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Via Electronc Mail

June 30, 2022

Mr. Joshua Fontaine
EPA Project Manager
U.S. Environmental Protection Agency
New England Region
Five Post Office Square, Suite 100
Boston, MA 02109

Re: GE-Pittsfield/Housatonic River Site
Rest of River (GECD850)
Revised Baseline Monitoring Plan

Dear Mr. Fontaine:

In accordance with EPA's conditional approval letter dated March 29, 2022, enclosed for EPA's review and approval is the General Electric Company's (GE's) *Revised Baseline Monitoring Plan*.

Please let me know if you have any questions about this revised plan.

Very truly yours,

Kevin G. Mooney
Senior Project Manager – Environmental Remediation

Enclosure

Cc: (via electronic mail)
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Public Information Repository at David M. Hunt Library in Falls Village, CT
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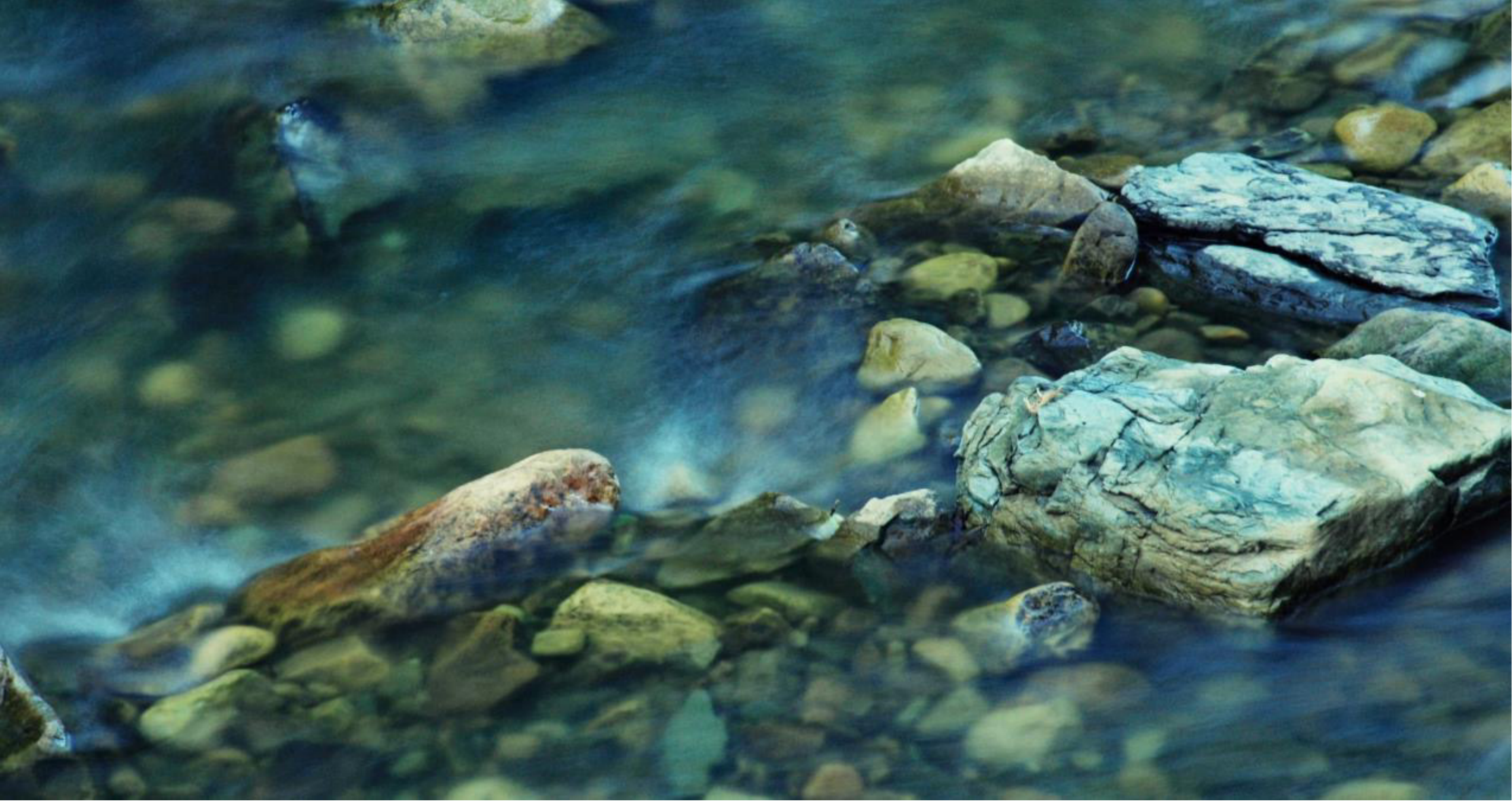

June 2022
Housatonic River – Rest of River

Revised Baseline Monitoring Plan

Prepared for General Electric Company

June 2022
Housatonic River – Rest of River

Revised Baseline Monitoring Plan

Prepared for
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Project Number: 190469-01.03

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ABBREVIATIONS

95th UCL	95th percentile Upper Confidence Limit on the mean
ANS	Academy of Natural Sciences
BB	brown bullhead
BBL	Blasland, Bouck & Lee
BDSR	Baseline Data Summary Report
BMP	*Baseline Monitoring Plan*
CAES	Connecticut Agricultural Experiment Station
CDEEP	Connecticut Department of Energy and Environmental Protection
CDEP	Connecticut Department of Environmental Protection (now CDEEP)
cm	centimeter
CT DOT	Connecticut Department of Transportation
CV	coefficient of variation
DO	dissolved oxygen
DQO	data quality objective
EAB	Environmental Appeals Board
EDI	equal discharge increment
EPA	U.S. Environmental Protection Agency
FF	fallfish
FSP/QAPP	*Revised Field Sampling Plan/Quality Assurance Project Plan*
GE	General Electric Company
GPS	global positioning system
Impd	impoundment
Interim BMP	*Interim Baseline Monitoring Work Plan*
LMB	largemouth bass
LMS	Lawler, Matusky & Skelly Engineers
mg/kg	milligram per kilogram
mm	millimeter
MNR	monitored natural recovery
ND	non-detect
ng/L	nanogram per liter
NGS	Northeast Generation Services
NP	northern pike
OC	organic carbon
PCB	polychlorinated biphenyl
PCBoc	OC-normalized PCB concentration
PQL	practical quantitation limit

PSA	Primary Study Area
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
Revised BMP	*Revised Baseline Monitoring Plan*
Revised Final Permit	Revised Final Modified RCRA Permit
RFI Report	*Housatonic River – Rest of River RCRA Facility Investigation Report*
ROR	Rest of River
SD	standard deviation
SMB	smallmouth bass
SOP	Standard Operating Procedure
SOW	*Rest of River Statement of Work*
USGS	U.S. Geological Survey
WS	white sucker
WWTP	Wastewater Treatment Plant
YOY	young-of-the-year
YP	yellow perch

1 Introduction

1.1 Background

In 2016, pursuant to the Consent Decree for the GE-Pittsfield/Housatonic River Site (EPA and GE 2000), the U.S. Environmental Protection Agency (EPA) issued to the General Electric Company (GE) a Modified Corrective Action Permit under the Resource Conservation and Recovery Act (RCRA), specifying a Remedial Action for the Rest of River (ROR) portion of that site, which extends from the Confluence of the East and West Branches of the Housatonic River in Pittsfield downstream through western Massachusetts and Connecticut. While many of the provisions of that Modified Permit were stayed pending an appeal to the EPA Environmental Appeals Board (EAB), one of the non-stayed provisions required GE to submit a *Baseline Monitoring Plan* (BMP) to provide for the collection of baseline (i.e., pre-remediation) data on polychlorinated biphenyls (PCBs) in surface water, sediments, and biota in the ROR area. GE submitted that BMP on June 12, 2017.

Subsequently, the EAB remanded the Modified Permit to EPA for reconsideration of two provisions. After such reconsideration, EPA issued a Revised Final Modified RCRA Permit (Revised Final Permit) to GE on December 16, 2020 (EPA 2020), setting forth a revised Remedial Action for the ROR.[1] In accordance with that revised permit, GE submitted a *Final Revised Rest of River Statement of Work* (SOW) on September 14, 2021, specifying the deliverables and activities to be conducted by GE to design and implement the ROR Remedial Action, and EPA approved that Final Revised SOW on September 16, 2021. The Revised Final Permit (like the 2016 Modified Permit) requires GE to conduct a baseline monitoring program, which must include the collection of "PCB data in surface water, sediment, and biota (and other data) . . . to serve as a baseline for the evaluation of the potential impacts of the Corrective Measures [i.e., remediation activities] and project operations as well as to inform model parameterization in the model re-evaluation plan" (Section II.B.4.b.(1)(a)). Further, Section II.B.4.b.(2) of the Revised Final Permit states: "For areas where MNR [monitored natural recovery] is the Performance Standard, monitoring shall begin with baseline monitoring and shall continue throughout the Remedial Action and O&M [operation and maintenance]." To address these requirements, the Final Revised SOW required GE to submit a revised BMP following the completion of discussions and conceptual agreement with EPA on the 2017 BMP and the scope of the baseline monitoring program.

In a letter dated November 24, 2021, EPA stated that it was still reviewing the 2017 BMP but was conditionally approving portions of four sections in that BMP to allow certain sampling to begin—specifically, sections relating to surface water sampling at selected locations and laboratory analysis of surface water samples. That surface water sampling was described in an *Interim Baseline*

[1] That Revised Final Permit was subsequently upheld by the EAB, rejecting arguments made by two environmental groups, in a decision dated May 8, 2022.

Monitoring Work Plan (Interim BMP) that GE submitted to EPA on January 10, 2022 (Anchor QEA 2022). EPA conditionally approved the Interim BMP in a letter dated February 17, 2022, and GE initiated surface water sampling pursuant to that plan in March 2022.

EPA conditionally approved the remainder of the 2017 BMP in a letter dated March 29, 2022, which reflected the discussions and conceptual agreement between GE and EPA on the scope of the baseline monitoring program and required GE to submit a revised BMP to implement that program. This *Revised Baseline Monitoring Plan* (Revised BMP) constitutes that revision.

1.2 Site Description

The ROR area consists of the portion of the Housatonic River and its backwaters and floodplain (excluding portions of certain residential properties) downstream of the Confluence (located approximately two miles downstream from the GE facility in Pittsfield). The ROR area is shown on Figure 1-1 and identified according to river reach designations established by EPA. Subreaches within Reaches 5 through 8 are shown on Figure 1-2. The ROR reaches and subreaches covered by the Revised Final Permit and this Revised BMP are as follows (from upstream to downstream):

- Reach 5, from the Confluence downstream to Woods Pond (the first significant impoundment). This reach is further divided into the following subreaches:
  - Reach 5A (Confluence to the Pittsfield Wastewater Treatment Plant [WWTP])
  - Reach 5B (Pittsfield WWTP to Roaring Brook)
  - Reach 5C (Roaring Brook to the start of Woods Pond)

  Reach 5 also contains several backwater areas adjacent to the Housatonic River, particularly in the more downstream portion of the reach (these backwaters were sometimes referred to as Reach 5D in past project documents but not in the Revised Final Permit).
- Reach 6, Woods Pond
- Reach 7, Woods Pond Dam to Rising Pond (the next significant impoundment). This reach is further divided into the following subreaches:
  - Reach 7A (Woods Pond Dam to the Columbia Mill Dam Impoundment)
  - Reach 7B (Columbia Mill Dam Impoundment)
  - Reach 7C (Former Eagle Mill Dam Impoundment)
  - Reach 7D (Former Eagle Mill Dam to the Willow Mill Dam Impoundment)
  - Reach 7E (Willow Mill Dam Impoundment)
  - Reach 7F (Willow Mill Dam to the Glendale Dam Impoundment)

  - Reach 7G (Glendale Dam Impoundment)
  - Reach 7H (Glendale Dam to Rising Pond)
- Reach 8, Rising Pond
- Reach 9, Rising Pond Dam to the Massachusetts/Connecticut border
- Reach 10, Massachusetts/Connecticut border to Falls Village Dam
- Reach 11, Falls Village Dam to Cornwall Bridge
- Reach 12, Cornwall Bridge to Bulls Bridge Dam
- Reach 13, Bulls Bridge Dam to Bleachery Dam
- Reach 14, Bleachery Dam to Shepaug Dam (Lake Lillinonah)
- Reach 15, Shepaug Dam to Stevenson Dam (Lake Zoar)
- Reach 16, Stevenson Dam to Lake Housatonic Dam (Lake Housatonic)

Section 2 of the *Housatonic Rest of River, Corrective Measures Study Proposal* (Arcadis BBL and QEA 2007) and Section 2 of the *Housatonic River – Rest of River, Revised Corrective Measures Study Report* (Arcadis et al. 2010) provided a more detailed description of the ROR area, including: (1) characteristics and landmarks associated with the river reaches; and (2) watershed, river, and floodplain characteristics. It also provided a summary of the nature and extent of PCBs in sediment, surface water, floodplain and riverbank soil, and biota, as well as a conceptual site model indicating that the highest concentrations and greatest mass of PCBs are found in Reaches 5 and 6—also known as the Primary Study Area (PSA)—with considerably lower concentrations downstream of Woods Pond Dam.

1.3 Summary of Applicable General Performance Standards for ROR Remedial Action

Section II.B.1 of the Revised Final Permit sets forth the General Performance Standards for the ROR Remedial Action. These include a Downstream Transport Performance Standard and Biota Performance Standards.

The Downstream Transport Performance Standard, specified in Section II.B.1.a.(1) of the Revised Final Permit, establishes annual average PCB flux values for transport of PCBs over Woods Pond Dam and Rising Pond Dam, depending on the annual average daily flow rates at those locations. It provides that an exceedance of the standard will occur if the annual average PCB flux is greater than the specified value(s) at either Woods Pond or Rising Pond in any three or more years within any five-year period following completion of construction-related activities.

There are two Biota Performance Standards, which are specified in Section II.B.1.b.(1)(a) of the Revised Final Permit. The first is a Short-Term Biota Standard, which is an average total PCB concentration of 1.5 milligrams per kilogram (mg/kg) wet weight, skin off, in adult fish fillets in each entire reach of the river and backwaters, to be achieved within 15 years of completion of construction-related activities for that reach (or, if the reach is subject to MNR, completion of construction in the closest upstream reach subject to active remediation). An exceedance of this standard is defined as concentrations above this level in any two consecutive monitoring periods after the 15-year period. The Long-Term Biota Standard consists of a requirement to continue to monitor biota to assess "progress towards achieving" specified long-term goals (average total PCB concentrations of 0.064 mg/kg, wet weight, in fish fillets in Massachusetts; 0.00018 mg/kg, wet weight, in fish fillets in Connecticut; and 0.075 mg/kg in duck breast tissue in all areas along the river).

In consideration of these standards, which apply following completion of remedial construction activities, the revised baseline monitoring program design has accounted for the types of data that would be needed to help evaluate the parameters subject to these standards prior to, during, and following construction. The revised program design has also considered the requirement of Section II.B.4.b.(2) of the Revised Final Permit that, for areas subject to active remediation, an inspection, monitoring, and maintenance program must be conducted upon completion of each phase of the Remedial Action. The baseline data collected under this Revised BMP will provide a basis for comparison in that post-construction monitoring program.

In addition, the Revised Final Permit establishes MNR as the Performance Standard for the flowing subreaches in Reach 7 (Reaches 7A, 7D, 7F, and 7H) and for Reaches 9 through 16 (Section II.B.2.h). It provides, in Section II.B.4.b.(2), that, "[f]or areas where MNR is the Performance Standard, monitoring shall begin with baseline monitoring and shall continue throughout the Remedial Action and O&M." Further, Section II.B.2.h provides that "[t]o achieve and maintain this Performance Standard, Permittee shall conduct monitoring of PCB concentrations in affected media (including surface water, sediment, and biota) in these reaches to see if recovery is occurring at the expected rate, maintain institutional controls, and perform all other related activities." Therefore, the design of the revised baseline monitoring program has considered factors such as data comparability over a long-term record to facilitate future evaluations of natural recovery.

1.4 Plan Organization

The remainder of this Revised BMP is organized into the following sections:

- Section 2 describes the Data Quality Objectives (DQOs) for the baseline monitoring program.
- Section 3 provides a summary of previous monitoring of surface water, sediment, and biota, including a summary of the existing PCB data from the prior monitoring.

- Section 4 presents a description of the proposed baseline monitoring activities, including sampling locations, number of samples, sampling procedures, and frequency.
- Section 5 describes the schedule for performance of baseline monitoring activities and provides a description of how the baseline data collection activities and analytical results will be reported.

2 Data Quality Objectives

Based on the requirements for Inspection, Monitoring, and Maintenance set forth in Section II.B.4 of the Revised Final Permit, and in accordance with Condition #1 in EPA's March 29, 2022 conditional approval letter, the following data quality objectives (DQOs) have been established for the baseline monitoring program:

DQO 1. Provide sufficient baseline data to support further evaluation of the effectiveness of the ROR Remedial Action/Corrective Measures in reaches with active remediation after remediation is complete in each such reach.

DQO 2. Collect sufficient data to support further evaluation, after the completion of active remediation, of long-term trends in MNR reaches and to evaluate if recovery is occurring at the expected rate.

DQO 3. Collect sufficient data to support further evaluations of the impacts of the Remedial Action/Corrective Measures during active remediation.

DQO 4. Provide sufficient data to allow for the subsequent Construction Monitoring Plan and for the inspection, monitoring, and maintenance programs and Post-Construction Inspection, Monitoring, and Maintenance Plans to achieve their objectives.

DQO 5. Inform model parameterization in the event a model re-evaluation plan is deemed necessary by EPA after consultation with GE.[2]

DQO 6. Support the development of the subsequent Performance Standards Compliance Plan insofar as it relates to the Downstream Transport Performance Standard.

DQO 7. Support the evaluation of progress towards biota consumption advisories, including for waterfowl, and toward achievement of the Short-Term and Long-Term Biota Performance Standards.

DQO 8. Assist in determining if there is a reduction in ecological risks to piscivorous mammals and birds.

DQO 9. Support monitoring of progress towards achieving National Recommended Water Quality Criteria and the State Numerical Water Quality Criteria that are applicable or relevant and appropriate requirements (ARARs) for the ROR Remedial Action.

[2] Although the Revised Final Permit identifies the need for a Model Reevaluation Plan (Section II.H.2.16), the Final Revised SOW specifies that such a plan will be submitted if and when deemed necessary by EPA after consultation with GE. As a result, it is not possible at this time to identify specific objectives for that plan that would require baseline sampling.

DQOs 1 through 5 are derived specifically from requirements of the Revised Final Permit. DQOs 6 through 9 are not explicitly required by the Revised Final Permit but reflect situations where baseline data collection can qualitatively support activities conducted under the Revised Final Permit.

3 Summary of Historical Monitoring Data

GE, EPA, the States of Massachusetts and Connecticut, and other parties have conducted extensive sampling of surface water, sediment, and biota within the Housatonic River since the 1970s. These data have been used, in conjunction with statistical analyses and discussions with EPA, to support the design of the baseline monitoring program and, specifically, to select sampling locations and make determinations regarding appropriate sample sizes and sampling frequencies needed to support the DQOs provided in Section 2. This section provides an overview of the historical data sets.

3.1 Surface Water

Investigation Summary

Numerous surface water investigations have been conducted since the late 1970s to study relevant surface water characteristics, as well as the presence, extent, and transport of PCBs and other chemical constituents in the water column of the Housatonic River. Early surface water studies (late 1970s through 1988) were conducted at a few sampling stations spread over large sections of the river, both in Massachusetts and in Connecticut. However, since 1988, surface water sampling investigations have focused primarily on the Massachusetts portion of the river, where PCBs were most routinely detected and found at the highest concentrations. Details regarding these earlier surface water sampling efforts are described in Section 3.2 of the *Housatonic River – Rest of River RCRA Facility Investigation Report* (RFI Report; BBL and QEA 2003).

The most comprehensive and consistent sampling of surface water in the Housatonic River began in 1996. Under that program, GE conducted monthly monitoring of surface water PCBs (and various other water quality constituents) at as many as 15 locations between Coltsville and Great Barrington in Massachusetts, with most locations occurring upstream of Woods Pond Dam. From 2000 to 2017, that monthly surface water sampling program was conducted at 10 locations in this stretch of the river. Six of those sampling locations are located in or just upstream of the ROR; they are summarized from upstream to downstream in Table 3-1.[3]

[3] The other four sampling locations consist of a station at Hubbard Avenue Bridge, which is a background station upstream of the GE facility, and stations at the Newell Street and Lyman Street Bridges and the Silver Lake Outfall, all of which are located within the two miles of the East Branch that were previously remediated. Under the requirements applicable to the latter three areas, sampling was conducted at these locations as part of the Housatonic River monthly sampling program until that program was discontinued. By letter dated June 6, 2017, GE proposed (and EPA agreed) to discontinue the monthly Housatonic River monthly surface water sampling program and to replace that program with the surface water baseline monitoring program for the ROR (GE 2017). However, GE agreed to, continue, and has continued, sampling at the Silver Lake Outfall and the Pomeroy Avenue Bridge on a quarterly basis as part of the Post-Removal Site Control programs for the Silver Lake Area and the 1½-Mile Reach, respectively.

Table 3-1
Historical Surface Water Monthly Monitoring Locations in ROR

Surface Water Location	Reach	Location Description
Pomeroy/Dawes Avenue Bridge	East Branch	Downstream end of 2 miles subject to previous remedial actions, representative of water flowing into the ROR from the East Branch
Holmes Road Bridge	Reach 5A	Approximately 1 mile downstream of Confluence
New Lenox Road Bridge	Reach 5B	Approximate midpoint of Reach 5B
Woods Pond Headwaters	Reach 5C	Approximately ¾ mile upstream of Woods Pond
Schweitzer Bridge	Reach 6	Approximately ¼ mile downstream of Woods Pond Dam
Division Street Bridge	Reach 8	Approximately 1¼ miles downstream of Rising Pond Dam

Most samples during this period were collected during low to moderate flows because higher flows occur during a small fraction of the time and, in some cases, high flows were avoided due to safety concerns. PCBs in surface water samples collected during this period were quantified as Aroclors using EPA Method 8082. The detection limit at all stations was 22 nanograms per liter (ng/L) per Aroclor until May 2007 (following completion of the 1½-Mile Reach remediation), when the detection limit at Pomeroy Avenue was lowered to 5.5 ng/L. The detection limit at the remaining five locations was lowered to this same level beginning in April 2014. These detection limits were used for the samples collected through November 2016. In December 2016, the laboratory previously used by GE for analysis of water samples closed, and the samples collected in December 2016 through February 2017 were sent to a laboratory that was not able to achieve the same low detection limit. Although samples were also collected in March and April 2017, they were not analyzed, and GE's monthly water column sampling program was discontinued (with EPA concurrence) later in the spring of 2017.

In addition to the monthly monitoring of surface water PCBs conducted by GE since 1996, EPA collected surface water samples between 1998 and 2002. This sampling included (but was not limited to) the routine monthly collection of surface water samples for approximately one year (1998 to 1999) at eight ROR locations, many of which are the same locations monitored by GE, with seven rounds of storm flow sampling conducted at three of those locations. EPA's monitoring program also included collection of surface water samples from the West Branch of the Housatonic River.

PCB Data Summary

Time series of PCB concentrations observed at the six monthly surface water monitoring locations listed in Table 3-1 from 1996 to early 2017 are presented on Figures 3-1a-c. These figures show there has been a thorough characterization of surface water PCB levels in Reaches 5 through 8 over the last 20 years. The monthly sampling frequency provides a robust means of quantifying differences in PCB concentrations among sampling stations and demonstrates a relatively strong seasonal pattern in surface water PCB concentrations (i.e., higher PCB concentrations in summer and lower concentrations in winter), particularly at the more downstream locations exhibiting higher PCB concentrations, likely due to temperature effects on release of PCBs from sediment porewater. These data provide a robust foundation to inform the design of the baseline monitoring program.[4]

A subset of the data presented on Figure 3-1 was selected to support the statistical analysis that was performed to determine the sample size and sampling frequency for the baseline monitoring program. For New Lenox Road Bridge, Woods Pond Headwaters, and Schweitzer Bridge, monthly PCB data collected since 2007 were selected (see Figures 3-1b and 3-1c). This time period reflects river conditions after the completion of remediation in the East Branch. For Pomeroy/Dawes Avenue Bridge, monthly data collected since 2009 were selected (see Figure 3-1a). This selected period starts two years after the completion of the East Branch remediation, because the 2007 data showed relatively large variability and the 2008 data were mostly non-detects. For Holmes Road Bridge (Figure 3-1a) and Division Street Bridge (Figure 3-1c), monthly data collected since April 2014 were selected, since PCB concentrations were consistently detected at these two locations after the detection limit was lowered at that time. Table 3-2 presents a summary of PCB concentrations at these six locations over the selected time periods described above, and Figure 3-2 shows the cumulative probability distribution of PCB concentrations at these same six locations during the same time periods. No visual or statistical outliers were identified in this data set.

Table 3-2
Summary of Surface Water Total PCB Data Used to Support Sample Size Determination

Location	Years	Number of Samples	Surface Water PCB Concentration (ng/L)[a]					
			Min[c]	Mean	Median	Max	SD	CV
Pomeroy/Dawes Avenue Bridge	Post-2009	99	ND	38	21	1,400	139	3.7
Holmes Road Bridge	Post-April 2014	35	ND	40	34	370	62	1.6
New Lenox Road Bridge	Post-2007	121	ND	67	44	1,040	104	1.5
Woods Pond Headwaters	Post-2007	106	ND	95	84	1,090	117	1.2
Schweitzer Bridge[b]	Post-2007	122	ND	82	75	479	69	0.84
Division Street Bridge	Post-April 2014	35	ND	51	46	171	28	0.54

Notes:
Means and standard deviations calculated using ProUCL 5.1.
a. Kaplan-Meier estimators applied for non-detect samples.
b. Field duplicates (routinely collected at this location) were averaged before calculating statistics.
c. ND: Minimum not estimated because lowest value is non-detect.
CV: coefficient of variation
ND: non-detect
SD: standard deviation

[4] All of these data have been validated pursuant to an approved Field Sampling Plan/Quality Assurance Project Plan (FSP/QAPP).

This robust surface water data set provides a sufficient foundation upon which to design the baseline monitoring program and can be used to supplement future baseline data collection to characterize current and historical conditions in the ROR.

3.2 Surface Sediment

Numerous investigations have been conducted since the mid-1970s to study the presence and extent of PCBs in sediments within the ROR. This section summarizes the previous sediment investigations in the reaches subject to MNR under the Revised Final Permit—i.e., the run-of-river reaches between Woods Pond and Rising Pond (Reaches 7A, 7D, 7F, and 7H) and the reaches downstream of Rising Pond Dam (Reaches 9 through 16)—because those reaches are the focus of the baseline monitoring program for surface sediments.[5]

Investigation Summary

The numerous historical sediment investigations conducted in the ROR were described in the RFI Report (BBL and QEA 2003) and the sediment PCB data summary for Connecticut (Avatar 2015). Those relating to the MNR reaches are summarized below.

Between 1979 and 1982, the Connecticut Agricultural Experiment Station (CAES), in cooperation with the Connecticut Department of Environmental Protection (CDEP) and the U.S. Geological Survey (USGS), performed a detailed study of the sediment in portions of the Housatonic River in Connecticut and, to a lesser extent, Massachusetts after the initial identification of PCBs in the river sediments. A total of 174 sediment core samples (of various depth increments) were collected and analyzed for PCBs.[6] Of these, 120 surface sediment samples were collected within the MNR reaches identified above.

GE conducted several sediment investigations in the 1980s and 1990s. From 1980 to 1982, Stewart collected a total of 892 sediment samples from Center Pond in Dalton to the Connecticut border, with 34 surface samples in Reaches 7 and 9. Most of the samples were sectioned in 0- to 6-inch intervals. In 1986, Lawler, Matusky & Skelly Engineers (LMS) collected six high-resolution sediment cores from Falls Village Impoundment (Reach 10), Bulls Bridge Impoundment (Reach 12), Route 133 Bridge (Reach 14), Shepaug Dam (Reach 14), Route 84 Bridge (Reach 14), and Stevenson Dam (Reach 15).[7] Cores were sectioned in one-inch increments, resulting in a total of 36 surface sediment

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[5] Sediment sampling in reaches subject to active remediation will be conducted as part of pre-design investigations in those reaches.

[6] Each sample was analyzed in both the CAES and USGS laboratories.

[7] The RFI Report indicated that the last of these cores was located "immediately upstream of the dam at Stevenson, Massachusetts" (BBL and QEA 2003). However, this core has been determined to be situated in Reach 15 in Connecticut based on the available information on river mile designation and the sediment PCB data summary for Connecticut (Avatar 2015).

samples analyzed for PCBs. In 1992, GE collected sediment samples at 55 stations between Great Barrington, Massachusetts, and the Stevenson Dam in Connecticut, pursuant to a 1992 Cooperative Agreement between GE and CDEP. Cores were mostly sectioned for the top three inches of each core, with a subset of cores sectioned in one-inch increments, resulting in a total of 87 surface sediment samples for PCB analysis within Reaches 9 through 15. From 1994 to 1996, a total of eight surface PCB samples were collected by Blasland, Bouck & Lee (BBL) in Reach 7A and near the Connecticut border (Reach 9) as part of the MCP Supplemental Phase II Investigation. Lastly, between 1997 and 1998, BBL collected additional sediment cores between Woods Pond and Connecticut. The sampling program consisted of surface sediment coring (sectioned into 0- to 2-centimeter [cm] and 2- to 16-cm segments) and high-resolution cores (sectioned into one-cm segments within the upper five cm and into 2 cm segments through the remaining length of the cores). A total of 86 PCB samples were collected above Glendale Dam impoundment (Reach 7F), Falls Village Dam impoundment (Reach 10), and Bulls Bridge Dam impoundment (Reach 12).

Between 1998 and 2002, EPA conducted a sediment investigation in both the Massachusetts and the Connecticut portions of the river. This study included systematic and discrete sediment sampling programs as part of EPA's Supplemental Investigation to further delineate the nature and extent of PCBs in sediment and to facilitate EPA's human health and ecological risk assessments and modeling study. Sediment cores were generally sectioned into 0- to 6-inch, 6- to 12-inch, 12- to 18-inch, and 18- to 24-inch depth intervals. Approximately 232 samples were collected and analyzed for PCBs within the MNR reaches identified above.

In 1999, GEI Consultants, Inc., on behalf of the Connecticut Department of Transportation (CT DOT) collected a total of 21 samples from four locations behind the Stevenson Dam in Lake Zoar (Reach 15) for the replacement of the Stevenson Dam Bridge (GEI 1999). This effort yielded three surface sediment samples for PCB analysis, sectioned into a single 0- to 6-inch depth interval.

In 2005, Northeast Generation Services (NGS) collected 17 core samples from five locations upstream of the Falls Village Dam (Reach 10) while the Falls Village Dam impoundment was lowered to facilitate dam repairs. This effort yielded five samples for PCB analysis, with each sectioned into a single 0- to 6-inch depth interval. During that same time, HydroTechnologies, Inc., on behalf of the Housatonic River Commission, collected four discrete samples and one composite sample from locations within the Falls Village Dam impoundment. Three of those five samples were collected from below one foot (sample depth information was missing for the other two samples). Thus, no surface sediment PCB data were provided from this study.

A summary of surface sediment PCB sample counts within the MNR reaches is provided in Table 3-3.

Table 3-3
Historical Surface Sediment Total PCB Sample Counts within MNR Reaches

Year	Sampler	Reach Summary											
		7A	**7D**	**7F**	**7H**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1979-1982	CAES/CDEP/USGS					12	10	4	4		64	26	
1980-1982	Stewart (GE)	3	7	7	1	15	1						
1986	LMS (GE)						6	3	6		18	6	
1992	GE					18	14		12		15	18	
1994-1996	BBL (GE)	5				3							
1998	BBL (GE)			5		13	26		42				
1998-2001	EPA	13	58	47	26	60	3	6	4	7	1	1	6
1999	CT DOT											3	
2005	NGS						7						
Total		21	65	59	27	121	67	13	68	14	98	54	6

Note:
Counts represent all samples collected within the top six inches of depth interval, including duplicates.

PCB Data Summary

Figures 3-3a through 3-3l show cumulative probability distributions of surface sediment PCB concentrations within the MNR reaches collected prior to 1998 (left panel), in and after 1998 (middle panel), and for all years (right panel). The pre-1998 data represent historical conditions, with most samples collected between 1980 to 1992. The post-1998 data represent more recent conditions, with most samples collected between 1998 and 2001 (Table 3-3). This evaluation indicates that surface sediment PCB concentrations exhibit a decreasing trend over time; concentrations in all reaches (except Reach 16) are generally higher in the historical data than in the more recent data.[8]

Average surface sediment PCB concentrations prior to 1998 were generally higher in Reach 7 (ranging from 1.4 to 11 mg/kg; Figures 3-3a through 3-3d, left panels) relative to the reaches downstream of Rising Pond (all generally well below 1 mg/kg; Figures 3-3e through 3-3l, left panels). A similar spatial decline in PCB concentrations was observed in the post-1998 data (Figure 3-3, middle panels). In Connecticut Reaches 13 through 16, post-1998 PCB concentrations were primarily non-detect (11 out of 16 values were non-detect; Figures 3-3i through 3-3l, middle panels).

PCB concentrations in sediments are often dependent on the amount of organic carbon (OC) in those sediments. The correlations between surface sediment PCB concentrations and OC content (expressed as fraction of OC [f_{oc}]; see Figure 3-4) were weak in Reach 7, with the coefficients of

[8] The decreasing trend is less certain in Reach 7H and Reach 14 due to the limited number of samples collected prior to 1998 and post-1998, respectively. Temporal trends cannot be assessed in Reach 16 because no samples were collected prior to 1998; however, all post-1998 data showed no detected PCBs.

determination (R^2) all below 0.3. The correlations were stronger for Reaches 9 through 15, with the R^2 ranging from 0.33 to 0.81. The correlation in Reach 16 cannot be evaluated because PCBs were not detected in that reach. Figures 3-5a through 3-5h show cumulative probability distributions of OC-normalized PCB concentrations for Reaches 9 through 15, where generally stronger correlations between PCBs and f_{oc} were observed.

For the statistical analysis that was conducted to support the design of the baseline monitoring program, a subset of sediment data was selected, balancing the preference for larger sample sizes against the preference for more recent data, reflective of the downward trends. In accordance with EPA's March 29, 2022 conditional approval letter, samples collected from 1998 to 2002 were used to support the statistical analysis for Reaches 7A, 7D, 7F, 7H, and 9, and samples collected from 1980 through 1992 were used for Reaches 10 through 15.[9] (No samples from Reach 16 were used in the analysis because there were no samples with PCB detections in that reach.) Furthermore, OC-normalized PCB concentrations were applied for Reaches 9 through 15, recognizing the stronger correlations between PCB and f_{oc} in those reaches. Dry-weight PCB concentrations were utilized in Reach 7. A summary of surface sediment PCB concentrations used in the statistical analysis is presented in Table 3-4. No visual or statistical outliers were identified in this data set.

Table 3-4
Summary of Surface Sediment Total PCB Data Used to Support Sample Size Determination

Reach	PCB Metric	Years	Number of Samples	Surface Sediment PCB Concentration (mg/kg)						Data Distribution[b]
				Min[e]	Mean	Median[e]	95th UCL[a]	Max	SD	
7A	PCB-dry	1998-2002	11	ND	0.42	ND	0.83	1.28	0.31	*[c]
7D	PCB-dry	1998-2002	53	ND	0.57	ND	1.06	4.29	0.82	*[c]
7F	PCB-dry	1998-2002	41	ND	0.38	ND	0.55	1.21	0.24	*[c]
7H	PCB-dry	1998-2002	25	ND	0.52	ND	1.35	4.68	0.95	*[c]
9	PCBoc	1998-2002	41	ND	28	20	34	155	27	Lognormal
10	PCBoc	1980-1992	17	12	48	28	72	203	49	Lognormal
11	PCBoc	1980-1992	5	2.8	7.7	9.0	11.8	12.5	4.3	Lognormal or normal[d]
12	PCBoc	1980-1992	12	4.0	11	8.0	17	38	9.9	Lognormal
13	PCBoc	1980-1992	5	3.1	4.7	4.5	6.3	7.1	1.7	Lognormal or normal[d]
14	PCBoc	1980-1992	40	ND	14	10	17.4	67	12	Gamma

[9] The samples collected by GE and EPA during these time periods have been validated pursuant to an approved FSP/QAPP; however, validation status of the USGS/CAES samples from the early 1980s is unknown.

Reach	PCB Metric	Years	Number of Samples	Surface Sediment PCB Concentration (mg/kg)						Data Distribution[b]
				Min[e]	Mean	Median[e]	95th UCL[a]	Max	SD	
15	PCBoc	1980-1992	24	1.5	7.0	5.7	9.3	29	5.8	Lognormal
16	PCBoc	1980-1992	0	--	--	--	--	--	--	--

Notes:

a. 95th percentile Upper Confidence Limit on the mean (95th UCL) computed using ProUCL 5.1.

b. ProUCL 5.1 was used to test whether the data distributions are significantly different from normal, lognormal, or gamma.

c. *: ProUCL did not characterize the distribution as normal, lognormal, or gamma.

d. Lognormal or normal: ProUCL characterized the sample as not significantly different from either normal or lognormal.

e. ND: median not estimated, because more than half of the values are non-detect. Minimum not estimated because lowest value is non-detect.

Duplicate samples were averaged.

Fractionation samples or samples of greater than 6-inch depth interval were excluded.

Samples with non-detect OC content were excluded from computing OC-normalized PCB concentrations.

PCBoc: OC-normalized PCB concentration

3.3 Fish

Investigation Summary

Fish sampling and analysis programs have been conducted on the Housatonic River since the late 1970s. These studies have targeted a range of species and size classes and have used several sample preparation methods and analytical procedures. Fish species representing a range of trophic levels have been collected, including top predators (e.g., largemouth bass in Massachusetts and smallmouth bass and brown trout in Connecticut), intermediate trophic level species (e.g., bluegill, pumpkinseed, and yellow perch), bottom-feeding species (e.g., brown bullhead and white suckers), and small forage fish (e.g., fallfish, golden shiner, and bluntnose minnow). Target size classes have included adult fish, juveniles, and fish in their first year of life, known as "young-of-the-year" (YOY). Sample preparation types have included various fillet types (e.g., skin-on or skin-off), offal (i.e., the remaining carcass after the fillet tissue is removed), ovaries, and individual or composite whole-body samples. These various species, trophic levels, and tissue preparations reflect diverse intended uses of the data to support site characterization, risk assessments, and trend evaluation. In addition, a variety of analytical methods have been used; analyses for PCBs have included both Aroclor-based and congener-based methods, depending on the program.

Within the Massachusetts portion of the river, several fish studies were conducted beginning in 1980, including efforts from GE in 1980 and 1982, in 1990 (as part of the MCP Phase II activities), and in 1998. More details about these studies were described in Section 6.2.1.1 of the RFI Report (BBL and QEA 2003). In addition, USGS collected samples for largemouth bass at Woods Pond in September 1994 and May 1995 as part of a national reconnaissance investigation (Smith and Coles 1997). In this investigation, whole-body samples were analyzed for total PCBs as Aroclors, a subset of PCB congeners, and lipid contents, and lengths and weights were also reported.

The most comprehensive fish sampling effort in this portion of the river was conducted by EPA in 1998 (with additional sampling in 1999 and 2000), as part of the Supplemental Investigation of the ROR (Weston 2000). More than 1,000 fish samples were collected in 1998; species collected included yellow perch, pumpkinseed, bluegill, largemouth and smallmouth bass, brown and yellow bullhead, and others. Tissue types included skin-off fillet, offal, and whole body. Sample locations included areas upstream of the Confluence in the East and West Branches, the Confluence to Woods Pond (in Reaches 5A and 5B/5C), Woods Pond, and Rising Pond.

Additional fish were collected by GE in 1999, 2002, 2008, and 2011 to support continued evaluation of PCB trends in adult fish, including: (1) largemouth bass from Reaches 5B/5C, Woods Pond, and Rising Pond; (2) yellow perch from Reach 5A (2011 only); and (3) largemouth bass from the HR6 location upstream of the Connecticut boarder (1999 only). Most of these samples were analyzed for PCB congeners; however, some limited analysis for PCB Aroclors was conducted in 1999.

Within the Connecticut portion of the river, fish sampling has primarily been conducted under two programs: one historical program by CDEP (now the Connecticut Department of Energy and Environmental Protection [CDEEP]) between 1977 and 1983 and the other by the Academy of Natural Sciences (ANS) of Drexel University (formerly ANS of Philadelphia), which conducted a biennial fish tissue sampling program on behalf of GE from 1984 through 2016. The CDEP collected and analyzed fillets from a variety of resident fish species, including brown trout and smallmouth bass, at West Cornwall, Bulls Bridge, Lake Lillinonah, and Lake Zoar. Samples were analyzed for PCB Aroclors and lipid content. The ANS program primarily targeted the collection of adult smallmouth bass fillets from the same four locations sampled historically by CDEP, as well as adult brown trout fillets from West Cornwall. Samples collected by ANS were analyzed for PCB Aroclors for the entire program (1984–2016) and PCB congeners beginning in 1992, using methods developed by ANS (ANS-Drexel 2018).

In addition to the adult fish sampling described above, GE conducted a biennial YOY fish sampling program in Massachusetts since 1994, with the most recent samples collected in 2014. Whole-body composite samples of YOY largemouth bass, yellow perch, bluegill, and pumpkinseed were collected and analyzed for PCB Aroclors. These samples were collected at four locations in the Massachusetts portion of the river, including a location between the Pittsfield WWTP and Roaring Brook (station designated "HR2" in Reach 5B), Woods Pond, the Glendale Dam impoundment (i.e., Reach 7G), and a location near the Massachusetts/Connecticut border (station designated "HR6").

A summary of the historical fish sampling programs is presented in Table 3-5.

Table 3-5
Historical Fish Total PCB Sample Counts

Age	Species Name	Tissue Type	Years	Sampler	Number of PCB Samples by Reach									
					5A	5B/5C	6	7	8	9	10/11	12/13	14	15
Adult	Bass	Fillet	1980-1982	GE			1	1	1	1				
	Brown bullhead	Fillet	1982	GE		1	1							
		Fillet	1977-1983	CDEP								16	14	11
		Fillet	1984-2004	GE/ANS							5	35	10	8
		Fillet	1998	GE					15	2				
		Fillet	1998	EPA	1	17	25		7					
		Offal	1998	EPA	1	17	25		7					
		Whole body	1998	EPA		2								
	Black crappie	Fillet	1977-1983	CDEP								3	16	14
	Bluegill	Fillet	1980	GE			1	1	1					
		Fillet	1983	CDEP								5	1	2
		Fillet	1984-2012	GE/ANS							17	13	20	18
		Fillet	1998	EPA	1									
		Offal	1998	EPA	1									
	Bluntnose minnow	Whole body	1998	GE					5	5				
	Brook Trout	Fillet	1977	CDEP							1			
	Brown trout	Fillet	1982	GE						1				
		Fillet	1977-1979	CDEP							57	2		1
		Fillet	1984-2016	GE/ANS							546			1
		Fillet	1990	GE			2		1					
	Carp	Fillet	1977-1979	CDEP								7	10	13
		Fillet	1984-1988	GE/ANS								4	4	4
	Creek chubsucker	Composite	1999	EPA			3							
		Whole body	2000	EPA		8								
	Chain pickerel	Fillet	1982	GE			1							
		Fillet	1979-1983	CDEP								11		
	Crappie	Fillet	1980-1982	GE			1							
	American eel	Fillet	1979-1983	CDEP										7
		Fillet	1988-1992	GE/ANS										26
	Fallfish	Composite	1998	EPA	5									
		Fillet	2012	GE/ANS							2			

Age	Species Name	Tissue Type	Years	Sampler	Number of PCB Samples by Reach									
					5A	5B/5C	6	7	8	9	10/11	12/13	14	15
Adult	Goldfish	Whole body	1998-2000	EPA		19	23							
	Golden shiner	Composite	1998	EPA		5	5							
	Largemouth bass	Body part	1999	EPA			6		6					
		Composite	1998	EPA	2	5	5		5					
		Fillet	1980-1982	GE			1		1	1				
		Fillet	1977-1983	CDEP								16	13	19
		Fillet	1984-2014	GE/ANS								36	13	10
		Fillet	1990	GE			8		8					
		Fillet	1998	GE						2				
		Fillet	1998	EPA	3	15	14		11					
		Fillet	2002	GE		15	16							
		Fillet	2008	GE		15	15		10					
		Fillet	2011	GE		15	15		15					
		Offal	1998-1999	EPA	3	15	20		17					
		Offal	2002	GE		15	15							
		Whole body	1994-1995	USGS			28							
		Whole body	1998	GE						3				
		Whole body	1998	EPA	5	10	11		14					
		Whole body	1999	GE						5				
		Whole body	2008	GE		15	15		10					
		Whole body	2011	GE		15	15		15					
	Northern pike	Fillet	2004-2012	GE/ANS							14	17	17	12
	Pumpkinseed	Composite	1998	EPA		5	5		5					
		Fillet	1988-2004	GE/ANS							3	5	10	13
		Fillet	1998	EPA	1	25	25		13					
		Offal	1998	EPA	1	25	25		13					
		Whole body	1998	GE						5				
	Pumpkinseed – Redbrested sunfish hybrid	Fillet	1983	CDEP									5	4
	Pumpkinseed – Unidentified sunfish hybrid	Fillet	1983	CDEP								1		
		Fillet	1988-2000	GE/ANS							1	1	1	

Age	Species Name	Tissue Type	Years	Sampler	Number of PCB Samples by Reach									
					5A	5B/5C	6	7	8	9	10/11	12/13	14	15
Adult	Rock bass	Fillet	1982	GE			1							
		Fillet	1983	CDEP								6	6	6
	Red-breasted sunfish	Fillet	1984-2004	GE/ANS								4	14	13
		Whole body	1998	GE/ANS								2	2	
	Rainbow trout	Fillet	1977-1983	CDEP							46	1		
		Fillet	1988	GE/ANS							9			
	Smallmouth bass	Fillet	1977-1983	CDEP							1	28	17	14
		Fillet	1984-2016	GE/ANS							191	172	206	170
		Whole body	1998	EPA	2									
	Bluegill & sunfish	Fillet	1980-1982	GE		1	2							
		Fillet	1979	CDEP								10	10	10
	Bluegill & pumpkinseed	Fillet	1980-1982	GE						1				
	Trout	Fillet	1982	GE			1	1						
	White catfish	Fillet	1977-1983	CDEP									30	19
		Fillet	1984-2004	GE/ANS									44	51
	White crappie	Fillet	1983	CDEP								2		
	White perch	Fillet	1977-1983	CDEP									19	21
		Fillet	1984-2008	GE/ANS									50	70
	White sucker	Fillet	1979	CDEP								9	10	10
		Whole body	2000	EPA	16	26	15							
	Yellow bullhead	Fillet	1983	CDEP									1	
		Fillet	2004	GE/ANS								1	5	1
	Yellow perch	Composite	1998	EPA	5	5	5		5					
		Fillet	1980-1982	GE		1	3	1	1	1				
		Fillet	1977-1983	CDEP							1	15	16	19
		Fillet	1984-2010	GE/ANS							7	112	43	43
		Fillet	1990	GE			8		1					
		Fillet	1998	GE					8	20				
		Fillet	1998	EPA	25	25	25		6					
		Fillet	2011	GE	15									
		Offal	1998	EPA	25	25	25		6					
		Whole body	1988	GE/ANS								2	1	1
		Whole body	2011	GE	15									

Age	Species Name	Tissue Type	Years	Sampler	Number of PCB Samples by Reach									
					5A	5B/5C	6	7	8	9	10/11	12/13	14	15
YOY	Bluegill	Whole body	1994-2014	GE		54	77	54		67				
	Largemouth bass	Whole body	1994-2014	GE		70	77	70		77				
	Pumpkinseed	Whole body	1994-2014	GE		16		17		9				
	Yellow perch	Whole body	1994-2014	GE		54	72	49		67				

Note:
For the 1980 to 1982 GE study, sample locations were approximated based on the reported river miles.

PCB Data Summary

Adults

A subset of the data presented in Table 3-5 was selected to support the statistical analysis that was performed to determine sample sizes for the baseline monitoring program. In Massachusetts, these included both pre-2000 data and more recent data on largemouth bass and yellow perch. In Connecticut, the data used consisted of a 30-year record of data on smallmouth bass and a 10-year record of data on northern pike. This subset of data provides a record that is spatially and temporally robust and is represented by more than one trophic level, including top predators.

Time series of wet-weight and lipid-normalized PCB concentrations in adult largemouth bass and yellow perch collected in the Massachusetts portion of the river (beginning with the comprehensive sampling conducted by EPA in 1998 and including the supplemental data sets collected by GE in 2002, 2008, and 2011 described above) are shown on Figures 3-6a (wet-weight data) and 3-6b (lipid-normalized data). Prior analysis of data comparability has indicated that the sample sizes, species, and locations in these data sets are generally comparable and, therefore, provide a good basis for evaluating temporal trends over this 13-year timeframe (Arcadis and Anchor QEA 2012). Also, previous analysis of these data sets led to the conclusion that there were observable decreases in PCB concentration (both wet-weight and lipid normalized) from the 1998/2002 period to the 2008/2011 period (in both fillets and reconstituted whole-body concentrations that were calculated from PCB concentrations measured in fillet and offal samples),[10] and these decreases are more notable in Reach 5B/5C and Woods Pond (Figure 3-6) (Arcadis and Anchor QEA 2012).

Time series of wet-weight and lipid-normalized PCB concentrations in adult smallmouth bass collected within the Connecticut portion of the river from 1984 to 2016 are shown on Figures 3-7a and 3-7b, respectively. These figures depict a thorough characterization of PCBs in fish over the last 30 years within the large impoundments in Connecticut (West Cornwall, Bulls Bridge, Lake Lillinonah, and Lake Zoar). PCB concentrations in fish in these areas closely track one another and show decreases in concentration since 1992 (ANS-Drexel 2018). Arithmetic average wet-weight PCB concentrations at these four locations generally ranged from 0.5 to 2 mg/kg beginning in the mid-1990s. PCB concentrations measured at West Cornwall and in the Bulls Bridge impoundment were similar to one another and tended to be somewhat higher than those observed at Lake Lillinonah and Lake Zoar, which are located farther downstream and also have similar PCB concentrations.

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[10] The temporal trend cannot not be evaluated for yellow perch in Reaches 5B/5C, 6, and 8 or for largemouth bass and yellow perch in Reach 9 due to limited data for those species in those reaches.

Time series in adult northern pike are available from 2004 to 2012. Similar to smallmouth bass, there was no consistent trend over this period (Figures 3-7c and 3-7d for wet-weight and lipid-normalized PCB concentrations, respectively). Average PCB concentrations were similar in the three downstream impoundments (Bulls Bridge, Lake Lillinonah, and Lake Zoar); wet-weight concentrations in these impoundments ranged from 1.6 to 4 mg/kg (Figure 3-7c). Average concentrations were higher and more variable in the most upstream impoundment at Falls Village.

The subset of data presented above was used to support the statistical analyses performed to select sample sizes for the baseline monitoring program.[11] For largemouth bass, the data collected in 2008 and 2011 were selected to represent more recent lower concentrations (Figures 3-6a and 3-6b). For yellow perch, both 1998 and 2011 data were selected because the declines were generally not as notable as for largemouth bass (trends can be evaluated only in Reach 5A; Figures 3-6a and 3-6b). Inclusion of the data collected in 1998 increases the number of samples in Reach 5 and permits analysis of yellow perch in other Massachusetts reaches. For smallmouth bass and northern pike in Connecticut, all data collected since 1998 were used (Figures 3-7a through 3-7d). A summary of wet-weight total PCB concentrations for the above adult species over the selected time periods is presented in Table 3-4. Cumulative probability distributions of the adult fish are provided on Figures 3-8a through 3-8p.[12]

Table 3-6
Summary of Adult Fish Total PCB Data Used to Support Sample Size Determination (Wet Weight)

Location	Species	Years	Number of Samples	Wet-Weight PCB Concentration (mg/kg)[a]					
				Min	Mean	Median	Max	SD	CV
Reach 5B/5C	LMB	2008-2011	30	1.16	5.64	5.10	10.40	3.03	0.54
Woods Pond	LMB	2008-2011	30	0.39	4.23	2.20	21.20	4.56	1.08
Rising Pond	LMB	2008-2011	25	0.15	3.48	2.66	11.10	2.69	0.77
Reach 5A	YP	1998, 2011	40	0.79	8.08	5.57	50.25	7.83	0.97
Reach 5B/5C	YP	1998	25	3.37	7.89	6.05	43.41	7.77	0.98
Woods Pond	YP	1998	25	0.54	3.40	3.55	6.35	1.90	0.56
Rising Pond	YP	1998	14	1.56	8.15	5.68	24.90	7.05	0.86
Reach 9	YP	1998	20	0.92	4.38	3.95	9.56	2.64	0.60
West Cornwall	SMB	1998-2016	104	0.27	1.35	1.23	5.22	0.69	0.52

[11] All of these data have been validated pursuant to an approved FSP/QAPP.

[12] As part of the overall weight of evidence evaluation, in a few cases, sample size calculations were performed with and without single high values in the historical data set, considering that designing an entire program around one or a few unusually high historical data point(s) is not appropriate. These high values were evaluated statistically, as discussed in Appendix A.

Location	Species	Years	Number of Samples	Wet-Weight PCB Concentration (mg/kg)[a]					
				Min	Mean	Median	Max	SD	CV
Bulls Bridge	SMB	1998-2016	104	0.31	1.21	0.99	3.76	0.66	0.55
Lake Lillinonah	SMB	1998-2016	102	0.12	0.81	0.53	7.07	0.95	1.17
Lake Zoar	SMB	1998-2016	102	0.11	0.91	0.51	5.20	0.98	1.07
Falls Village	NP	2004-2012	14	0.70	7.07	2.01	42.83	11.15	1.58
Bulls Bridge	NP	2004-2012	17	0.19	1.71	1.53	4.43	1.23	0.72
Lake Lillinonah	NP	2004-2012	17	0.42	1.40	1.25	2.58	0.60	0.43
Lake Zoar	NP	2004-2012	12	0.56	2.07	1.43	5.19	1.51	0.73

Notes:
a. Total PCBs analyzed by Aroclor method.
CV: coefficient of variation
LMB: largemouth bass
NP: northern pike
SD: standard deviation
SMB: smallmouth bass
YP: yellow perch

Young-of-the-Year

Time series of PCB concentrations in YOY largemouth bass, yellow perch, and bluegill/pumpkinseed collected within the Massachusetts portion of the river from 1994 to 2014 are shown on Figures 3-9a (wet-weight data) and 3-9b (lipid-normalized data). These figures depict a thorough characterization of PCBs in YOY fish for over 20 years at the four YOY sampling locations described above (HR2, Woods Pond, Glendale Dam impoundment, and HR6). These figures show that both wet-weight and lipid-normalized PCB concentrations for all species generally decreased from upstream (HR2) to downstream (HR6) in the ROR. In addition, the YOY fish data show a general decline in PCB concentrations over time. The overall trends and rates of decline observed in the YOY fish are similar to those observed in the adult fish in Massachusetts, as described above.

YOY data collected from 2010 through 2014 were selected for the statistical analysis for the baseline monitoring program design to balance the preference for larger sample sizes against the preference for more recent data, reflective of the downward trends (Figures 3-9a and 3-9b).[13] The analysis focused on largemouth bass and yellow perch. Bluegill/pumpkinseed concentrations were generally similar to or lower than those in yellow perch. A summary of wet-weight total PCB concentrations for YOY largemouth bass and yellow perch is presented in Table 3-7. Cumulative probability distributions of YOY data are provided on Figures 3-10a through 3-10h.

[13] All of these data have been validated pursuant to an approved FSP/QAPP.

Table 3-7
Summary of YOY Fish Total PCB Data Used to Support Sample Size Determination (Wet Weight)

Location	Species	Years	Number of Samples	Wet-weight PCB Concentration (mg/kg)[a]					
				Min	Mean	Median	Max	SD	CV
Reach 5B/5C (HR2)	LMB	2010-2014	21	11.00	15.46	15.00	20.50	2.66	0.17
Woods Pond	LMB	2010-2014	21	10.00	15.77	16.00	22.60	3.08	0.20
Glendale Dam Impd	LMB	2010-2014	21	2.30	4.43	4.48	5.60	0.77	0.17
Reach 9 (HR6)	LMB	2010-2014	21	0.81	1.67	1.70	2.70	0.56	0.34
Reach 5B/5C (HR2)	YP	2010-2014	15	12.00	15.42	15.00	20.10	3.10	0.20
Woods Pond	YP	2010-2014	21	2.00	14.96	14.00	26.00	5.01	0.33
Glendale Dam Impd	YP	2010-2014	14	3.44	4.99	4.90	6.50	1.01	0.20
Reach 9 (HR6)	YP	2010-2014	14	2.00	2.49	2.53	2.80	0.22	0.09

Notes:
a. Total PCBs analyzed by Aroclor method.
CV: coefficient of variation
Impd: impoundment
LMB: largemouth bass
SD: standard deviation
YP: yellow perch

3.4 Benthic Invertebrates

Benthic invertebrates were sampled for nearly 40 years near West Cornwall (Reach 11) in Connecticut between 1978 and 2016 (Figure 3-11). From 1978 to 1990, samples of caddisfly larvae and composite of hellgrammite larvae and stonefly nymph samples were collected by CDEP annually in most years and analyzed for total PCBs as Aroclors. From 1992 to 2016, samples of caddisfly larvae, hellgrammite larvae, and stonefly nymphs were collected by ANS biannually and analyzed for total PCBs as congeners. PCB concentrations for all three species declined over time, with no clear trend in recent years. PCB concentrations have been below 3 mg/kg consistently since 2001. A summary of total PCB concentrations for benthic invertebrates at West Cornwall in recent years between 2001 and 2016 is presented in Table 3-8.[14]

[14] These data have been validated pursuant to an approved FSP/QAPP.

Table 3-8
Historical Benthic Invertebrate Total PCB Concentrations (West Cornwall, Connecticut; 2001 and 2016)

Species	Number of Samples	PCB Concentration (mg/kg)					
		Min	Mean	Median	Max	SD	CV
Caddisfly larvae	17	0.48	0.93	0.88	1.61	0.33	0.35
Hellgrammite larvae	17	0.31	1.53	1.75	2.32	0.54	0.35
Stonefly nymphs	15	0.46	0.82	0.86	1.26	0.26	0.31

Notes:
CV: coefficient of variation
SD: standard deviation

3.5 Waterfowl

Waterfowl samples were collected on the Housatonic River in late 1990s. In Massachusetts, mallard and wood duck samples were collected by EPA in 1998 from Reaches 5 and 6. Samples were prepared as breast muscle tissue and liver tissue and analyzed for PCB congeners. In Connecticut, one sample of mallard breast tissue was collected by CDEP near Newtown (a few miles west of Lake Zoar) in 1999. The single mallard sample was analyzed for PCBs as both a skin-off and a skin-on sample. A summary of total PCB concentrations in waterfowl tissue samples is presented in Table 3-9.[15]

[15] The samples collected by EPA in 1998 have been validated pursuant to an approved FSP/QAPP; however, validation status of the CDEP results is unknown.

Table 3-9
Historical Waterfowl Total PCB Concentrations

Location	Species	Sample Type	Number of Samples	PCB Concentration (mg/kg)					
				Min	Mean	Median	Max	SD	CV
Reach 5	Mallard	Breast[a]	3	1.59	4.99	5.57	7.80	3.15	0.63
Reach 5	Mallard	Liver	3	3.56	13.54	15.15	21.90	9.27	0.68
Reach 5	Wood Duck	Breast[a]	9[b]	4.75	7.70	6.84	12.20	2.93	0.38
Reach 5	Wood Duck	Liver	8	5.19	11.90	7.16	38.49	11.44	0.96
Reach 6	Mallard	Breast[a]	2	11.20	15.27	15.27	19.34	—	—
Reach 6	Mallard	Liver	2	10.79	13.72	13.72	16.66	—	—
Reach 6	Wood Duck	Breast[a]	14[c]	1.06	6.13	5.26	17.85	4.19	0.68
Reach 6	Wood Duck	Liver	12	0.34	8.02	4.45	23.99	8.86	1.10
Newtown, CT	Mallard	Breast (skin-off)	1	—	0.27	—	—	—	—
Newtown, CT	Mallard	Breast (skin-on)	1	—	2.05	—	—	—	—

Notes:

a. Database does not indicate whether skin is included.
b. Includes one duplicate breast sample.
c. Includes two duplicate breast samples.

For wood ducks, the mean PCB concentrations were slightly higher in Reach 5 than Reach 6 for both breast and liver samples. The PCB samples from mallard showed somewhat different trend—average PCB concentrations in mallard breast tissue was approximately three times higher in Reach 6 than in Reach 5, but average concentrations in liver tissue were similar in both reaches. The average PCB concentrations in mallard breast tissue in Massachusetts (Reaches 5 and 6) were higher than the single sample collected in Connecticut.

4 Baseline Activities

The baseline monitoring program has been designed to meet the DQOs specified in Section 2. The program is extensive and includes sample collection over the entire ROR extending from Pittsfield, Massachusetts (Reach 5A) to Lake Housatonic (Reach 16). The program is intensive, involving sampling in every reach within the ROR. Furthermore, the program is integrated, including sediment, water, and several species and age classes of biota, all of which will support future evaluations of trends in PCB concentrations. Sampling locations and field and laboratory methodologies have been selected to provide consistent, reliable data.

DQOs 1 and 2 (see Section 2) are the primary focus of the statistical analyses used to determine baseline sample size and frequency (provided in Appendix A). Assessment of remedy impacts and effectiveness, including MNR in applicable reaches, as described under DQOs 1 and 2, requires monitoring of pre-remedy (i.e., baseline) PCB concentrations in reaches to be actively remediated and in reaches for which MNR is the selected remedy. These will provide the basis for comparison with data to be collected in the future after remediation is complete. The design of the analyses is based on an evaluation of uncertainty bounds around anticipated remedy impacts, as described in Appendix A.

A conservative program designed to evaluate long-term changes in PCB concentrations, and thus to meet DQOs 1 and 2, is anticipated to provide sufficient support for DQOs 3, 4, and 5. Decision frameworks specifically for DQOs 3, 4, and 5 have not been developed, and thus there is no basis upon which to base a quantitative analysis of sample size.

A statistical evaluation of sample sizes that will support post-remedy evaluation of the Downstream Transport Performance Standard (DQO 6) is described herein and is used to support design of the water column program.

DQOs 7 through 9 focus on evaluating post-remedy progress towards addressing advisories, standards, criteria, and risk reduction. These are fundamentally the same goals as for DQOs 1 and 2, which address the evaluation of post-remedy reductions in PCB concentrations in sediments, fish, and water. As such, the sampling programs designed to address DQOs 1 and 2 will be sufficient to address DQOs 7 through 9.

4.1 Surface Water Monitoring

The baseline surface water monitoring program has been designed to satisfy the DQOs presented in Section 2 that are pertinent to surface water. Specifically, the program will support future evaluation of the impacts of the Remedial Action, both during and after completion, in reaches that are subject to active remediation and in the MNR reaches (DQOs 1 through 4), and it will provide data that may be used to inform model parameterization in the event a model re-evaluation plan is deemed necessary by EPA after consultation with GE (DQO 5). The baseline surface water data will also be qualitatively used to support development of the portion of the Performance Standards Compliance Plan relating to the Downstream Transport Performance Standard (DQO 6) and to support monitoring of progress towards achieving national and state water quality criteria (DQO 9).

In general, the baseline surface water monitoring program will consist of surface water quality monitoring, flow monitoring, and surface water sample collection and analysis, as discussed in the subsections below.

4.1.1 Sampling and Analysis for PCBs

4.1.1.1 Sampling Locations and Approach

Table 4-1 lists the surface water sampling locations to be included in the baseline monitoring program, consistent with Table 2 in EPA's March 29, 2022 conditional approval letter. This table provides an overview of the anticipated sampling method and frequency of sampling at each location;[16] additional details on sampling methods and frequency are provided below. A summary of all surface water sampling locations is shown on Figure 4-1, and more detailed information for each individual location is provided on Figures 4-2a through 4-2o.

Table 4-1
Summary of Baseline Surface Water Sampling

Location	Reach	Anticipated Sample Collection Method[5]	Sampling Location Notes	Sampling Frequency and Duration
East Branch at Pomeroy Avenue[1]	Upstream of the Confluence	Manual (Grab Sampler)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	Monthly sampling for minimum 2 years prior to remediation (24 total samples per location)
West Branch at South Street/Route 7[1]	Upstream of the Confluence	Manual (Grab Sampler)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	
Near Pittsfield WWTP	5A/5B	Manual (Grab Sampler)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	
New Lenox Road	5B	Manual (Grab Sampler)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	
Woods Pond Dam (Wing Walls)[2]	6	Automated Sampling		

[16] The sampling method shown is the anticipated sampling method to be used at each location. This is subject to change based on the conditions present at each location (to be determined based on future field reconnaissance). Sampling methods may also change at some locations based on the results of sampling currently being conducted pursuant to the Interim BMP. Any change in sampling method will be determined in consultation with EPA.

Location	Reach	Anticipated Sample Collection Method[5]	Sampling Location Notes	Sampling Frequency and Duration
Route 102 in Lee[3]	7D	Manual (Grab Sampler)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	Monthly sampling for minimum 2 years prior to remediation (24 total samples per location)
Rising Pond Dam (Wing Walls)[2]	8	Automated Sampling		
Sheffield at Ashley Falls Road[4]	9	Manual (Kemmerer)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	
Falls Village Dam	10	Manual (Kemmerer)	2-point composite of mid-depth samples collected near wing walls	
Route 7 Bridge	11	Manual (Kemmerer)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	
Bulls Bridge	12	Manual (Kemmerer)	2-point composite of mid-depth samples collected near wing walls	
Bleachery Dam (Boardman Road)	13	Manual (Kemmerer)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	
Lake Lillinonah (Shepaug Dam)	14	Manual (Kemmerer)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	
Lake Zoar (Stevenson Dam)	15	Manual (Kemmerer)	Composite of mid-depth grab samples at 25%, 50%, and 75% of channel width	
Lake Housatonic Dam	16	Manual (Kemmerer)	2-point composite of mid-depth samples collected near shoreline	

Notes:

1. The need for baseline sampling at both the East Branch and West Branch locations is subject to results of a PCB loading analysis to be conducted using data being collected during 2022 pursuant to the Interim BMP.
2. Sample collection at the Woods Pond and Rising Pond Dam wing walls (versus the nearby locations sampled historically at Schweitzer Bridge and Division Street, respectively) is subject to revision based on an evaluation of data being collected during 2022 pursuant to the Interim BMP. See Section 4.1.1.2.2.
3. Depending upon field conditions, another suitable location in Reach 7D may be selected in consultation with EPA.
4. Rannapo Road is a possible alternate location to Ashley Falls Road.
5. Sampling methods may be revised at a given location based on field conditions. Any change in sampling method will be determined in consultation with EPA.

4.1.1.2 Sample Collection Methods

4.1.1.2.1 Manual Sampling

The majority of water sampling locations will be collected using manual grab sampling methods, with the exception of the automated stations at Woods Pond Dam and Rising Pond Dam (see Section 4.1.1.2.2 and Table 4-1). Samples will generally be collected as three mid-depth grab samples at 25%, 50%, and 75% of the channel width at each location (except where otherwise noted in Table 4-1 where it is not possible to collect a three-point composite) using either: (1) a Kemmerer stainless steel bottle sampler (at locations where there is sufficient water depth to use this type of sampler); or (2) a surface water grab sampler consisting of a beaker-like container attached to a telescoping pole (or equivalent sampling device) at locations where water depth is shallow. EPA will be consulted in the event that a change in sampling device is required due to unanticipated field conditions. A Standard Operating Procedure (SOP) for manual water sampling is provided in Appendix B.[17]

4.1.1.2.2 Automated Sampling

GE proposes to construct automated sampling stations at two locations—Woods Pond Dam and Rising Pond Dam. The Downstream Transport Performance Standard specifies these two locations as measurement points for the evaluation of post-remedy compliance with that standard. Baseline data are not necessarily required at these two locations to evaluate post-remedy achievement of this standard; however, data collected from this location may be relevant for monitoring operations during construction. Automated sampling stations (established during the baseline program) will allow for consistent collection of samples (including temporal composites) throughout a wide range of environmental and operational conditions.

A conceptual schematic of the automated station configuration is presented on Figure 4-3. This schematic assumes that the automated stations are installed at the dam wing walls; however, a decision regarding the location where these stations will be installed (wing walls versus nearby locations sampled historically at Schweitzer Bridge and Division Street) is being deferred until after surface water data collected under the Interim BMP are evaluated. Preparation of an SOP for the location, construction, installation, and operation of these automated stations will be prepared and submitted to EPA following that evaluation, particularly given that the design of the automated stations is partly dependent on the locations where they are installed.

4.1.1.3 Sampling Frequency

The overall goal of the baseline monitoring program is to provide data to support a future evaluation of the effectiveness of the remedy in reducing PCB concentrations in remediation reaches and to characterize the rate of natural recovery in MNR reaches. EPA has not established any action levels

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[17] Condition 3 in EPA's February 17, 2022 conditional approval of GE's Interim BMP stated that EPA reserved the right to require GE to utilize, during future sampling under the full baseline monitoring program, an isokinetic, depth integrated method using either an equal-width increment (EWI) or equal-discharge-increment (EDI) sampling method where appropriate at locations where the river is sufficiently wide and deep. The only locations where the river is sufficiently wide and deep to potentially warrant this type of sampling are the larger impoundments in Connecticut. However, because those impoundments are located at a considerable distance downstream of the PSA (up to 100 miles downstream) and initial surface water PCB results collected in Connecticut as part of the interim baseline sampling program indicate concentrations are relatively low, composite samples of mid-depth grabs collected at 25%, 50%, and 75% of channel width are expected to be sufficient to characterize surface water PCBs in those impoundments.

based on comparisons of pre- versus post-remedy PCB concentrations and has not developed a future decision-making process that relies upon before/after comparisons or trends. Rather, the goal of the baseline monitoring program is to provide information needed to estimate post-remedy reductions in PCB concentrations. As stated in the Revised Final Permit (Section II.B.2.h.(2)): "Permittee shall conduct monitoring of PCB concentrations in affected media (including surface water, sediment, and biota) in these [MNR] reaches to see if recovery is occurring at the expected rate." Thus, the objective is to assess how much reduction has occurred. This is a straightforward task that does not depend on hypothesis testing. Therefore, an estimation approach has been used in designing the baseline monitoring program.

Details regarding the determination of appropriate sample size for surface water sampling are provided in Appendix A. Based on that evaluation, a sample size of 24 (equivalent to monthly samples collected for two years) was selected for the baseline monitoring program. After evaluation of the first year of data, GE may propose a reduction in the number of sampling locations in the second year (e.g., if PCB concentrations in adjacent reaches are shown to be similar). Any changes in the program described in this Revised BMP will be subject to EPA review and approval.

4.1.1.4 Laboratory Analysis

Surface water samples will be analyzed for PCBs using either a high-resolution PCB congener method (EPA Method 1668C) or a low-resolution PCB congener method (EPA Method 8270D-SIM). The determination regarding which PCB method will be used for baseline surface water samples, and the corresponding detection limit and reporting limit or practical quantitation limit (PQL) will be made based on an evaluation of samples collected and analyzed using both methods during the Interim BMP. In addition, all baseline surface water samples will be analyzed for total suspended solids using Standard Method (SM) 2540D, using the entire sample for analysis.

4.1.2 General Water Quality Monitoring

Water quality parameters, including dissolved oxygen (DO), pH, temperature, conductivity, and turbidity, will be measured at each station every time the station is sampled. These data will be collected using a hand-held multi-parameter probe, such as a YSI EXO2 or equivalent, in accordance with the methodology outlined in Appendix O to GE's current *Revised Field Sampling Plan/Quality Assurance Project Plan* (FSP/QAPP; Arcadis 2013) (or the comparable SOP in the Rest of River FSP/QAPP if it has been submitted and approved by the time of monitoring).

