Sheboygan River and Harbor Superfund Site

Baseline Upper and Lower River
Fish Monitoring Report

Prepared for
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Region 5

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1.0 Introduction

Monitoring of post-remedial fish tissue concentrations of polychlorinated biphenyls (PCBs) is being conducted on the Sheboygan River in accordance with the *Post-Remediation Monitoring Plan* (PMP). As stated in the PMP, the monitoring is being conducted in three phases consisting of the following:

- Baseline monitoring after remediation of the Upper River and prior to remediation of the Lower River reaches to determine the mean PCB concentration of each fish species of interest and establish a comparison point for future sampling,[1]
- Phase 1 annual monitoring following remediation of each reach to determine if the PCB concentration of each fish species is changing compared to the baseline and track the progress of the fish in meeting the remedial goals, and
- Phase 2 conformational sampling to verify the fish have reached the remedial goals.

This Baseline Upper and Lower River Fish Monitoring Report documents the post-remediation monitoring performed in 2008, specifically the collection of fish to establish baseline concentrations of several different fish species downstream of the portion of the river known as the Upper River. Baseline fish monitoring for the Upper River is considered the first annual sampling event following remediation documenting post-remedial conditions.

The data obtained during the baseline fish sampling will allow post-remedial fish tissue concentrations to be compared to baseline results to monitor remedial progress. Fish tissue results in the Upper River will be compared to the baseline fish monitoring performed in the first annual sampling event post-remediation, and the 2002 Interim Monitoring Program (IMP) Report. Fish tissue results in the Lower River reaches will be compared to the baseline fish monitoring performed prior to remediation.

In accordance with the *Upper River Statement of Work* (URSOW), post-remedial monitoring will occur until fish consumption advisories for the Upper River based on PCBs are lifted by the Wisconsin Department of Health, fish fillet concentrations of PCBs decrease to the target levels specified on page 32 of the *Record of Decision* (ROD), or for 30 years, whichever comes first.

[1] The Upper River has already been remediated. The first annual event will be used as the baseline event.

1.1 Site Description

The Sheboygan River and Harbor Superfund Site (the Site) is located on the western shore of Lake Michigan approximately fifty-five miles north of Milwaukee, Wisconsin, in Sheboygan County (Figure 1). The Site includes the former Tecumseh Manufacturing site and the lower fourteen miles of the Sheboygan River from the Sheboygan Falls Dam downstream to, and including, the Inner Harbor. This segment of the river flows west to east through the cities of Sheboygan Falls, Kohler, and Sheboygan before entering Lake Michigan.

During the Remedial Investigations (RI), the river was segmented in separate sections, known as reaches, based on physical characteristics such as average depth, width, and level of polychlorinated biphenyl (PCB) sediment contamination. The Upper River extends from the Sheboygan Falls Dam downstream four miles to the Waelderhaus Dam in Kohler. The Middle River extends seven miles from the Waelderhaus Dam to the former Chicago & Northwestern (C&NW) railroad bridge. The Lower River extends three miles from the C&NW railroad bridge to the Pennsylvania Avenue Bridge in downtown Sheboygan. The Inner Harbor includes the Sheboygan River from the Pennsylvania Avenue Bridge to the river's outlet to the Outer Harbor. The Outer Harbor is defined as the area formed by the two break walls. Figure 2 provides an overview of each river reach.

Remedial Design (RD) and Remedial Action (RA) work at the Site has been phased in order to achieve proper source control prior to beginning down river work. Phase I RA work for the Upper River, which included the Tecumseh plant soils, groundwater, and adjoining riverbank soils was completed in 2004. Phase II RA work for the Upper River included addressing the Near-Shore Sediments, Armored Areas, and Soft Sediment deposits was completed in 2007.[2] The Upper River floodplains have not been addressed due to access limitations. Remedial work in the Lower River has not been implemented.

1.2 Site History

The following information was obtained from the ROD. The Sheboygan Harbor was constructed at the mouth of the Sheboygan River in the early 1920's. In 1954, the lower Sheboygan River, namely the channel upstream of the 8th Street Bridge, was added as a part of the United States Army Corps of Engineers (USACE) maintenance dredging. Between 1956 and 1969, a total of 404,000 cubic yards of sediment were removed downstream of the 8th Street bridge between 1956 and 1969. The portion of the river above the 8th Street Bridge has not been dredged since 1956.

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[2] The Near-Shore sediments are defined as sediment segments that may be found in the bank or river bed adjacent to the shoreline of the former Tecumseh plant, along the north side of the Sheboygan River as described in the *External Source Assessment* (ESA). Armored Areas were portions of the river bed that had been covered with a geotextile fabric, a one-foot layer of run-of-bank material, another layer of geotextile fabric, gabions (cages filled with larger stone pieces or cobbles) along the sediment periphery, and cobbles to fill in any gaps between the gabions and atop the fabric (i.e. armoring) to stabilize the river bed and prevent a release of contaminated sediments into the river. Soft Sediments are defined as the sediment found on the river bed as a result of the river deposited suspended material where sediment was measured greater than 1 foot thick during the 2004 pre-design investigation.

Prior to 1969, the USACE disposed of the sediment from the Harbor in an authorized deep water disposal area in Lake Michigan. However, there has been no dredging in the Sheboygan Harbor since the United States Environmental Protection Agency (USEPA) and Wisconsin Department of Natural Resources (WDNR) determined that the sediment was unsuitable for open-water disposal. Sediment sampling and analysis performed by the USACE in 1979 detected what was reported as moderate to high levels of lead, zinc, PCBs, and chromium. According to the ROD, the USACE last dredged the Harbor mouth in 1991 however; in 1982 a policy to discontinue maintenance dredging was promulgated due to the discovery of PCBs in the sediments.

In June 1979, the USACE collected 11 cores from the Harbor area ranging in depth from 1.5 to 9 feet. The analytical results revealed greater PCB and metal levels in the sediment of the Inner Harbor than in sediment of the Outer Harbor. In October 1979, the USACE collected a second round of 21 cores. The analytical results indicated an increase in PCB concentrations with the distance upstream from the Harbor and with the depth of sediment.

Examination of 98 sediment profile samples collected by the USACE in December, 1982 from the Harbor indicated the presence of PCBs in the surface sediment of the Harbor. The possibility that this sediment may be classified as regulated material was reason for discontinuing maintenance dredging.

Tecumseh Products Company (Tecumseh) was located adjacent to the Sheboygan River in Sheboygan Falls and operated from 1966 to 2003. Tecumseh was considered a Potentially Responsible Party (PRP) when PCBs were discovered in coolant fluids disposed to sewer lines that discharged to the Upper River reach of the Sheboygan River. The contamination level was high in the sediment adjacent to the Tecumseh Plant, but decreased in concentration downstream. Tecumseh discontinued use of PCB impregnated coolant fluids in the early 1970's.

In 1978, the WDNR conducted a survey and found numerous industries that discharged contaminants to the Sheboygan River. Some had levels of PCBs discharged to the river and others had heavy metals in their discharge. In 1985, the outfall from Thomas Industries, located along the Inner Harbor, contained PCBs when analyzed by the WDNR on two different dates. A sample collected on June 13, 1975, from the storm sewer outfall had a concentration of 125 parts per billion (ppb) PCBs. A second sample collected on August 19, 1975, had a PCB concentration of 88 ppb. The Kohler Company, downstream of Sheboygan Falls and adjacent to the Middle River, was found to have heavy metal discharges to the river above the permit limits in the 1970s. In addition, the Kohler Landfill Superfund Site is located on the banks of the river.

The USEPA placed the Sheboygan River and Harbor Site on the National Priorities List (NPL) in 1986. Remedial work performed since that time includes source removal at the former Tecumseh property and removal of 94.1% of the impacted sediment in the Upper River. This work was completed in 2007.

1.3 River Characteristics

1.3.1 Upper River

The Upper River consists of discrete Soft Sediment deposits and non-Soft Sediment areas which include a mix of Soft Sediment, rocks, cobbles, and bare river bottom. The sediment contamination in the Upper River acts as a partial source of PCB-contaminated sediment for the rest of the river system during high river conditions in addition to the other sources identified in the Middle River, Lower River, and Inner Harbor. PCB sampling results in 1989 and 1990 showed concentrations from 1.4 to 4,500 ppm. PCB-contaminated sediment was removed near the former Tecumseh facility in 1990 and 1991. Subsequent sampling of the same area showed concentrations ranging from non-detect to as high as 840 ppm. The concentrations of PCBs in the sediment vary due to the dynamic nature of this river reach.

During the 2006/2007 seasons, sediment was removed from nine (9) Armored Area Remedial Management Units (RMUs) and 122 Soft Sediment RMUs. The Soft Sediment RMUs and Armored Areas removed in 2006/2007 contained the majority of the PCB mass within the Upper River. The Upper River remedial action conducted in 2006 and 2007 removed 20,728 cubic yards of sediment and 552 pounds of PCBs for a total mass removal percentage of 94.1% exceeding the PCB mass reduction objective of 88%. The Upper River SWAC was reduced from 5.2 ppm to 1.96 ppm and based on the mass removed, should reach a SWAC of 0.5 ppm over time.

1.3.2 Middle River

The Middle River consists of Soft and non-Soft Sediment areas similar to the Upper River, but due to the hydrodynamics of this reach, the areas of Soft Sediment are shallower and more widely scattered. The Waelderhaus dam, which marks the end of the Upper River, prevents most of the Upper River sediments from migrating downstream. As such, the Middle River sediments act as the primary source of PCB-contamination for the rest of the Lower River system. Information collected during the Remedial Investigation (RI) indicated PCB concentrations ranging from non-detect to 8.8 parts per million (ppm). WDNR sediment trap data, between 1990 and 1996, showed PCB concentrations ranging from 1.4 to 3.0 ppm. Samples obtained by the WDNR in 1997 indicated PCB concentrations ranging from 0.6 ppm to 37 ppm. Like the Upper River, sediment in the Middle River is likely to vary due to the dynamic nature of this river reach.

1.3.3 Lower River

The flow rate in the Lower River decreases leading to a more continuous layer of Soft Sediment throughout the reach. Based on the hydrodynamics of this reach, the Lower River is where much of the sediment released in the Middle River is deposited. During the RI, sample results showed PCB concentrations as high as 67 ppm adjacent to the WPSC Camp Marina MGP site, a site undergoing investigation and remediation under the oversight of the USEPA. WDNR sediment trap data, from 1994 to 1996, showed PCB concentrations ranging from 1.9 to 4.2 ppm.

1.3.4 Inner Harbor

The Inner Harbor is generally the river reach where upstream Soft Sediment is deposited. However, while the Inner Harbor is generally depositional, deposition occurs primarily between the 8th Street Bridge and the harbor mouth. The area between the Pennsylvania Bridge and 8th Street Bridge has little deposition and shows evidence of scour. RI sampling indicated PCB concentrations as high as 220 ppm in the Inner Harbor; however these levels were detected in 1979 and exist many feet below the surface. Surface (0-6 inches) sampling conducted in 1987 showed PCB results ranging from 0.17 to 5.8 ppm. Surface (0-6 inches) sampling conducted in 1999 showed PCB results ranging from 0.38 to 5.3 ppm. As a general rule, PCB concentrations increase with depth between the 8th Street bridge and harbor mouth. This is not the case for certain areas between the Pennsylvania Bridge and 8th Street Bridge.

1.4 Summary of Previous Fish Species Evaluation

This section is provided to demonstrate how sediment cleanup goals were established. The consumption of the fish is the primary exposure route for human receptors of the PCBs in the river sediments. The PCBs in the river sediments bioaccumulate in the fish from contact with impacted sediment, surface water, or by ingesting prey that are impacted. An understanding of the process in developing the sediment PCB cleanup goals based on allowable fish PCB concentrations is important in the evaluation of long-term assessment of remedial success.

There is considerable seasonal fishing in the Middle River, Lower River, and Inner Harbor.[3] Fishing is more limited in the Upper River. According to WDNR surveys, most fishing occurs during spring and fall salmon and trout runs. Resident fish taken from the Sheboygan River, between the Sheboygan Falls dam and the mouth of the river, fall into the "do not eat" consumption advisory category. Migrating trout and salmon are subject to Lake Michigan advisories as they obtain most of their PCB body burden from Lake Michigan. One objective of the sediment removal is to reduce the concentrations of PCBs in the fish over time so all the consumption advisories are lifted.

The physical setting of the Site provides several possible pathways of exposure to the contamination in the sediment: dermal contact, ingestion of contaminated surface water or sediment, and consumption of fish contaminated by sediment. The sediments are contaminated with PCBs, hydrophobic organic compounds that will strongly prefer to partition to organic material. It is assumed that the most significant exposure is from contaminated sediment, where virtually all PCBs reside, and not the surface water. In general, there is likely to be only limited direct contact with the sediment itself (i.e., dermal and/or ingestion pathway). Many studies have found that bioaccumulation of hydrophobic organic sediment contaminants is the critical and dominant fate of these compounds in the environment. As such, the human health analysis assumed that for this Site, the pathway presenting the majority of the risk and likely to yield the most protective assessment of risks is consumption of contaminated fish and not dermal contact. This does not imply that no other exposure pathways are occurring at this site, only that there is a focus on the pathway which contributes the majority of risk, the fish ingestion pathway.

[3] Much of the information presented in this section was obtained from the ROD.

Tecumseh collected fish tissue samples between 1990 and 1998 that showed smallmouth bass and white sucker PCB concentrations ranging from 1.3 ppm to 23.1 ppm. Carp had PCB levels ranging from 10.5 to 200 ppm. In general, the highest fish tissue PCB concentrations were found nearest the Tecumseh plant and tended to decrease downstream. The most recent studies by WDNR found that carp and smallmouth bass had the following mean concentrations, respectively:[4]

- Upper River 16.43 and 0.44 ppm
- Middle River 12.5 and 2.73 ppm
- Lower River 2.32 and 1.35 ppm, and
- Inner Harbor 1.45 and 2.0 ppm.

An Interim Monitoring Program (IMP) was performed by Blasland, Bouck, and Lee, Inc. (BBL) that consisted of the collection of smallmouth bass and white suckers at Rochester Park in the Upper River reach and between the dams in the Upper River reach.[5] During the baseline and subsequent post-remedial monitoring, these areas are known as Upper River 1 and Upper River 2 Sites. These fish were also collected near Kiwanis Park or in the Lower River reach. The range of smallmouth bass PCB concentrations detected is as follows:

- Upper River 1 2.1 to 10.3 ppm
- Upper River 2 1.1 to 7.3 ppm, and
- Lower River 0.82 to 3.7 ppm.

