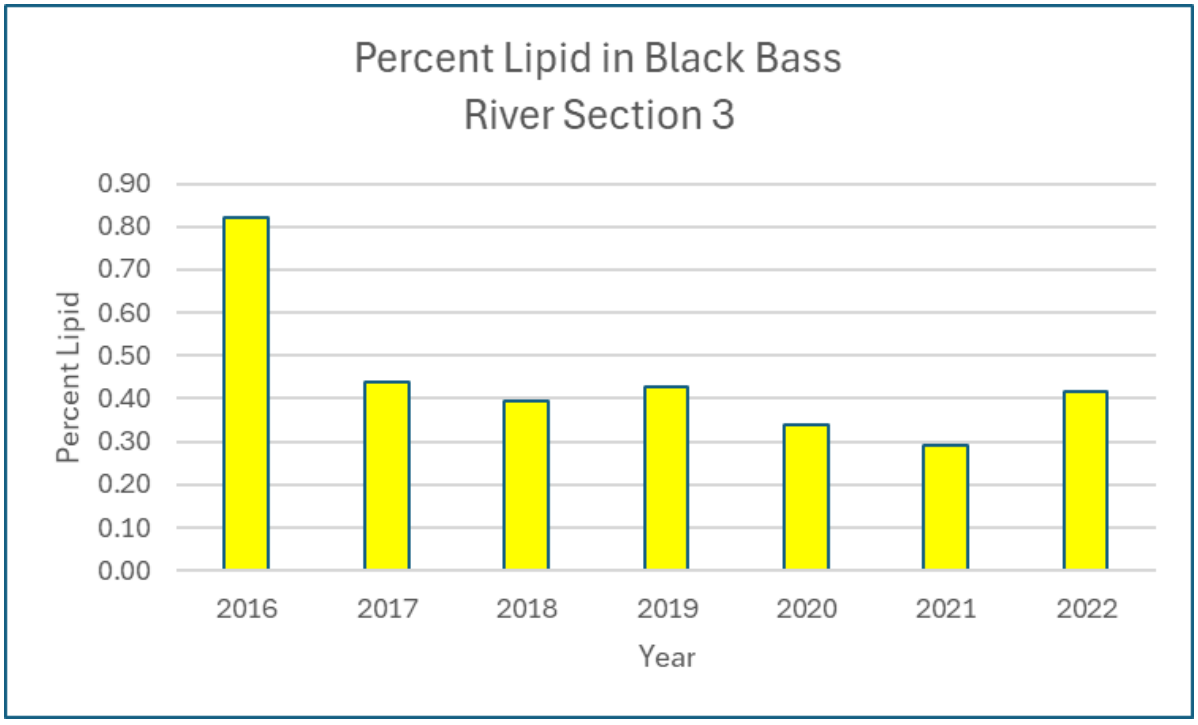


FIGURE 6.

Percent Lipid in Black Bass Samples Collected in River Section 3 From 2016-2022



D. Evaluation of Pumpkinseed Data During Monitored Natural Recovery

Besides the three main sport fish used in the weighted average metric used by EPA,[6] the monitoring program also includes the collection of forage fish (primarily minnow species) and pumpkinseed. The pumpkinseed are collected utilizing a size criterion intended to collect primarily yearling (age 1+), however, the pumpkinseed are not aged and may be of different age classes. The forage fish are collected at the same time; however, from year to year, differing mixes of species are collected according to availability which may confound year-to-year comparisons. Pumpkinseed have been collected consistently from the same Upper Hudson River stations since 2004 and provide a high-quality dataset of forage fish PCB content.

The FOCH coalition has evaluated the PCB concentrations of pumpkinseed during the period of monitored natural recovery (2016-2021). This analysis is done using both total PCB and lipid-based PCB concentrations, in order to take into account the potential for changing lipid content in the fish to better understand the trends in total PCB concentrations.

In evaluating the pumpkinseed data, it appears that there has been little change in PCB concentrations overtime during the period of monitored natural recovery. In terms of both total PCB and lipid-based PCB there has been little reduction in concentrations. This similarity is due to relatively small changes in lipid content in the pumpkinseed sampled from year-to-year.