4.1.3 Flow Monitoring

As described in the Interim BMP, GE intends to install a permanent, USGS-style flow gauging station in the vicinity of Woods Pond Dam and anticipates completing that installation in 2022. USGS also has an active flow gauge in the Massachusetts portion of the ROR immediately downstream of Rising

Pond Dam near Great Barrington, Massachusetts (Gauge #01197500). GE will capture flow data from these two locations as part of the baseline monitoring program (and beyond).

In addition, in accordance with the directives in EPA's March 29, 2022 conditional approval letter, GE will also capture flow data from one additional USGS gauge in Massachusetts (Housatonic River near Ashley Falls, Massachusetts; Gauge #01198125), and from three locations in the Connecticut portion of the ROR. The three Connecticut locations include the Housatonic River at Gaylordsville, Connecticut (Gauge #01200500), the Tenmile River near Gaylordsville (Gauge #01200000), and the Housatonic River near New Milford, Connecticut (Gauge #01200600). The gauge at New Milford was previously discontinued, so GE will coordinate with USGS to reactivate this gauge. Table 4-2 provides a summary of locations where flow data will be captured during the baseline monitoring program.

Table 4-2
Summary of Baseline Flow Monitoring

Location	Reach	USGS Gauge Station Number
Housatonic River near Woods Pond	6	TBD[1]
Housatonic River near Great Barrington, MA	8	#01197500
Housatonic River near Ashley Falls, MA	9	#01198125
Housatonic River at Gaylordsville, CT	12	#01200500
Tenmile River near Gaylordsville, CT	12	#01200000
Housatonic River near New Milford, CT[2]	13	#01200600

Notes:
1. Pending installation of new USGS gauging station
2. GE to work with USGS to reactivate gauging station

4.2 Surface Sediment Monitoring

The baseline surface sediment monitoring program has been designed to satisfy the pertinent DQOs presented in Section 2. Specifically, the program will support future evaluation of the impacts of Remedial Action during and after completion (DQOs 1 through 4) and will provide data that may be used to inform model parameterization in the event a model re-evaluation plan is deemed necessary by EPA after consultation with GE (DQO 5). This plan focuses on baseline surface sediment sampling that will be performed in the MNR portions of the ROR, including Reaches 7A, 7D, 7F, and 7H, as well as Reaches 9 through 16.[18]

There are no General Performance Standards in the Revised Final Permit setting numerical values for future sediment concentrations. However, Section II.B.2.h of the Revised Final Permit states that

[18] As noted above, sediment sampling in reaches subject to active remediation will be conducted as part of the pre-design investigations to be conducted in those reaches and thus is not included in this Revised BMP.

monitoring of affected media, including sediments, shall be conducted in portions of the ROR where MNR is the Performance Standard (beginning with baseline). Fish data will be used as the primary line of evidence in the assessment of long-term trends in the MNR portions of the ROR; however, surface sediment data will be collected and used as another line of evidence in that assessment.

4.2.1 Sampling Approach and Locations

Surficial sediment samples will be collected from the 0- to 6-inch depth interval in each reach to be consistent with historical surface sediment data. Sediment sampling for the baseline monitoring program will include two components:

1. Sampling on systematic transects that are approximately equally spaced and constitute 80% of the sampling effort in each reach; and
2. Sampling at stratified random (i.e., flexible) transects/locations that are placed to sample specific river features such as aggrading areas, sand bars, and depositional areas. As directed in EPA's March 29, 2022 conditional approval letter, a subset of the stratified random sampling will include collection of surface sediments in some beach areas and boat launches. This component of the sediment sampling program will constitute 20% of the sampling effort in each reach.

The total number of transects in each reach (N, which equals the total number of systematic and flexible transects that need to be collected in a given reach) was determined using the statistical analysis presented in Appendix A and summarized in Section 4.2.2. The systematic transects were approximately equally spaced within each reach and are shown on Figures 4-4a through 4-4l. The locations of the flexible transects/samples have not yet been determined and will be located based upon reconnaissance to be conducted at the time of the systematic sediment sampling. Proposed locations for the flexible sampling locations will be provided to EPA for review and approval.

Each of the transects located in the Massachusetts reaches will consist of three discrete samples, one collected at approximately mid-river and one near each shore. Each of the transects located in Connecticut will consists of five discrete samples, distributed at approximately equal intervals across the river. The Connecticut transects include more discrete samples because the river is generally wider in that area. The three or five discrete samples collected at each transect will be composited and submitted to the laboratory for a single PCB analysis.

Sediment sample collection and processing will be performed following the methodology outlined in Appendix F (Sediment Sampling Procedures) to GE's current FSP/QAPP (or the comparable SOP in the Rest of River FSP/QAPP if it has been submitted and approved by the time of sampling). The sampling crew will navigate to the proposed sediment sampling locations using a differential global positioning system (GPS). Depending on access and water depth, sediment samples will be collected from a flat-bottomed vessel or by personnel wearing waders. A surface sediment grab sampler will be used to collect the top six inches of sediment. It may be necessary to make small adjustments to some of the target sampling locations based on conditions encountered in the field. Further, several reaches in the ROR (or portions of them) are relatively shallow and swift-flowing reaches; therefore, it is anticipated that there may be insufficient sediment present for sample collection at some of the systematic transect locations specified in this Revised BMP.[19] If insufficient sediment is found at a particular location, the transect will be moved a maximum of 50 feet upstream or downstream of the original target location. If still no sediment is encountered, GE will consult with the EPA field representative regarding further modification of the transect location.

4.2.2 Number of Samples and Sampling Frequency

Based on the statistical evaluation presented in Appendix A, a total of 810 discrete surface sediment samples will be collected under this baseline monitoring program, resulting in 210 PCB analyses after compositing. The number of discrete sediment locations and PCB analyses (equal to the number of transects) are provided in Table 4-3.

Table 4-3
Summary of Baseline Sediment Sampling Locations and PCB Analyses by Reach

Reach	Reach Length (miles)	Number of Sediment Locations	Number of PCB Analyses
Reach 7A	1.6	60	20
Reach 7D	5.4	120	40
Reach 7F	6.1	60	20
Reach 7H	2.7	60	20
Reach 9	22.5	60	20
Reach 10 (Falls Village)	7.3	75	15
Reach 11	11.8	75	15
Reach 12 (Bulls Bridge)	12.4	50	10
Reach 13 (Bleachery)	11.3	50	10
Reach 14 (Lake Lillinonah)	12.5	100	20
Reach 15 (Lake Zoar)	10.3	50	10
Reach 16 (Lake Housatonic)	5.9	50	10
Total	**109.8**	**810**	**210**

A single round of baseline sediment sampling will be conducted prior to commencement of any remediation activity in the ROR. The timing of that sediment sampling will be determined in consultation with EPA.

[19] Sufficient sediment is defined as at least two inches of sediment with a grain size less than about ½ inch in diameter.

4.2.3 Laboratory Analysis

Each composite baseline sediment sample will be submitted for analysis of PCBs as Aroclors using EPA Method 8082A, targeting a reporting limit/PQL of approximately 10 micrograms per kilogram. Each sediment sample will also be analyzed for moisture content (using Standard Method 2540G), total organic carbon (using the Lloyd Kahn Method), and grain size using ASTM Method D422. The baseline analytical data will be reported for each reach or subreach, showing the number of samples, the arithmetic mean, median, and maximum PCB concentrations, 95th percentile upper confidence limit on the mean (95th UCL), standard deviation, and statistical distribution.

4.2.4 Sediment Type Characterization

A brief description of the physical characteristics of each sample will be recorded for each sample. These characteristics will include the general soil type (fine sand, medium sand, coarse sand, gravel, silt, clay, and organic/other matter such as wood chips), presence of observable biota, odor, and color.

4.3 Biota Monitoring

The baseline biota monitoring program has been designed to satisfy the pertinent DQOs presented in Section 2. Specifically, the program will support future evaluation of the impacts of Remedial Action during and after completion both in reaches subject to active remediation and in MNR reaches (DQOs 1 through 4), and it will provide data that may be used to inform model parameterization in the event a model re-evaluation plan is deemed necessary by EPA after consultation with GE (DQO 5). The baseline biota data will also be qualitatively used to support evaluation of progress towards biota consumption advisories (for both fish and waterfowl) and progress towards achievement of the Short-Term and Long-Term biota Performance Standards (DQO 7) and to assist in determining if there is a reduction in ecological risks to piscivorous mammals and birds (DQO 8). Baseline biota sampling efforts will include sampling of adult and YOY fish, benthic invertebrates, and waterfowl.

4.3.1 Sampling and Analysis of Fish

The design of the baseline sampling program for fish is partly based upon previous sampling of fish in the ROR (described in Section 3.3), as well as the scope of future monitoring activities anticipated to occur during and after construction. Fish will be collected at a location or locations within each targeted reach based on habitat availability. Because the Biota Performance Standards specified in the Revised Final Permit are based on PCB exposure in adult fish, baseline fish sampling will include the collection and analysis of adult fish. YOY fish will be included as well to provide additional lines of evidence for the evaluation of time trends. A description of the sampling approach for the collection of fish samples is provided in the subsections that follow, and the baseline fish sampling program is summarized in Table 4-4.

4.3.1.1 Sampling Locations and Approach

In accordance with EPA's March 29, 2022 conditional approval letter, Table 4-4 lists the 14 locations selected for adult fish sampling, and Table 4-5 lists the eight locations for YOY fish sampling. Target species are discussed in Section 4.3.1.2. Figure 4-5a is a map showing baseline fish sampling locations in all reaches, and Figure 4-5b is a map showing the fish sampling locations in Reaches 5 through 8.

Table 4-4
Summary of Baseline Adult Fish Sampling Locations and Species

Reach	Location Description	State	Species
Reach 5A	Confluence to Pittsfield WWTP	MA	LMB, YP, BB or WS
Reach 5B/5C	Pittsfield WWTP to upstream Woods Pond	MA	LMB, YP, BB
Reach 6	Woods Pond	MA	LMB, YP, BB
Reach 7D		MA	LMB, YP, BB
Reach 7G	Glendale Dam Impoundment	MA	LMB, YP, BB
Reach 8	Rising Pond	MA	LMB, YP, BB
Reach 9	End of reach near MA/CT border (near Rt. 341 bridge)	MA	LMB, YP, BB
Reach 10	Falls Village	CT	LMB, YP, BB
Reach 11	West Cornwall	CT	SMB, YP, BB, NP
Reach 12	Bulls Bridge Impoundment	CT	SMB, YP, BB, NP
Reach 13	RT 7 Gaylordsville to New Milford	CT	SMB, YP, FF
Reach 14	Lake Lillinonah	CT	SMB, YP, BB, NP
Reach 15	Lake Zoar	CT	SMB, YP, BB, NP
Reach 16	Lake Housatonic	CT	SMB, YP, BB, NP

Notes:
BB: brown bullhead
FF: fallfish
LMB: largemouth bass
NP: northern pike
WS: white sucker
YP: yellow perch

Table 4-5
Summary of Baseline YOY Fish Sampling Locations and Species

Reach	Location Description	State	Species
5A	Confluence to Pittsfield WWTP	MA	LMB, YP
5B/5C	Pittsfield WWTP to upstream Woods Pond	MA	LMB, YP
6	Woods Pond	MA	LMB, YP
7D		MA	LMB, YP
7G	Glendale Dam Impoundment	MA	LMB, YP
8	Rising Pond	MA	LMB, YP
9	MA/CT Border (HR6)	MA	LMB, YP
11	West Cornwall	CT	LMB, YP

Notes:
LMB: largemouth bass
YP: yellow perch

Sampling locations and collection methods will generally be consistent with those used in past sampling events to facilitate evaluation of long-term temporal trends. Specific sampling areas at each location (shown as discrete points on Figures 4-5a and 4-5b) may be adjusted or expanded as needed based on fish availability and habitat conditions within each reach. Reasonable attempts will be made to maintain sample location integrity throughout the program. To achieve this objective, sampling events will initially target locations sampled previously within each reach. If fish are not available at historical locations, the target locations will be expanded or moved within a reach (after consultation with the EPA field representative).

4.3.1.2 Target Fish Species and Size

As indicated in Table 4-4, baseline fish sampling will include the collection of adult fish at 14 sampling locations. The species to be collected will be generally consistent with those targeted historically and will primarily include largemouth bass (*M. salmoides*), yellow perch (*Perca flavescens*), and brown bullhead (*Ameiurus nebulosus*) at the Massachusetts locations and smallmouth bass (*Micropterus dolomiueu*), yellow perch, and brown bullhead at the Connecticut locations. Since the Biota Performance Standards for fish apply to the edible portion for humans (i.e., fillets), collection of these fish will target the legal or edible size, which are fish greater than 305 millimeters (mm) for bass, 200 mm for bullhead, and 170 mm for yellow perch.[20]

As shown in Table 4-5, the baseline monitoring program will also include the collection of YOY fish at eight locations. Species to be collected in all targeted reaches (Reaches 5A through 11) will include

[20] Largemouth and smallmouth bass are the only fish in the States of Massachusetts and Connecticut that have a legal minimum size requirement (305 mm in both states). Minimum sizes specified for bullhead and yellow perch are based on an evaluation of sizes of adult fish collected previously.

largemouth bass and yellow perch. Similar to historical collections, YOY samples will be composite samples consisting of fish of the same species of similar size. Composite samples will consist of typically a minimum of five fish, as was true historically (see the 2003 RFI Report) with increased numbers if more fish are needed to obtain adequate mass for analysis.

4.3.1.3 Number of Samples and Sampling Frequency

Based on the statistical evaluation presented in Appendix A, a total of 10 adult fish and seven YOY composite samples will be targeted per species per sampling event within each of the reaches targeted for sampling. This is generally consistent with the numbers of fish collected historically. Fish sampling for the baseline monitoring program will be performed during two separate events, for a total of 20 adult and 14 YOY fish per species per reach. The timing of those two sampling events will be determined in consultation with EPA. After collection of the first year of data, GE may propose a reduction in the number of sampling locations in the second year based on an evaluation of the first year of data (e.g., if PCB concentrations in adjacent reaches are shown to be similar). Any changes in the program described here will be subject to EPA review and approval. After evaluation of the baseline data, the data collected during the two-year period will be pooled as one data set to define baseline conditions.

4.3.1.4 Sample Collection Procedures

Fish sample collection, processing, and handling will be performed following the methodology outlined in Appendix H (Biota Sampling and Analysis Procedures) to GE's current FSP/QAPP (or the comparable SOP in the Rest of River FSP/QAPP if it has been submitted and approved by that time). Standard sampling methods, including netting and electroshocking, will be used to collect target species. Methods of collection will vary depending on the sampling location and the targeted species, although electrofishing is the preferred sampling method (as site conditions allow), consistent with historical sampling events. If electrofishing proves ineffective, nets (e.g., gill or trap) may be set to collect the desired number of fish. If fish are not present and target numbers cannot be collected after a reasonable effort, sampling may be discontinued in that reach; any decision to discontinue sampling will be made in consultation with the EPA field representative. Prior to sampling at each location, water quality data will be collected with a multi-parameter probe such as a YSI 6000 series sonde (or equivalent). Electrofishing will occur generally along transects near the riverbanks, targeting areas of preferred habitat (e.g., vegetation, undercut banks, downed trees, and deep pools). GPS coordinates will be logged at the upstream and downstream extent of the transects at each sampling location, and shocking seconds will be noted in the field log. If nets are used, a set of GPS coordinates will be logged at each net location.

Each fish collected will be weighed (to the nearest 1.0 gram for adult fish and nearest 0.1 gram for YOY fish), and total length will be measured (to the nearest mm) and recorded. These measurements will be made as soon as possible following collection. In addition, observed external abnormalities will be noted in the field log. Fish otoliths will be collected in the field and archived in the event that it is necessary to determine the age of fish collected. Sex of fish will be determined in the field (if possible) prior to shipment to the analytical laboratory.

The portions of adult fish generally eaten by humans will be analyzed (i.e., fillets). Fish samples will be prepared by removing the left fillet, excluding the rib cage, and removing the skin for analysis; the right fillet will be included only if needed for sufficient sample mass. For YOY fish, samples will be analyzed as whole-body composites.

4.3.1.5 Laboratory Analysis

Fish samples will be analyzed for PCB as Aroclors using EPA Method 8082A and for percent lipid content.[21] The target reporting limit/PQL for fish tissue Aroclor PCB analysis will be approximately 0.05 mg/kg. A subset (approximately 25%) of adult and YOY fish will be split and submitted for PCB congener analyses by EPA Method 1668C, in addition to the Aroclor analyses, to evaluate if the Aroclor method can meet project DQOs. This selected subset will include adult fish samples from Lake Zoar and YOY fish samples from West Cornwall. The individual congener PCB reporting limits for fish tissue analysis range from approximately 0.5 to 4.25 picograms per gram (per congener). The congener PCB results will be compared to the Aroclor results using graphical and statistical analyses. If these analyses indicate that the Aroclor method can meet the pertinent DQOs, all future fish tissue PCB analyses will be conducted using the Aroclor method. In addition, the sex of each individual fish will be determined by the laboratory independent of the field determination.

4.3.2 Sampling and Analysis of Benthic Invertebrates

The baseline benthic invertebrate monitoring program will provide data to supplement the more robust fish monitoring program described above.

4.3.2.1 Sampling Locations and Approach

Benthic invertebrate sampling will be conducted within a single reach in Connecticut (West Cornwall, Reach 11), consistent with historical sampling (Figure 4-5a). Specifically, caddisfly, hellgrammite, and stonefly nymphs will be collected from this reach (Table 4-6).

Table 4-6
Summary of Baseline Benthic Macroinvertebrate Sampling Location and Species

Reach	Location Description	State	Species
Reach 11	West Cornwall	CT	Caddisfly, hellgrammite, and stonefly nymphs

[21] Prior analyses of fish have included use of the congener-based Green Bay Method for adult fish in recent sampling in Massachusetts and the ANS analytical methods for both Aroclors and congeners for adult fish in Connecticut. The Green Bay Method is no longer commercially available, and GE is not proposing to use the ANS methods for the baseline fish sampling program.

4.3.2.2 Number of Samples and Sampling Frequency

Sampling will include collection of two samples per species during a single event within this reach.

4.3.2.3 Sample Collection Procedures

Benthic invertebrate sample collection, processing, and handling will be performed following the methodology outlined in the SOP in Appendix H (Biota Sampling and Analysis) to GE's current FSP/QAPP (or the comparable SOP in the Rest of River FSP/QAPP if it has been submitted and approved by the time of sampling).[22] In summary, surface sediment samples will be collected with a grab sampler (ponar or similar) lowered from a vessel to the river bottom. Sediment will then be rinsed with site water through a sieve to remove the fine sediment, and the remaining sediment and benthic invertebrates will be transferred to an appropriate container. If vegetation is present near the surface, a dip net will be swept through the area for collection. If the location is wadeable, a kick net or dip net may be used. This method involves positioning the net on the river bottom and disturbing the sediment directly upstream by kicking or jabbing to dislodge the benthic invertebrates and capture them in the net as they float downstream. Benthic samples will be picked from the collection containers with forceps and placed in sample containers provided by the laboratory, labeled, and preserved in the field in accordance with the applicable SOP. Benthic invertebrate samples will be composited as whole-body composites by taxon. Composite samples will be weighed to ensure sufficient mass is available for laboratory analyses.

4.3.2.4 Laboratory Analysis

Benthic invertebrate samples will be analyzed for PCBs as Aroclors using EPA Method 8082A and percent lipid content. The target reporting limit/PQL for tissue Aroclor PCB analysis will be approximately 0.05 mg/kg.

4.3.3 Sampling and Analysis of Waterfowl

The waterfowl baseline program will address DQO 8 and will provide data to supplement the more robust fish program.

4.3.3.1 Sampling Locations and Approach

Waterfowl sampling (including both wood ducks and mallards) will be conducted in three areas—Woods Pond and Rising Pond in Massachusetts and an impoundment area in Connecticut that is to be determined in consultation with EPA and CDEEP (Table 4-7 and Figure 4-5a).[23]

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[22] The methods described here for benthic invertebrate sampling are consistent with the collection method historically implemented at this site by ANS (as described in ANS-Drexel 2018).

[23] Note that for illustrative purposes, Figure 4-4a shows the to-be-determined Connecticut waterfowl sampling location in Reach 12.

Table 4-7
Summary of Baseline Waterfowl Sampling Locations and Species

Reach	Location Description	State	Species
6	Woods Pond Area	MA	Wood Duck, Mallards
8	Rising Pond Area	MA	Wood Duck, Mallards
TBD[1]	CT Impoundment Area	CT	Wood Duck, Mallards

Note:
1. Location to be determined in consultation with EPA and CDEEP.

4.3.3.2 Number of Samples and Sampling Frequency

Sampling will consist of 20 samples per species per area. Samples will be collected during a single event prior to the fall migration of waterfowl. Timing of the baseline waterfowl sampling event will be determined in consultation with EPA.

4.3.3.3 Sample Collection Procedures

An SOP for waterfowl sampling is provided in Appendix C. Standard sampling methods to collect the waterfowl, similar to those used by EPA in 1998, include the use of baited traps such as floating box traps or walk-in traps. Historical sampling activities at the site used a combination of these methods to collect waterfowl for analysis. Trap sites will be baited with whole and cracked corn for approximately one week before traps are deployed. Traps will be deployed for approximately one month. While deployed, traps will be checked once or twice a day. All captured waterfowl will be removed from the traps and transported to the sample preparation area for processing. Waterfowl breast tissue samples will be prepared by removing and discarding the feathers, removing the breast, carving the tissue from the rib cage, and removing the skin for analysis. Samples will be weighed to ensure sufficient mass is available for laboratory analyses. A sample of the baits used will also be sent to the laboratory for analysis.

4.3.3.4 Laboratory Analysis

Waterfowl breast tissue samples will be analyzed for PCB as Aroclors using EPA Method 8082A and for percent lipid content. The target reporting limit/PQL for tissue Aroclor PCB analysis will be approximately 0.05 mg/kg.

4.4 Summary

A complete summary of data collection to be conducted under the baseline monitoring program is presented in Table 4-8.

Table 4-8
Summary of Baseline Monitoring Program

Reach	Surface Water[1]	Sediment[2]	Fish Adult[3]	Fish YOY[3]	Benthic Invertebrates[2]	Waterfowl[2]
East Branch	✓					
West Branch	✓					
5A	✓[4]	✓[5]	✓	✓		
5B	✓	✓[5]	✓	✓		
5C		✓[5]				
5D		✓[5]				
6	✓	✓[5]	✓	✓		✓
7A		✓				
7B		✓[5]				
7C		✓[5]				
7D	✓	✓	✓	✓		
7E		✓[5]				
7F		✓				
7G		✓[5]	✓	✓		
7H		✓				
8	✓	✓[5]	✓	✓		✓
9	✓	✓	✓	✓		
10	✓	✓	✓			
11	✓	✓	✓	✓	✓	
12	✓	✓	✓			✓[6]
13	✓	✓	✓			
14	✓	✓	✓			
15	✓	✓	✓			
16	✓	✓	✓			

Notes:
1. Two years of monthly sampling.
2. One sampling event for baseline sampling of sediments, benthic invertebrates, and waterfowl.
3. Two sampling events for baseline sampling of fish (adults and YOY). Reaches 5B and 5C to be combined.
4. This station is near Pittsfield WWTP.
5. Sediment in these reaches will be sampled as part of Pre-Design Investigations and for disposal.
6. Specific location in CT is to be determined in consultation with EPA and CDEEP (specified as Reach 12 for this summary).

5 Schedule and Reporting

As noted in Section 4, the timing of data collection for several components of the baseline monitoring program will be determined in consultation with EPA. At this time, GE anticipates the following:

- **Surface Water:** A few aspects of the baseline surface water sampling are dependent on the results of the surface water sampling currently being conducted during 2022 under the Interim BMP (i.e., the need for sample collection in both the East and West Branches; specific locations for sampling near Woods Pond Dam and Rising Pond Dam; PCB analytical methods). As such, GE anticipates initiating the surface water sampling described in this Revised BMP during spring 2023.
- **Sediment:** Baseline sediment sampling will be conducted no later than two years prior to the anticipated start of construction in Reach 5A.
- **Biota:** Two rounds of baseline fish collection need to be conducted prior to construction in Reach 5A. The timing of the first round of fish sampling will be determined in consultation with EPA but may be conducted as early as fall 2023. The schedule for the second fish sampling event has yet to be determined but will occur no later than the last full field season prior to the anticipated start of construction in Reach 5A. Benthic invertebrate and waterfowl sampling will be conducted coincident with the second fish sampling event.

Summary tables of analytical results received in each month collected under this Revised BMP will be included in GE's monthly progress reports under the Consent Decree. The results of baseline monitoring conducted during each year of such monitoring will be presented in an annual Baseline Data Summary Report (BDSR). Each BDSR will present a summary of the work performed during the previous year, including a tabulation of results, processing data, chain-of-custody forms, procedure modifications, copies of field and laboratory audits, data validation results, copies of laboratory reports, and an electronic version of the project database. Each BDSR will be submitted by March 31 of the following year.

6 References

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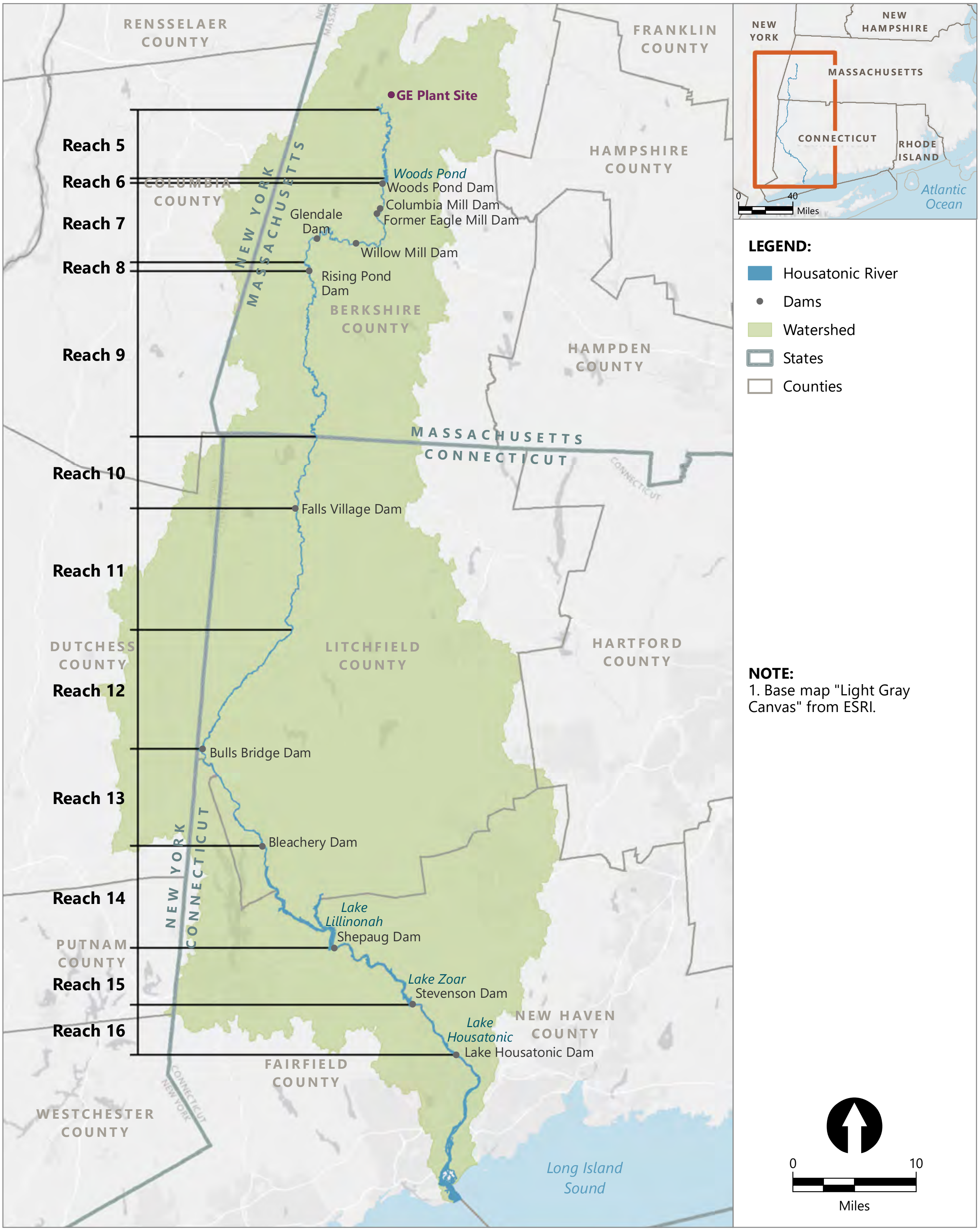
Figures



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ANCHOR QEA

Figure 1-1
Housatonic River Map
Revised Baseline Monitoring Plan
Housatonic River – Rest of River

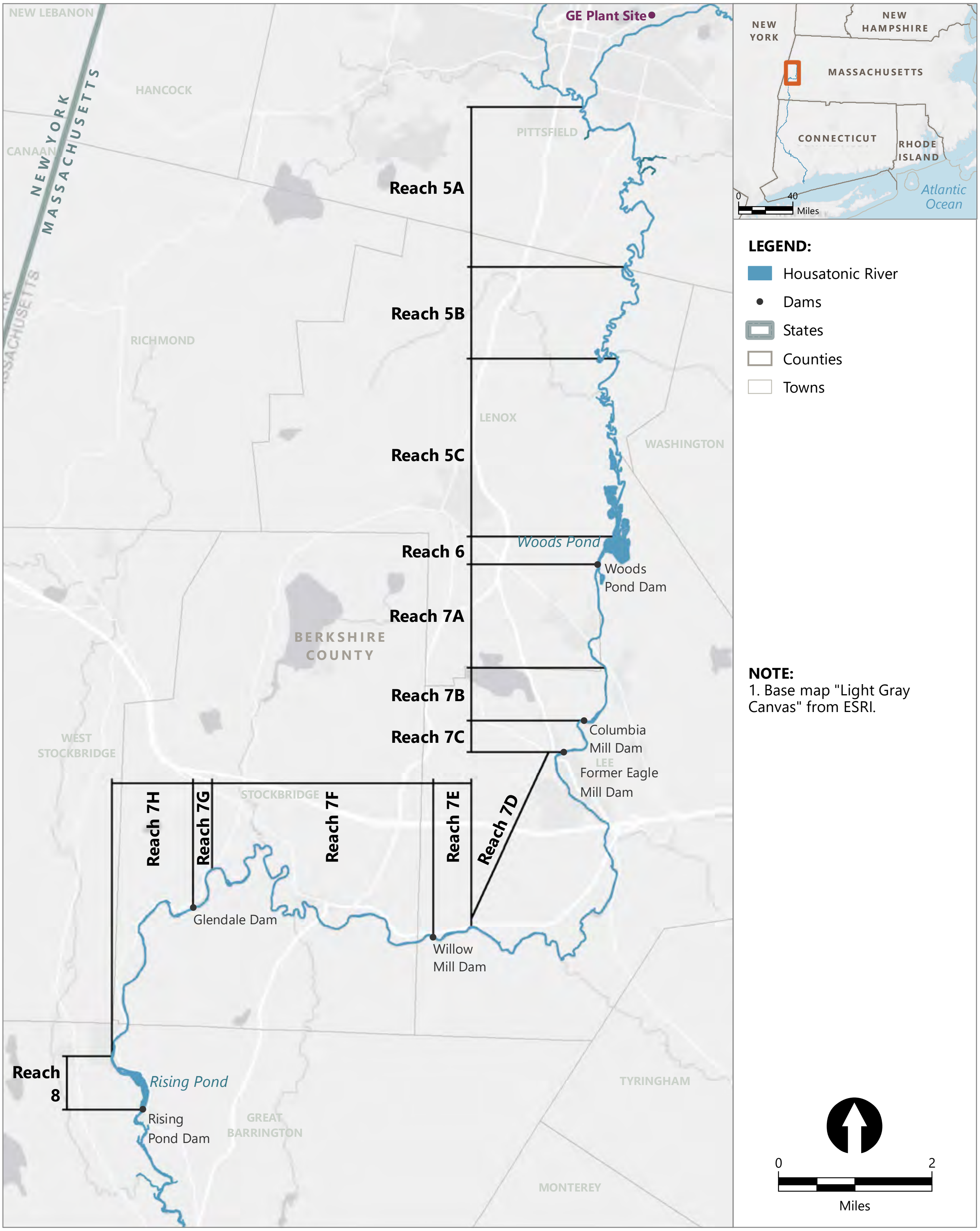

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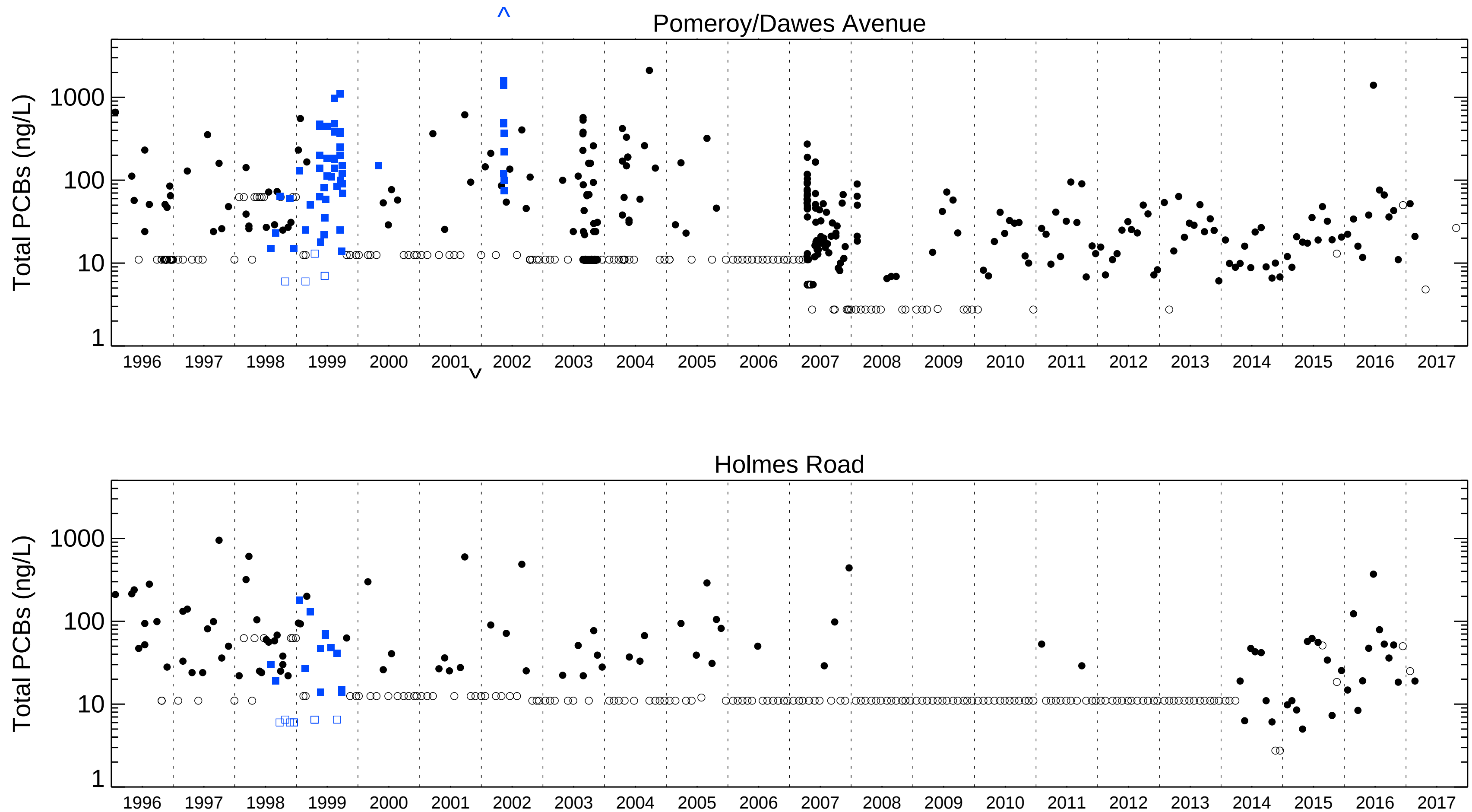
Figure 1-2
Housatonic River Map (Subreaches in Reaches 5 and 7)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River



Non-detects plotted as open symbols at half the value reported in database.
Data collected at Dawes Avenue Bridge and Pomeroy Avenue Bridge were combined.
EPA data at Woods Pond Footbridge and Lenoxdale Bridge plotted at Schweitzer Bridge location.

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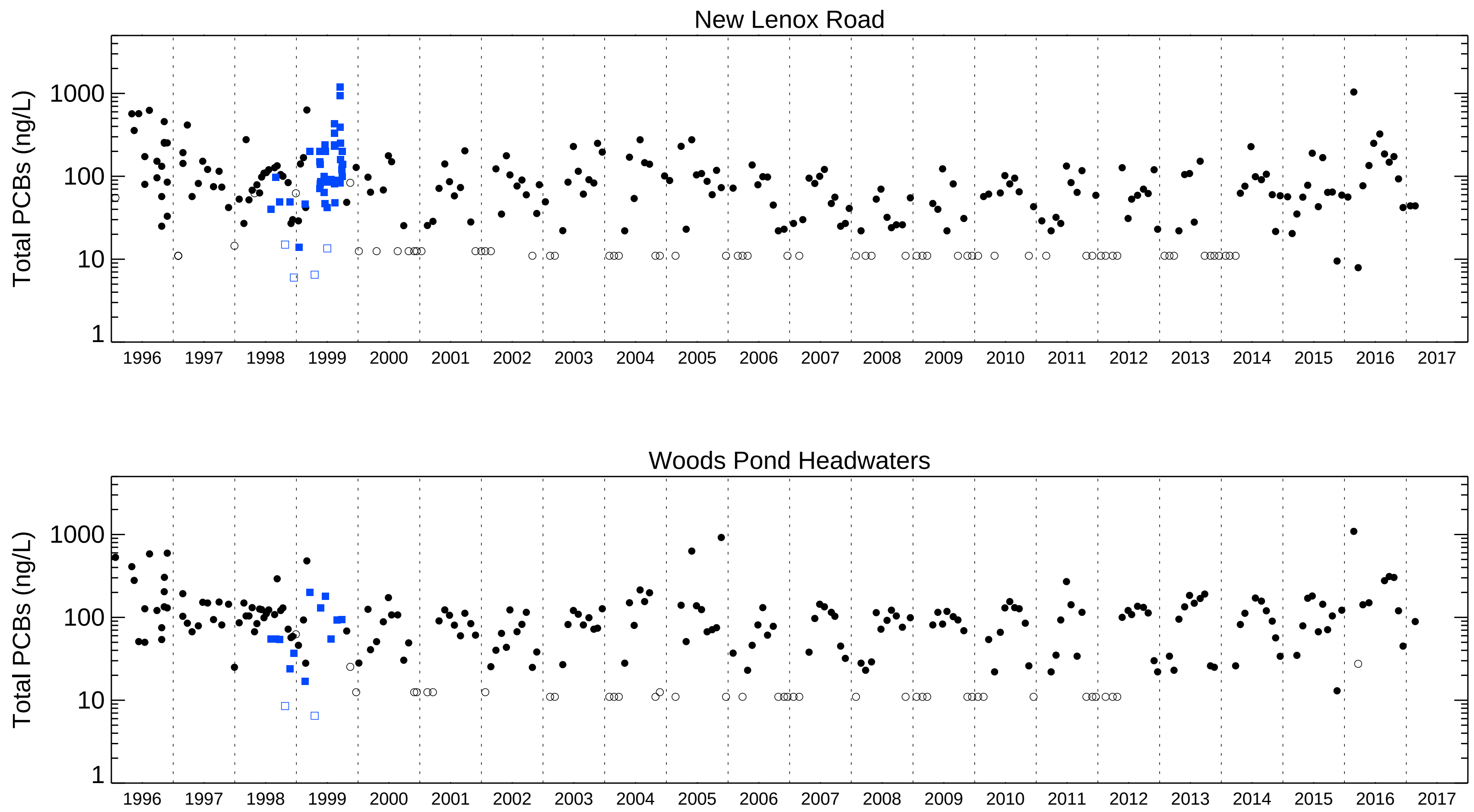
Figure 3-1a

Time Series of Total PCBs at Six Monthly Water Column Monitoring Locations from 1996 to 2017



Non-detects plotted as open symbols at half the value reported in database.
Data collected at Dawes Avenue Bridge and Pomeroy Avenue Bridge were combined.
EPA data at Woods Pond Footbridge and Lenoxdale Bridge plotted at Schweitzer Bridge location.

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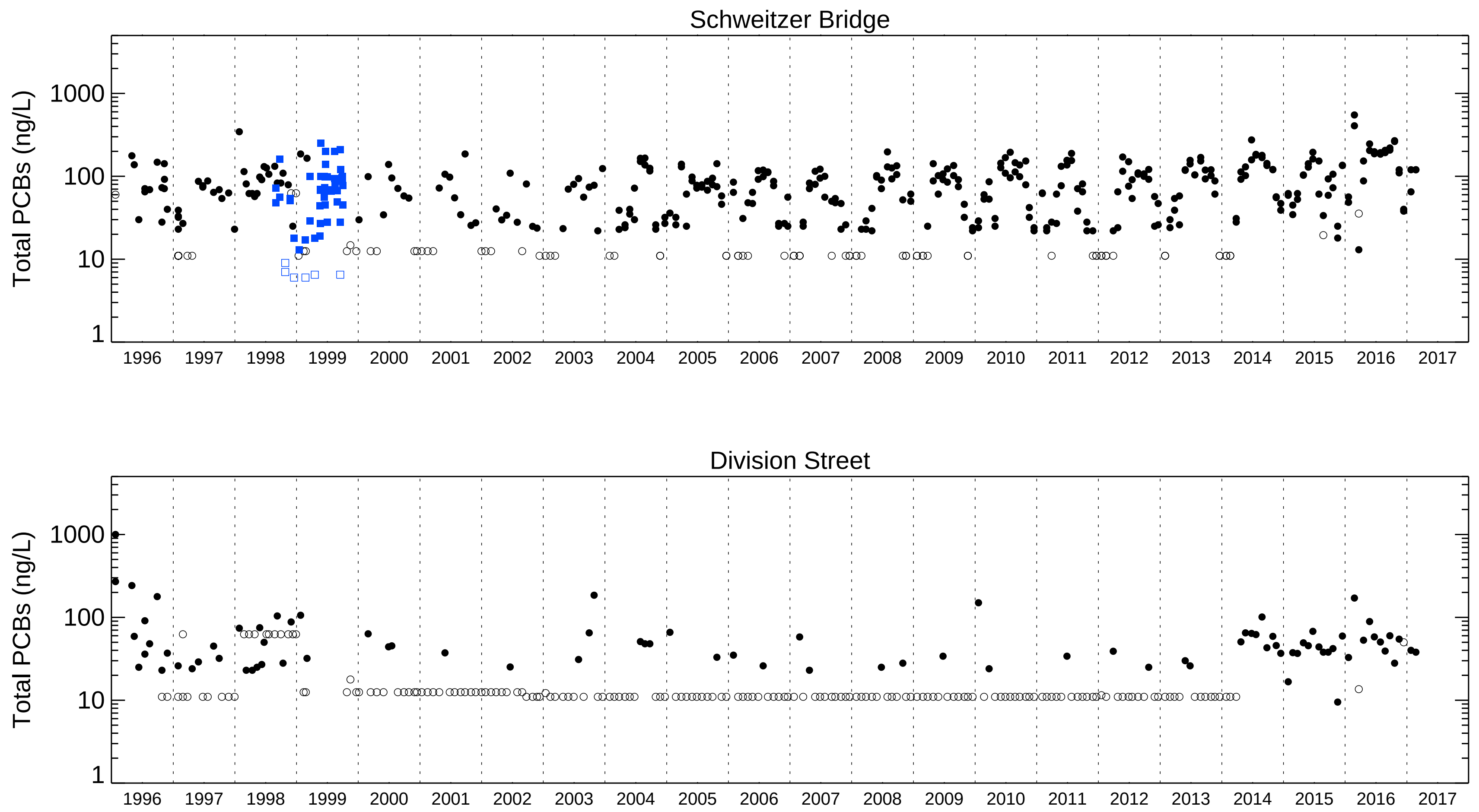
ANCHOR QEA

Figure 3-1b

Time Series of Total PCBs at Six Monthly Water Column Monitoring Locations from 1996 to 2017

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Non-detects plotted as open symbols at half the value reported in database.
Data collected at Dawes Avenue Bridge and Pomeroy Avenue Bridge were combined.
EPA data at Woods Pond Footbridge and Lenoxdale Bridge plotted at Schweitzer Bridge location.

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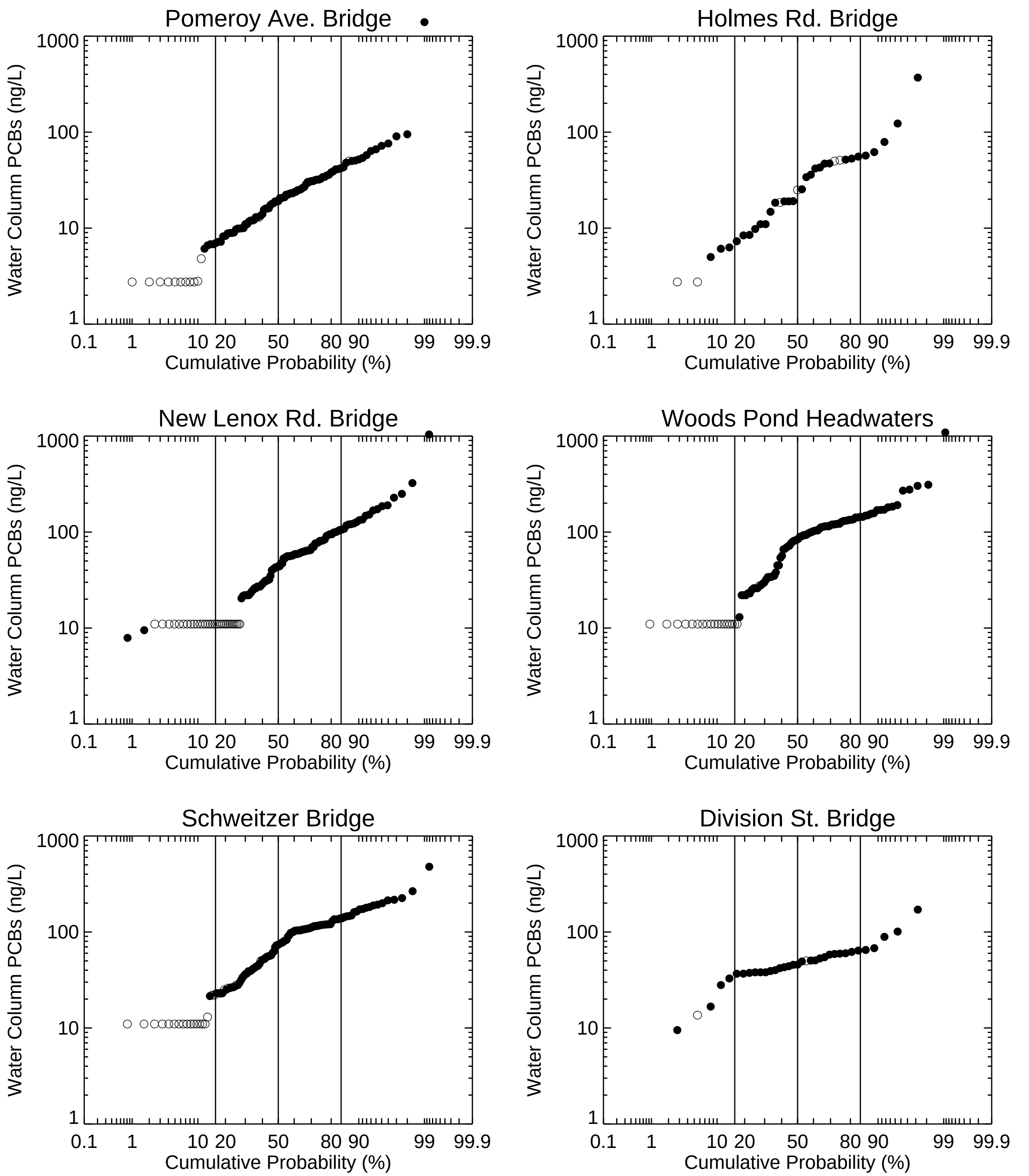
ANCHOR QEA

Figure 3-1c

Time Series of Total PCBs at Six Monthly Water Column Monitoring Locations from 1996 to 2017



Data from Holmes Road and Division Street are between April 2014 through 2017; data from Pomeroy Avenue are between January 2009 through 2017;
data from the remaining stations are between January 2007 through 2017.
Non-detect PCBs plotted as open symbols at 1/2 method detection limit.

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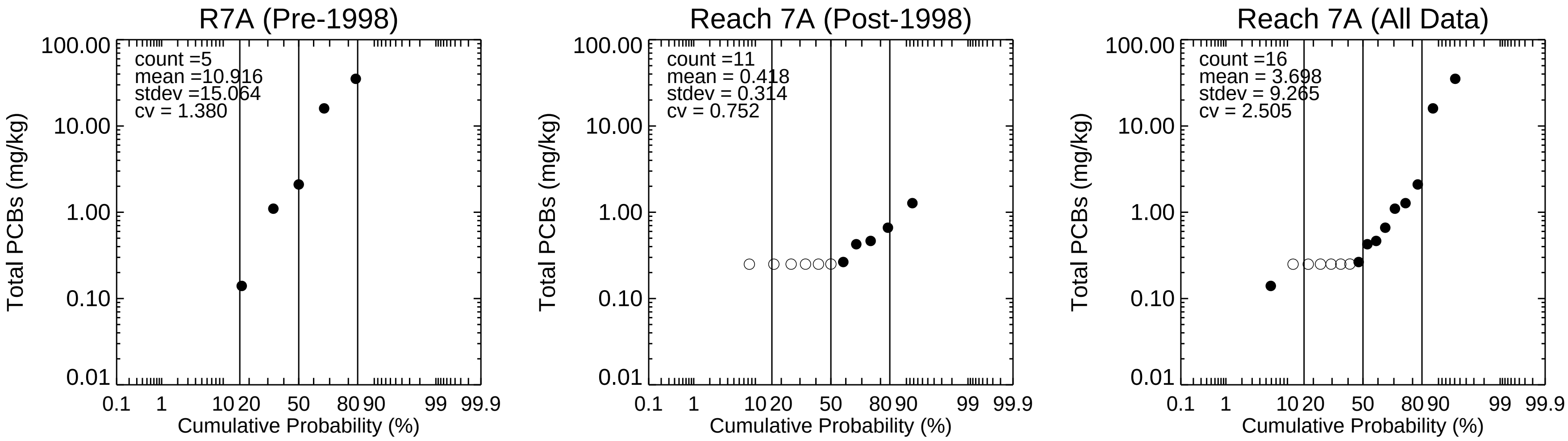
ANCHOR QEA

Figure 3-2

Cumulative Probability Distribution of Total PCBs at Six Monthly Water Column Monitoring Locations

Revised Baseline Monitoring Plan
Housatonic River - Rest of River

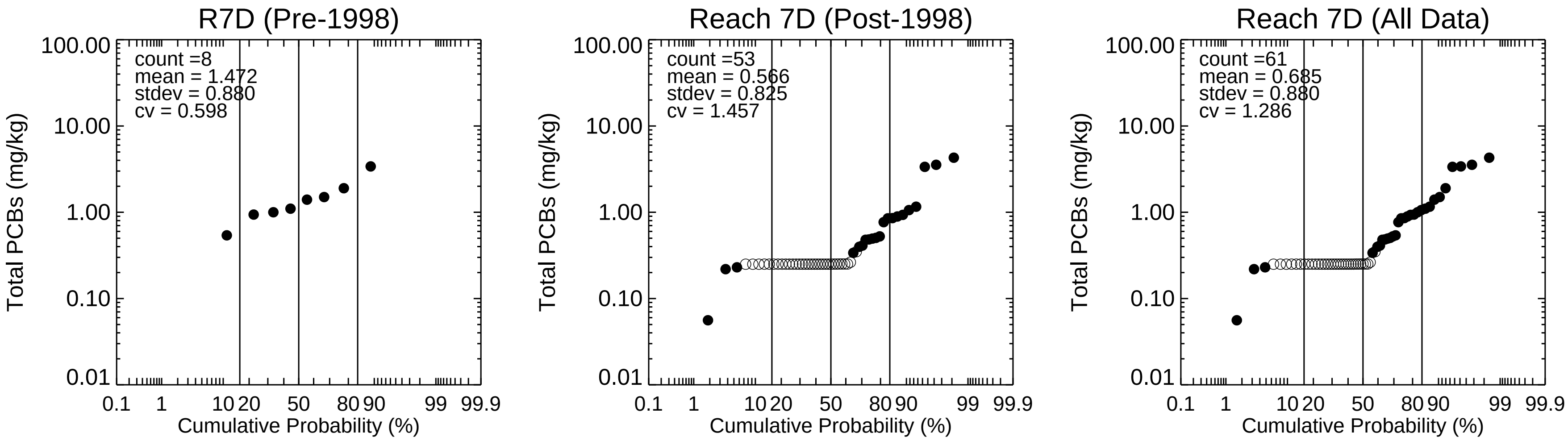


Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

ANCHOR QEA

Figure 3-3a
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 7A)



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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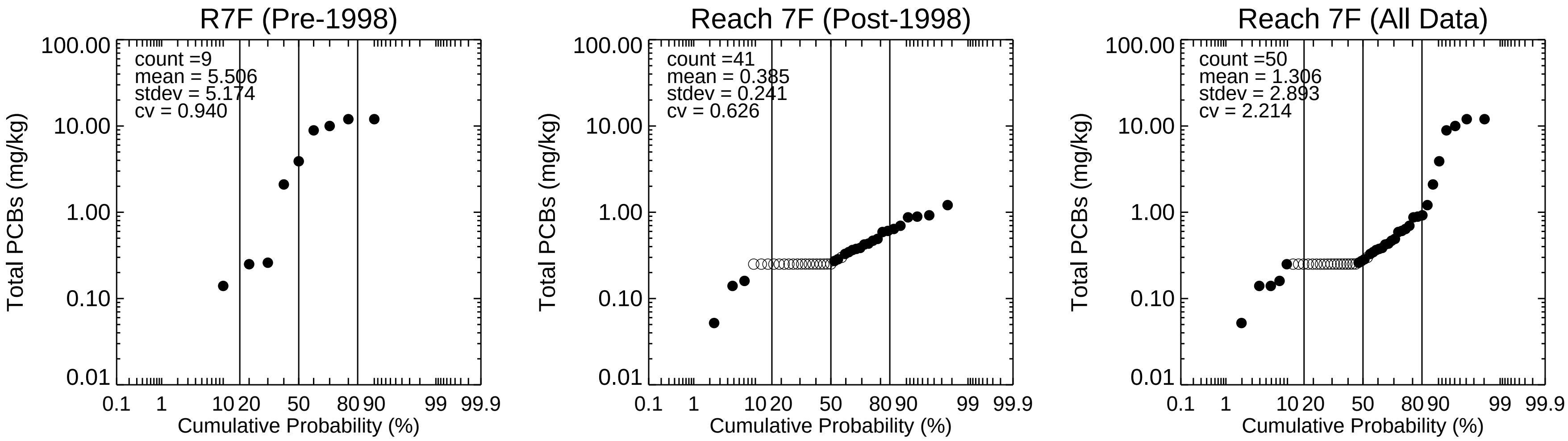
ANCHOR QEA

Figure 3-3b
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 7D)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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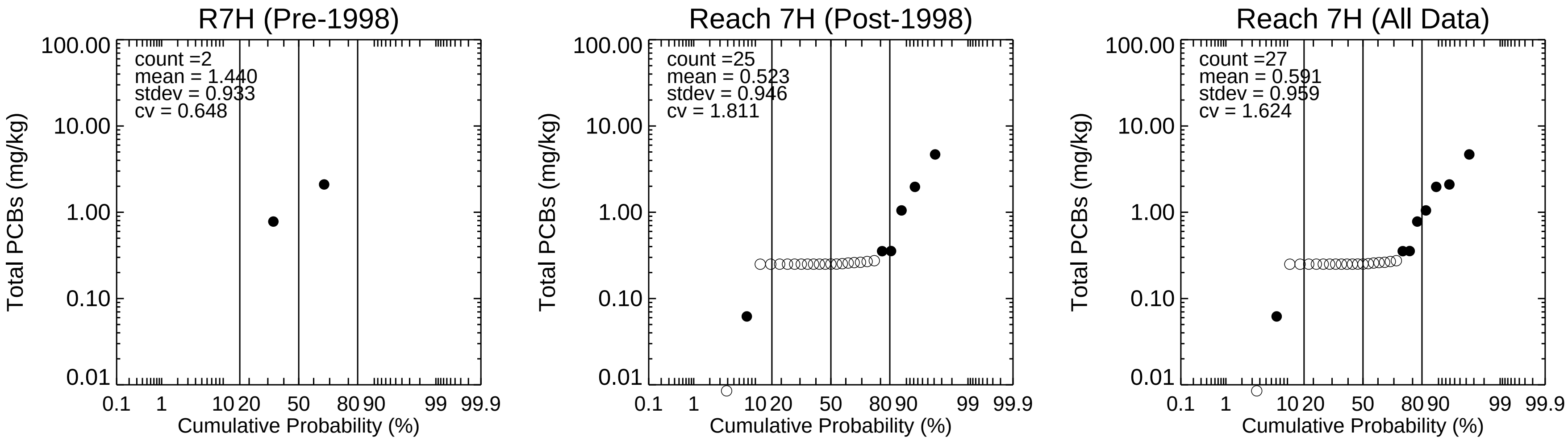
Figure 3-3c
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 7F)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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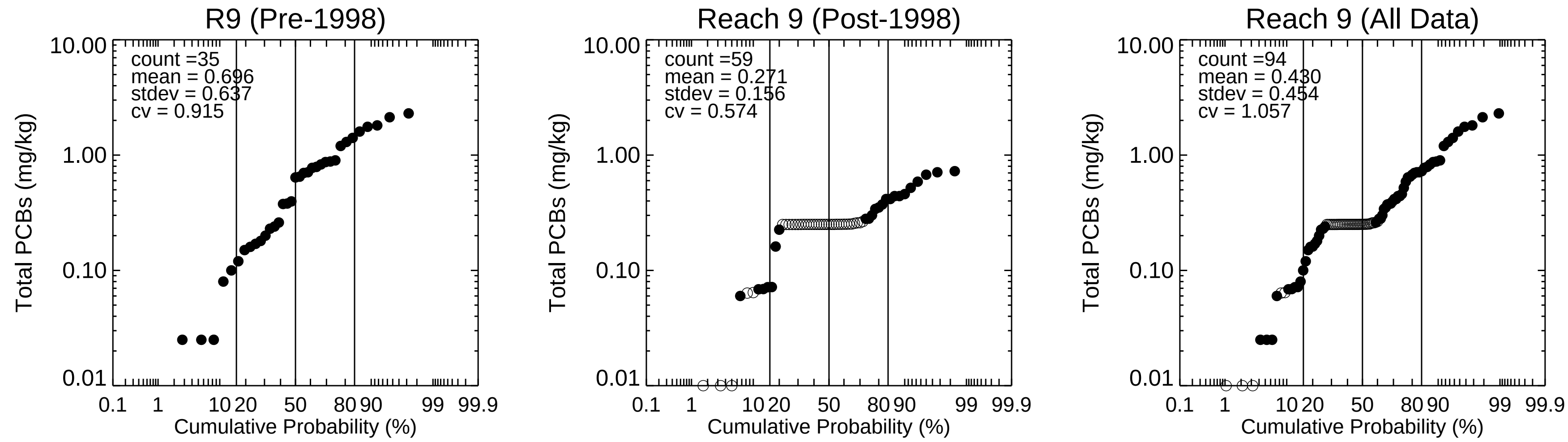
Figure 3-3d
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 7H)



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

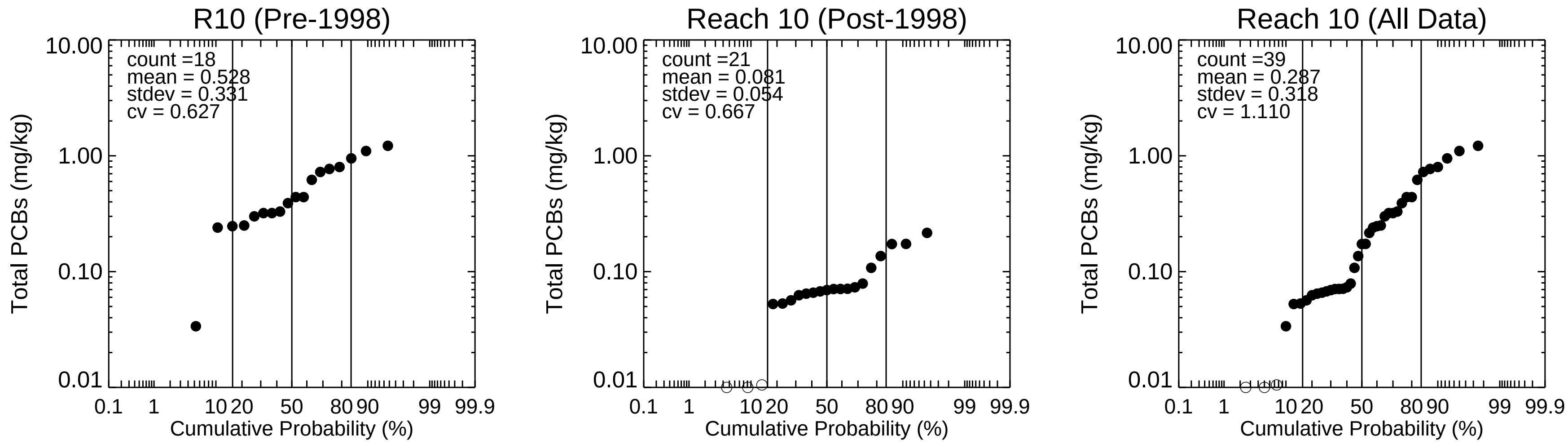
● Detect
○ Non-detect

ANCHOR QEA

Figure 3-3e

Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 9)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



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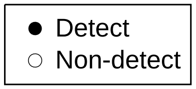
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.



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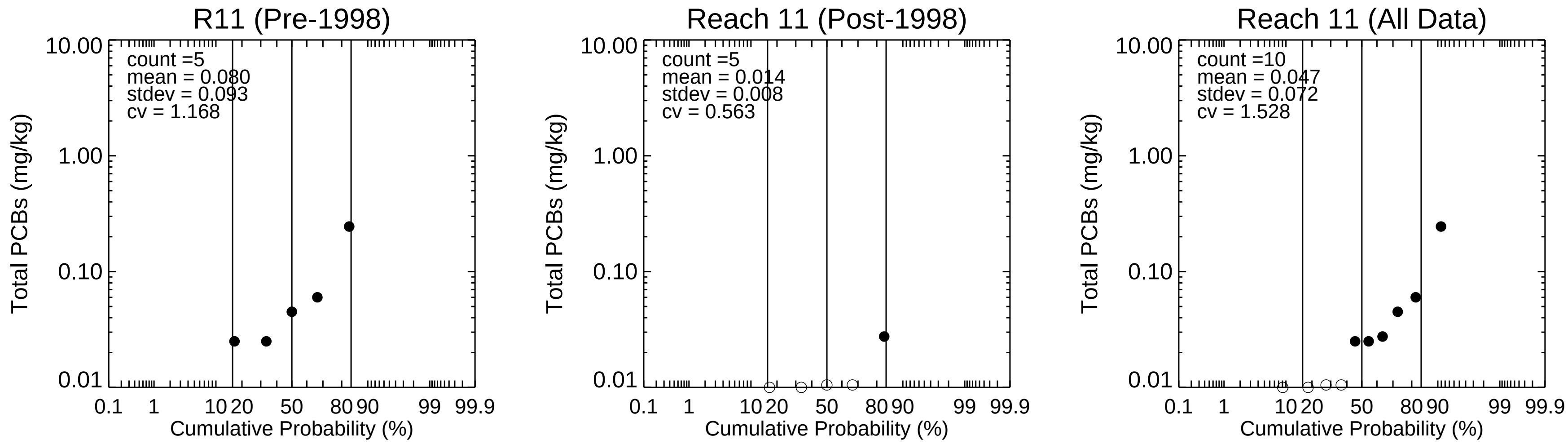
ANCHOR QEA

Figure 3-3f
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 10)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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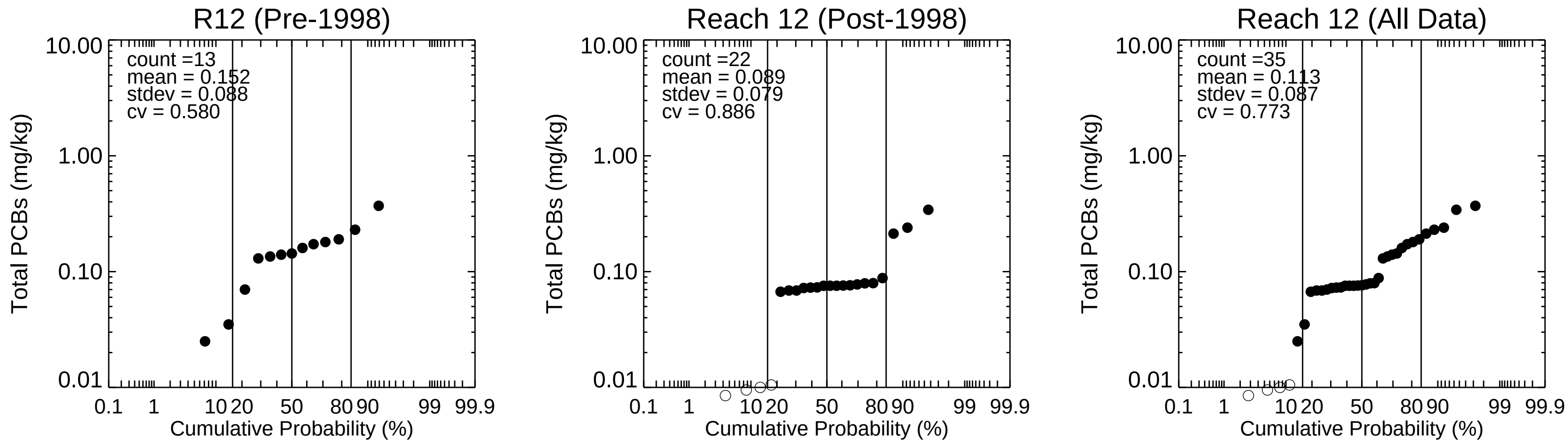
Figure 3-3g
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 11)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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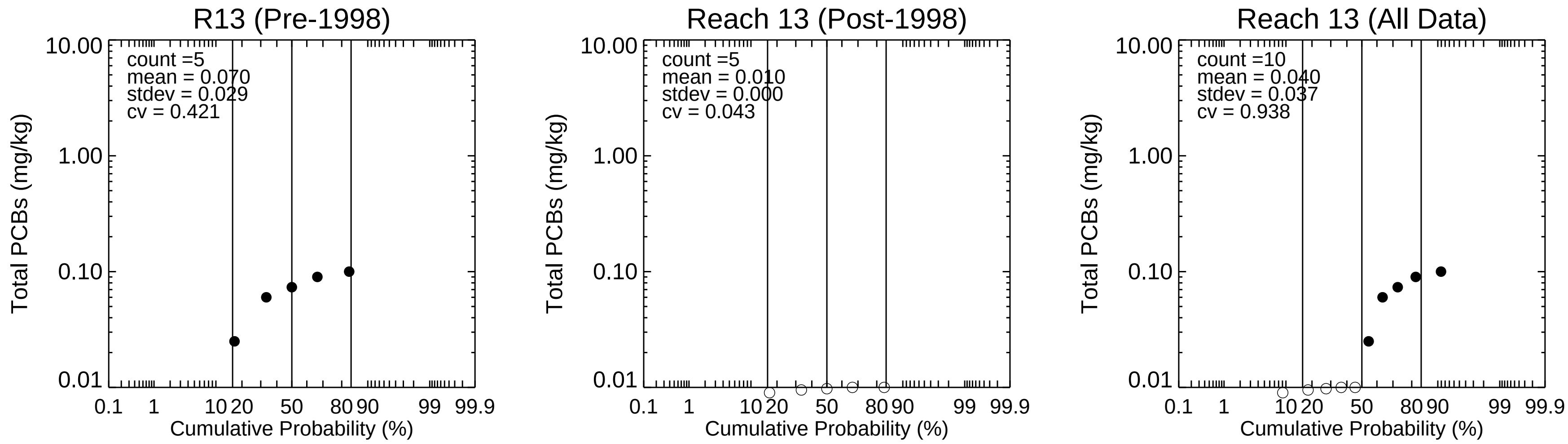
ANCHOR QEA

Figure 3-3h
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 12)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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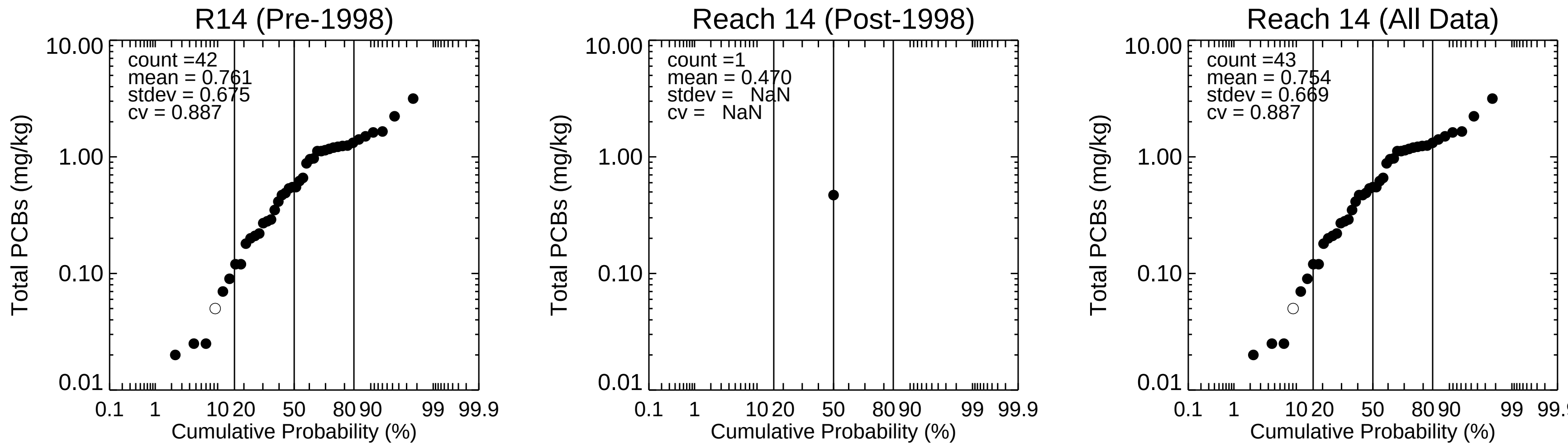
Figure 3-3i
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 13)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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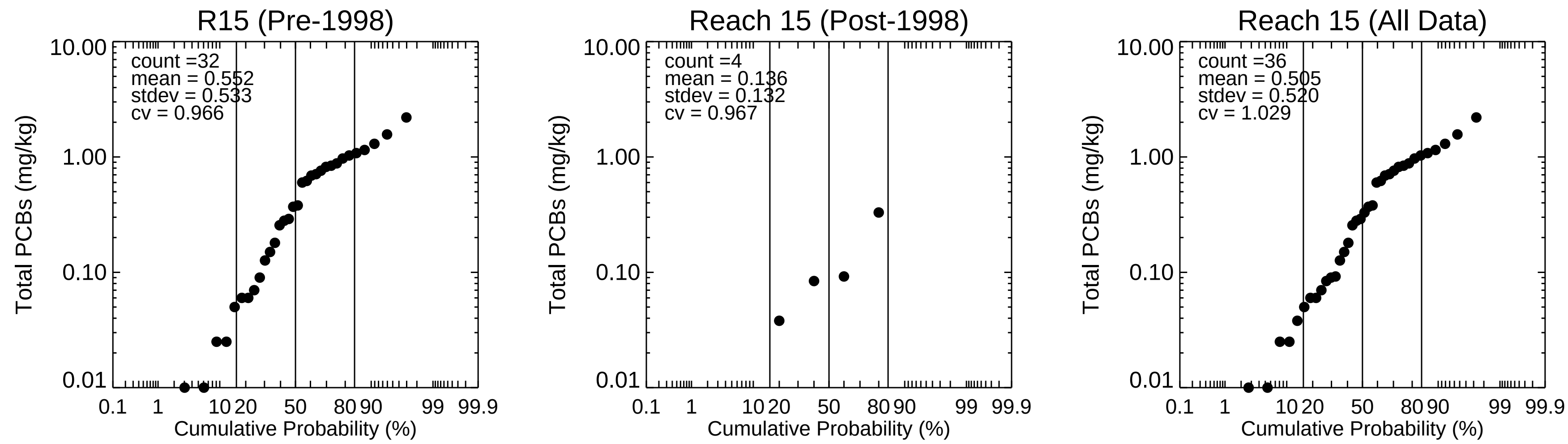
Figure 3-3j
Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 14)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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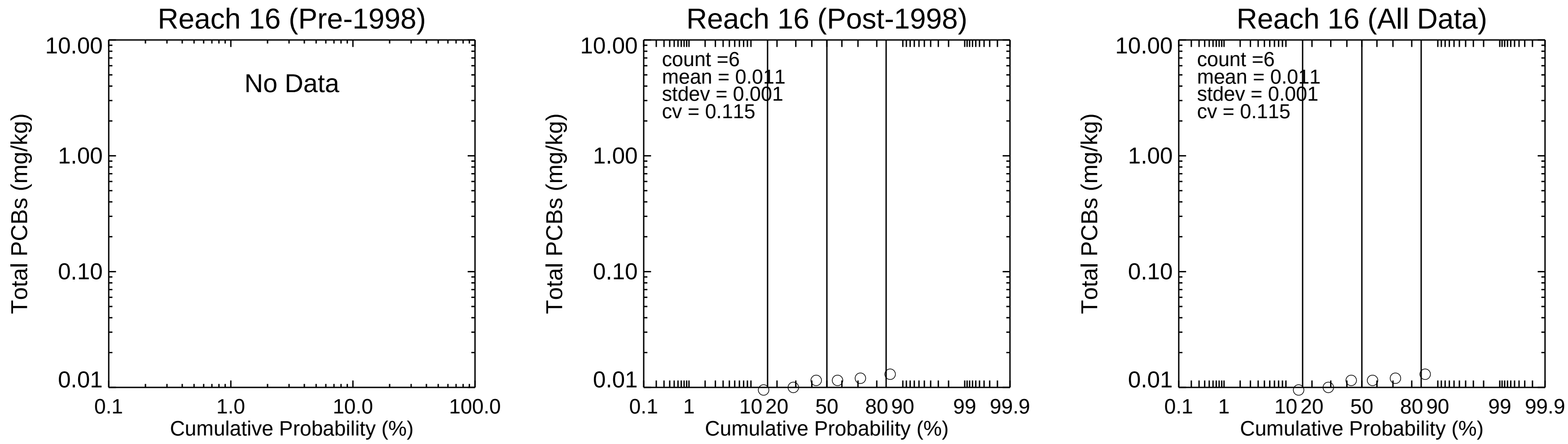
Figure 3-3k

Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 15)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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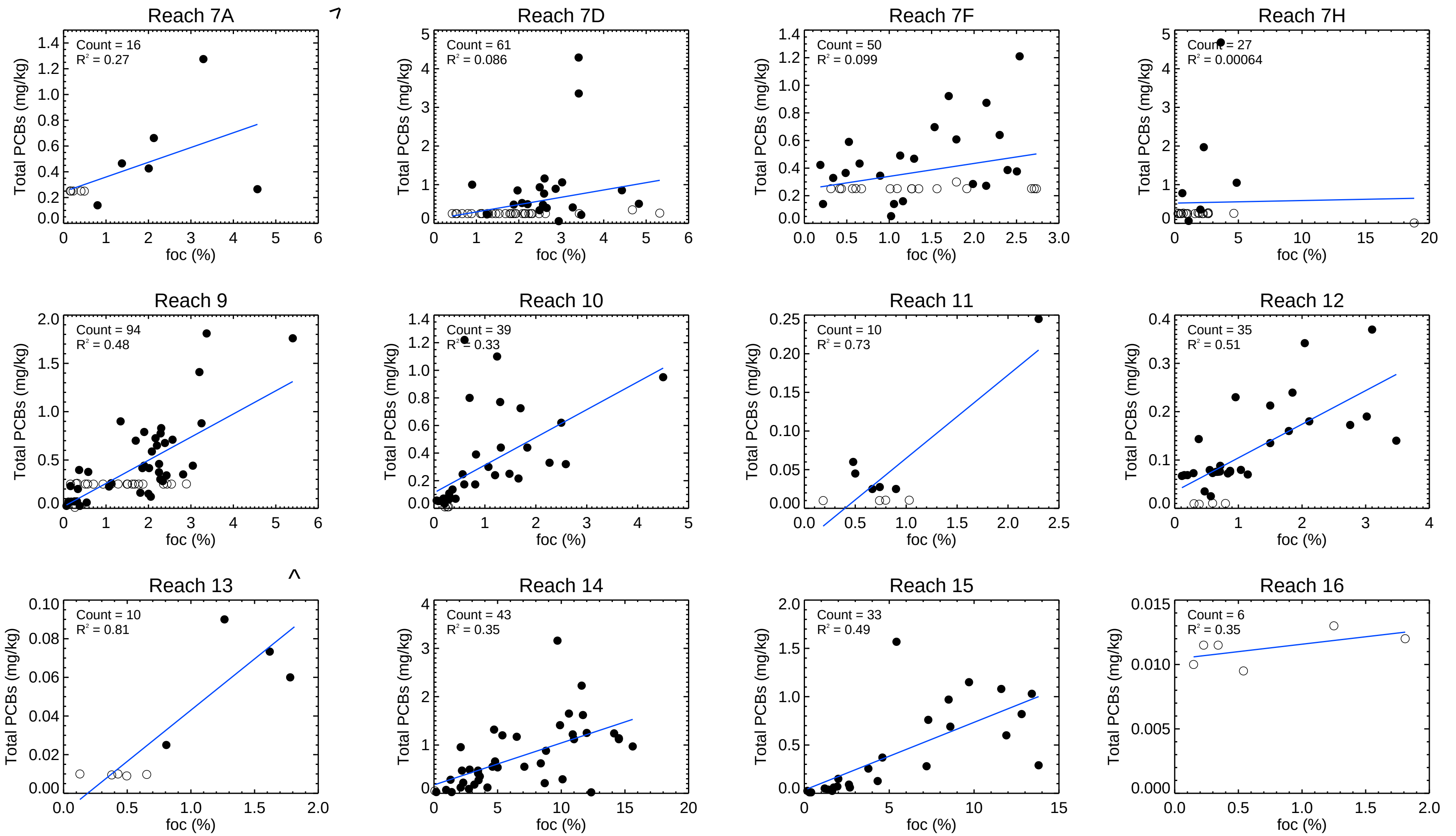
Figure 3-3l

Cumulative Probability Distribution of Surface Sediment Total PCBs (Reach 16)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.
foc: fraction of organic carbon.

