Hudson River PCBs Site Proposed Second Five Year Review – Supplement to Technical Review

Prepared for:

Scenic Hudson, Inc.
Riverkeeper, Inc.

Prepared by:

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

February 2019

7944 Wisconsin Avenue, Bethesda, Maryland 20814-3620 • (301) 718-8900

Table of Contents

1. Introduction 4
2. NYSDEC 2017 Sediment Sampling Data 5
   - **2.1 PCB concentrations in the Hudson River surface sediments remain elevated** 6
   - **2.2 PCB concentrations in the areas that have been dredged have been locally re-contaminated** 8
   - **2.3 PCBs hotspots remain in surface sediments outside of the dredged areas** 8
3. 2017 Fish Tissue Data 9
   - **3.1 NYSDEC 2017 Fish Tissue Data** 9
   - **3.2 GE 2017 Fish Tissue Data** 10
   - **3.3 EPA Recovery Rates and Trend Analysis supplemented with GE 2017 data** 11
   - **3.4 PCB Concentrations Vary Within a River Reach** 14
   - **3.5 Remedial Objectives in the 2002 ROD Have Not Been Met** 14
4. Conclusions 17
5. References 18

List of Figures

Figure S1a Cumulative Distribution of Total PCBs in 2017 Surface Sediments Compared against Relevant Standards

Figure S1b Total PCBs in 2017 Dredged and Non-Dredged Area Surface Sediments Compared Against Relevant Standards

Figure S2a 2017 Sediment Data in Dredged Areas – Reach 8

Figure S2b 2017 Sediment Data in Dredged Areas – Reaches 7 and 6

Figure S2c 2017 Sediment Data in Dredged Areas – Reach 5

Figure S2d 2017 Sediment Data in Dredged Areas – Reaches 4 and 3

Figure S2e 2017 Sediment Data in Dredged Areas – Reaches 2 and 1

Figure S3a Sediment Samples 2017 Total PCB Concentrations – Subset of Reach 4, North of Mechanicville, West Side of River

Figure S3b Sediment Samples 2017 Total PCB Concentrations – Subset of Reach 7, North of Tuttle Brook

Figure S3c Sediment Samples 2017 Total PCB Concentrations – Near Three Sisters Islands

Figure S4a Lipid Normalized Total PCBs in Pumpkinseed – River Reach 8

Figure S4b Lipid Normalized Total PCBs in Pumpkinseed – River Reach 7

Figure S4c Lipid Normalized Total PCBs in Pumpkinseed – River Reach 6

Figure S4d Lipid Normalized Total PCBs in Pumpkinseed – River Reach 5

Figure S5a Lipid Normalized Total PCBs in Pumpkinseed – Location R8-3 (Station TD3)

Figure S5b Lipid Normalized Total PCBs in Pumpkinseed – Location R5N-1 (Station SW1)

Figure S5c Lipid Normalized Total PCBs in Pumpkinseed – Location R5N-2 (Station SW2)

Figure S6 Spottail Shiner Samples Collected in 2017, Split by Sampling Campaign

List of Tables

Table S1 NYSDEC 2017 – PCB Concentrations in Sediment by River Reach

Table S2a PCB Exceedances in Dredged Areas by River Reach

Table S2b PCB Exceedances in non-Dredged Areas by River Reach

Table S3 NYSDEC 2017 Fish Tissue Samples Summary

Table S4: GE 2017 Fish Tissue Samples Summary in Reaches 8 - 5

Table S5a: Lipid Normalized Total PCB Aroclor Trends in Sport Fish Standard Fillets

Table S5b: Lipid Normalized Total PCB Aroclor Trends in Forage Fish Whole Body

Table S6a: Recovery times for Spottail Shiner Whole body without length weighting (current average wet weight concentration: 3.55 mg/kg)

Table S6b: Recovery times for species and length weighted average recovery rates (current average wet weight concentration: 1.20 mg/kg)

1. Introduction

This is a supplement to the previous report titled "Hudson River PCBs Site Proposed Second Five-Year Review – Technical Review, August 2017". The August 2017 report was a review of the data presented in support of the United States Environmental Protection Agency (EPA) Proposed Five-Year Review for the Hudson River PCBs Superfund Site Operable Units (OUs) 1 and 2.

In the June 2017 report, EPA proposed that the selected remedy for the Hudson River Superfund Site was performing as intended. EPA concluded that the performance standards established in the 2002 Record of Decision (ROD) are being met and that the cleanup goal for the river will be achieved as predicted in the 2002 ROD. EPA concluded that the selected remedy for the site, REM-3/10/Select, will be protective, and that no further remedial action is required for OUs 1 and 2. EPA's conclusions are based primarily on the interpretation of complex fish data and trend analyses.

In our August 2017 report, we concluded that EPA's evaluation of the data failed to properly account for the variability and uncertainty inherent to the fish tissue data and that the recovery rates calculated by EPA are uncertain and unreliable. The major issue with EPA's recovery rate calculations and trend analysis is that EPA failed to account for the uncertainty introduced by: a) using data from different types of fish tissue samples (i.e., rib-in and rib-out samples); b) using results from different field studies; c) using results obtained by different analytical methods; d) using analytical results obtained by different laboratories over several years; and e) transforming all PCB concentration data from the various data sources into calculated PCB homologue equivalent values using dated empirical correlations that did not account for variability and uncertainty. Our main conclusion upon review of the EPA methodology was that the trends calculated from the fish tissue data are too variable and uncertain to provide a scientific support for the conclusions reached by EPA in the June 2017 report. To further evaluate the EPA calculated recovery rates, we calculated rates based on trends derived from the PCB Aroclor data without the empirical conversions to PCB homologue values, applying the EPA methodology. Results showed that recovery rates calculated based on the more

comparable PCB Aroclor datasets were different and substantially slower than those calculated by EPA.

Since August 2017, additional sediment and fish tissue data have become available from sampling conducted by New York State Department of Environmental Conservation (NYSDEC) and General Electric (GE). The main purpose of the NYSDEC data collection was to independently evaluate the performance of the EPA dredging and monitoring natural recovery remedy for the Hudson River. The new data from NYSDEC is reported in "Final Data Summary Report Data, Hudson River PCB Sediments OU-2 Site (546031) Upper Hudson River, New York, December 2018 (EA)". The data provided includes sediment and fish tissue data collected in River Reaches 1 to 8 of the Hudson River PCB Superfund Site. The GE sampling was part of the routine sampling campaign. The NYSDEC sampling took place in River Reaches 1 to 8 (as defined by NYSDEC) and the GE sampling was focused on River Reaches 5 to 8, with some additional samples collected upstream of the GE plant and downstream of River Reach 1.

A review and evaluation of the new data and information is the subject of this technical supplement.

2. NYSDEC 2017 Sediment Sampling Data

In the summer of 2017 (June 15 to August 31, 2017), the New York State Department of Environmental Conservation (NYSDEC) conducted independent sediment sampling to assess the nature and extent of contamination left behind after six years of dredging to remove PCBs from sections of the Hudson River. NYSDEC collected 1,269 (including 116 duplicates) surface sediment samples in the 0 to 2-inch depth interval. Both dredged and non-dredged areas were sampled in Operable Unit 2 (River Reaches 1 to 8 as defined by NYSDEC). The samples were analyzed by Pace Analytical Services for PCB Aroclors, grain size, moisture content, and total organic carbon (TOC). Ten percent of the samples were randomly selected to be analyzed for PCB congeners. The range for Total PCBs was between Not Detected (ND) and 67.1 mg/kg (River Reach 4). The lowest average PCB concentration was observed in River Reach 2 (0.5 mg/kg) and the highest in River Reach 7 (5.2 mg/kg).

A summary description of the dataset is provided in Table S1, and an interpretation of the data is discussed below.

Table S1: NYSDEC 2017 – PCB Concentrations in Sediment by River Reach

		Total Aroclors (mg/kg)			
River Reach	**Number of Samples**	**Min**	**Mean**	**Median**	**Max**
Reach 8	211	0.0	1.7	0.8	23.1
Reach 7	90	0.0	5.2	2.8	60.9
Reach 6	79	0.2	2.4	1.6	19.1
Reach 5	242	0.0	1.3	0.8	11.6
Reach 4	238	0.0	1.7	1.1	67.1
Reach 3	108	0.0	2.2	1.1	39.8
Reach 2	69	0.0	0.5	0.3	2.4
Reach 1	116	0.0	0.7	0.5	15.4
Old Champlain Canal	9	0.1	8.7	0.3	50.2

2.1 PCB concentrations in the Hudson River surface sediments remain elevated

A review of the NYSDEC 2017 sediment dataset indicates that compared to the most common cleanup goal of 1 mg/kg most often required by EPA for Superfund Site river sediments, large portions of the Hudson River remain contaminated by PCBs. The extent of contamination is even greater if one compares the Hudson River sediment PCB concentrations to the Preliminary Remediation Goal (PRG) of 0.48 mg/kg for Total PCBs selected by EPA for the Gowanus Canal Superfund Site (Record of Decision for Gowanus Canal, Brooklyn, NY; USEPA 2013, Table 13). A summary of percent exceedances for the NYSDEC 2017 sediment samples is provided in Tables S2a and S2b. The data indicate that PCB concentrations in several River Reaches is elevated above commonly applied PRGs in both the dredged and non-dredged areas with a substantial percentage of the samples reported at concentrations above 10 mg/kg.

Table S2a: PCB Exceedances in Dredged Areas by River Reach

*Percentage of samples from **dredged** areas with Total PCBs greater than selected concentrations*				
	Number of Samples	**> 0.48 mg/kg***	**> 1 mg/kg****	**> 10 mg/kg**
River Reach 8	138	45.8	32.2	0.0
River Reach 7	28	44.0	36.0	0.0
River Reach 6	30	82.8	58.6	0.0
River Reach 5	19	57.9	26.3	0.0
River Reach 4	12	75.0	25.0	16.7
River Reach 3	12	37.5	25.0	12.5
River Reach 2	3	0.0	0.0	0.0
River Reach 1	3	33.3	0.0	0.0
Old Champlain Canal	0	NA	NA	NA

*0.48 mg/kg is the PRG for Total PCBs at the Gowanus Canal Superfund Site

**1 mg/kg is the most commonly used cleanup goal or PRG for Total PCBs

Table S2b: PCB Exceedances in non-Dredged Areas by River Reach

*Percentage of samples from **non-dredged** areas with Total PCBs greater than selected concentrations*				
	Number of Samples	**> 0.48 mg/kg***	**> 1 mg/kg****	**> 10 mg/kg**
River Reach 8	56	82.7	57.7	7.7
River Reach 7	79	98.7	93.7	10.1
River Reach 6	49	95.9	81.6	4.1
River Reach 5	209	78.3	39.9	1.0
River Reach 4	240	70.1	55.2	0.5
River Reach 3	96	75.8	53.7	3.2
River Reach 2	66	32.8	16.4	0.0
River Reach 1	113	50.9	21.7	0.9
Old Champlain Canal	9	44.4	33.3	22.2

*0.48 mg/kg is the PRG for Total PCBs at the Gowanus Canal Superfund Site

**1 mg/kg is the most commonly used cleanup goal or PRG for Total PCBs

2.2 PCB concentrations in the areas that have been dredged have been locally re-contaminated

Areas that were dredged should not have appreciable PCB concentrations because clean material was backfilled into the dredged locations. Cumulative concentration distributions (Figure S1a-b) show that although PCB concentrations in the surface sediments in dredged areas are lower than in the non-dredged areas, the concentrations nevertheless remain elevated in the dredged areas with 34% of dredged areas exceeding 1 mg/kg total PCBs (52% exceeding 0.48 mg/kg). The most likely explanation for the elevated PCB concentrations in the areas that have been dredged is re-contamination by PCB-laden sediment from non-dredged areas. The contamination in the dredged areas is illustrated in Figure S1b and Figure S2a-e.

2.3 PCBs hotspots remain in surface sediments outside of the dredged areas

Elevated PCB concentrations, well in excess of the commonly applied cleanup goal of 1 mg/kg, remain in several sub-areas of the Hudson River. These contaminated sub-areas are extensive. For example:

- In the subset of River Section 3 north of Mechanicville on the west side of the river, 66 of 78 samples (85%) have Total PCB concentrations above 1 mg/kg with maximum concentration value of 67.1 mg/kg (Figure S3a).
- In the subset of River Section 2 north of Tuttle Brook, 53 of 69 samples (77%) have Total PCB concentrations above 1 mg/kg with maximum concentration value of 60.9 mg/kg (Figure S3b).
- In the subset of samples north of and including the Three Sisters Islands, 15 of 38 samples (39%) have Total PCB concentrations above 1 mg/kg with a maximum concentration of 5.3 mg/kg (See Figure S3c).

These examples show that there remain larges areas within the individual River Reaches that are elevated in PCBs. This also illustrates the danger of averaging data over large river sections to monitor recovery and exposure risk.