The PCB concentration decreased between 1990 and 2002 as seen in Charts 2 and 3 of Appendix 3. The results for smallmouth bass in the Upper River Site 1 show a general decreasing trend and the regression shows a decrease with a moderate correlation. For Upper River Site 2, the decrease has a very strong correlation for the regression. The range of white sucker concentrations detected is as follows:

- Upper River 1 2.7 to 18.3 ppm
- Upper River 2 1.9 to 8.7 ppm, and
- Lower River 1.4 to 3.9 ppm.

These PCB concentrations also decreased between 1990 and 2002 based on a comparison of the 2002 result to the 1990 result. While a regression of all the data between this period indicates a slight increase, the correlation is very weak (Chart 4, Appendix 3).

In 1996, the United States Environmental Protection Agency (USEPA) performed a baseline risk assessment for the Site, relying on data available from WDNR on fish tissue concentrations from 1994. The USEPA assessed sport fishing and subsistence fishing. The sport fishing scenario

[4] Most recent WNDR data available was used. This ranged from 1990 (Inner Harbor) 2000 to 2004 (others), depending on species and reach.
[5] Conducted in 1994, 1995, 1996, 1998, 1999, 2000, 2001, and 2002.

was developed to represent a mid-point or central tendency estimate of risk, and the subsistence fishing scenario was developed to represent an upper-bound estimate of risk. The sport fishing scenario variables were chosen to be reasonable, and not overly conservative in their assumptions. The USEPA used Great Lakes specific fish consumption information, available from an assessment of Michigan anglers. It was assumed that of the total amount of fish consumed; only half of the fish came from the Sheboygan River. This is accounted for in the fraction ingested term. For the upper-bound subsistence scenario, USEPA used a conservative estimate of all fish ingested coming from the Sheboygan River. Through this risk assessment, USEPA determined the following risks:

- Average $1x10^{-4}$ to $1x10^{-5}$
- Subsistence $1x10^{-2}$ to $1x10^{-4}$

In order to address unacceptable risks at the Site, USEPA calculated sediment cleanup goals, protective of human health. The USEPA made a conscious decision to model and be protective of the more contaminated resident fish species of smallmouth bass and carp at the Site. By selecting a cleanup goal protective of bass (or carp), the cleanup will be protective of the lesser contaminated species such as walleye, trout, salmon, and steelhead. This choice adds a layer of conservatism to allow for more fish consumption at the Site, especially of several non-resident species. Therefore, a cleanup based on resident species may allow for possibly more consumption of other types of fish that may occur as advisories are lifted.

To calculate a sediment cleanup goal or surface goal, target fish tissue levels were placed into a Biota to Sediment Accumulation Factor (BSAF) equation to estimate the sediment concentrations that would meet these fish targets. The term "surface goal" is more appropriate for sediment at the Sheboygan Site than the usual cleanup goal because what is calculated is a surface that the fish can be exposed to that will result in the target fish tissue levels. Looking at the Site, it's necessary to calculate what the residual concentration is after dredging certain levels, or what's left after taking out everything above a certain concentration. In the case of the Sheboygan Site, it's the target Surface Weighted Average Concentration, or SWAC, of the river after remediation.

The BSAF methodology is the same as used in the *Ecological Risk Assessment* and is similar to what was used in the *Remedial Investigation/Feasibility Study (RI/FS)*, except USEPA risk assessments include total organic carbon (TOC) and lipids in the calculation. Note that BSAFs were only calculated for smallmouth bass and carp and not the lesser contaminated migratory species of salmon and steelhead, to provide protection for anglers who consume several different species of fish. BSAFs were calculated for smallmouth bass because of their prevalence in the river and for carp as an indicator of concentrations in fish with higher lipid levels.

The analysis begins by calculating a site-specific BSAF using PCBs in sediment, TOC, PCBs in fish, and lipid data. The site-specific BSAFs are derived from the following values: RI/FS total river bed SWAC, and NOAA Risk Assessment TOC, and 1994 fish data (from FIELDS database). However, because the data in the RI/FS were given as summary statistics, the USEPA could not derive its own sediment surface area weighted PCB that is normalized to TOC. This term is necessary for the BSAF model. Therefore, the SWAC derived in the RI/FS is not useable in calculating a site-specific BSAF. Because the NOAA ecological risk assessment for the site also developed BSAFs, USEPA considered the NOAA BSAFs, and found that they were quite similar to the human health based BSAFs. Using the BSAFs, the USEPA determined the sediment cleanup goals as follows:

Sediment Cleanup Goal = (TOC x Conc. Fish) / (site specific BSAF x % lipid)

As can be seen, the sediment cleanup goal is entirely dependent on the accuracy of the BSAF. Therefore, the concentrations of PCBs in the fish may reach the target levels although the sediment contains more than the sediment cleanup goal. Conversely, the sediment cleanup goal may be reached before the fish actually reach the target levels. We have noted that prior to remediation; the PCB levels in the most recent fish collected in the Upper River as compared to the characterization sediment results have less PCBs than predicted by the BSAF. Therefore, the fish target levels may be reached before the sediment cleanup goals.

Target fish tissue levels corresponding to the SWAC Sediment Cleanup Goal include the following:

- Smallmouth Bass 0.31 ppm (skin on fillet)
- Walleye 0.63 ppm (skin on fillet)
- Trout 0.09 ppm (skin on fillet)[6]
- Carp 2.58 ppm (skin on fillet)
- Catfish 2.53 ppm (skin off fillet)

Using the BASF and these goals, the USEPA determined that the sediment cleanup goal SWAC is 0.5 ppm. The USEPA model predicts that once the SWAC reaches 0.5 ppm, the fish target levels will be met.[7] However, as the sediment cleanup goal was determined by modeling, the fish could reach the goals before the SWAC is 0.5 ppm. Conversely, the SWAC could reach 0.5 ppm and the fish do not reach the goal.

[6] This is a migratory fish species and most PCB burden is from Lake Michigan.
[7] There could be a lag period as older fish may have PCB concentrations reflective of when the sediment was more impacted.

2.0 Sampling and Analysis

2.1 Summary of Baseline Sampling Plan

The baseline sampling and analysis of fish species was conducted consistent with the *Post Remedial Monitoring Plan* (PMP) and the *Quality Assurance Project Plan* (QAPP). These plans were conditionally approved with comment on August 13, 2008. The PMP, which was developed with assistance from WDNR and the USEPA, determined statistically the number of fish to collect in each reach as well as in two sites within both the Upper and Middle River reaches.

Smallmouth bass, carp, walleye, and catfish were selected as they have assigned target goals in the *Record of Decision* (ROD). According to the ROD, smallmouth bass and carp are the more contaminated resident fish species at the Site and the USEPA selected these fish to determine cleanup goals believing that if these fish met the goals, the lesser contaminated species such as walleye, trout, salmon, and steelhead would be protected. Therefore the monitoring included these fish as well as walleye and catfish. Walleye and smallmouth bass will also help evaluate risk reduction for sport fisherman while carp and catfish for sustenance fisherman.

Rock bass and longnose dace were added because catfish and walleye are rarely caught according to WDNR. Juvenile carp and white suckers were added at the suggestion of the WDNR. Initially, the draft PMP that was approved stated that "carp or white suckers" were to be caught. After realizing this may not lead to a statistically valid sample set, WDNR and Pollution Risk Services (PRS) decided that both should be collected and the final PMP was written accordingly. The following table outlines the final fish species collection requirements.

Fish Species (size)	Number of Samples Per River Reach					
	Upper (Site 1)	Upper (Site 2)	Middle (Site 1)	Middle (Site 2)	Lower	Inner Harbor
Smallmouth Bass (10-17")	8	8	8	8	8	8
Adult Carp (15-25")	16	16	8	8	8	8
Juvenile Carp (3-8")	16	16	8	8	8	8
Adult Suckers (8-16")	8	8	8	8	8	8
Juvenile Suckers (3-8")	8	8	8	8	8	8
Rock Bass (5-9")	8	8	8	8	9	9
Longnose Dace (1-4")	8	8	8	8	8	8
Walleye (12-22")	8	8	8	8	9	9
Catfish (12-22")	8	8	8	8	8	8

The WDNR requested that the Upper and Middle River be divided into two sites per reach. The rational was stated as "Sampling stations should include the following number of sites per reach in order to represent the amount of contaminated sediment that will be removed and the variability expected. Specimens may be collected at different locations within a reach and collections sites within a reach can vary in exact location and length of river sampled (distance and location data should be reported in annual reports):"

As such, the collection included two sites in the Upper River – one from the former Tecumseh facility to River Bend reach and another from the Riverbend to Waelderhaus Dam in Kohler. For the Middle River, fish were collected from two sites within the reach: between the Waelderhaus dam and the Kohler landfill and downstream of the Kohler landfill to the C&NW Railroad Bridge.

The fish collection would target the habitats most conducive for each species. Table 1 presents a summary of the fish species, known habitat, and range. This information was primarily obtained from *Fishes in Wisconsin* (1983) and is intended to provide a summary of the characteristics of the target species and their typical habitat and is not intended to describe the habitats where the target species where encountered in the Sheboygan River. The habitats where fish were collected in 2008 are shown in Figures 3 through 6.

2.2 Baseline Procedures

After receipt of the Scientific Collectors permit on August 19, 2008, collection began in the Upper River reach before generally proceeding in order to the Lower River, Inner Harbor, and finally, the Middle River reaches. Due to an inability to initially collect Longnose Dace and juvenile species, the Upper and Middle River reaches were revisited. The fish collection occurred between August 19, 2008, and September 17, 2008. Table 2 provides a summary of the daily fish collection. Figures 3 through 6 show the locations where fish were collected in each reach.

With one exception, all fish were collected using electro-fishing equipment. The electro-fishing equipment used to collect fish, a Smith Root, Inc. Model 2.5 GPP, was either a boat-mounted array set-up or a hand held wand, depending on the location and species to collect. Due to the inability to obtain longnose dace with this method, seining was employed for this species. Electro-fishing was performed by selecting the appropriate pulsed DC power setting to stun-fish. The appropriate DC pulse setting (30 or 60) was made based on what set-up was used (30 for the wand, 60 for the arrays). At that point the percentage of output power was adjusted from 0-100 to stun the fish size needed without stunning more fish than needed or killing the fish. This percentage was determined by trial and error. Current was then applied to the river water by closure of the operating switch (i.e. foot pedal) while the generator and control equipment were operative. Once fish were stunned, the fish were collected with dip nets. The fish collected in the dip nets were identified for targeted species, measured to confirm they met size requirement, and were either retained in a live well or on ice in an insulated cooler until collection was completed.

Both shore and quarter arc seining was performed to collect Longnose Dace (dace). To collect dace, a seine with dimensions and mesh size appropriate for the dace and collecting conditions was selected (20' long with 1/4" mesh). For shore seining, the seining was performed by maintaining the seine approximately perpendicular to a shoreline, with one end at or near the edge of the water and the other held out as far out from shore as practicable. The seine was pulled along the shore with both ends moving at about the same rate. At the end of the seine haul, the outer end was moved around to the shore, and the entire seine was pulled out of the water while maintaining the leadline on the bottom as practicable. The seine was pulled onto shore until the leadline was completely out of the water.

For quarter-arc seining, the seining was performed by holding one end of the seine in one place at or near the shoreline and first pulling the other end of the seine out into the water perpendicular to the shore. The water-end of the seine was moved down and back toward shore so that the outer end of the net moves approximately through a quarter of a circle. When the outer end of the net reaches shore, the entire seine was pulled out of the water while maintaining the leadline on the bottom as practicable. The seine was pulled onto shore until the leadline was completely out of the water.

All fish samples were processed and packaged in accordance with the procedures described in the *WDNR's Division of Environmental Standards Field Procedures Manual* in addition to the PMP. During and after collection, samples were held in a live well or on ice in an insulated cooler. Samples remained whole and ungutted. Each fish was numbered and the following recorded in field log book:

- Length,
- Species[8],
- Sex (if possible),
- Age (if possible),
- Sample location,
- Other distinguishing features,
- Sampler(s), and
- Any unusual skin lesions, tumors, or other irregularities should also be noted.

The individual fish were wrapped in aluminum foil, then in freezer paper, and finally taped securely so that the package did not open during shipment. All samples were frozen as soon as possible after collection. No composite samples were created or analyzed.

For shipment to the laboratory, all fish samples were placed in a Ziploc bag or industrial grade trash bag, a label affixed and placed into second Ziploc bag, and then into a cooler with double bagged ice on the bottom of the cooler. The cooler was filled with fish samples, leaving enough room for double bagged ice on top of samples. A chain-of-custody form was placed in a sealable plastic bag and taped to the inside of cooler lid. The coolers were collected by the laboratory and as such custody seals were not used.

[8] Species was determined by SOP #10, *Fish Identification,* and with assistance from CH2MHill.

The laboratory prepared and analyzed the samples in accordance with the analytical method USEPA SW846-8082 Modified and Laboratory Standard Operating Procedures (SOPs) developed in accordance with method 8082 including the following:

- GB-L-001, Rev .0 – Tissue Preparation
- GB-L-003, Rev. 0 – Lipids
- GB-O-031, Rev. 1 – Extraction
- GB-O-034, Rev. 1 – Sulfuric Acid Cleanup
- GB-O-036, Rev. 1 – Florosil Cleanup
- GB-O-026, Rev. 2 – PCB Analysis

The analysis to be performed on fish included total PCBs (Aroclor basis), percent lipids, and gender. The PCB method detection limit was 0.019 mg/kg.

QA/QC samples consisted of a matrix spike and matrix spike duplicate. A minimum of one matrix spike/matrix spike duplicate analysis was performed with every batch of fish being analyzed for PCBs. Batch size was limited to no more than 20 samples. For analysis of PCBs in tissues, the QA procedures in USEPA's *Statement of Work for Organic Analysis* (Feb 1988) was used, including laboratory blanks consistent with required detection limits, and initial and continuing calibration to verify recoveries.

2.3 Deviation from Plan

The only field deviation was not all targeted fish were collected. Table 3 provides a summary of the success of the collection process. It was anticipated that walleye or catfish would not be collected and as surrogates, rock bass and longnose dace were used. While we did not expect to catch any walleye or catfish, some were collected. Catfish were collected from the Middle, Lower and Inner Harbor River reaches. Walleye were collected from the Middle River and Inner Harbor reach.