● Detect
○ Non-detect

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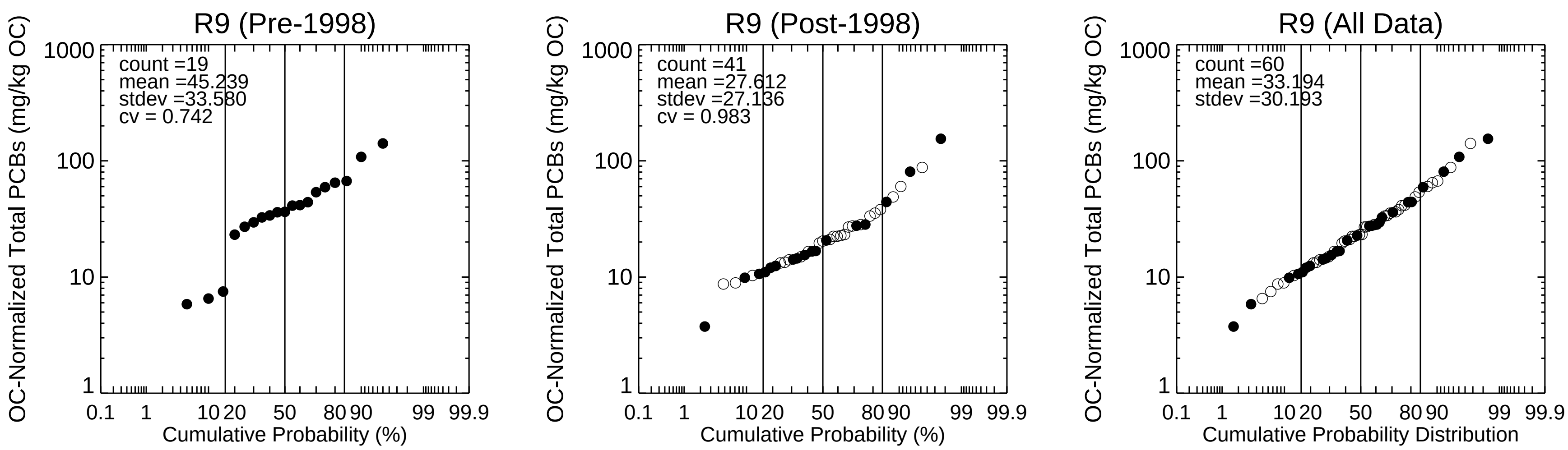
Figure 3-4
Correlation Between Surface Sediment Total PCBs and Organic Carbon

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

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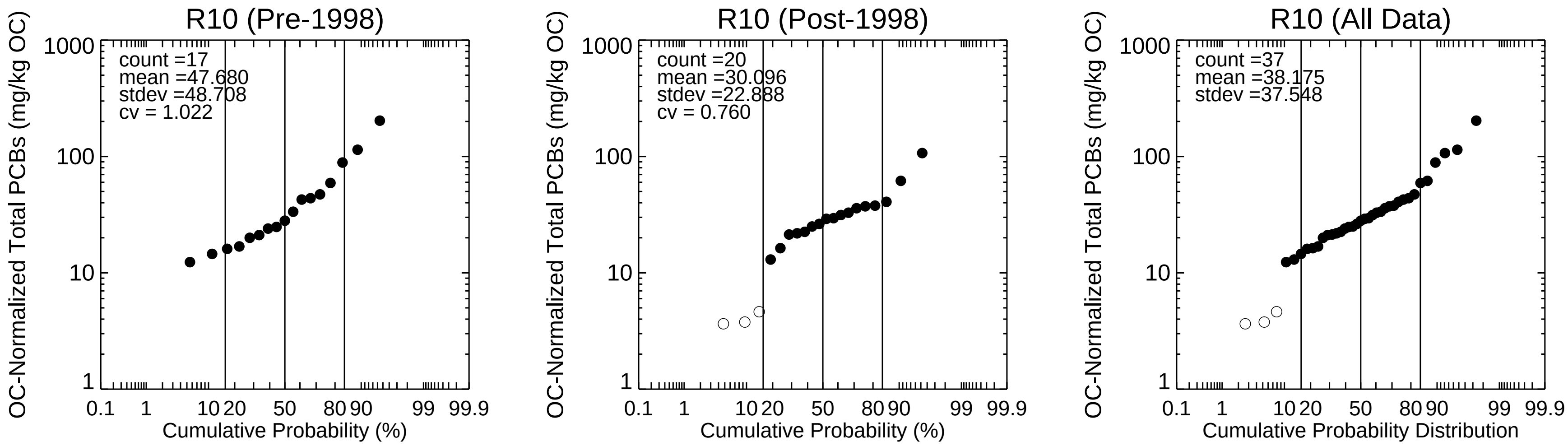
Figure 3-5a

Cumulative Probability Distribution of OC-Normalized Surface Sediment Total PCBs (Reach 9)



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\Fig3_5_Sediment_PCBoc_dist.pro

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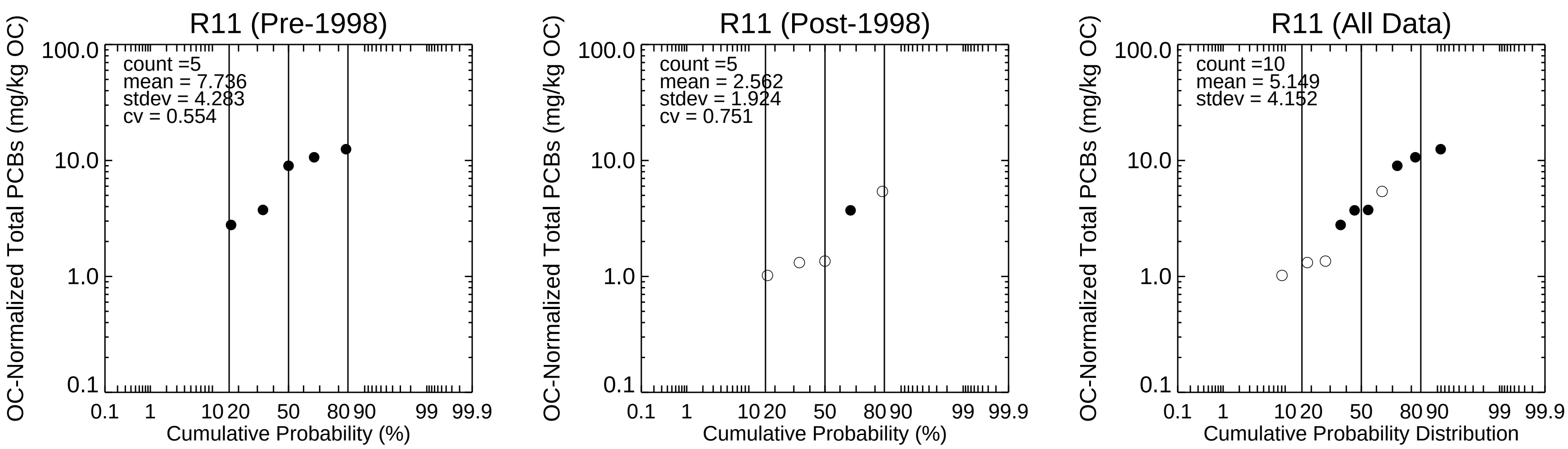
Figure 3-5b

Cumulative Probability Distribution of OC-Normalized Surface Sediment Total PCBs (Reach 10)



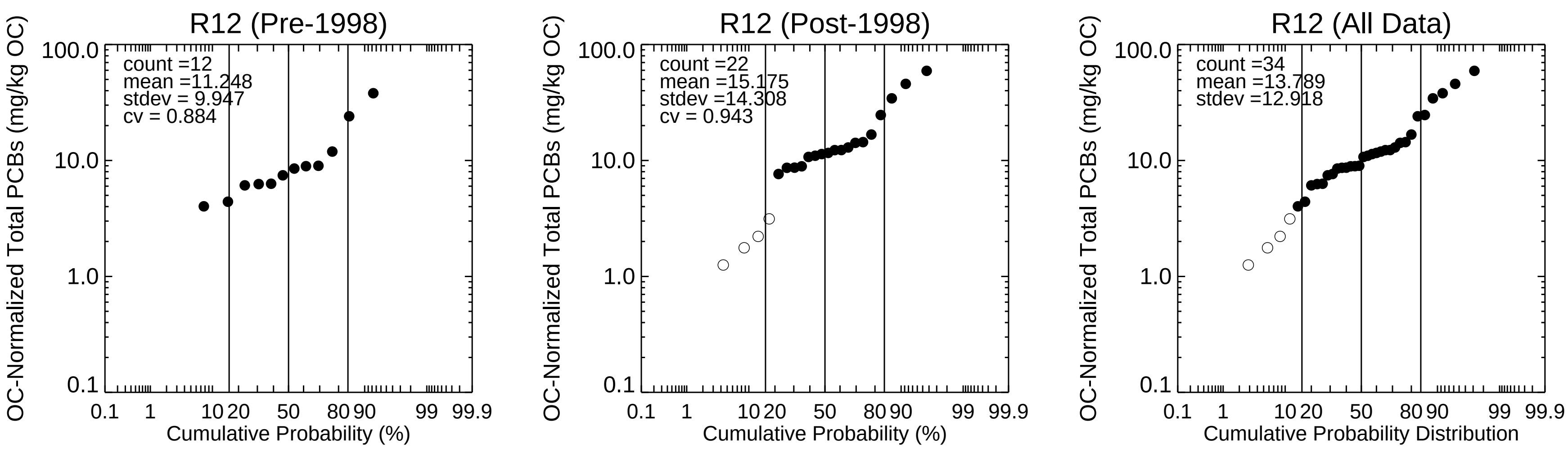
Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

ANCHOR QEA

Figure 3-5c

Cumulative Probability Distribution of OC-Normalized Surface Sediment Total PCBs (Reach 11)



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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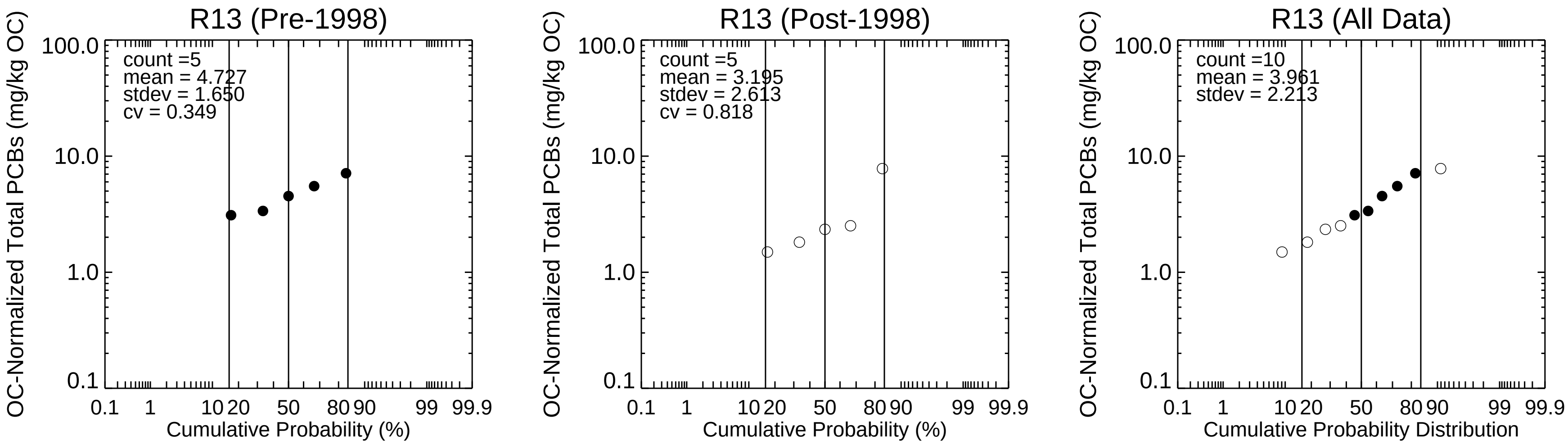
Figure 3-5d

Cumulative Probability Distribution of OC-Normalized Surface Sediment Total PCBs (Reach 12)



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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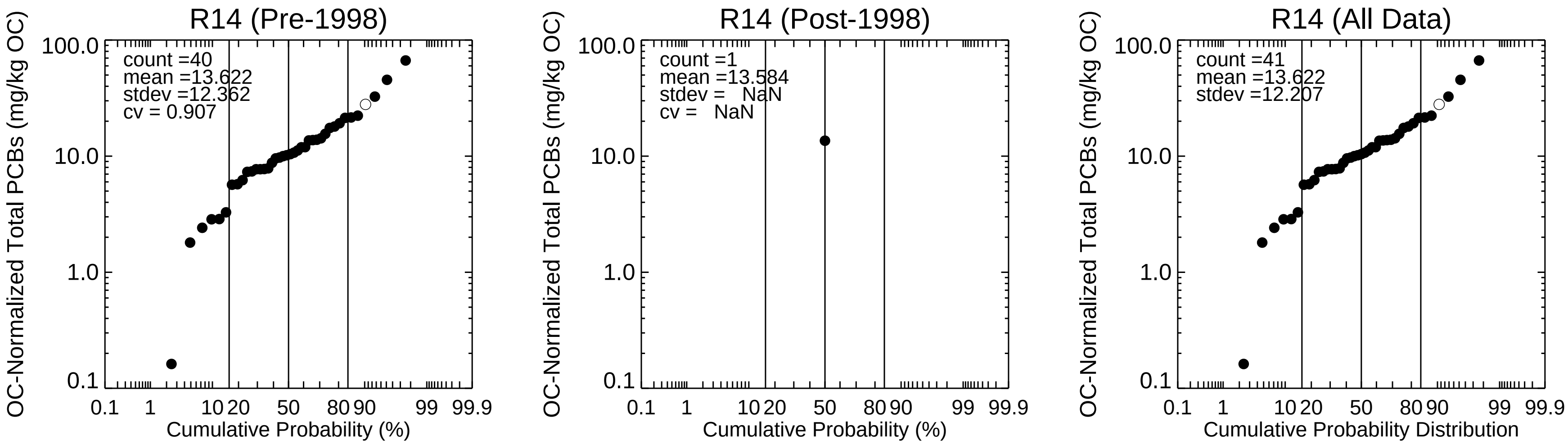
Figure 3-5e

Cumulative Probability Distribution of OC-Normalized Surface Sediment Total PCBs (Reach 13)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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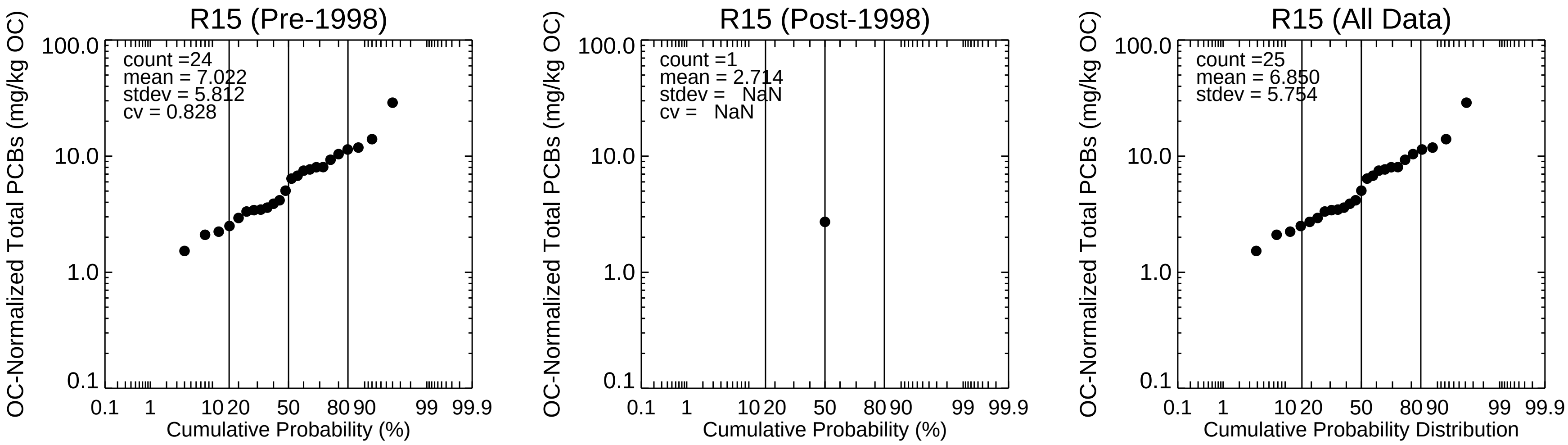
Figure 3-5f
Cumulative Probability Distribution of OC-Normalized Surface Sediment Total PCBs (Reach 14)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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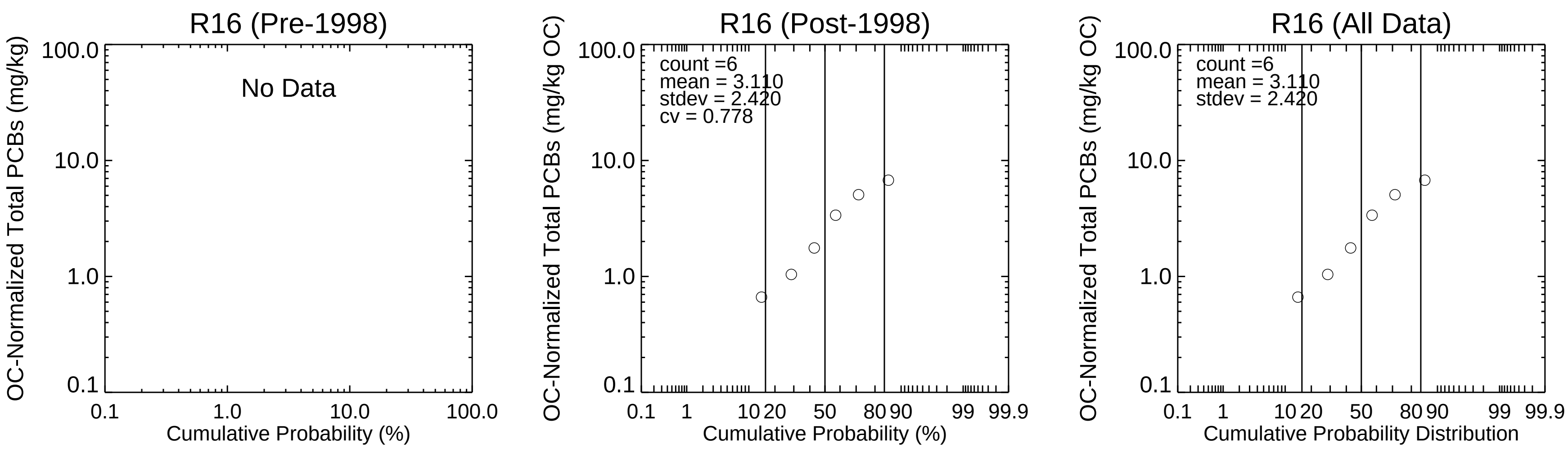
Figure 3-5g

Cumulative Probability Distribution of OC-Normalized Surface Sediment Total PCBs (Reach 15)



Post-1998 data include GE 1998, EPA 1998-2002, CT DOT 1999, and CT 2005 samples. Non-detects plotted as open symbols at 1/2 method detection limit.
Duplicate samples were averaged.
Samples without detected TOC were removed.
Sample intervals greater than 6 inches thick were excluded.
Fractionation cores were excluded.

● Detect
○ Non-detect

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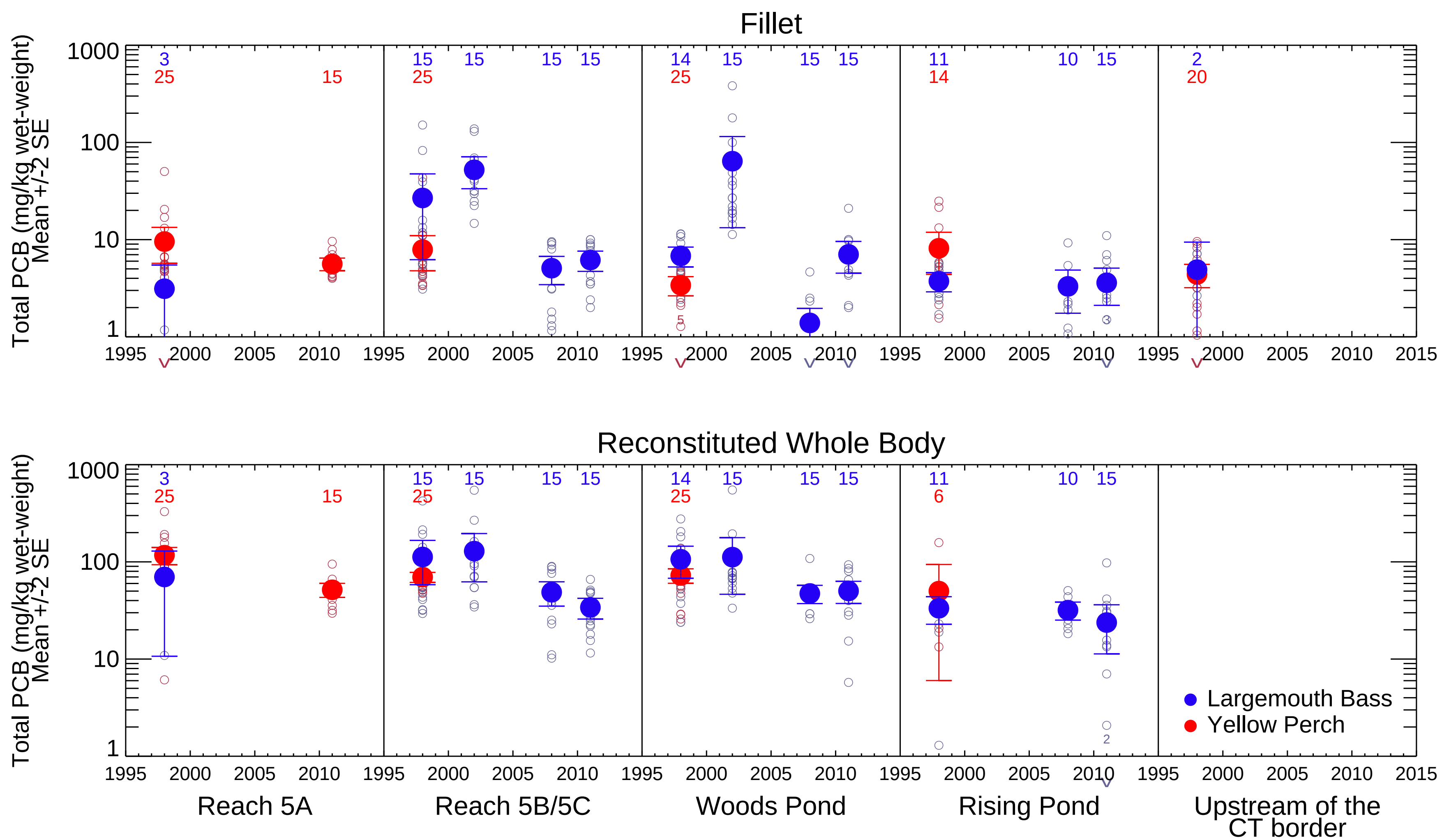
Figure 3-5h

Cumulative Probability Distribution of OC-Normalized Surface Sediment Total PCBs (Reach 16)



Posted numbers represent sample counts.
SE = standard error

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Figure 3-6a

Temporal and Spatial Trends in Adult Fish Total PCB Concentrations from Massachusetts Portion of Rest of River (Wet-weight)

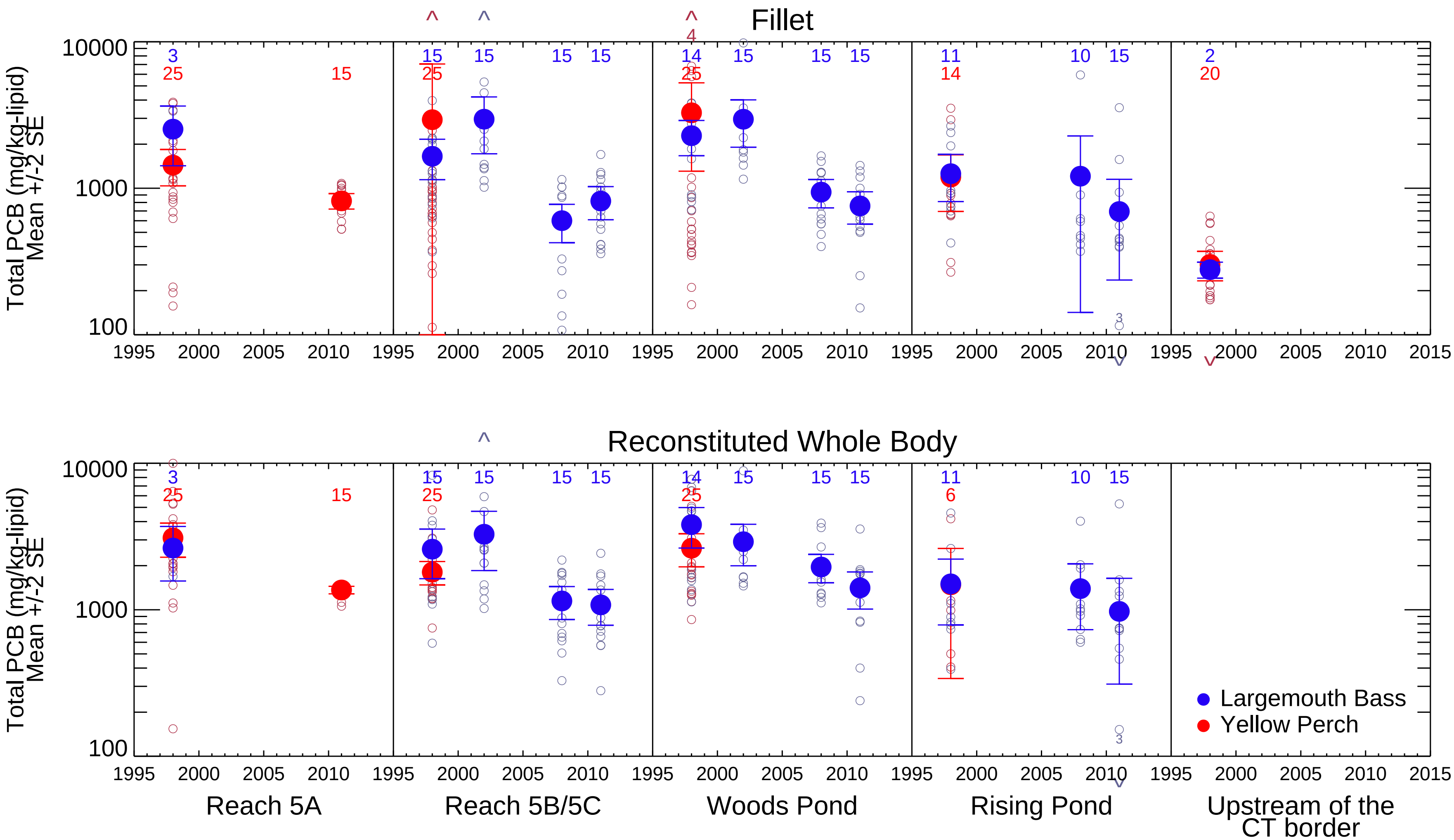

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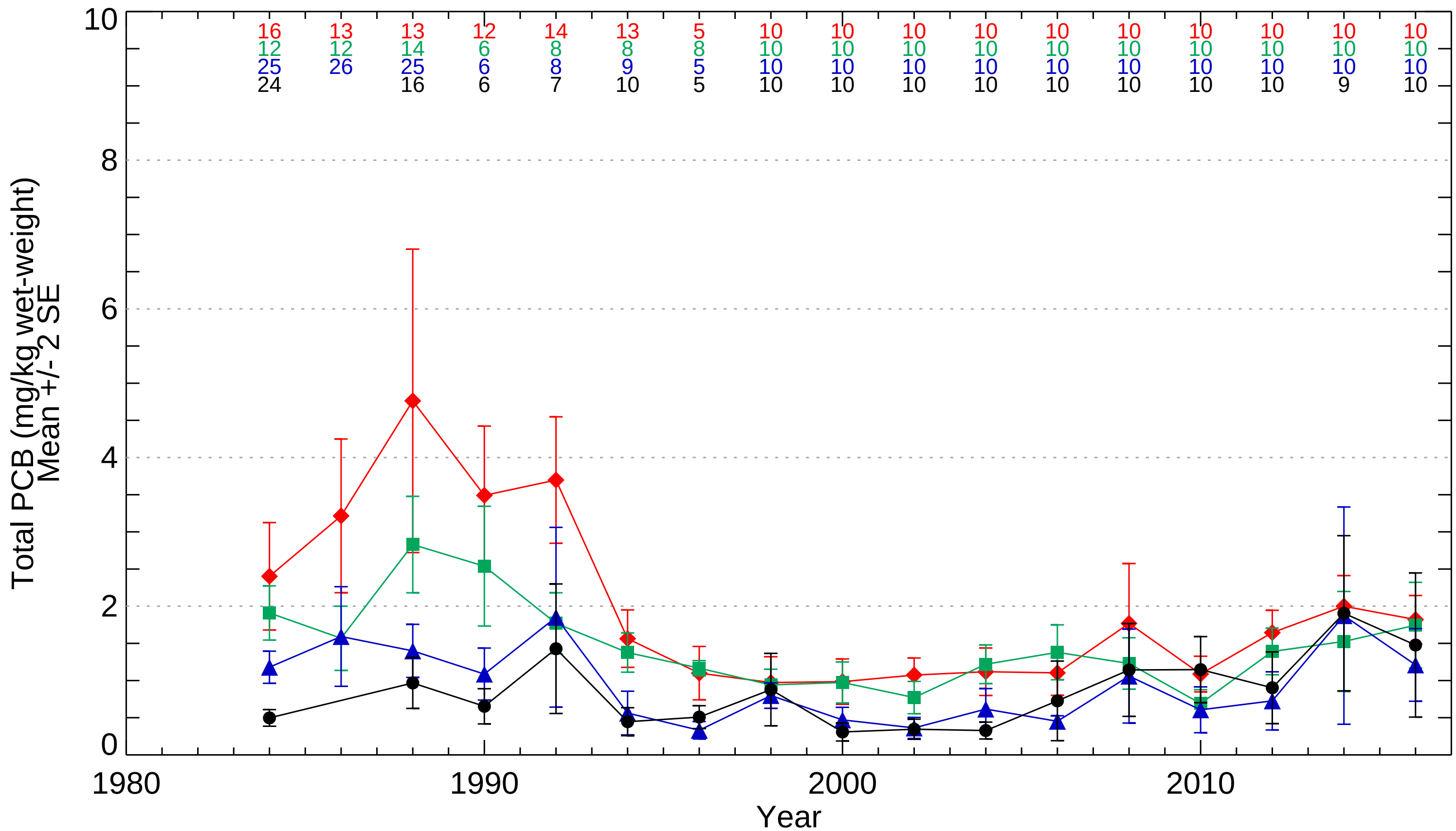
Figure 3-6b

Temporal and Spatial Trends in Adult Fish Total PCB Concentrations from Massachusetts Portion of Rest of River (Lipid-normalized)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



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SE = standard error

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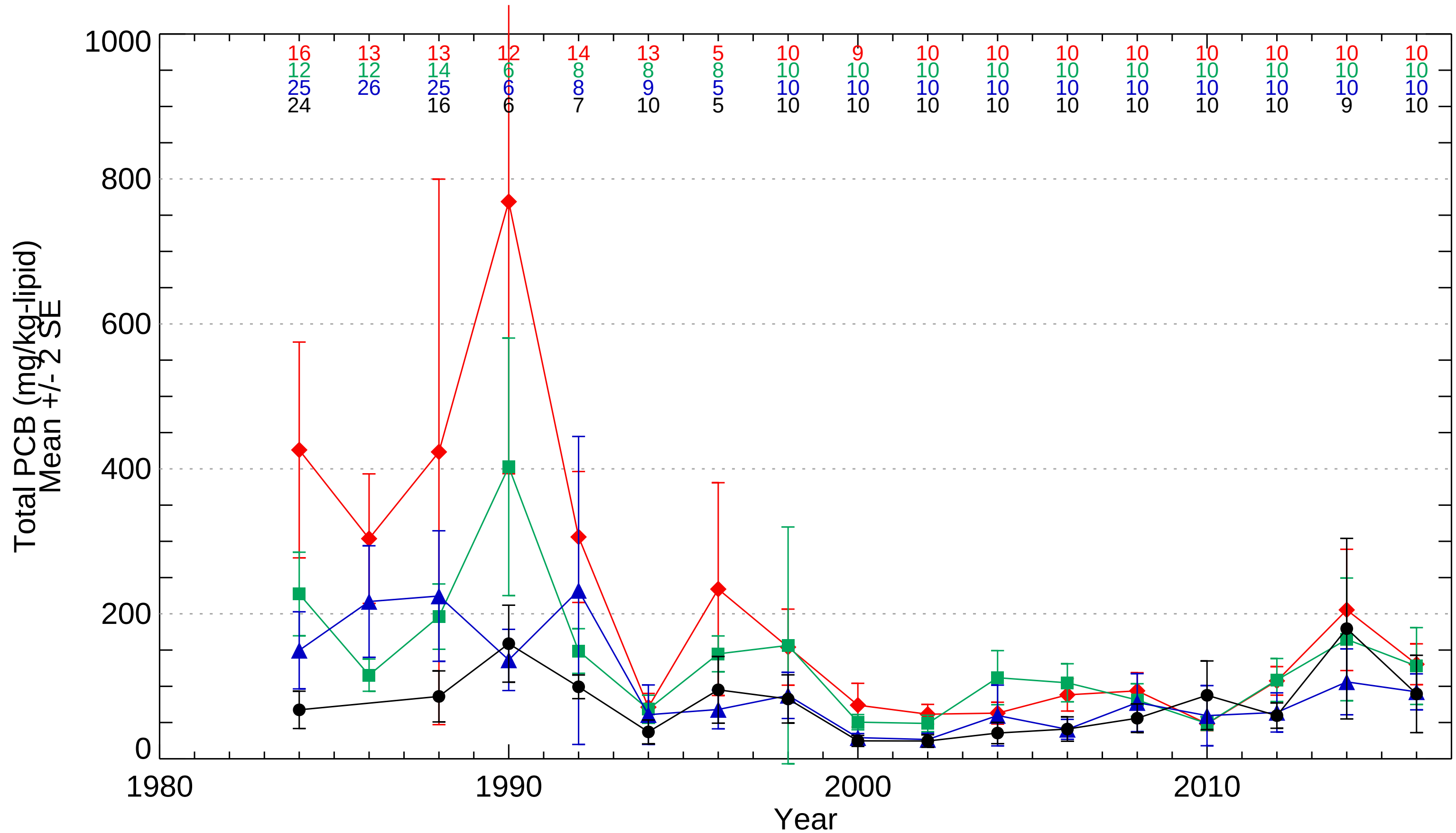
Figure 3-7a

Time Series of Annual Average Total PCB Concentrations in Smallmouth Bass Fillets Collected from Connecticut Portion of Rest of River (Wet-weight)



Posted numbers represent sample counts. Duplicate samples were averaged.
SE = standard error

Publish Date: 06/15/2022 12:27 | User: LD/MK
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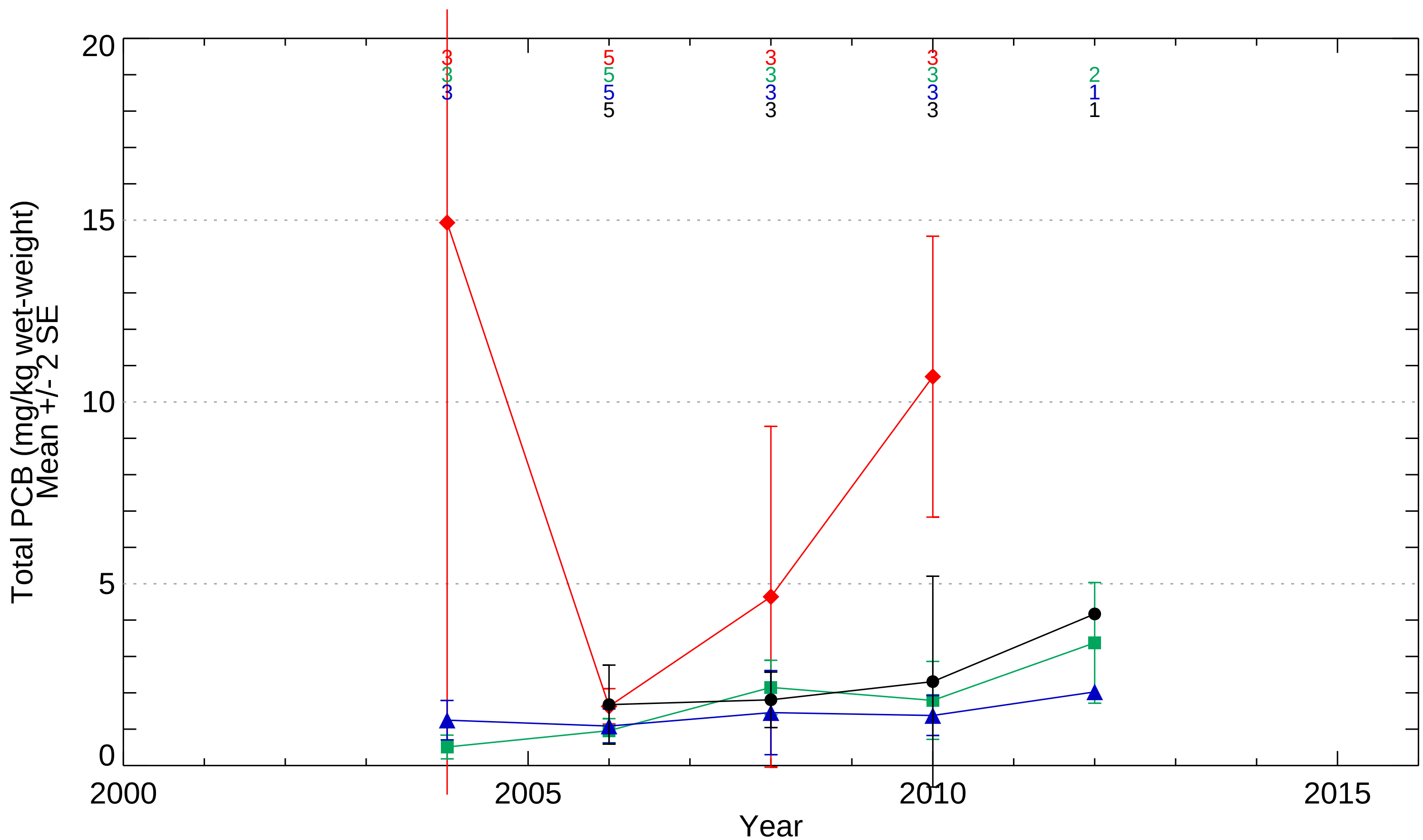
ANCHOR QEA

Figure 3-7b

Time Series of Annual Average Total PCB Concentrations in Smallmouth Bass Fillets Collected from Connecticut Portion of Rest of River (Lipid-normalized)

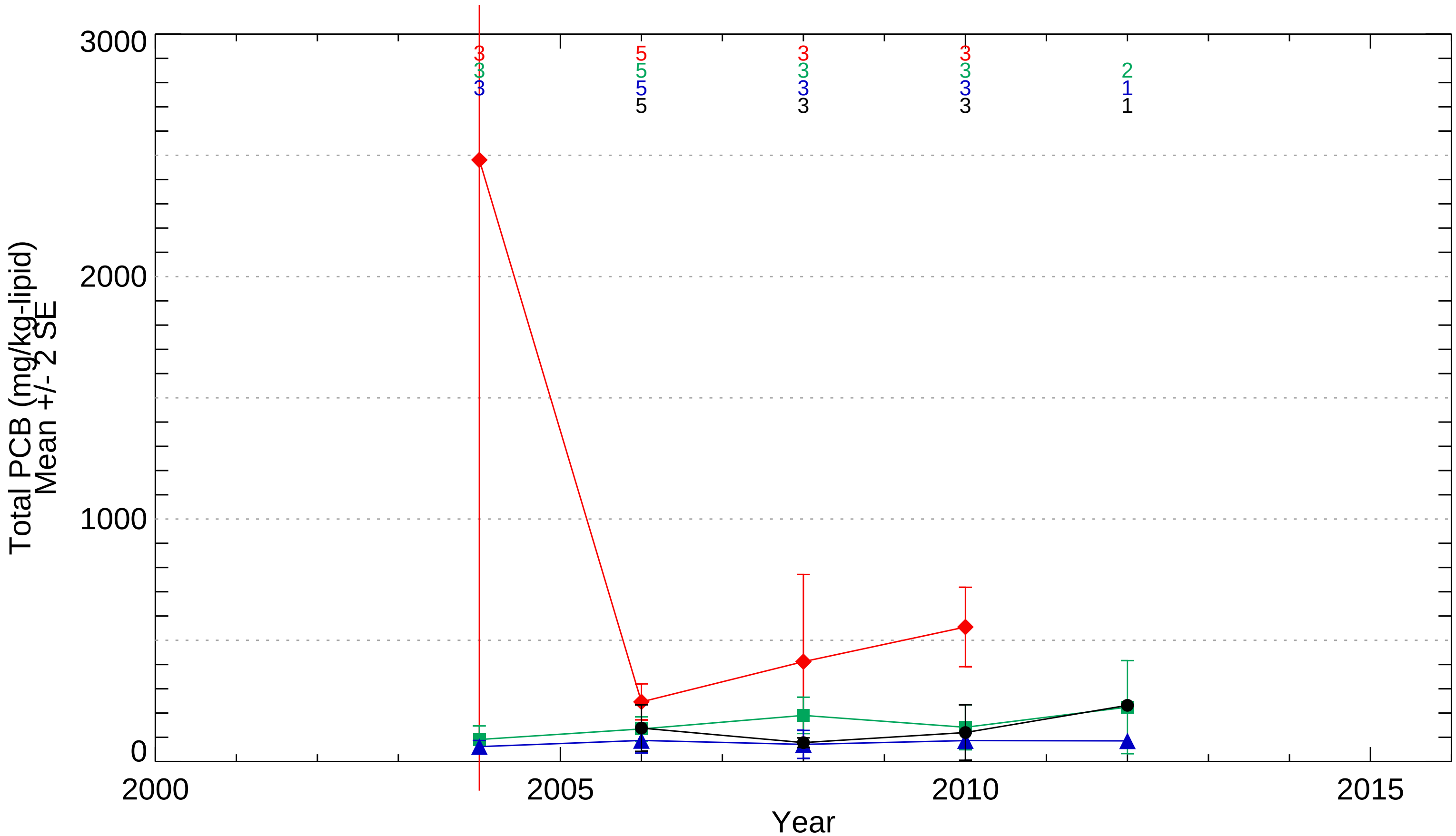


Posted numbers represent sample counts. Duplicate samples were averaged.
SE = standard error

ANCHOR QEA

Figure 3-7c

Time Series of Annual Average Total PCB Concentrations in Northern Pike Fillets Collected from Connecticut Portion of Rest of River (Wet-weight)



Posted numbers represent sample counts. Duplicate samples were averaged.
SE = standard error

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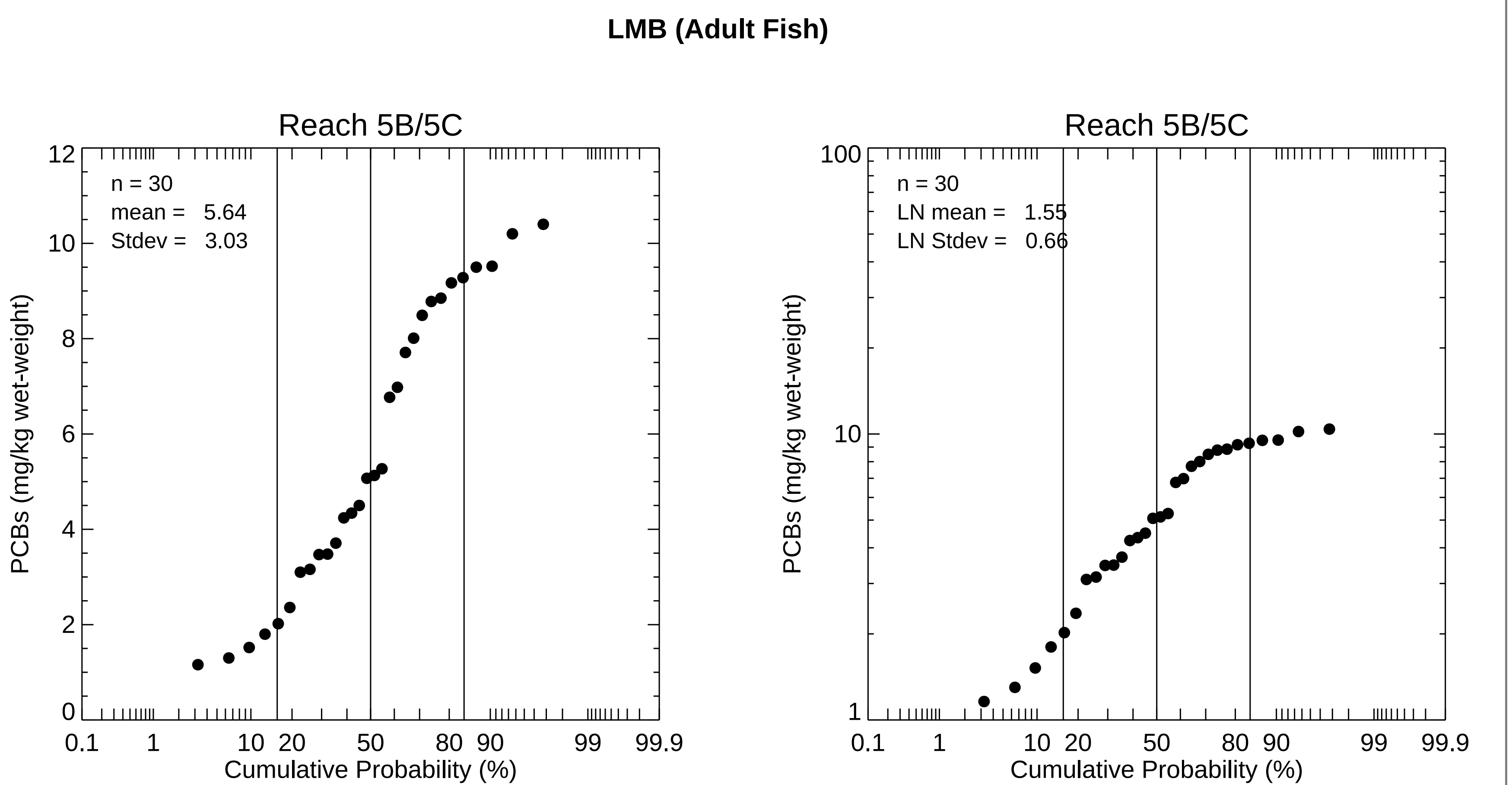
Figure 3-7d

Time Series of Annual Average Total PCB Concentrations in Northern Pike Fillets Collected from Connecticut Portion of Rest of River (Lipid-normalized)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Includes data from 2008 - 2011

Publish Date: 06/29/2022 10:02 | User: wk
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\Fig3_8_RoR_BMP_fish_probplot.pro

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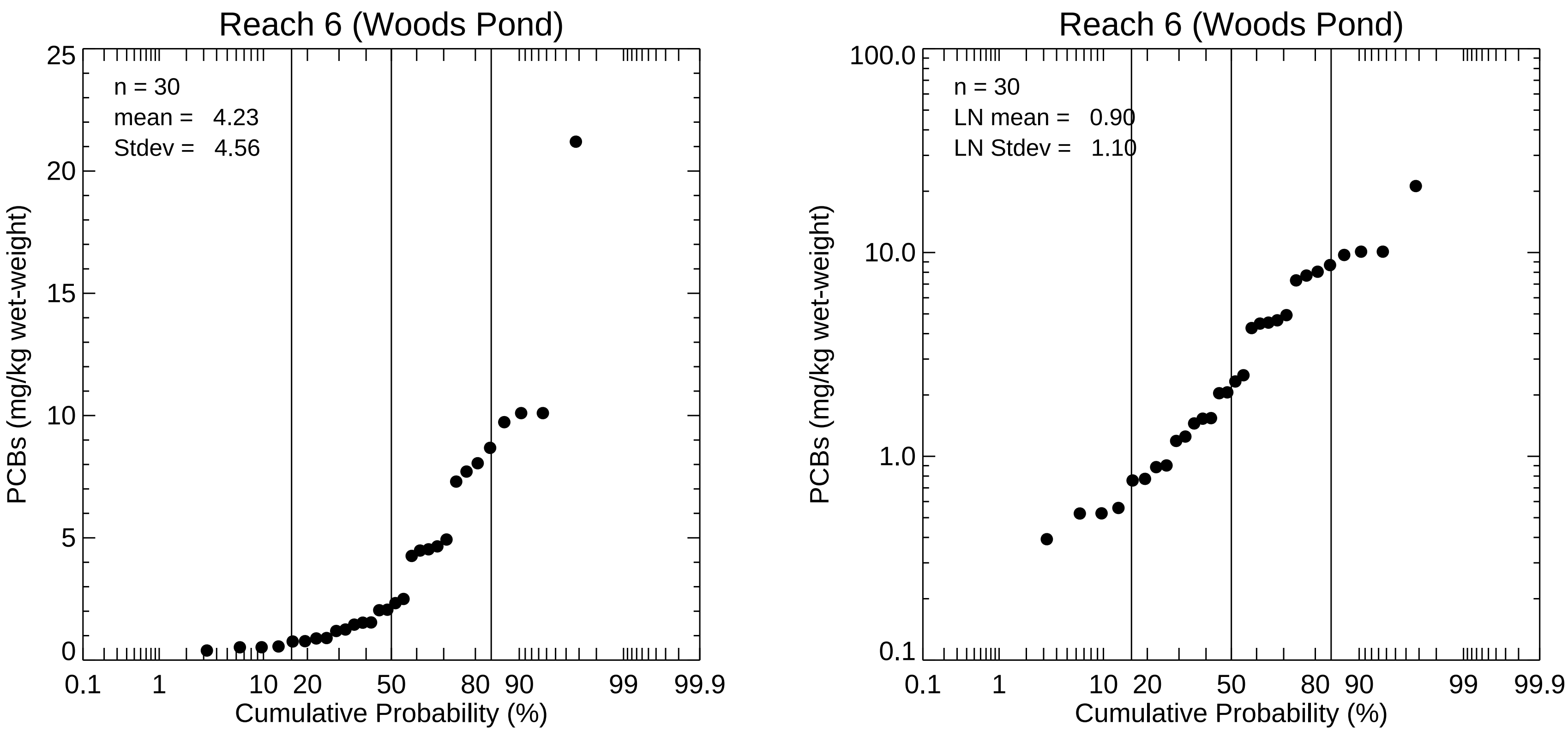
Figure 3-8a
Cumulative Probability Distribution of Adult Fish (LMB) Total PCB Concentrations (Wet-weight) in Reach 5B/5C

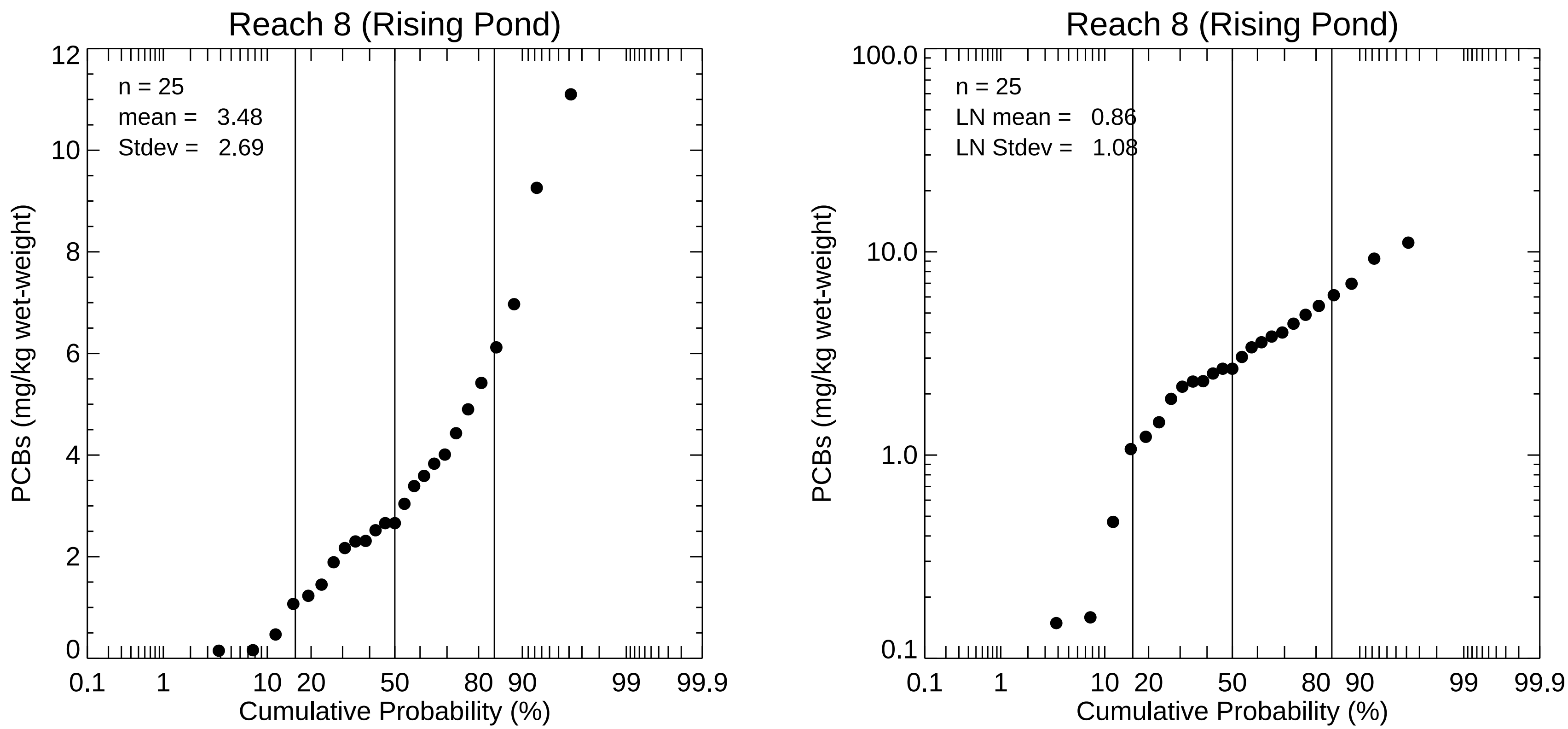
LMB (Adult Fish)



Includes data from 2008 - 2011

Figure 3-8b
Cumulative Probability Distribution of Adult Fish (LMB) Total PCB Concentrations (Wet-weight) in Reach 6 (Woods Pond)

LMB (Adult Fish)



Includes data from 2008 - 2011

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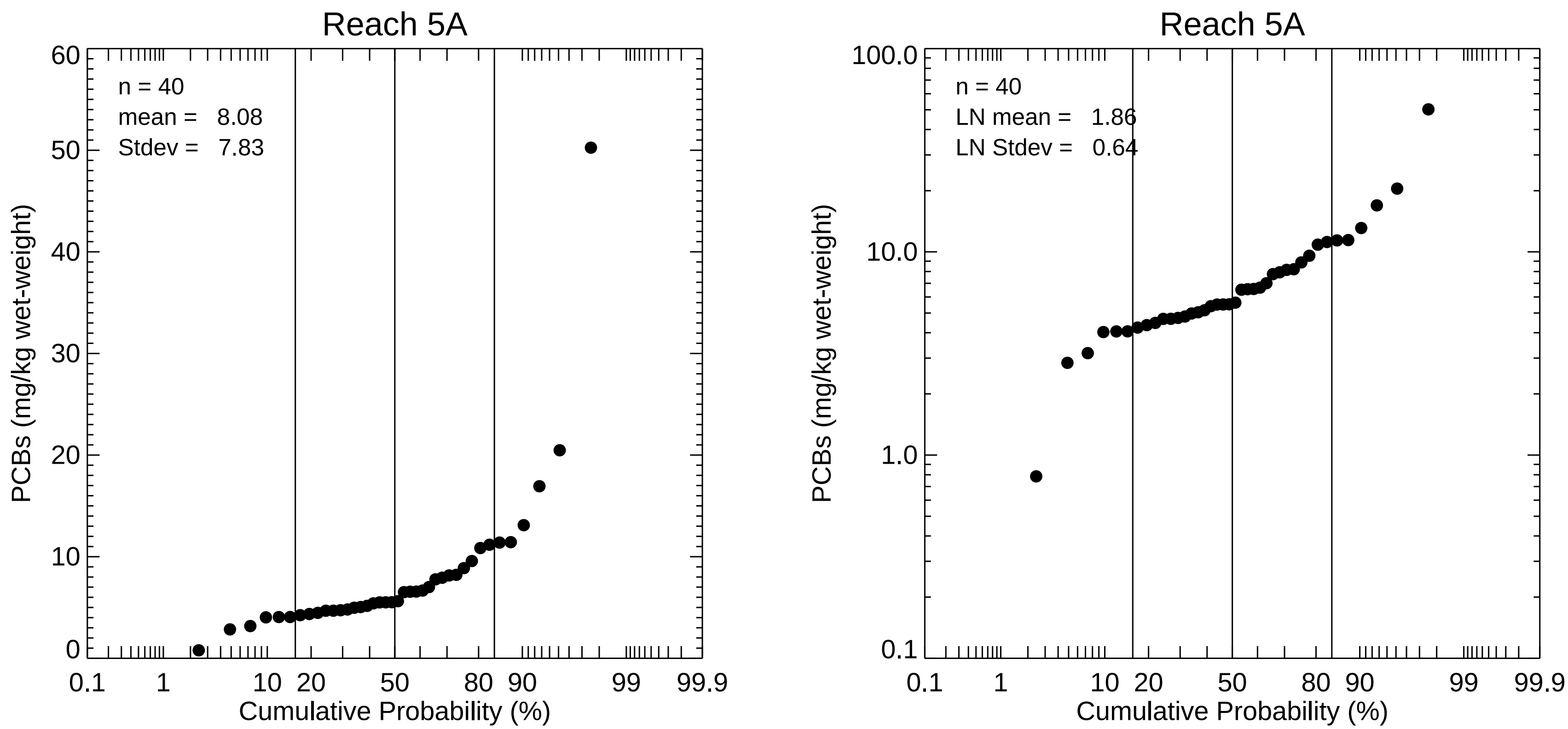
Figure 3-8c
Cumulative Probability Distribution of Adult Fish (LMB) Total PCB Concentrations (Wet-weight) in Reach 8 (Rising Pond)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River

YP (Adult Fish)



Includes data from 1998 - 2011

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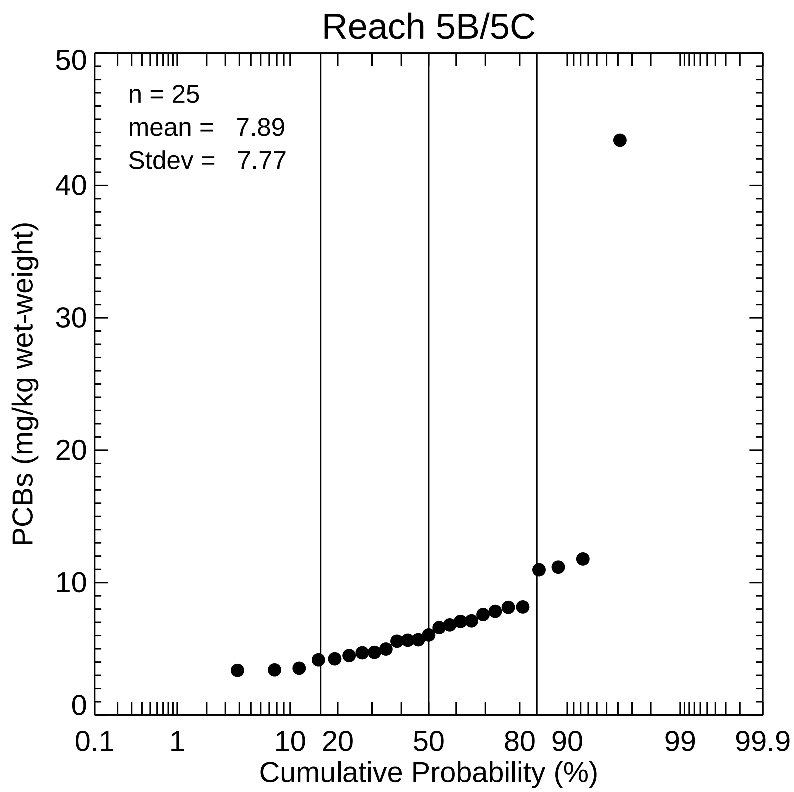
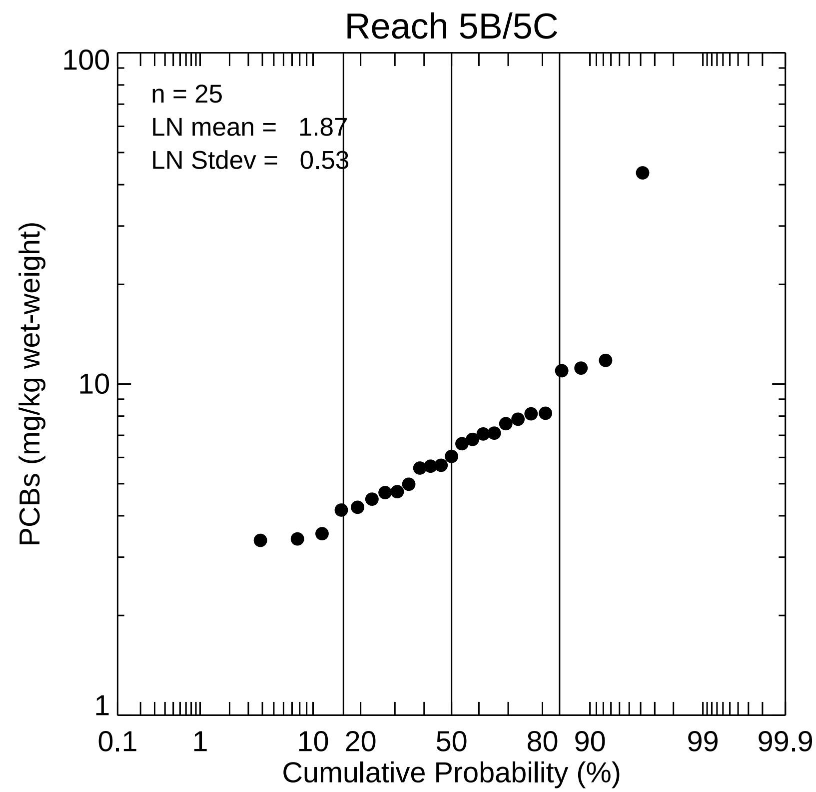
Figure 3-8d
Cumulative Probability Distribution of Adult Fish (YP) Total PCB Concentrations (Wet-weight) in Reach 5A

YP (Adult Fish)





Includes data from 1998 - 2011

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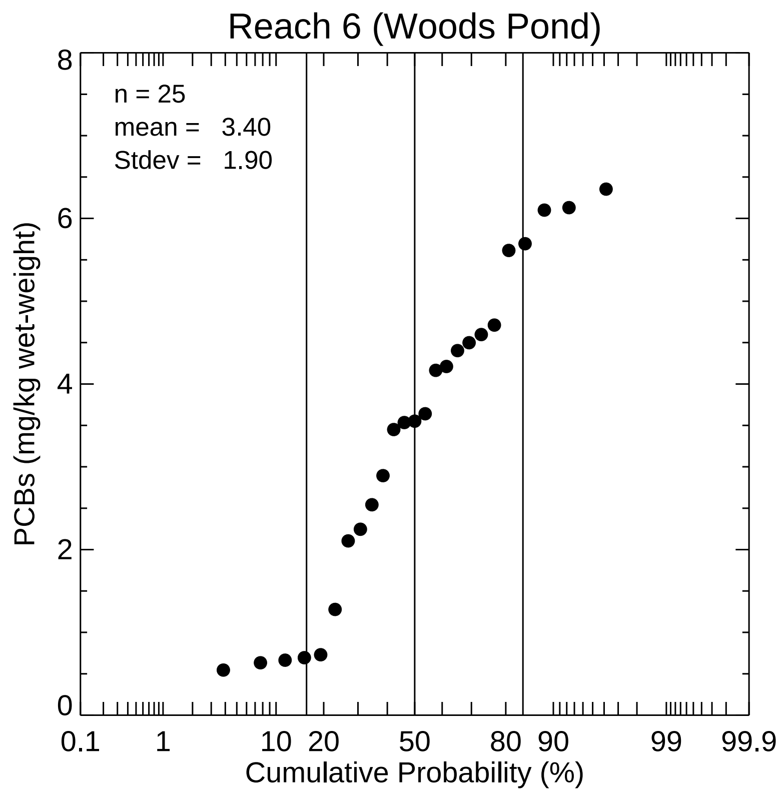
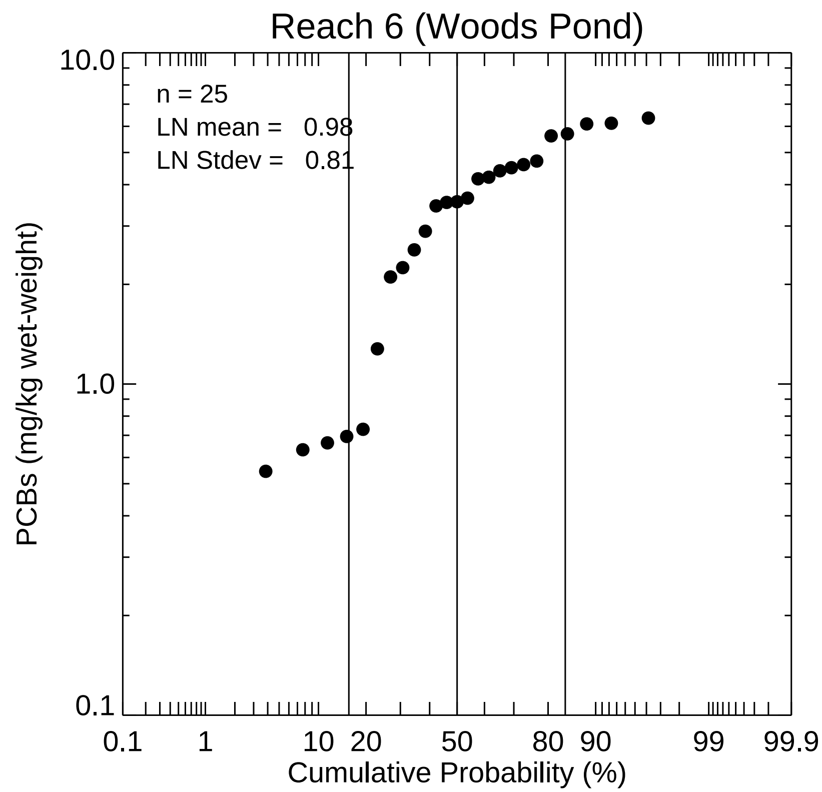
Figure 3-8e
Cumulative Probability Distribution of Adult Fish (YP) Total PCB Concentrations (Wet-weight) in Reach 5B/5C