3. 2017 Fish Tissue Data

3.1 NYSDEC 2017 Fish Tissue Data

NYSDEC collected 232 forage fish samples (89 composite and 143 single forage fish samples) between September 11 and September 18, 2017. The project objective was to assess and evaluate spatial relationships and temporal trends in Hudson River PCB contamination by the means of forage fish tissue analysis. Forage fish (primarily Shiners) and centrarchid (primarily Pumpkinseed) samples were collected in the eight River Reaches previously sampled by NYSDEC for surface sediments. The samples were analyzed by Pace Analytical Services for PCB congeners, percent lipids, and percent moisture. The PCB congener data were also reported as PCB homologues and Total PCBs concentrations. The fish tissue samples were for "Whole Body" fish analysis. Pumpkinseed samples were one fish per sample whereas samples for the Shiners were a composite of up to 10 fish per sample. In addition, fish length, weight, and age were measured for the Pumpkinseed fish samples (fish ages were primarily 1 year old with a small percentage of 2 years old). Table S3 summarizes the dataset.

Table S3: NYSDEC 2017 Fish Tissue Samples Summary

Common Name	Number of Fish Sampled	Average Lipids (%)	Average Total PCBs (mg/kg)	Lipid Normalized Average Total PCBs (mg/kg)	Total Tri+ PCBs (mg/kg)	Lipid Normalized Tri+ PCBs (mg/kg)
Emerald Shiner	6	5.20	0.85	8.99	0.81	8.64
Fall Fish	2	1.88	0.92	39.96	0.90	39.15
Golden Shiner	1	5.57	1.32	23.70	1.24	22.22
Pumpkinseed	120	1.88	0.08	1.26	0.06	0.98
Redbreasted Sunfish	23	2.71	0.86	12.25	0.81	11.50
Spotfin Shiner	32	4.02	0.78	11.69	0.77	11.50
Spottail Shiner	48	1.33	0.15	4.79	0.14	4.73

3.2 GE 2017 Fish Tissue Data

GE performed routine sampling in 2017, sampling of sport fish in June 2017 (6/12/2017 – 6/19/2017), and sampling of forage fish in August 2017 (8/28/2017 to 8/30/2017, a few weeks earlier than the forage fish sampling by NYSDEC). In the sport fish dataset from GE, yellow perch was the most frequently sampled species and constituted 33% of the samples. In both the NYSDEC and GE 2017 forage fish datasets, Pumpkinseeds were the most extensively sampled fish, constituting 52% and 71% of the samples in each dataset, respectively. The NYSDEC dataset was analyzed for PCB congeners by Method 1668 (Total PCBs in the dataset represents the sum of the congeners). The samples analyzed by GE were analyzed for PCB Aroclors by Method 8082. GE sampling locations only partially overlap with the NYSDEC locations (EA Engineering 2018, Figure 2-2). Those difference make the NYSDEC and GE datasets different and not directly comparable. However, the datasets individually support the main conclusion that PCB concentrations in fish remains elevated in the river reaches. The GE 2017 dataset is summarized in Table S4.

Table S4: GE 2017 Fish Tissue Samples Summary in Reaches 8 - 5

Common Name	Sample Prep Code	Number of Fish Sampled	Average Lipids (%)	Min Total PCBs (mg/kg)	Average Total PCBs (mg/kg)	Median Total PCBs (mg/kg)	Max Total PCBs (mg/kg)	Lipid Normalized Average Total PCBs (mg/kg)
Brown Bullhead	SF	76	0.93	0.15	1.33	0.89	9.84	154.89
Golden Shiner	WH	10	3.40	0.61	2.00	1.63	5.47	62.57
Largemouth Bass	SF	37	0.41	0.09	1.36	1.02	4.75	340.86
Pumpkinseed	WH	85	2.86	0.38	5.44	2.39	93.20	179.28
Spottail Shiner	WH	13	4.49	1.27	3.80	3.71	8.03	82.72
Yellow Perch	SF	85	0.96	0.09	0.77	0.60	2.36	86.64
Yellow Bullhead	SF	9	0.56	0.14	0.54	0.41	1.23	95.05
Smallmouth Bass	SF	48	0.46	0.05	1.62	1.43	5.65	398.09
Mimic Shiner	WH	1	3.10	2.34	2.34	2.34	2.34	75.48
Fallfish	WH	3	1.83	1.26	2.96	1.50	6.11	168.32
Spotfin Shiner	WH	2	5.30	1.03	1.18	1.18	1.33	22.50
Bluntnose Minnow	WH	1	5.10	4.25	4.25	4.25	4.25	83.33

3.3 EPA Recovery Rates and Trend Analysis supplemented with GE 2017 data

In this Supplemental Report we calculated the trends by river reach using the EPA Aroclor datasets (1995-2008 and 2016 data) compared to the same data set supplemented with the GE 2017 Aroclor dataset. While we do not endorse the EPA's trend analysis methodology to determine the effectiveness of the remedy, the purpose of this comparison is to show that the current data does not support the EPA's original conclusion. The comparison shows that when the current data is included, the EPA trend methodology would conclude that the remedy is not on track to reach the goals of the 2002 ROD. This conclusion is consistent with our analysis of PCB levels in the sediments.

The trend analysis comparison was performed for the standard sport fish fillets, whole body Pumpkinseed and Spottail Shiner datasets, and a combined Shiner dataset where all species of Shiners are grouped. The trends including the 2017 Aroclor data while excluding the 2016 Aroclor data were also calculated as a sensitivity check. Results are summarized in Table S5a-b and illustrated on Figures S4a-d.

Table S5a: Lipid Normalized Total PCB Aroclor Trends in Sport Fish Standard Fillets

		Lipid Normalized Total PCB Aroclor in Standard Fish Fillets								
		1995-2008, 2016 Data			**Supplemented with 2017 GE Data**			**Supplemented with 2017 GE Data (excluding 2016 data)**		
Reach	**Fish**	**N**	**Recovery Rate (%)**	**Half-life (years)**	**N**	**Recovery Rate (%)**	**Half-life (years)**	**N**	**Recovery Rate (%)**	**Half-life (years)**
River Reach 8	Brown Bullhead	185	-6.63	10.45	210	-6.84	10.14	180	-6.52	10.64
River Reach 8	Largemouth Bass	190	-6.76	10.25	199	-6.79	10.2	181	-6.72	10.32
River Reach 8	Smallmouth Bass	97	-5.11	13.55	118	-3.56	19.46	103	-3.05	22.72
River Reach 8	Yellow Perch	191	-12.12	5.72	221	-9.85	7.04	190	-7.65	9.06
River Reach 7	Brown Bullhead	32	-9.21	7.53	41	-6.14	11.29	30	-2.27	30.5
River Reach 7	Smallmouth Bass	51	0.74	-93.36	61	1.01	-68.97	51	0.44	-158.62
River Reach 7	Yellow Perch	51	-7.55	9.18	61	-5.95	11.65	51	-4.72	14.69
River Reach 6	Brown Bullhead	74	-3.21	21.6	88	-4.11	16.88	71	-4.76	14.55
River Reach 6	Largemouth Bass	38	-9.65	7.19	42	-8.2	8.45	31	-4.4	15.76
River Reach 6	Smallmouth Bass	43	-3.82	18.16	54	-2.78	24.93	47	-2.35	29.53
River Reach 6	Yellow Perch	72	-12.73	5.44	87	-8.97	7.73	71	-6.13	11.31
River Reach 5	Brown Bullhead	203	-4.46	15.55	231	-3.49	19.85	202	-2.12	32.67
River Reach 5	Largemouth Bass	202	-5.6	12.37	226	-3.93	17.64	199	-2.7	25.69
River Reach 5	Smallmouth Bass	68	-1.05	65.92	74	-1.4	49.58	71	-1.44	48.14
River Reach 5	Yellow Perch	177	-8.92	7.77	207	-5.98	11.6	176	-4.13	16.78
River Reach 8	Arithmetic Mean for Sport Fish Recovery		-7.66	9.05		-6.76	10.25		-5.99	11.58
River Reach 7	Arithmetic Mean for Sport Fish Recovery		-5.34	12.98		-3.69	18.77		-2.18	31.75
River Reach 6	Arithmetic Mean for Sport Fish Recovery		-7.35	9.43		-6.02	11.52		-4.41	15.72
River Reach 5	Arithmetic Mean for Sport Fish Recovery		-5.01	13.84		-3.70	18.73		-2.60	26.69
All Reaches	Arithmetic Mean for Sport Fish Recovery		-6.41	10.82		-5.13	13.51		-3.90	17.77
All Reaches	Frankenfish*		-6.56	10.57		-5.83	11.90		-4.67	14.85
Min Rate (Fastest Recovery)			-12.73	5.44		-9.85	7.04		-7.65	9.06
Max Rate (Slowest Recovery			0.74	65.92		1.01	49.58		0.44	48.14
Standard Deviation (Sample)			3.79	31.68		2.92	24.40		2.25	47.60

* Reach 7 is not included due to lack of data for Largemouth Bass

Table S5b: Lipid Normalized Total PCB Aroclor Trends in Forage Fish Whole Body

		Lipid Normalized Total PCB Aroclor in Whole Body								
		1995-2008, 2016 Data			**Supplemented with 2017 GE Data**			**Supplemented with 2017 GE Data (2016 Removed)**		
Reach	**Fish**	**N**	**Recovery Rate (%)**	**Half-life (years)**	**N**	**Recovery Rate (%)**	**Half-life (years)**	**N**	**Recovery Rate (%)**	**Half-life (years)**
River Reach 8	Pumpkinseed	373	-9.01	7.7	403	-6.93	10.01	369	-4.23	16.37
River Reach 8	Spottail Shiner	23	-9.18	7.55	25	-6.98	9.93	18	-4.19	16.53
River Reach 8	All Shiners	32	-10.18	6.81	39	-9.11	7.61	32	-8.98	7.72
River Reach 7	Pumpkinseed	27	-3.87	17.9	37	-0.53	130.14	27	2.12	-32.72*
River Reach 7	All Shiners	6	2.1	-33.02*	10	2.36	-29.4*	8	2.51	-27.66*
River Reach 6	Pumpkinseed	155	-8.31	8.34	170	-4.71	14.72	155	-3.62	19.16
River Reach 6	Spottail Shiner	12	-7.31	9.48	18	-6.23	11.13	12	-5.62	12.33
River Reach 6	All Shiners	36	-2.89	24.02	42	-0.66	104.33	36	-1.35	51.21
River Reach 5	Pumpkinseed	413	-8.88	7.8	443	-6.34	10.93	412	-5.65	12.26
River Reach 5	Spottail Shiner	26	-2.13	32.54	30	-1.34	51.83	23	-0.59	117.82
River Reach 5	All Shiners	46	-3.45	20.08	55	-1.74	39.83	43	-0.47	148.52
Arithmetic Mean of Pumpkinseed			-7.52	9.22		-4.63	14.98		-2.85	24.36
Arithmetic Mean of Forage Fish (Excluding All Shiners)			-6.96	9.97		-4.72	14.68		-3.11	22.28
Min Rate (Fastest Recovery)			-10.18	6.81		-9.11	7.61		-5.65	-32.72
Max Rate (Slowest Recovery			2.10	-33.02		2.36	-29.40		2.12	-27.66
Standard Deviation (Samples)			2.82	9.35		2.70	44.99		2.86	41.93

NA = Not Available (insufficient data)

* A negative half-life indicates that concentrations are increasing.

As shown in Table S4 and Figures S4a-d, when the GE 2017 dataset is added, the recovery rates for the forage fish are slower than the EPA's rate of decline of 8% per year. For the sport fish fillets, only the rates of the yellow perch in Reaches 6 and 8, and the largemouth bass in Reach 6, meet or exceed the 8% average yearly recovery rate advocated by the EPA. If the 2016 data is excluded for a sensitivity analysis, all recovery rates for the forage fish and sport fish datasets are slower than the 8% per year rate.

These results indicate that by applying the EPA methodology on the Aroclor data the EPA 8% per year recovery rate is generally not met. This implies that the EPA conclusion that natural restoration alone is on track to reach the goals of the 2002 Record of Decision is inconsistent with the Aroclor data collected to monitor the progress of recovery in the Hudson River.

3.4 PCB Concentrations Vary Within a River Reach

In the NYSDEC's December 2018 Data Summary Report, it is correctly noted that River Reaches should not be grouped without close consideration of intra-reach variability (EA Engineering 2018, p 5-1). This is supported by the data, and Figures S5a-c illustrate the intra-reach variability for PCBs in forage fish in: a) River Reach 8 near Three Sisters Islands (location R8-3 and Station TD3), b) River Reach 5 (locations R5N-1 and Station SW1), and c) River Reach 5 (locations R5N-2 and Station SW2). The recovery rate in these three areas are substantially slower than the average in the respective River Reaches. The yearly recovery rate for these three+ areas based on the Aroclor data are: -4.8%, -3.9%, and -2.5%, respectively. This compares to average rates of -6.9% for River Reach 8 and -6.34% for River Reach 5 (*see* Table S4b). Averaging over an entire Reach or River Section masks the unacceptably low recovery rates of these regions and masks the contamination that prevents these areas from reaching the goals of the EPA.