No juvenile carp could be obtained. According to *Fishes of Wisconsin* (1983), carp typically spawn in late in May or early June and the incubation period is 3 to 16 days depending on temperature. Young carp grow very rapidly and by middle August have an average size of almost four inches and a range of 3 to 5 inches. Based on this growth rate, it may be difficult to catch juvenile carp in the 3 to 8 inches range specified in the PMP in late August and early September. Earlier fish collection of juvenile carp should be considered in the future.

For adult White Suckers, the target numbers were reached at both Upper River sites and one of the Middle River site. The target goal was only missed by one fish in Middle River 1 and the number collected was similar to WDNR efforts in 1999 and 2004. Failure to collect the target goal in the Lower River (2 of 8) and in the Inner Harbor (0 of 8) is attributed to lack of habitat. Very little areas with vegetation and warm shallows of estuaries and bays, the preferred habitat of white sucker, were observed in the Lower River and none were observed in the Inner Harbor (see Figures 5 and 6). Information on habitat was obtained from *Fishes of Wisconsin* (1983).

WDNR has also not had much success collecting this species in the Lower River or Inner Harbor reaches. Failure to collect the target goal of juvenile White Suckers is also attributed to lack of habitat in the Lower River and Inner Harbor.

Finally, the Sheboygan River does not appear to provide an abundance of quality habitat for Longnose Dace being too deep in many areas. However, there is some suitable habitat where shallows are present (i.e. Upper River, Site 1 and Middle River, Site 1 and 2). The water is too deep in the Lower River and Inner Harbor reaches to provide suitable habitat. It is also unsuitable in Site 2 of the Upper River reach. The baseline collection obtained 61% of the expected target goal. Based on the results as compared to habitat requirements, the goal of collecting certain fish in certain locations was optimistic at best. If the completion success is based on a target goal limited to the reaches conducive to dace, a 65% completion percentage was obtained. For the adult fish in the ROD that were expected to be caught, carp, suckers and smallmouth bass, the success rate is 76%.

The inability to collect the target number of fish for some of the species can increase the chances of a Type II error. That is, believing the fish tissue PCB results are less than the action level when they are not. Reducing the number of samples reduces the confidence in the decision. This is the baseline sampling event and this decision is not being made. As such, this error cannot occur.

There were no deviations from the laboratory method in order to analyze or report the fish tissue results.

3.0 Sampling Results

3.1 Fish Tissue Results

A summary of the results is provided in Appendix 1 while copies of the analytical reports are provided in Appendix 2 as a compact disc. Except for catfish, all fish samples that were analyzed were skin on fillets. Catfish samples analyzed were skin off fillets. A summary of the baseline statistics is provided in Table 4. The adult fish tissue PCB results tend to decrease moving from the Upper River to the Inner Harbor. An exception is that in almost every case, the PCB concentrations were higher in the Lower River reach than the Middle River 2 site. This would correspond to the increase in PCBs in the sediment in the Lower River and Inner Harbor due to the identified sources in these reaches. Chart 1 in Appendix 3 provides a graphical summary of the PCB concentrations of the adult fish that were most successfully collected across reaches demonstrating the decreasing trend from upstream to downstream

Adult carp tended to have the highest mean PCB concentrations of the fish species, due to being the most prevalent species collected. Although for the few caught, catfish had the highest mean concentration. These are bottom feeders and the results are not unexpected compared to the sport fish. As will be discussed in the following section, the results are higher than the most recent Interim Monitoring results. They are also higher than the older results from the Interim Monitoring Program. Adult carp had the highest mean concentration in the Upper River. However, in both sites of the Middle River, as well as the Lower River and Inner Harbor reaches, this was the only fish caught that many of the individual results were less than the ROD goal.

The age of the fish was determined by EA Engineering, Science, and Technology, Inc. who performs fish aging for the Fox River monitoring program and was recommended by Foth Infrastructure and Engineering LLC (Foth). All of the adult fish were of the age where they should have been sexually mature. None of the fish collected appeared to be of an age that exceeded the usual published longevity period. The majority of the fish collected were males.

3.2 Data Quality

The laboratory performs a validation of the analytical procedure using the quality control sample results, as applicable. This validation is discussed in the Narrative section of each of the 13 lab reports generated by this sampling and analysis event. The laboratory reported the following:

- All samples were extracted and analyzed within the allowable holding time,
- There were no problems with the initial or continuing calibrations,
- There were no problems with duplicate samples,
- All laboratory control spikes were within the allowable range, and
- PCBs were not detected in the method blanks.

There were problems with the surrogate recoveries in 36% of the samples. The problem was that the surrogates could not be evaluated against the control limits due to sample dilution. This should not affect the data as for the 64% that could be compared, there were no problems.

There were 9 occasions where the laboratory identified problems with the matrix spike (MS)/matrix spike duplicate (MSD) results. The purpose of MS and MSD is to identify method accuracy and precision. Matrix spikes are generated by the addition of a known amount of target analyte to a sub-sample. Unless the added target analyte is infused within a similar matrix, the ability of the matrix spike to represent method performance is limited; rather, matrix spikes often assist in the identification on chemical interferences inherent in the matrix. The efficiency of any method to dissolute an aqueous standard solution will always be significantly greater than a real world sample.

Five of the 9 samples had no recovery (0%) of the matrix spike or matrix spike duplicate for PCB 1242. None of these fish samples contained PCB 1242 and as such, this lack of recovery does not affect the data. The MS/MSD results in two of the samples actually fell within the control limits. However, the laboratory had to dilute the samples heavily making it difficult to discern the spike from the actual background PCB and identified this as a possible problem. In the other two samples, the MS/MSD recovery exceeded the control limit of 130%. Both samples had relatively high levels of PCBs which based on the MS/MSD results may be biased high. However, neither sample was identified as an outlier and both had PCB concentrations less than the mean for that reach. As such, it does not appear the results are biased high. None of the MS/MSD problems or potential problems appears to affect the data or conclusions drawn from the data.

Differences in the matrix between fish are more marked than in other environmental media such as soil or groundwater and could be due to the large differences in lipid content. However, according to the laboratory, the matrix spike problem is not attributed to this difference in lipid content. According to Mr. Ted Noltemeyer, Project Manager at PACE Analytical, "The analysis of fish is typically more of a challenge than waters and soils, but our methods and cleanups take care of that. The MS/MSD recoveries here are affected by the relatively high concentrations of PCBs in the samples, not by the matrix itself. Bottom line is most MS/MSD samples required dilutions which negated the ability to appropriately measure the spike recoveries."

4.0 Data Analysis

4.1 Summary Statistics

Summary statistics are provided with the data in Appendix 1 and in Table 4. The data distribution and upper 95% confidence levels (95% UCL) were calculated using ProUCL as requested by USEPA. ProUCL documentation is provided in Appendix 4. Consistent with historical results, the variability of the data was rather low and the majority of the data had a normal distribution.[9] The distribution was calculated by ProUCL using a variety of goodness-of-fit methods including Shapiro-Wilk, and Kolmogorov-Smirnov tests. Knowledge of the distribution is needed to determine the proper methods for calculating 95% UCL as well as other statistical tests. Coefficient of variations ranged from 0.22 to 1.67 with an average of 0.59. The highest coefficient of variations were observed in adult carp with the largest variation observed from Middle River site 1 and the next largest variation at Upper River site 2.

Outliers are inevitable in data sets originating from environmental applications. Outliers are defined to be an observation that does not conform to the pattern established by other observations (Gilbert, 1987). Prior to calculating the UCL, ProUCL recommends an outlier analysis. In the case of the fish tissue data from the baseline monitoring, a few of the results appeared to be outliers because the concentrations was significantly greater than the mean for the same species within the same reach. As such, ProUCL was also used to evaluate the possibility of outliers. ProUCL uses both the Dixon and Rosner outlier tests and uses the Dixon test where the data sets are less than 25 samples. Using ProUCL, a total of six outliers was detected (Appendix 4). These outliers and the significance levels at which they were identified are summarized below.[10]

Location	Adult Carp	Adult Sucker	Dace	Catfish
Middle River 1	22.8 ppm @ 0.01	19.9 ppm @ 0.1	17.8 ppm @ 0.1	None
Lower River	44.9 ppm @ 0.05	None	None	28.4 ppm @ 0.1
Inner Harbor	9.14 ppm @ 0.1	None	None	None

The outlier analysis identified six samples that were not representative of the river reach. Reasons why these fish are not representative are discussed in the following. The two fish that represented the outliers in the Lower River reach were a carp and a catfish. They smallest fish within their species for the reach but had the highest levels of fat (lipids). As such, the length and weight variables can not explain the differences. The higher levels of lipids may be connected to the only other variable that could explain the difference, habitat. The carp outlier caught in the Lower River could be from the Upper River; its concentration of 17.8 mg/Kg is very close to the mean for the Upper River (25.9 mg/kg). The catfish outlier in the Lower River could also have been from the Middle River; site 2 offers suitable habitat for catfish. The Middle River habitat, where the shoreline is much less developed than the Lower River, may have produced a more abundant food supply leading to the large fat content. According to *Fishes in Wisconsin*, carp range extensively and are capable of jumping dams or falls. As such, it's not

[9] Historical results were provided by the USEPA and WDNR. These included the BBL Interim Monitoring Program data and WDNR fish advisory studies. The data was provided in the *Post Remedial Monitoring Plan.*
[10] The significance level is the risk of a false rejection.

unexpected that an Upper River carp would be found downstream. Catfish are also known to move great distances and the fish caught in the Lower River could have originated from Middle River.

The PCB content of the adult carp collected in the Inner Harbor is more than 400% larger than the mean for the remainder of the species in this reach. The size and fat content were within the median of this species collected from this reach. As such, increases in PCB content cannot be attributed to these variables. The only other variable is habitat. The PCB result is very close to the mean results for this species in the Lower River.

The adult carp collected in the Middle River was older and larger than other fish of this species collected in this reach. It also had the second highest fat content. At six years old, it was 50% older than the other fish collected from the reach and near the end of its life span. This sample may not be representative adult carp in this reach because of its age. The adult sucker collected in this reach was the same age and size (weight, length, fat) as the other fish of this species collected in this reach. White suckers are also known to move about extensively. The longnose dace outlier had a PCB content (17.8 mg/Kg) that was much closer to those collected in the Upper River reach (mean 13.3 mg/Kg, maximum 17.6 mg/Kg) than those in the Middle River reach (mean 7.8 mg/Kg). While dace are not known to move much, there size would indicate the possibility of being washed over the dams from the Upper River during high river level events.

Based on this information, the outliers could be eliminated when calculating the summary statistics for the fish species within the reach. However, Region V USEPA requested that this not be done since fish from other reaches can migrate between reaches and represent possible exposure to humans via consumption. As the outliers would only be eliminated in the comparison of fish between sites, reaches, fish species and historical data but not in the covariant analysis, elimination of the outliers has no bearing on protection of human health. Elimination of the outliers allows a clearer understanding of differences between sites, reaches, fish species, and historical data. Regardless, the outliers were not eliminated from the statistical comparisons discussed.

Data analysis included an analysis of means using the t-test and analysis of variance (ANOVA). The t-test was performed based on unequal variance after an assessment indicated that was the most appropriate test. As far as the appropriateness of the test, PRS reviewed several publications such as *A Guide for Selecting Statistical Techniques for Analyzing Social Science Data* (The University of Michigan, 1981), *Intuitive Biostatistics* (Oxford University Press, 1995), *Lake and Reservoir Bioassessment and Biocriteria Technical Guidance Document* (USEPA, 1998) and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (USEPA, 2007). All of these indicated the t-test was an appropriate method for the comparisons being performed. This was also the test proposed in the approved *Lower Fox River Baseline Monitoring Plan.*

Both tests can evaluate if there is a significant difference between data sets. ANOVA is actually a collection of statistical methods that can evaluate the conceptual classes of data variability, fixed effect, random effect, and mixed effect. The one-way ANOVA is used to test differences in two or more independent groups. Since the t-test can be used for two groups, the one-way ANOVA is typically used for analysis of three groups. The ANOVA was used with the t-test as an additional test of differences based on a different approach to add a measure of robustness to the evaluation. The tests of differences were performed to evaluate the following:

- Differences in fish species PCB concentrations between sites in the Upper and Middle River reaches,
- Differences in fish species PCB concentrations between the river reaches,
- Difference of fish species PCB concentrations compared to all fish collected, and
- Difference with historical data

No statistical analysis was performed to evaluate differences in PCB concentrations among males and females by reach. Typically, there were insufficient females collected to evaluate. In addition, differences due to age were not evaluated due to the variability of the ages. Neither sex nor adult age would appear to be a factor in decision making as anglers would not differentiate consumption patterns based on these factors.

Based on the redundancy of the t-test and the ANOVA tests, the Mann-Whitney test was used when the t-test and ANOVA results differed and box and whisker plots (boxplots) were also generated. This testing was done at the request of the USEPA. The Mann-Whitney test is a non-parametric test for assessing whether two independent samples of observations come from the same distribution. It is virtually identical to performing an ordinary parametric t-test on the data after ranking over the combined samples. The null hypothesis in the Mann–Whitney test is that the two samples are drawn from a single population, and therefore that their probability distributions are equal. It requires the two samples to be independent, and the observations to be ordinal or continuous measurements, i.e. one can at least say, of any two observations, which is the greater.

In descriptive statistics, a box-and-whisker is a convenient way of graphically depicting groups of numerical data through their five-number summaries (the smallest observation (sample minimum), lower quartile (Q1), median (Q2), upper quartile (Q3), and largest observation (sample maximum). Boxplots can be useful to display differences between populations without making any assumptions of the underlying statistical distribution: they are non-parametric. While the boxplots provide a convenient way of comparing data, they were not used for making decisions concerning the data.

Appendix 5 provides the results of the analysis. The t-test and ANOVA analyses were performed in Excel using equations obtained from *Practical Statistics for Analytical Chemists* (1987). The spreadsheets were validated using examples from the book. The analysis was only performed for the fish that were caught in sufficient quantities needed for each type of analysis. Juvenile fish were also not evaluated because of the infrequency of collection and the failure to collect these in the past.

Boxplots were generated using ProUCL then exported to Excel for formatting. The Mann-Whitney test was run using U-Test, a Southwestern Medical Center statistical software program.

The results were exported to Excel for formatting. Post-hoc tests were not performed. These tests are difficult to interpret and unless decisions and recommendations based on the statistical tests are accepted, unnecessary.