YP (Adult Fish)





Includes data from 1998 - 2011

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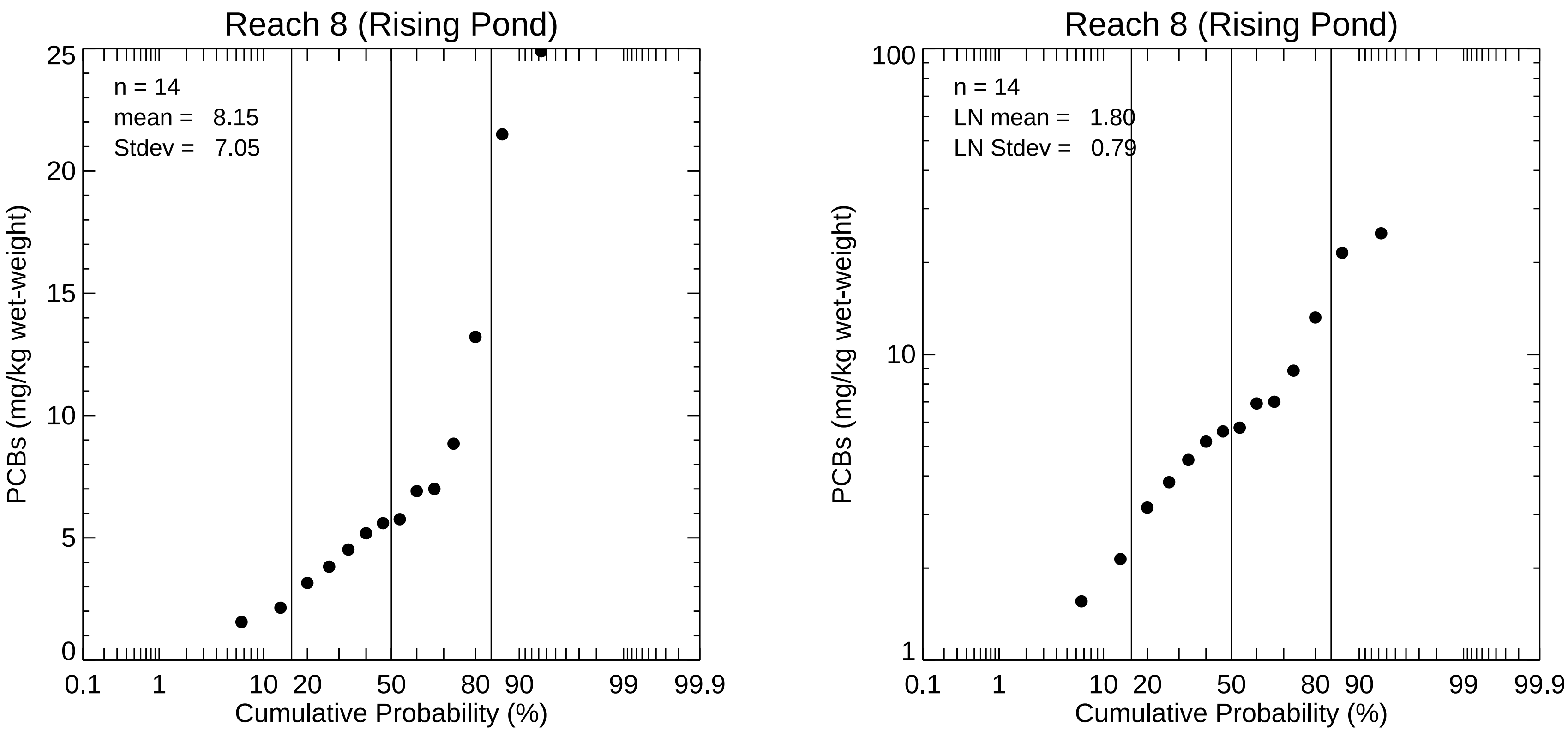
Figure 3-8f

Cumulative Probability Distribution of Adult Fish (YP) Total PCB Concentrations (Wet-weight) in Reach 6 (Woods Pond)

YP (Adult Fish)



Includes data from 1998 - 2011

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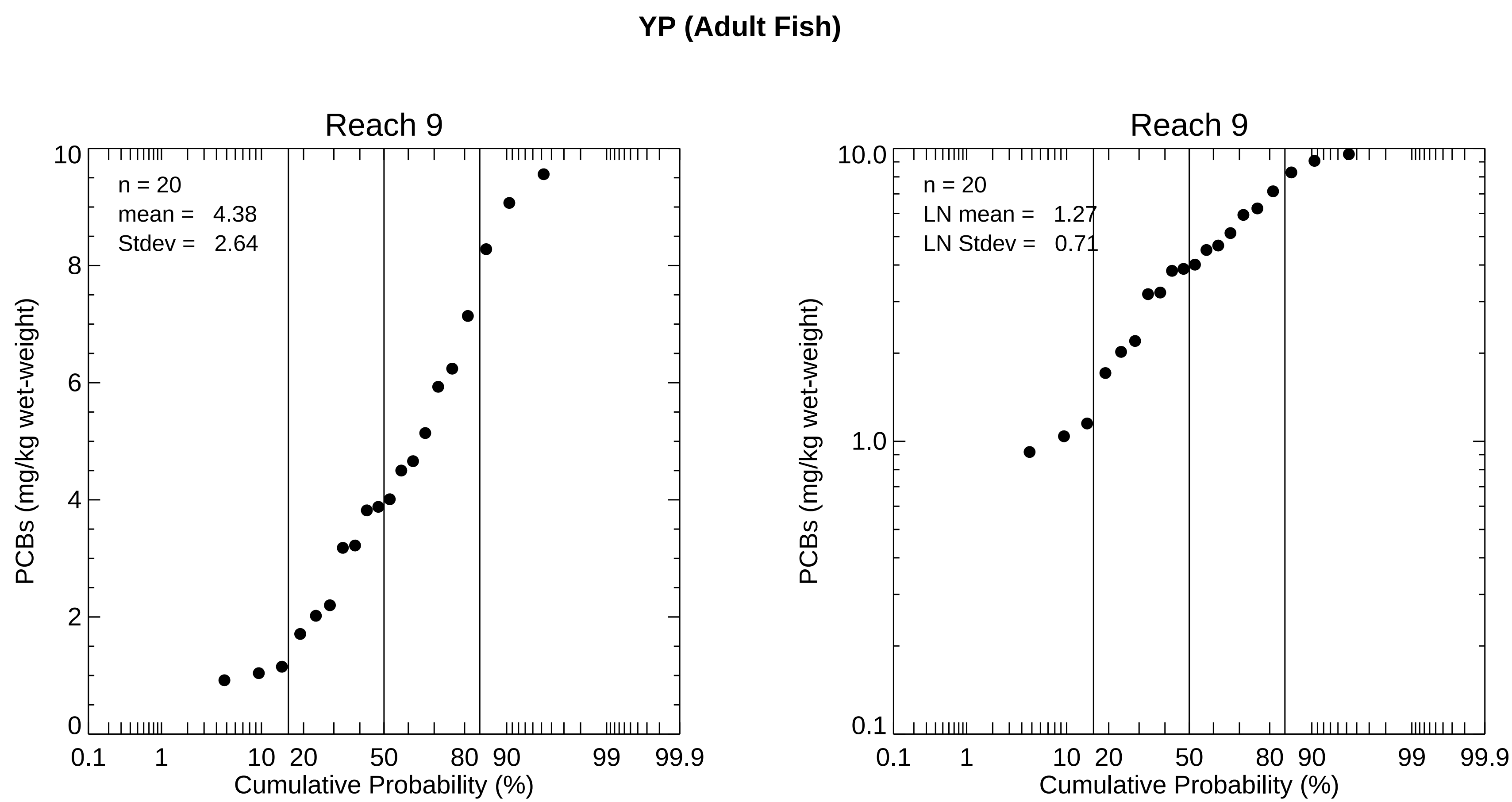
Figure 3-8g
Cumulative Probability Distribution of Adult Fish (YP) Total PCB Concentrations (Wet-weight) in Reach 8 (Rising Pond)



Includes data from 1998 - 2011

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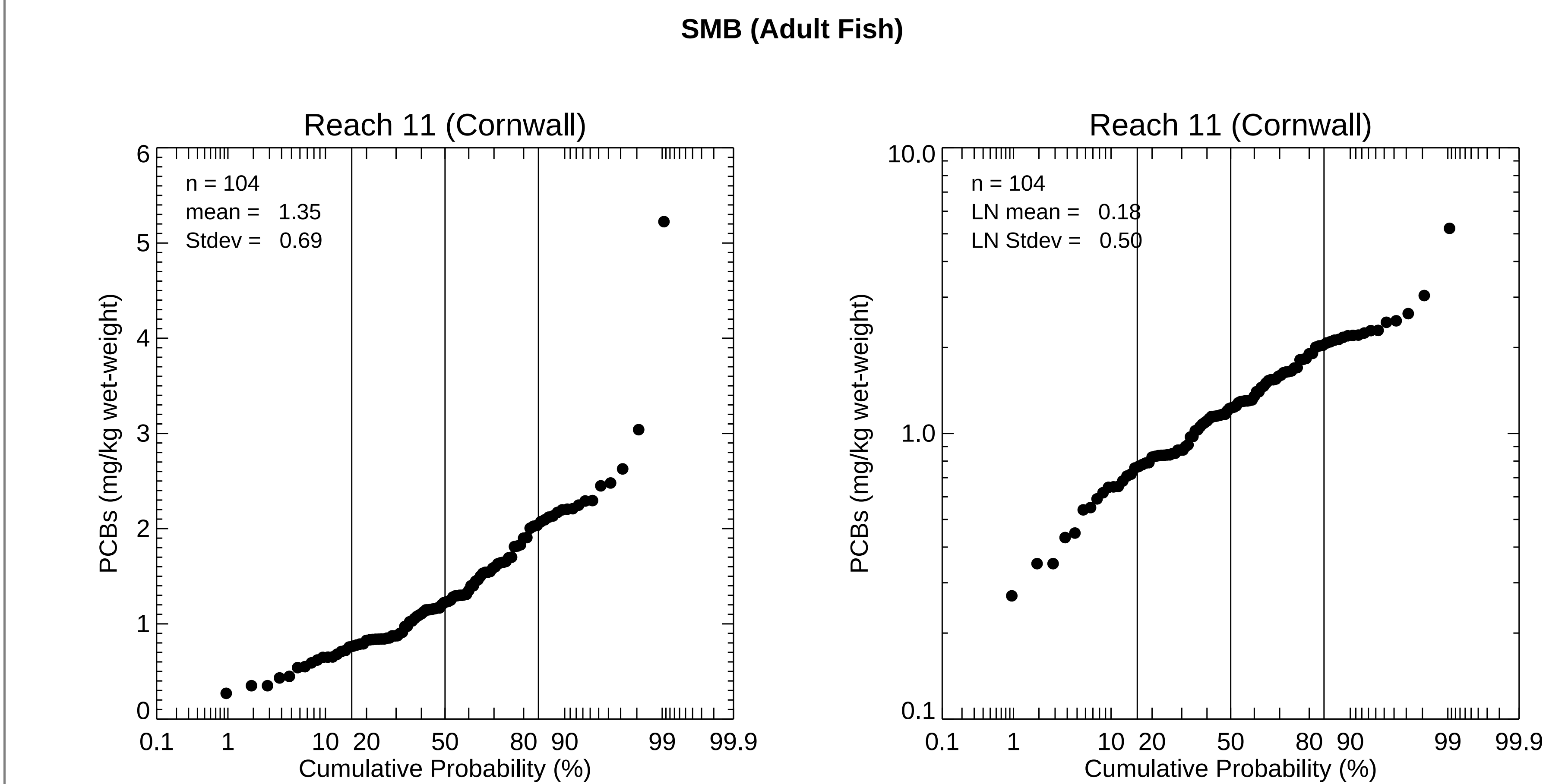
Figure 3-8h

Cumulative Probability Distribution of Adult Fish (YP) Total PCB Concentrations (Wet-weight) in Reach 9



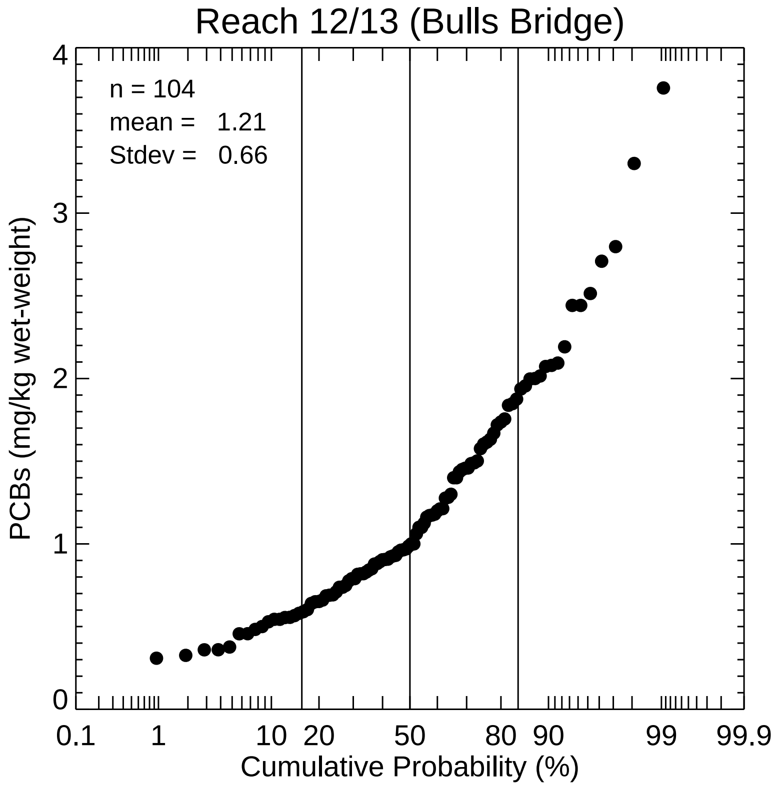
Includes data from 1998 - 2016

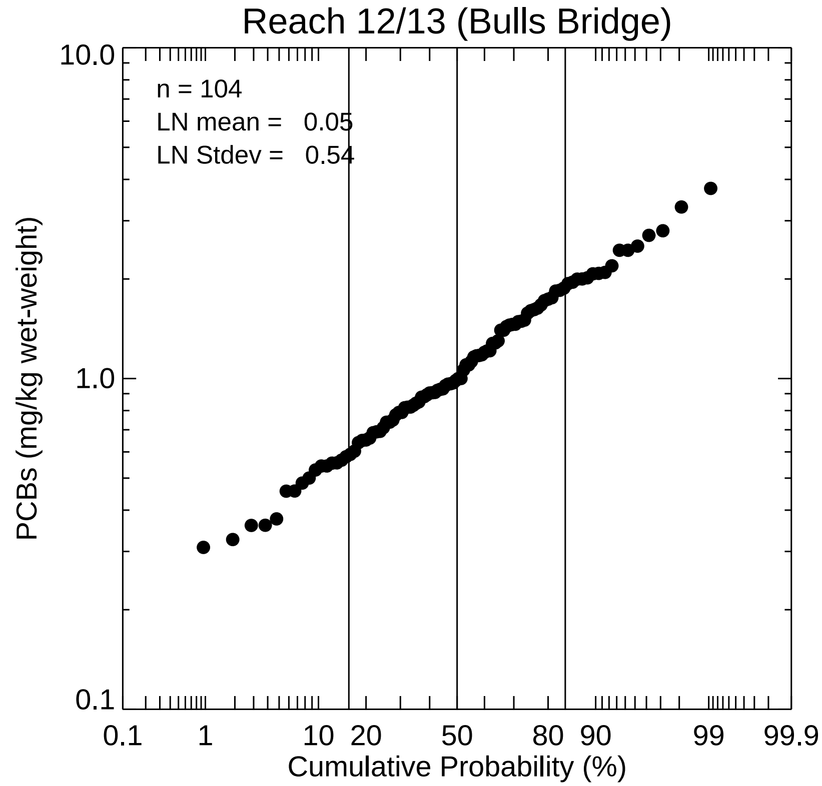
ANCHOR QEA

Figure 3-8i

Cumulative Probability Distribution of Adult Fish (SMB) Total PCB Concentrations (Wet-weight) in Reach 11 (Cornwall)

SMB (Adult Fish)





Includes data from 1998 - 2016

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File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\Fig3_8_RoR_BMP_fish_probplot.pro

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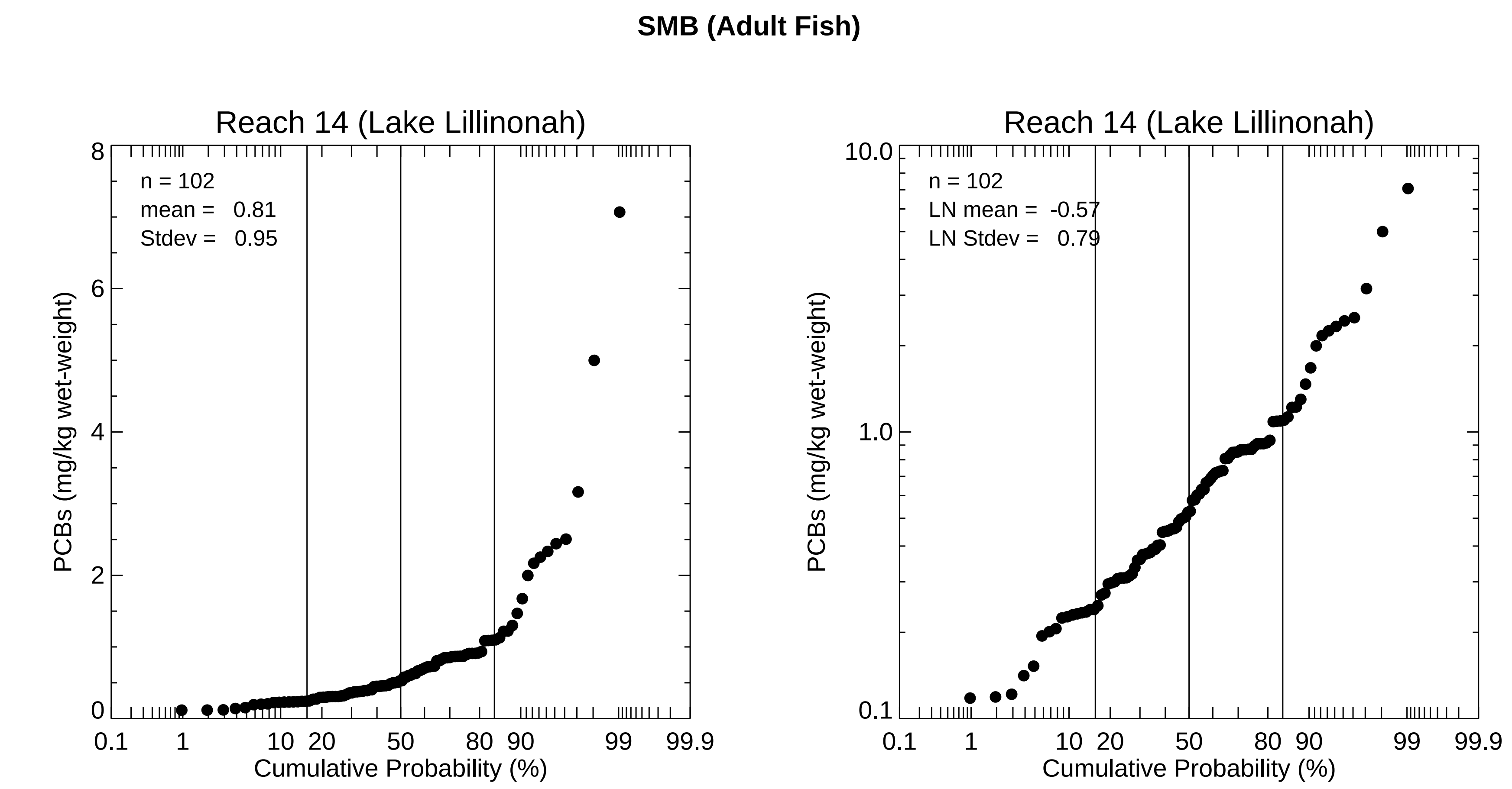
Figure 3-8j

Cumulative Probability Distribution of Adult Fish (SMB) Total PCB Concentrations (Wet-weight) in Reach 12/13 (Bulls Bridge)



Includes data from 1998 - 2016

Publish Date: 06/29/2022 10:02 | User: wk
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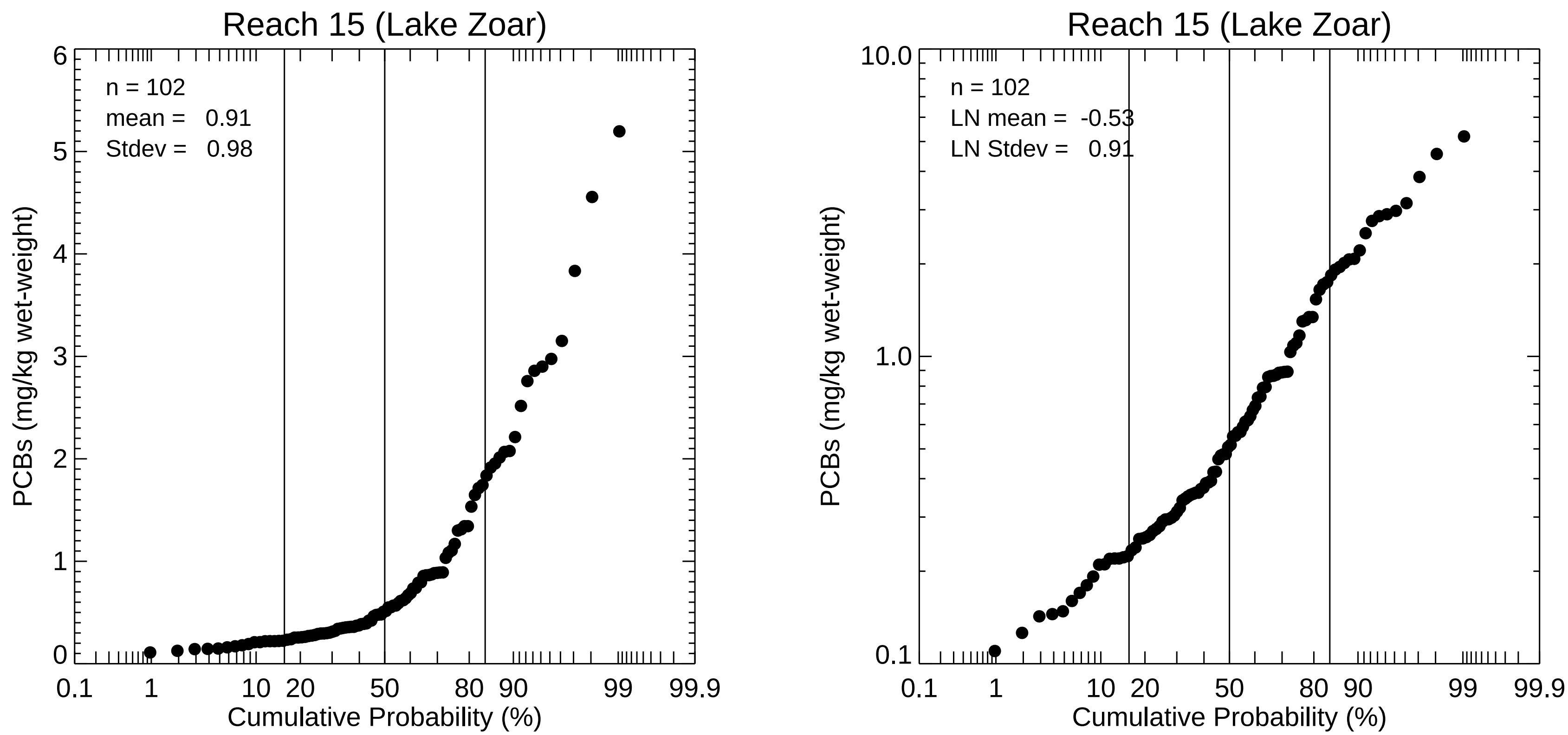
ANCHOR QEA

Figure 3-8k

Cumulative Probability Distribution of Adult Fish (SMB) Total PCB Concentrations (Wet-weight) in Reach 14 (Lake Lillinonah)

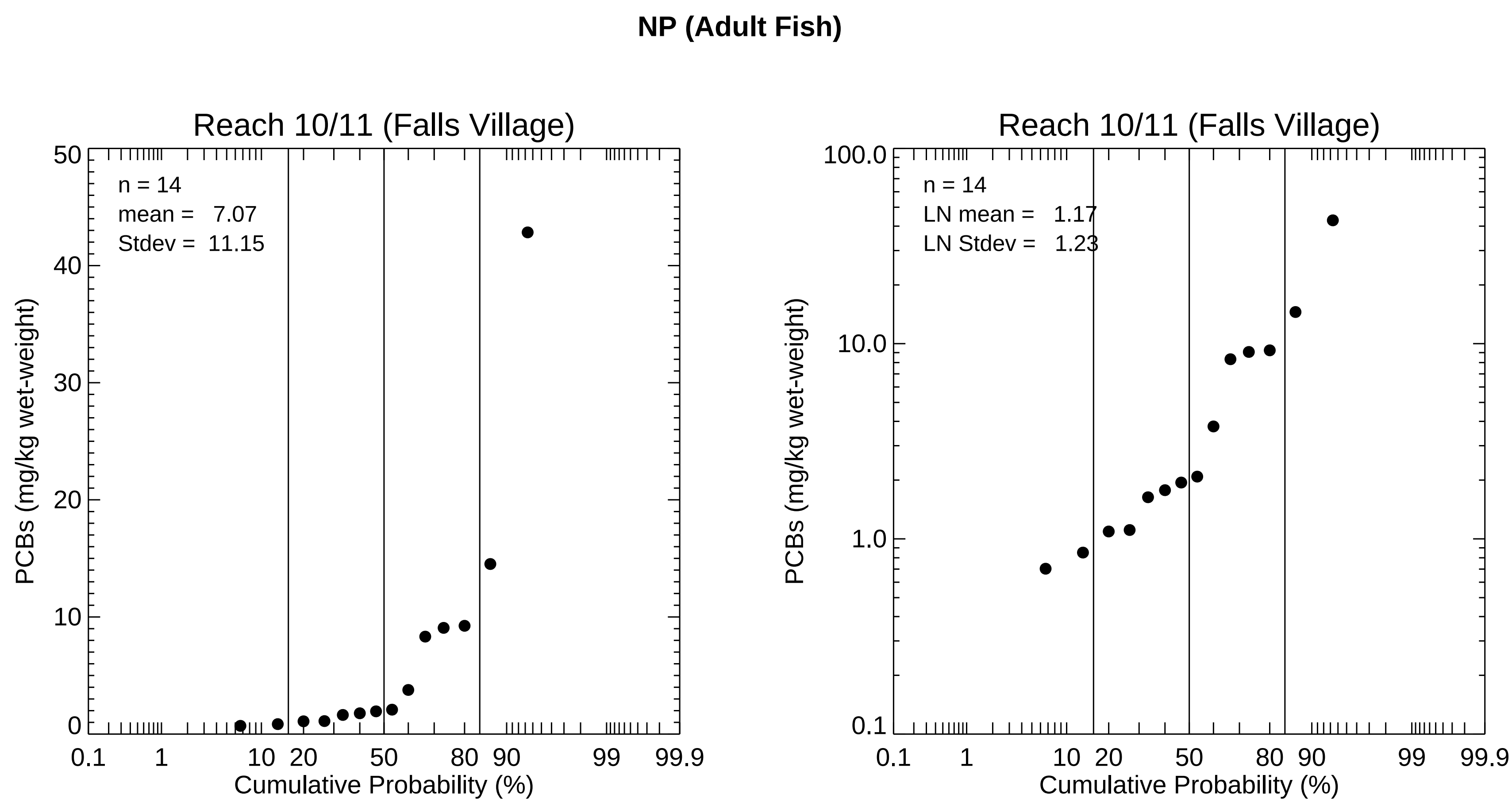
SMB (Adult Fish)



Includes data from 1998 - 2016

ANCHOR QEA

Figure 3-8l
Cumulative Probability Distribution of Adult Fish (SMB) Total PCB Concentrations (Wet-weight) in Reach 15 (Lake Zoar)



Includes data from 2004 - 2012

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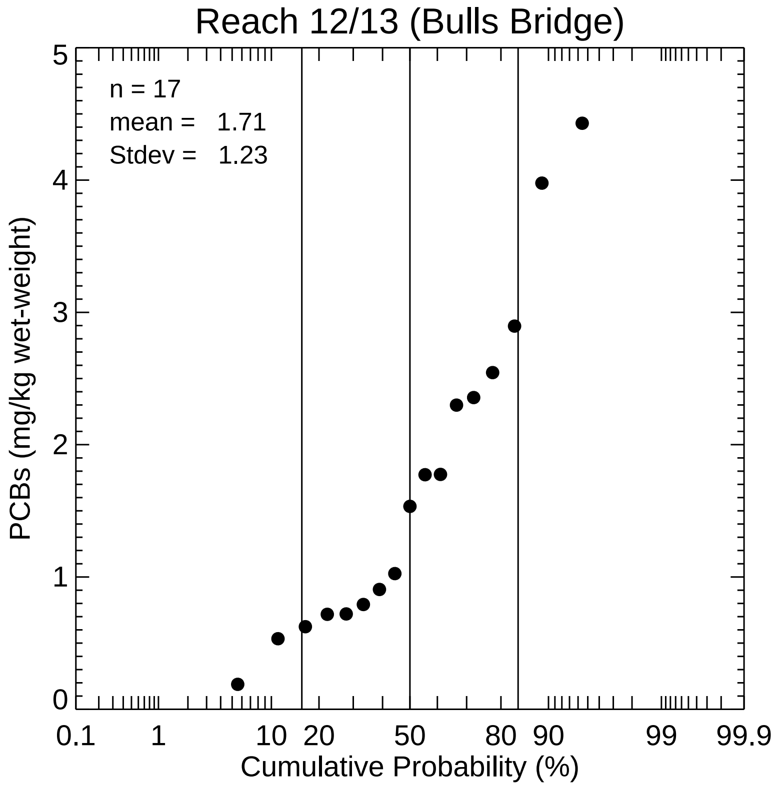
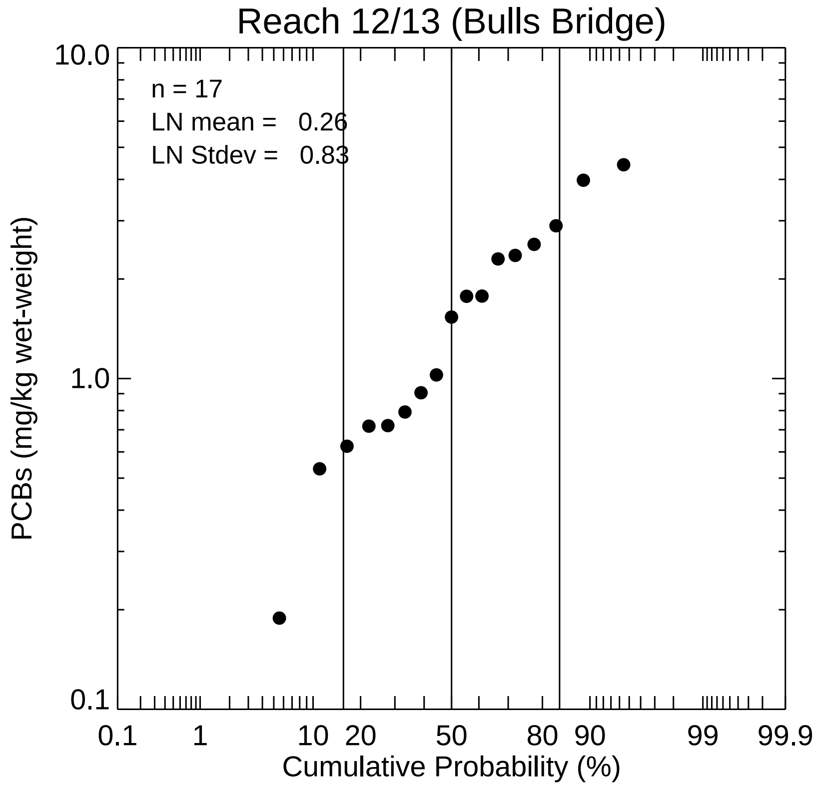
Figure 3-8m

Cumulative Probability Distribution of Adult Fish (NP) Total PCB Concentrations (Wet-weight) in Reach 10/11 (Falls Village)

NP (Adult Fish)





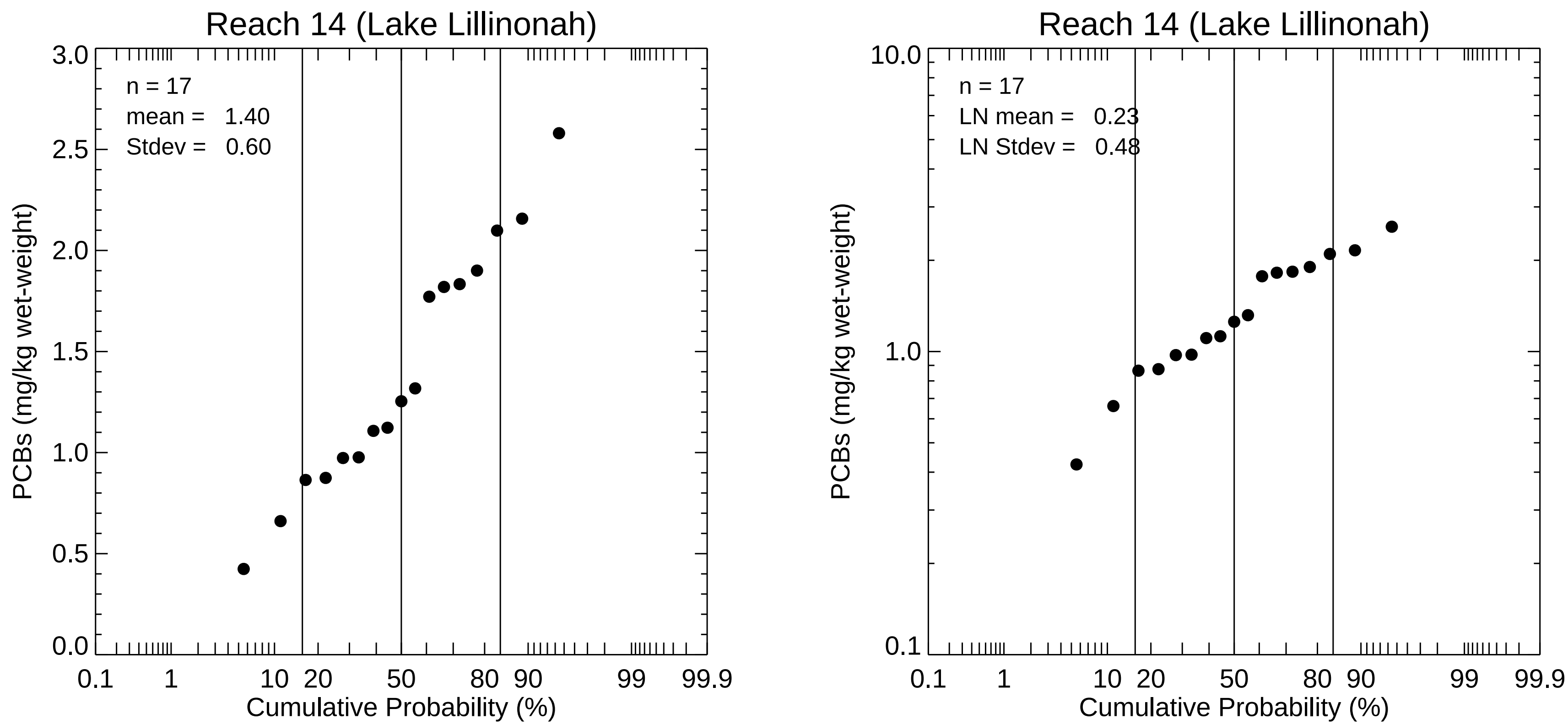
Includes data from 2004 - 2012

ANCHOR QEA

Figure 3-8n

Cumulative Probability Distribution of Adult Fish (NP) Total PCB Concentrations (Wet-weight) in Reach 12/13 (Bulls Bridge)

NP (Adult Fish)



Includes data from 2004 - 2012

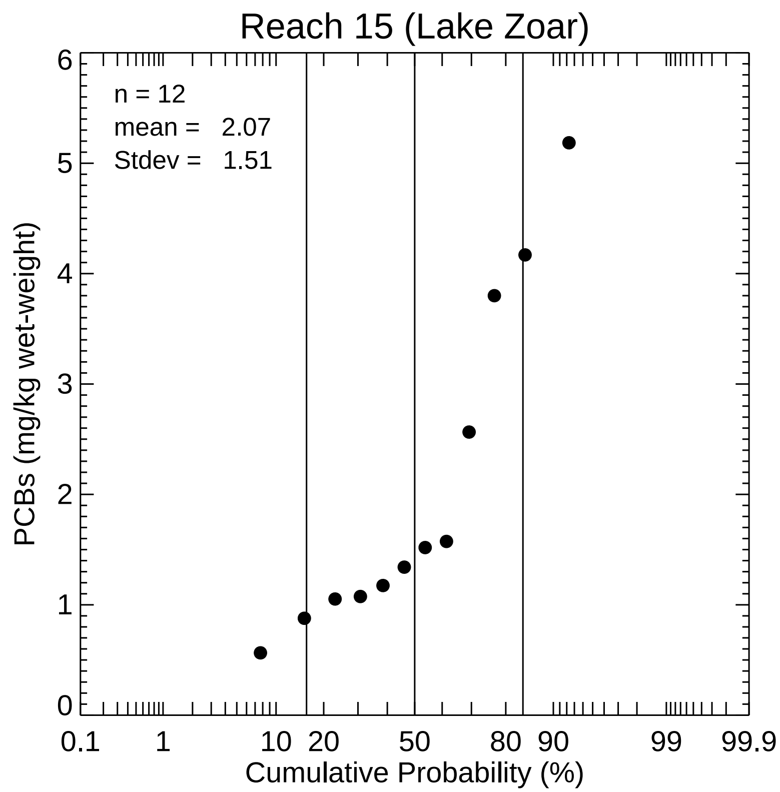
ANCHOR QEA

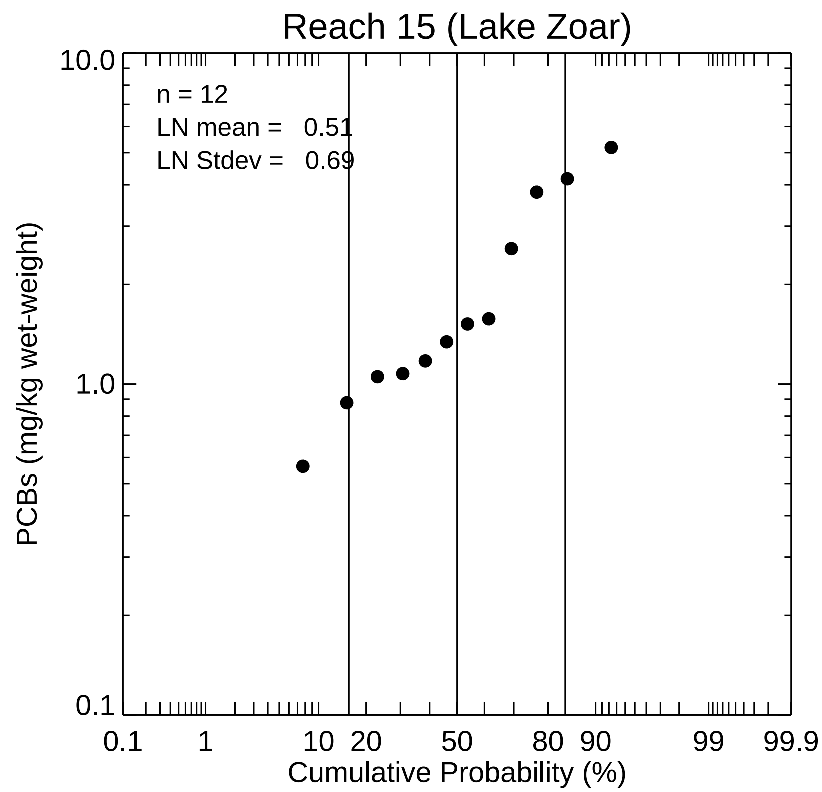
Figure 3-8o

Cumulative Probability Distribution of Adult Fish (NP) Total PCB Concentrations (Wet-weight) in Reach 14 (Lake Lillinonah)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River

NP (Adult Fish)





Includes data from 2004 - 2012

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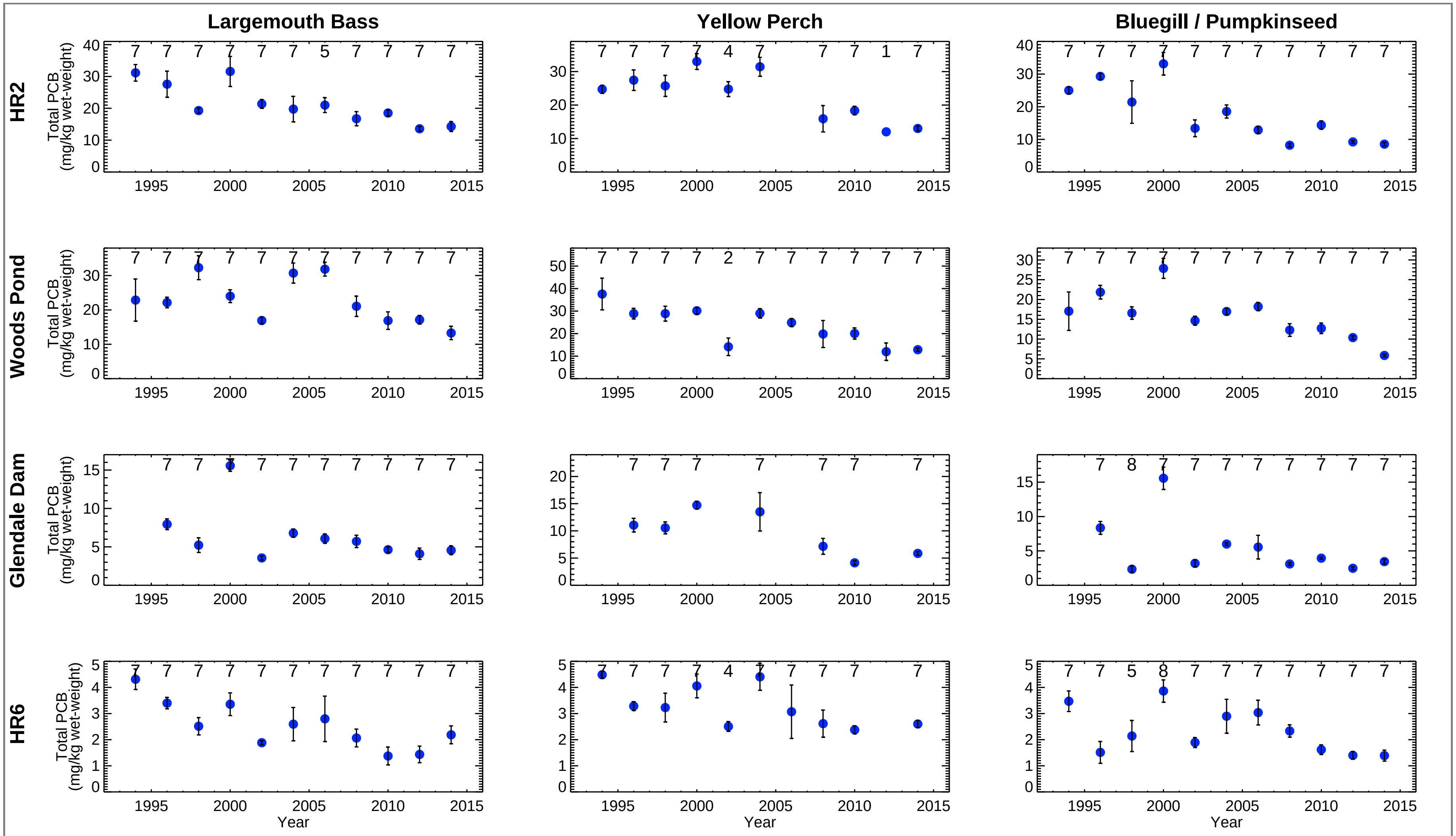
Figure 3-8p
Cumulative Probability Distribution of Adult Fish (NP) Total PCB Concentrations (Wet-weight) in Reach 15 (Lake Zoar)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Note:
Data are shown as the mean +/- 2 standard errors.

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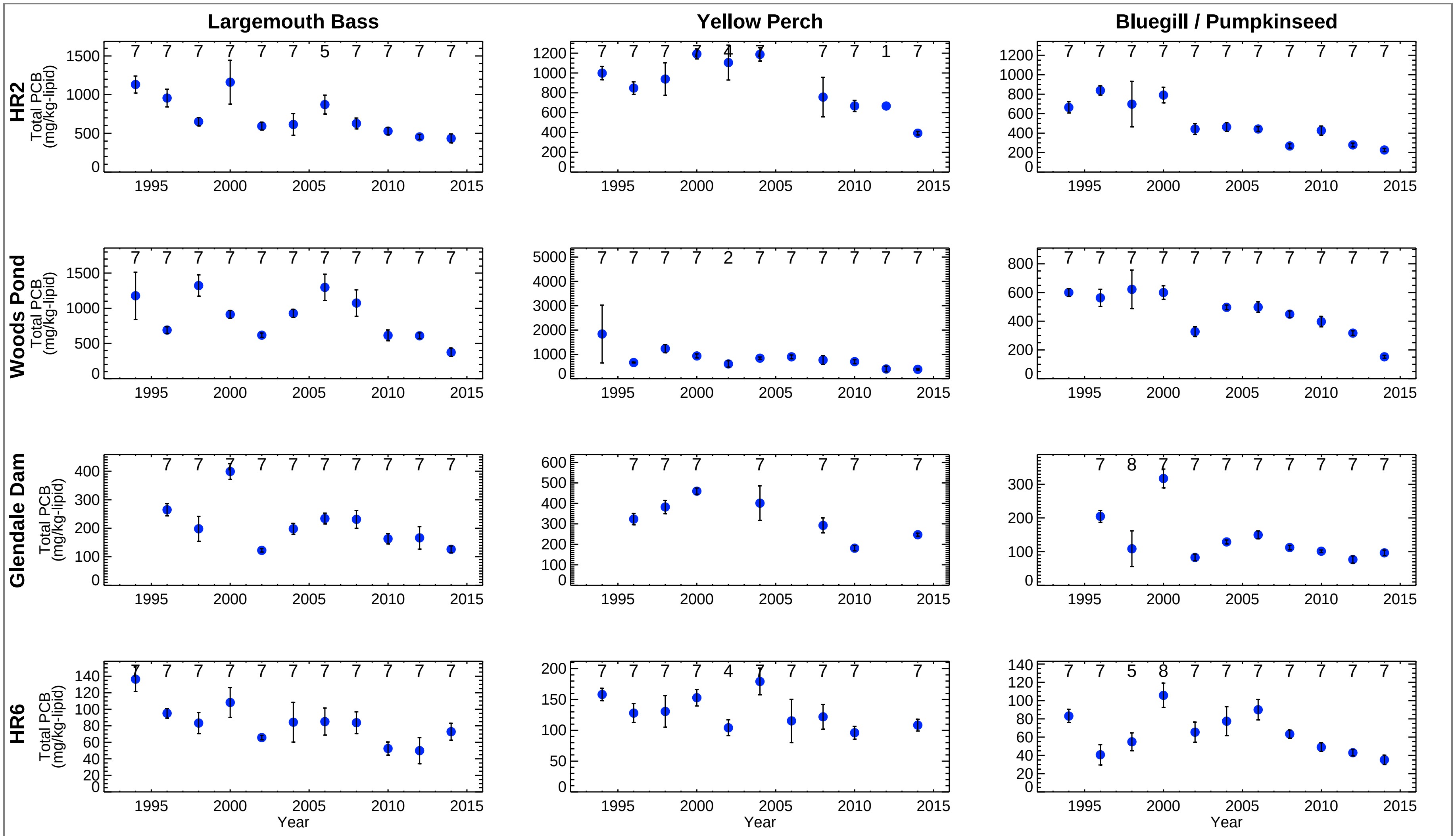
Figure 3-9a

Time Series of Annual Average Total PCB Concentrations in YOY Fish (Wet-weight)



Note:
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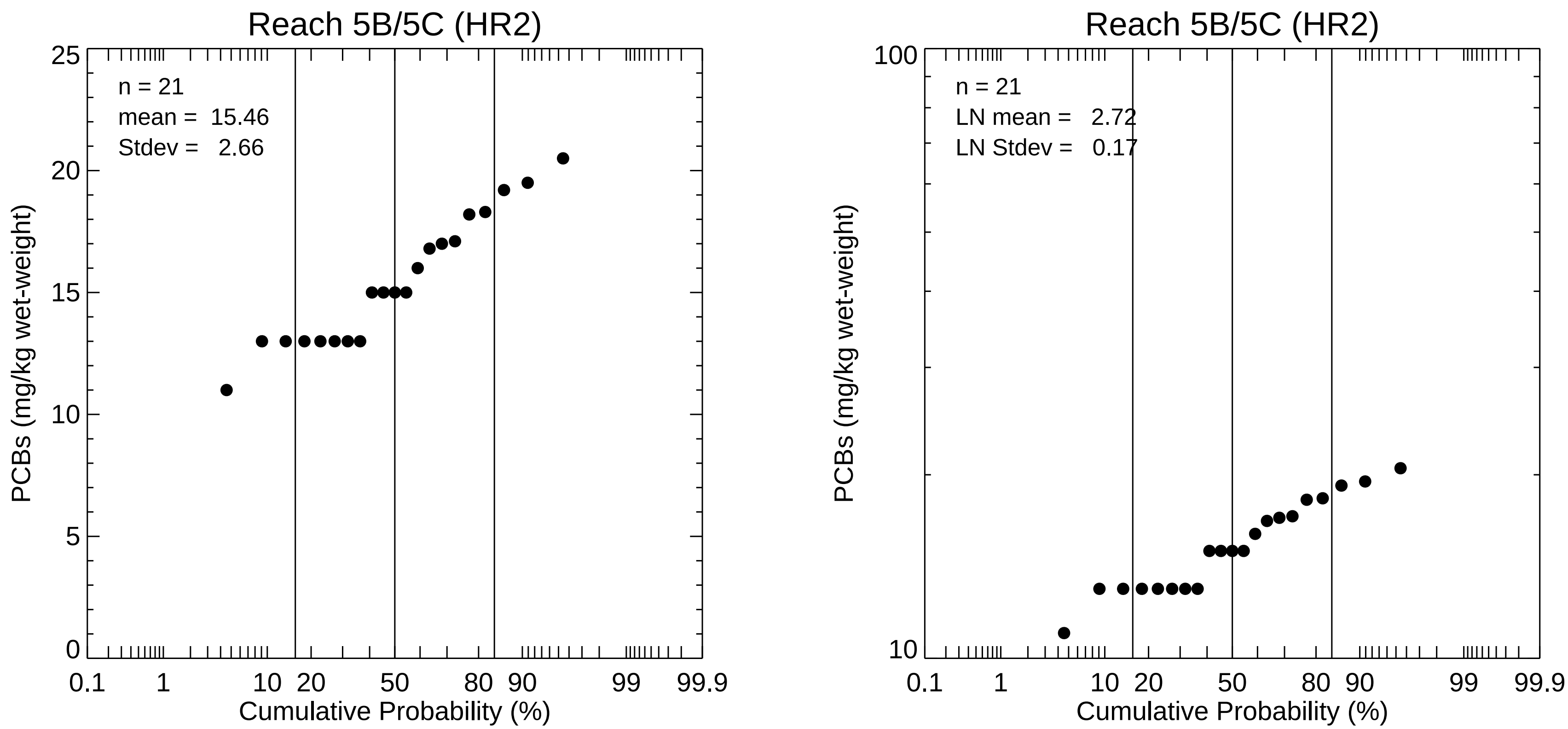
Figure 3-9b

Time Series of Annual Average Total PCB Concentrations in YOY Fish (Lipid-normalized)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River

LMB (YoY)



Includes data from 2010 - 2014

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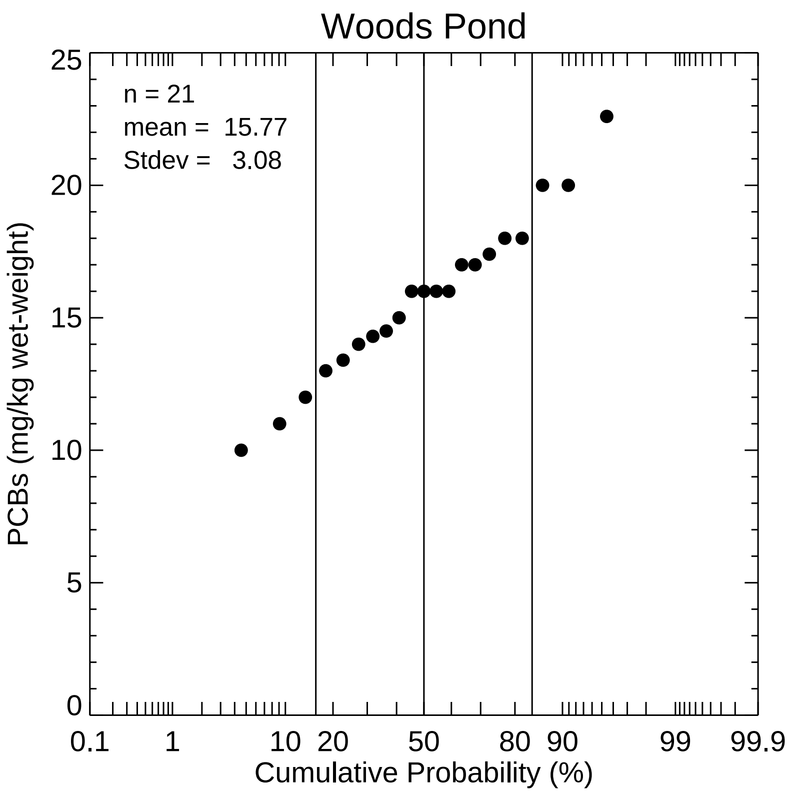
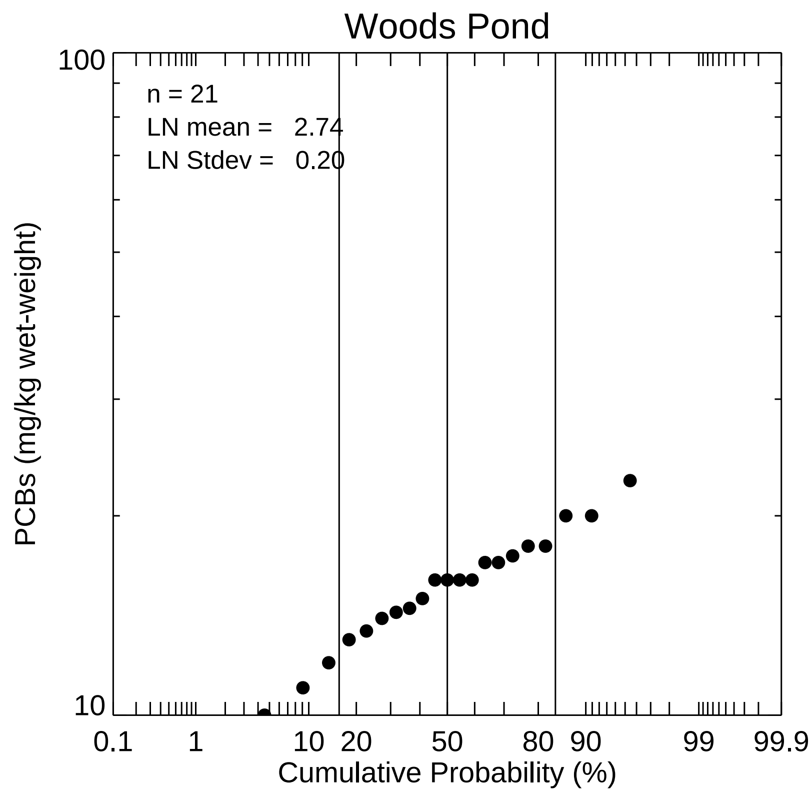
Figure 3-10a
Cumulative Probability Distribution of YOY Fish (LMB) Total PCB Concentrations (Wet-weight) in Reach 5B/5C (HR2)

Revised Baseline Monitoring Plan
Housatonic River - Rest of River

LMB (YoY)





Includes data from 2010 - 2014

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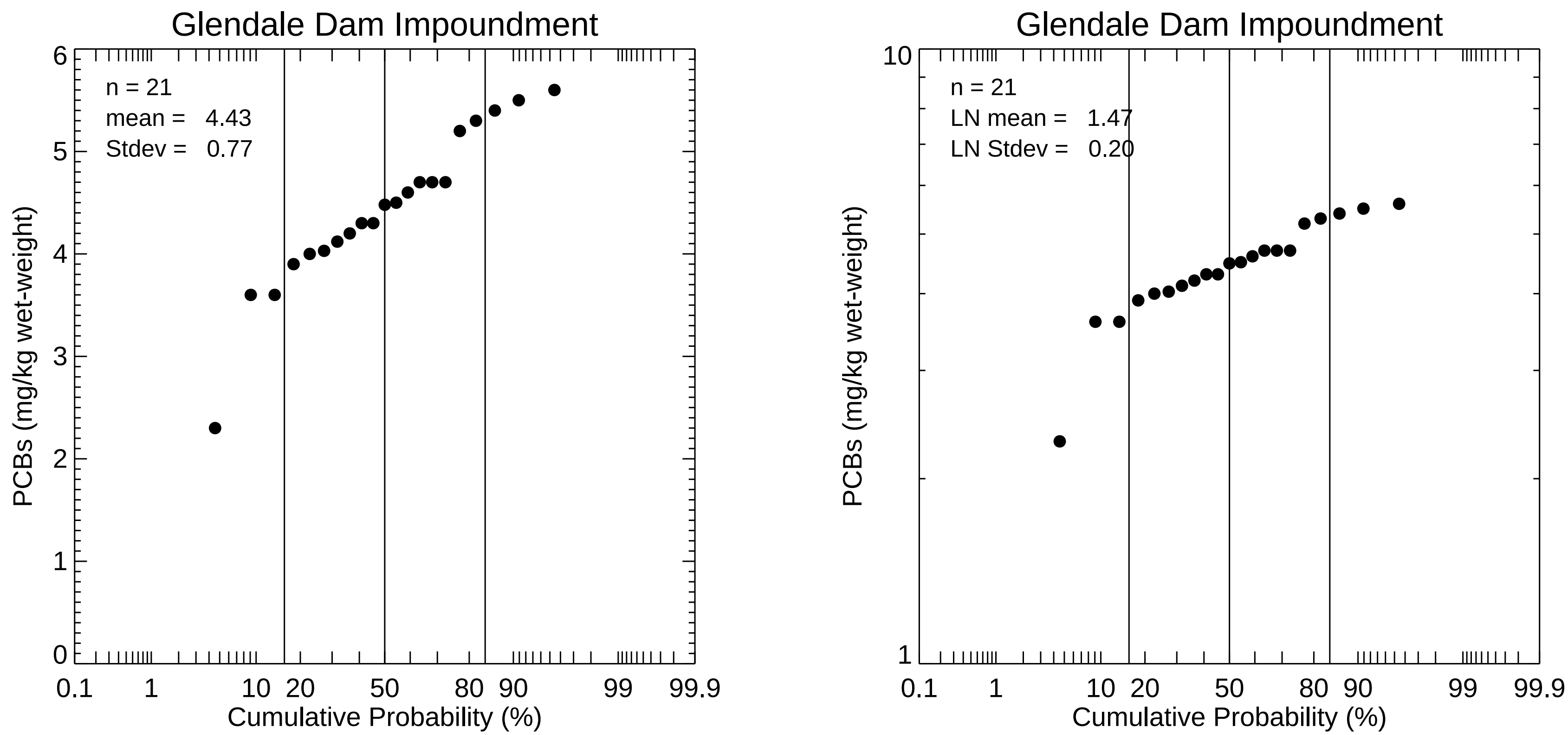
Figure 3-10b

Cumulative Probability Distribution of YOY Fish (LMB) Total PCB Concentrations (Wet-weight) in Woods Pond

LMB (YoY)



Includes data from 2010 - 2014

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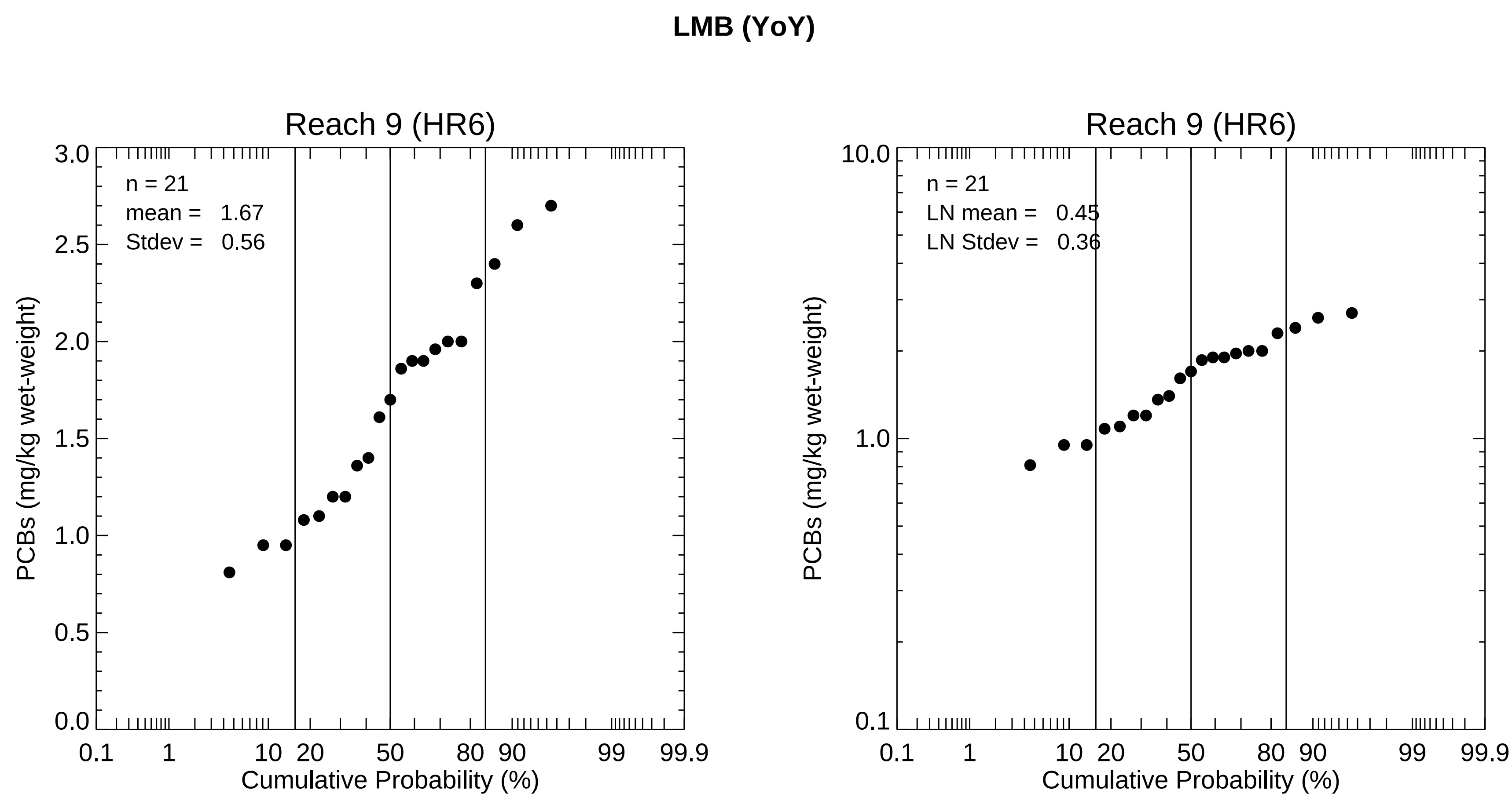
Figure 3-10c
Cumulative Probability Distribution of YOY Fish (LMB) Total PCB Concentrations (Wet-weight) in Glendale Dam Impoundment

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Includes data from 2010 - 2014

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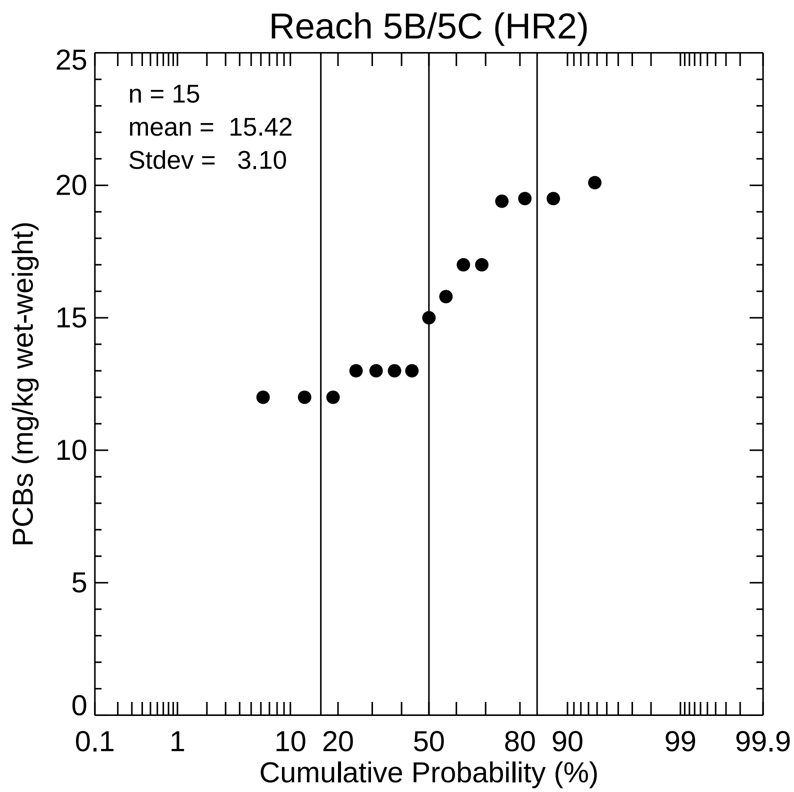
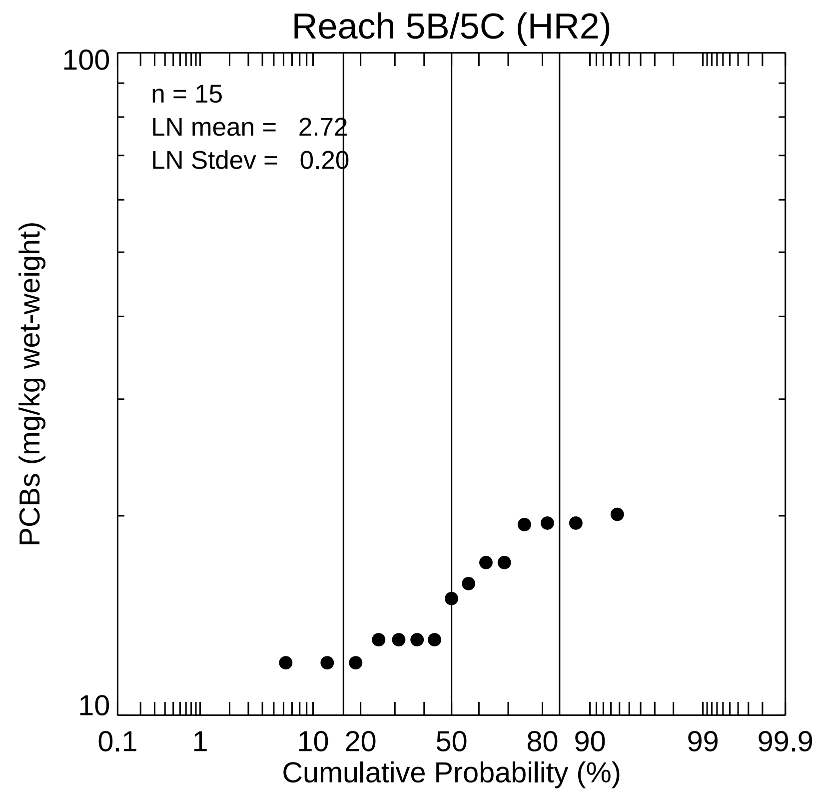
Figure 3-10d
Cumulative Probability Distribution of YOY Fish (LMB) Total PCB Concentrations (Wet-weight) in Reach 9 (HR6)

YP (YoY)