3.5 Remedial Objectives in the 2002 ROD Have Not Been Met

In the 2002 Record of Decision, a concentration goal of 0.7 mg/kg and 0.07 mg/kg Total PCBs was established for the Spottail Shiner based on the Lowest Observed Adverse Effect Level (LOAEL) and the No Observed Adverse Effect Level (NOAEL) for the protection of the mink (USEPA 2002, p. 50). Figure S7 shows the total PCB concentration

for the Spottail Shiners gathered in 2017 by the NYSDEC and GE. Of these samples, 100% of the GE samples and 71% of the NYSDEC samples exceeded the LOAEL-based concentration goal (risk-based PRG). Furthermore, 100% of Spottail Shiners collected by both GE and NYSDEC exceed the NOAEL risk-based PRG of 0.07 mg/kg. The estimated time for the Spottail Shiner to reach a concentration of 0.7 mg/kg Total Aroclors is just over 30 years, and way beyond that for the 0.07 mg/kg criterion. These compliance times are much longer than required by the 2002 ROD. (*see* Table S6a)

Similarly, the 2002 ROD estimated that the interim goals of 0.4 mg/kg and 0.2 mg/kg for the species and length weighted fish fillet would be achieved 5 years and 16 years post-dredging, respectively. Using the rates of recovery that incorporate the most recent data, the time to reach these goals goes up to 19 and 31 years, respectively. These estimated recovery times are much longer than projected in the 2002 ROD. The fish tissue data indicates that the remedy is not on track to meet the goals of the 2002 ROD.

The mean concentration of Total Aroclors in the Spottail Shiner and "Frankenfish" are shown in Figure S7a-b. The 2002 ROD remedial action objectives for these two fish targets are 0.4 mg/kg for the "Frankenfish" and 0.7 mg/kg for the Spottail Shiner. The data indicate that the Spottail Shiner greatly exceeds the objective in all river reaches. The "Frankenfish" also exceeds the objective in all river reaches, except for one location in Reach 8. The data clearly demonstrate that the objectives outlined in the 2002 ROD are not met.

Table S6a: Recovery times for Spottail Shiner Wholebody					
Approach	**River Reach**	**Average Wet Weight Concentration**	**Rate**	**Years to 0.7 mg/kg**	**Years to 0.07 mg/kg**
Aroclor Trend	Overall*	3.80	-0.05	32	75
Aroclor Trend Supplemented with GE 2017	Overall*	3.80	-0.03	56	131
Aroclor Trend Supplemented with GE 2017	River Reach 8	2.65	-0.07	19	52
Aroclor Trend Supplemented with GE 2017	River Reach 7**	6.1	0.02	-92	-189
Aroclor Trend Supplemented with GE 2017	River Reach 6	3.85	-0.06	27	64
Aroclor Trend Supplemented with GE 2017	River Reach 5	3.71	-0.01	124	296

*The mean of all Spottail Shiner samples, not normalized by reach length.

** River Reach 7 only has 1 Spottail Shiner sample

Table S6b: Recovery times for species and length weighted average recovery rates					
Approach	**River Reach**	**Average Wet Weight Concentration**	**Rate**	**Years to .4 mg/kg**	**Years to .2 mg/kg**
Aroclor Trend	Overall*	1.20	-0.07	17	27
Aroclor Trend Supplemented with GE 2017	Overall*	1.20	-0.06	19	31
Aroclor Trend Supplemented with GE 2017	River Reach 8	1.11	-0.07	14	24
Aroclor Trend Supplemented with GE 2017	River Reach 7**	2.69	-0.06	33	45
Aroclor Trend Supplemented with GE 2017	River Reach 6	1.57	-0.06	21	32
Aroclor Trend Supplemented with GE 2017	River Reach 5	1.09	-0.04	26	43

* Not including Reach 7 because there is no Largemouth bass sampled

** River Reach 7 did not include any Largemouth Bass sampling in 2017. The contributions of Yellow Perch and Brown Bullhead were scaled to compensate.

4. Conclusions

The integration of the NYSDEC 2017 and GE 2017 datasets in our analysis of the fish tissue data confirms the main conclusions reached in our August 2017 report, namely:

- PCB concentrations in surface sediments remain elevated and well above common cleanup goals implemented at other sediment sites.
- PCB recontamination has taken place in certain dredged areas.
- PCB concentrations in fish remains elevated and above the target concentrations in the 2002 Record of Decision.
- EPA's conclusion that natural recovery rates are sufficient to remedy the River Reaches and achieve the goals of the 2002 Record of Decision is not supported by the data.

Based on the review of sediment and fish tissue data for the Hudson River, we conclude that it is unlikely that the goals of the 2002 ROD can be met through natural recovery alone.

5. References

EA Engineering P.C. and Its Affiliate. 2018. Final Data Summary Report: Hudson River PCB Sediments OU-2 Site (546031) Upper Hudson River, New York. December.

S.S. Papadopulos & Associates Inc. 2017. Hudson River PCBs Site Proposed Second Five-Year Review – Technical Review. August.

U.S. Environmental Protection Agency. 2002. *Record of Decision - Hudson River PCBs Site, New York*.

U.S. Environmental Protection Agency. 2013. *Record of Decision - Gowanus Canal Superfund Site, Brooklyn, Kings County, New York*. September.

U.S. Environmental Protection Agency. 2017. *Proposed Second Five-Year Review Report for the Hudson River PCBs Superfund Site*. May 31.

GE 2017 dataset in excel format.

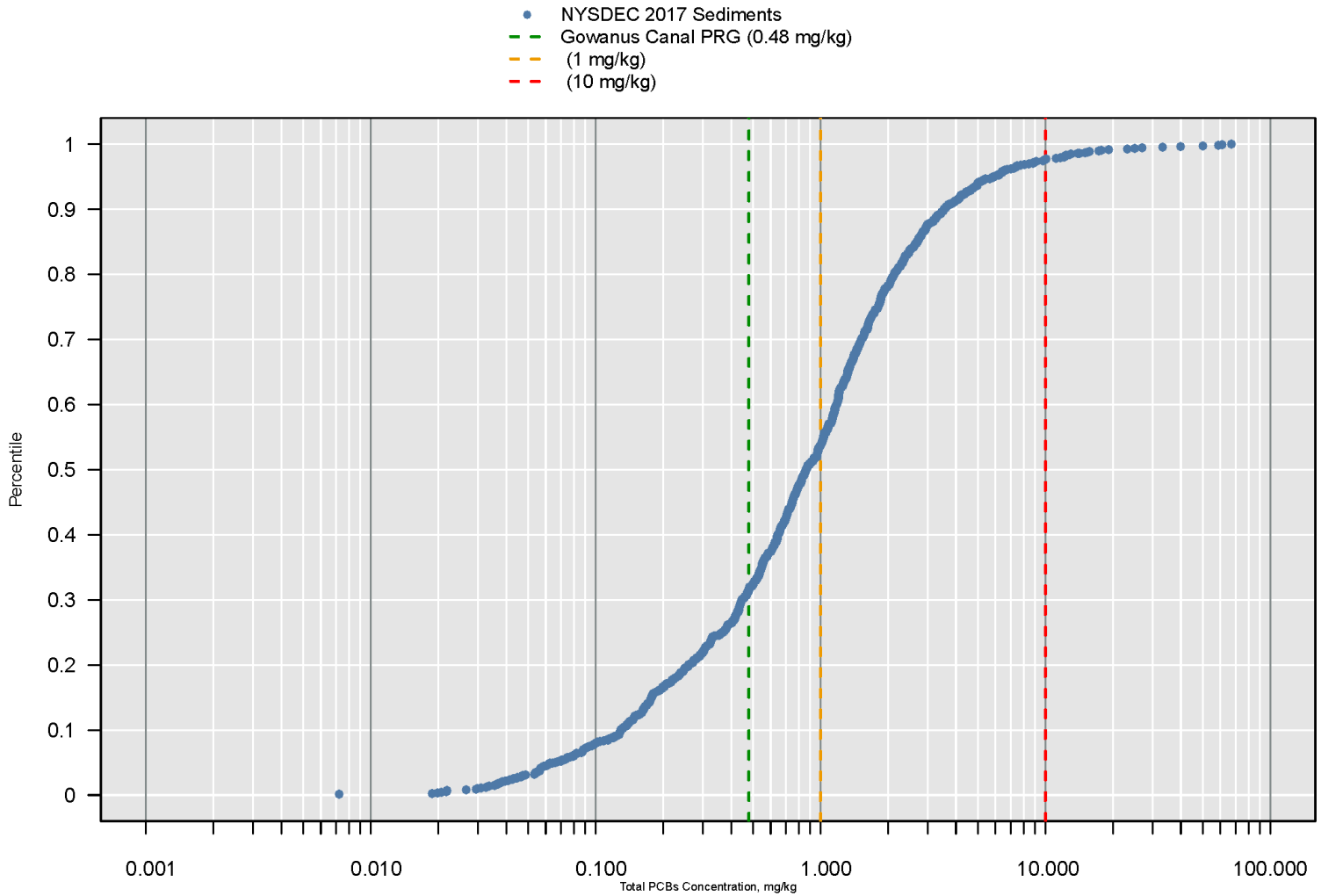


Figure S1a: Cumulative Distribution of Total PCBs in 2017 Surface Sediments Compared against Relevant Standards

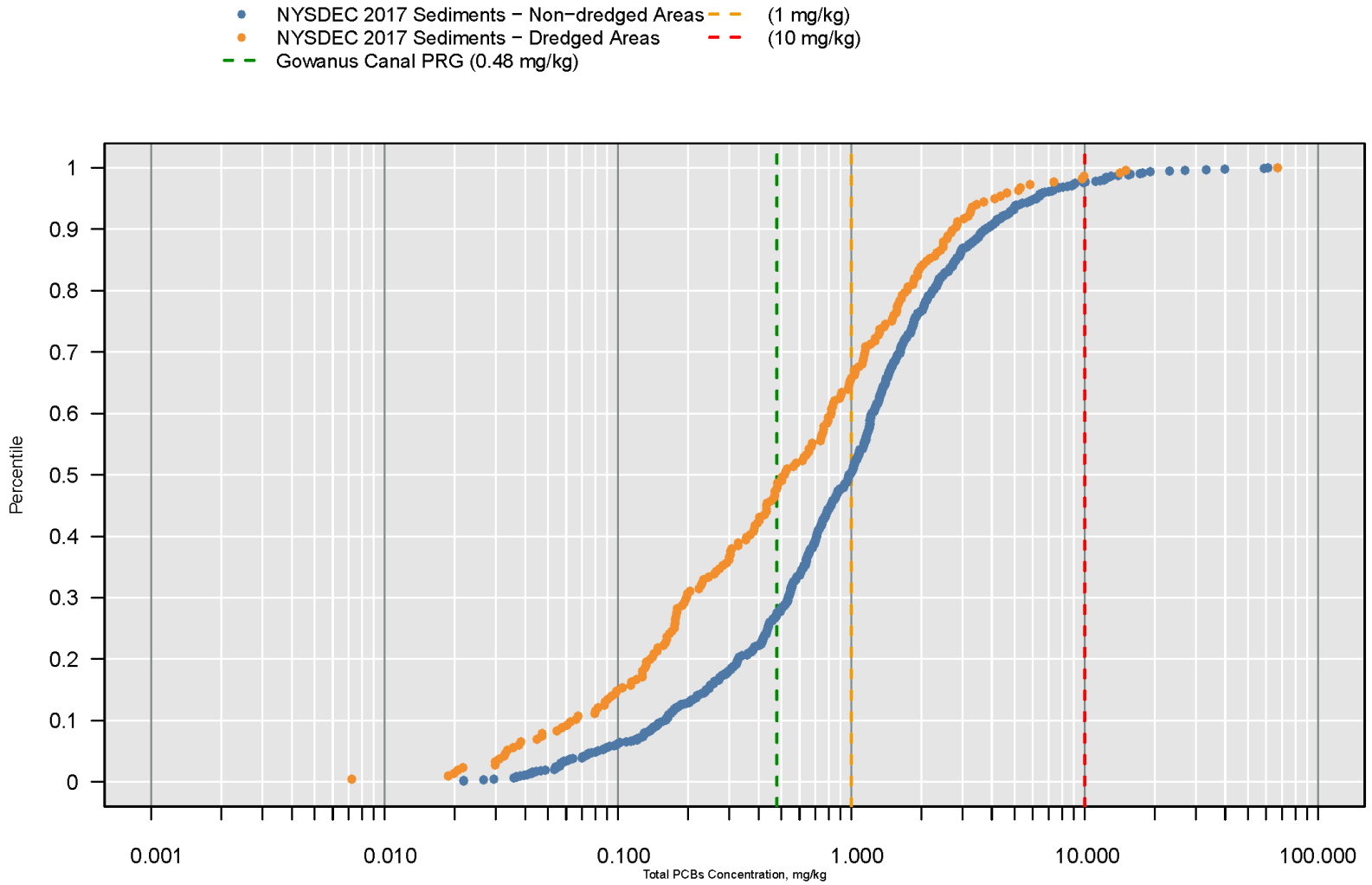


Figure S1b: Total PCBs in 2017 Dredged and Non-Dredged Area Surface Sediments Compared Against Relevant Standards