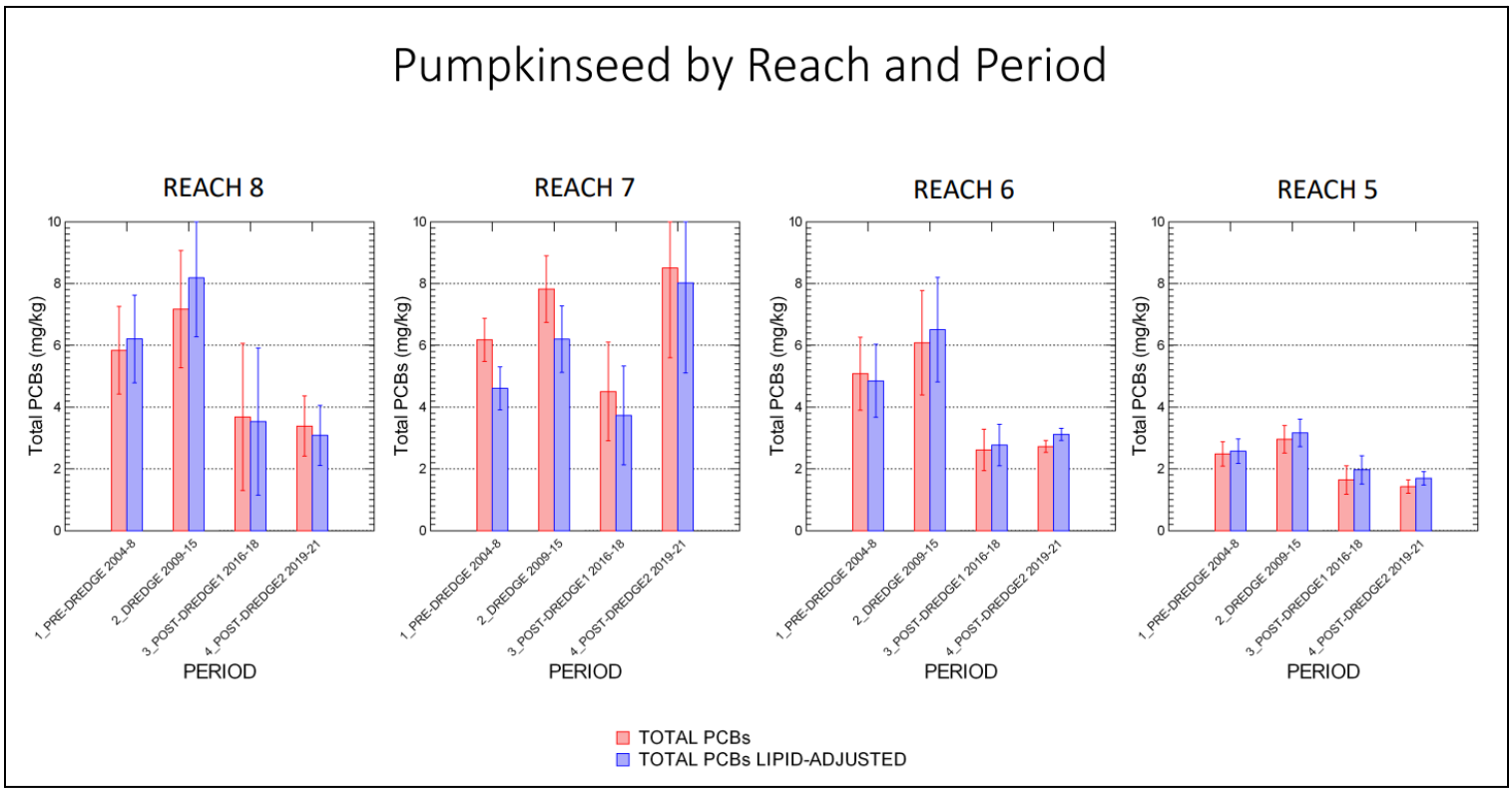
Pumpkinseed data collected during the period of monitored natural recovery is a key factor to take into consideration when evaluating the sport fish data used in EPA's weighted average metric. Pumpkinseed are monitored to represent the year to year changes in PCB exposure conditions in the Upper Hudson, and also represent the food base for the sport fish in the monitoring program. With little change in pumpkinseed PCB concentrations over this period, there is little reason to believe that there has been any significant decline in sport fish concentrations during this same period. This, combined with the observations noted in the November 2023 FOCH report that there has been little decline in PCB concentrations in the average top two inches of surface sediment during the period of monitored natural recovery, is an important element of the FOCH finding that the remedy is not performing as anticipated and that the appropriate protectiveness determination in the upcoming FYR should be not protective.