4.2 Comparison of Sites in a Reach

Fish monitoring in the Upper and Middle River reaches were divided into two sites at the request of the WDNR, in order to represent the amount of contaminated sediment removed and the variability expected. As can be seen in Table A5-1 (Appendix 5), there was no significant difference at the 95% level for fish species collected in the Upper River sites using the t-test. Table A5-2 confirmed this except for carp. As can be seen in Table A5-1, the calculated t-value for carp of 1.71 is very close to the critical value of 1.75 and as such, the ANOVA result is not surprising. The Mann-Whitney test confirmed the t-test (Table A5-3, Appendix 5) for carp indicating there was no significant difference between sites.

In the Middle River, both the t-test and the ANOVA indicated a significant difference for suckers and smallmouth bass. The statistical evaluation generally shows there is no difference in the PCB results for fish collected in the different sites of the Upper River reaches. For two out of the three fish species that were collected in sufficient numbers to perform the statistical comparison, there was a significant difference between sites with site 1 having much higher concentrations than site 2.

4.3 Comparison of Reaches

In addition to comparing the sites within the Upper and Middle River reaches, all reaches were compared. The t-test (Table A5-4) and ANOVA (Table A5-5) indicated the differences in fish PCB concentrations were significantly different between the Upper River and the Middle River reaches. Consistent with the sampling strategy of the Interim Monitoring Program which did not believe the Middle River and Lower River reaches were very different, the differences in PCB concentrations between the these two reaches were not significantly different. Consequently, the difference between the Upper River and Lower River would be significantly different between reaches. For the Lower River and Inner Harbor reaches, the t-test results indicate significant differences for smallmouth bass. The ANOVA and Whitney Mann tests did not indicate there were significant differences between the reaches for smallmouth bass. The Whitney-Mann test is documented in Table A5-6.

Two variables have been identified that would account for the differences between the Upper River and the Lower river reaches: the magnitude of sediment impact in each of these reaches and the Upper River reach was remediated while the others were not. However, the Inner Harbor has a high level of PCB sediment impact but the fish tissue concentrations are much lower than the Upper River reach (Table 4). Comparison of the fish tissue results in Section 4.4 will provide an evaluation of the differences observed between the Upper River and other reaches.

ProUCL generated boxplots comparing fish species across the reaches are provided in Appendix 5. The boxplots are consistent with Chart 1 showing a general reduction in PCB fish tissue concentration moving from upstream to downstream. The boxplots also identified outliers.

4.4 Comparison of Fish

The mean concentrations of each fish species was also compared to the mean concentrations of all fish, excluding the fish species under comparison. Based on the t-test (Table A5-7) the concentrations of white suckers, smallmouth bass, longnose dace, and walleye are not significantly different than the concentrations of all fish. However, the ANOVA (Table 5-8) test indicated there were differences for white suckers, smallmouth bass, and longnose dace. This could not be confirmed with the Mann-Whitney test (Table A5-9). The t-test and Mann-Whitney analyses indicate that the collection of either white suckers, smallmouth bass, or longnose dace alone could be used to evaluate the trend of fish concentrations following remediation. The data set for the walleye is not sufficiently large to be used however.

4.5 Comparison with Historical Data

Finally the data was compared to the historical data[11], where available (Tables A5-10 and A5-11). A non-statistical comparison of the means shows the mean concentrations were higher than the most recent historical result. The differences were most extreme in the Upper River sites, the only areas remediated. The smallmouth bass results and Upper River 2 white sucker were higher than the oldest of the Interim Monitoring results as can be seen in Charts 2 through 5 in Appendix 3.[12]

The t-test evaluation indicated that 5 of the 8 adult fish species evaluated had statistically different results in the Upper River sites. The ANOVA evaluation was similar though there was some disagreement as was there with the Mann-Whitney tests (Table A5-12). Based on the weight of evidence, it appears that the remediation of the Upper River caused an increase in the PCB concentrations in the fish. Prior to the fish collection, we anticipated that this may occur due to disturbance of the sediment causing increased suspension of sediment. The increase in biota concentrations following dredging was discussed in *Sediment Dredging at Superfund Megasites, Assessing the Effectiveness* (National Academy of Sciences, 2007). Cadmium levels in benthic invertebrates increased compared to pre-dredging levels for the first four years following dredging at the Marathon Battery site.[13] A decrease was not noted until the fifth year. At the Black River site in Ohio, an increase in cancer was noted following dredging that was "probably due to the exposure of fish and their prey to higher concentrations of PAHs in sediment and water during dredging."

While the turbidity was not measured during baseline monitoring, the results of the Lower Fox River baseline monitoring showed a strong correlation between PCB levels in the water column and the total suspended solids (TSS). This is consistent with the National Academy of Sciences findings that dredging exposes biota to more PCBs in the sediment and water column. Dredging increases TSS, which contains PCBs, and increased water column PCB levels, thus increasing exposure to the fish.

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[11] Historical results were provided by the USEPA and WDNR. These included the BBL Interim Monitoring Program data and WDNR fish advisory studies. The data was provided in the *Post Remedial Monitoring Plan.*

[12] The mean results were used.

[13] Fish were not monitored.

The water column had the highest PCB levels during the fall sampling period in the Lower Fox River study. This would not account for the historical differences in the fish tissue results in the Sheboygan River since the Interim Monitoring program fish collection occurred during the fall.

The repercussion of an increase in fish tissue concentrations following dredging indicates a need for further analysis. The affects of the lipid content of the fish should be evaluated during the comparison. Similar to the Waukegan Superfund site as discussed in *Sediment Dredging at Superfund Megasites, Assessing the Effectiveness,* the historical comparison was repeated after normalizing the PCB fish tissue results with the percent lipid concentration (Tables A5-13 and A5-14 in Appendix 5). This analysis demonstrated the pre and post-dredging fish tissue concentrations were not much different when using the lipid normalized data. Using non-normalized data, 58% of the adult species in the reaches evaluated had statistically significant differences between pre and post-dredging PCB concentrations based on the Mann-Whitney, confirmed t-test or ANOVA test. Using lipid normalized data, 60% had a significant difference. Clearly, there was another variable besides lipid content controlling the pre and post-dredge PCB concentrations in fish tissues. This variable is apparently remediation.

4.6 PCB Correlation and Controlling Variables

4.6.1 Linear Regression

During development of the PMP, WDNR had stated that percent lipids and length could be controlling variables for fish tissue PCB content excluding external variables such as TSS, river flow rates, river temperature, etc. The Lower Fox River baseline monitoring indicated there was contradictory information concerning TSS and temperature but that there is a strong correlation between TSS and water column PCB results. Therefore, there could be a correlation between fish tissue PCB content and water column PCB concentrations although we can not evaluate this as water column testing was not performed.

Simple (one-variable) linear regression was evaluated as a data analysis tool. Charts 6 and 7 in Appendix 3 provide the results for this evaluation. Most of the adult fish in the Upper River 1 site and random adult fish from other reaches were evaluated. The regression was not performed using log transformed data since the majority of the data had a normal distribution. Generally the evaluation showed there was a positive correlation between PCB concentrations and percent lipids, for the species evaluated. The highest correlation was for catfish and white suckers, bottom feeders. While these showed good correlation, the other species did not. The evaluation also showed a generally positive but poor correlation between PCB concentrations and length. However, three of the 8 evaluated had a negative correlation and one had basically no slope (Upper River 1 smallmouth bass). These results show one-variable linear regression provides little help analyzing the data and it will not be performed for the remainder of the fish and reaches.

4.6.2 Co-variant Analysis

WDNR had recommended during development of the Plan that co-variant analysis be used to assess both lipid content and length to better account for co-variance between these variables. In the fish tissue PCB post remedial monitoring program we will attempt to determine if PCB concentrations change (on average) between sequential sampling events. In its simplest form we can think of describing the process as a model, where we attempt to "explain" fish tissue concentrations by the sampling event date. For example, if concentrations fall between sampling events 1 and 2, the sampling event date (as a factor in the model) has a decreasing effect on the fish tissue concentrations.

The variation found within a sampling event in this example is attributed to model error. If the within event model variation is large in comparison to the observed sampling event effect, we cannot conclude one way or the other that concentrations have changed. However, if we can further explain away the within event variation (thereby reducing the model error) it may still be possible to detect a concentration change. Adding covariates to the model attempts to do exactly that. By adding measurements of fish length and percent lipids as explanatory variables, we may reduce within event variation in the model so concentration changes over time are more easily detected.

This type of model is called a covariance model or analysis of covariance (ANCOVA). It is a mixture of regression analysis and analysis of variance (ANOVA) in that both qualitative and quantitative explanatory variables are utilized. The chief independent variables of interest are qualitative, with quantitative variables being introduced mainly to reduce the variance of the error terms.

This analysis will strengthen the statistical comparison of Phase 1 fish tissue results as compared to the baseline results. The analysis was performed by Foth and is documented in Appendix 7. A summary of the results is summarized in Table 5.

Foth concluded that lipids and/or length significantly affected fish tissue PCB concentrations in 17 of 27 data sets.[14] Lipids had 100% more affect on PCB concentration than length. In fact, length showed an inverse affect on PCB concentration in several data sets. Both lipids and length contributed to PCB concentrations in 5 of 17 data sets. Lipid content affected PCB concentrations mostly in the two bass species and length most affected the carp. Foth concluded that inclusion of these variables into the analysis would reduce variability in the PCB concentrations. This will allow for a more powerful comparison of the Phase 1 fish monitoring results with the baseline results.

4.6.3 Adequacy of Fish-Tissue Samples

The number of each fish species collected during baseline monitoring was determined by using a statistical procedure based on the coefficient of variation of the most recent historical data. If the baseline coefficient of variation is much higher than the historical variation, it could be possible that insufficient fish were collected for the baseline event to detect a 50% reduction in the fish tissue PCB concentrations. The results of the coefficient of variation comparison are summarized in Table 6. It includes the number of fish to be collected as determined in the Plan compared to the number that would be required based on the coefficient of variation from the baseline event. There is excellent agreement. In 8 of 32 (25%) of the comparisons, it indicates

[14] Each data set represented one fish species in one site or reach.

the numbers in the plan were not sufficient. Two of these were for rock bass where only 1 additional fish was required. Based on the data available at the time the Plan was developed, a 75% agreement is excellent.

5.0 Phase 1 Monitoring

The number of fish to collect for annual sampling is to be calculated by the same method as used for baseline sampling. With the exception of coefficient of variation, the input variables are the same. Please note, some fish were not collected in sufficient quantities to statistically determine the number of fish necessary for the first Phase 1 monitoring event. The same number of fish collected during the baseline event will be used for these fish.

When the number of fish to be collected as determined by the statistical method is less than 8, the number was increased to 8. That is, a minimum of 8 fish will be collected and analyzed. In addition, annual sampling will not collect more fish of a species than was obtained during baseline monitoring. Appendix 6 provides the calculations on the number of fish to collect during the first post remedial annual monitoring event while the following summarizes the results.

Fish Species	Number of Samples Per River Reach					
	Upper (Site 1)	Upper (Site 2)	Middle (Site 1)	Middle (Site 2)	Lower	Inner Harbor
Smallmouth Bass	8	8	8	8	8	8
Adult Carp	12	16	8	8	8	8
Juvenile Carp	16	16	8	8	8	8
Adult Suckers	8	8	8	8	8	8
Juvenile Suckers	8	8	8	8	8	8
Rock Bass	8	8	8	8	8	9
Longnose Dace	8	8	8	8	8	8
Walleye	8	8	8	8	9	8
Catfish	8	8	8	8	8	8

Only the Upper River reach has been remediated and as such, this reach will be the only portion of the river where post remedial monitoring will occur in 2009. Recommendations to revise the annual monitoring requirements, based on the statistical analysis, are made in Section 6.0. If these recommendations are not accepted, the number of each fish species discussed in this section will be collected in the Upper River reach in 2009 and during the first post remedial event in the other reaches.

6.0 Assessment and Recommendations

6.1 Sampling Frequency

Comparison of the Upper River results to the historical data shows that the remediation will cause an increase in the PCB concentrations in the fish. Since PCBs bioaccumulate, we should not expect to see a decrease in PCB concentrations in the adult species until they die out and are replaced with fish hatched since the remediation. This indicates that collection of adult fish immediately following remediation has little value and consideration should be given to revising our approach to annual monitoring. Expected fish life spans, based on *Fishes in Wisconsin* are as follows:

- Adult Carp 9 – 15 years
- Adult White Suckers 5 years
- Smallmouth Bass Not provided, 5 – 7 years[15]
- Rock Bass 6 – 8 years
- Longnose Dace Not provided, 3 – 4 years
- Walleye 6 – 7 years
- Channel Catfish 8 years

Similar to the earthworm monitoring in the floodplain where the earthworms are not collected following remediation until after the average life span of adult earthworm has passed, collection of adult fish in the years immediately following remediation should be postponed. A recommendation based on all of the assessments will be made at the end of this section.

6.2 Sample Locations

The data analysis indicated there was little variability between sites in the Upper River reach. However, the differences in remediation in the Upper River should be considered. A recommendation based on all of the assessments will be made at the end of this section.

6.3 Fish Species

The comparison of several adult fish species to all adult fish species indicated smallmouth bass, white suckers, longnose dace, and walleye could be used as indicator species when monitoring trends. White suckers, longnose dace, and walleye could not be collected in all reaches and as such, could not be used as indicators. However, smallmouth bass were successfully collected in all reaches and could be used as an indicator when monitoring trends. A recommendation based on all of the assessments will be made at the end of this section.

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[15] Where not provided in *Fishes of Wisconsin*, lifespan were obtained from various internet sources.

6.4 Fish Sample Numbers

The fish sample numbers specified in the Plan is appropriate and provides statistical confidence and power for decision making. No changes to the number of fish collected in the Phase 1 sampling event or the method of calculating the number of fish is recommended.

6.5 Summary of Assessment Recommendations

Based on the data analysis performed, PRS believes that resources would be better utilized if the Phase 1 monitoring was revised. Based on the lack of variability between the two sampling sites established in the Upper River reach, there is no reason to collect fish from both sites. However, the dams do divide the Upper River causing each site to be physically different (depth, flow, etc.). In addition, different PCB mass exist between these sites and the amount and extent of remediation varied. As such, PRS does not propose that the site concept be dropped.

Comparison of the fish concentrations in the Upper River to historical results demonstrate that remediation will cause an increase in PCB concentrations in adult fish tissue. Since PCBs bioaccumulate, there is no reason remediation will affect adult fish that were adults when remediation was performed. As such, PRS recommends that adult fish species not be collected following remediation until such time the adults have died. According to the available data, the average life span is 6.8 years and increases to 7.3 when dace are not considered. However, we propose to begin Phase 1 monitoring of the adult fish five years following remediation, coinciding with sediment sampling. To fulfill the requirements of the ROD which requires annual monitoring but does not specify which fish require monitoring, PRS recommends that adult smallmouth bass be collected annually during the first four years following remediation. Juvenile species of carp and white suckers would also continue to be collected annually following remediation.