Includes data from 2010 - 2014

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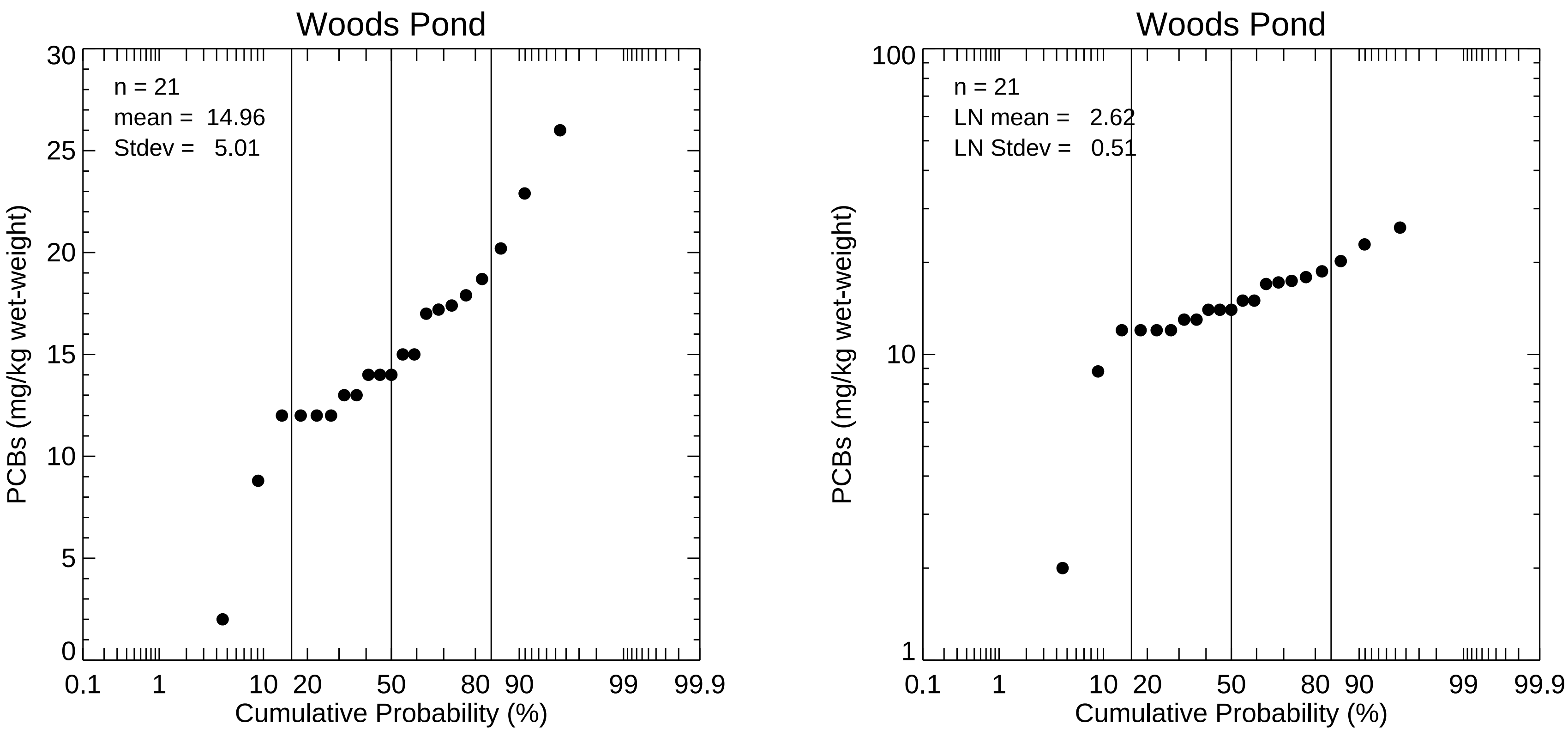
Figure 3-10e

Cumulative Probability Distribution of YOY Fish (YP) Total PCB Concentrations (Wet-weight) in Reach 5B/5C (HR2)

YP (YoY)



Includes data from 2010 - 2014

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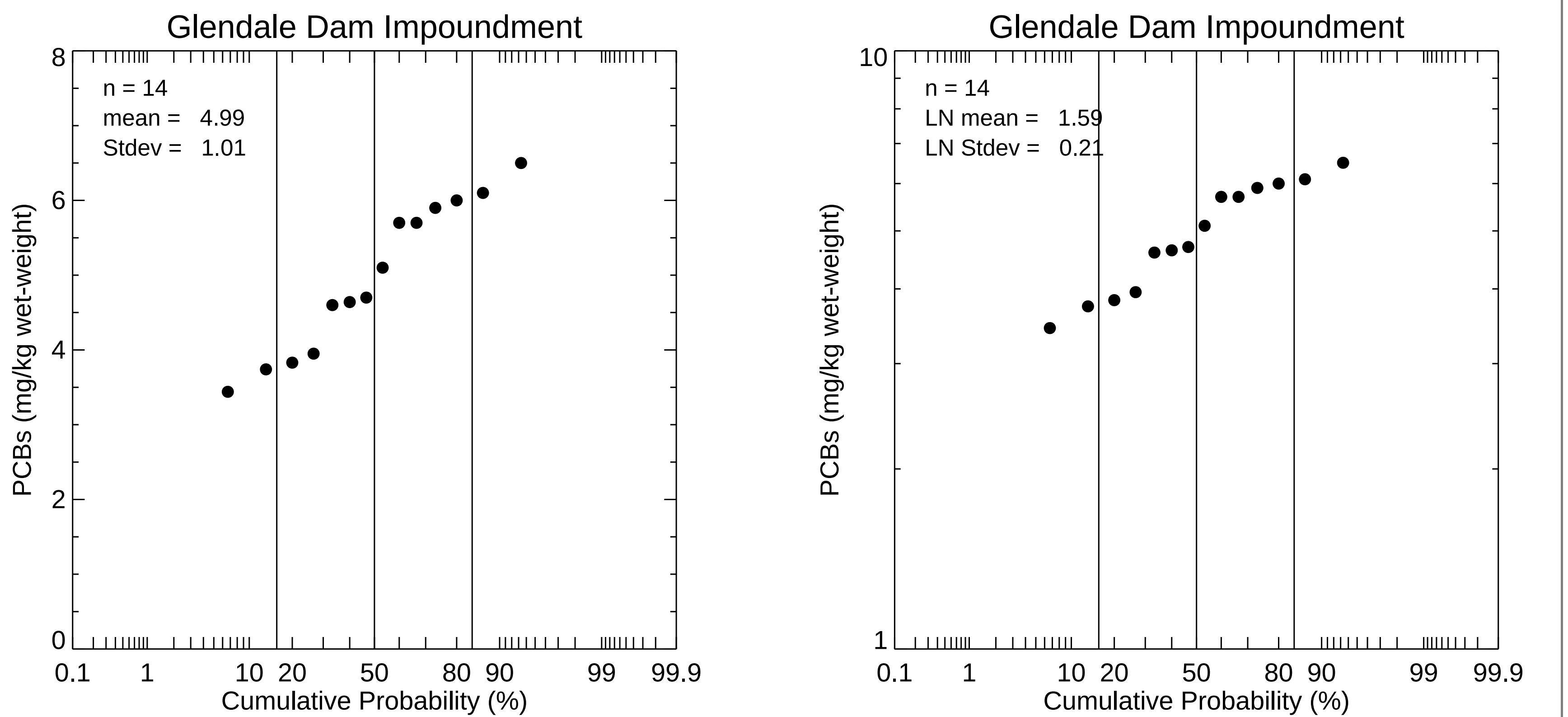
Figure 3-10f

Cumulative Probability Distribution of YOY Fish (YP) Total PCB Concentrations (Wet-weight) in Woods Pond

YP (YoY)



Includes data from 2010 - 2014

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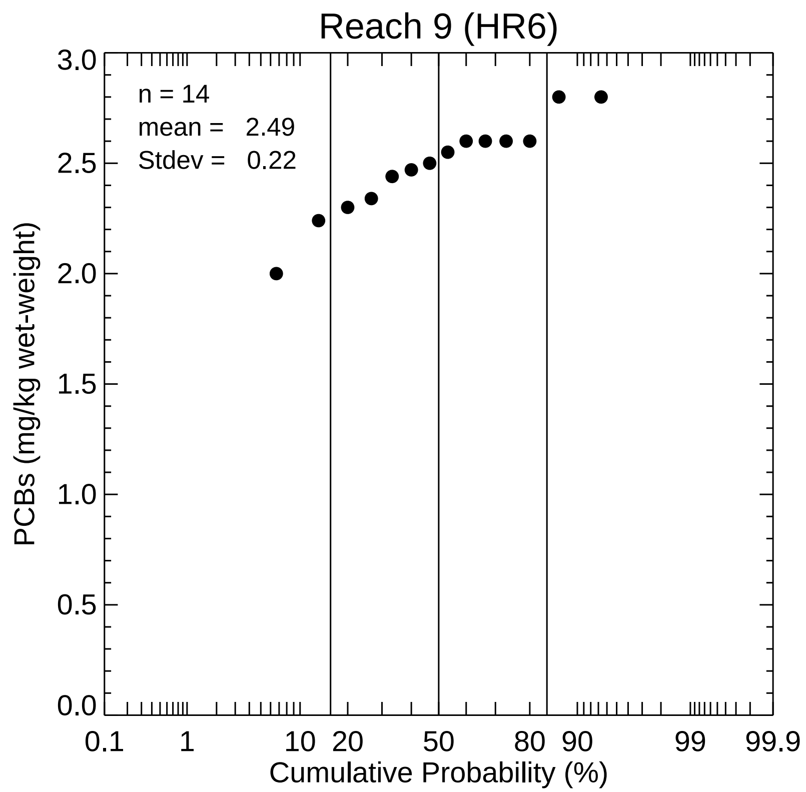
Figure 3-10g
Cumulative Probability Distribution of YOY Fish (YP) Total PCB Concentrations (Wet-weight) in Glendale Dam Impoundment

YP (YoY)



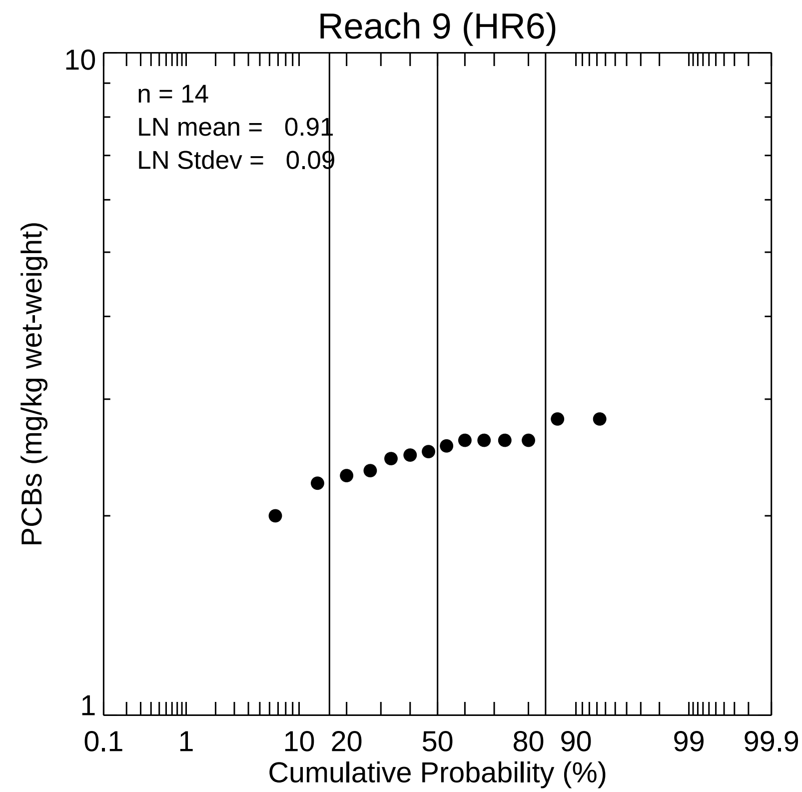


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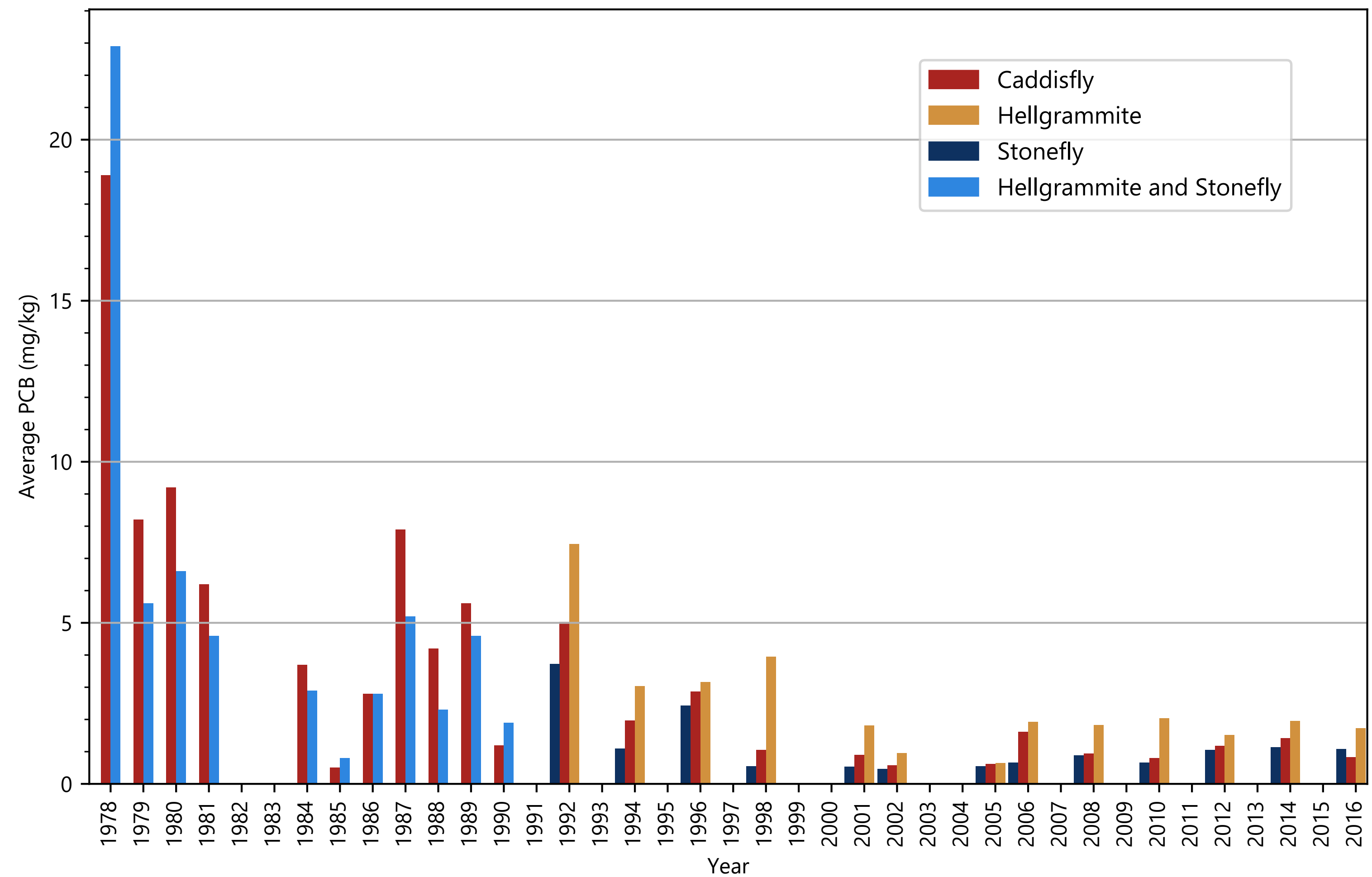
Figure 3-10h
Cumulative Probability Distribution of YOY Fish (YP) Total PCB Concentrations (Wet-weight) in Reach 9 (HR6)



Values shown represent arithmetic means; all years are based on Aroclor totals. Results for duplicate samples were averaged.

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Figure 3-11
Time Series of Annual Average Total PCB (Aroclor) Concentrations in Benthic Macroinvertebrates Collected from Reach 11 (West Cornwall, CT)
Revised Baseline Monitoring Plan
Housatonic River - Rest of River

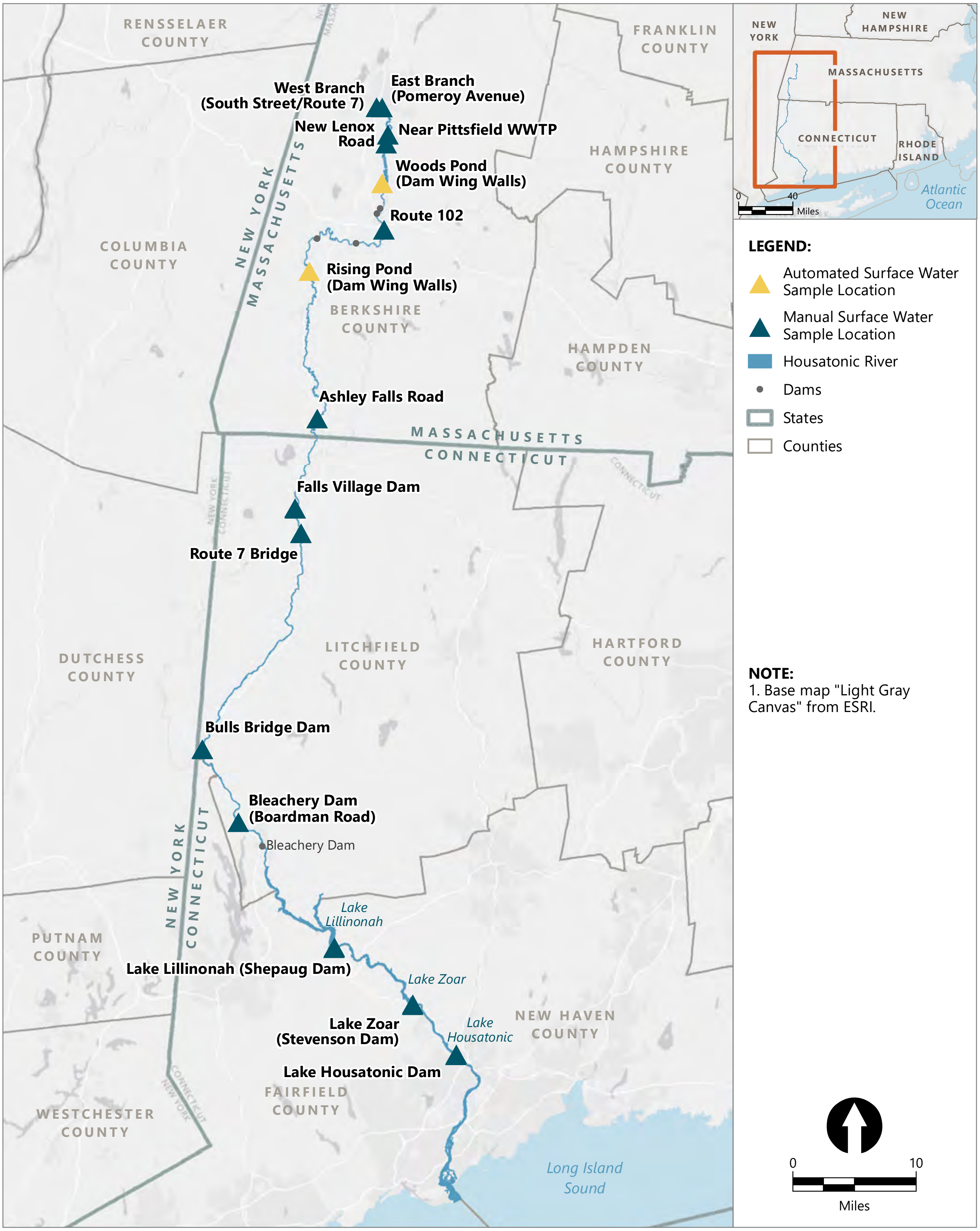

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Figure 4-1
Overview of Surface Water Sampling Locations
Revised Baseline Monitoring Plan
Housatonic River – Rest of River

LEGEND:

Surface Water Sample Location

0 50
Feet

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ANCHOR QEA

Figure 4-2a
Surface Water Sampling Locations (East Branch – Pomeroy Avenue)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

LEGEND:

Surface Water Sample Location

0 50

Feet

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Filepath: \\orcas\gis\Jobs\GE_0469\HousatonicRiver\Maps\Reports\BMP\AQ_BMP_Fig4-2a-h_SurfWaterLocations_MA.mxd

ANCHOR QEA

Figure 4-2b

Surface Water Sampling Locations (West Branch – South Street/Route 7)

Revised Baseline Monitoring Plan

Housatonic River – Rest of River

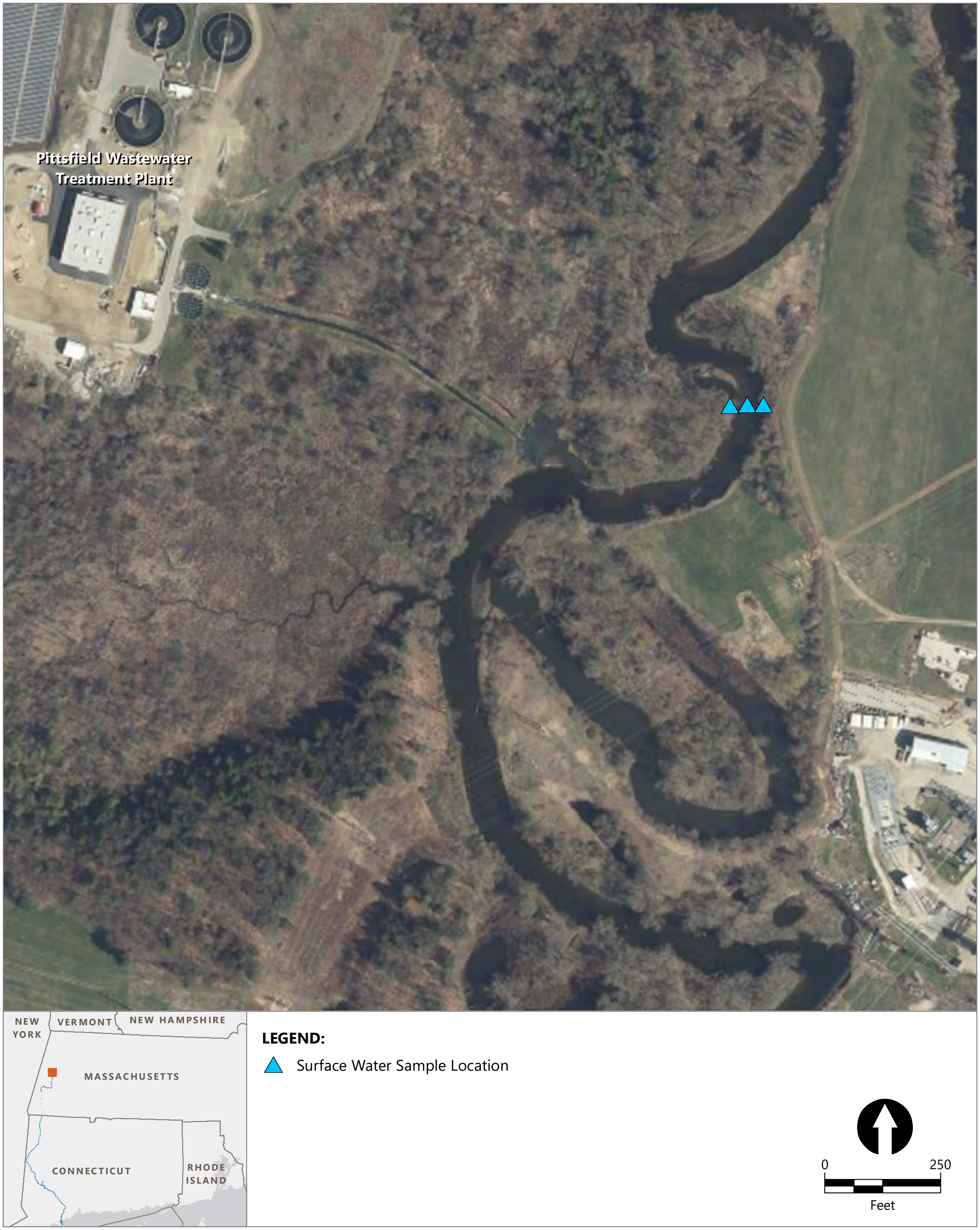

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Figure 4-2c
Surface Water Sampling Locations (Near Pittsfield WWTP)

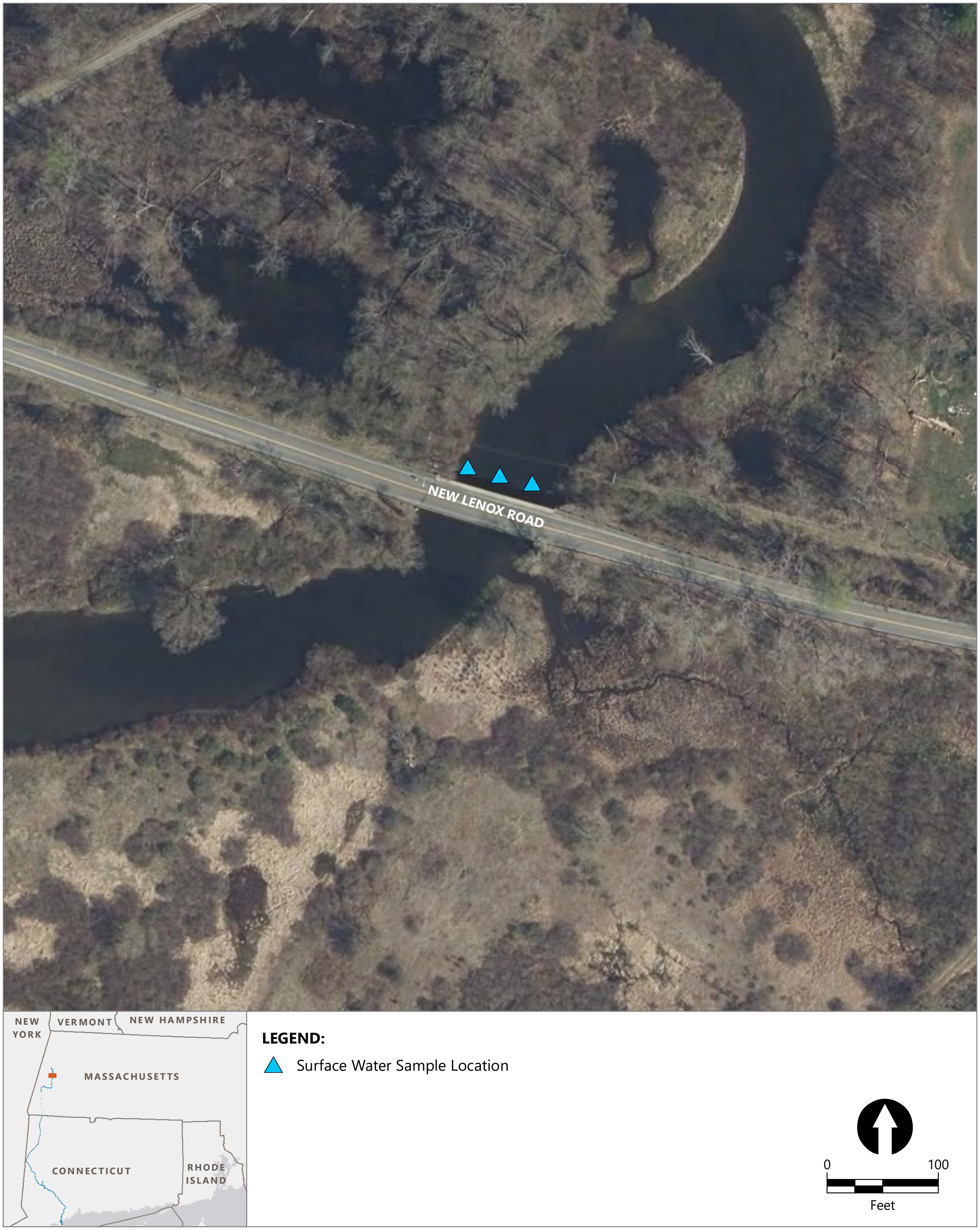

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Figure 4-2d
Surface Water Sampling Locations (New Lenox Road)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

LEGEND:

Surface Water Sample Location

0 100
Feet

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Figure 4-2e
Surface Water Sampling Locations (Woods Pond Dam)
Revised Baseline Monitoring Plan
Housatonic River – Rest of River

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Figure 4-2f
Surface Water Sampling Locations (Route 102)
Revised Baseline Monitoring Plan
Housatonic River – Rest of River

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Figure 4-2g
Surface Water Sampling Locations (Rising Pond Dam)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

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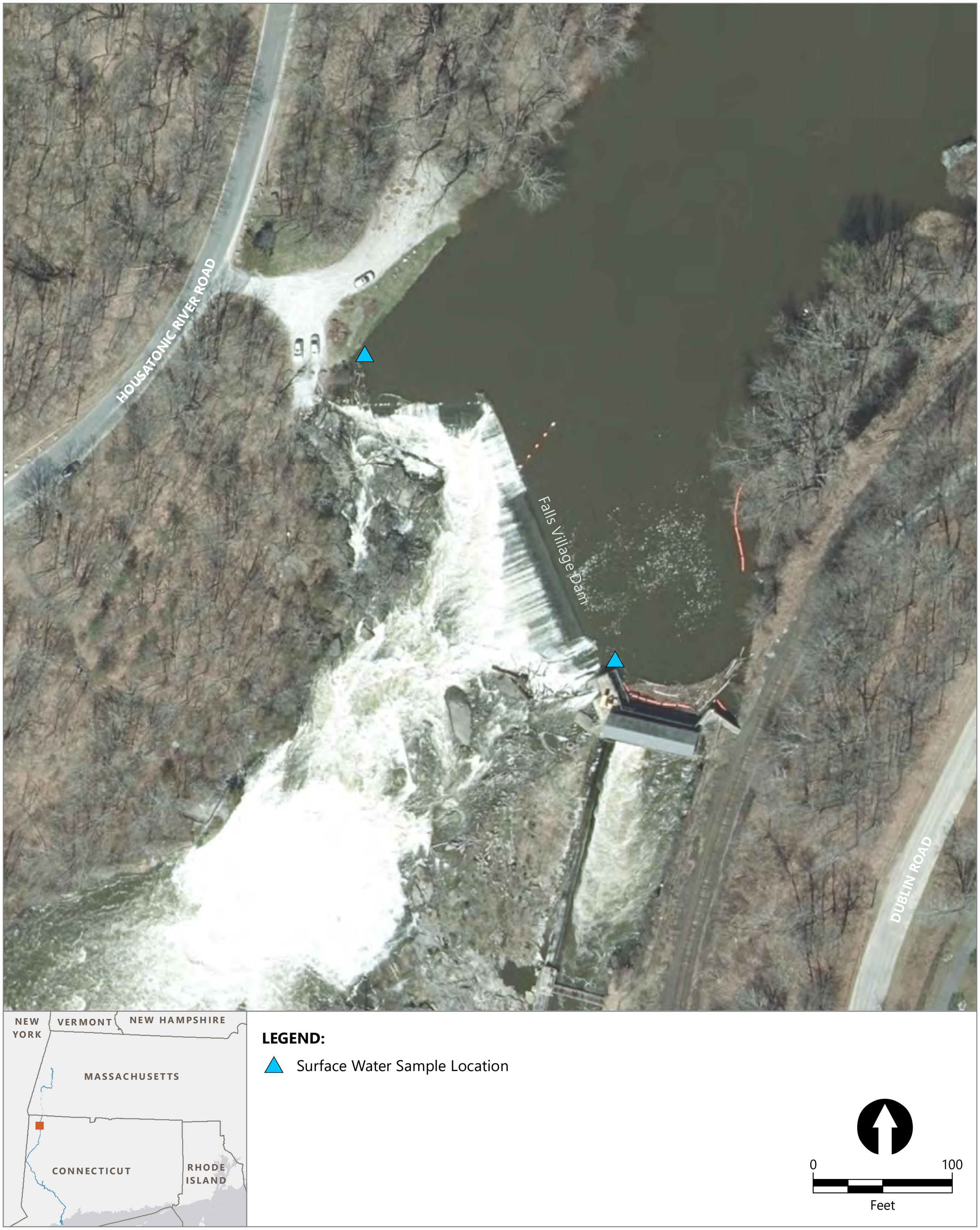
Figure 4-2h
Surface Water Sampling Locations (Ashley Falls Road)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River



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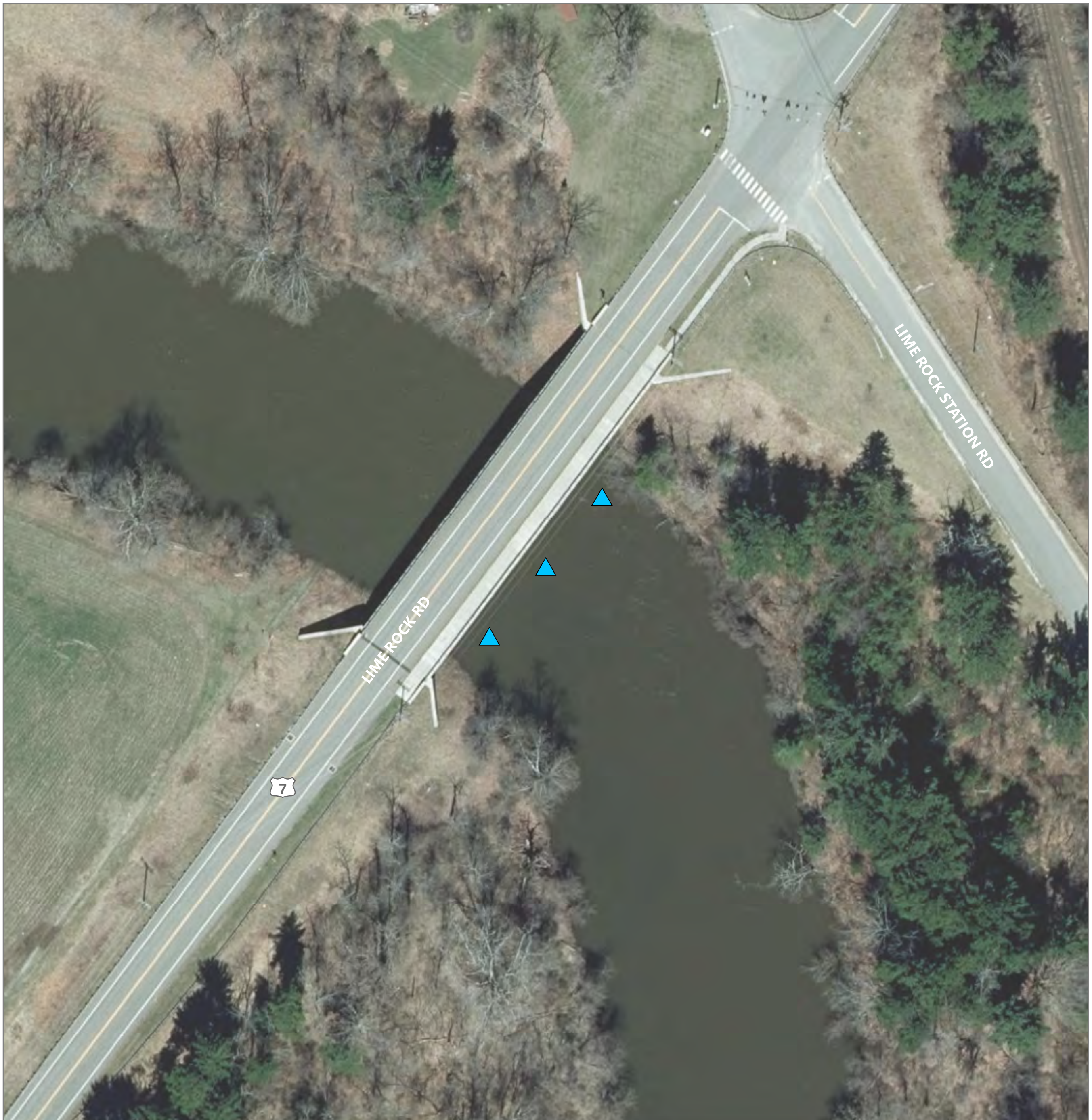
ANCHOR QEA

Figure 4-2i
Surface Water Sampling Locations (Falls Village Dam)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River



LEGEND:

▲ Surface Water Sample Location

0 100
Feet

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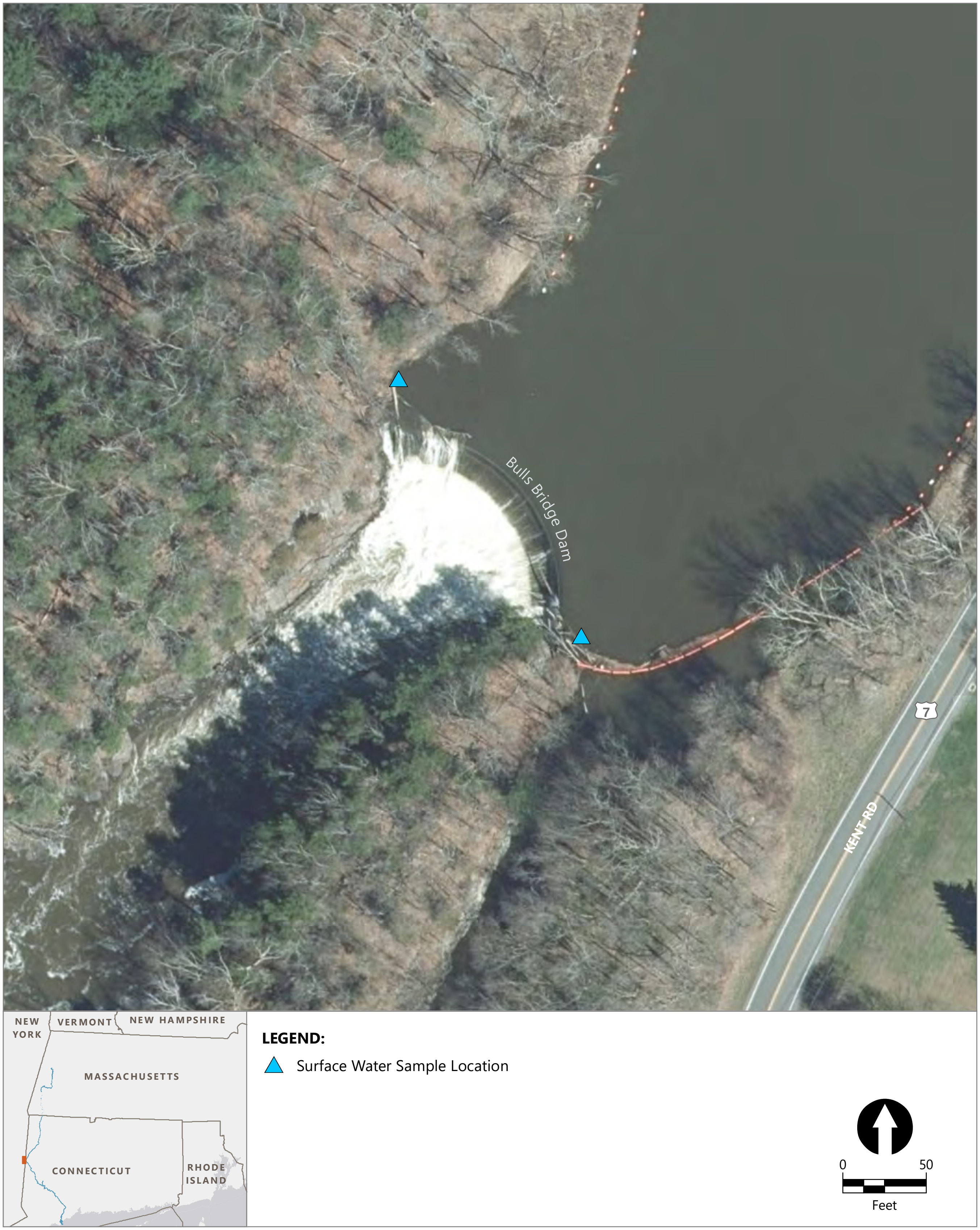
ANCHOR QEA

Figure 4-2j
Surface Water Sampling Locations (Route 7 Bridge)
Revised Baseline Monitoring Plan
Housatonic River – Rest of River



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ANCHOR QEA

Figure 4-2k
Surface Water Sampling Locations (Bulls Bridge Dam)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

LEGEND:

Surface Water Sample Location

0 50
Feet

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ANCHOR QEA

Figure 4-2l
Surface Water Sampling Locations (Bleachery Dam – Boardman Road)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

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ANCHOR QEA

Figure 4-2m
Surface Water Sampling Locations (Lake Lillinonah – Shepaug Dam)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

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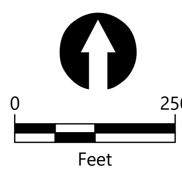
ANCHOR QEA

Figure 4-2n
Surface Water Sampling Locations (Lake Zoar – Stevenson Dam)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

LEGEND:

Surface Water Sample Location



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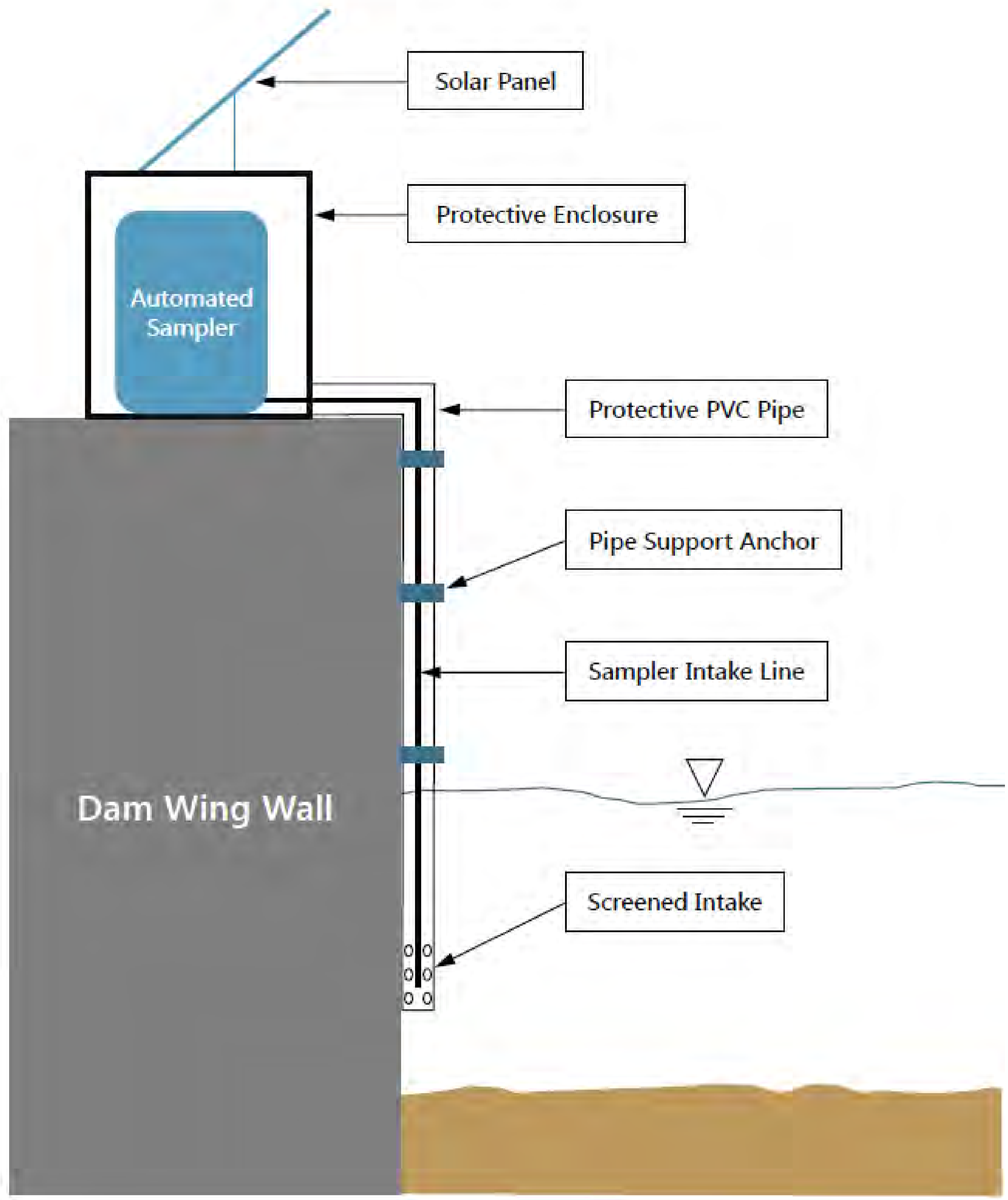
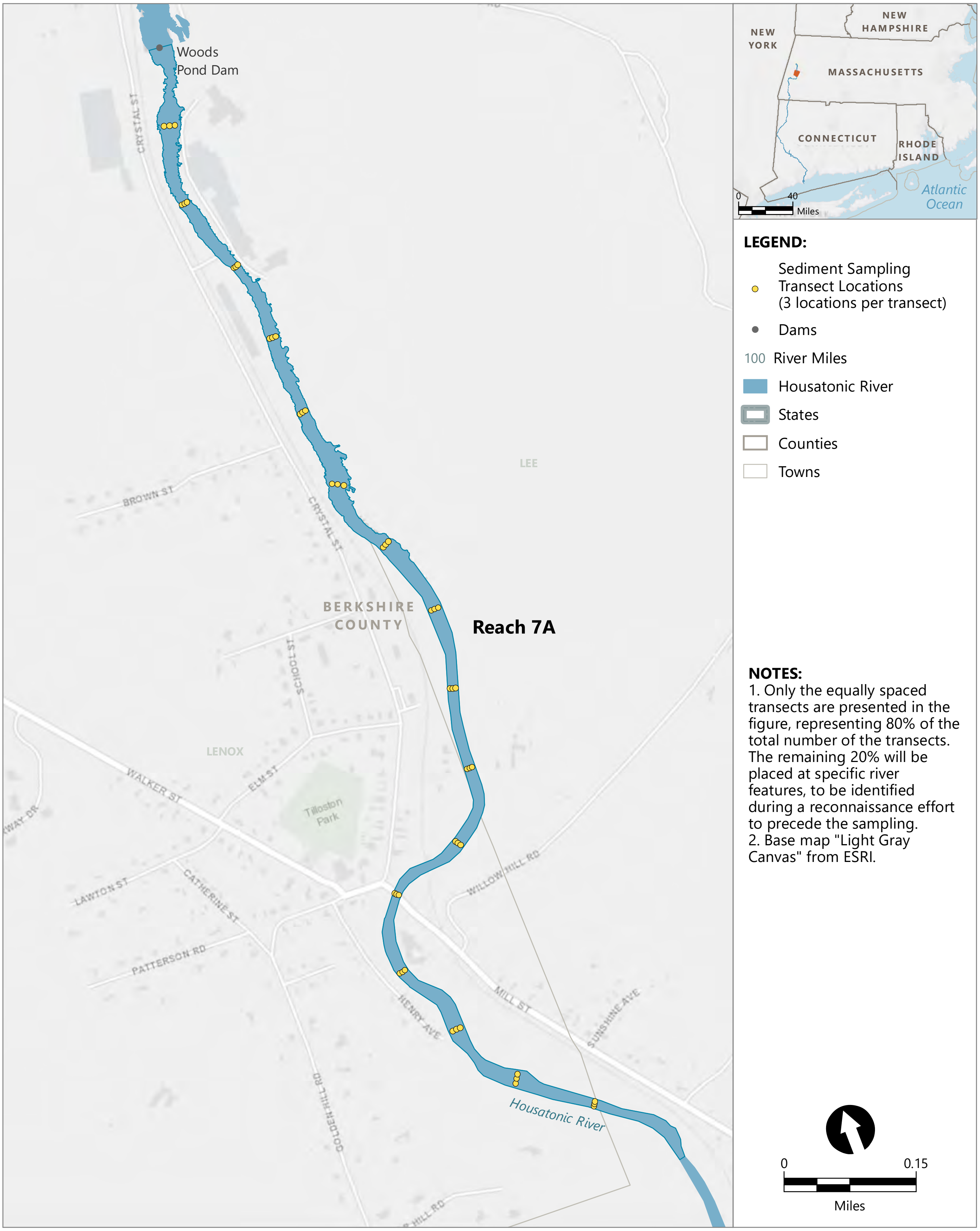
ANCHOR QEA

Figure 4-2o
Surface Water Sampling Locations (Lake Housatonic Dam)



ANCHOR QEA

Figure 4-3
Automated Station Schematic
Revised Baseline Monitoring Plan
Housatonic River – Rest of River



LEGEND:

- Sediment Sampling Transect Locations (3 locations per transect)
- Dams
- 100 River Miles
- Housatonic River
- States
- Counties
- Towns

NOTES:

1. Only the equally spaced transects are presented in the figure, representing 80% of the total number of the transects. The remaining 20% will be placed at specific river features, to be identified during a reconnaissance effort to precede the sampling.
2. Base map "Light Gray Canvas" from ESRI.

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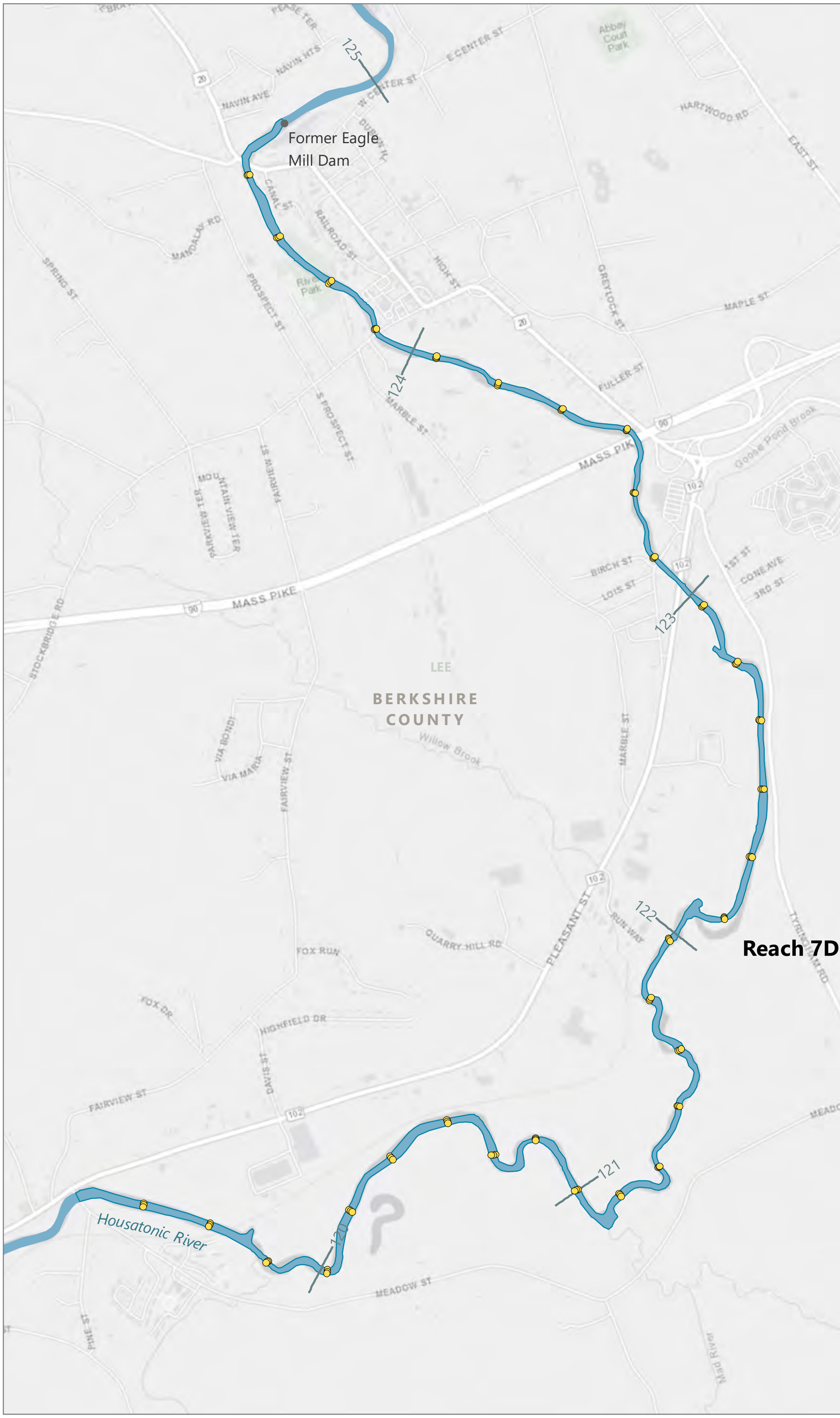
Figure 4-4a
Sediment Sampling Locations (Reach 7A)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River



LEGEND:

- Sediment Sampling Transect Locations (3 locations per transect)
- Dams
- 100 River Miles
- Housatonic River
- States
- Counties
- Towns

NOTES:

1. Only the equally spaced transects are presented in the figure, representing 80% of the total number of the transects. The remaining 20% will be placed at specific river features, to be identified during a reconnaissance effort to precede the sampling.
2. Base map "Light Gray Canvas" from ESRI.

0 0.3
Miles

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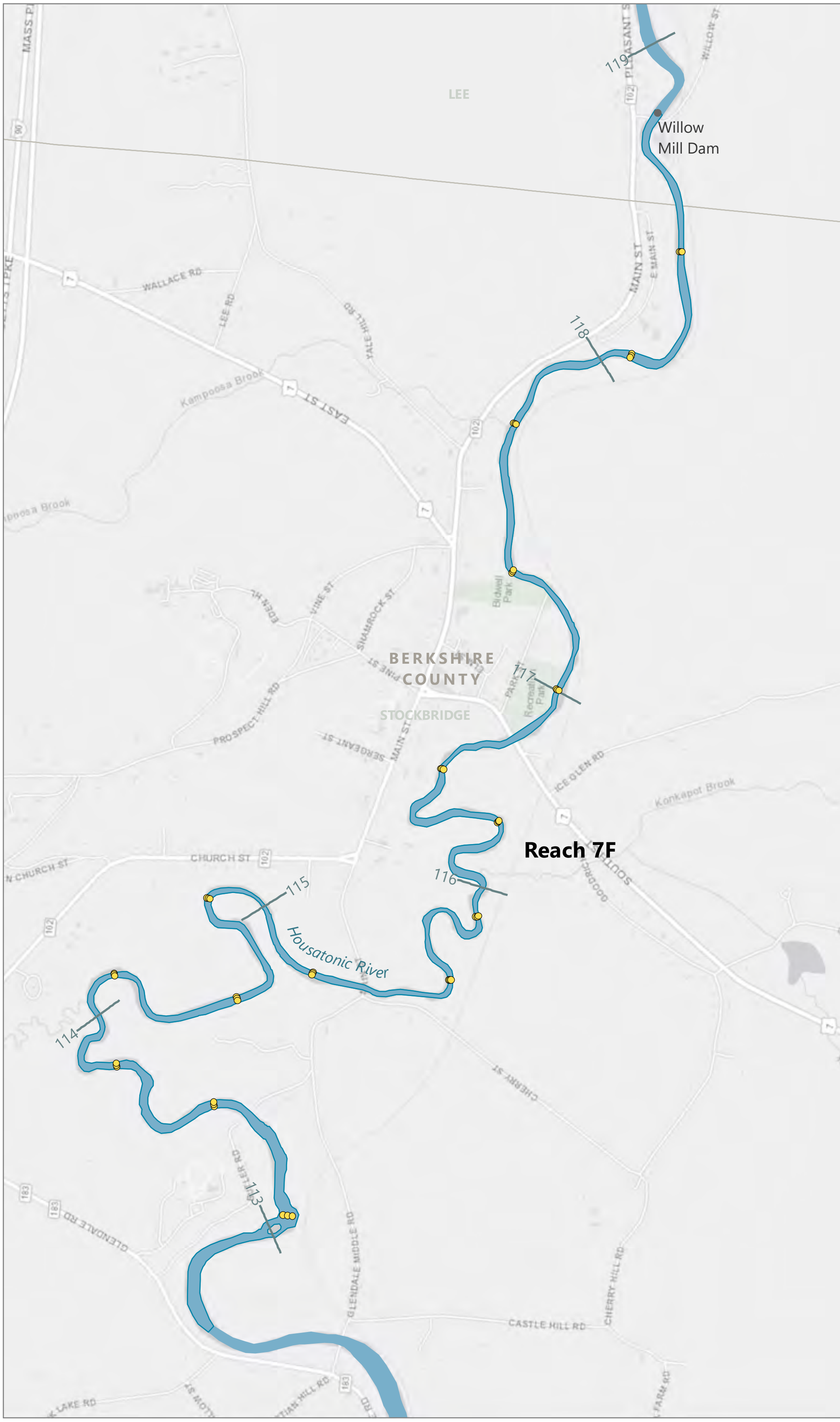
ANCHOR QEA

Figure 4-4b
Sediment Sampling Locations (Reach 7D)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River



LEGEND:

- Sediment Sampling Transect Locations (3 locations per transect)
- Dams
- 100 River Miles
- Housatonic River
- States
- Counties
- Towns

NOTES:
1. Only the equally spaced transects are presented in the figure, representing 80% of the total number of the transects. The remaining 20% will be placed at specific river features, to be identified during a reconnaissance effort to precede the sampling.
2. Base map "Light Gray Canvas" from ESRI.

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Figure 4-4c
Sediment Sampling Locations (Reach 7F)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

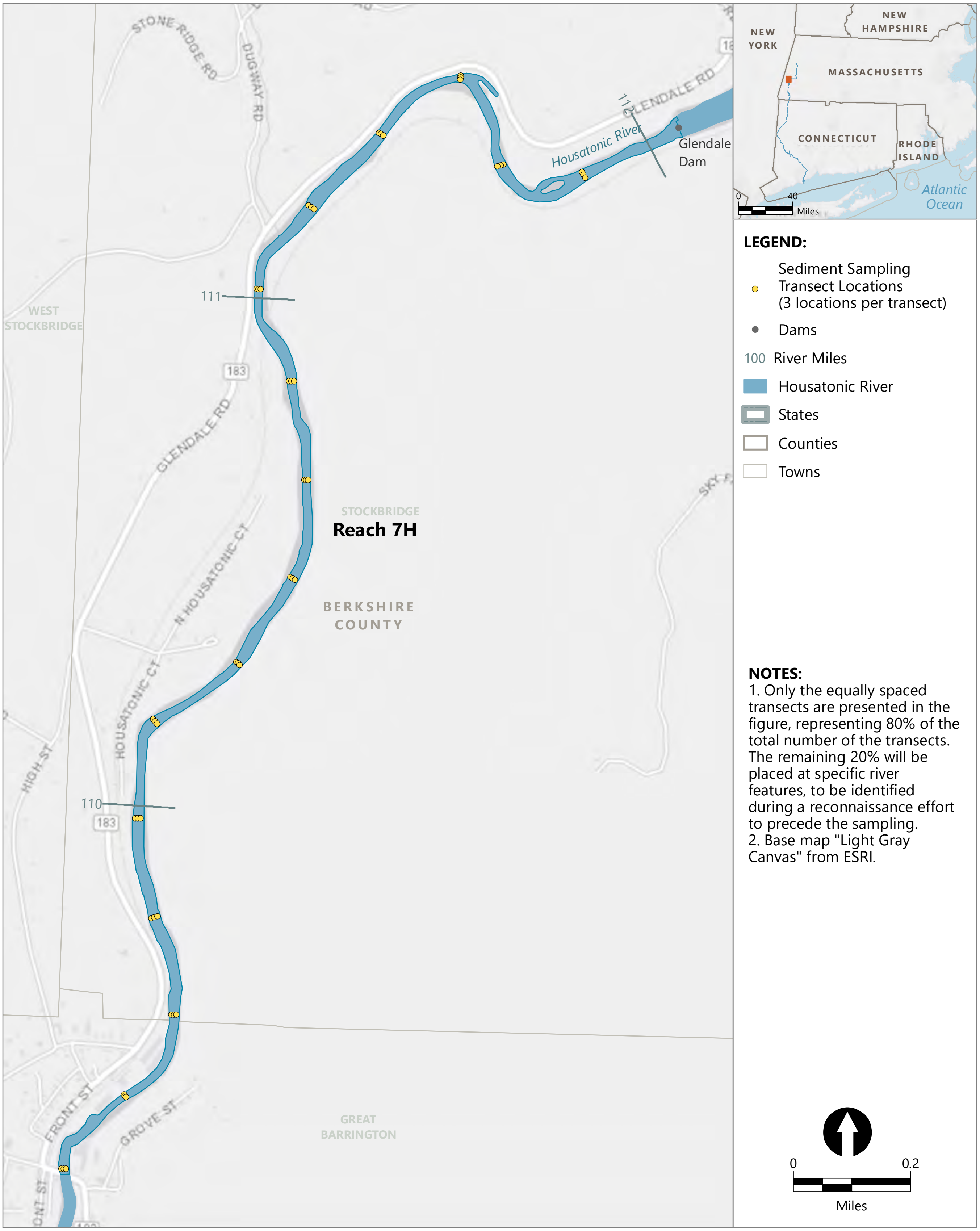

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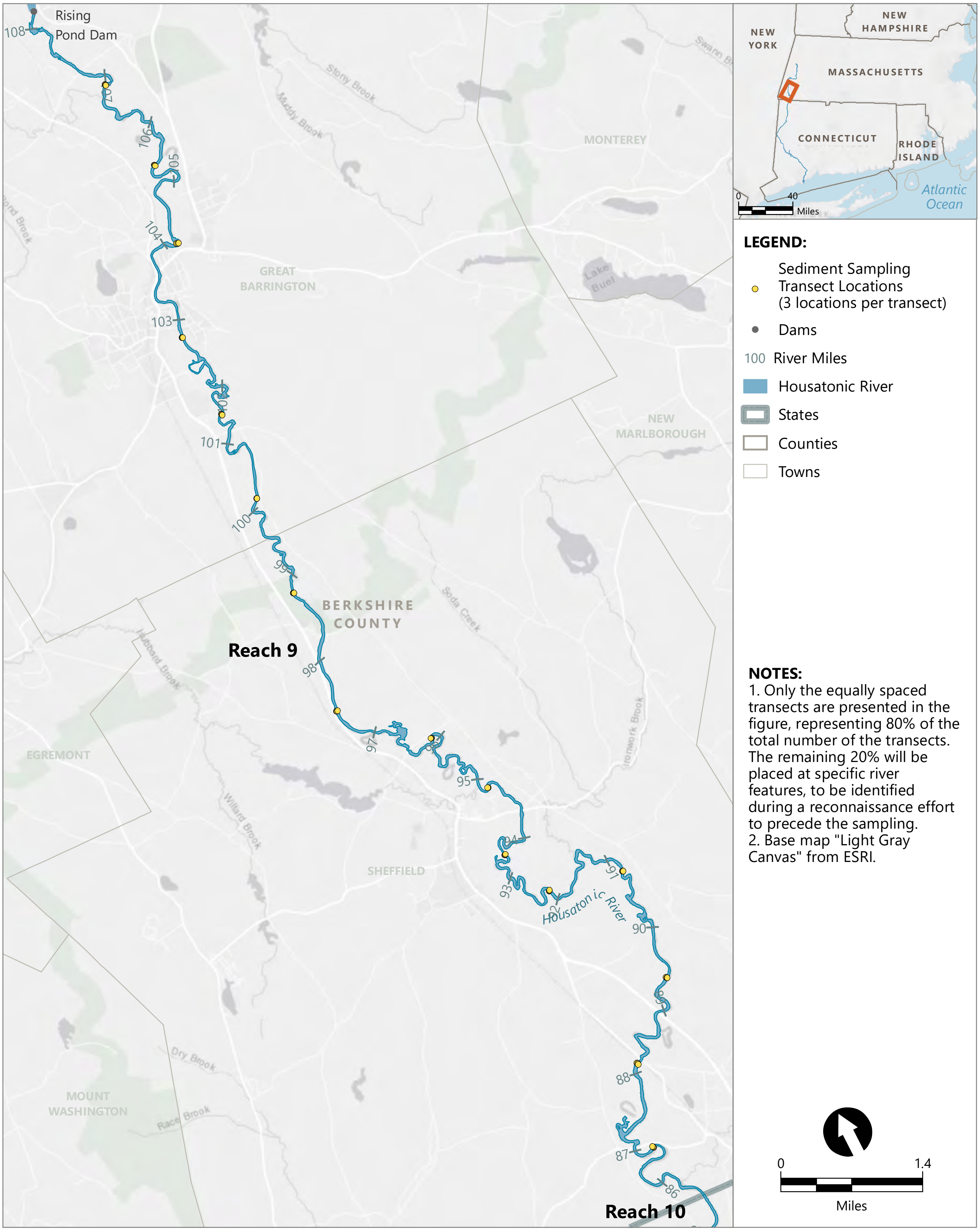
Figure 4-4d
Sediment Sampling Locations (Reach 7H)



LEGEND:

- Sediment Sampling Transect Locations (3 locations per transect)
- Dams
- 100 River Miles
- Housatonic River
- States
- Counties
- Towns

NOTES:

1. Only the equally spaced transects are presented in the figure, representing 80% of the total number of the transects. The remaining 20% will be placed at specific river features, to be identified during a reconnaissance effort to precede the sampling.
2. Base map "Light Gray Canvas" from ESRI.

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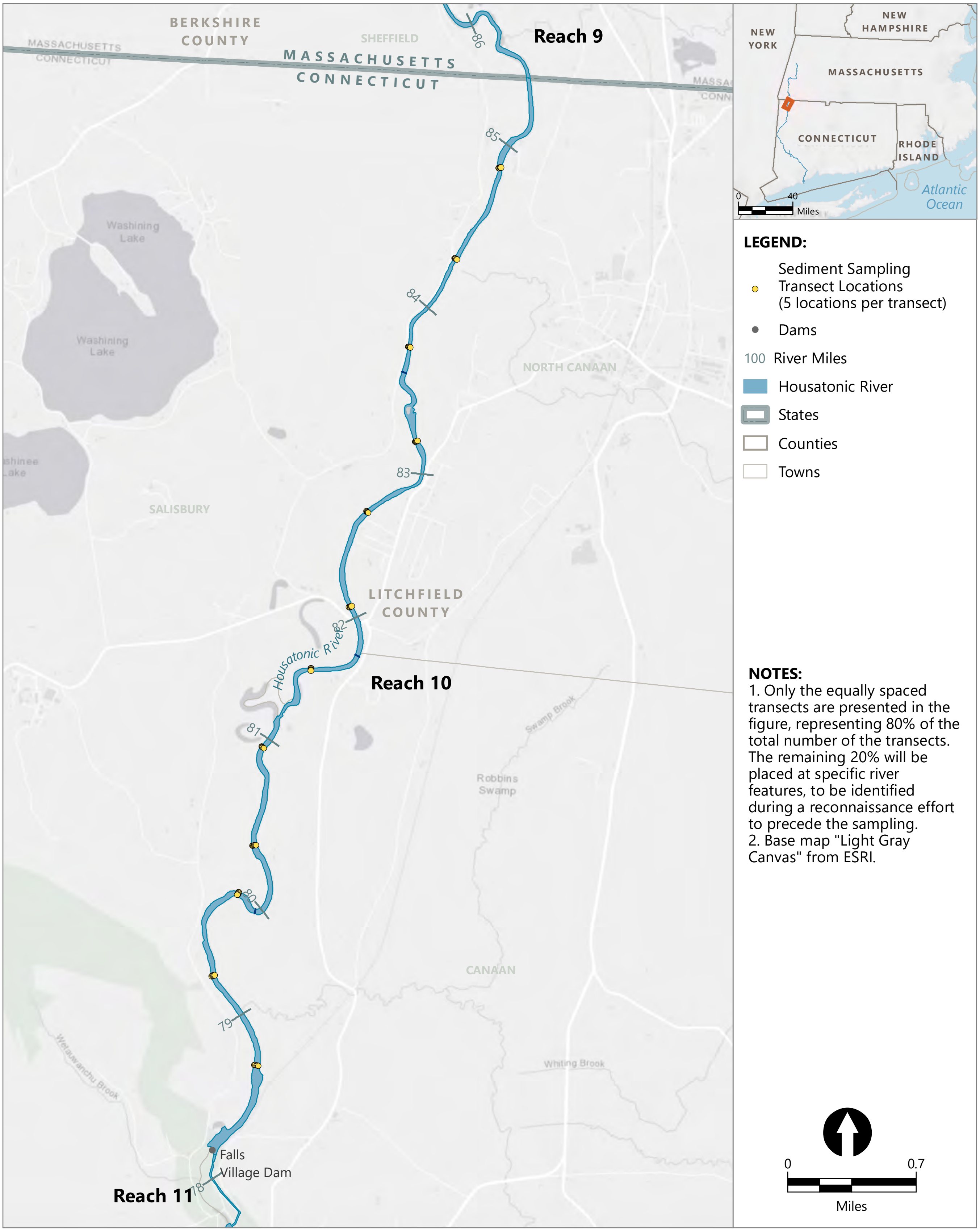
Figure 4-4e
Sediment Sampling Locations (Reach 9)



LEGEND:

- Sediment Sampling Transect Locations (5 locations per transect)
- Dams
- 100 River Miles
- Housatonic River
- States
- Counties
- Towns

NOTES:

1. Only the equally spaced transects are presented in the figure, representing 80% of the total number of the transects. The remaining 20% will be placed at specific river features, to be identified during a reconnaissance effort to precede the sampling.
2. Base map "Light Gray Canvas" from ESRI.

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Miles

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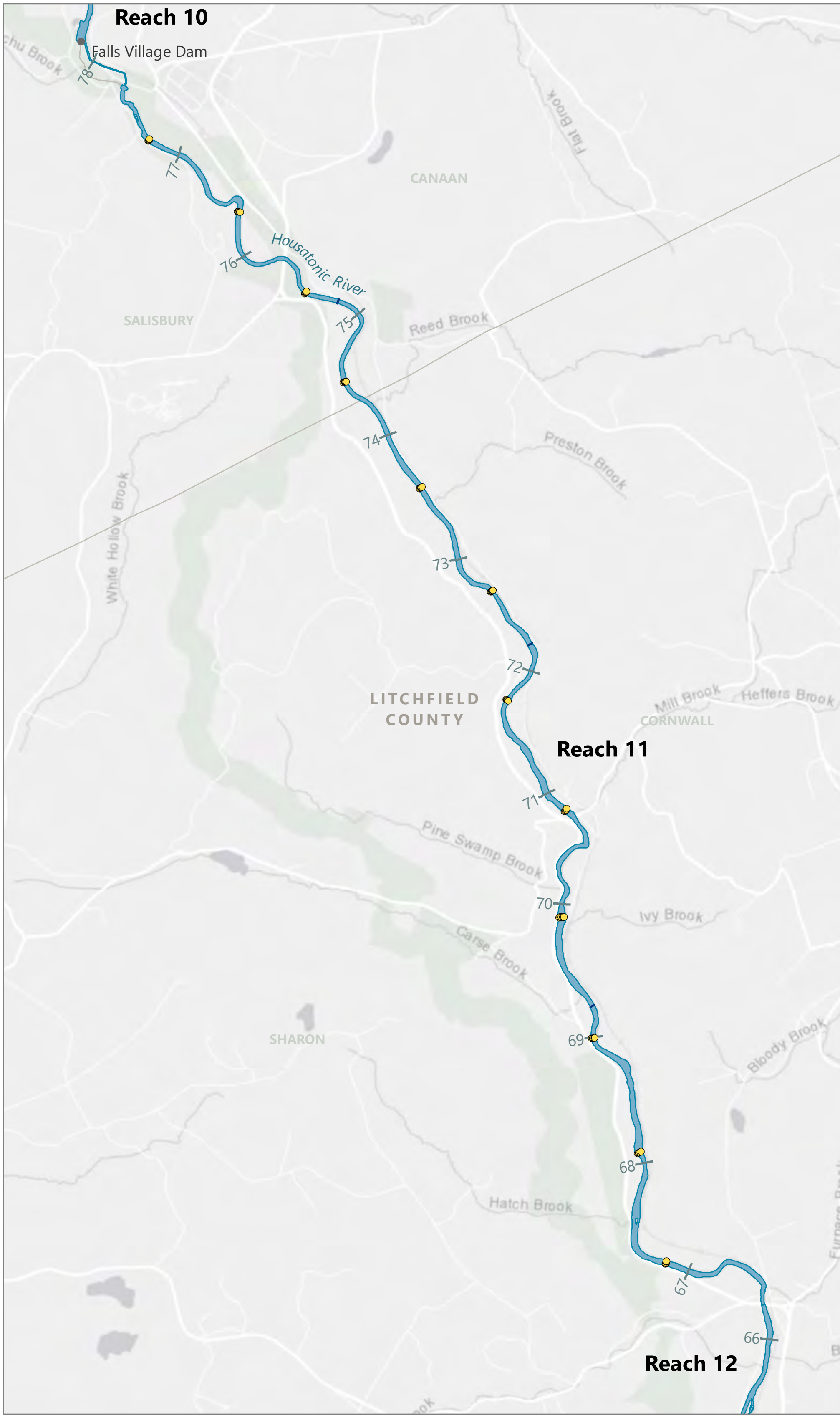
Figure 4-4f
Sediment Sampling Locations (Reach 10)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River



LEGEND:

- Sediment Sampling Transect Locations (5 locations per transect)
- Dams
- 100 River Miles
- Housatonic River
- States
- Counties
- Towns

NOTES:

1. Only the equally spaced transects are presented in the figure, representing 80% of the total number of the transects. The remaining 20% will be placed at specific river features, to be identified during a reconnaissance effort to precede the sampling.
2. Base map "Light Gray Canvas" from ESRI.