The pumpkinseed data set in the Upper Hudson represents a continuous series of data from the start of the baseline monitoring program in 2004, continuing to the present, and is one of the most complete data sets available for PCB concentrations in Upper Hudson fish. In the graphs below, the pumpkinseed PCB data are grouped into four time periods; before dredging, during dredging, during the first three years post dredging, and the second three-year period after dredging. While there has been some small reduction after dredging, there appears to be little improvement during the post-dredging period of monitored natural recovery. In these graphs, both the total PCB data and lipid-adjusted PCB (taking into account changes in lipid content in the samples) are presented. *(It is important to note that EPA has not included Reaches 1 through 4 in the routine monitoring program; as a result, Figure No. 7 below depicts the available data for Reaches 5 through 8, from Mechanicville to Fort Edward.)*

[6] The three main sport fish used in the weighted average metric used by EPA are Black Bass (47%), Bullhead (44%), and Perch (9%).

FIGURE 7.

Total PCB Concentrations in Pumpkinseed by River Reach and Period



E. Fish Data Summary

As described in the November 2023 report, FOCH found that the concentrations of PCB in Upper Hudson fish have not recovered as anticipated at the time of remedy selection. Using the reach and species weighted total PCB metric developed by EPA, the FOCH coalition found that the first targeted PCB concentration (0.4 mg/kg total PCB, to be met five years after dredging) was not met in 2020, and remains unmet today.

Further analysis of the available fish data has also led to the finding that the apparent decline in fish PCB concentrations after dredging is primarily due to changes in fish lipid concentration. When accounting for the measured declines in fish lipid concentrations, the FOCH coalition has found that there has been little change in fish PCB concentrations.

EPA anticipated at the time of remedy selection that there would be an ongoing decline in fish PCB concentrations of approximately 8% per year. This anticipated decline is not observed in the available total PCB data. Additionally, after accounting for changes in fish lipid concentrations, the apparent rate of decline appears to also be very small.

V. PCB Concentrations in Sediment After Dredging

A. PCB Concentrations in Sediment Have Failed to Decline as Anticipated in the ROD

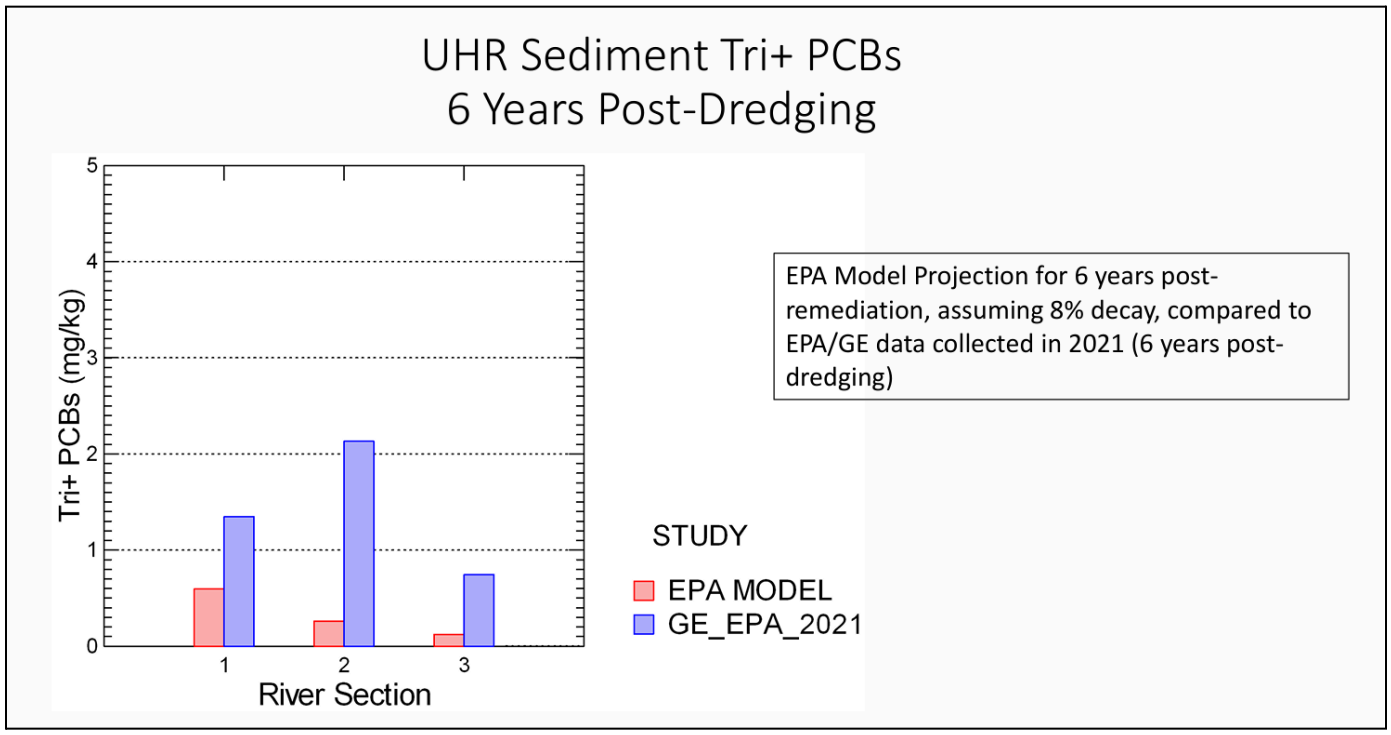
As described in the November report, the FOCH coalition found that there has been little improvement in surface sediment PCB concentrations after the sediment removal was completed. Throughout the Upper Hudson, surface sediment PCB concentrations were found in 2021 to be similar, or even higher, than was found after dredging in 2016 and 2017.