PRS also proposes to collect all adult fish every 5 years when the sediment sampling is performed. In the years between sediment sampling, only smallmouth bass would be collected as their concentration is representative of all fish and are easily found through out the river. This would occur until such time that it appears that the adult species, as represented by annual smallmouth bass results or 5-year adult fish species results, indicates the PCB concentrations are reaching target levels. At that time, all adult fish species will be collected if the decision is being made on annual smallmouth data, to verify that Phase 2 confirmation monitoring can begin. If the 5-year data indicates Phase 2 monitoring can begin, no additional Phase 1 monitoring will be needed since the decision would be made based on all fish species.

In summary, PRS proposes the following as the post remedial fish monitoring:

- Collect adult smallmouth bass, juvenile carp, and juvenile white suckers annually following remediation for the first five years following remediation,

- Collect all adult and juvenile fish species listed in the this Plan during the first 5-year sediment sampling event, and
- Collect adult smallmouth bass, juvenile carp, and juvenile white suckers annually following the first 5-year sediment sampling event and all adult and juvenile fish species listed in this plan during subsequent 5-year sediment sampling events until Phase 1 monitoring is completed, and

Based on this recommendation, PRS proposes to sample the following during the Phase 1 annual fish monitoring event, when applicable.

Fish Species	Number of Samples Per River Reach					
	Upper (Site 1)	Upper (Site 2)	Middle (Site 1)	Middle (Site 2)	Lower	Inner Harbor
Smallmouth Bass	8	8	8	8	8	8
Juvenile Carp	16	16	8	8	8	8
Juvenile Suckers	8	8	8	8	8	8

Phase 1 monitoring based on juvenile fish and adult small mouth bass will require that additional efforts be made to collect juvenile carp to establish baseline conditions. To ensure collection of juvenile carp, the collection of these fish should be performed earlier in the summer when there is a greater chance of encountering this species in the required size range. This baseline monitoring would be performed prior to remediation of the Lower River reaches and in 2009 for the Upper River reach.

7.0 References

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Tables

Table 1
Summary of Targeted Fish Species

Fish Species	Characteristics	Habitat Targeted for Collection *	
		Upper – Lower River	Inner Harbor
Smallmouth bass	Occurs in all three drainage basins in Wisconsin. A non-migratory fish, they retreat to pools, undercut banks, or fairly deep water to avoid sunlight. Spawn in May through June when the water reaches 55-75°F. The average length of young-of year in Wisconsin is 2.7 inches by the end of September. The fish begin to reach sexual maturity at the ages of 3-4 depending on sex. The usual longevity is 5-7 years.	Area of little soft sediment. Sandy or gravel bottom best. Area of stumps or downed trees.	Near structures offering protection. Bridge abutments, docks, etc.
Carp	Occurs in all drainage basins in Wisconsin. It is found in a wide variety of habitats but prefer warm turbid water. Spawn in April to August when the water reaches 65-75°F. The average length of young-of year in Wisconsin is 3.7 inches by the end of September. In Wisconsin, carp mature between the ages of 2 and 3 depending on the sex. The usual longevity is 9-15 years. They can have a fairly extensive range and can jump small dams.	Areas with vegetation	
White suckers	Occurs in all drainage basins in Wisconsin and is probably the most widespread of all fish in Wisconsin. It is found in warm shallows of estuaries and bays and can tolerate all stream gradients and a wide range of environmental conditions and pollution. Spawn in April to May when the water reaches about 45°F. The typical length of young-of year in Wisconsin is 2.6 inches by the end of September. The usual longevity is 5 years after maturing between the ages of 2 and 3. They move about extensively.	Areas with vegetation	
Rock Bass	Occurs in all three drainage basins in Wisconsin. It is found in clear water over a gravel or rocky bottom and is often found near breakwaters and stone-armored shorelines. Often found with other sunfish such as smallmouth bass. Spawn in spring when the water reaches 60-70°F. The average length of young-of year in Wisconsin is 1.7 inches by the end of September. They reach maturity between ages 2 and 3. The usual longevity is 6-8 years. They have a limited range.	Prefers clear, rocky, and vegetated stream pools.	
Longnose Dace	Occurs in all drainage basins in Wisconsin. Occurs in riffles or torrential water over a bottom of boulder and gravel; it generally avoids pools and quiet runs. Spawn in late April to mid-June at an average water temperature of 63°F. The average length of young-of year in Wisconsin is 1.7 inches by the end of September. The usual longevity is 3-4 years after reaching maturity at age 2. No information on their range of migration was found.	Area of little soft sediment. Sandy, gravel or cobble bottom that have some vegetation for cover are best.	
Walleye	Present throughout Wisconsin. During the day, hovers in shadows of submerged objects or in shadows of deep water. At dusk, emerge to feed over shallow weed beds or rocky shoals. Spawn in mid-April to mid-May when water reaches 42-50°F. The average length of young-of year in Wisconsin is 3 inches by the end of July. Maturity occurs between the ages of 2 to 5 for males and 5 to 7 for females. The usual longevity is 6-7 years. They have a fairly extensive range and can jump small dams.	Area of little soft sediment. Sandy or gravel bottom best. Area of rough water.	
Catfish	Occurs in all three drainage basins in Wisconsin. It is found in a wide variety of habitats but prefer warm water. Spawn in May or June when the water reaches 75°F. The average length of young-of year catfish in Wisconsin is 3.4 inches by the end of September. Sexual maturity varies by body of water but it appears both sexes begin maturing by the age of 5. Few catfish live beyond 8 years. They can have a fairly extensive range.	Prefers some current and deep water with sand, gravel or rubble bottoms. Areas near bank overhangs or downed trees or stumps	

* - General tips on fish locations: outside bends of river, downstream of rocks, area where fast water meets slower water, area of merging currents (streams, brooks, rivers et.) current edges, areas with overhanging trees or branches, drop offs, undercuts, below dams or falls, above springs, riparian zones

Table 2
Baseline Daily Fish Collection Summary

Date	River Reach	Adult Carp	Adult White Suckers	Juvenile White Suckers	Small Mouth Bass	Rock Bass	Longnose Dace	Walleye	Channel Catfish
8/18/2008	UR1	3	2		2				
8/19/2008	UR1	1	2	4	6	1			
8/20/2008	UR1			4		7			
8/21/2008	UR2	4	4	8	8	3			
8/22/2008	UR2					4			
8/25/2008	LR	2	2	1	8				4
8/26/2008	LR			3		9			
8/27/2008	IH	8			7			1	
9/2/2008	IH				1				1
9/3/2008	LR	6		1					
9/5/2008	IH							2	
9/6/2008	UR1	12	4						
9/6/2008	UR2	12	4			1			
9/8/2008	MR2		8	2	8	2			1
9/10/2008	MR2						8		
9/10/2008	MR1						4		
9/11/2008	MR1						2		
9/12/2008	UR1						4		
9/15/2008	MR2	1		5		6			3
9/16/2008	MR1	8	3		8			8	
9/17/2008	MR1		4			1			4
9/17/2008	UR1						2		
TOTAL		57	33	28	48	34	20	11	13

UR1 – Upper River from former Tecumseh Site to Riverbend Dam
UR2 – Upper River from Riverbend Dam to Waelderhaus Dam
MR1 – Middle River from Waelderhaus Dam to Kohler Landfill (County Road A Bridge)
MR2 – Middle River from Kohler Landfill (County Road A Bridge) to C&NW Railroad Bridge
LR – Lower River from C&NW Railroad Bridge to Pennsylvania Avenue Bridge
IH – Inner Harbor from Pennsylvania Avenue Bridge to Coast Guard Station

Table 3
Baseline Fish Collection Summary

Species	UR1 Target	UR1 Collected	UR2 Target	UR2 Collected	MR1 Target	MR1 Collected	MR2 Target	MR2 Collected	LR Target	LR Collected	IH Target	IH Collected
Adult Carp	16	16	16	16	8	8	8	1	8	8	8	8
Juvenile Carp	16	0	16	0	8	0	8	0	8	0	8	0
Adult White Sucker	8	8	8	8	8	7	8	8	8	2	8	0
Juvenile White Sucker	8	8	8	8	8	0	8	7	8	5	8	0
Smallmouth Bass	8	8	8	8	8	8	8	8	8	8	8	8
Rock Bass	8	8	8	8	8	1	8	8	9	9	9	0
Longnose Dace	8	6	8	0	8	6	8	8	8	0	8	0
Walleye	8	0	8	0	8	8	8	0	9	0	9	3
Channel Catfish	8	0	8	0	8	4	8	4	8	4	8	1
Total	88	54	88	48	72	42	72	44	74	36	74	20

UR1 – Upper River from former Tecumseh Site to Riverbend Dam
UR2 – Upper River from Riverbend Dam to Waelderhaus Dam
MR1 – Middle River from Waelderhaus Dam to Kohler Landfill (County Road A Bridge)
MR2 – Middle River from Kohler Landfill (County Road A Bridge) to C&NW Railroad Bridge
LR – Lower River from C&NW Railroad Bridge to Pennsylvania Avenue Bridge
IH – Inner Harbor from Pennsylvania Avenue Bridge to Coast Guard Station

Table 4
Summary Statistics

Statistic[16]	UR1	UR2	MR 1	MR 2	LR	IH
			Adult Carp			
Mean	25.9	14.7	4.44	N/A	11.3	3.16
Minimum	1.63	1.02	1.28	1.27	0.458	0.243
Maximum	73.1	47.7	22.8	1.27	44.9	9.14
Count	16	16	9	1	9	9
Standard Deviation	21.4	15.0	7.43	N/A	15.2	2.81
Coefficient of Variation	0.83	1.02	1.67	N/A	1.35	0.89
Distribution	Normal	Gamma	Non-Par	N/A	Lognormal	Normal
95% UCL	35.3	24.9	15.89	N/A	32.63	5.05
			Adult White Sucker			
Mean	12.4	8.92	8.77	3.96	4.31	N/A
Minimum	5.74	3.95	3.24	0.925	3.65	N/A
Maximum	20.6	16.6	19.9	6.98	4.96	N/A
Count	8	8	8	8	2	0
Standard Deviation	5.00	4.19	5.86	2.01	0.926	N/A
Coefficient of Variation	0.40	0.47	0.669	0.51	0.22	N/A
Distribution	Normal	Normal	Normal	Normal	N/A	N/A
95% UCL	15.8	11.7	13.07	5.31	N/A	N/A
			Juvenile White Sucker			
Mean	6.01	6.82	N/A	1.37	1.04	N/A
Minimum	1.99	3.73	N/A	0.980	0.587	N/A
Maximum	9.71	11.5	N/A	2.03	1.64	N/A
Count	8	8	0	7	5	0
Standard Deviation	2.85	2.96	N/A	0.389	0.427	N/A
Coefficient of Variation	0.47	0.43	N/A	0.28	0.41	N/A
Distribution	Normal	Normal	Normal	Normal	Normal	N/A
95% UCL	7.9	8.8	N/A	1.66	1.44	N/A
			Small Mouth Bass			
Mean	13.0	14.5	8.75	4.30	5.77	3.36
Minimum	4.09	3.12	4.20	2.64	1.78	1.44
Maximum	22.2	33.5	18.2	7.65	10.90	4.43
Count	8	8	8	8	8	8
Standard Deviation	7.28	11.1	4.94	1.61	3.05	1.04
Coefficient of Variation	0.56	0.77	0.56	0.37	0.53	0.31
	Normal	Normal	Normal	Normal	Normal	Normal
95% UCL	17.8	22.0	12.1	5.38	7.8	4.06
			Rock Bass			
Mean	6.94	4.27	N/A	2.49	2.60	N/A
Minimum	1.22	0.739	2.79	1.42	1.40	N/A
Maximum	16.8	8.72	2.79	3.70	4.27	N/A
Count	8	8	1	8	9	0
Standard Deviation	5.01	2.94	N/A	0.790	1.11	N/A
Coefficient of Variation	0.72	0.69	N/A	0.32	0.43	N/A
Distribution	Normal	Normal	N/A	Normal	Normal	N/A
95% UCL	10.3	6.2	N/A	3.02	3.29	N/A

[16] Units and other information provided on last page of table.

Table 4
Summary Statistics

Statistic[16]	UR1	UR2	MR 1	MR 2	LR	IH
			Longnose Dace			
Mean	7.67	N/A	9.47	8.51	N/A	N/A
Minimum	1.72	N/A	7.08	4.86	N/A	N/A
Maximum	17.6	N/A	17.8	11.0	N/A	N/A
Count	6	0	7	8	0	0
Standard Deviation	6.85	N/A	4.15	2.25	N/A	N/A
Coefficient of Variation	0.89	N/A	0.44	0.26	N/A	N/A
Distribution	Normal	N/A	Non-Par	Normal	N/A	N/A
95% UCL	13.3	N/A	12.88	10.0	N/A	N/A
			Channel Catfish			
Mean	N/A	N/A	27.9	8.18	13.7	N/A
Minimum	N/A	N/A	15.9	0.532	6.37	19.4
Maximum	N/A	N/A	49.2	16.6	28.4	19.4
Count	0	0	4	4	5	1
Standard Deviation	N/A	N/A	15.6	6.62	10	N/A
Coefficient of Variation	N/A	N/A	0.56	0.81	0.73	N/A
Distribution	N/A	N/A	N/A	N/A	N/A	N/A
95% UCL	N/A	N/A	43.2	14.7	25.1	N/A
			Walleye			
Mean	N/A	N/A	11.1	N/A	N/A	2.03
Minimum	N/A	N/A	5.58	N/A	N/A	1.36
Maximum	N/A	N/A	16.8	N/A	N/A	3.00
Count	0	0	8	0	0	3
Standard Deviation	N/A	N/A	4.63	N/A	N/A	0.857
Coefficient of Variation	N/A	N/A	0.42	N/A	N/A	0.42
Distribution	N/A	N/A	Normal	N/A	N/A	N/A
95% UCL	N/A	N/A	14.2	N/A	N/A	3.00

Mean, Minimum, Maximum, Standard Deviation and 95% UCL in mg/Kg.
Count is number of samples.
Non-Par – Non Parametric Distribution
N/A – Not Applicable, insufficient data