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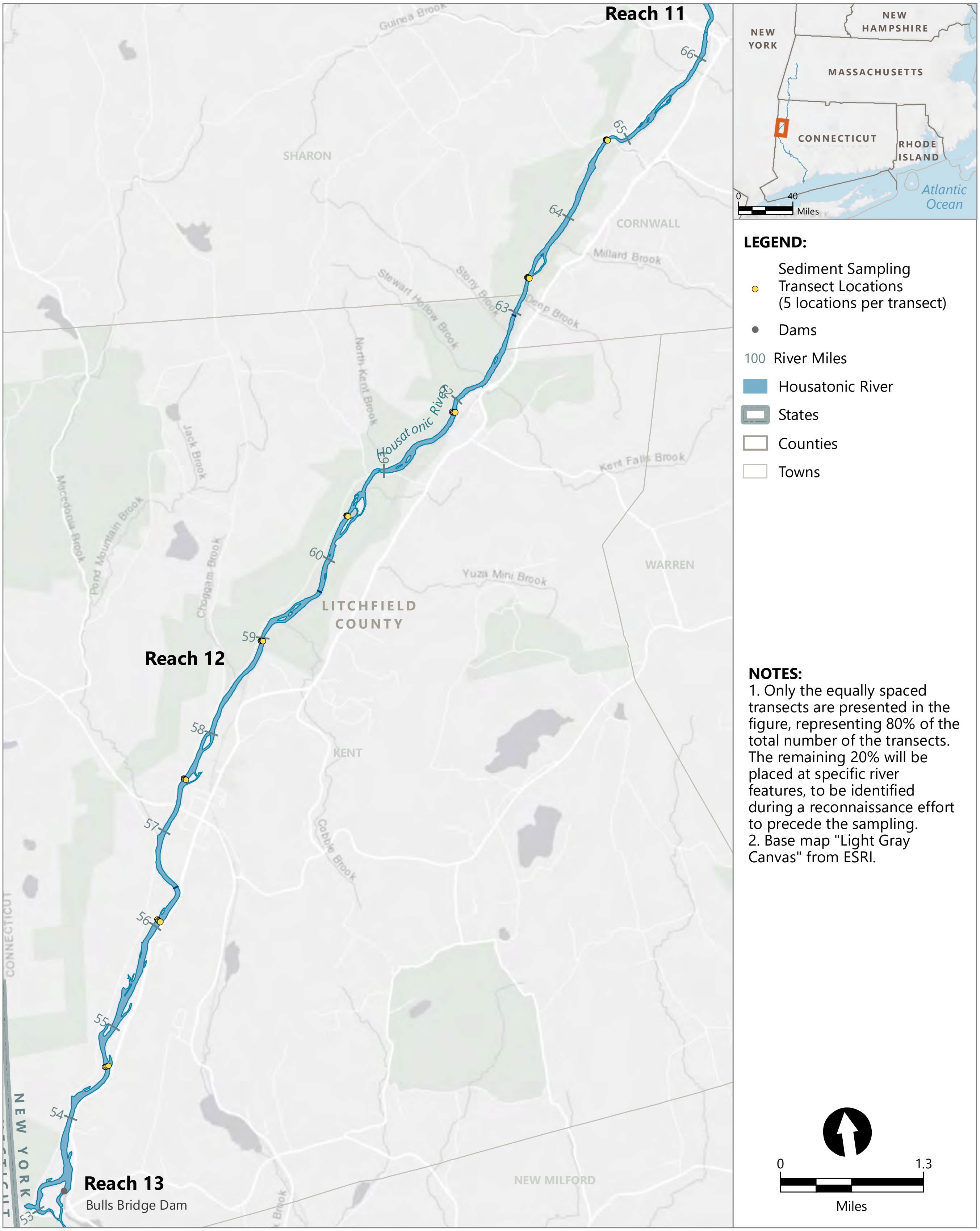
Figure 4-4g
Sediment Sampling Locations (Reach 11)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River



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Filepath: \\orcas\gis\Jobs\GE_0469\HousatonicRiver\Maps\Reports\BMP\AQ_BMP_Fig4-4_SedSamplingLocations.mxd

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Figure 4-4h
Sediment Sampling Locations (Bulls Bridge)

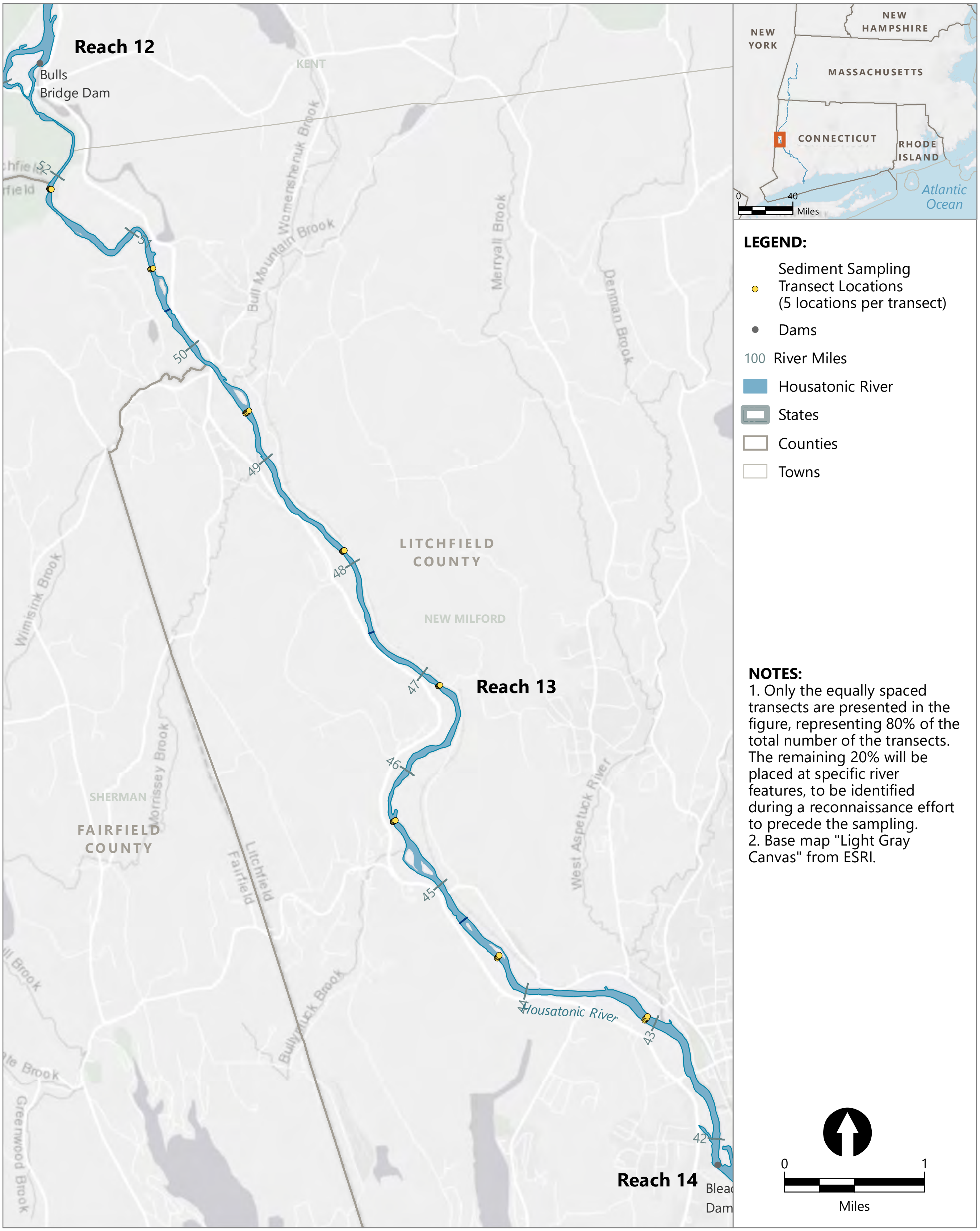

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Figure 4-4i
Sediment Sampling Locations (Reach 13)

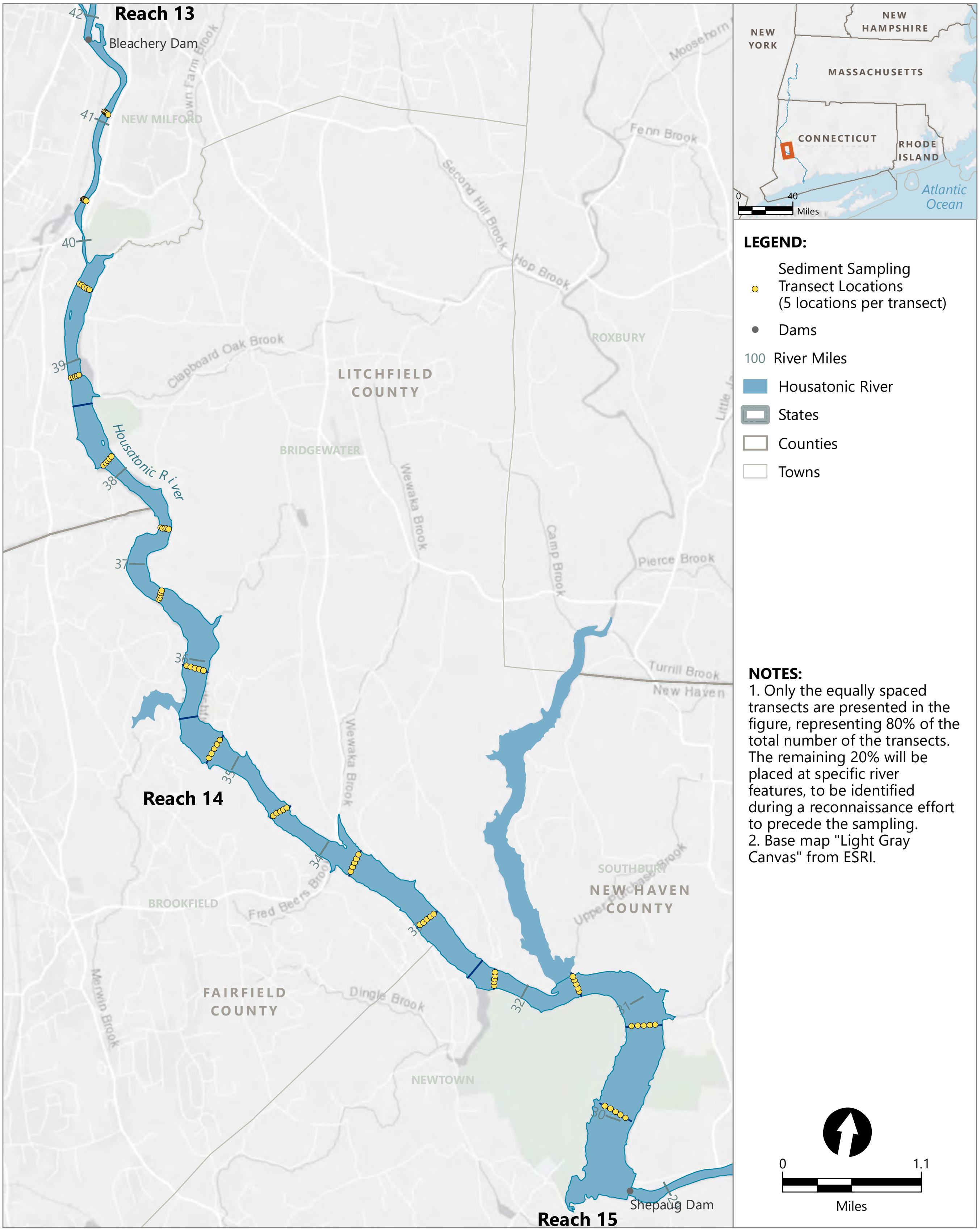

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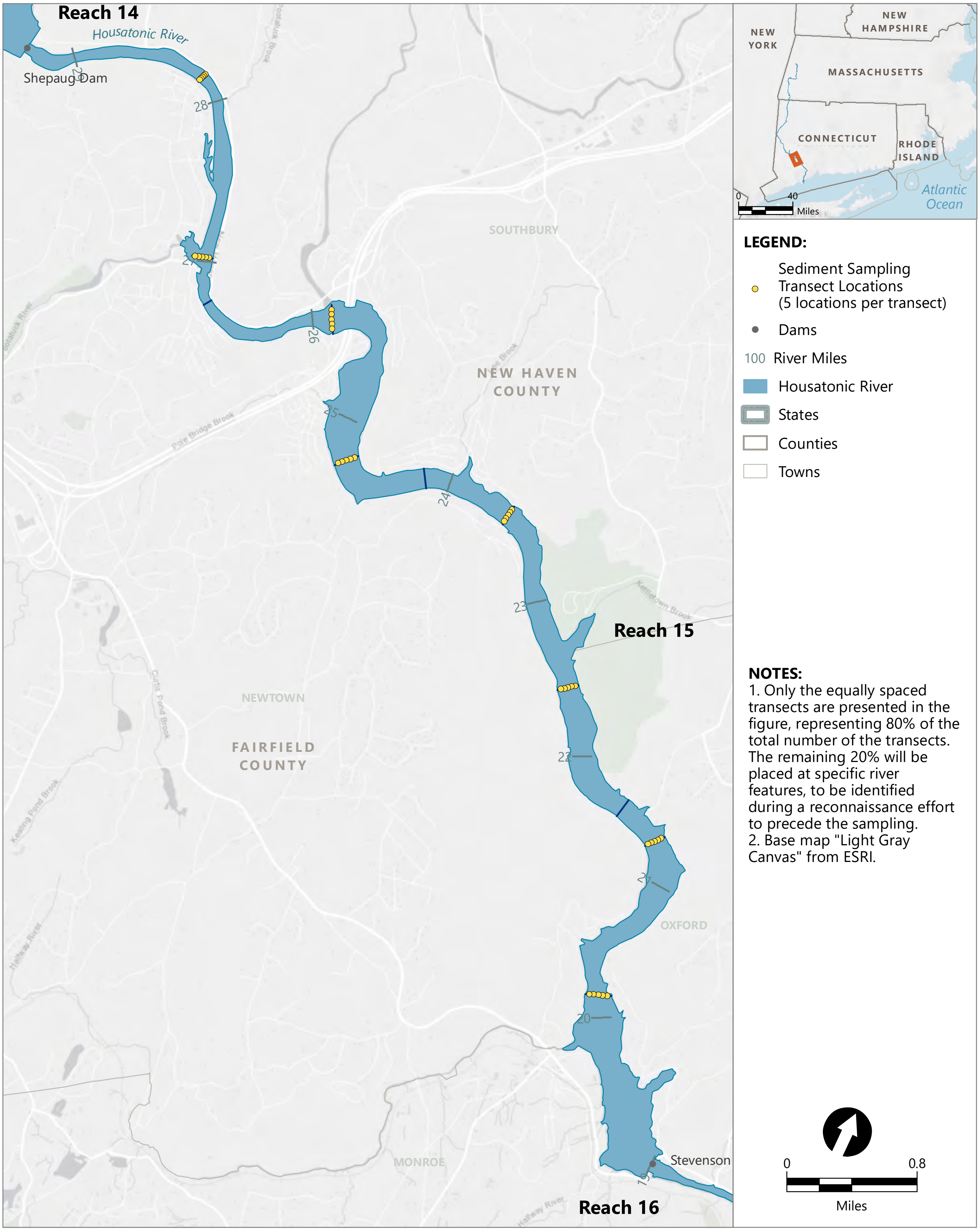
Figure 4-4j
Sediment Sampling Locations (Lake Lillinonah)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River



NOTES:
1. Only the equally spaced transects are presented in the figure, representing 80% of the total number of the transects. The remaining 20% will be placed at specific river features, to be identified during a reconnaissance effort to precede the sampling.
2. Base map "Light Gray Canvas" from ESRI.

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Figure 4-4k
Sediment Sampling Locations (Lake Zoar)

Revised Baseline Monitoring Plan
Housatonic River – Rest of River

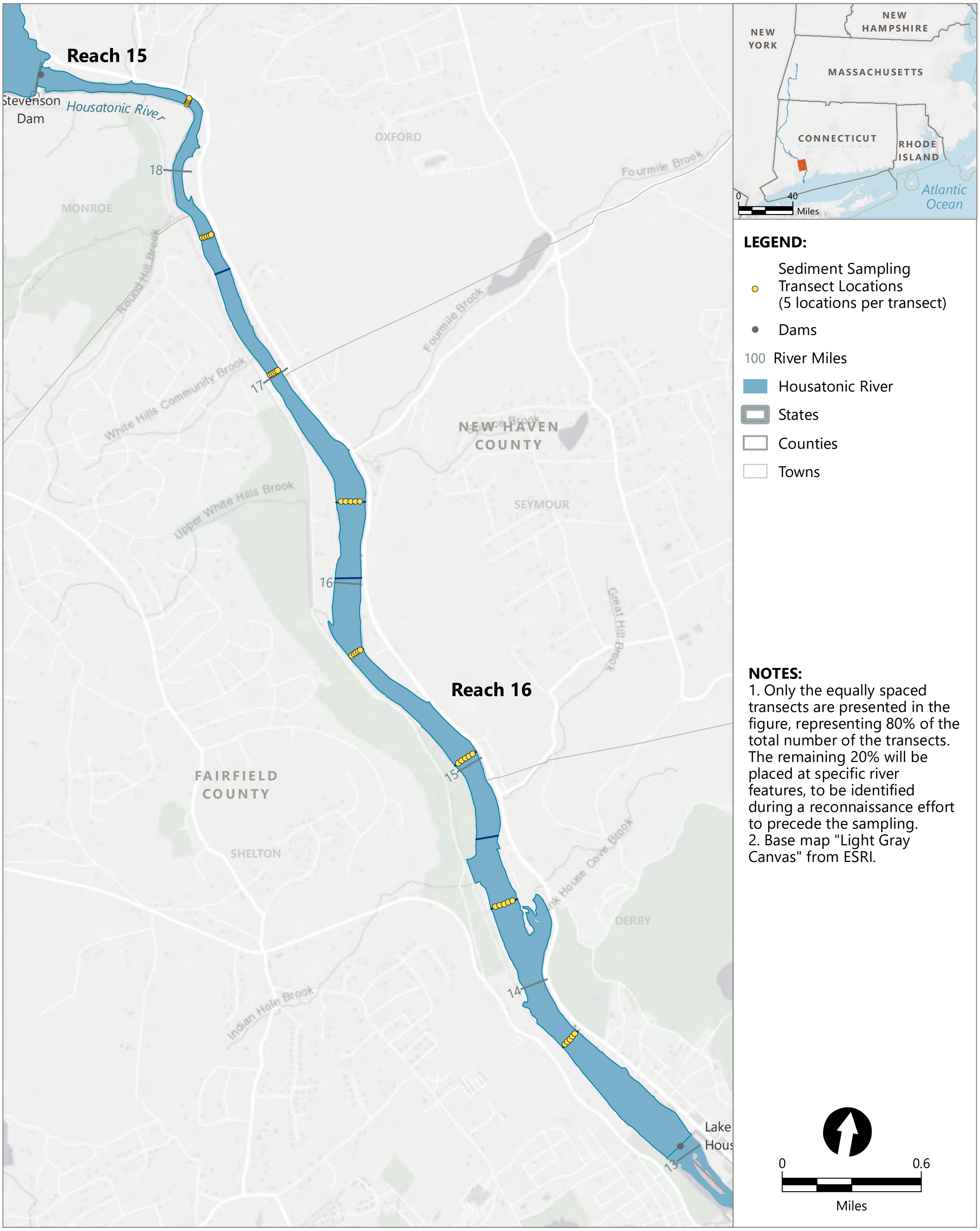

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Figure 4-4l
Sediment Sampling Locations (Lake Houstonic)
Revised Baseline Monitoring Plan
Housatonic River – Rest of River

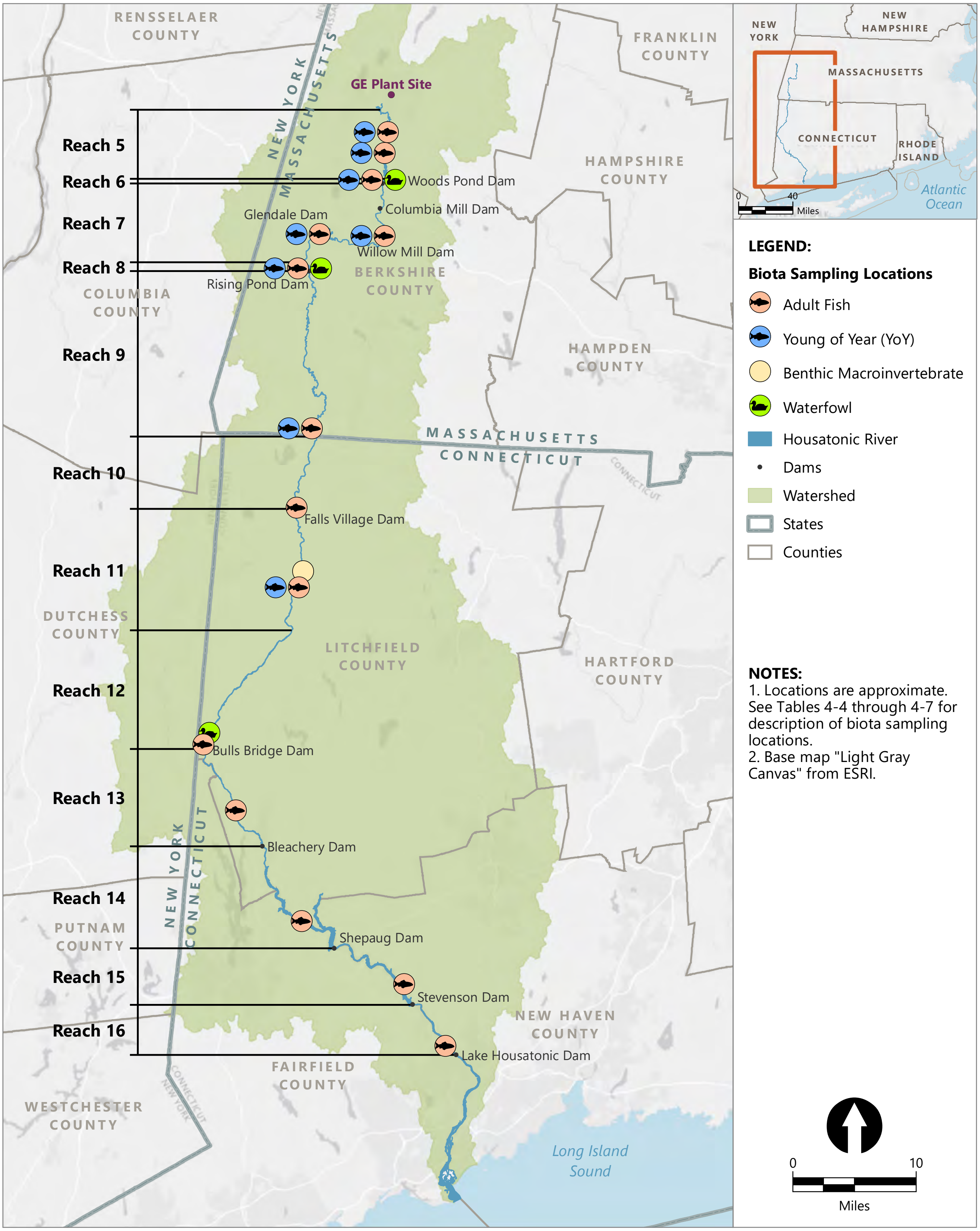

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Figure 4-5a
Biota Sampling Locations (All Reaches)

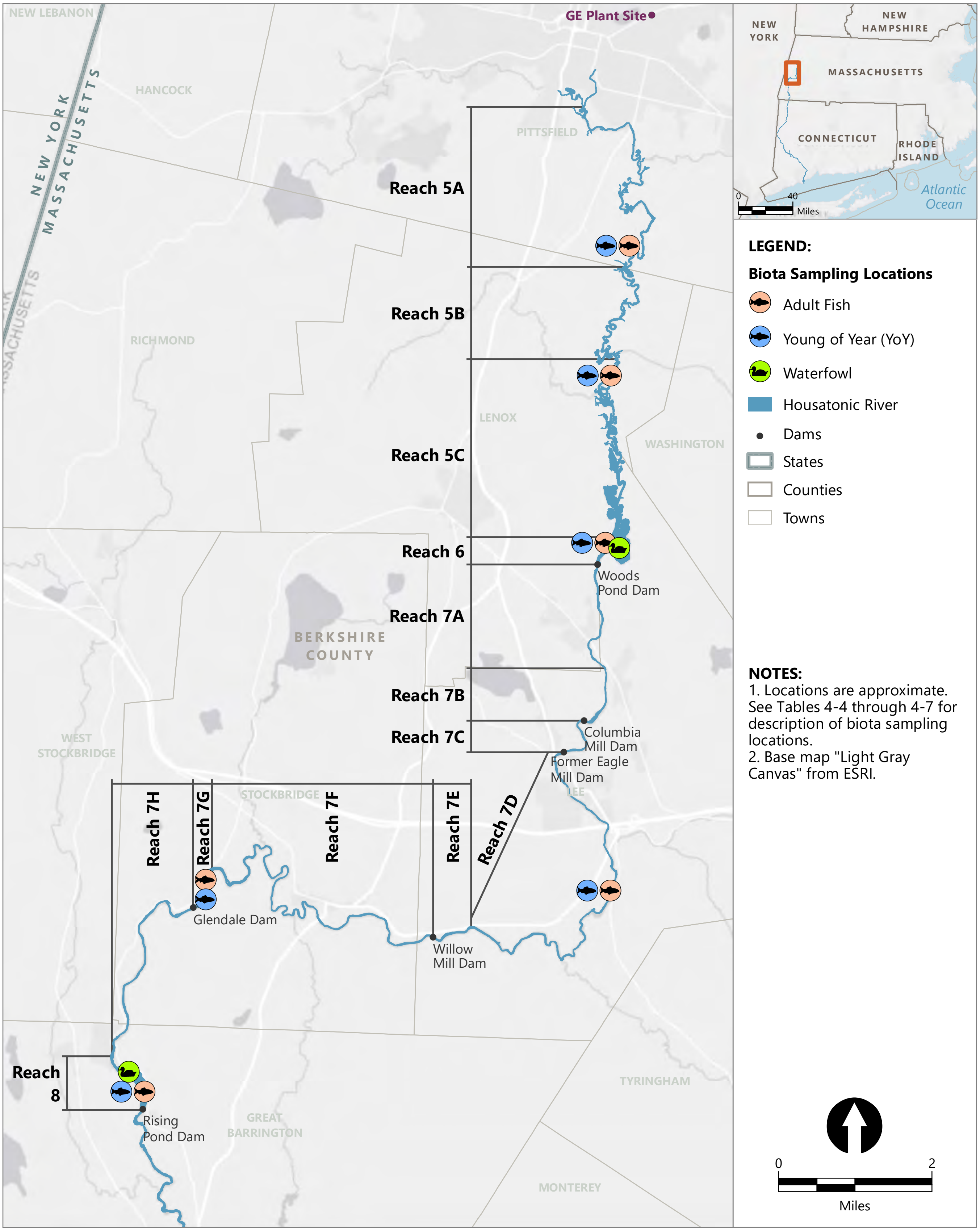

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Figure 4-5b
Biota Sampling Locations (Reaches 5 Through 8)
Revised Baseline Monitoring Plan
Housatonic River – Rest of River

Appendix A
Statistical Approach to Baseline Monitoring Program Design

Appendix A
Statistical Approach to Baseline Monitoring Program Design

Introduction

This appendix presents the statistical approach used to calculate sample sizes for the estimation of PCB concentrations in sediment, water, and biota in the Rest of River Baseline Monitoring Program. Selected sample sizes for each medium are included.

Use of Estimation Approach to Evaluate the Post-Remedy Reduction in Polychlorinated Biphenyl Concentrations

An estimation approach is used in designing the Baseline Monitoring Program. As implied by EPA (2006), an estimation approach is appropriate for monitoring programs:

> "DQA [data quality assessment] is the scientific and statistical evaluation of environmental data to determine if they meet the planning objectives of the project and, thus, are of the right type, quality, and quantity to support their intended use. This guidance applies DQA to environmental decision-making (e.g., compliance determinations) and also addresses **DQA in environmental estimation (e.g., monitoring programs)** [emphasis added]" (EPA 2006).

The estimation approach based on a decision-making framework is appropriate when environmental data are to be compared against an action level. Decision-making is the primary focus of the guidance presented by EPA (2000), which states that for decision-making, "[t]he burden of proof is placed on rejecting the baseline condition, because the test-of-hypothesis structure maintains the baseline condition as being true until overwhelming evidence is presented to indicate that the baseline condition is not true."

The overall goal of the Baseline Monitoring Program is to provide data to later characterize the effectiveness of the remedy in reducing polychlorinated biphenyl (PCB) concentrations in remediation reaches and to characterize the rate of natural recovery in monitored natural recovery reaches. Action levels based on comparisons of pre- versus post-remedy PCB concentrations have not been set, and EPA has not developed a future decision-making process that relies upon before/after comparisons or trends. Rather, the goal of the Baseline Monitoring Program is to provide information needed to estimate post-remedy reductions in PCB concentrations. As stated in the Final Revised Permit (Section II.B.2.h.(2)): "Permittee shall conduct monitoring of PCB concentrations in affected media (including surface water, sediment, and biota) in these [MNR] reaches to see if recovery is occurring at the expected rate." Thus, the objective is to assess the extent to which reduction has occurred. This is a straightforward task that does not depend on hypothesis testing. Therefore, an estimation approach is used in designing the Baseline Monitoring Program.[1]

Approach

A measure of central tendency and a measure of uncertainty are required to assess whether changes in concentration reflect the expected declines with a specified degree of confidence.

For the purposes of designing the Baseline Monitoring Program, the arithmetic average PCB concentration was selected as the measure of central tendency of PCB concentrations for all three media. (This was not meant to preclude the use of other measures of central tendency in post-remedy data analyses.) Projections using EPA's model were used as best estimates of arithmetic average concentrations.

The uncertainty metrics evaluated as part of program design are 80th, 90th, and 95th percentile confidence intervals (CIs) on average PCB concentrations in sediments, water, and fish. CIs were determined using parametric bootstrap simulations. For each realization, a value was selected randomly from a normal or lognormal distribution with the same average and standard deviation as the data. The historical data were used to select an appropriate data distribution for each medium. For water and fish, lognormal distributions were applied, based on upon review of cumulative probability plots (water: Figure 3-2; fish: Figure 3-8). For sediments, normal distributions were applied for data in the Reach 7 subreaches,[2] and lognormal was applied for Reaches 9 to 16, based upon review of the cumulative probability plots (Figures 3-3 and 3-5) and statistical distribution tests (Table3-4).

10,000 bootstrap simulations were performed to simulate a range of sample sizes. 80, 90, and 95 CIs were estimated and compared with judgment-based target values to set sample sizes, as described in the following paragraphs. For example, the 80 CI was estimated by selecting the 1,000th and 9,000th of the average concentrations calculated in each of 10,000 realizations, ordered from low to high.

For surface sediment concentrations in the MNR reaches, bootstrap-estimated CIs around the first-order decline rate projected by the model that align with precision ranges of ± 1% and ±1.5% by sample size were selected. The rate of decline projected by the fate and transport model for Massachusetts reaches was less than 1%/year; a rate of zero was used for the bootstrap simulations. For the Connecticut reaches, the model projected a rate of approximately 8%/year,

[1] In contrast, certain components of the post-remedy monitoring program specified in the Final Revised Permit do involve comparisons to target concentrations, and sampling programs to meet these needs might be designed as hypothesis-testing programs. These include comparison of water column concentrations to water quality criteria, water column loads to the load standard, and fish tissue concentrations to the short-term standard. However, these data quality objectives (DQOs) focus on comparison of post-remedy data with the target concentrations; they do not require baseline data. The programs to address these DQOs will be designed after completion of the remedy.

[2] The historical sediment data from the Reach 7 subreaches were not characterized as either normal, lognormal or gamma by ProUCL (Table 4-10). For simplicity, normal distributions were applied for these subreaches, with lognormal distribution applied as a sensitivity analysis.

which was used in the bootstrap simulations. The bootstrap realizations simulated the compositing scheme described in the main document: each PCB analysis represented a composite of three and five samples for reaches in Massachusetts and Connecticut, respectively.

For surface water and fish, sample sizes that generate CIs having upper and lower uncertainty bounds of approximately a factor of two relative to the projected target value were selected. A projected 95% post-remedy reduction in concentration was assumed, and bootstrap-estimated CIs were targeted to lie within a factor of two (i.e., between 97.5% and 90% post-remedy reductions).

The approach was different for water column PCB load. The bootstrap-estimated probability of violation of the load standard is based upon the post-remedy water column concentrations estimated by the model over 10 years. The bootstrap-calculated probability of violation for quarterly, monthly, and biweekly sampling programs are compared with the probability of violation calculated using the daily model projections over 10 years. The appropriate sampling frequency is based on the degree to which the probability of violation for each sampling frequency reflects the probability of violation from the daily model projections.

The translation between "CI" and "uncertainty bounds" descriptions is as follows. For 80 CI, one expects the true rate of decline to lie within the uncertainty bounds over repeated sampling, apart from a chance of 2 in 10. For a 90 CI, one expects the true rate of decline to lie within the uncertainty bounds over repeated sampling, apart from a chance of 1 in 10, and for a 95 CI, apart from a chance of 1 in 20.

Weight-of-Evidence Interpretation

Post-remedy data evaluations will incorporate multiple lines of evidence, including three media (water, fish, and sediment), multiple locations, and multiple species of adult and young-of-year (YOY) fish. The uncertainty estimates are provided in this appendix separately for each medium in each reach and for each species of adult and YOY fish. That is, the program is designed such that nearly every medium/location/species/age class meet the precision guidelines (±1% rate of reduction for sediment and ±2 times future concentrations for water and biota). Because of the availability of many lines of evidence, the strength of the overall program for evaluating changes in PCB concentrations throughout the Housatonic River will be much greater than the uncertainty estimates for individual media or species in individual reaches. In this way, the overall program is designed conservatively.

In some cases (in particular, two species/locations of adult fish), single high values appeared visually to be outliers. These high values were evaluated using cumulative probability plots and statistical outlier testing, as described below. In these cases, sample sizes were determined both with and without the inclusion of these high values. Following the weight-of-evidence approach, both results were considered in setting sample sizes for the Baseline Monitoring Program. It was necessary to consider whether single high values result in significant changes to sample sizes, because designing an entire program around one or a few unusually high historical data point(s) is not appropriate.

Sample Size Determination

Sediments

80, 90, and 95 Cis calculated from the bootstrap evaluation are presented in Figures A-1a through A-1h. The vertical axis presents the rate of decline calculated in the bootstrap realizations. For Massachusetts reaches, the model-predicted rate of decline was zero (i.e., no decline; Figures A-1a through A-1d). For Connecticut reaches, the predicted rate of decline was 8% per year (Figures A-1e through A-1h). The confidence limits estimated by the bootstrap lie above and below these predicted rates; the widest CI is the 95 CI, and the narrowest is the 80 CI. The CIs narrow as the number of PCB analyses increases along the horizontal axis. The horizontal dashed lines represent ±1% per year, the uncertainty bounds selected for this evaluation.

Based on the results shown on these figures, the number of PCB analyses required for 80, 90, and 95 Cis to lie within ±1% of the model rate of decline are provided in Table A-1 (second, third, and fourth columns). For example, as shown in Figure A-1a and in Table A-1 (fourth column), 35 samples are required in Reach 7A for 95 CI to detect a decline of PCB concentration that lies within ±1% per year.

The comparison value used here, ±1% per year, was selected based on professional judgment. Over 20 years, this range of rates of decline produces post-remedy concentrations that are 18% below and 22% above the model-projected concentrations. Simulations were also compared with ±1.5% per year, which produces post-remedy concentrations that are 26% below and 35% above the model projections. The numbers of PCB analyses required for 95 CI to lie within the bounds of ±1.5% per year are also provided in Table A-1 (fifth column).

The selected program includes a total of 210 PCB analyses (Table A-1, sixth column). This program is more stringent than needed for 80 CI to lie within ±1% per year (Table A-1, second column) and for 95 CI to lie within ±1.5% per year (Table 1, fifth column). The sensitivity analysis assuming lognormal distributions for the Reach 7 subreaches results in greater power, i.e., smaller required sample sizes.

Water Column

Sample sizes were determined using data collected over the entire year. The variation in the data used to set sample sizes is influenced by short-term temporal variability, spatial variability, and sampling and laboratory factors, as well as by the annual cycle observed in PCB concentrations. Thus, while the program is designed for comparison performed over the entire year, future analyses may focus on portions of the year to reduce variance.

A factor of two around the projected decline of 95% (i.e., 0.025 and 0.1 times the current concentrations; horizontal dashed lines in Figures A-2a through A-2f) was applied as a guideline for comparison with the CIs (Table A-2). A sample size of 24 for each location, which is based on monthly sampling for 2 years, was sufficient to achieve 80, 90 and 95 CIs within a factor of two for every case except one (Holmes Road, 95 CI, n = 28). For Holmes Road, a sample size of 24 is sufficient for 90 CI. A sample size of 24 (equivalent to monthly samples for 2 years) was selected for the Baseline Monitoring Program.

Fish

Figures A-3a through A-3x provide CIs for fish samples on a wet-weight basis. The CIs were compared with the horizontal dashed lines, which represent a factor of two around the projected decline of 95%.

The sample sizes associated with 80, 90 and 95 CIs are presented in Table A-3 both on a wet-weight basis and a lipid-normalized basis. Often, lipid normalization tends to reduce variability in PCB concentrations. This is especially true for older fish that are growing slower and in fish with more variable lipid contents. In some cases, lipid normalization does not reduce variability; these are often younger, faster-growing fish and fish with limited variability in lipid contents.

Because growth rate and lipid content may vary among species, among locations, and over time, the selection of a wet-weight basis versus a lipid-normalized basis depends on the particulars of each dataset. This selection will be made in the future, after collection of the post-remedy data. To design the Baseline Monitoring Program, sample sizes were determined using both lipid-normalized and wet-weight PCB data. In some cases, lipid-normalized data resulted in smaller required sample sizes, as discussed below.

Adults

80 CI: A sample size of 20 adult fish was sufficient to ensure 80 CI lies within a factor of two of the model-projected reduction in concentration on both a wet-weight and lipid-normalized basis for all but one case (Table A-3, fourth and seventh columns). For Yellow Perch in Reach 6, lipid-normalized data required 30 samples, while wet-weight data required only 8 samples. In this case, lipid normalization increased variability and, therefore, would not likely be appropriate for trend evaluation.

90 CI: On a lipid-normalized basis, 13 out of 16 species/locations were calculated to require at most 20 samples for 90 CI to lie within a factor of two of the model-projected reduction (Table A-3, fifth column). In one case, NP in Reach 10/11, exclusion of one outlier reduced the required sample size from 25 to 10.[3] On a wet-weight basis, two species/locations required more than 20 samples (Table A-3, eighth column).

95 CI: On a lipid-normalized basis, 12 out of 16 species/locations were calculated to require at most 20 samples for 95 CI to lie within a factor of two of the model-projected reduction (Table A-3, sixth column). For two cases, YP in Reach 5B/5C and NP in Reach 10/11, exclusion

[3] NP in Reach 10/11: The data are lognormally distributed (Figure 3-8r; ProUCL 5.1, $p<0.05$). The single high value is an outlier (Dixon test; $p<0.05$).

of one high value reduced the required sample size below 20.[4] On a wet-weight basis, this increased to 13 species/locations (Table A-3, ninth column).

In conclusion, for 90 CI, a sample size of 20 was sufficient on a wet-weight basis in all but two cases, and in those two cases, a single high value caused the sample size to exceed 20. Moreover, for a sample size of 20, 80 CI was met for all species/locations, and 95 CI was met in most cases. For operational simplicity, a single sample size was targeted for all adult species/locations. Considering that the evaluation of remedy impact will incorporate approximately 50 adult species/locations, including more than one species in every reach, a program of 20 fish for every species/location (10 in each of 2 years) is considered reasonably conservative and therefore meets the overall goals of the program.

YOY

For YOY, in every species/location, fewer than five samples were required for 80, 90, and 95 CI to lie within a factor of two of the model-projected reduction in PCB concentration (Table A-3). A program consisting of seven composites collected in each of 2 years is, therefore, sufficient. This program is consistent with historical YOY fish-collection efforts.

References

EPA (U.S. Environmental Protection Agency), 2000. *Data Quality Objectives Process for Hazardous Waste Site Investigations* EPA QA/G-4HW. Final. EPA/600/R-00/007.

EPA, 2006. *Data Quality Assessment: Statistical Methods for Practitioners EPA QA/G-9S*. EPA/240/B-06/003.

EPA 2006b. *Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4*. EPA/240/B-06/001 February 2006.

[4] YP in Reach 5B/5C: The data are lognormally distributed after excluding the one highest value (Figure 3-8e; ProUCL 5.1, $p<0.05$). The highest value is an outlier (Rosner test; $p<0.05$).

Tables

Table A-1
Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches

MNR Reach	Confidence Intervals Bounded by Model Rate of Decline ±1% per Year			Confidence Interval Bounded by Model Rate of Decline ±1.5% per Year	Selected Sample Size for Baseline Monitoring Program
	80% CI	90% CI	95% CI	95% CI	
7A	15 (10)	25 (15)	35 (20)	15 (10)	20
7D	30 (20)	50 (30)	65 (40)	30 (20)	40
7F	15 (10)	20 (15)	25 (20)	15 (10)	20
7H	15 (10)	20 (15)	25 (20)	15 (10)	20
9	14	25	35	15	20
10	10	20	25	10	15
11	10	20	25	10	15
12	7	13	20	7	10
13	7	13	20	7	10
14	17	25	40	20	20
15	8	13	20	7	10
16	8	13	20	7	10
Total	156 (131)	257 (217)	355 (305)	158 (133)	210

Notes:
Numbers of PCB analyses (samples sizes) were estimated from graphics.
Statistical analysis was not performed for Reaches 7H, 11, 13, and 16. Sample sizes for those reaches were set to be the same as in reaches immediately upstream (i.e., Reaches 7F, 10, 12, and 15, respectively).
For Reach 7 subreaches, sample sizes in parenthesis were estimated assuming historical data were lognormally distributed.
CI: confidence interval
MNR: monitored natural recovery
PCB: polychlorinated biphenyl

Table A-2
Estimated Sample Sizes for Surface Water in Remedy and MNR Reaches

Location	80% CI	90% CI	95% CI	Selected Sample Size for Baseline Monitoring Program
Pomeroy Avenue Bridge	8	14	18	24
Holmes Road Bridge	12	20	28	24
New Lenox Road Bridge	10	18	24	24
Woods Pond Headwaters	11	16	24	24
Schweitzer	8	12	16	24
Division	3	4	6	24

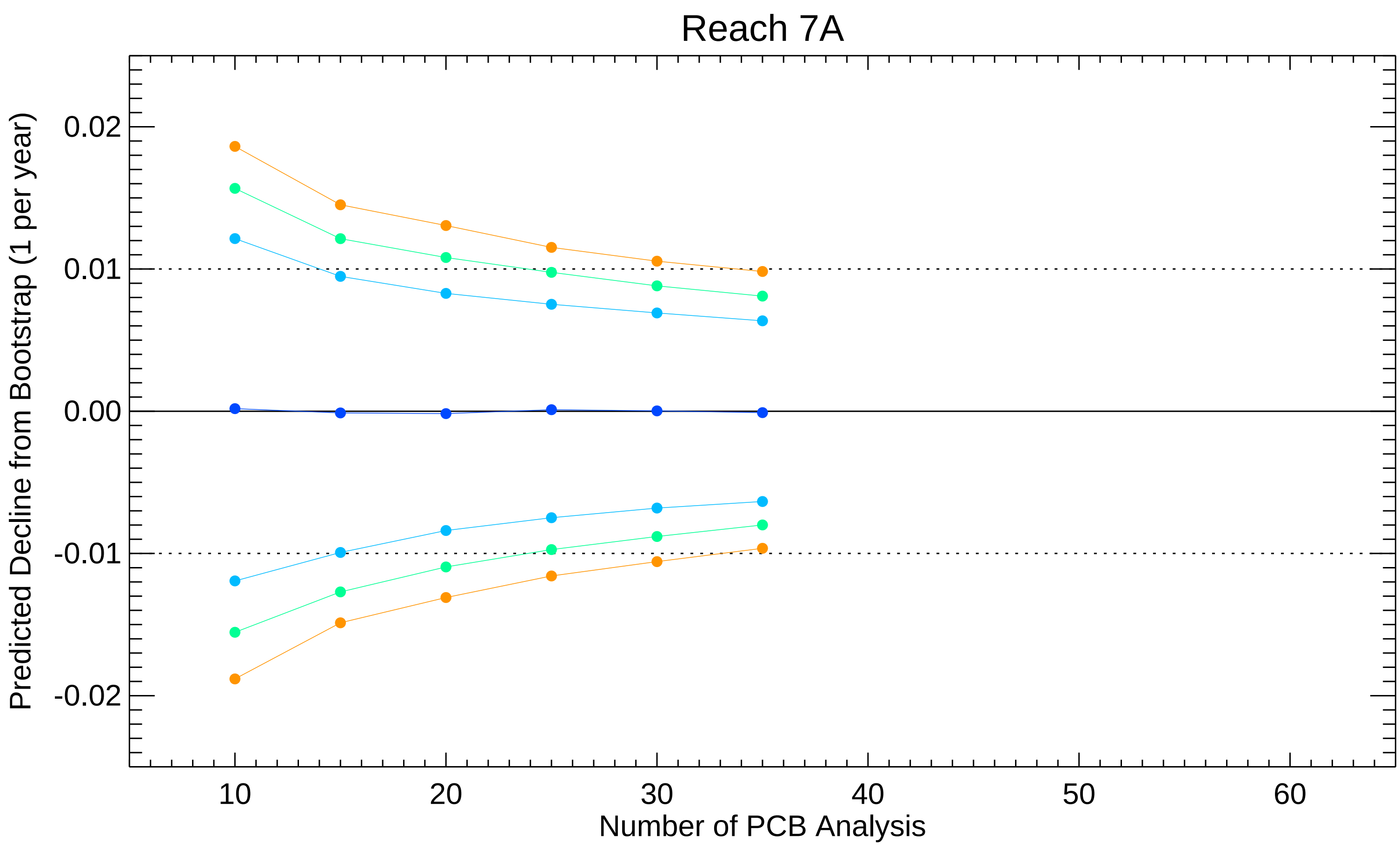
Notes:
Sample sizes were estimated based on full-year samples.
CI: confidence interval
MNR: monitored natural recovery

Table A-3
Estimated Sample Sizes for Fish in Remedy and MNR Reaches

Species	Reach	Age	Lipid-Normalized			Wet-Weight			Selected Sample Size for Baseline Monitoring Program
			80% CI	90% CI	95% CI	80% CI	90% CI	95% CI	
LMB	R5B/5C	Adult	<5	8	10	<5	8	10	20
LMB	R6	Adult	<5	<5	6	15	25	30	20
LMB	R8	Adult	20	35	50	15	20	30	20
YP	R5A	Adult	5	8	10	<5	6	8	20
YP	R5B/5C	Adult	15 (5)	20 (8)	30 (10)	<5	<5	6	20
YP	R6	Adult	30	50	>50	8	10	15	20
YP	R8	Adult	5	8	12	8	10	15	20
YP	R9	Adult	<5	<5	5	5	8	10	20
SMB	R11	Adult	<5	8	10	<5	<5	5	20
SMB	R12/13	Adult	<5	8	10	<5	<5	6	20
SMB	R14	Adult	<5	10	15	8	10	15	20
SMB	R15	Adult	6	10	15	10	15	20	20
NP	R10/11	Adult	15 (5)	25 (10)	35 (13)	20	30	45	20
NP	R12/13	Adult	<5	<5	8	8	10	15	20
NP	R14	Adult	<5	<5	<5	<5	<5	5	20
NP	R15	Adult	<5	6	8	5	8	10	20
LMB	R5B/5C	YoY	<5	<5	<5	<5	<5	<5	14
LMB	R6	YoY	<5	<5	<5	<5	<5	<5	14
LMB	R8	YoY	<5	<5	<5	<5	<5	<5	14
LMB	R9	YoY	<5	<5	<5	<5	<5	<5	14
YP	R5B/5C	YoY	<5	<5	<5	<5	<5	<5	14
YP	R6	YoY	<5	<5	<5	<5	<5	5	14
YP	R8	YoY	<5	<5	<5	<5	<5	<5	14
YP	R9	YoY	<5	<5	<5	<5	<5	<5	14

Notes:
Highlighted cells show sample sizes greater than 20, the sample size selected for the program.
Values in parenthesis denote sample sizes estimated from a dataset excluding one high value.
High values were selected based on visual review of cumulative probability plots. The goal of the evaluation was to qualitatively assess the impact of single values on program size, for consideration in the weight-of-evidence evaluation.
CI: confidence interval
LMB: Largemouth Bass
MNR: monitored natural recovery
NP: Northern Pike
SMB: Smallmouth Bass
YoY: young-of-year
YP: Yellow Perch

Figures



Notes:
Analysis based on post-1998 dry-weight PCBs data in Reach 7A. Number of bootstraps = 10000. Number of composites = 3.
Predicted decline rate = 0.00 per year. Each bootstrap simulates a first-order decline rate between means of n random samples at year 0 and year 20.
Normal distribution used in bootstrap analysis.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

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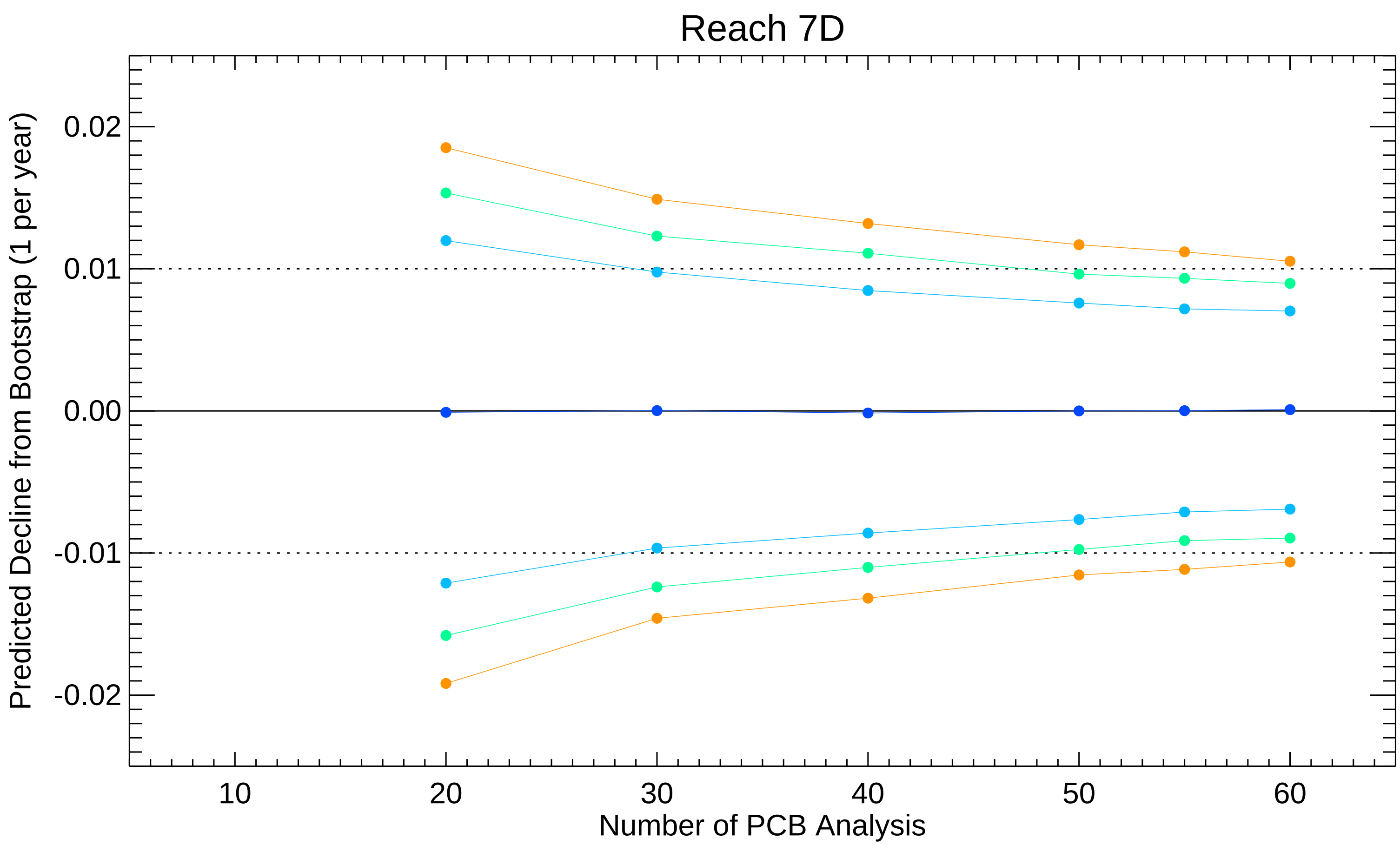
Figure A-1a
Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches: Reach 7A

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis based on post-1998 dry-weight PCBs data in Reach 7D. Number of bootstraps = 10000. Number of composites = 3.
Predicted decline rate = 0.00 per year. Each bootstrap simulates a first-order decline rate between means of n random samples at year 0 and year 20.
Normal distribution used in bootstrap analysis.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/10/2022 14:45 | User: wk
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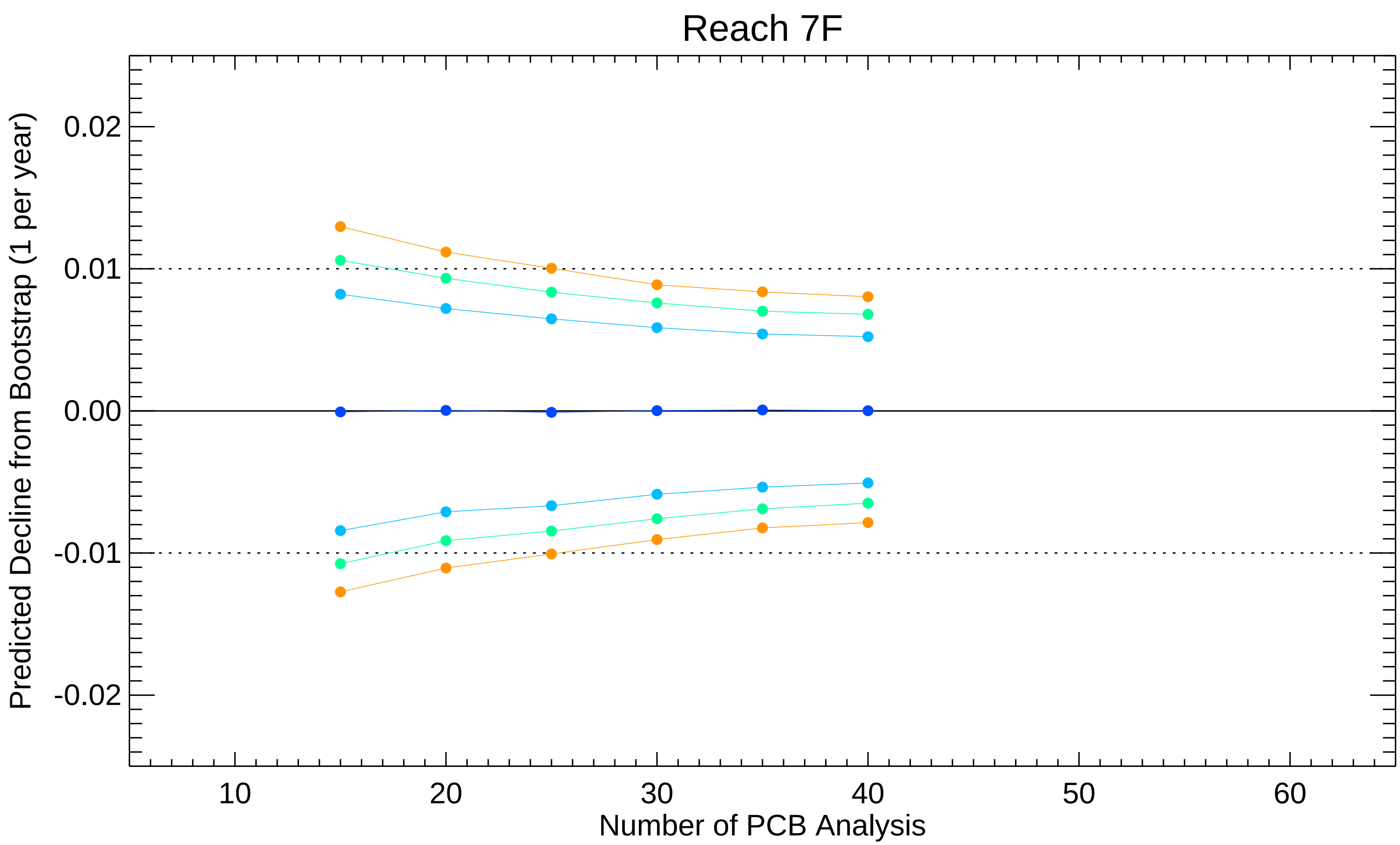
Figure A-1b

Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches: Reach 7D

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis based on post-1998 dry-weight PCBs data in Reach 7F. Number of bootstraps = 10000. Number of composites = 3.
Predicted decline rate = 0.00 per year. Each bootstrap simulates a first-order decline rate between means of n random samples at year 0 and year 20.
Normal distribution used in bootstrap analysis.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/10/2022 14:45 | User: wk
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_1_Sed_BMP_SampleSize_MNR_Alt_mixDist.pro

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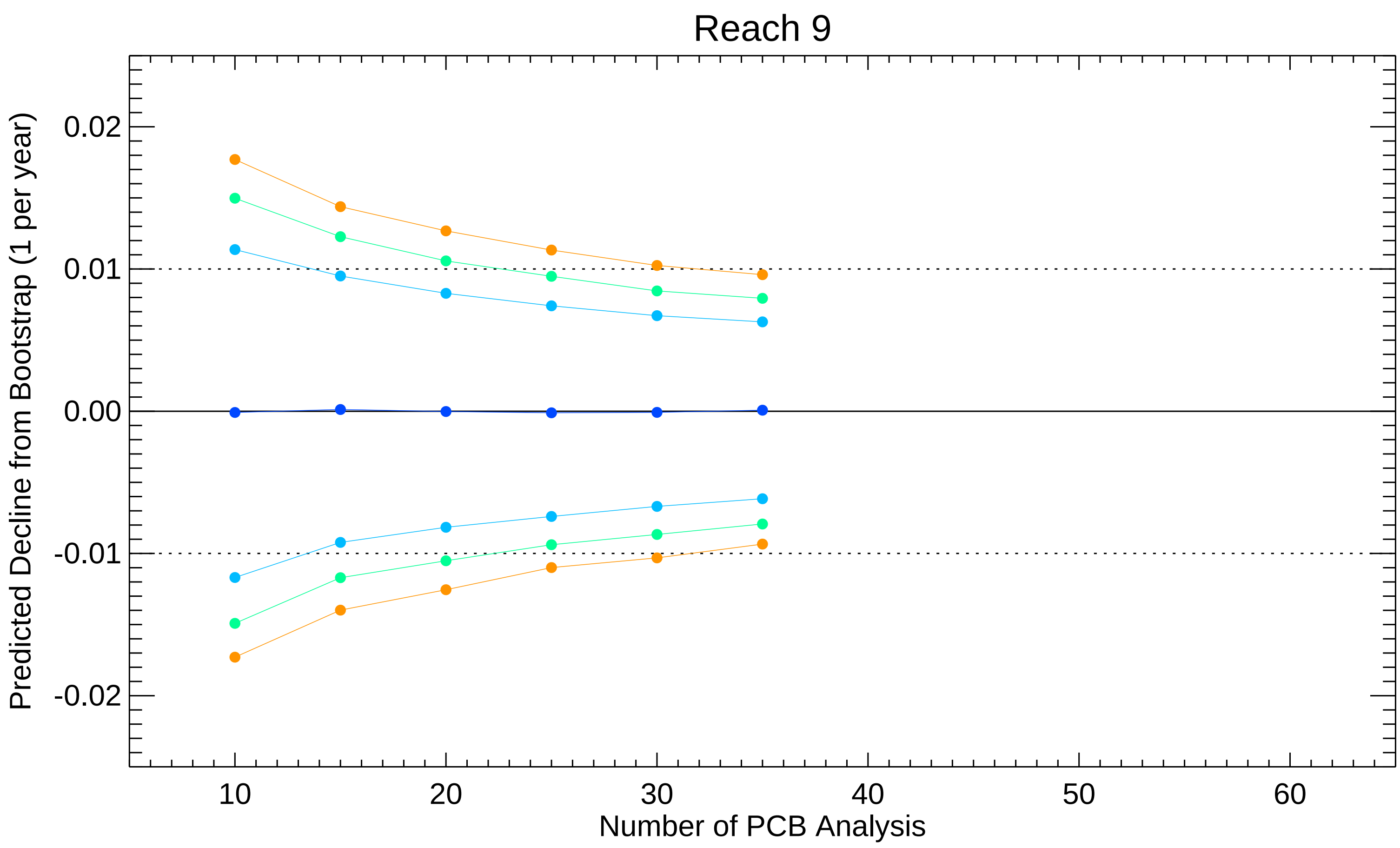
Figure A-1c
Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches: Reach 7F

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis based on post-1998 OC-normalized PCBs data in Reach 9. Number of bootstraps = 10000. Number of composites = 3.
Predicted decline rate = 0.00 per year. Each bootstrap simulates a first-order decline rate between means of n random samples at year 0 and year 20.
Log-normal distribution used in bootstrap analysis.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/10/2022 14:45 | User: wk
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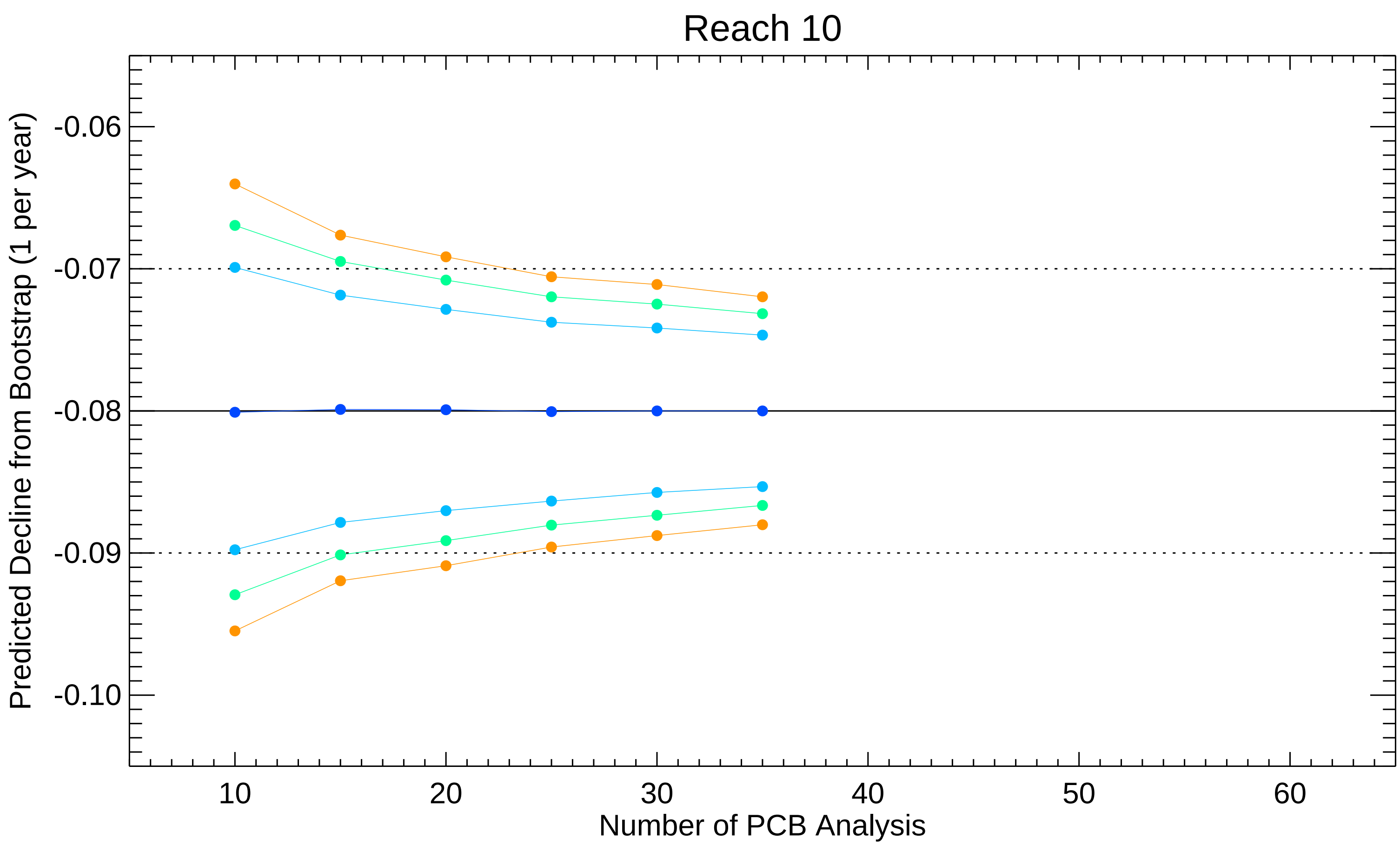
Figure A-1d

Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches: Reach 9

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis based on prior-1998 OC-normalized PCBs data in Reach 10. Number of bootstraps = 10000. Number of composites = 5.
Predicted decline rate = -0.08 per year. Each bootstrap simulates a first-order decline rate between means of n random samples at year 0 and year 20.
Log-normal distribution used in bootstrap analysis.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/10/2022 14:45 | User: wk
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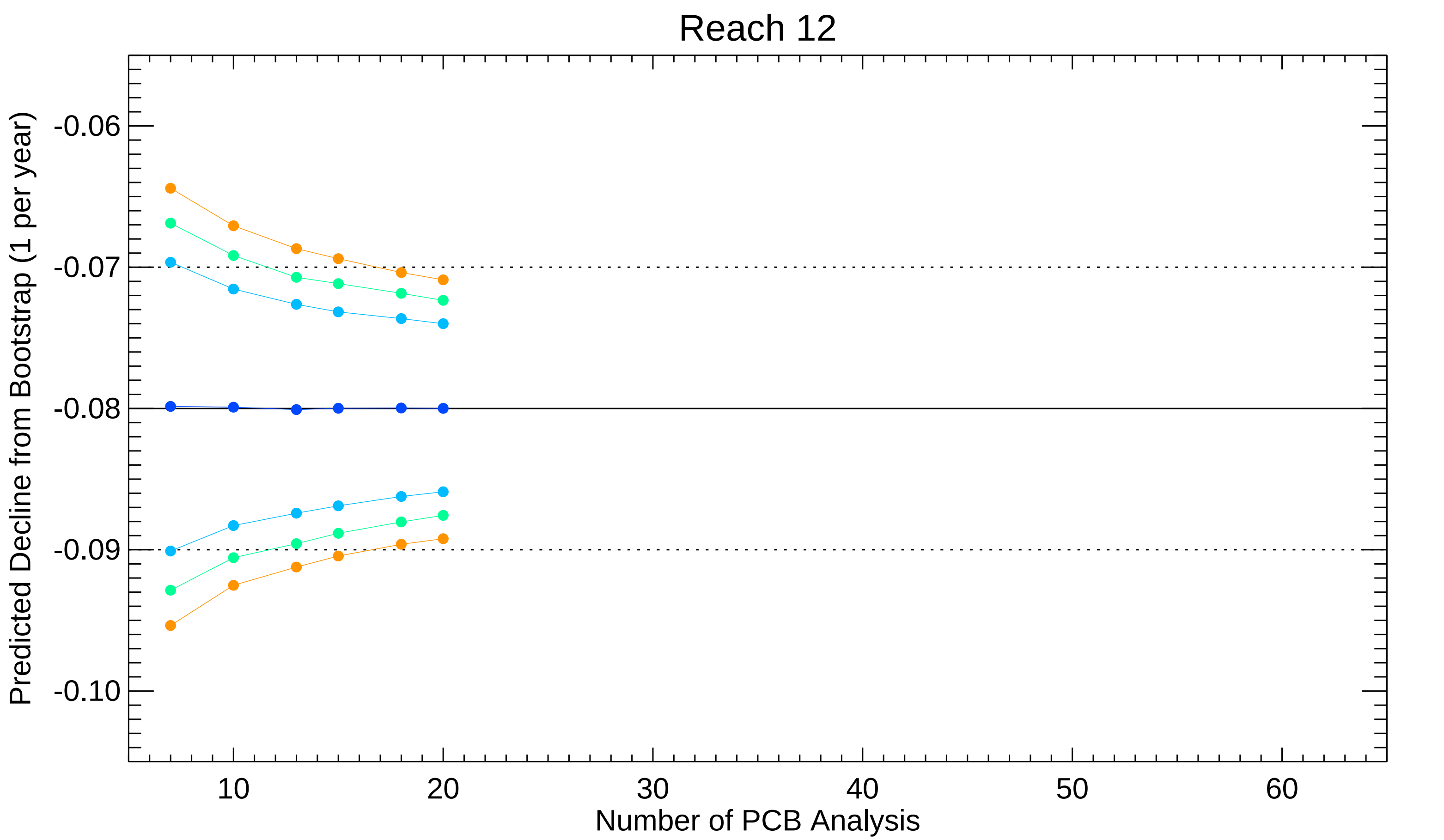
Figure A-1e

Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches: Reach 10

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis based on prior-1998 OC-normalized PCBs data in Reach 12. Number of bootstraps = 10000. Number of composites = 5.
Predicted decline rate = -0.08 per year. Each bootstrap simulates a first-order decline rate between means of n random samples at year 0 and year 20.
Log-normal distribution used in bootstrap analysis.
CI: confidence interval
PCB: polychlorinated biphenyl

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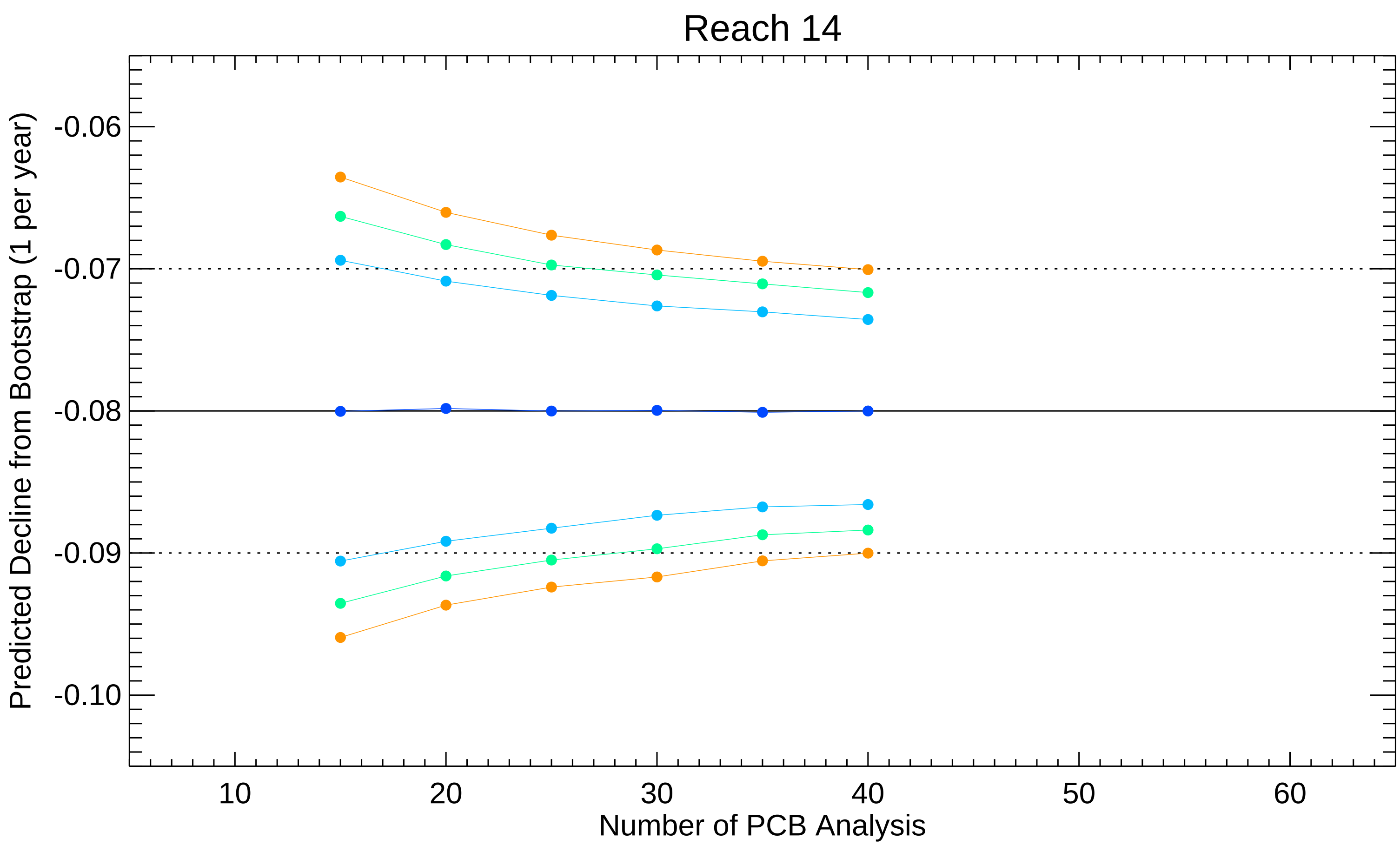
Figure A-1f
Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches: Reach 12