Unfortunately, as the sediment monitoring programs only sampled the top two inches of sediment, EPA is unable to compare surface sediment PCB concentrations to target cleanup levels for the surface which were based on PCBs in the surface top 12 inches. As a result, the currently bioavailable sediments in the Upper Hudson have not been evaluated after sediment removal, and the changes (if any) in the available PCB exposure to biota from the remaining contaminated sediment cannot be quantified. In Figure No. 8 below, the surface sediment PCB concentrations in 2021 are compared to the concentrations that would be expected given the anticipated 8% per year reduction starting with the first post-dredging sampling events in 2016/17. (*The metric presented, Tri Plus PCBs, is one used by EPA to define those PCBs that accumulate most in fish - those with three or more chlorine atoms in the PCB molecules).*

One conclusion that can be drawn from the available data is that the rate of change in post-dredging sediment PCBs between 2016 and 2021 is much less than expected throughout the Upper Hudson. Six years after dredging, PCB concentrations in the top two inches of surface sediment remain higher than models used by the ROD to predict remedial effectiveness.

FIGURE 8.

Tri+ PCB Concentrations in Upper Hudson River Sediment Samples Collected in 2021 Compared to Tri+PCB Concentrations in Upper Hudson River Sediment Projected to be Achieved in 2021 by EPA's Models[7]