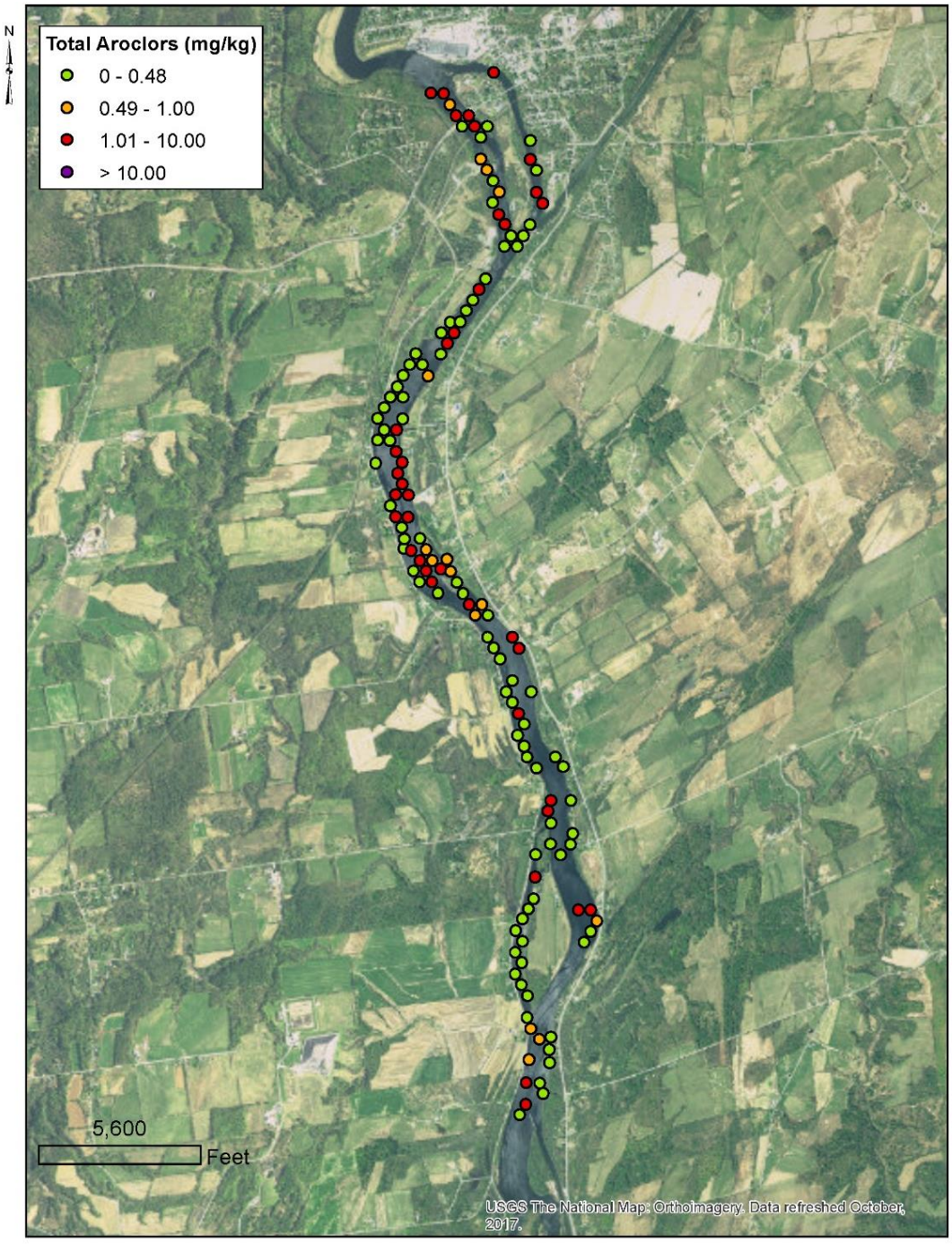


Figure S2a: 2017 Sediment Data in Dredged Areas – Reach 8

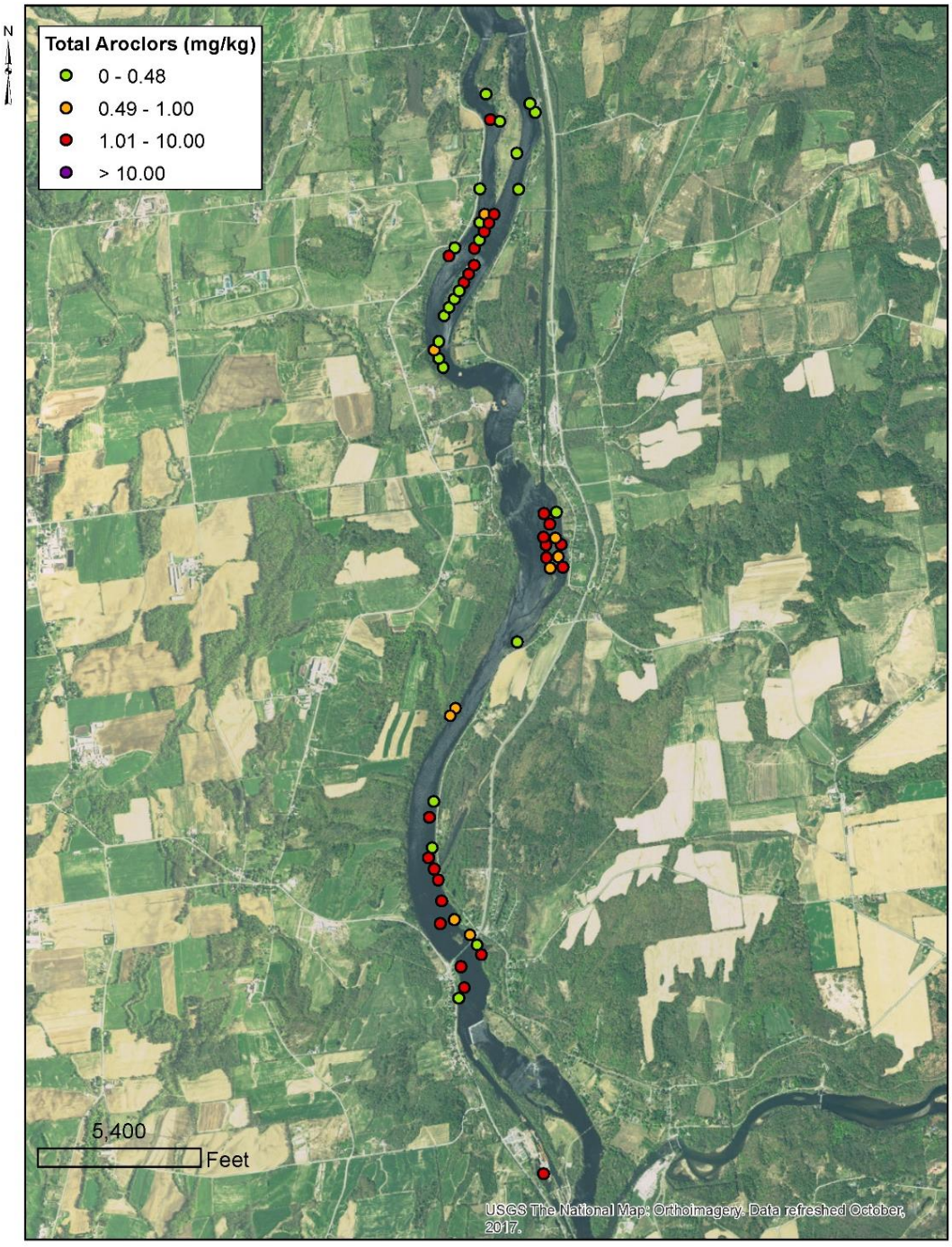


Figure S2b: 2017 Sediment Data in Dredged Areas – Reaches 7 and 6

Figure S2c: 2017 Sediment Data in Dredged Areas – Reach 5

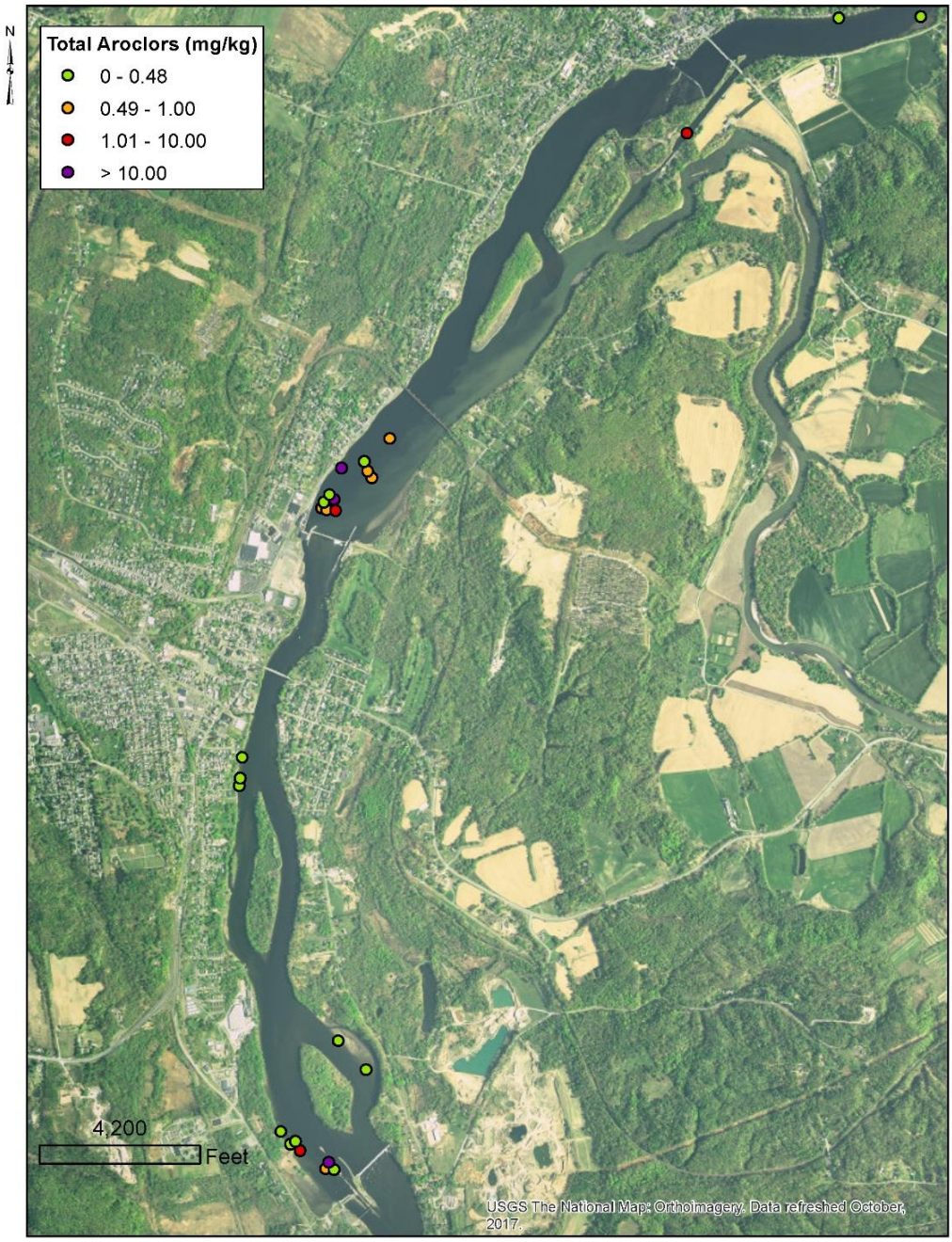


Figure S2d: 2017 Sediment Data in Dredged Areas – Reaches 4 and 3

Figure S2e: 2017 Sediment Data in Dredged Areas – Reaches 2 and 1