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis based on prior-1998 OC-normalized PCBs data in Reach 14. Number of bootstraps = 10000. Number of composites = 5.
Predicted decline rate = -0.08 per year. Each bootstrap simulates a first-order decline rate between means of n random samples at year 0 and year 20.
Log-normal distribution used in bootstrap analysis.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

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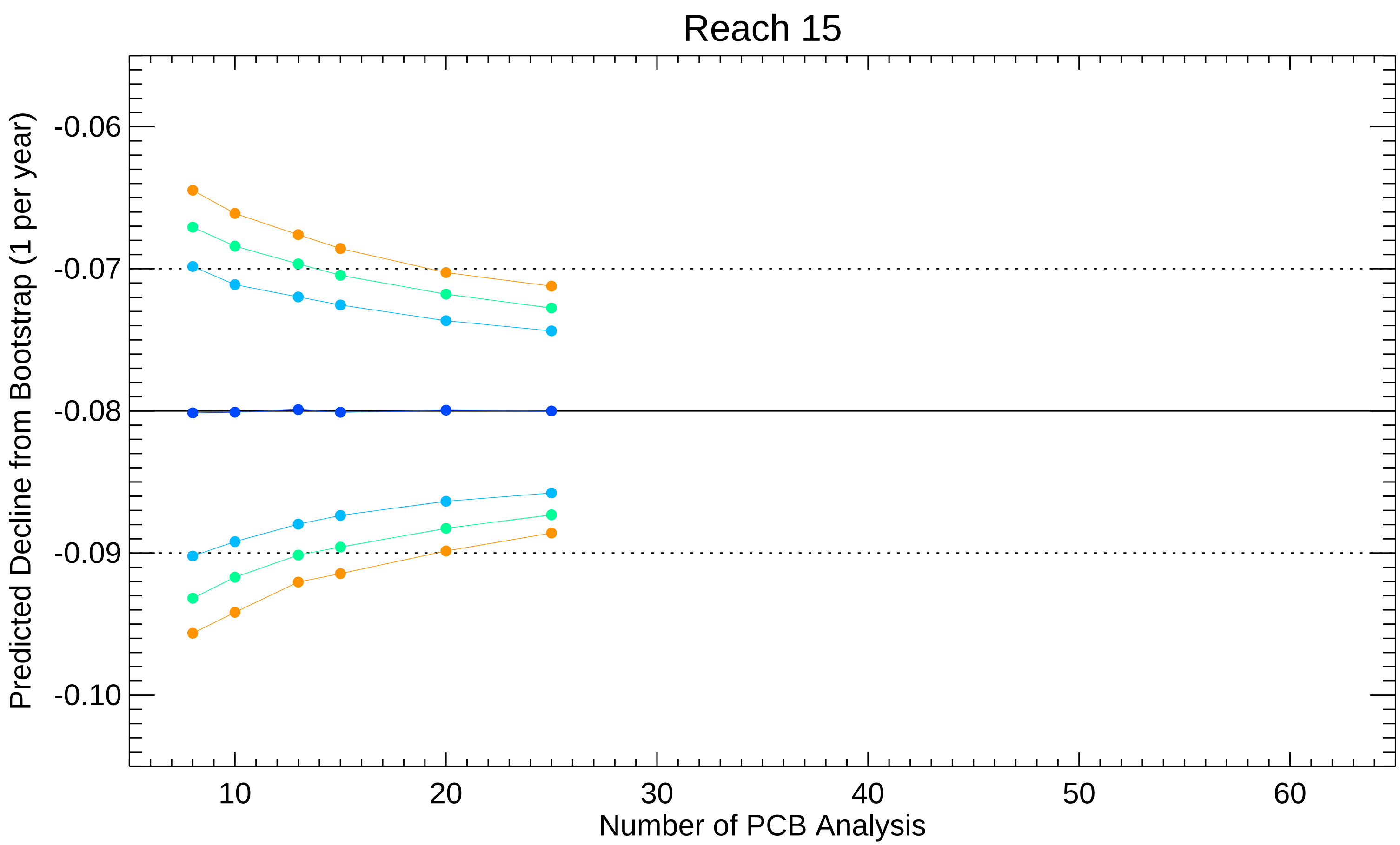
Figure A-1g

Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches: Reach 14

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis based on prior-1998 OC-normalized PCBs data in Reach 15. Number of bootstraps = 10000. Number of composites = 5.
Predicted decline rate = -0.08 per year. Each bootstrap simulates a first-order decline rate between means of n random samples at year 0 and year 20.
Log-normal distribution used in bootstrap analysis.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

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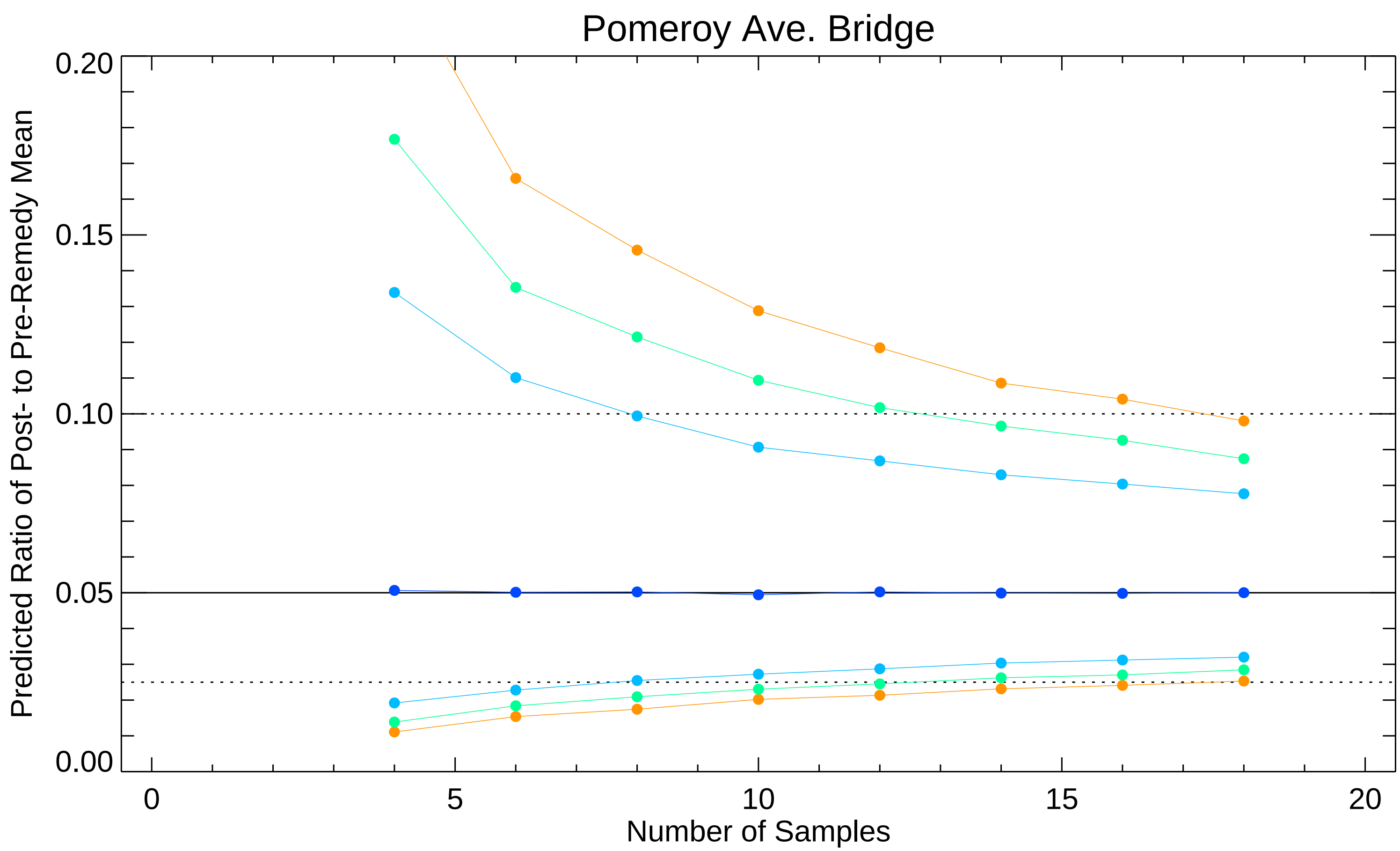
Figure A-1h
Estimated Number of PCB Analyses for Surface Sediments in MNR Reaches: Reach 15

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis used all data collected since January 1, 2009. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
Kaplan-Meier method applied for non-detects. Duplicate samples averaged.
CI: confidence interval
MNR: monitored natural recovery

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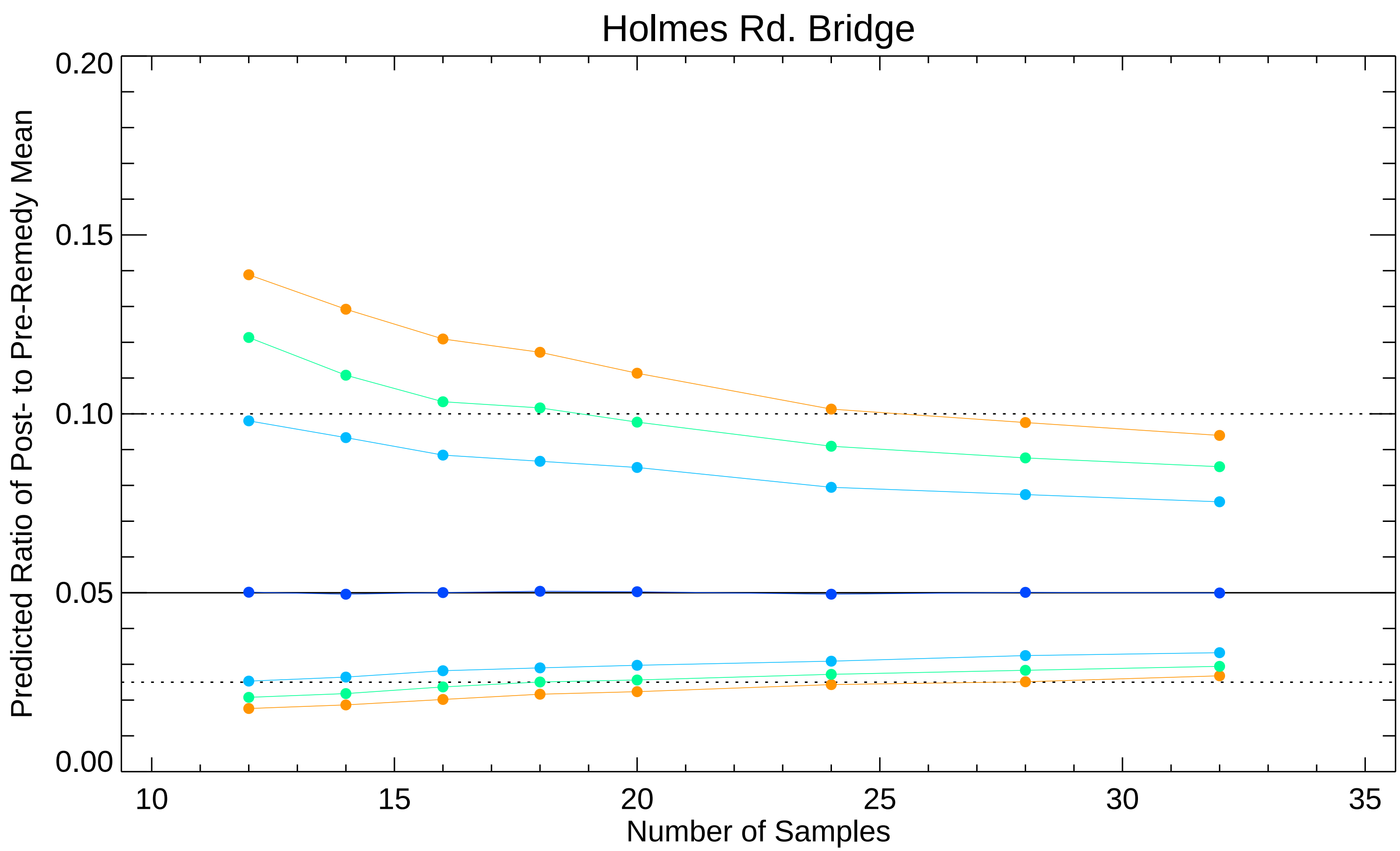
Figure A-2a

Estimated Sample Sizes for Surface Water Remedy and MNR Reaches: Pomeroy Ave. Bridge



Notes:
Analysis used all data collected since April 1, 2014. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
Kaplan-Meier method applied for non-detects. Duplicate samples averaged.
CI: confidence interval
MNR: monitored natural recovery

Median
80% CI
90% CI
95% CI

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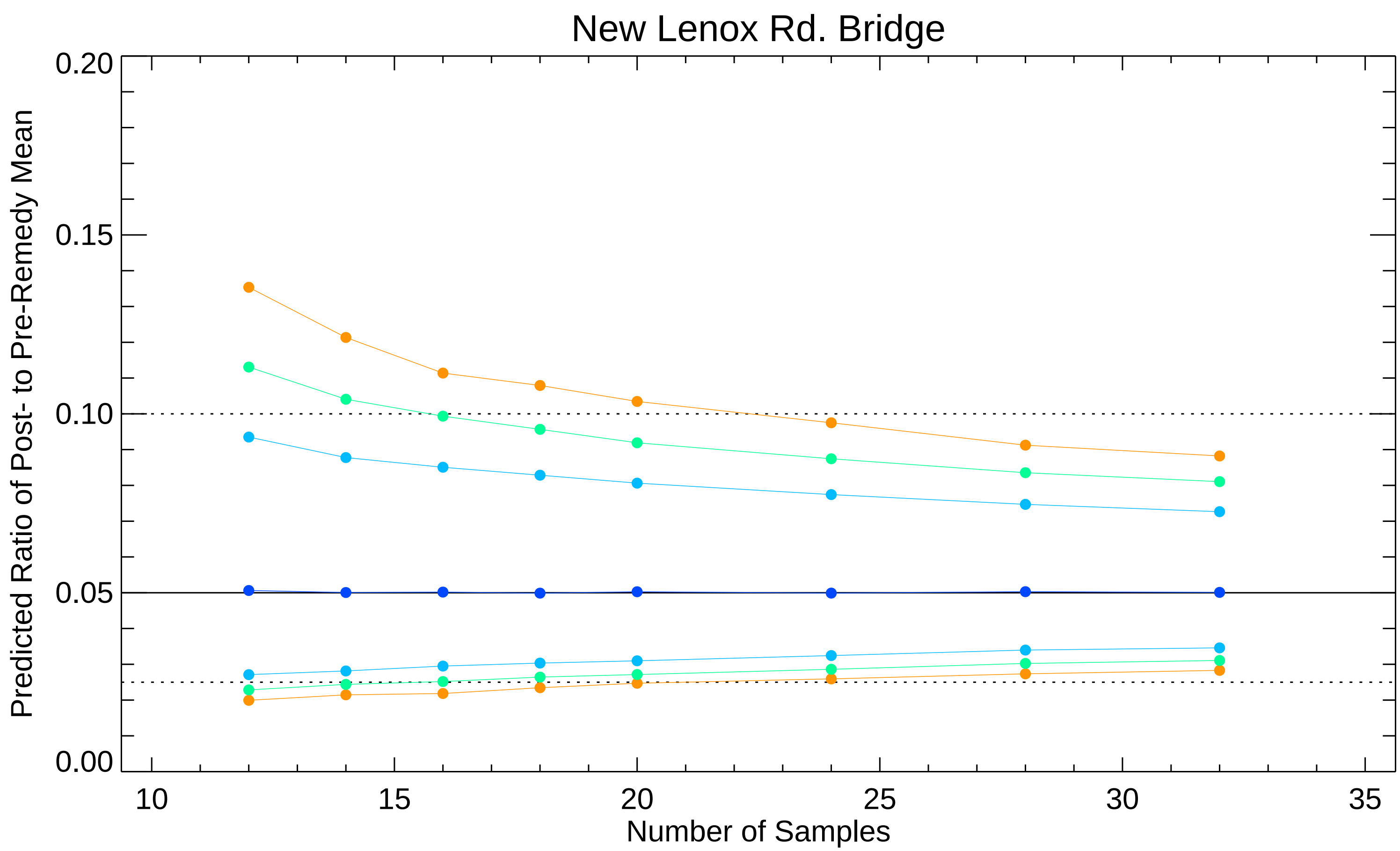
Figure A-2b

Estimated Sample Sizes for Surface Water Remedy and MNR Reaches: Holmes Rd. Bridge

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis used all data collected since January 1, 2007. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
Kaplan-Meier method applied for non-detects. Duplicate samples averaged.
CI: confidence interval
MNR: monitored natural recovery

Median
80% CI
90% CI
95% CI

Publish Date: 06/10/2022 14:46 | User: wk
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_2_Evaluate_WC_BMP_SampleSize_RemReaches_20210910_alt.pro

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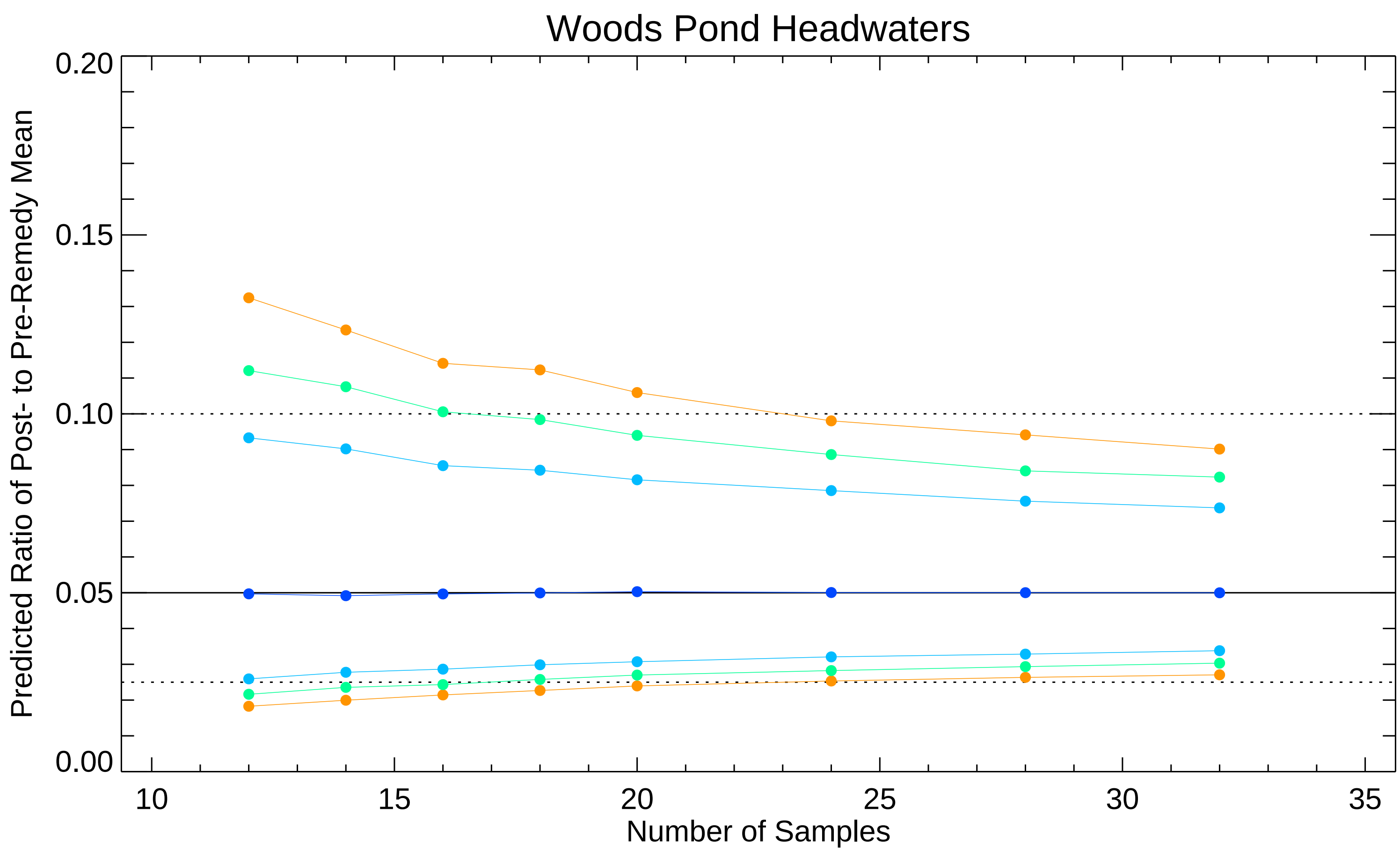
Figure A-2c

Estimated Sample Sizes for Surface Water Remedy and MNR Reaches: New Lenox Rd. Bridge

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis used all data collected since January 1, 2007. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
Kaplan-Meier method applied for non-detects. Duplicate samples averaged.
CI: confidence interval
MNR: monitored natural recovery

- Median
- 80% CI
- 90% CI
- 95% CI

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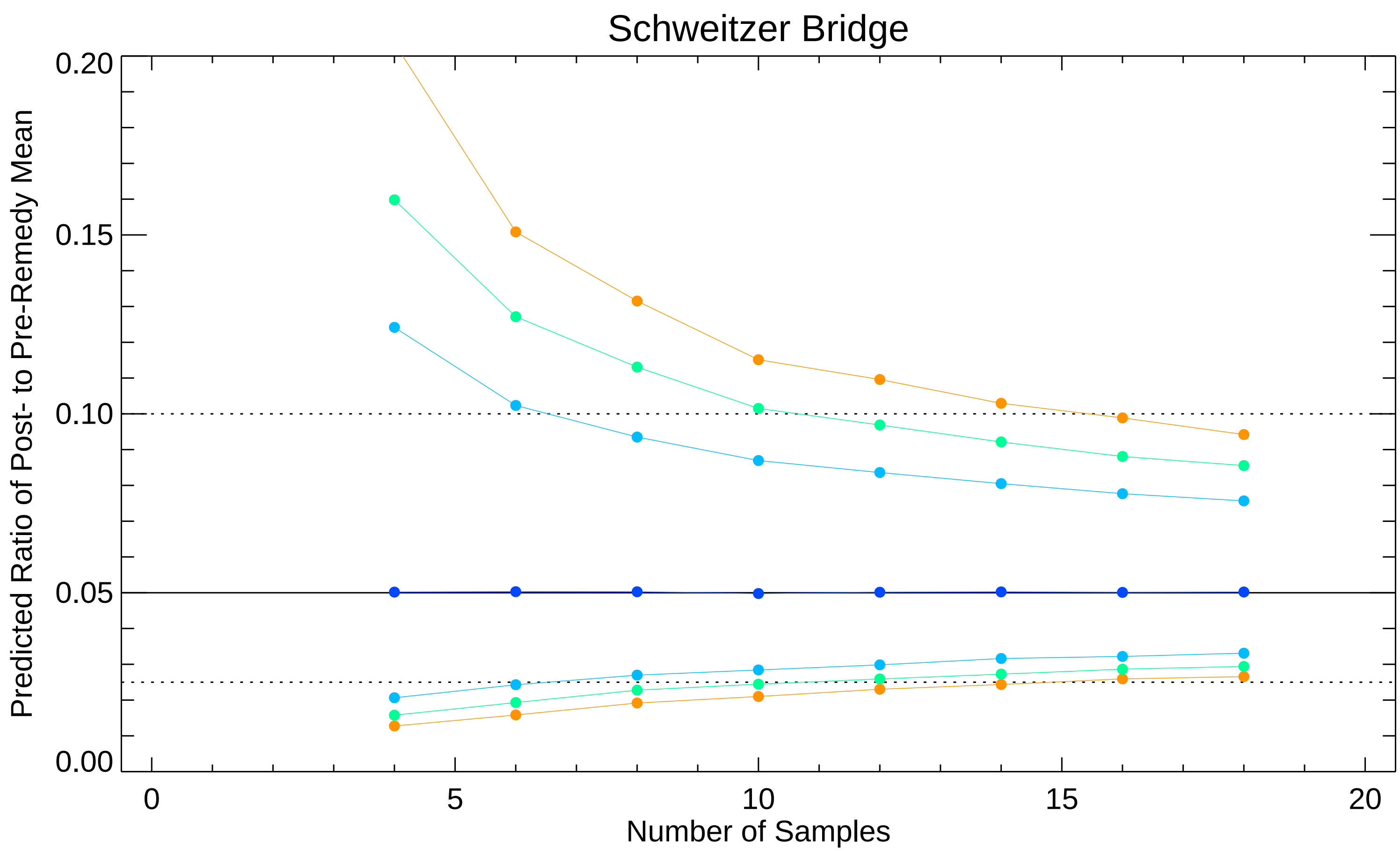
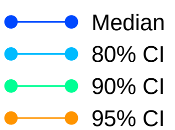
Figure A-2d

Estimated Sample Sizes for Surface Water Remedy and MNR Reaches: Woods Pond Headwaters

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis used all data collected since January 1, 2007. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
Kaplan-Meier method applied for non-detects. Duplicate samples averaged.
CI: confidence interval
MNR: monitored natural recovery



Publish Date: 06/10/2022 14:46 | User: wk
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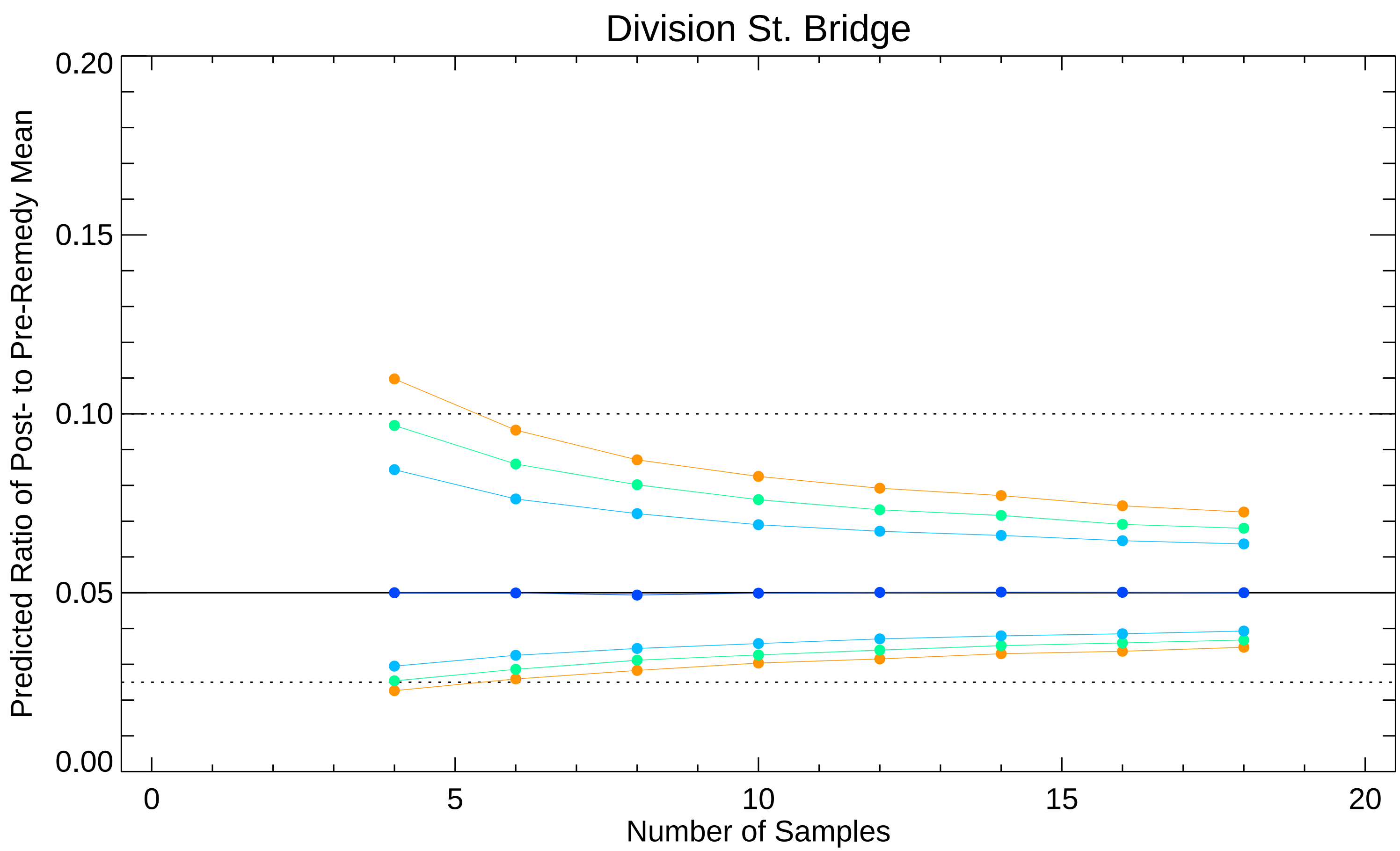
Figure A-2e

Estimated Sample Sizes for Surface Water Remedy and MNR Reaches: Schweitzer Bridge

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
Analysis used all data collected since April 1, 2014. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
Kaplan-Meier method applied for non-detects. Duplicate samples averaged.
CI: confidence interval
MNR: monitored natural recovery

Median
80% CI
90% CI
95% CI

Publish Date: 06/10/2022 14:46 | User: wk
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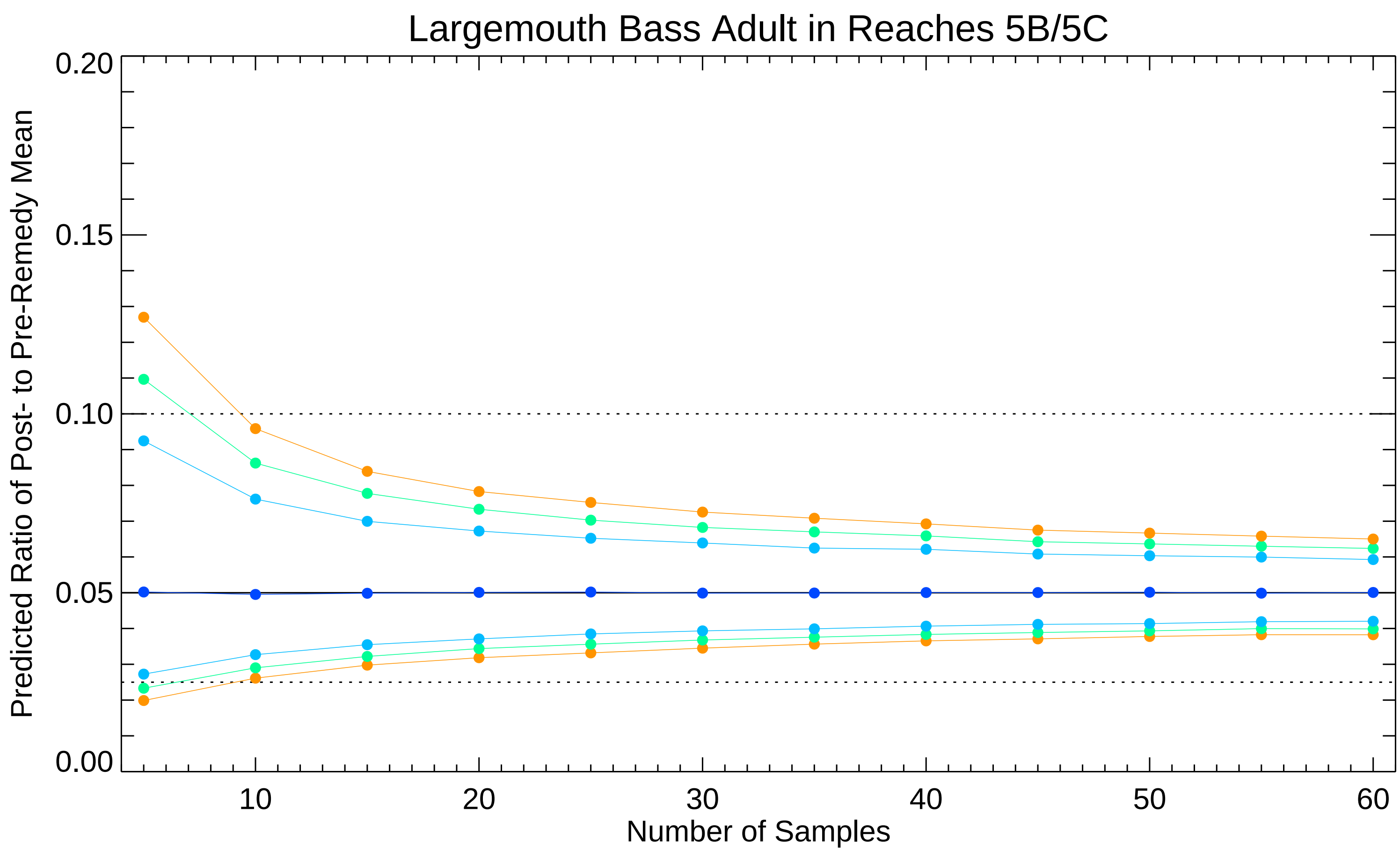
Figure A-2f

Estimated Sample Sizes for Surface Water Remedy and MNR Reaches: Division St. Bridge

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
2008 and 2011 wet-weight based PCB data in Reach 5B/5C for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
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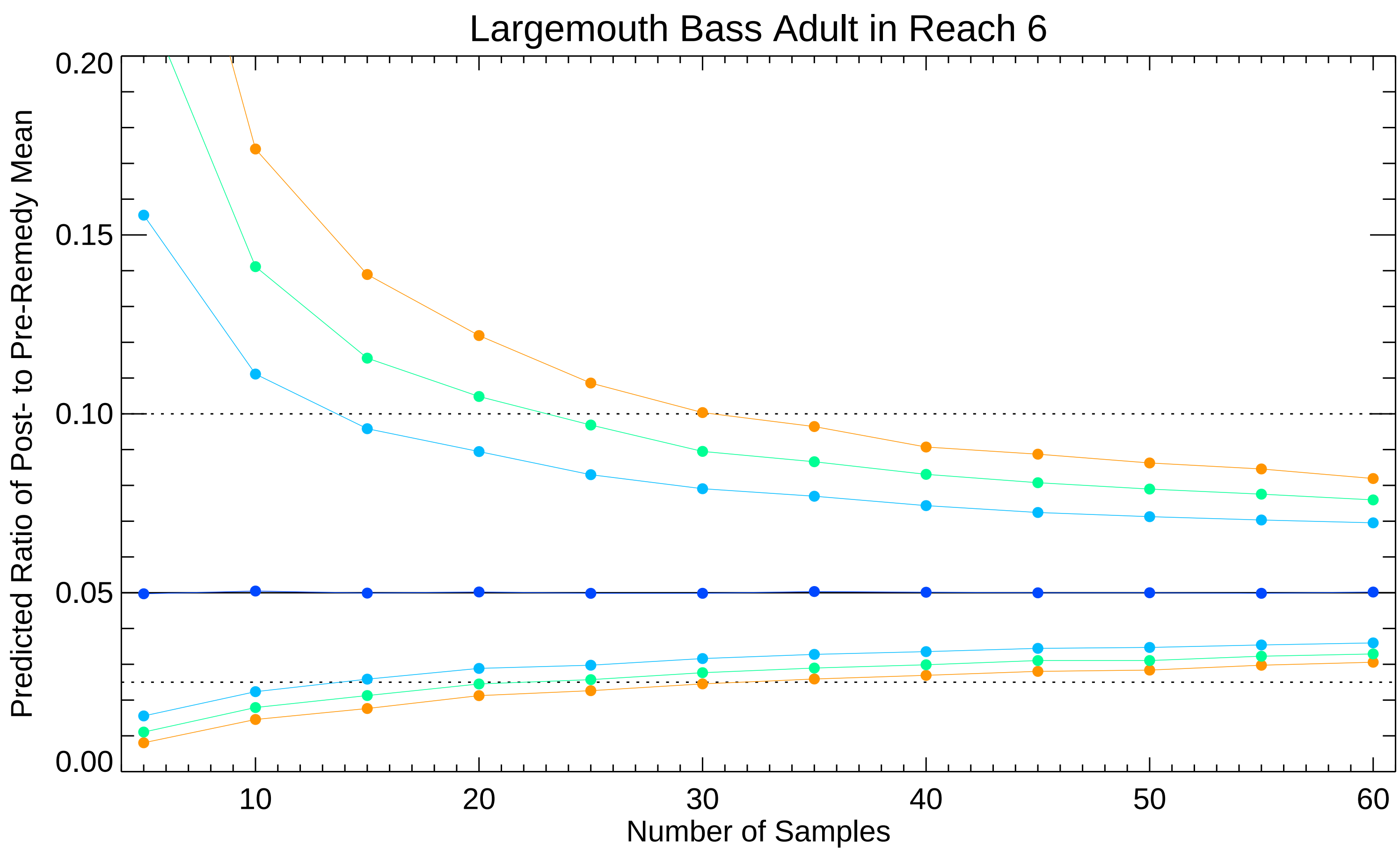
Figure A-3a
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Largemouth Bass Adult in Reaches 5B/5C



Notes:
2008 and 2011 wet-weight based PCB data in Woods Pond for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
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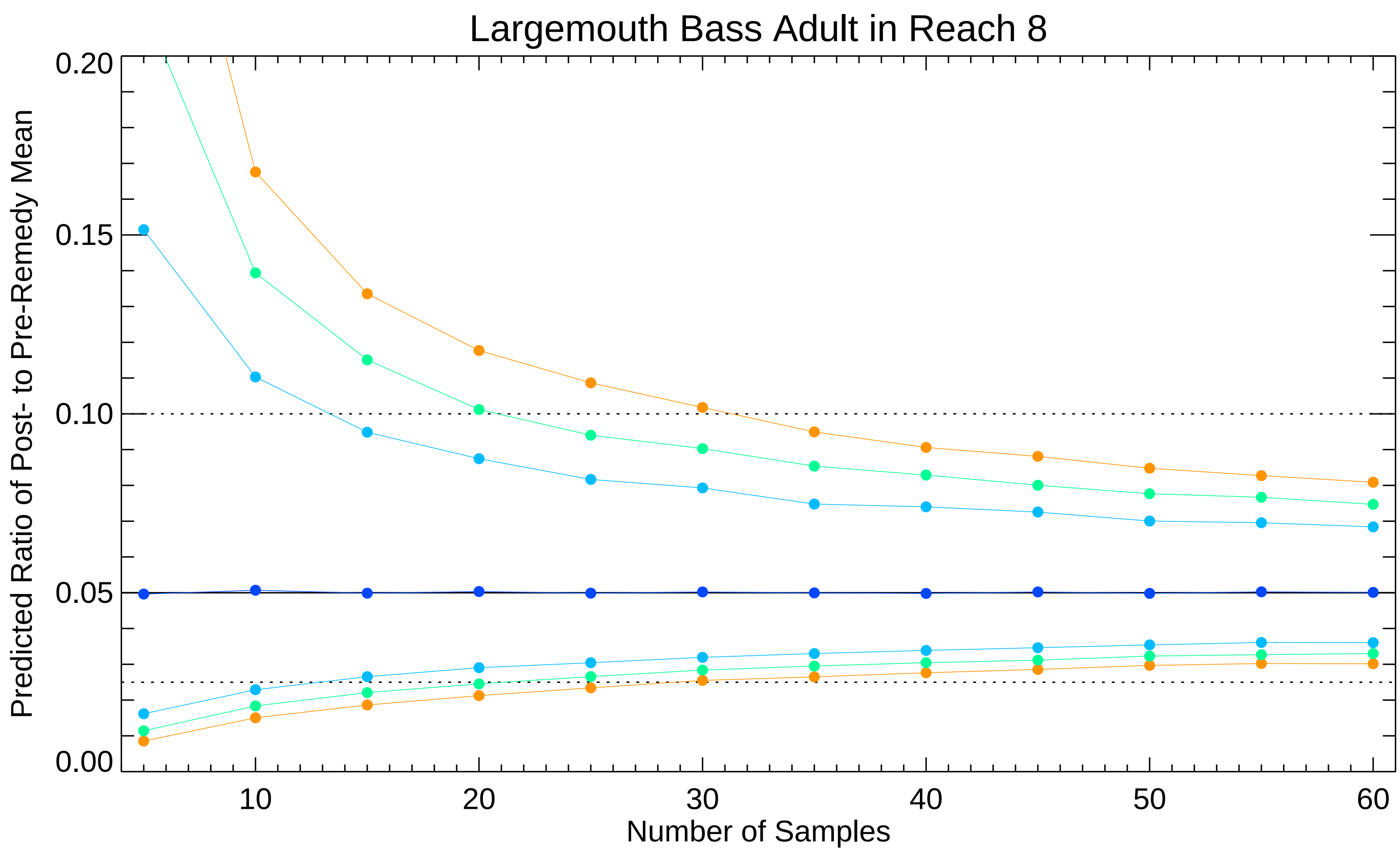
Figure A-3b
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Largemouth Bass Adult in Reach 6

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
2008 and 2011 wet-weight based PCB data in Rising Pond for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

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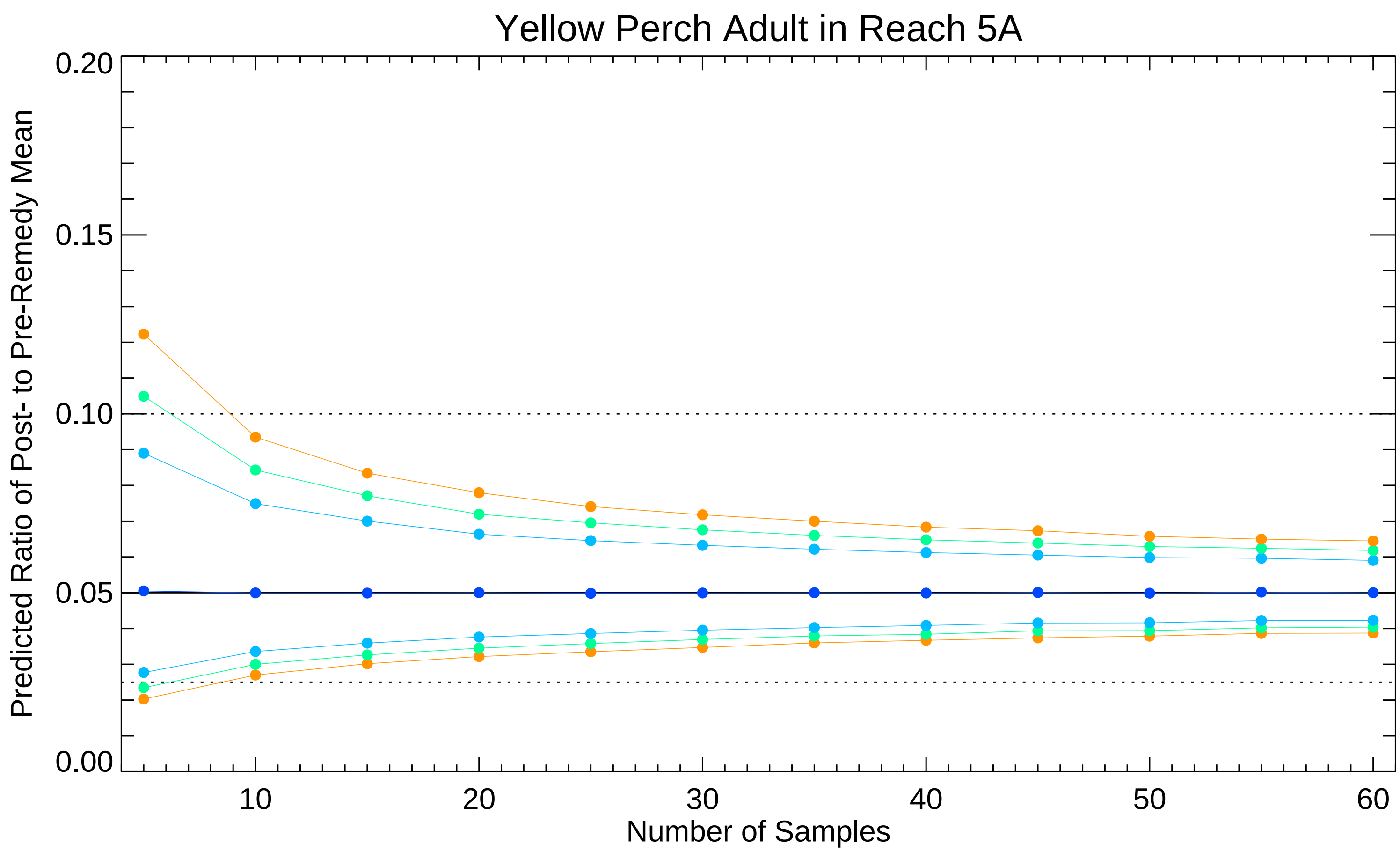
Figure A-3c
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Largemouth Bass Adult in Reach 8



Notes:
1998 and 2011 wet-weight based PCB data in Reach 5A for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
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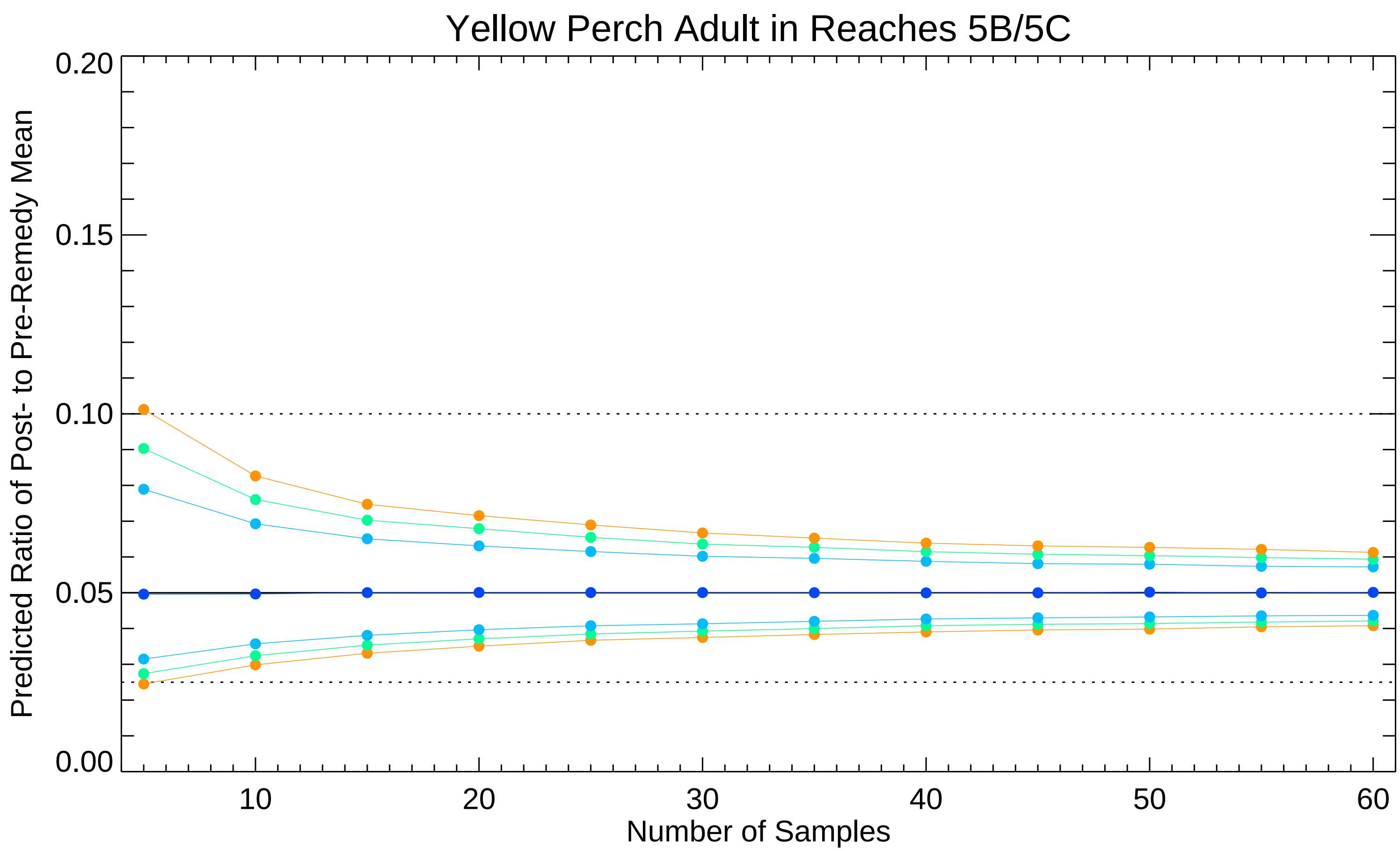
Figure A-3d
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Yellow Perch Adult in Reach 5A

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
1998 and 2011 wet-weight based PCB data in Reach 5B/5C for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
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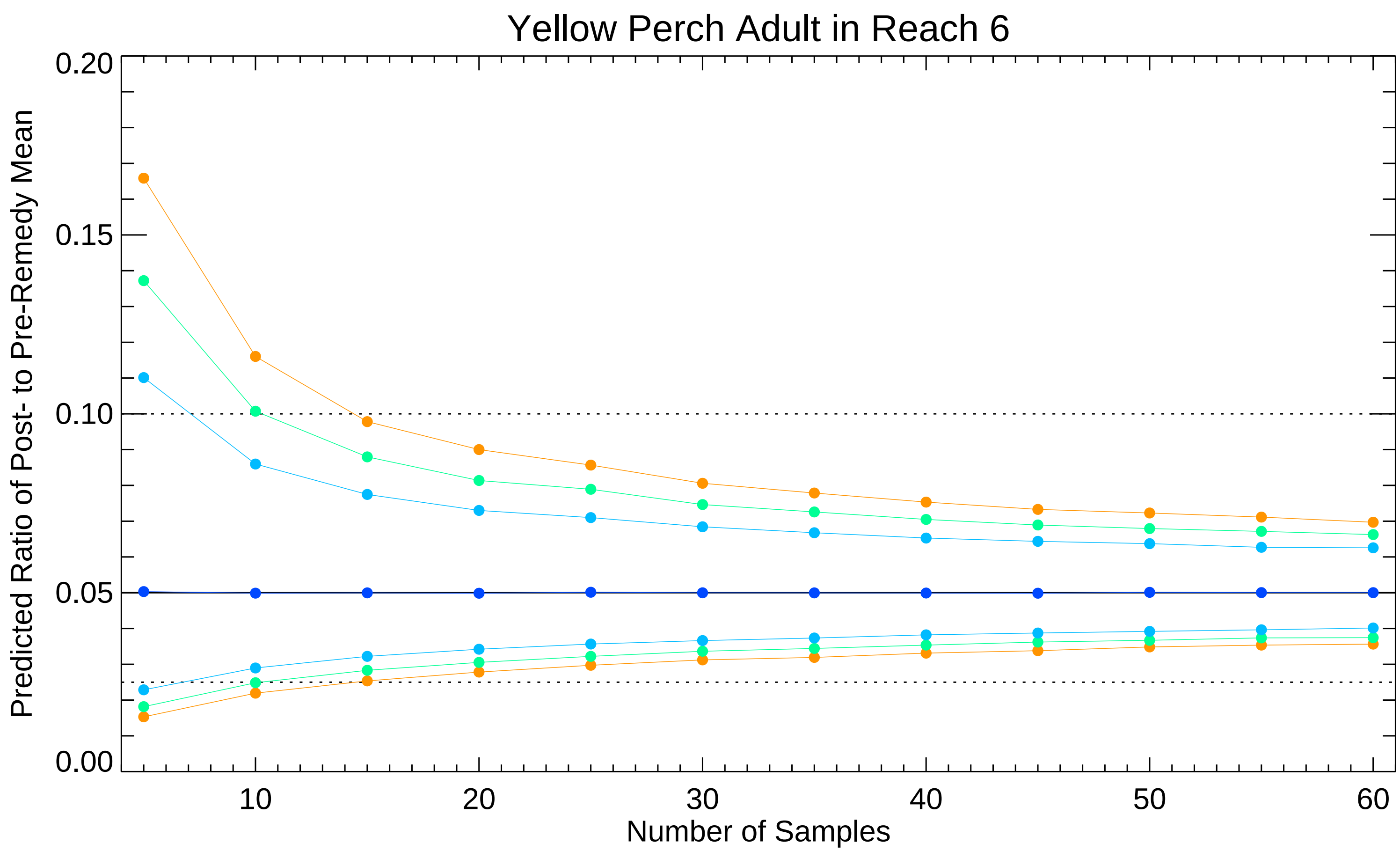
Figure A-3e
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Yellow Perch Adult in Reaches 5B/5C

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
1998 and 2011 wet-weight based PCB data in Woods Pond for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
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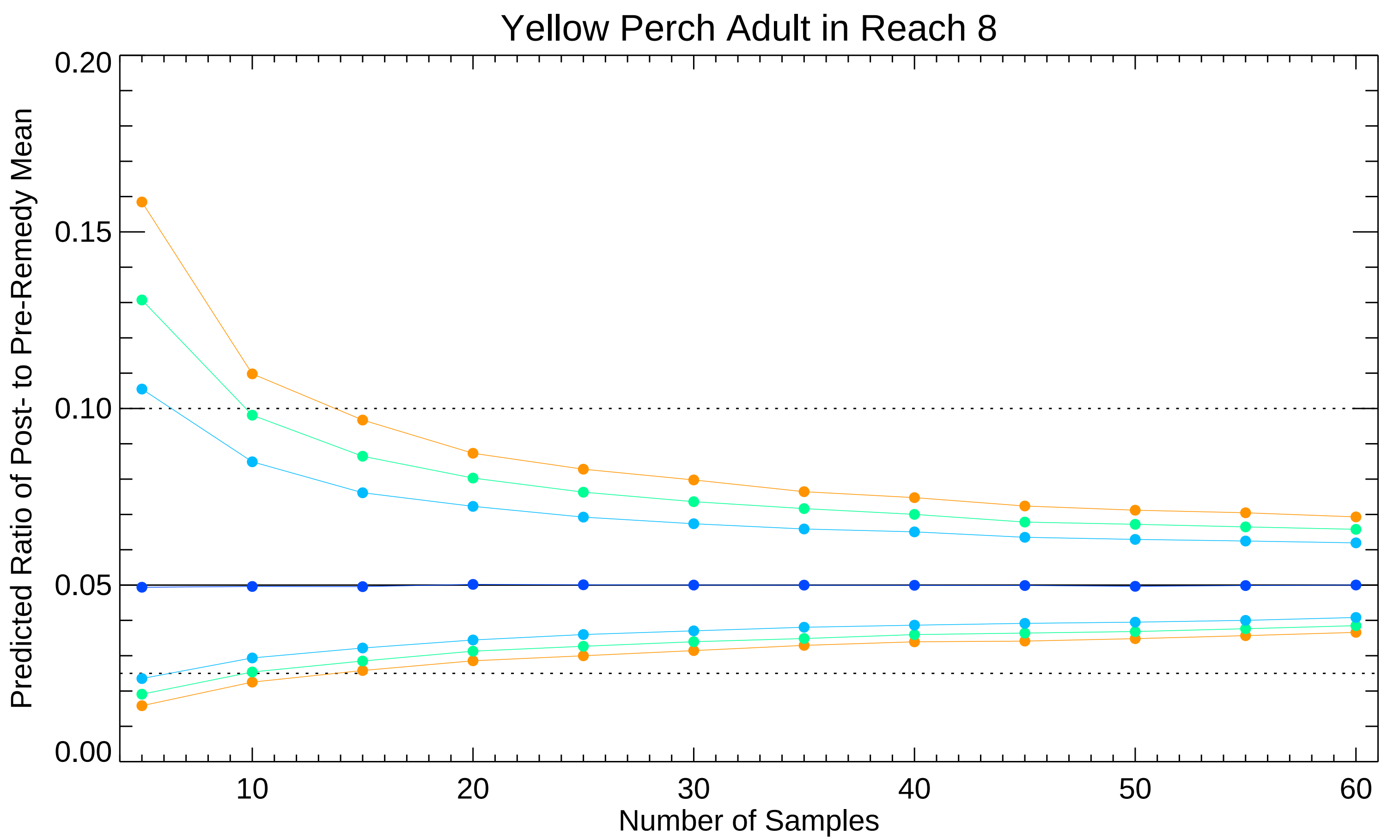
Figure A-3f
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Yellow Perch Adult in Reach 6



Notes:
1998 and 2011 wet-weight based PCB data in Rising Pond for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
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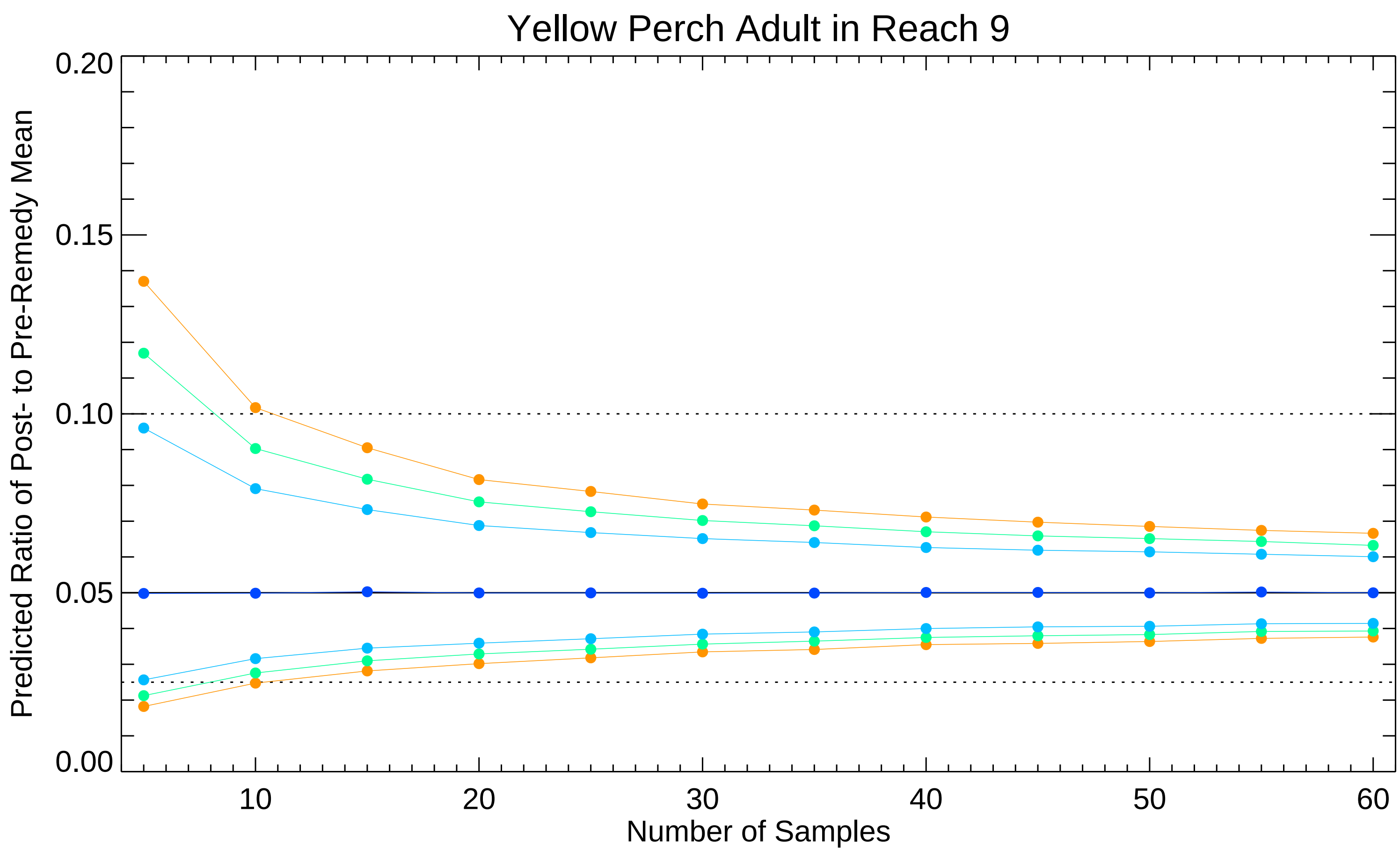
Figure A-3g
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Yellow Perch Adult in Reach 8

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



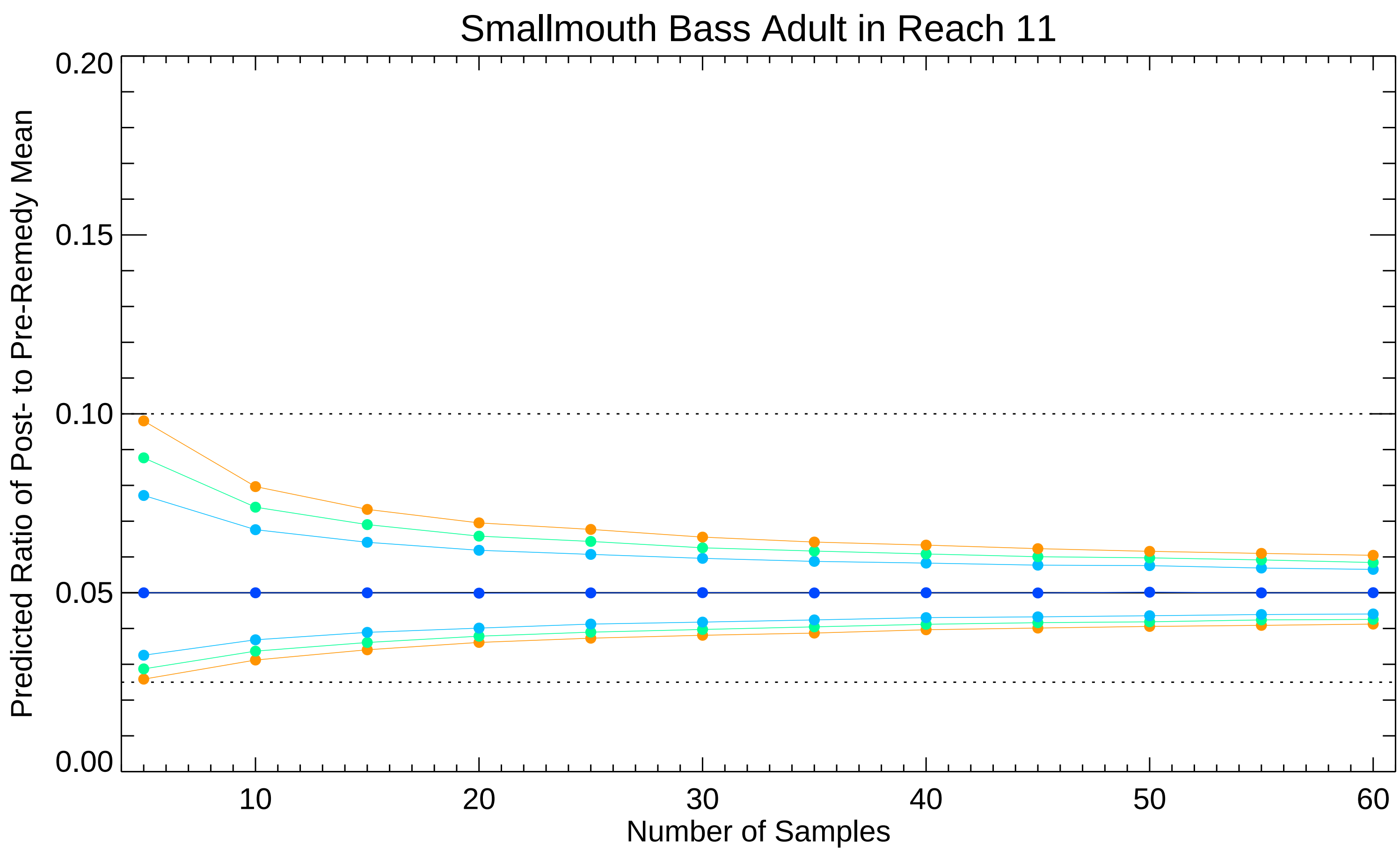
Notes:
1998 and 2011 wet-weight based PCB data in Reach 9 for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

ANCHOR QEA

Figure A-3h
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Yellow Perch Adult in Reach 9

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
1997 to 2016 wet-weight based PCB data in Bulls Bridge for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

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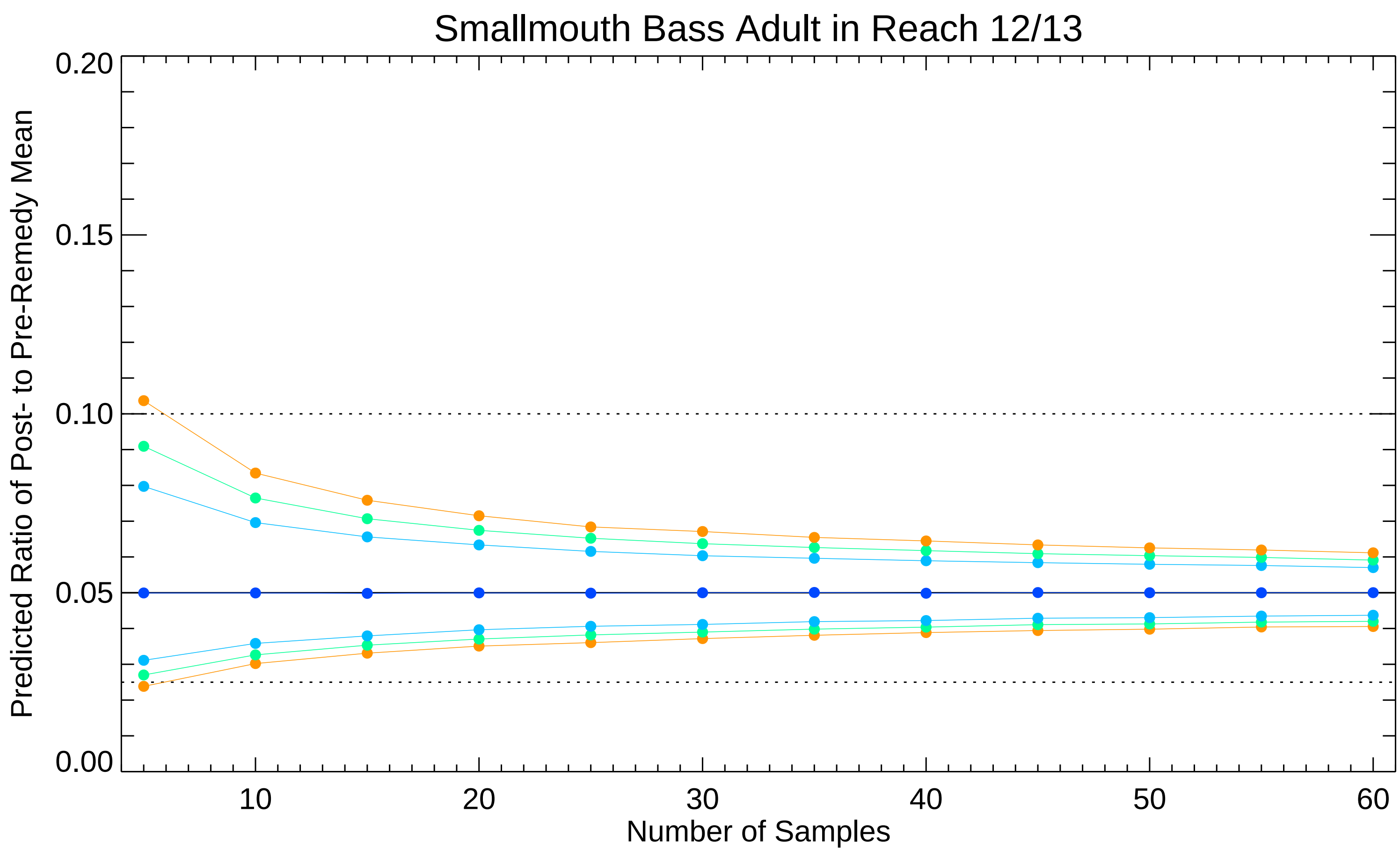
Figure A-3i
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Smallmouth Bass Adult in Reach 11

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
1997 to 2016 wet-weight based PCB data in Lake Lillinonah for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

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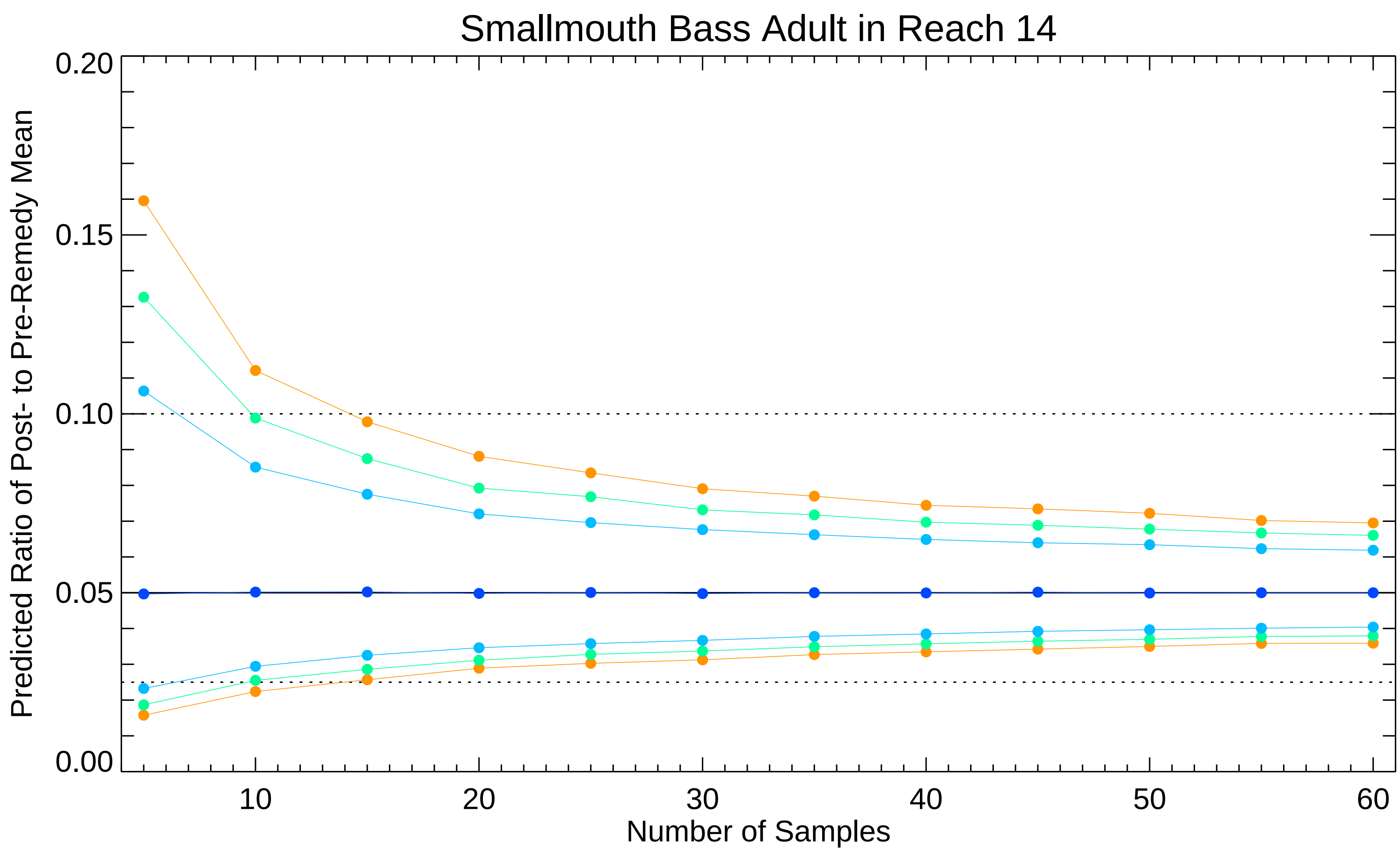
Figure A-3j
Estimated Sample Sizes for Fish in Remedy and MNR Reaches:
Smallmouth Bass Adult in Reach 12/13