Table 5
Co-variable Analysis Results

Reach	Statistic	Adult Carp		Adult Suckers		Juvenile Suckers		Smallmouth Bass		Rock Bass		Longnose Dace		Walleye		Catfish	
		Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids
Upper River 1	N	16		8		8		8		8		6		0		0	
	R^2	0.39		0.91		0.02		0.20		0.53		0.85		-		-	
	Coefficient	0.195	4.59	-0.485	1083.66	-0.036	57.48	3.137	- 1911.86	-0.876	1344.79	1.503	8.67	-	-	-	-
	Standard Error	0.093	8.24	0.458	150.04	0.490	184.79	3.008	1690.26	1.548	870.67	0.507	19.21	-	-	-	-
	p (2-tail)	0.056	0.587	0.338	0.001	0.944	0.768	0.345	0.309	0.596	0.183	0.059	0.682	-	-	-	-
	Model	Exponential		Linear		Exponential		Linear		Linear		Exponential		-		-	
Upper River 2	N	16		8		8		8		8		0		0		0	
	R^2	0.88		0.69		0.09		0.59		0.95		-		-		-	
	Coefficient	1.925	341.85	-0.224	191.41	-0.072	-136.27	1.033	2442.65	-1.153	645.16	-	-	-	-	-	-
	Standard Error	0.517	55.57	0.096	57.33	0.180	291.98	2.564	910.63	0.514	146.26	-	-	-	-	-	-
	p (2-tail)	0.003	0.000	0.067	0.021	0.707	0.660	0.704	0.044	0.075	0.007	-	-	-	-	-	-
	Model	Linear		Exponential		Exponential		Linear		Linear		-		-		-	
Middle River 1	N	8		7		0		8		1		6		8		4	
	R^2	0.88		0.37		-		0.05		-		0.77		0.96		0.96	
	Coefficient	0.445	20.95	0.159	33.50	-	-	0.655	50.73	-	-	2.716	140.90	0.017	635.96	-1.850	436.13
	Standard Error	0.123	18.07	0.131	96.16	-	-	1.731	481.56	-	-	1.428	89.31	0.399	165.11	3.011	102.35
	p (2-tail)	0.015	0.299	0.294	0.745	-	-	0.721	0.920	-	-	0.153	0.213	0.967	0.012	0.649	0.147
	Model	Exponential		Exponential		-		Linear		-		Linear		Linear		Linear	
Middle River 2	N	1		8		7		8		8		8		0		4	
	R^2	-		0.53		0.25		0.37		0.62		0.91		-		0.97	
	Coefficient	-	-	0.615	265.92	-0.054	89.09	0.072	57.54	-0.299	102.52	0.238	12.56	-	-	3.040	-298.64
	Standard Error	-	-	0.680	134.30	0.155	79.19	0.056	37.53	0.297	48.80	0.068	3.23	-	-	0.491	100.24
	p (2-tail)	-	-	0.407	0.105	0.746	0.324	0.255	0.186	0.360	0.090	0.017	0.012	-	-	0.102	0.206
	Model	-		Linear		Exponential		Exponential		Linear		Exponential		-		Linear	
Lower River	N	8		2		5		8		9		0		0		4	
	R^2	0.64		-		0.93		0.76		0.67		-		-		0.86	
	Coefficient	-0.639	425.64	-	-	0.414	-145.70	-0.710	506.71	0.022	311.03	-	-	-	-	-0.508	499.45
	Standard Error	1.341	144.76	-	-	0.083	75.92	0.635	125.95	0.392	89.06	-	-	-	-	4.001	400.02
	p (2-tail)	0.654	0.032	-	-	0.038	0.195	0.315	0.010	0.957	0.013	-	-	-	-	0.920	0.430
	Model	Linear		-		Linear		Linear		Linear		-		-		Linear	
Inner Harbor	N	8		0		0		8		0		0		3		1	
	R^2	0.64		-		-		0.90		-		-		-		-	
	Coefficient	0.165	67.67	-	-	-	-	-0.533	196.02	-	-	-	-	-	-	-	-
	Standard Error	0.133	23.19	-	-	-	-	0.081	43.76	-	-	-	-	-	-	-	-
	p (2-tail)	0.269	0.033	-	-	-	-	0.001	0.007	-	-	-	-	-	-	-	-
	Model	Exponential		-		-		Linear		-		-		-		-	

Numbers in the table represent the statistic.

$p<0.05$ Significance level is below 0.05

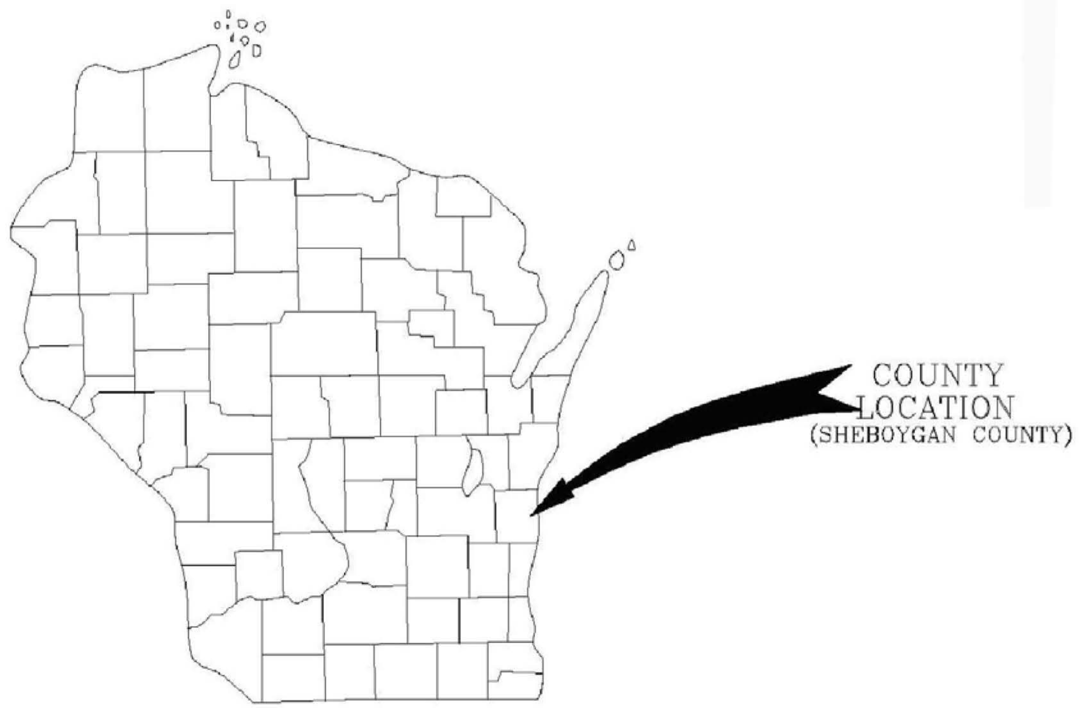
$0.05<p<0.1$ Significance level is greater than 0.05 and less than 0.1

Note: p-Level indicates the probability of the coefficient being equal to zero. Lower values of p indicate higher probabilities that the factors of length or percent lipids significantly affect fish tissue PCB concentrations.

Table 6
Analysis of Number of Fish Sampling Requirements

Location and Species	Coefficient of Variation		Number of Fish Needed	
Upper River 1	**Historical**	**Baseline**	**Historical C/V**	**Baseline C/V**
Smallmouth Bass	0.36	0.56	8	8
Adult Carp	0.93	0.83	16	12
Adult Suckers	0.36	0.40	8	8
Juvenile Suckers	0.36	0.47	8	8
Rock Bass	0.58	0.72	8	9
Longnose Dace	0.08	0.89	8	14
Upper River 2				
Smallmouth Bass	0.36	0.77	8	11
Adult Carp	0.93	1.02	16	19
Adult Suckers	0.66	0.47	8	8
Juvenile Suckers	0.66	0.43	8	8
Rock Bass	0.58	0.69	8	9
Middle River 1				
Smallmouth Bass	0.36	0.56	8	8
Adult Carp	0.66	1.67	8	50
Adult Suckers	0.66	0.67	8	8
Juvenile Suckers	0.66	0.47	8	8
Longnose Dace	0.08	0.559	8	8
Walleye	0.48	0.42	8	8
Catfish	0.08	0.56	8	8
Middle River 2				
Smallmouth Bass	0.36	0.37	8	8
Adult Suckers	0.66	0.51	8	8
Juvenile Suckers	0.66	0.28	8	8
Rock Bass	0.25	0.32	8	8
Lower River				
Smallmouth Bass	0.69	0.53	8	8
Adult Carp	0.44	1.35	8	33
Adult Suckers	0.44	0.22	8	8
Juvenile Suckers	0.44	0.41	8	8
Rock Bass	0.58	0.43	9	8
Catfish	0.07	0.73	8	10
Inner Harbor				
Smallmouth Bass	0.69	0.31	8	8
Adult Carp	0.44	0.89	8	14
Walleye	0.69	0.42	9	8
Catfish	0.07	0.3	8	8

C/V - Coefficient of variation
Comparison made only for fish where sufficient were caught to determine C/V.



COUNTY LOCATION MAP

NOT TO SCALE

SHEBOYGAN RIVER AND HARBOR SUPERFUND SITE
BASELINE UPPER & LOWER RIVER FISH MONITORING REPORT
SHEBOYGAN FALLS, WISCONSIN

SHEBOYGAN RIVER LOCATION MAP

Pollution Risk Services
7870 East Kemper Road, Suite 240
Cincinnati, Ohio 45249
Phone: 513-489-2793
Fax: 513-489-2794

FILE NAME:
DRAWN BY: KDA DATE: JANUARY 2009

SIGNATURES	BY	DATE
APPROVED		
REVIEWED		
DESIGNED		

REVISIONS NO.	BY	DATE
△		
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△		

Scale: SHOWN

FIGURE NO. 1

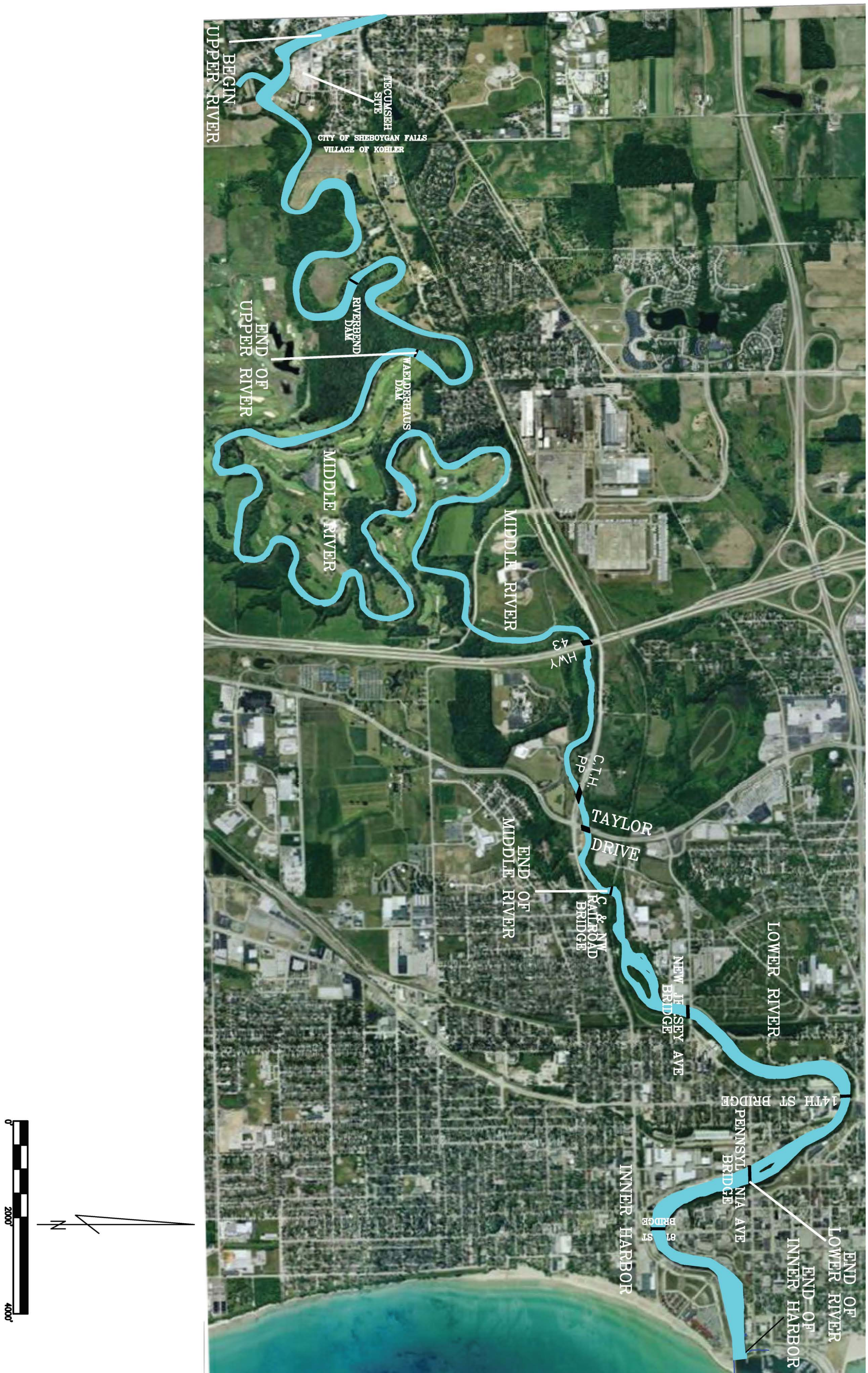

FIGURE NO. 2

Scale: SHOWN

SHEBOYGAN RIVER AND HARBOR SUPERFUND SITE
BASELINE UPPER AND LOWER RIVER FISH MONITORING REPORT
SHEBOYGAN FALLS, WISCONSIN

RIVER REACHES

Pollution Risk Services
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Cincinnati, Ohio 45249
Phone: 513-489-2793
Fax: 513-489-2794