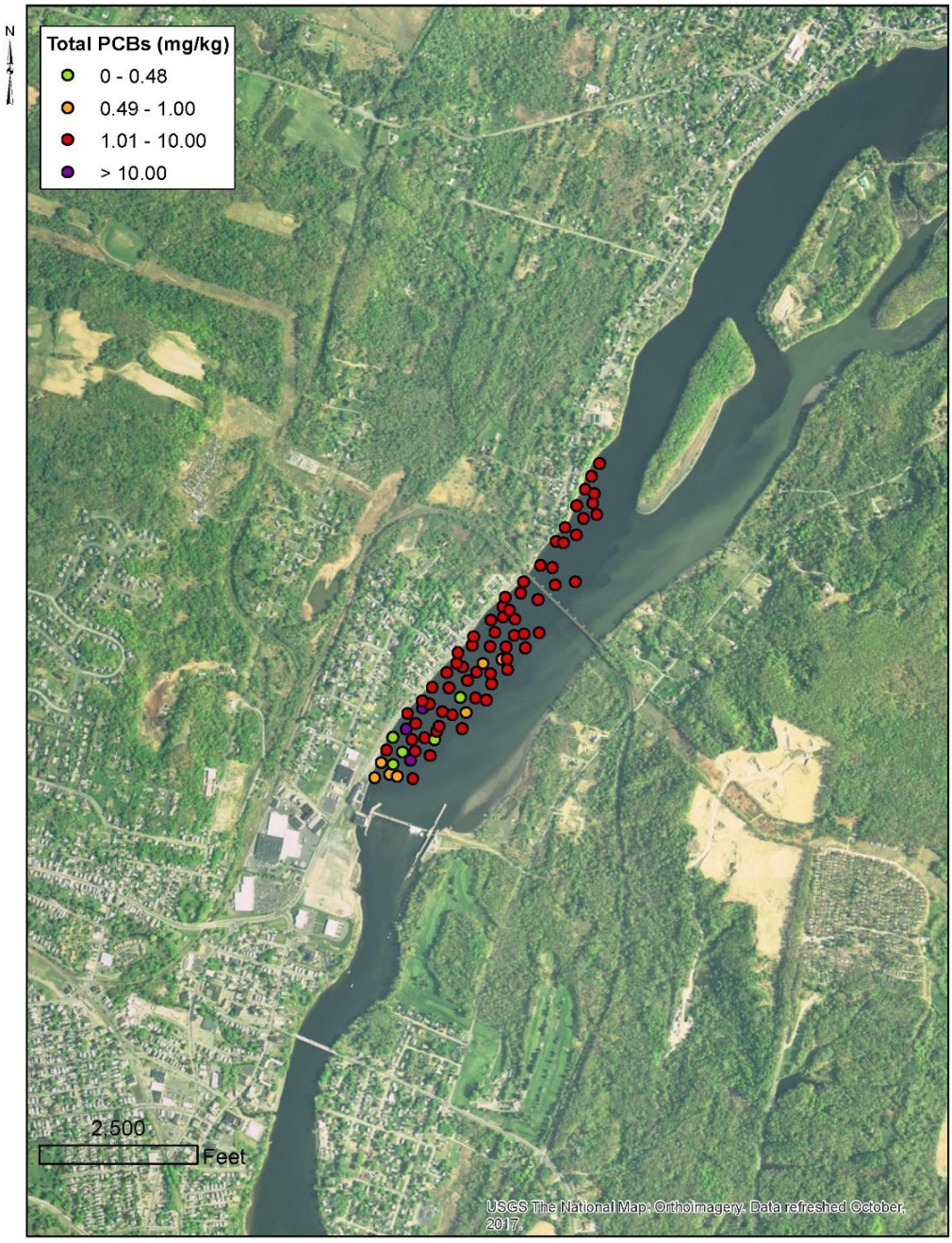


Figure S3a: Sediment Samples 2017 Total PCB Concentrations – Subset of Reach 4, North of Mechanicville, West Side of River

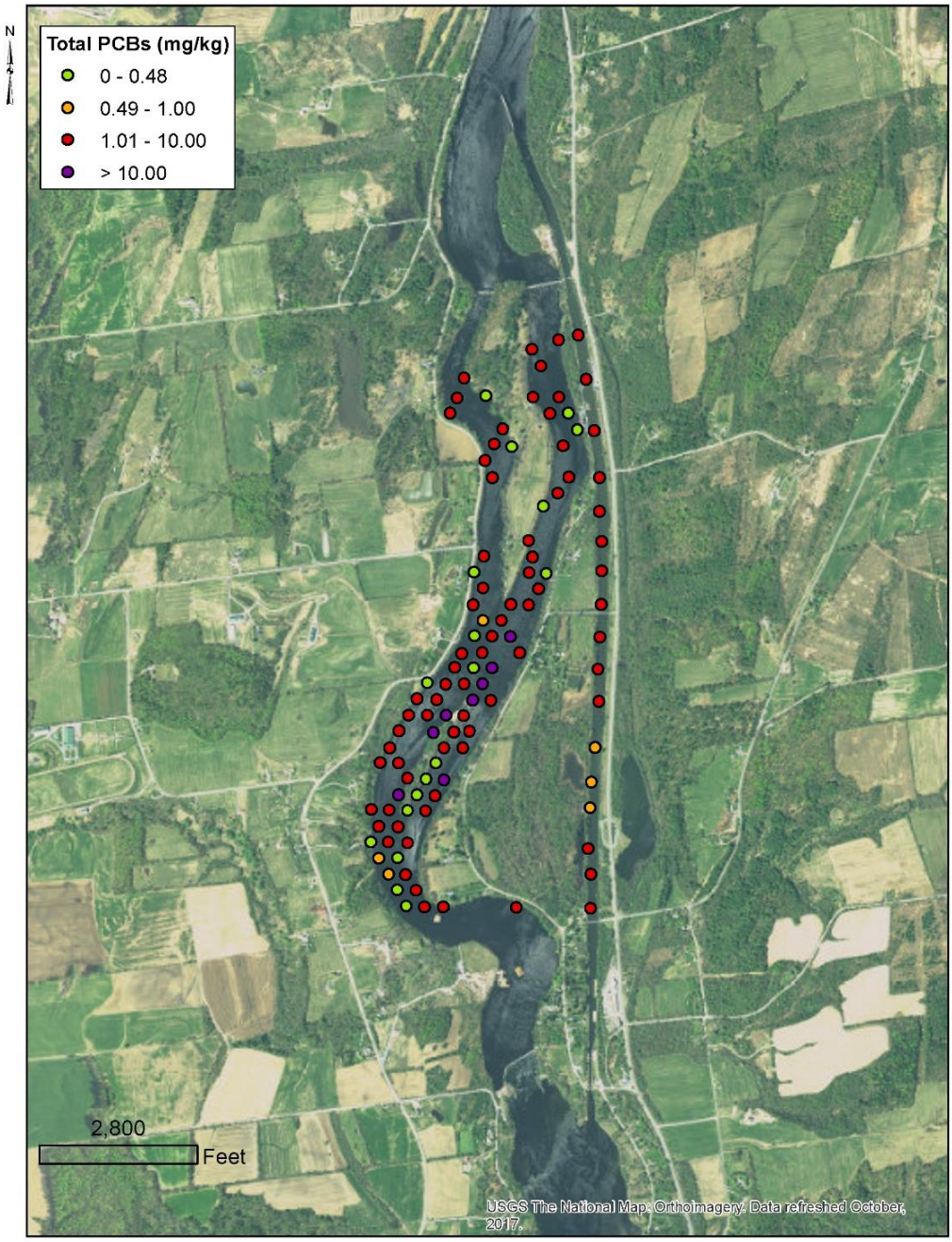


Figure S3b: Sediment Samples 2017 Total PCB Concentrations – Subset of Reach 7, North of Tuttle Brook

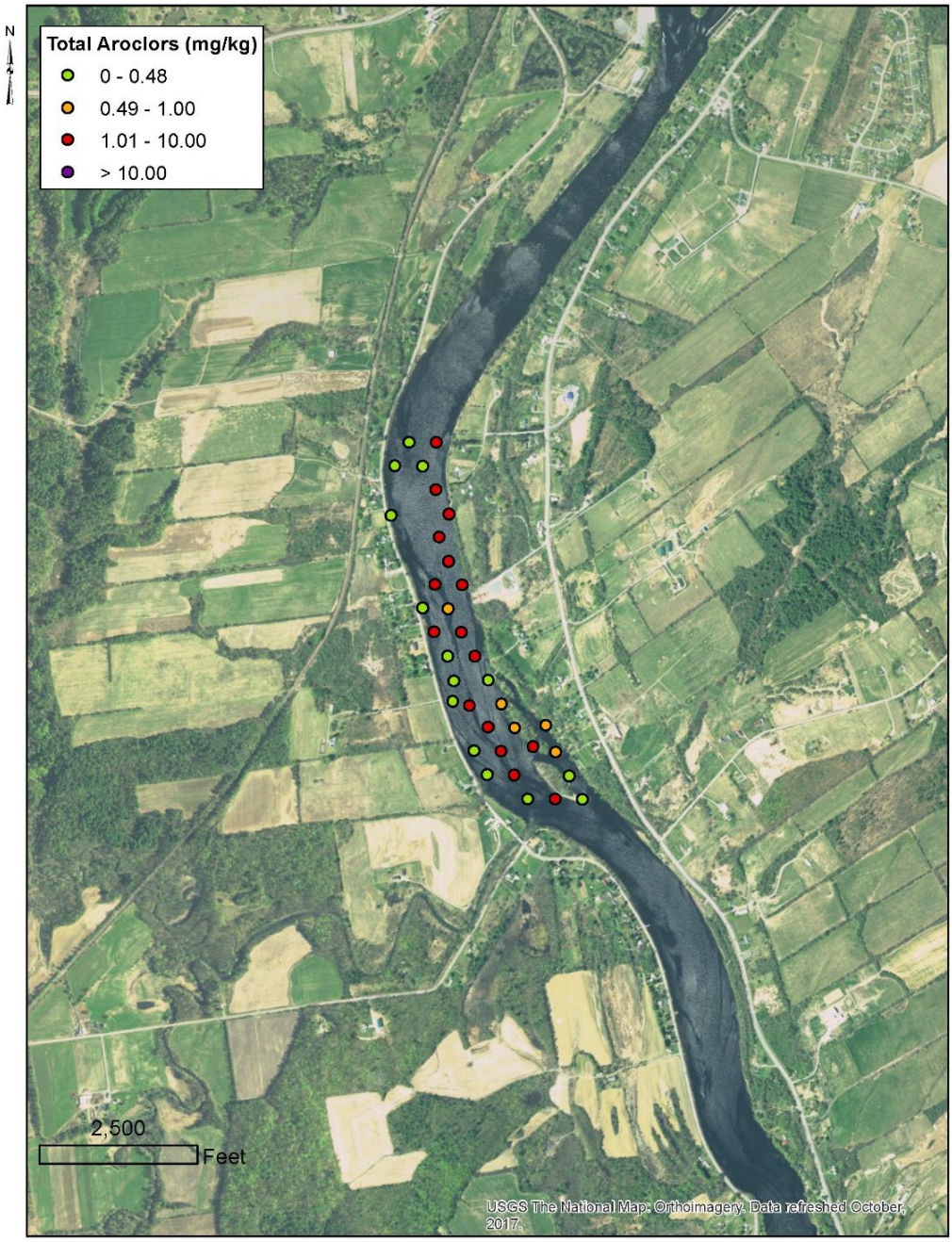
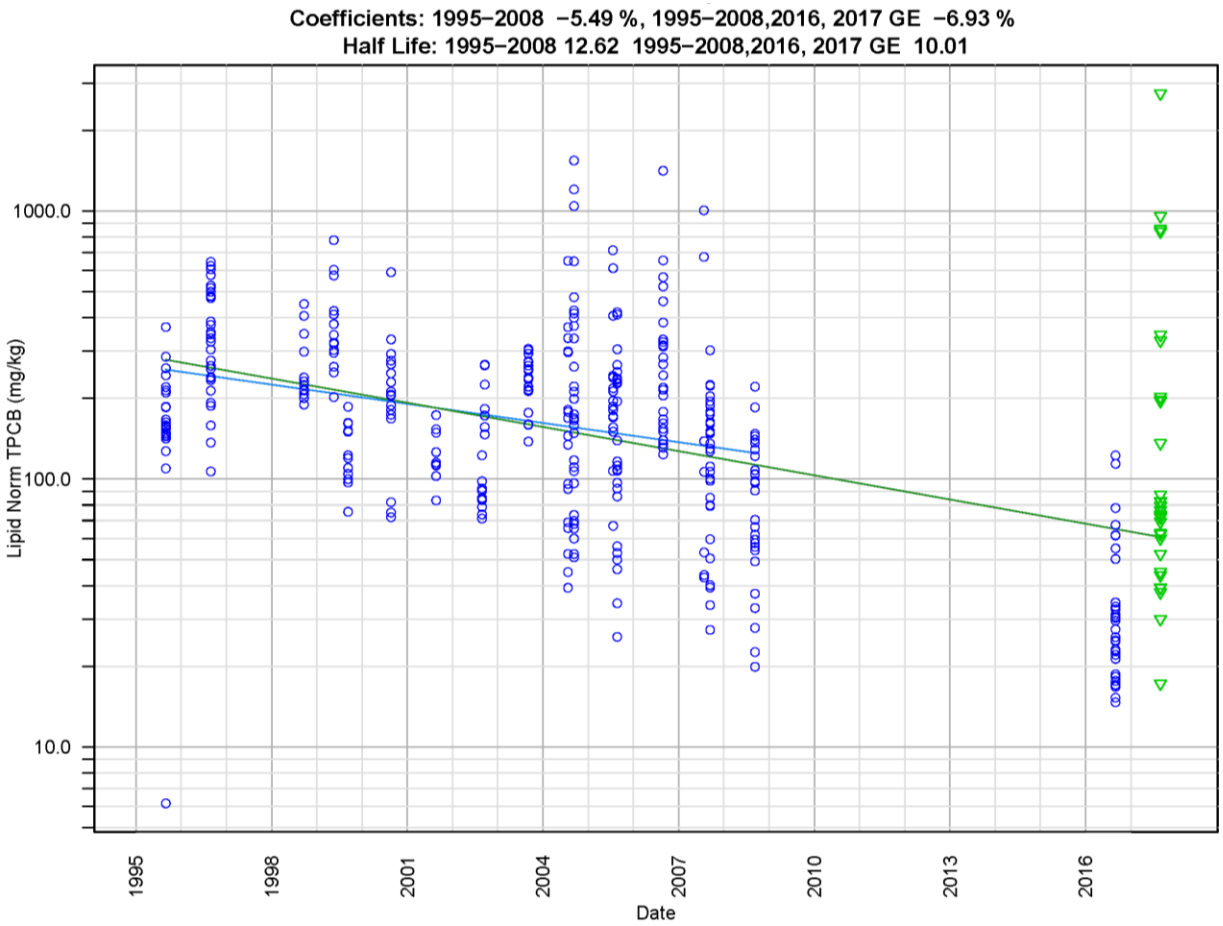