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



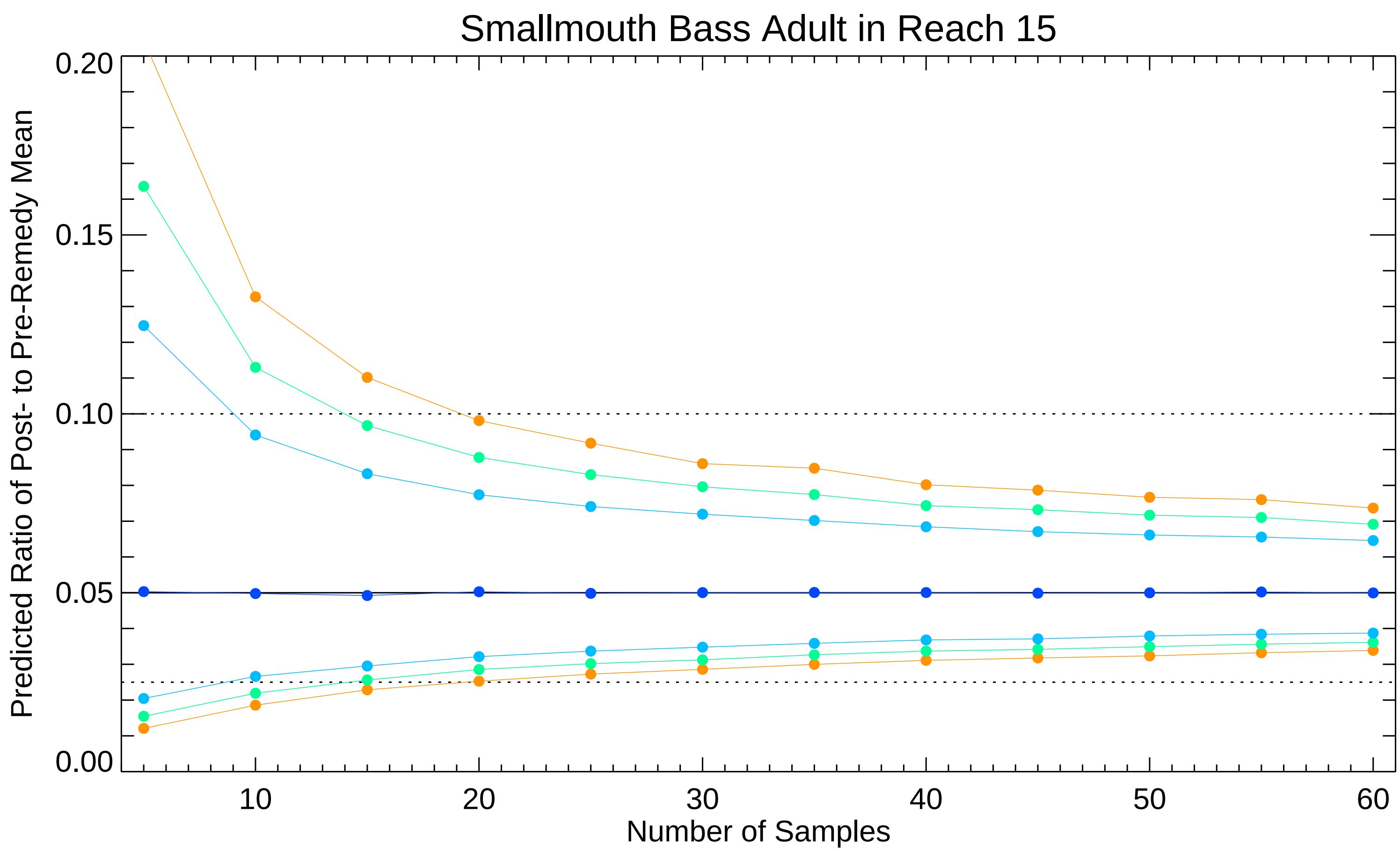
Notes:
1997 to 2016 wet-weight based PCB data in Lake Zoar for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

Figure A-3k
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Smallmouth Bass Adult in Reach 14

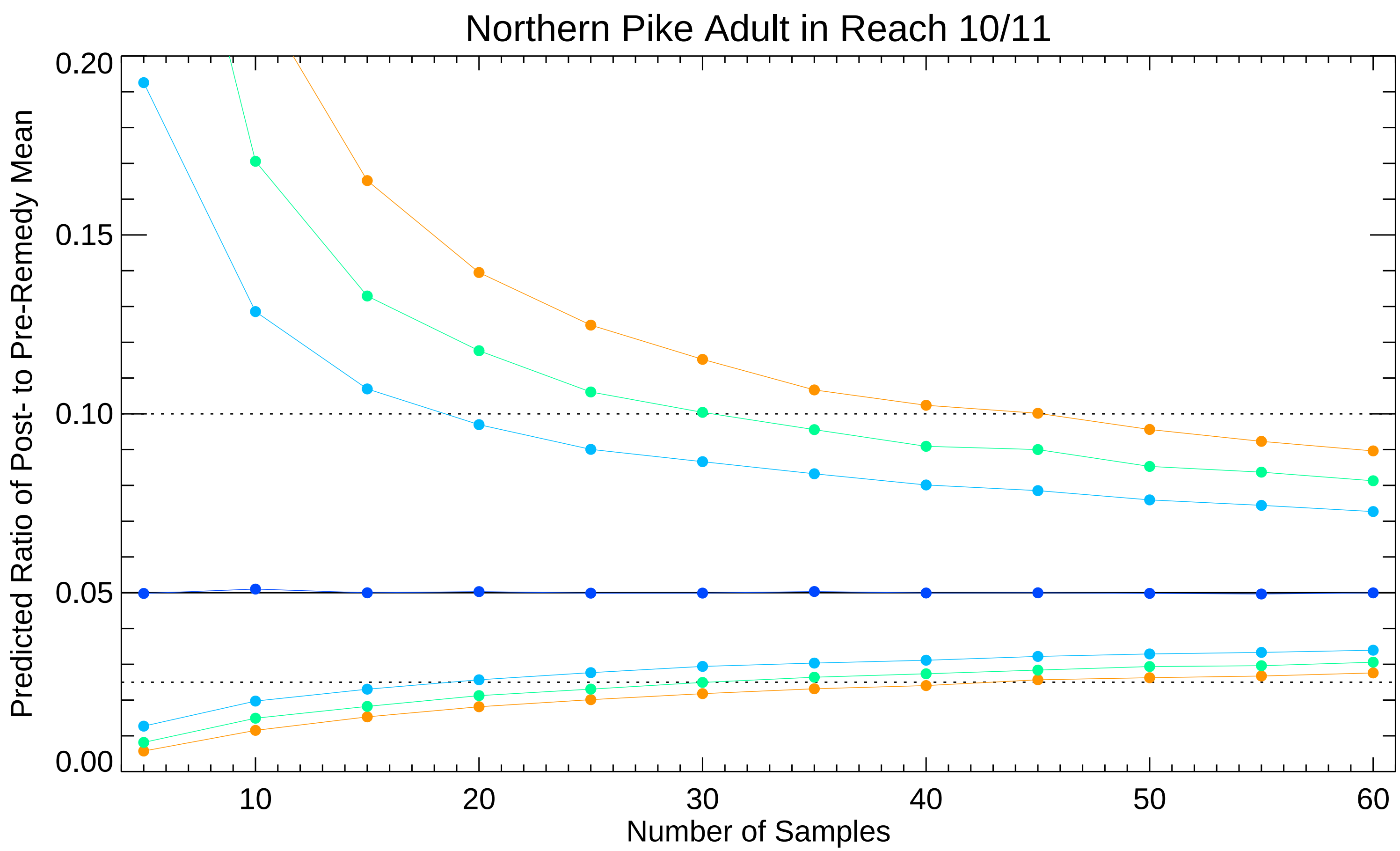
Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
1997 to 2016 wet-weight based PCB data in West Cornwall for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

Figure A-3l
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Smallmouth Bass Adult in Reach 15



Notes:
1997 to 2014 wet-weight based PCB data in Falls Village for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

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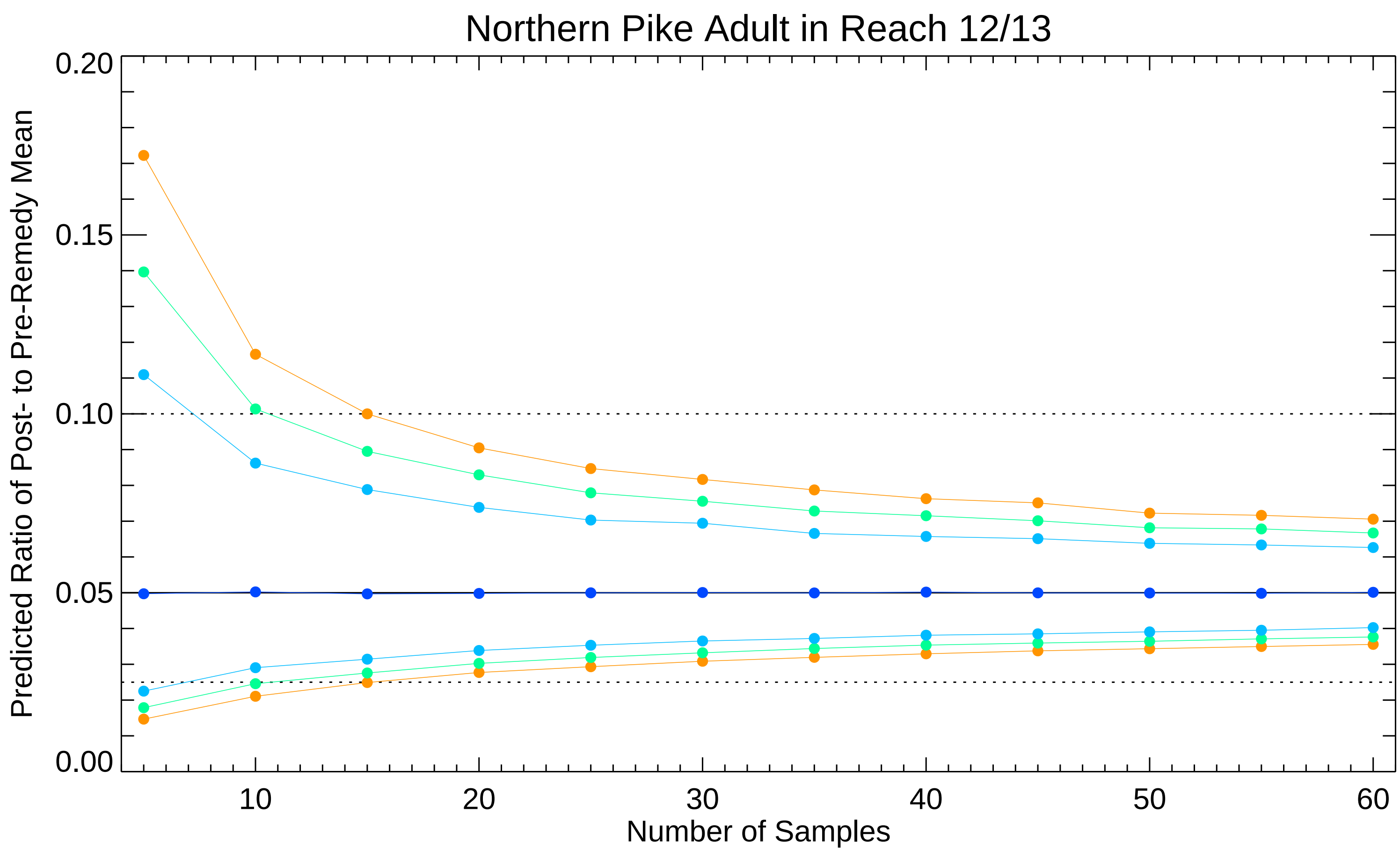
Figure A-3m

Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Northern Pike Adult in Reach 10/11

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



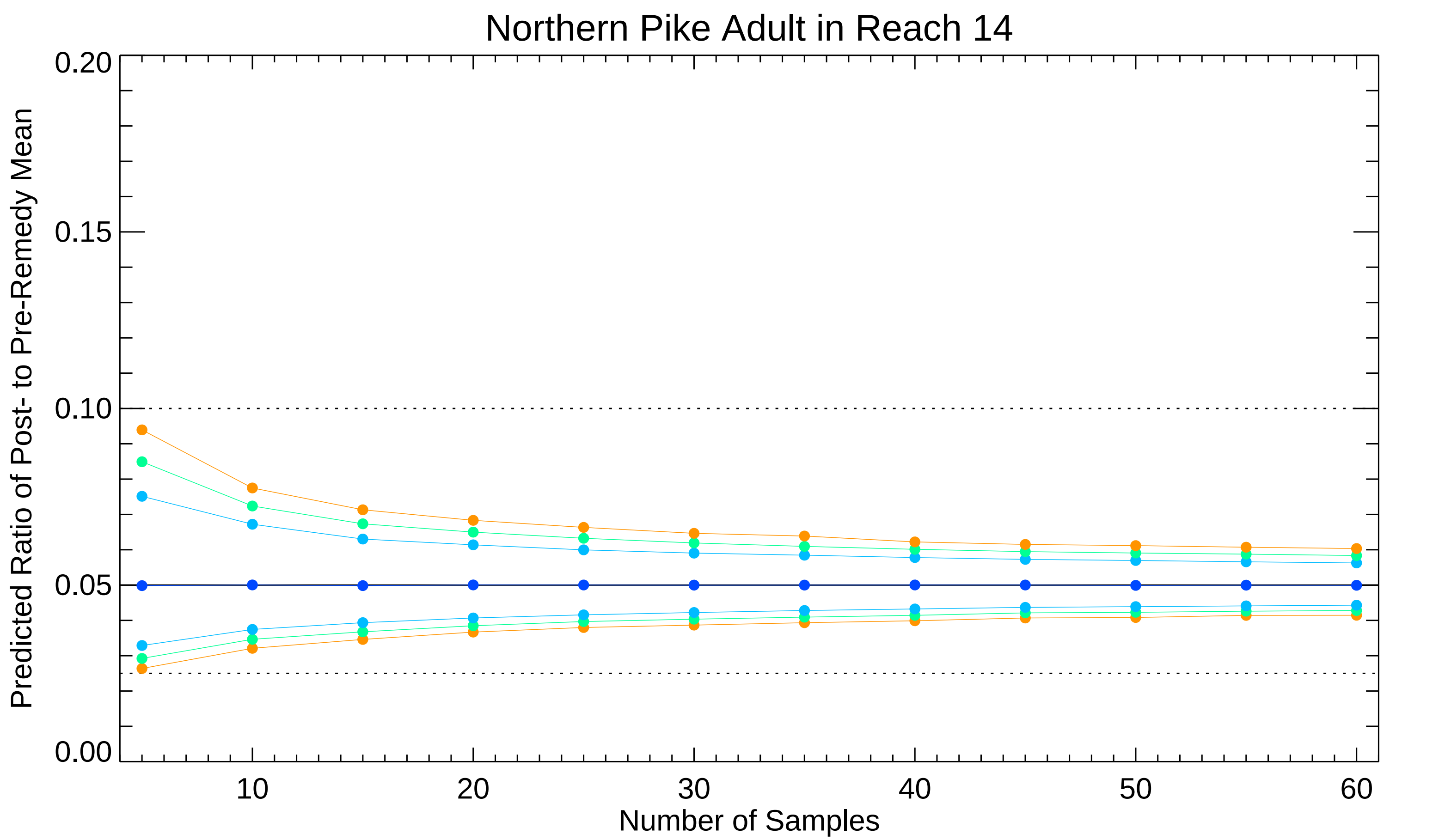
Notes:
1997 to 2014 wet-weight based PCB data in Bulls Bridge for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

ANCHOR QEA

Figure A-3n
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Northern Pike Adult in Reach 12/13

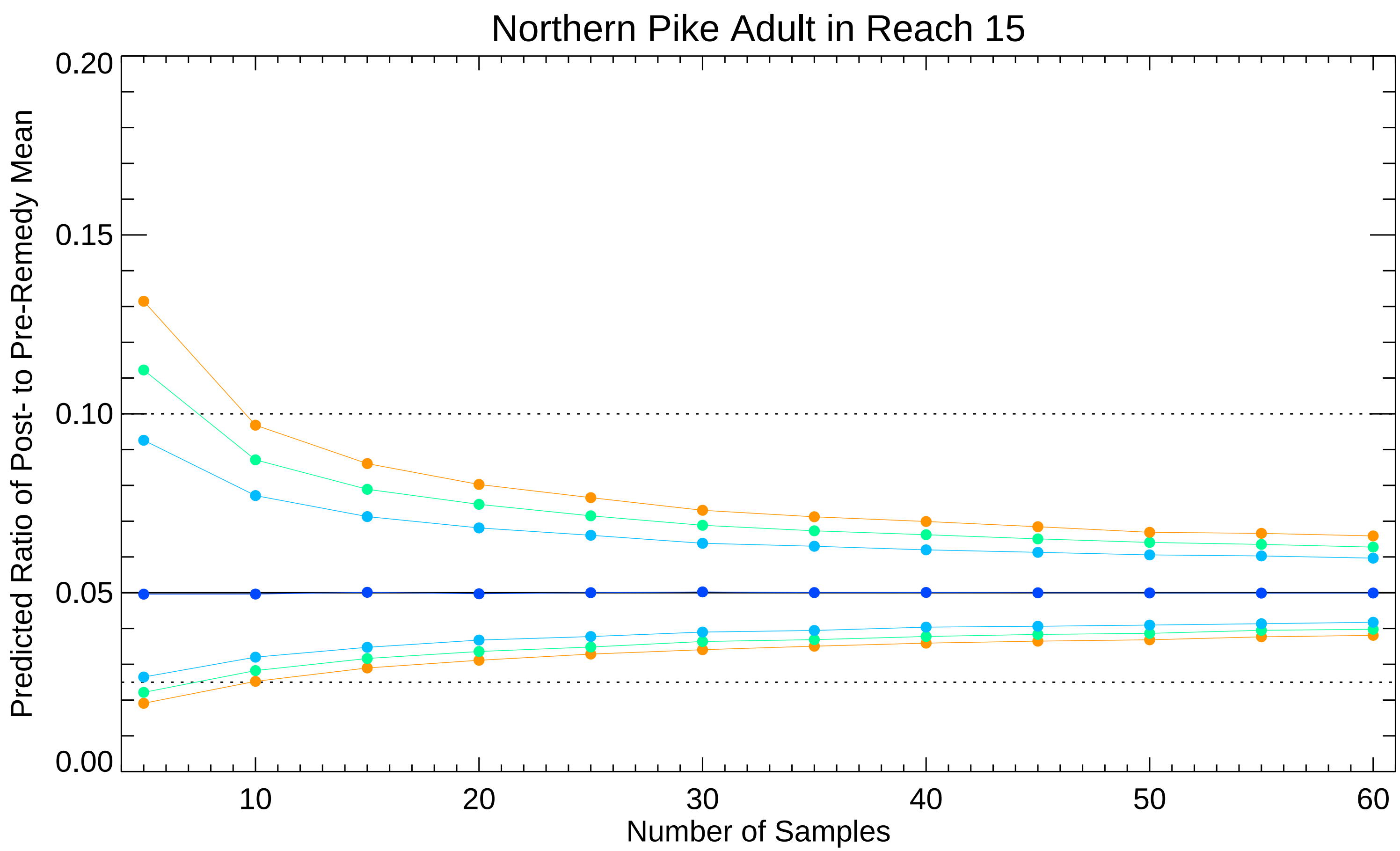


Notes:
1997 to 2014 wet-weight based PCB data in Lake Lillinonah for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

ANCHOR QEA

Figure A-3o
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Northern Pike Adult in Reach 14



Notes:
1997 to 2014 wet-weight based PCB data in Lake Zoar for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

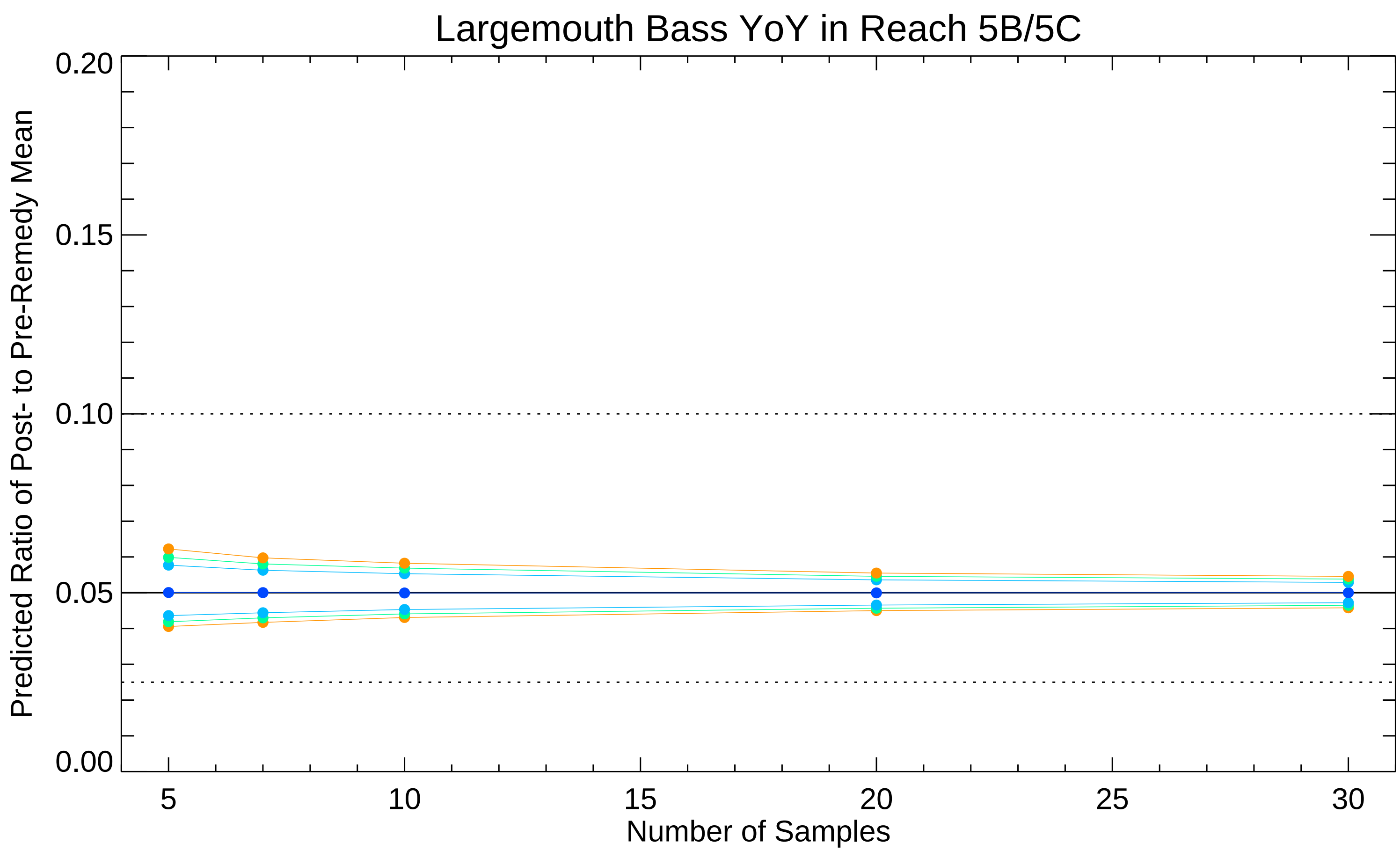
Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

ANCHOR QEA

Figure A-3p
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Northern Pike Adult in Reach 15

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
2010, 2012, and 2014 wet-weight based PCB data in Reach 5B/5C for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

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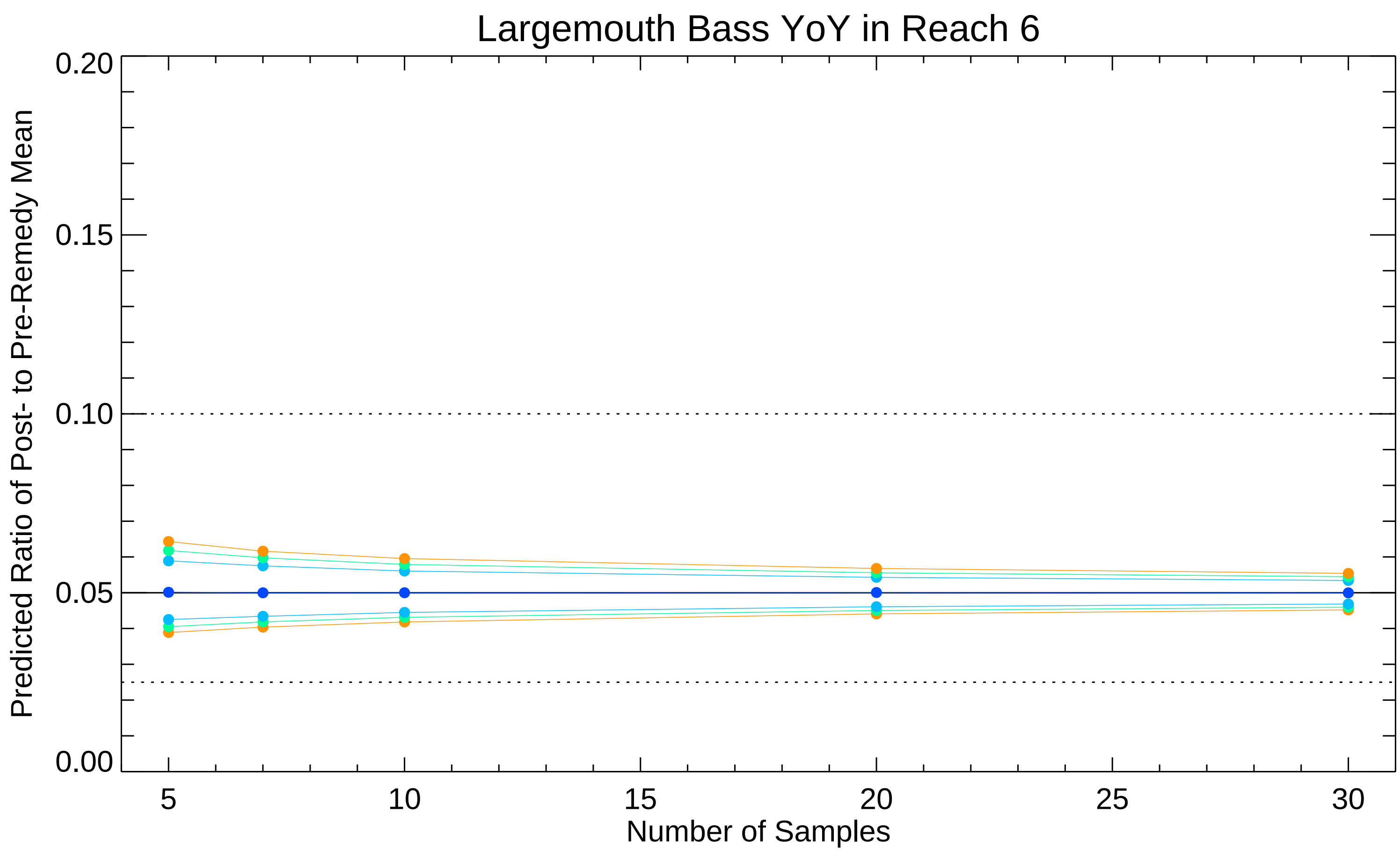
Figure A-3q
Estimated Sample Sizes for Fish in Remedy and MNR Reaches:
Largemouth Bass YoY in Reach 5B/5C

Revised Baseline Monitoring Plan
Housatonic River - Rest of River

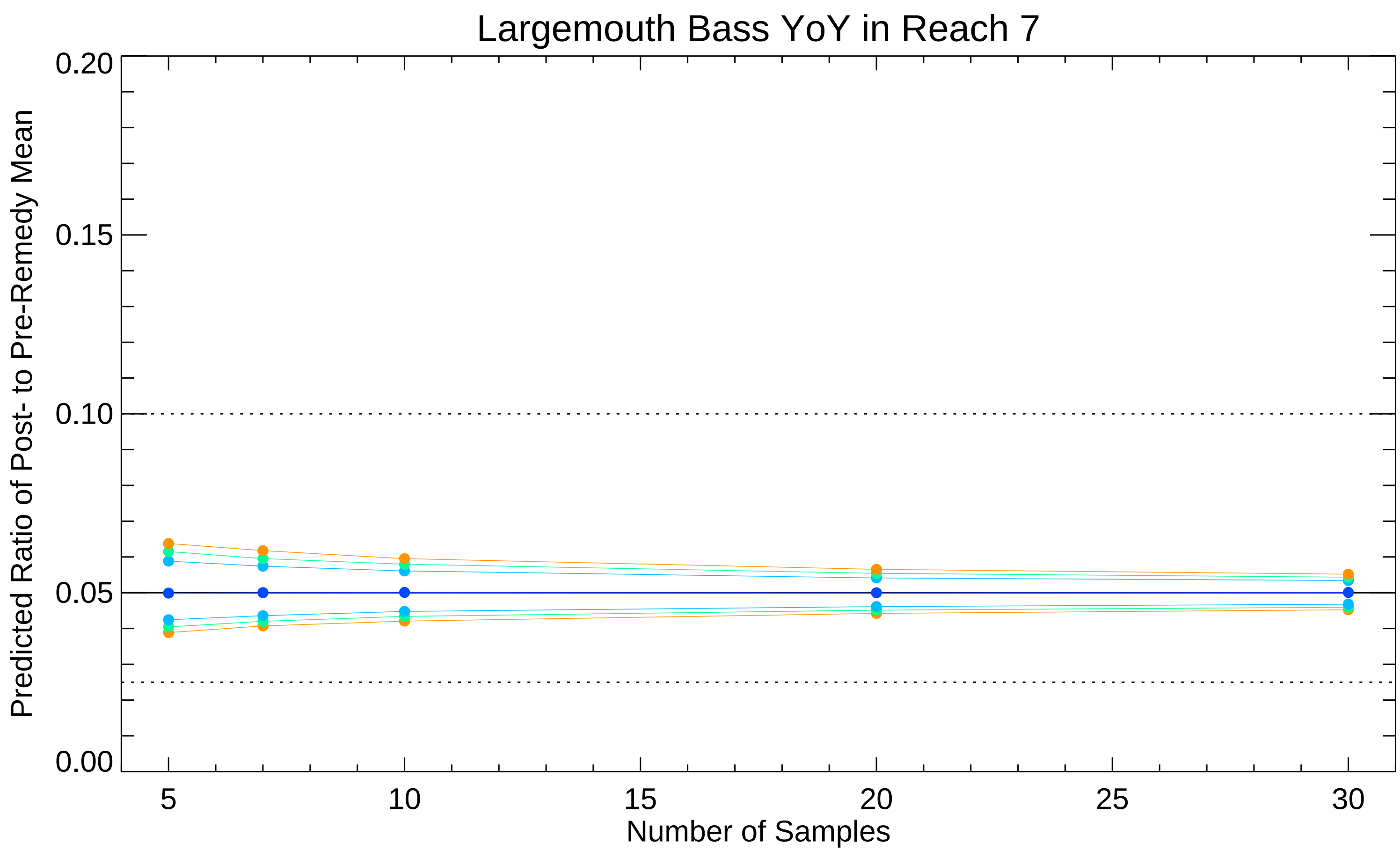


Notes:
2010, 2012, and 2014 wet-weight based PCB data in Woods Pond for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

Figure A-3r
Estimated Sample Sizes for Fish in Remedy and MNR Reaches:
Largemouth Bass YoY in Reach 6



Notes:
2010, 2012, and 2014 wet-weight based PCB data in Rising Pond for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

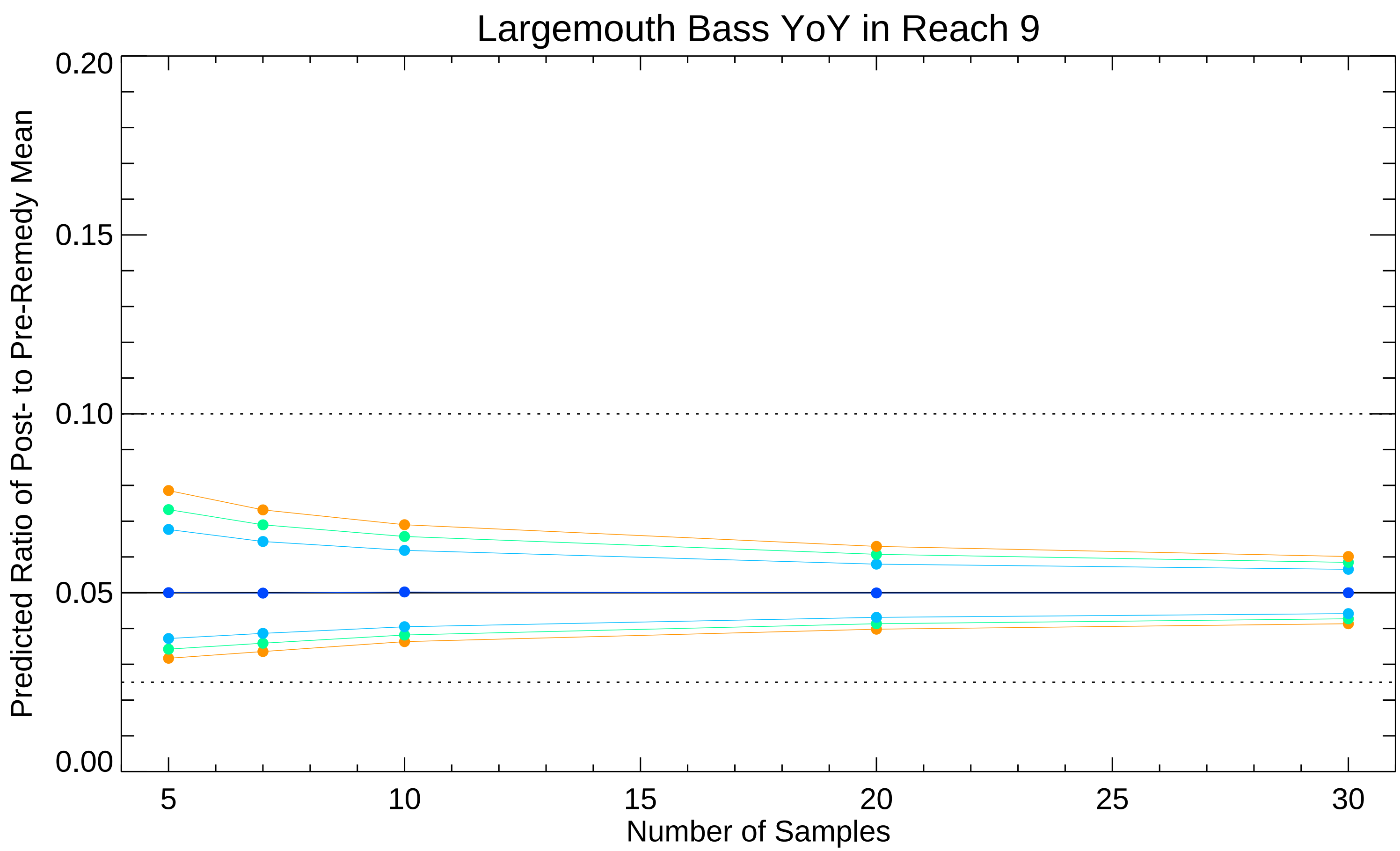
Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

ANCHOR QEA

Figure A-3s
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Largemouth Bass YoY in Reach 7

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
2010, 2012, and 2014 wet-weight based PCB data in Reach 9 for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
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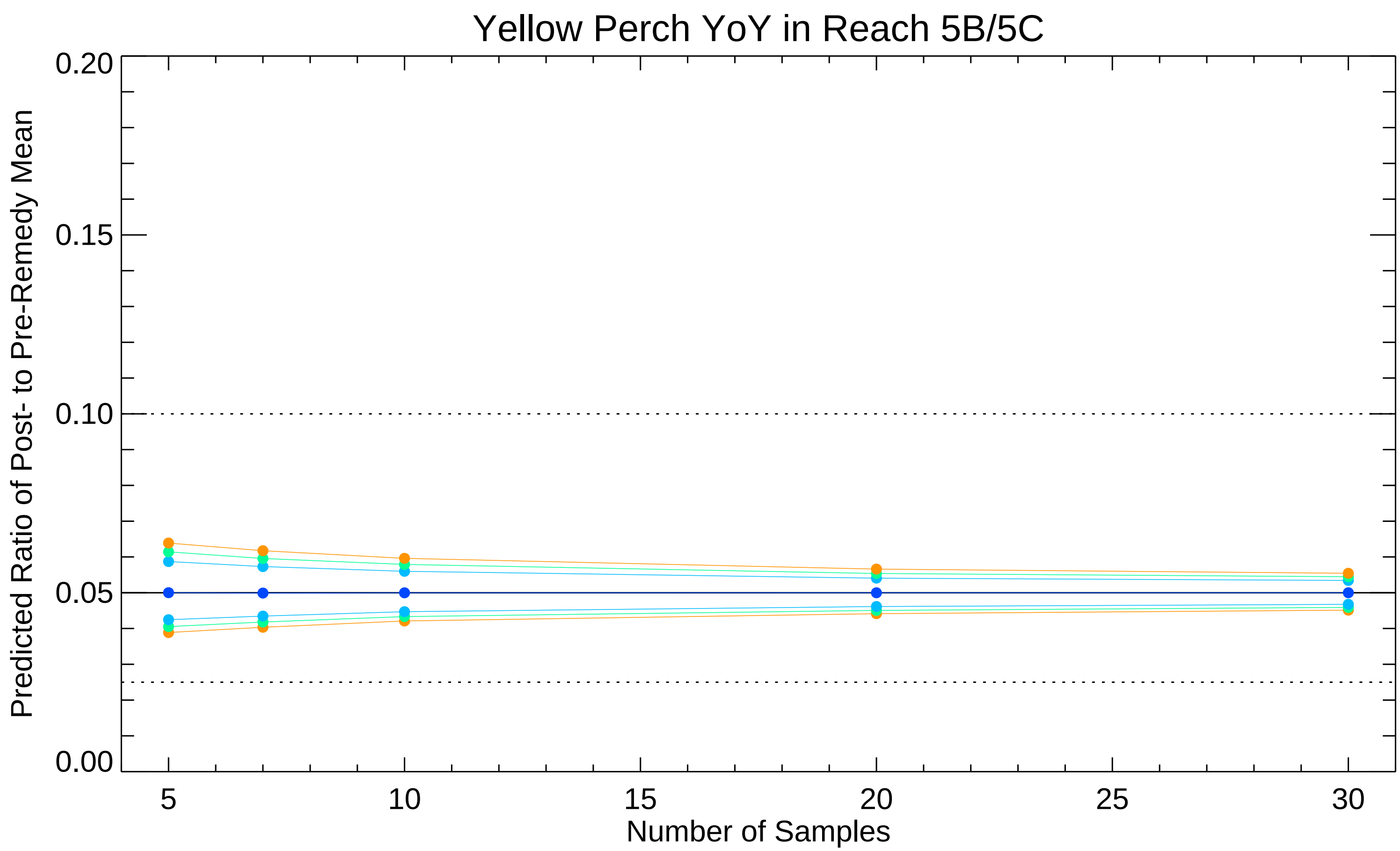
ANCHOR QEA

Figure A-3t
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Largemouth Bass YoY in Reach 9



Notes:
2010, 2012, and 2014 wet-weight based PCB data in Reach 5B/5C for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

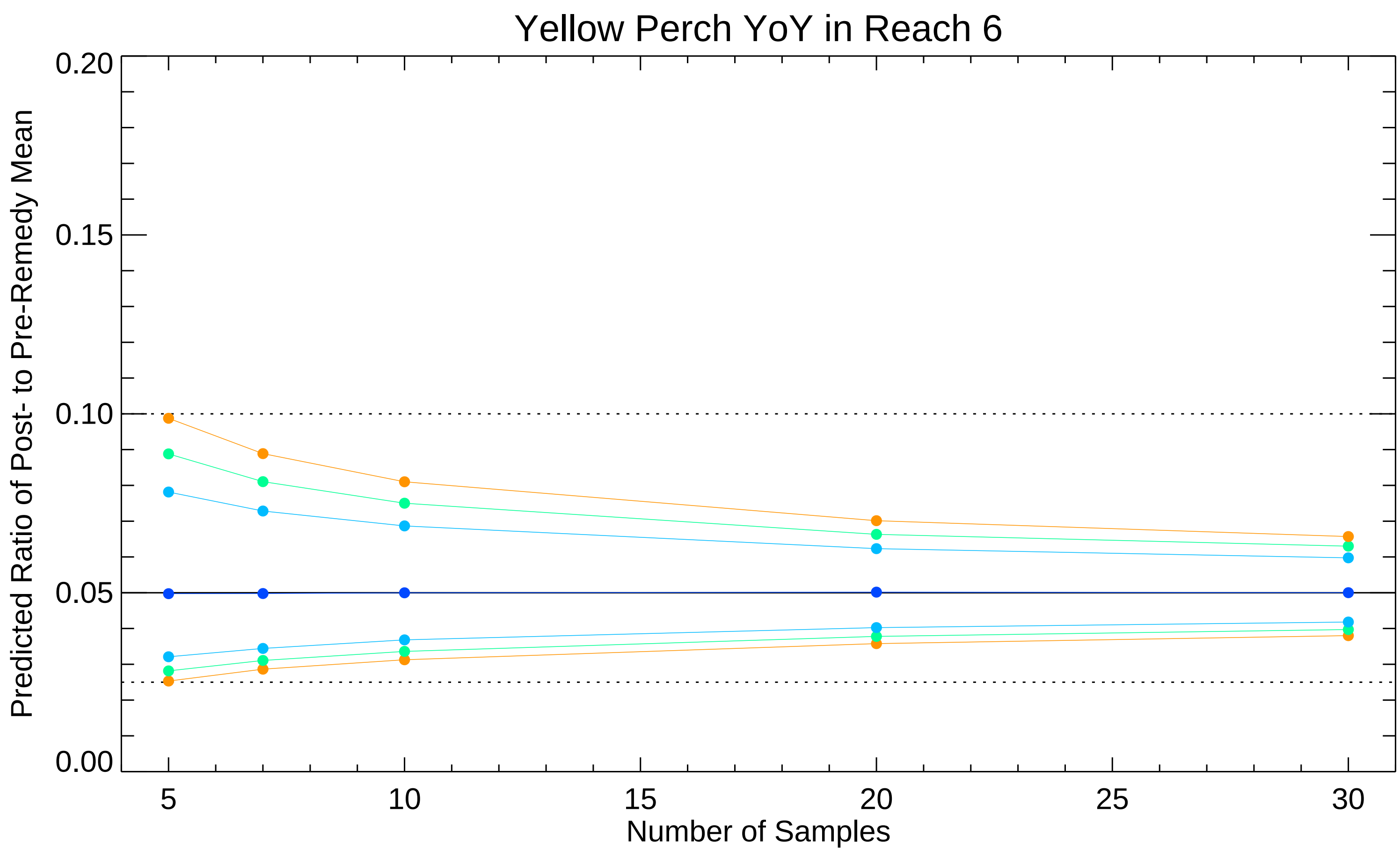
Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

ANCHOR QEA

Figure A-3u
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Yellow Perch YoY in Reach 5B/5C

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
2010, 2012, and 2014 wet-weight based PCB data in Woods Pond for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

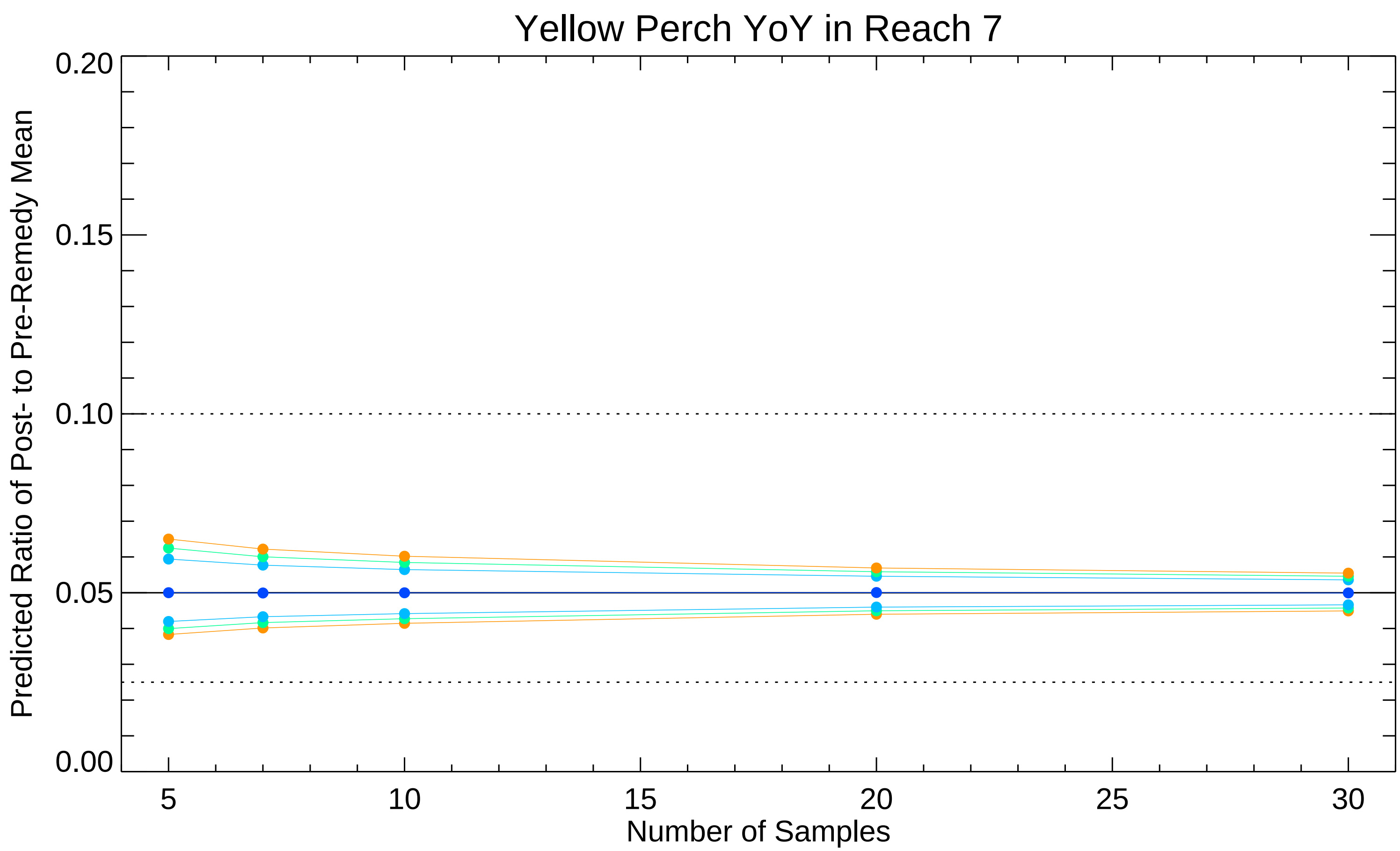
Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

ANCHOR QEA

Figure A-3v
Estimated Sample Sizes for Fish in Remedy and MNR Reaches:
Yellow Perch YoY in Reach 6

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
2010, 2012, and 2014 wet-weight based PCB data in Rising Pond for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

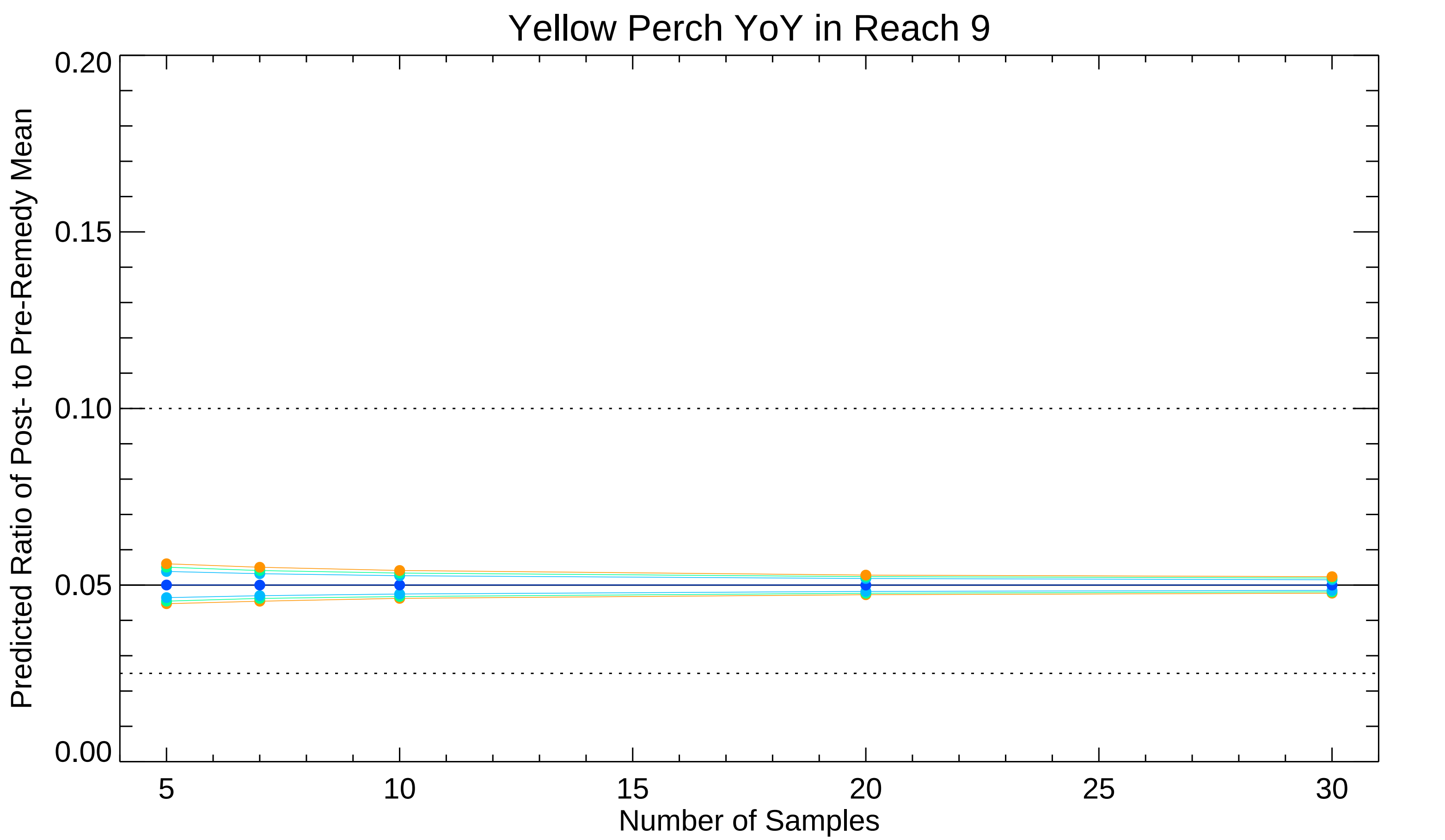
Median
80% CI
90% CI
95% CI

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

ANCHOR QEA

Figure A-3w
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Yellow Perch YoY in Reach 7

Revised Baseline Monitoring Plan
Housatonic River - Rest of River



Notes:
2010, 2012, and 2014 wet-weight based PCB data in Reach 9 for bootstrapping. Number of bootstraps = 10000.
Log-normal distribution used in bootstrap analysis.
General Electric Company split samples are not included.
CI: confidence interval
PCB: polychlorinated biphenyl

Publish Date: 06/14/2022 23:12 | User: BG/WK
File Path: \\athena\Syracuse\Projects\GE\Housatonic_Rest-of-River\Severable_Tasks\Documents\Baseline_Monitoring\2022 revised draft BMP\Figures\Source Files\FigureA_3_RoR_BMP_fish_master_bootstrap_byRch_20210625_V2_Alt_1Panel.pro

ANCHOR QEA

Figure A-3x
Estimated Sample Sizes for Fish in Remedy and MNR Reaches: Yellow Perch YoY in Reach 9

Revised Baseline Monitoring Plan
Housatonic River - Rest of River

Appendix B
SOP for Water Column Grab Sampling

Surface Water Sampling Procedures

I. Introduction

This appendix specifies several types of surface water sampling procedures. These include procedures for collecting surface water samples for subsequent chemical analysis; and procedures for obtaining velocity profile measurements at selected river/stream cross-sections.

II. Surface Water Sampling for Chemical Analysis

This section specifies the procedures for collecting surface water samples for chemical analysis. Several methods for collecting surface water samples are available, depending on the type of surface water to be sampled (i.e., rivers, streams, discharges, ponds, or impoundments). Regardless of the sample collection method used, sampling will not take place during precipitation events (unless so specified in the project-specific work plan), and samples will be obtained beginning with the most downstream location and proceeding upstream.

Materials

The following materials will be available, as required, during surface water sampling.

- Health and safety equipment (as required by the Health and Safety Plan);
- Cleaning equipment (as required in Appendix W);
- Boat;
- Rope;
- Surveyor's rod and/or 6-foot rule;
- Duct tape;
- Measuring tape;
- Electromagnetic velocity meter;
- Large glass or stainless steel mixing container;
- Beaker or equivalent glass measuring device;
- Field notebook;
- Conductivity meter;
- Temperature meter;
- pH meter;
- DO meter;

- Turbidity meter;
- Appropriate blanks (trip), if necessary;
- Appropriate sampling containers and forms;
- Appropriate preservatives (as required);
- Coolers with ice or "blue" ice; and
- Appropriate water sampler as specified in the project-specific work plan, which may include following:
  - Surface water grab sampler (Attachment B-1) consisting of a 1,000 mL narrow-mouth amber-glass bottle, adjustable clamp, and two-or three-piece telescoping surveyor's rod or an equivalent acceptable sampling device; or
  - Kemmerer stainless steel bottle sampler (Attachment B-2).

Procedures

A. The following procedures will be used to obtain grab samples:

Step 1 - Identify surface water sampling location on appropriate sampling log sheet (Attachment B-3) and/or field notebook along with other appropriate information;

Step 2 - Don health and safety equipment (as required by the Health and Safety Plan);

Step 3 - Clean the sampling equipment in accordance with the procedures in Appendix W;

Step 4 - Assemble the water grab sampler (Attachment B-1). Make sure that the sampling bottle and the bolts and nuts that secure the clamp to the pole are tightened properly;

Step 5 - Where grab samples will be collected at 25%, 50%, and 75% of the total river width to form a composite sample, measure the river width with a measuring tape to determine station locations;

Step 6 - Obtain sample by slowly submerging the bottle with minimal surface disturbance to a depth that is 0.5 times the total water depth, unless otherwise specified in the project specific work plan;

Step 7 - Retrieve the water sampler from the surface water with minimal disturbance;

Step 8 - Remove the cap from the large glass or stainless steel mixing container and slightly tilt the mouth of the container below the sampling device;

Step 9 - Empty the sampler slowly, allowing the sample stream to flow gently down the side of the container with minimal entry turbulence;

Step 10 - Continue delivery of the sample until the mixing container contains a sufficient volume for all laboratory samples;

Step 11 - Mix the entire sample volume with the Teflon® stirring rod and transfer the appropriate volume into the laboratory sample jar. Where sampling methods involve collection of grab samples from 25%, 50%, and 75% of the total river width to form a composite sample, add equal volumes from each station to the sample jar. Preserve samples as specified in Table 1 of the FSP/QAPP;

Step 12 - The sample collection order (as appropriate) will be as follows:
1. PCBs; and
2. TSS.

Step 13 - If sampling for total and filtered PCBs, two samples must be collected, one of which will be filtered by the laboratory prior to analysis;

Step 14 - Secure the sample jar cap(s) tightly;

Step 15 - Label all sample containers as appropriate, as discussed in Appendix L;

Step 16 - After sample containers have been filled, fill a beaker or glass container with the water sample and measure the pH and conductivity, as discussed in Appendix O. Alternatively, direct measurements for pH and conductivity can be taken at the approximate mid-depth location as detailed in Appendix O;

Step 17 - Measure the water temperature at the approximate mid-depth location or from a beaker or glass container filled with the water sample if an in-river measurement is not possible, and record the ambient air temperature;

Step 18 - Record required information on the appropriate forms and/or field notebook; and

Step 19 - Handle, pack, and ship the samples in accordance with the procedures in Appendix L.

B. To obtain surface water samples at depth from lakes (including Silver Lake), ponds, and impoundments with water depth greater than 6 to 8 feet, a Kemmerer sampler (Attachment B-2) will be used (for all analytes.) To use the Kemmerer sampler, the Kemmerer bottle is lowered to the approximate mid-depth location and the device trigger is released causing the sample vessel to be filled. After the sample vessel is filled, the Kemmerer sampler is slowly raised to minimize disturbance to the sample. Repeat Steps 8 through 19 from Procedure A after sample vessel is retrieved.

III. Velocity Profile Measurement Procedures

The following materials will be required for this activity:

- Health and safety equipment (as required by the Health and Safety Plan);
- Field notebook and pen;
- Calculator;
- Boat, as required;
- Rope;
- Surveyor's rod;
- Duct tape;
- Measuring tape; and
- Electromagnetic velocity meter.

Note: Based on extensive past experience in obtaining velocity measurements in the Housatonic River, the electromagnetic velocity meter is the most appropriate flow measurement device for measuring velocity in the river's different flow regimes and channel configurations.

The following procedures will be used to determine the velocity profile at river/stream cross sections:

Step 1 - Don personal protective equipment (as required in the Health and Safety Plan).

Step 2 - Extend rope across the river/steam.

Step 3 - Measure the width of the river/stream, then divide and mark into equally spaced measurement locations. For rivers/streams less than 30 feet in width, the spacing should be 5 feet. For rivers/streams between 30 feet and 100 feet in width, the spacing should be 10 feet; and for rivers/streams greater than 100 feet in width, the spacing should be 20 feet.

Step 4 - Calibrate velocity meter as per manufacturer's specifications.

Step 5 - Lower the surveyor's rod and measure and record the water depth to the nearest 0.1 foot at each measurement location.

Step 6 - Velocities will be determined using the two-point method. Attach the velocity meter probe to the surveyor's rod, measure, and record the velocity in feet per second at depths equaling 0.2 and 0.8 times the total river depth at each measurement location. Average the two velocity measurements to obtain the average velocity for that vertical section.

Step 7 - Record all measurements in field notebook.

Step 8 - Calculate the river flow rate by multiplying the average velocity reading for a particular vertical section times the area represented by the portion of the total cross-section extending half-way to the adjacent vertical sections (i.e., the Avelocity-area method@). The total flow rate is the sum of the flow of the partial sections.

$$Q_T = V_1 A_1 + V_2 A_2 + ... + V_n A_n$$

Where: Q_T = Total flow in cubic feet per second

V_{1-n} = Average velocity for a vertical section in feet per second

A_{1-n} = Cross-section area extending half-way to the adjacent vertical sections in square feet.

IV. Duplicate Sample Collection

Collection of duplicates involves the collection of two independent samples. The sample collection procedures are repeated at the same location and sample depth to the extent possible. The sample device (e.g., Kemmerer bottle) is sent down to a specific depth, retrieves the sample, and is brought to the surface, and the sample is transferred to the duplicate sample container. The duplicate sample will be labeled in such a way that the sample descriptions will not indicate the duplicate nature of the samples.

V. Survey

A field survey control program will be conducted using standard instrument survey techniques to document the surface water sampling locations when necessary to have record of the exact location. Generally, to accomplish this, a local control baseline will be set up. This local baseline control may then be tied into the appropriate vertical and horizontal datum such as the National Geodetic Vertical Datum of 1929 and the State Plane Coordinate System.

VI. Equipment Cleaning

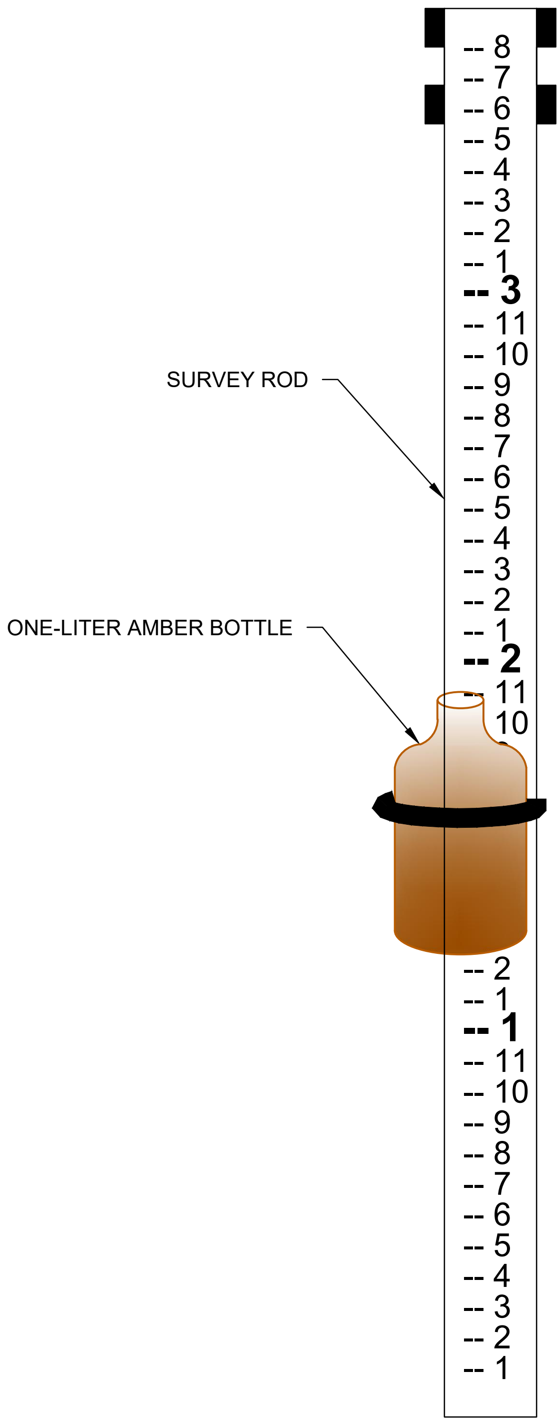
Equipment cleaning will occur at the beginning of each sampling event and between each sampling location as described in Appendix W.

VII. Disposal Methods

Rinse water, PPE, and other residuals generated during the equipment cleaning procedures will be placed in appropriate containers. Containerized waste will be disposed of by GE consistent with its ongoing disposal practices.

Attachment B-1

Surface Water Grab Sampler



NOTE:
ONE-LITER AMBER BOTTLE CLAMPED TO SURVEY ROD. DEPTH ADJUSTED TO REFLECT ONE HALF TOTAL DEPTH AT SAMPLE LOCATION.

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
SURFACE WATER SAMPLING PROCEDURES

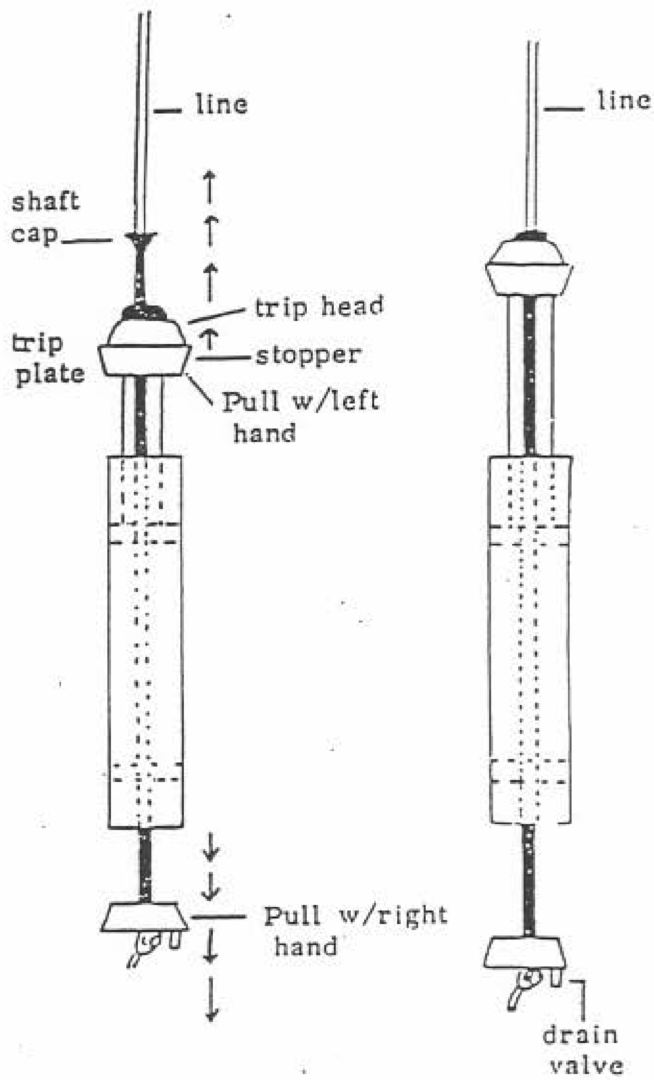
SURFACE WATER GRAB SAMPLER

ARCADIS

ATTACHMENT
B-1

Attachment B-2

Kemmerer Bottle


line
shaft
cap
trip head
trip
plate
stopper
Pull w/left
hand
Pull w/right
hand
line
drain
valve

Attachment B-3

Surface Water Grab Sample Field Log

Housatonic River Monthly Water Date: _____________ Project #:_________________________

Weather ________________________

Location ___________________________________ Time: _________

Total Width: __________

Sample Widths: 25% (0 + ______) 50% (0 +_______) 75% (0 + ______)

Total Depths: ______________ ________________ ________________

Sample Depths: ______________ ________________ ________________

Samplers: ______________

Water Temperature: ______________

pH __________ Conductivity _______mS/cm Turbidity _______ntu DO_________mg/L

Staff Gage: ____________

USGS Coltsville, MA Gage: _________________

******* QA/QC***** ________________________________**

Location _______________________________ Time: _________

Total Width: __________

Sample Widths: _____________

Total Depths: ______________

Sample Depths: ______________

Samplers: ___ ____________

Water Temperature: ______________

pH __________ Conductivity _______mS/cm Turbidity _______ntu DO_________mg/L

Gage: __________

******* QA/QC***** _______________________________**

Appendix C
SOP for Waterfowl Sampling

Standard Operating Procedure for Waterfowl Sampling

Scope and Application

This standard operating procedure (SOP) is applicable to the collection of waterfowl samples using baited traps. Baited traps will be placed at each targeted sampling location and will be checked daily for a period of one month or until the targeted number of waterfowl have been collected. This SOP contains methods for data collection and general safety considerations.

Health and Safety Considerations

Health and safety issues for the work associated with this SOP are addressed in the *Housatonic River – Rest of River, Health and Safety Plan* (HASP; Arcadis 2017), as it may be updated. The HASP will be followed during all activities conducted by field personnel. Two personnel are mandatory to assist with record keeping and act as a watch person in the event an emergency were to occur.

Personnel Qualifications

Field personnel executing these procedures will have read, be familiar with, and comply with the requirements of this SOP and the *Revised Baseline Monitoring Plan* (Anchor QEA 2022). Field personnel will also work under the direct supervision of qualified professionals who are experienced in performing the tasks described herein.

Equipment and Supplies

The following equipment and materials will be available as needed to carry out the procedures contained in this SOP. Additional equipment may be required depending on field conditions.

- Floating box traps or walk-in clover traps
- Baiting: whole and cracked corn
- Global Positioning System (Real-time kinematic [RTK] GPS)
- Chest or hip waders
- Laptop computer or tablet
- Field logbook or forms
- Labels
- Laboratory grade scale
- Coolers
- Plastic re-sealable bags
- 2- to 3-foot-long wooden garden stakes

- Rope
- Sharp sheers
- Wet ice
- Contractor grade trash bags
- Temperature blanks
- Chain of Custody
- Personal Protective Equipment (PPE)— personal flotation device, safety glasses, steel toe boots

Procedures

Collection of Waterfowl with Baited Traps

1. Establish RTK GPS connection.
2. Approximately one week before traps are deployed, locate an area within 10 feet of the targeted trap location and bait that area with whole and cracked corn. Coordinates for data collection locations will be predetermined using Geographic Information System (GIS).
3. After one week, return to the targeted trap location area and deploy the trap. Bait trap with whole and cracked corn. Record date and time of deployment on a laptop computer and manually in field logbook.
    a. If a floating box trap is used, secure the trap by tying a rope to the trap and attaching the other end to a garden stake that has been driven into the ground in an adjacent upland area.
    b. If a walk-in clover trap is used, drive garden stakes into the ground through the trap to secure the trap at the target location.
4. Check traps once to twice per day, re-baiting when corn is observed to be limited.
5. Remove captured waterfowl from traps and place into crates for transportation to a processing area.
6. Any waterfowl that were kept overnight before processing will be placed in a pet travel kennel with hay for bedding, corn, and water. Any corn used for feed or bait will be collected for analysis.

Specimen Handling and Preparation for Shipment

1. Once the waterfowl are transported to the processing area, they will be euthanized by first stunning with a blow to the head, followed by severing the head from the body with sharp shears (USACE 2000). The specimen will be immediately placed on ice in a cooler where the temperature is maintained at < 6°C.

2. Complete the waterfowl specimen collection forms (and log-book entry) after each location, each day. Field personnel will record the following information (State of New York 2008):
    a. Species identity
    b. Date and location of collection
    c. Sex and age
    d. Total weight to the nearest 10 grams (specimen should be dry and without attached or adhered debris prior to weighing)
    e. Presence of any tags/bands attached to the specimen at the time of taking (e.g., leg bands) or any other unusual observations (e.g., deformities, blindness, etc.)
3. Attach a tag to the specimen having a unique identifying number. Record this number in the Specimen ID No. column of the specimen collection records form.

    Nomenclature for the Specimen ID should be in accordance with the following example:

    MAL-WPA-M-01

    Identifiers in the Specimen ID correspond to the following:
    a. Species (MAL: Mallard Duck; WOD: Wood Duck)
    b. Location (WPA: Woods Pond Area; RPA: Rising Pond Area; CTA: CT Impoundment Area)
    c. Sex (M: Male; F: Female)
    d. Incremental specimen number recorded at each location
4. Place each specimen in a clear, food grade plastic bag. Tie bag. Attach ID tag to outside of bag in accordance with the nomenclature outlined above.
5. Place field-processed specimen back into cooler on ice.
6. Complete chain-of-custody form for each day and location's collection.
7. Transport each whole specimen, on ice, to a frozen storage facility until final shipment to the analytical laboratory. Specimens will be frozen as soon as possible on the day of collection.
8. When shipping the waterfowl specimen to the analytical laboratory, in a cooler, placed on wet ice, the original chain-of-custody form will accompany the specimen during all future transactions.
9. Make a copy of the waterfowl specimen collection records and chain-of-custody forms for sampler's records.

Field Data Collection

In addition to the information recorded in Step 2 above, the following information should also be collected and recorded at each monitoring location:

1. Date and time
2. Names of field personnel
3. Weather and water conditions at the time
4. Location identification/name
5. GPS position (northing, easting)
6. Waterfowl specimen collection records forms
7. Notes regarding conditions that might affect the measurements obtained or issues encountered

References

Anchor QEA (Anchor QEA, LLC), 2022. *Revised Baseline Monitoring Plan*. Prepared for General Electric Company, Pittsfield, Massachusetts, June 2021.

Arcadis, 2017. *Housatonic River – Rest of River, Health and Safety Plan*. Prepared for General Electric Company, Pittsfield, Massachusetts. September 2017.

State of New York, 2008. *Study Plan for Waterfowl Injury Assessment: Determining PCB Concentrations in Hudson River Resident Waterfowl*. Hudson River Natural Resource Trustees. December 2008.

USACE (U.S. Army Corps of Engineers), 2000. *Final Supplemental Investigation Work Plan for the Lower Housatonic River*. Volume II: Appendices. Task Order No. 0032. February 22, 2000.