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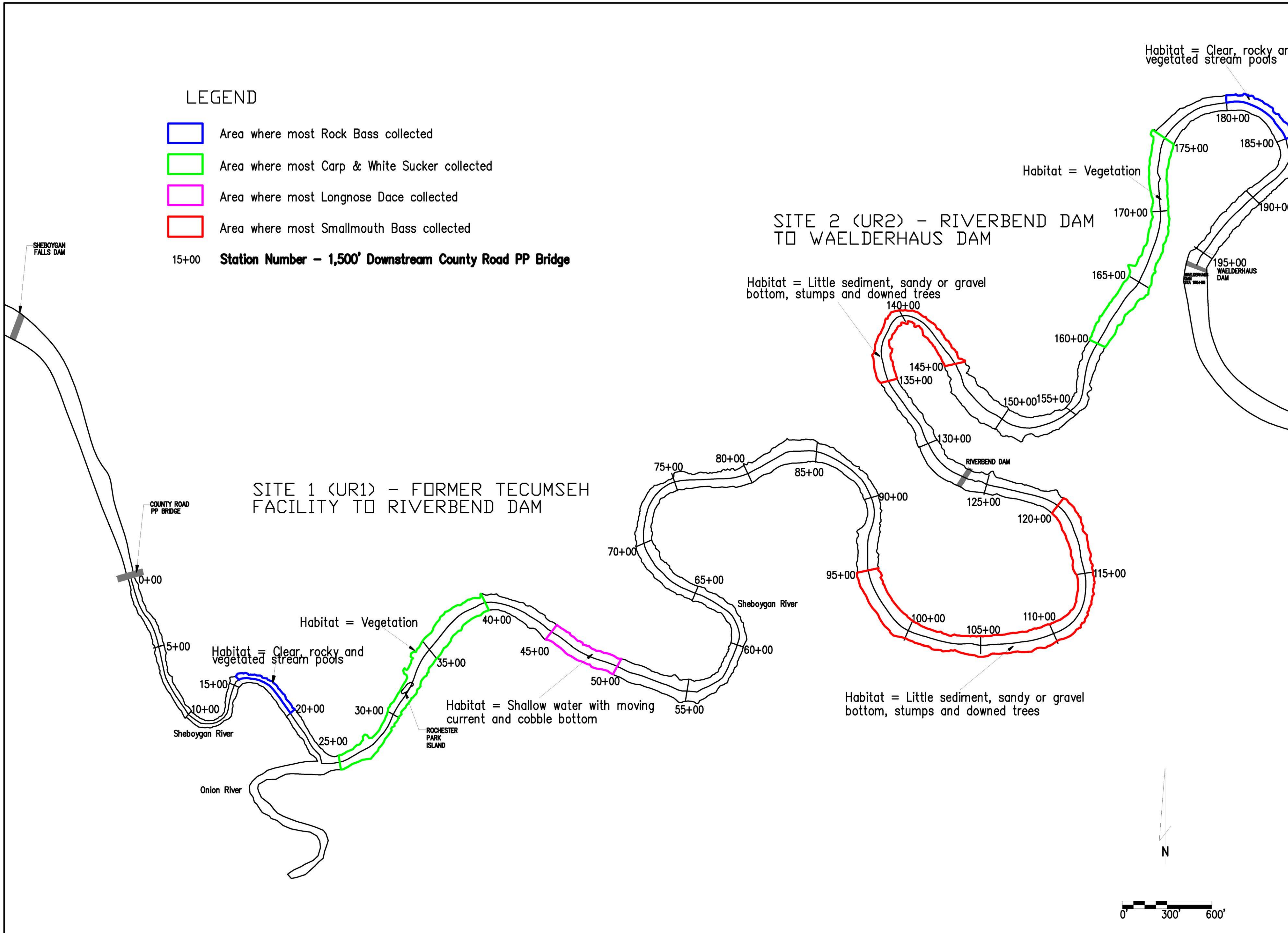

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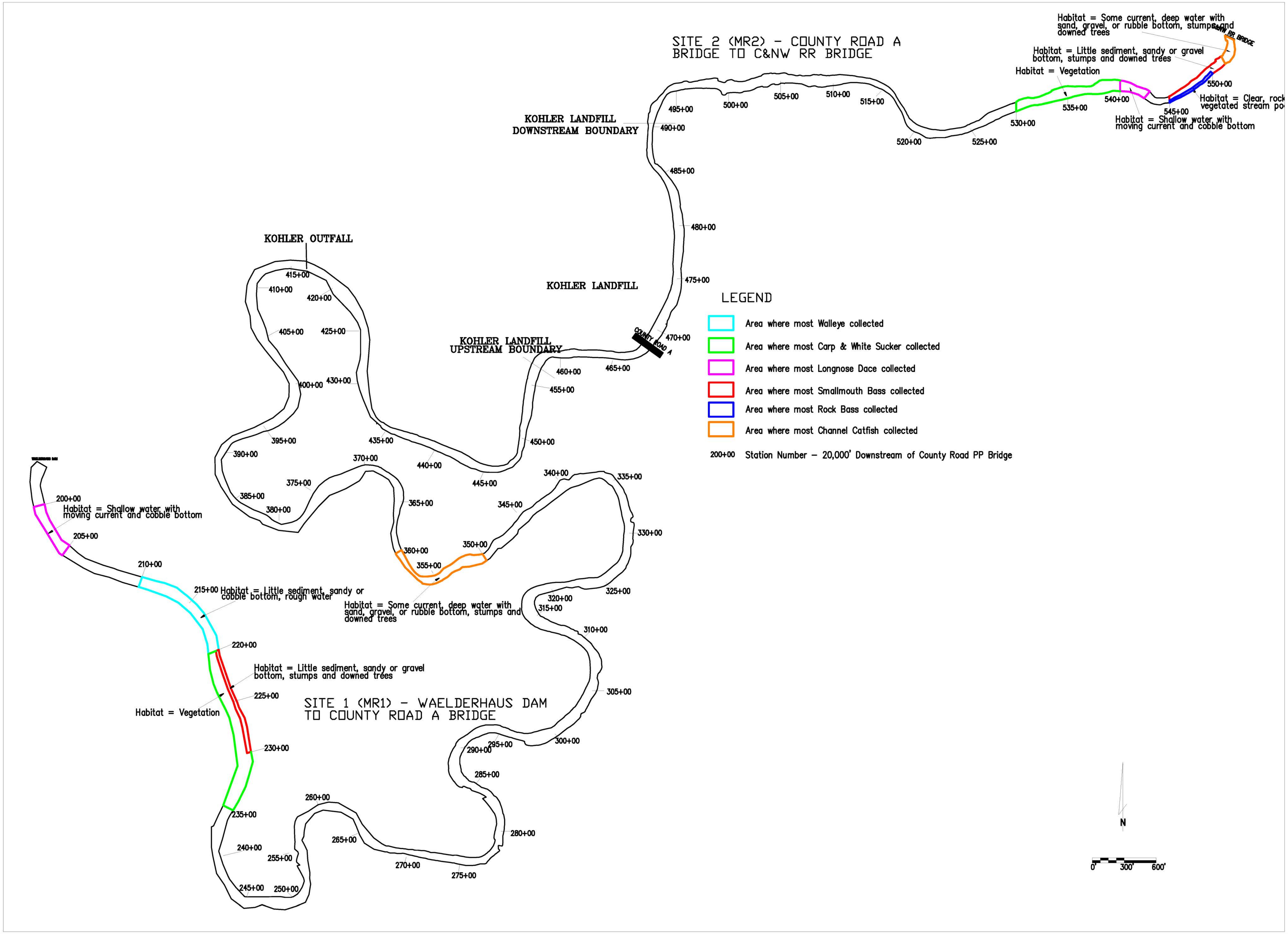
SHEBOYGAN RIVER AND HARBOR SUPERFUND SITE
BASELINE UPPER AND LOWER RIVER FISH MONITORING REPORT
SHEBOYGAN FALLS, WISCONSIN

UPPER RIVER FISH COLLECTION AREAS

SCALE: SHOWN

FIGURE NO. 3



SHEBOYGAN RIVER AND HARBOR SUPERFUND SITE
BASELINE UPPER AND LOWER RIVER FISH MONITORING REPORT
SHEBOYGAN FALLS, WISCONSIN

MIDDLE RIVER FISH COLLECTION AREAS

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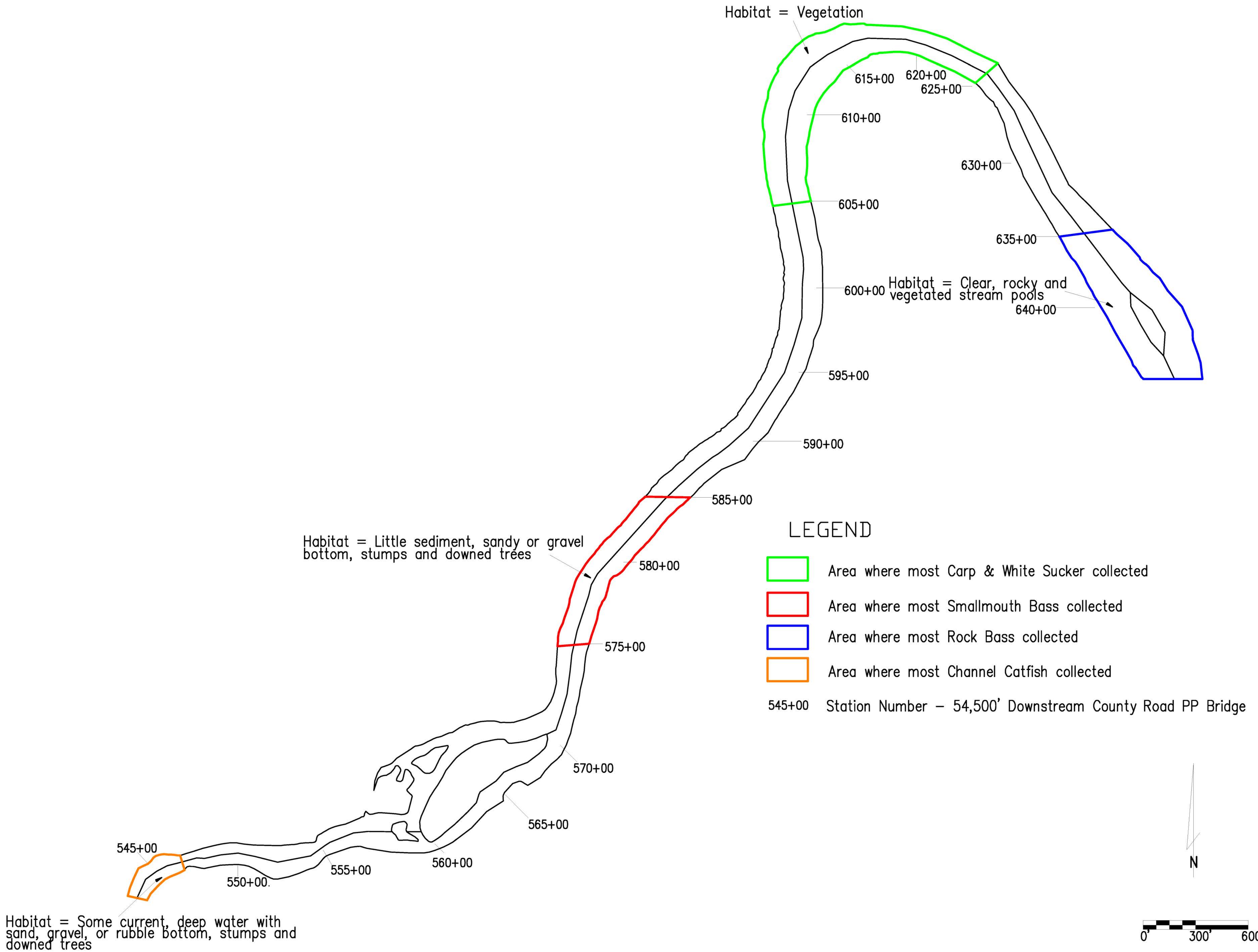
FIGURE NO. 4



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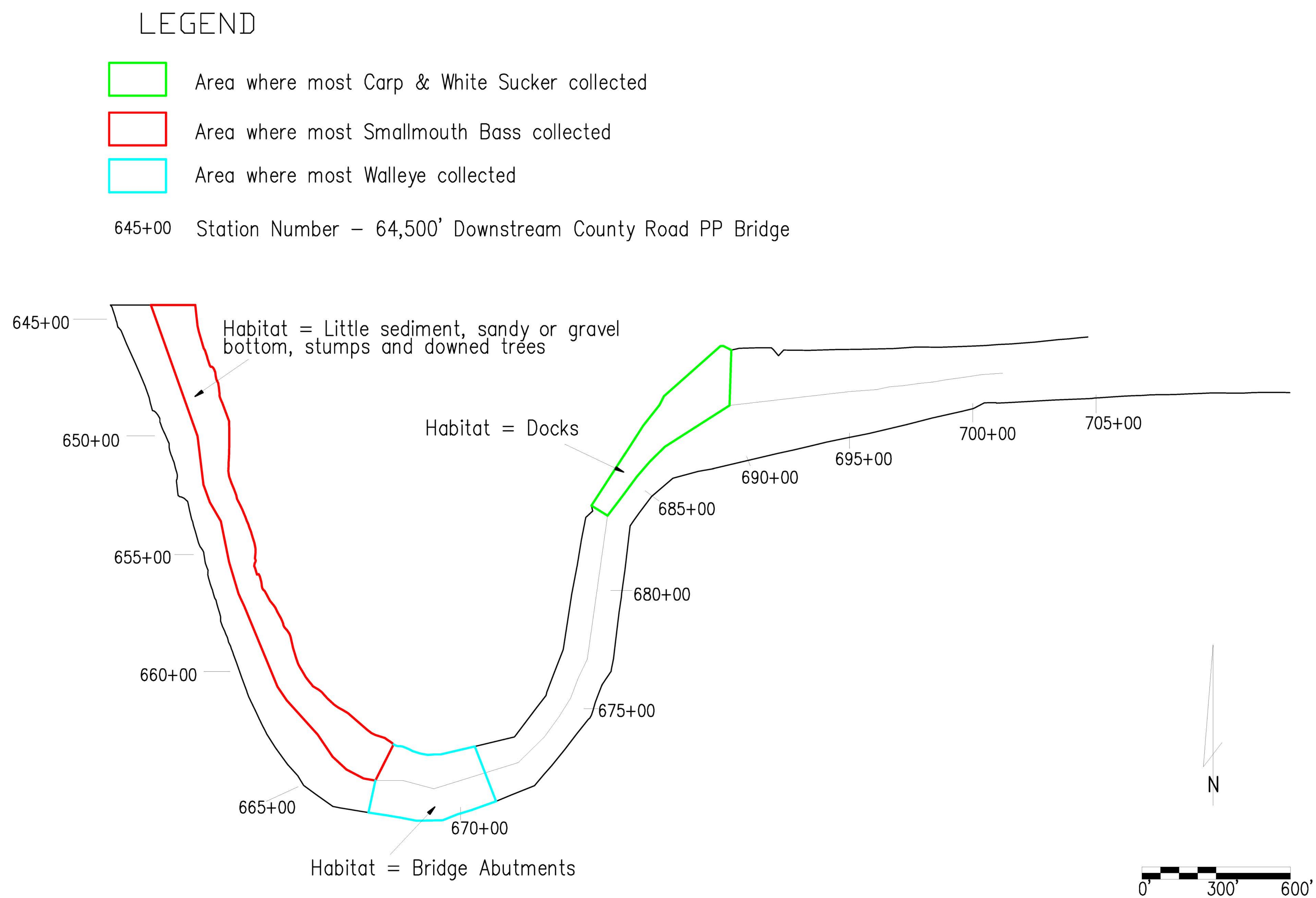
SHEBOYGAN RIVER AND HARBOR SUPERFUND SITE
BASELINE UPPER AND LOWER RIVER FISH MONITORING REPORT
SHEBOYGAN FALLS, WISCONSIN