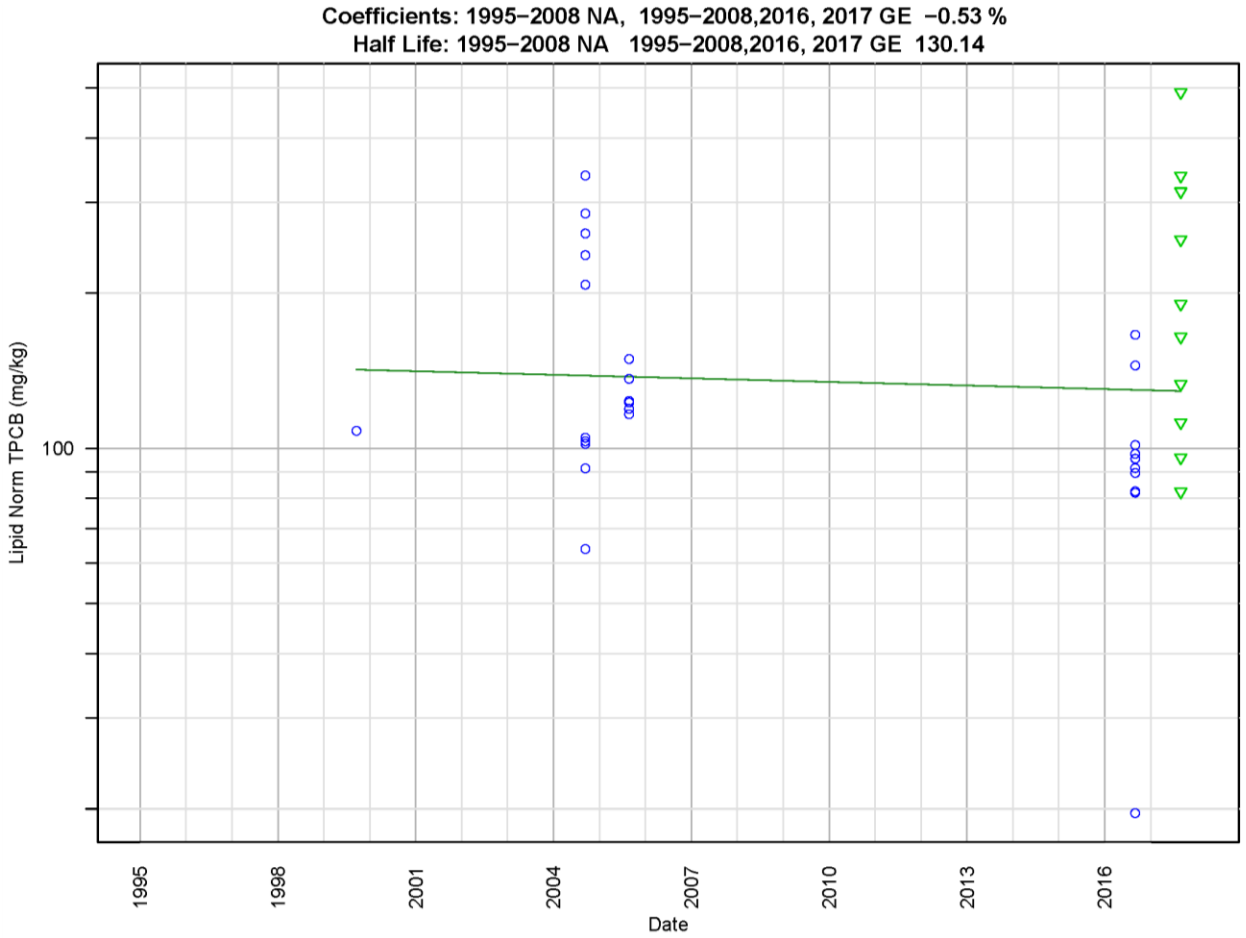
Figure S3c: Sediment Samples 2017 Total PCB Concentrations – Near Three Sisters Islands

Figure S4: Total PCB Congeners vs Total PCB Aroclors in 2017 Sediments (3 data points plot outside of the graph)

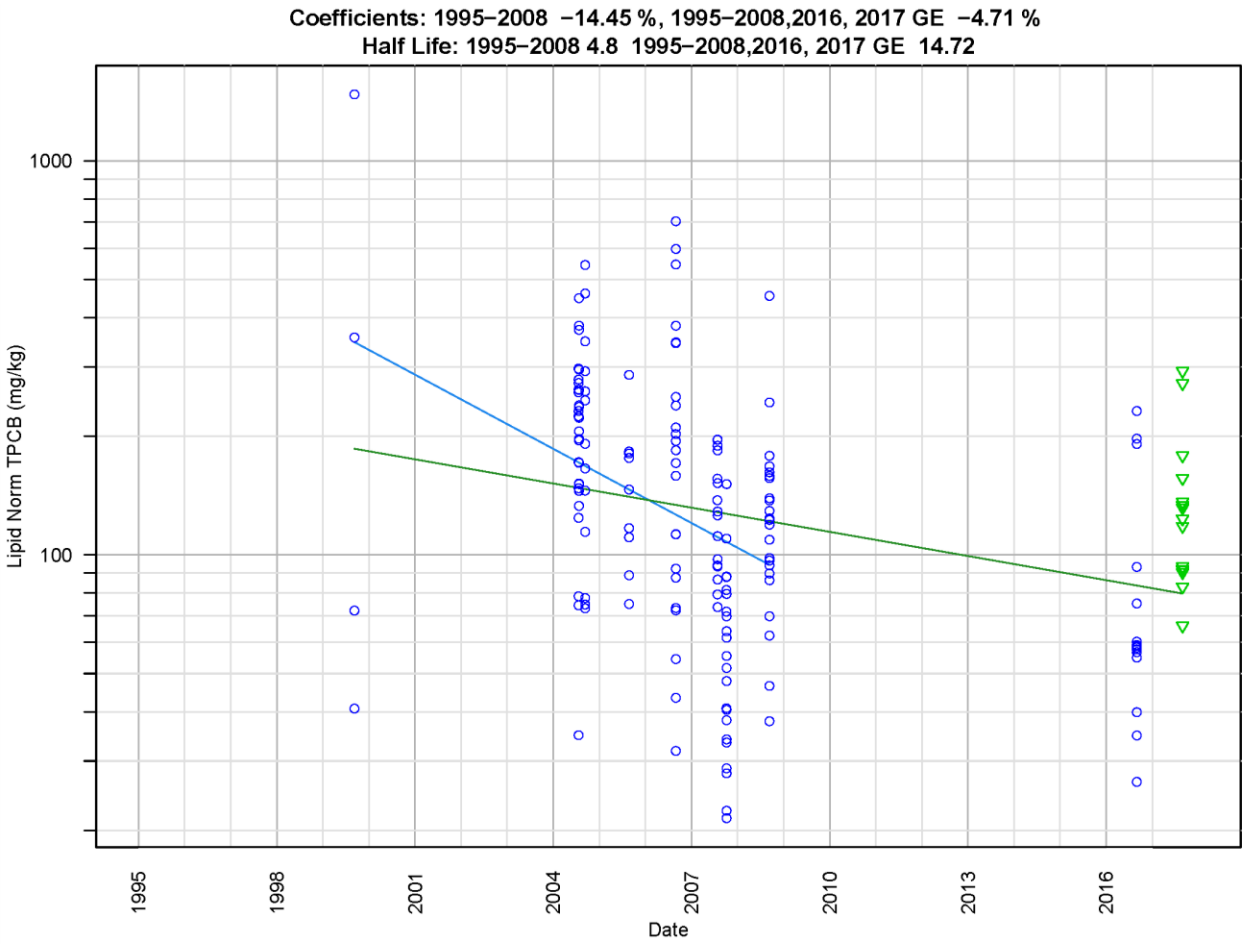


Blue circles are base Pumpkinseed dataset (1995:2008, 2016) and green triangles are GE 2017 Pumpkinseed

Figure S4a: Lipid Normalized Total Aroclors in Pumpkinseed – River Reach 8

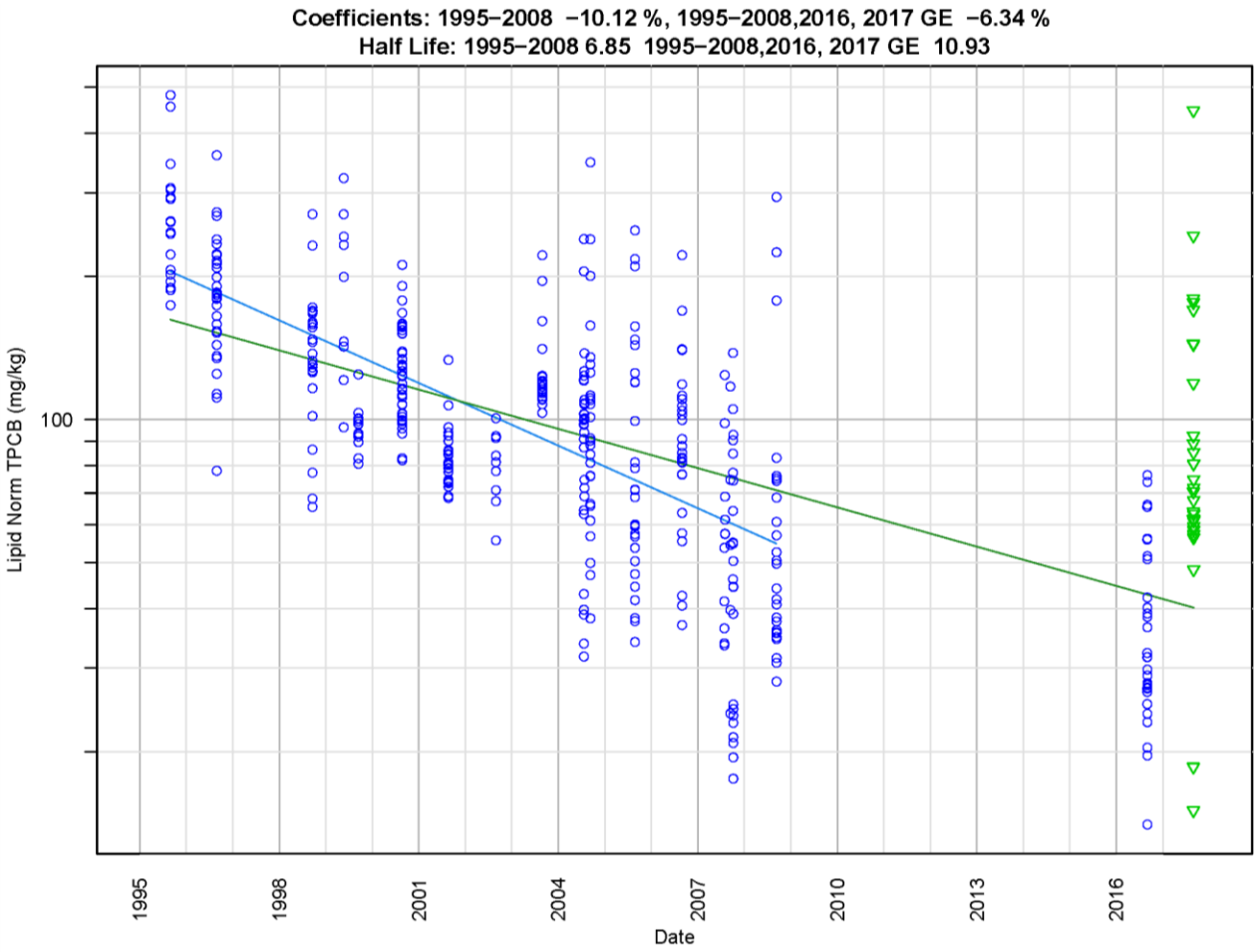


Blue circles are base Pumpkinseed dataset (1995:2008, 2016) and green triangles are GE 2017 Pumpkinseed
NA: Not Available (insufficient data)
Figure S4b: Lipid Normalized Total Aroclors in Pumpkinseed – River Reach 7