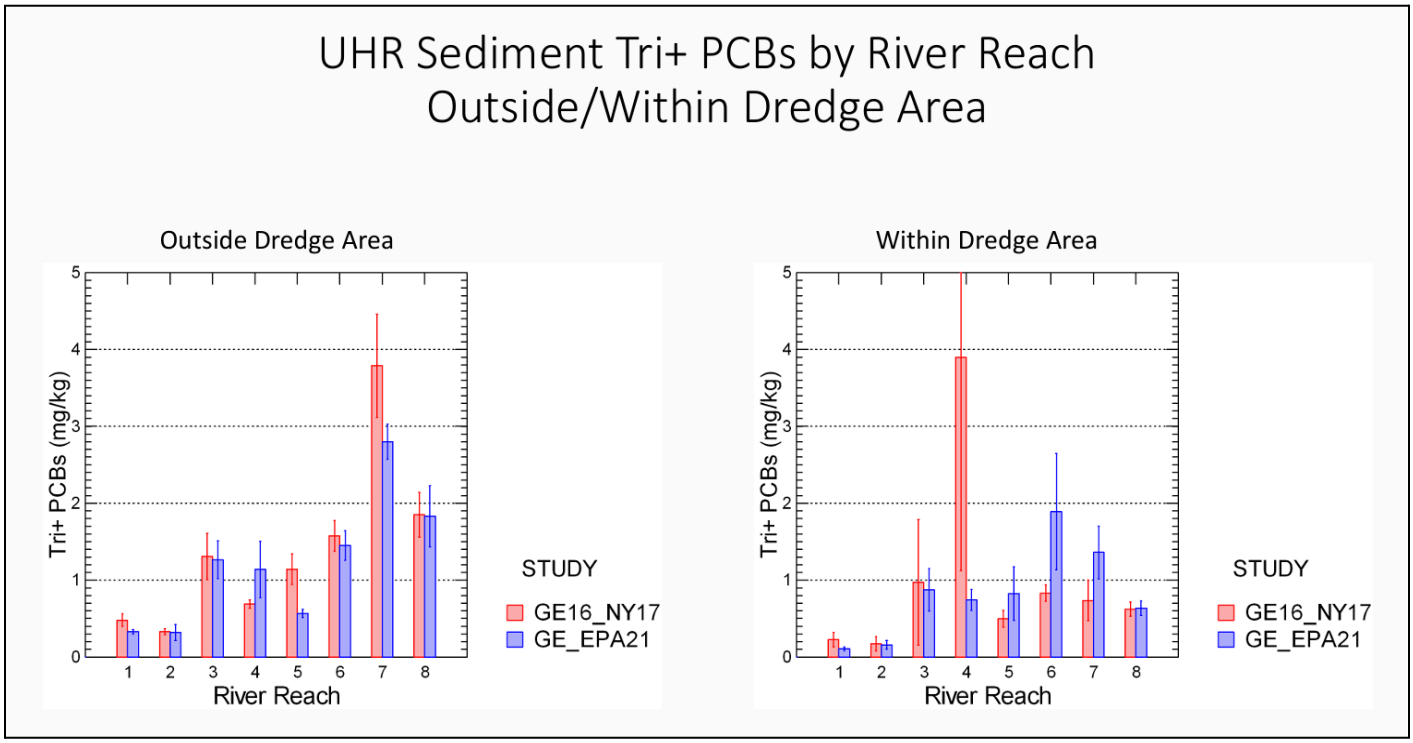


[7] Tri Plus PCBs is one metric used by EPA to define those PCBs that accumulate most in fish - those with three or more chlorine atoms in the PCB molecules.

PCB concentrations in the top two inches of surface sediment in areas that were dredged are also much higher than EPA expected in the 2002 ROD, indicating re-contamination from un-dredged PCB-contaminated sediment. Re-contamination of dredged areas is particularly high in River Section 2, where highly elevated concentrations in surface sediment adjacent to dredged areas were documented.

FIGURE 9.

Tri+ PCB Concentrations in Upper Hudson River Sediment Samples Collected in 2016/17 Compared to Tri+PCB Concentrations in Upper Hudson River Sediment Samples Collected in 2021 Based on River Reach and Dredge Area