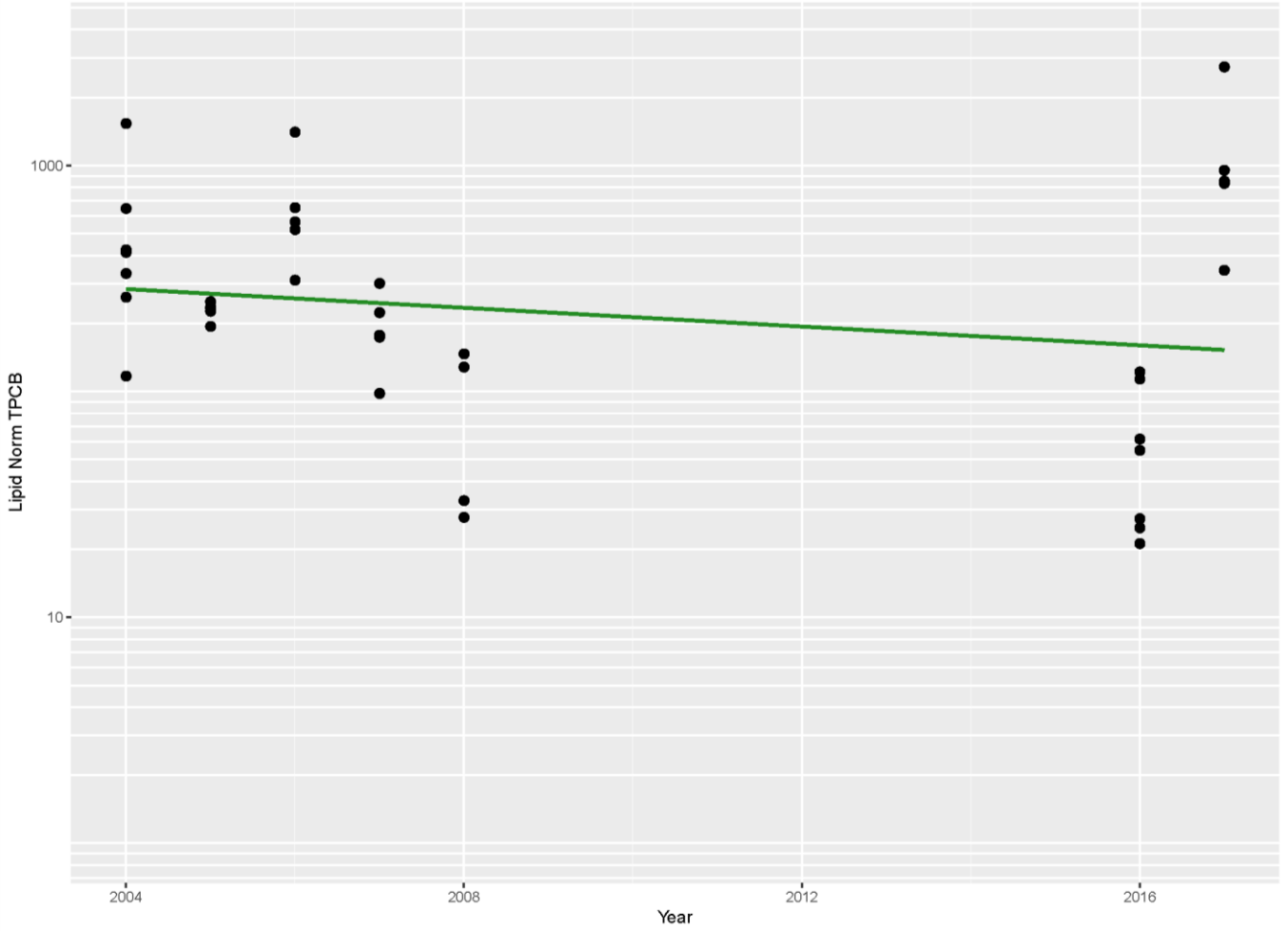
Blue circles are base Pumpkinseed dataset (1995:2008, 2016) and green triangles are GE 2017 Pumpkinseed

Figure S4c: Lipid Normalized Total Aroclors in Pumpkinseed – River Reach 6



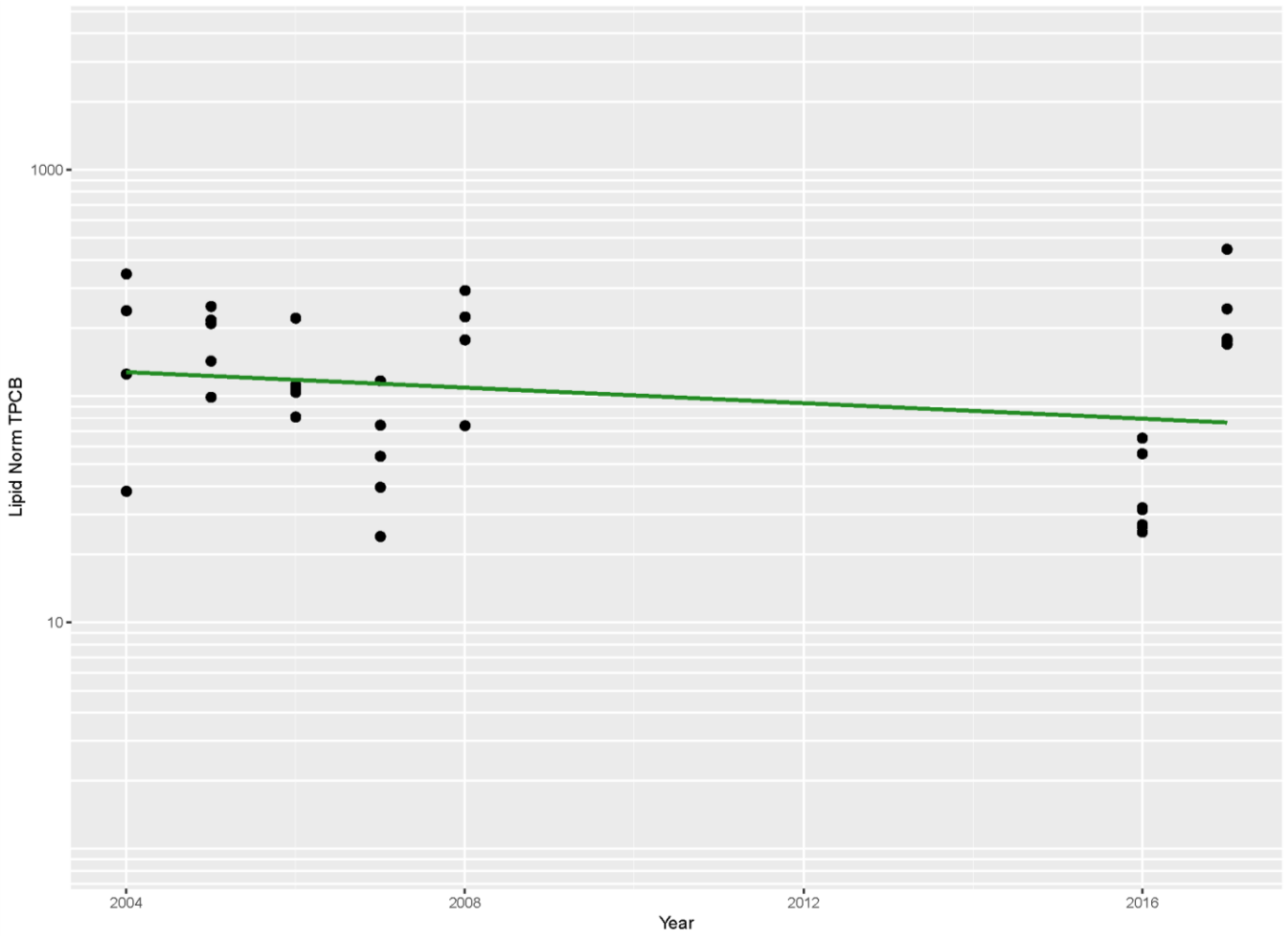
Blue circles are base Pumpkinseed dataset (1995:2008, 2016) and green triangles are GE 2017 Pumpkinseed

Figure S4d: Lipid Normalized Total PCBs in Pumpkinseed – River Reach 5



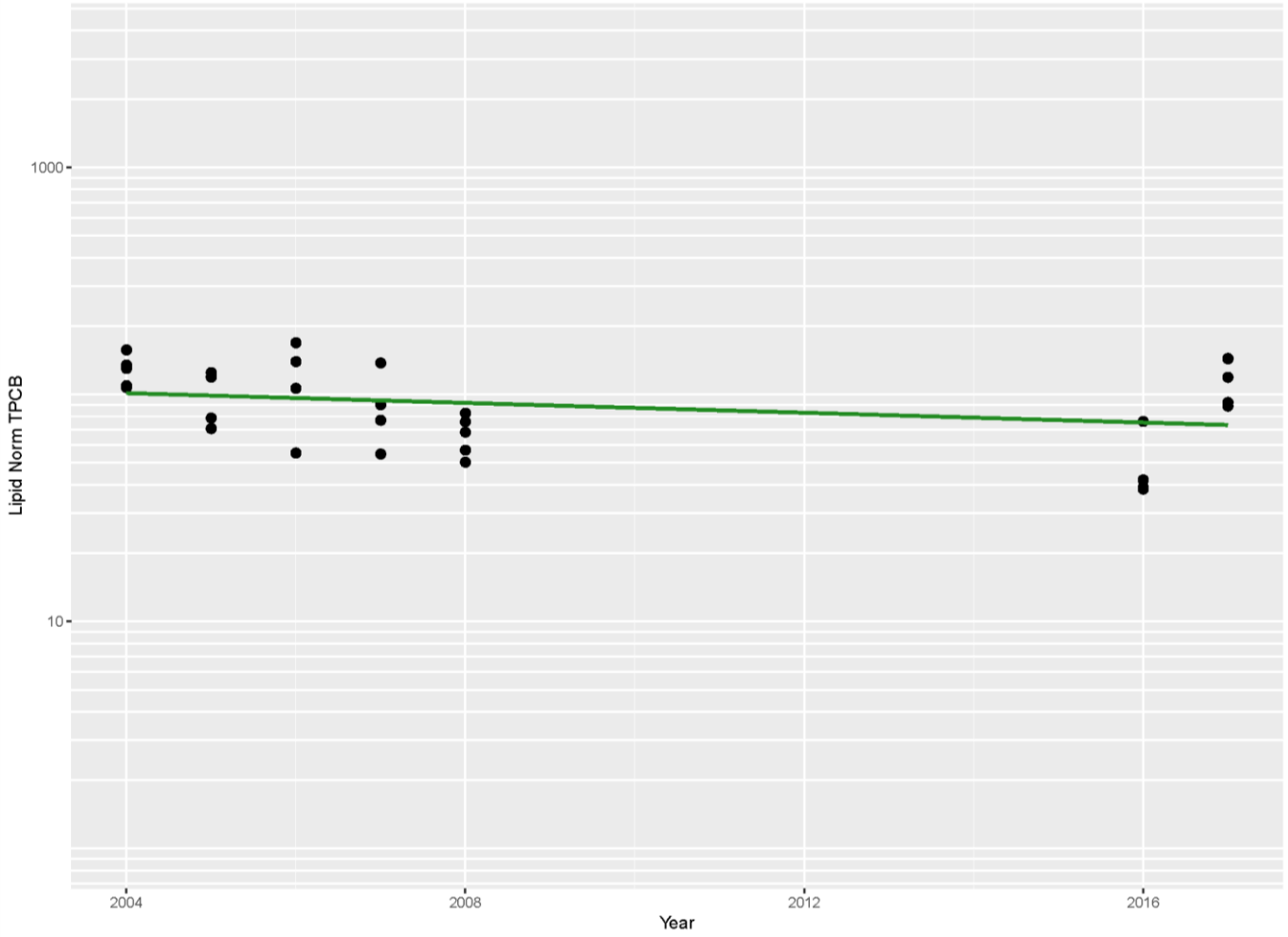
Using Lipid Normalized Total Aroclor data, including the GE 2017 data, the coefficient is -4.8% and the half-life is 14.4 years.