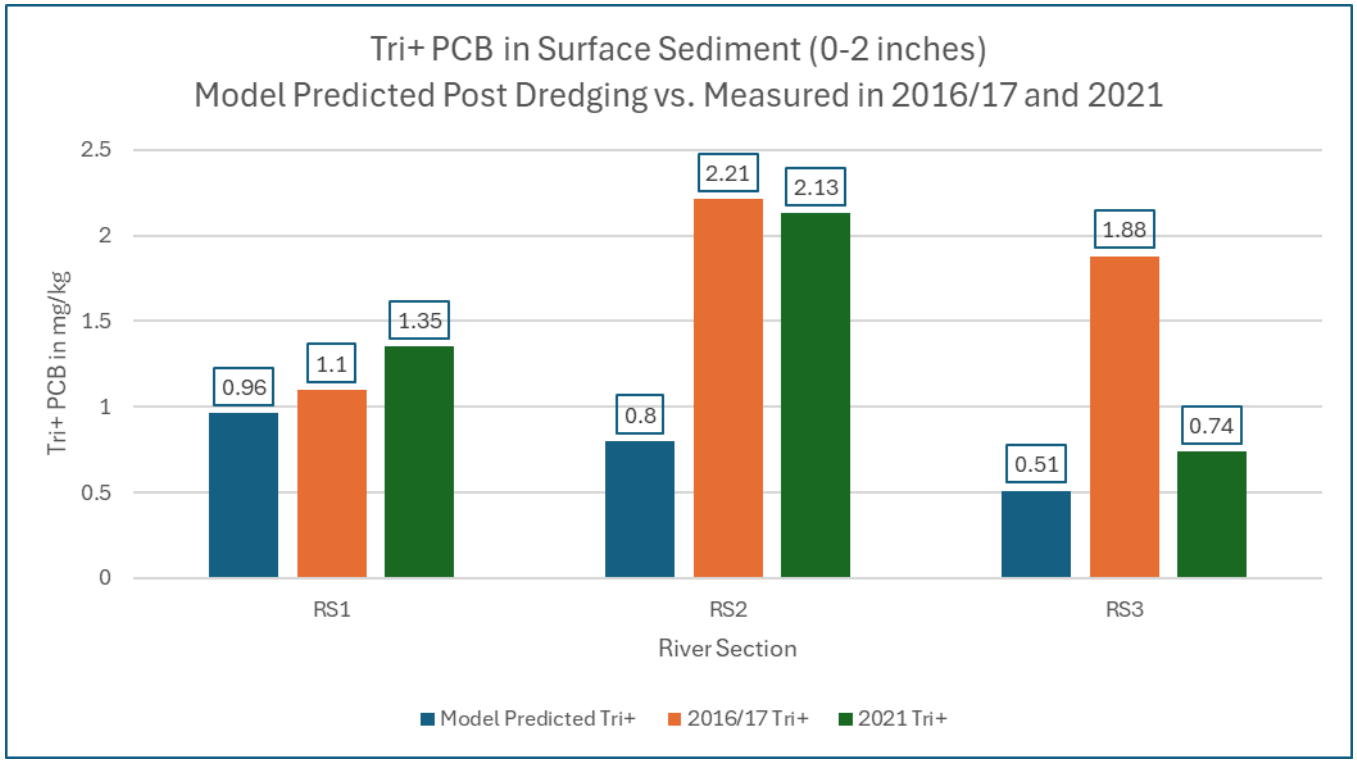


B. EPA's Anticipated PCB Decline in Surface Sediment has not Been Observed in Post Dredging Monitoring

In reviewing the available information related to EPA's anticipated sediment concentrations (in the top two inches) after dredging, the FOCH coalition also reviewed a memo issued by EPA in May 2012. In this memo, EPA summarized the available sediment PCB data and published a table comparing the anticipated PCB concentrations before and after dredging at the time of remedy selection. The anticipated post-dredging surface sediment PCB concentrations, when viewed in concert with the relative stability of the surface PCB concentrations measured in 2016/17 and in 2021, indicate that the magnitude of remaining surface PCB concentrations, and the lack of recovery in the surface PCB concentrations, are not in keeping with EPA's anticipated performance of the remedy.

FIGURE 10.

Tri+ PCB Concentrations in Upper Hudson River Sediment Samples Collected in 2016/17 Compared to Tri+PCB Concentrations in Upper Hudson River Sediment Samples Collected in 2021 and Tri+ PCB Concentrations in Upper Hudson River Sediment Projected to be Achieved in 2021 by EPA's Models



VI. Status of Upper Hudson Remedy

The FOCH coalition concludes that the performance of the remedy has proven to be much less complete than EPA believed at the time of remedy selection. Sediment PCB concentrations indicate that there has been little recovery during monitored natural recovery. In addition, when taking into account changes in fish lipid concentrations, there appears to be little improvement in PCB concentrations in Upper Hudson River fish.

The observed PCB concentrations in bass, bullhead, and perch (the sport fish species that make up the EPA's composite metric) follow similar patterns as other data from pumpkinseed and surface sediment. As described above and in the November 2023 FOCH report, there has been little improvement in both surface sediment and pumpkinseed.

The data available support the conclusion that the monitored natural recovery element of the remedy is not functioning as anticipated and that the targeted reductions in fish and sediment PCB concentrations in the Upper Hudson have not occurred. Surface sediment, pumpkinseed, and sport fish data all show similar trends – limited improvement as compared to the declines anticipated by EPA at the time of remedy selection. As a result, the FOCH coalition recommends that the appropriate protectiveness determination for the current Five-Year Review should be "not protective."

VII. Conclusion

The FOCH coalition finds that sufficient data exists for EPA to draw conclusions on the performance of the remedy at this time. EPA has been, since the last five-year review report, stating that sufficient data had yet been collected to evaluate the trends in fish PCB concentrations in the Upper Hudson. However, this report concludes that sufficient data exists to understand the performance of the remedy, particularly the performance of monitored natural recovery as compared to the anticipated performance of the remedy at the time of remedy selection. This conclusion is based primarily on available sediment and fish tissue data collected in the Upper Hudson since the active portions of the remedy (source control and targeted dredging of contaminated sediments) have been completed.