Figure S5a: Lipid Normalized Total PCBs in Pumpkinseed – Location R8-3 (Station TD3)



Using Lipid Normalized Total Aroclor data, including the GE 2017 data, the coefficient is -3.9% and the half-life is 17.5 years.

Figure S5b: Lipid Normalized Total PCBs in Pumpkinseed – Location R5N-1 (Station SW1)



Using Lipid Normalized Total Aroclor data, including the GE 2017 data, the coefficient is -2.5% and the half-life is 27.7 years.

Figure S5c: Lipid Normalized Total PCBs in Pumpkinseed – Location R5N-2 (Station SW2)

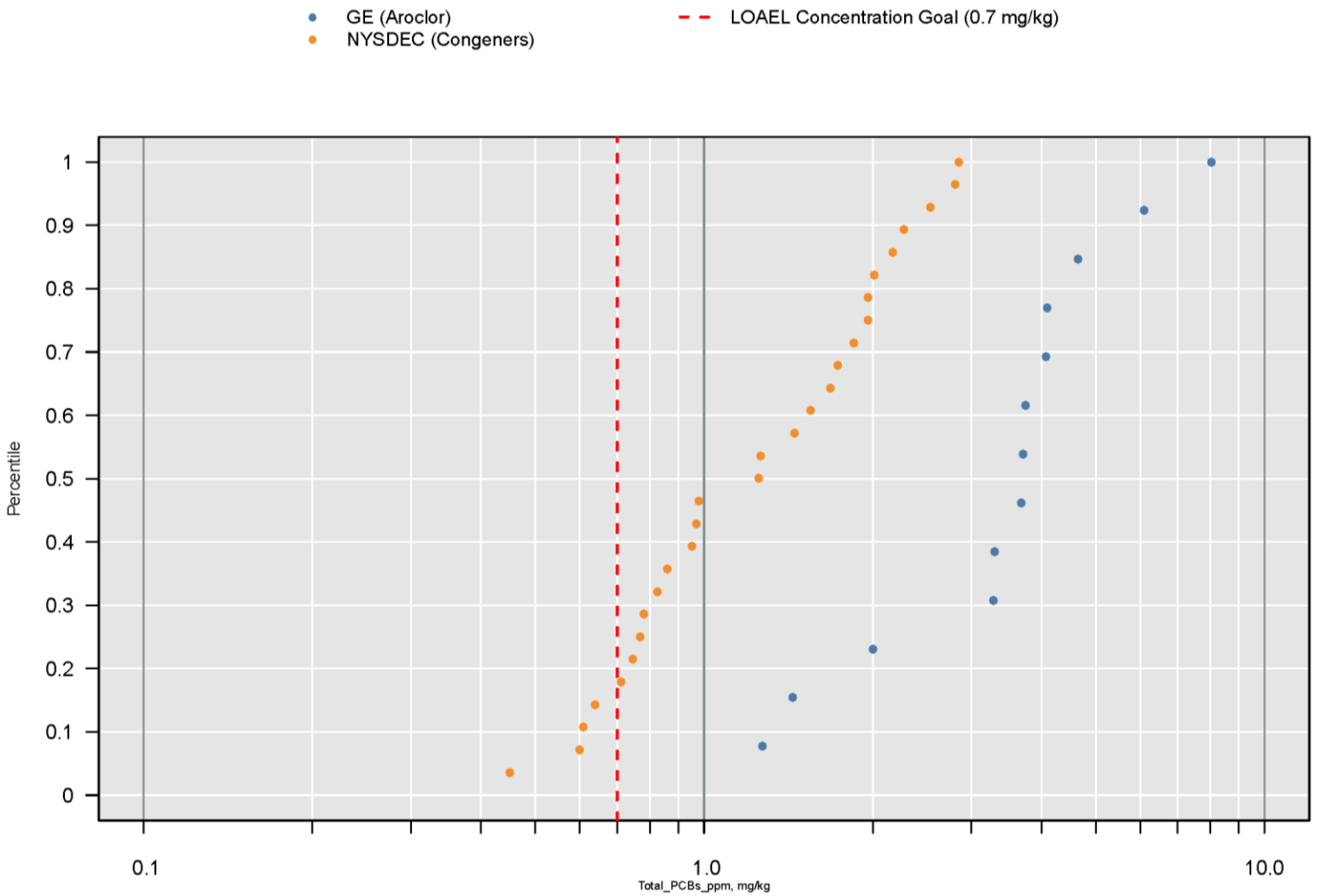


Figure S6: Spottail Shiner Samples Collected in 2017, Split by Sampling Campaign (all samples exceed the NOAEL risk-based criterion of 0.07 mg/kg)

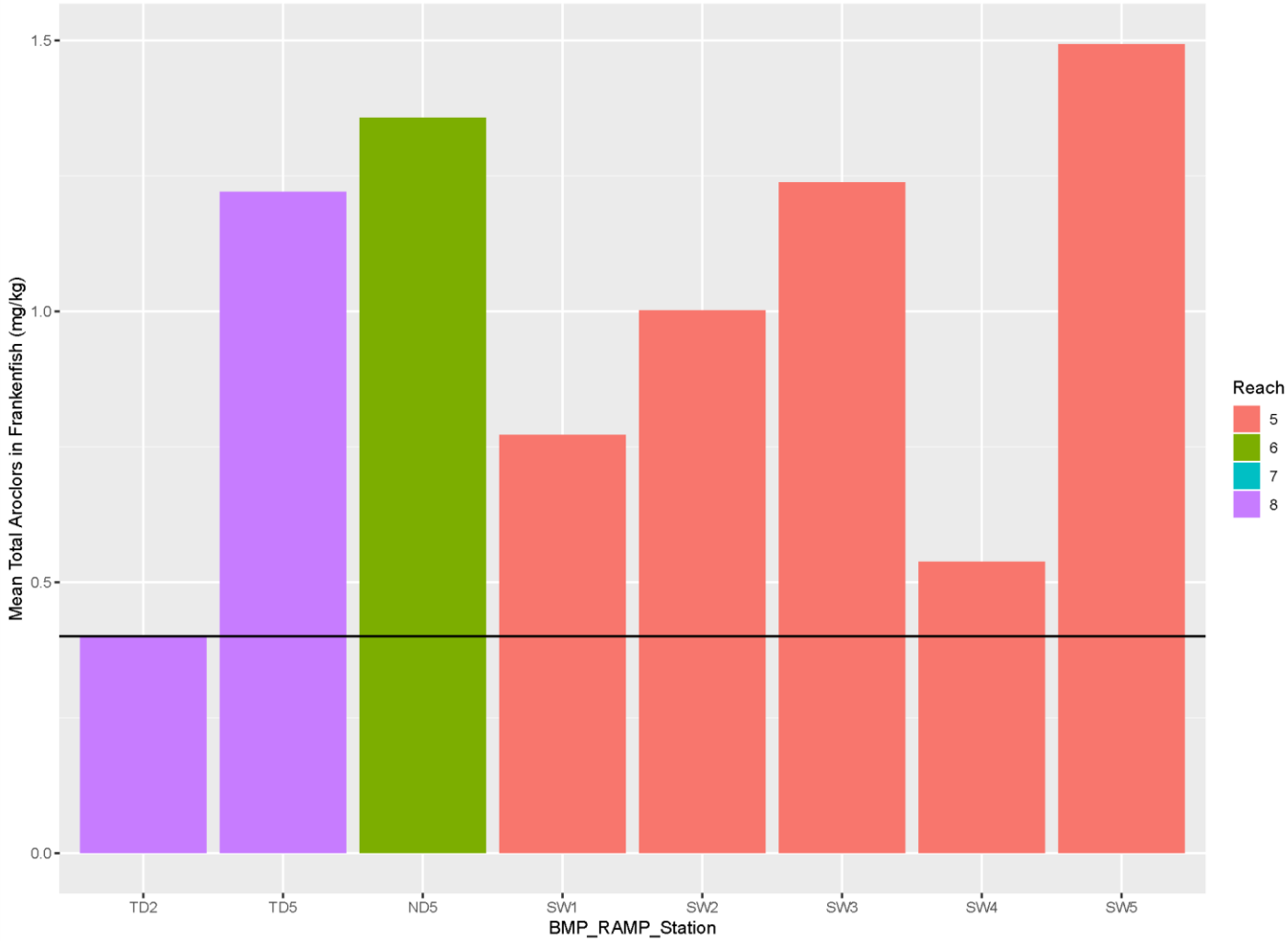


Figure S7a: 2017 Mean Total Aroclors in the Frankenfish for each sampling location

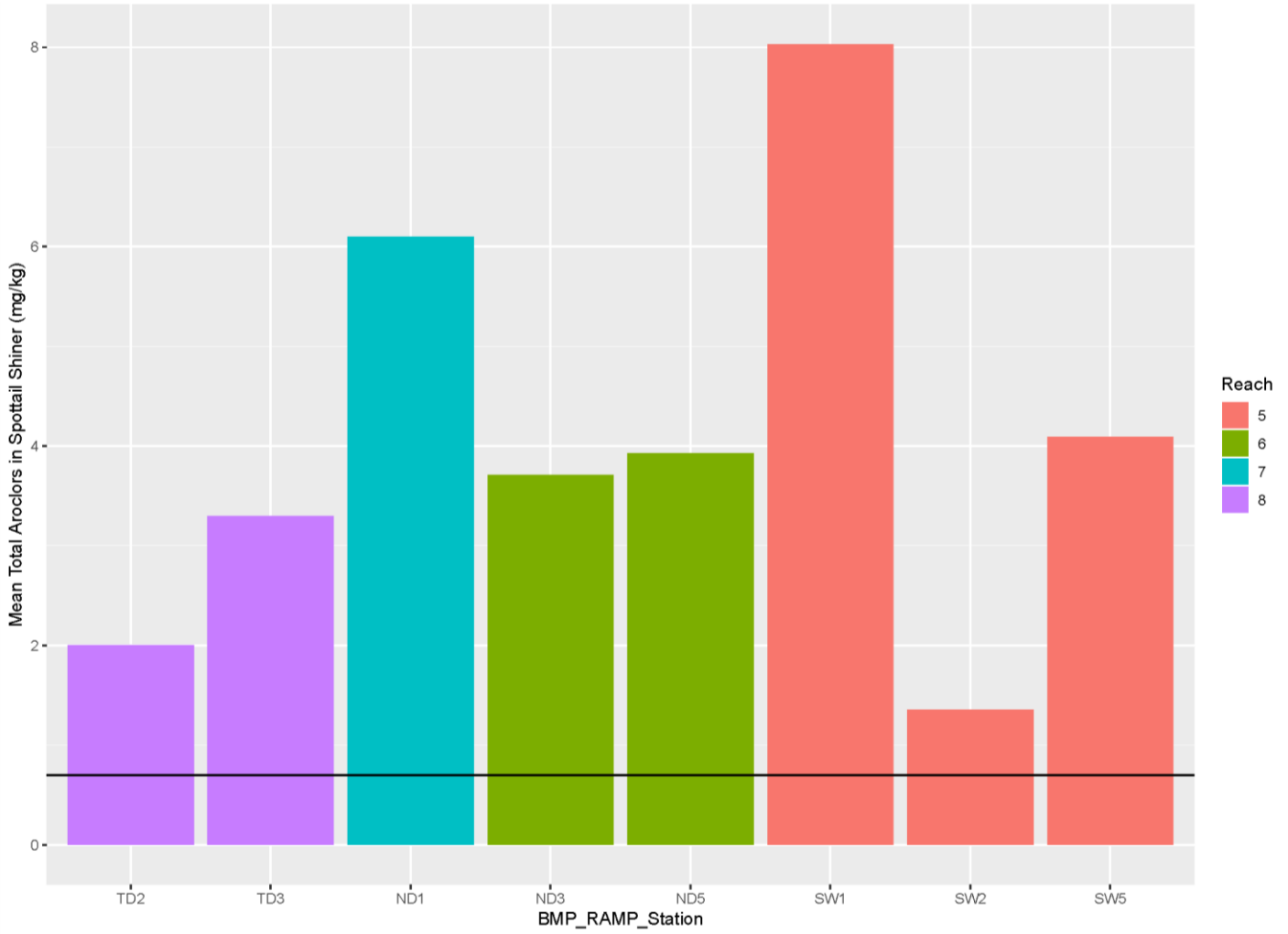


Figure S7a: 2017 Mean Total Aroclors in the Spottail Shiner for each sampling location