LOWER RIVER FISH COLLECTION AREAS

Scale: SHOWN

FIGURE NO. 5



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SHEBOYGAN RIVER AND HARBOR SUPERFUND SITE
BASELINE UPPER AND LOWER RIVER FISH MONITORING REPORT
SHEBOYGAN FALLS, WISCONSIN

INNER HARBOR FISH COLLECTION AREAS

Scale: SHOWN

FIGURE NO. 6

Appendix 1

Summary of Baseline Fish Tissue Results

UPPER RIVER 1

FISH SAMPLE RESULTS - UPPER RIVER SITE 1 (UR1)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-UR1-AC1-G, 8/19/08	Adult Carp	SO	24.0	61.0	82.0	2325	F	7/8	4.60%	37.0
BL-UR1-AC2-G, 8/18/08			21.0	53.3	61.0	1729	M	6	1.33%	73.1
BL-UR1-AC3-G, 8/18/08			18.0	45.7	32.0	907	M	4	4.84%	1.63
BL-UR1-AC4-G, 8/18/08			19.0	48.3	50.0	1417	F	4	4.45%	7.44
BL-UR1-AC5-G, 9/6/08			15.0	38.1	30.0	850	F	4	2.19%	4.77
BL-UR1-AC6-G, 9/6/08			16.0	40.6	30.0	850	M	3/4	0.625%	14.0
BL-UR1-AC7-G, 9/6/08			20.0	50.8	64.0	1814	M	5	2.50%	17.6
BL-UR1-AC8-G, 9/6/08			19.5	49.5	48.0	1361	M	4/5	0.340%	2.08
BL-UR1-AC9-G, 9/6/08			25.0	63.5	113	3203	M	8	7.49%	53.9
BL-UR1-AC10-G, 9/6/08			24.0	61.0	124	3515	M	7/8	7.55%	28.4
BL-UR1-AC11-G, 9/6/08			21.0	53.3	69.0	1956	F	5/6	3.44%	9.48
BL-UR1-AC12-G, 9/6/08			23.0	58.4	96.0	2722	M	7	3.02%	29.4
BL-UR1-AC13-G, 9/6/08			25.0	63.5	152	4309	F	8	13.69%	33.3
BL-UR1-AC14-G, 9/6/08			25.0	63.5	123	3487	F	8	1.01%	9.55
BL-UR1-AC15-G, 9/6/08			22.5	57.2	96.0	2722	F	6/7	8.70%	55.5
BL-UR1-AC16-G, 9/6/08			23.0	58.4	100	2835	M	7	7.03%	36.9
Mean Result for Adult Carp			21.3	54.1	79.4	2250	NA	6.01	4.55%	25.9
Minimum Results for Adult Carp			15.0	38.1	30.0	850	NA	3.50	0.340%	1.63
Maximum Results for Adult Carp			25.0	63.5	152.0	4309	NA	8.00	13.69%	73.1
Standard Deviation for Adult Carp			3.18	8.08	37.4	1059	NA	1.65	3.60%	21.4
Coefficient of Variation for Adult Carp			0.149	0.149	0.471	0.471	NA	0.274	0.791	0.83
Distribution for Adult Carp			Normal							
Upper 95% UCL for Adult Carp			22.9	58.1	97.7	2769	NA	6.82	6.31%	35.3

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - UPPER RIVER SITE 1 (UR1)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-UR1-AWS1-G, 8/18/08	Adult White Sucker	SO	16.0	40.6	24.0	680.4	M	4	1.40%	15.9
BL-UR1-AWS2-G, 8/18/08			14.0	35.6	16.0	454	M	4	1.33%	16.6
BL-UR1-AWS3-G, 8/19/08			13.0	33.0	16.0	454	M	3	0.555%	10.3
BL-UR1-AWS4-G, 8/19/08			12.0	30.5	19.0	539	M	3	1.52%	20.6
BL-UR1-AWS5-G, 9/6/08			14.0	35.6	18.0	510	M	4	0.855%	10.6
BL-UR1-AWS6-G, 9/6/08			12.0	30.5	14.0	397	M	3	0.495%	5.74
BL-UR1-AWS7-G, 9/6/08			14.0	35.6	19.0	539	M	3	0.330%	7.34
BL-UR1-AWS8-G, 9/6/08			11.5	29.2	11.0	312	M	3	0.760%	12.3
Mean Result for Adult White Sucker			13.3	33.8	17.1	485	NA	3.38	0.905%	12.4
Minimum Results for Adult White Sucker			11.5	29.2	11.0	312	NA	3.00	0.330%	5.74
Maximum Results for Adult White Sucker			16.0	40.6	24.0	680	NA	4.00	1.52%	20.6
Standard Deviation for Adult White Sucker			1.49	3.77	3.87	110	NA	0.518	0.454%	5.00
Coefficient of Variation for Adult White Sucker			0.112	0.111	0.226	0.226	NA	0.153	0.502	0.402
Distribution for Adult White Sucker			Normal							
Upper 95% UCL for Adult White Sucker			14.3	36.4	19.8	562	NA	3.73	1.22%	15.8

BL-UR1-JWS1-G, 8/19/08	Juvenile White Sucker	SO	6.00	15.2	2.00	56.7	M	1	0.151%	9.71
BL-UR1-JWS2-G, 8/19/08			6.00	15.2	1.00	28.3	M	1	0.367%	8.93
BL-UR1-JWS3-G, 8/19/08			5.00	12.7	1.00	28.3	M	1	0.462%	6.08
BL-UR1-JWS4-G, 8/19/08			6.00	15.2	2.00	56.7	M	1	0.248%	4.85
BL-UR1-JWS5-G, 8/20/08			7.00	17.8	2.00	56.7	M	1	0.330%	7.76
BL-UR1-JWS6-G, 8/20/08			6.00	15.2	1.00	28.3	M	1	0.638%	6.51
BL-UR1-JWS7-G, 8/20/08			6.50	16.5	2.00	56.7	M	1	0.281%	2.28
BL-UR1-JWS8-G, 8/20/08			6.00	15.2	2.00	56.7	M	1	0.275%	1.99
Mean Result for Juvenile White Sucker			6.06	15.4	1.63	46.1	NA	1.00	0.344%	6.01
Minimum Results for Juvenile White Sucker			5.00	12.7	1.00	28.3	NA	1.00	0.151%	1.99
Maximum Results for Juvenile White Sucker			7.00	17.8	2.00	56.7	NA	1.00	0.638%	9.71
Standard Deviation for Juvenile White Sucker			0.563	1.43	0.518	14.7	NA	0.00	0.149%	2.85
Coefficient of Variation for Juvenile White Sucker			0.093	0.093	0.318	0.318	NA	0.00	0.434	0.474
Distribution for Juvenile White Sucker			Normal							
Upper 95% UCL for Juvenile White Sucker			6.45	16.4	1.98	56.2	NA	NA	0.448%	7.92

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - UPPER RIVER SITE 1 (UR1)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)*[1]	*Fat (%)*	*PCB (mg/kg)*
BL-UR1-SB1-G, 8/18/08	Smallmouth Bass	SO	13.0	33.0	22.0	624	F	5	0.625%	18.6
BL-UR1-SB2-G, 8/18/08			10.0	25.4	8.0	227	M	3	0.400%	21.5
BL-UR1-SB3-G, 8/19/08			15.0	38.1	34.0	964	F	6	1.43%	15.2
BL-UR1-SB4-G, 8/19/08			10.0	25.4	11.0	312	M	3/4	0.490%	22.2
BL-UR1-SB5-G, 8/19/08			10.0	25.4	8.0	227	M	3	0.695%	7.33
BL-UR1-SB6-G, 8/19/08			11.0	27.9	12.0	340	M	3/4	0.765%	6.14
BL-UR1-SB7-G, 8/19/08			14.0	35.6	23.0	652	F	6	1.17%	8.59
BL-UR1-SB8-G, 8/19/08			10.0	25.4	8.00	227	M	4	0.430%	4.09
Mean Result for Smallmouth Bass			11.6	29.5	15.8	447	NA	4.25	0.750%	13.0
Minimum Results for Smallmouth Bass			10.0	25.4	8.00	227	NA	3.00	0.400%	4.09
Maximum Results for Smallmouth Bass			15.0	38.1	34.0	964	NA	6.00	1.43%	22.2
Standard Deviation for Smallmouth Bass			2.07	5.25	9.57	271	NA	1.25	0.368%	7.28
Coefficient of Variation for Smallmouth Bass			0.178	0.178	0.608	0.608	NA	0.295	0.490	0.562
Distribution for Smallmouth Bass			Normal							
Upper 95% UCL for Smallmouth Bass			13.1	33.2	22.4	635	NA	5.12	1.00%	17.8

BL-UR1-RB1-G, 8/19/08	Rock Bass	SO	8.50	21.6	8.00	227	M	5	0.415%	6.53
BL-UR1-RB2-G, 8/20/08			8.00	20.3	7.00	198	M	4/5	0.590%	5.82
BL-UR1-RB3-G, 8/20/08			5.50	14.0	2.00	57	M	4	0.775%	16.8
BL-UR1-RB4-G, 8/20/08			6.00	15.2	4.00	113	M	3/4	1.02%	10.4
BL-UR1-RB5-G, 8/20/08			6.00	15.2	4.00	113	M	4	0.581%	7.91
BL-UR1-RB6-G, 8/20/08			7.00	17.8	4.00	113	M	4	0.325%	1.22
BL-UR1-RB7-G, 8/20/08			8.00	20.3	6.00	170	M	4	0.485%	1.57
BL-UR1-RB8-G, 8/20/08			5.50	14.0	3.00	85.0	M	3	0.619%	5.30
Mean Result for Rock Bass			6.81	17.3	4.75	135	NA	4.00	0.601%	6.94
Minimum Results for Rock Bass			5.50	14.0	2.00	56.7	NA	3.00	0.325%	1.22
Maximum Results for Rock Bass			8.50	21.6	8.00	227	NA	5.00	1.02%	16.8
Standard Deviation for Rock Bass			1.22	3.11	2.05	58.2	NA	0.598	0.217%	5.01
Coefficient of Variation for Rock Bass			0.180	0.180	0.432	0.432	NA	0.149	0.362	0.722
Distribution for Rock Bass			Normal							
Upper 95% UCL for Rock Bass			7.66	19.5	6.17	175	NA	4.41	0.752%	10.3

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - UPPER RIVER SITE 1 (UR1)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-UR1-LD1-G, 9/12/08	Longnose Dace	W	3.00	7.62	0.260	7.37	TS	NA	2.77%	17.6
BL-UR1-LD2-G, 9/12/08			2.50	6.35	0.120	3.40	TS	NA	1.24%	3.20
BL-UR1-LD3-G, 9/12/08			2.00	5.08	0.070	1.98	TS	NA	1.14%	1.72
BL-UR1-LD4-G, 9/12/08			2.50	6.35	0.100	2.83	TS	NA	2.30%	3.29
BL-UR1-LD5-G, 9/17/08			3.50	8.89	0.260	7.37	TS	NA	4.00%	15.1
BL-UR1-LD6-G, 9/17/08			2.50	6.35	0.090	2.55	TS	NA	4.40%	5.11
Mean Result for Longnose Dace			2.67	6.77	0.150	4.25	NA	NA	2.64%	7.67
Minimum Results for Longnose Dace			2.00	5.08	0.070	1.98	NA	NA	1.140%	1.72
Maximum Results for Longnose Dace			3.50	8.89	0.260	7.37	NA	NA	4.40%	17.6
Standard Deviation for Longnose Dace			0.516	1.31	0.087	2.46	NA	NA	1.363%	6.85
Coefficient of Variation for Longnose Dace			0.194	0.194	0.578	0.578	NA	NA	0.516	0.894
Distribution for Longnose Dace			Normal							
Upper 95% UCL for Longnose Dace			3.08	7.82	0.22	6.22	NA	NA	3.73%	13.3

NA - Not applicable
TS - Too small to gender/age
SO - Scale off, skin on fillet
SOF - Skin off fillet
W - Whole fish

[1] Where fish ages were in between ages, a half age was applied for the calculations. For example: 4/5 would be 4.5 years.

Distribution of PCB results determined using ProUCL, Version 4.00.02.

UPPER RIVER 2

FISH SAMPLE RESULTS - UPPER RIVER SITE 2 (UR2)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-UR2-AC1-G, 8/21/08	Adult Carp	SO	21.0	53.3	70.0	1984	M	5/6	7.39%	34.5
BL-UR2-AC2-G, 8/21/08			23.0	58.4	86.0	2438	M	6/7	2.05%	5.14
BL-UR2-AC3-G, 8/21/08			18.0	45.7	32.0	907	M	4	3.99%	3.18
BL-UR2-AC4-G, 8/21/08			15.0	38.1	31.0	879	M	4	4.64%	7.84
BL-UR2-AC5-G, 9/6/08			18.0	45.7	35.0	992	M	4	1.26%	3.73
BL-UR2-AC6-G, 9/6/08			23.5	59.7	94.0	2665	M	7	3.25%	30.2
BL-UR2-AC7-G, 9/6/08			21.5	54.6	84.0	2381	M	6	0.975%	9.23
BL-UR2-AC8-G, 9/6/08			22.5	57.2	95.0	2693	M	6	3.16%	22.7
BL-UR2-AC9-G, 9/6/08			18.0	45.7	46.0	1304	F	4	0.955%	3.55
BL-UR2-AC10-G, 9/6/08			15.0	38.1	22.0	624	F	4	0.315%	1.71
BL-UR2-AC11-G, 9/6/08			25.0	63.5	122	3459	F	8	10.03%	47.7
BL-UR2-AC12-G, 9/6/08			20.5	52.1	64.0	1814	M	7	1.06%	10.5
BL-UR2-AC13-G, 9/6/08			20.0	50.8	47.0	1332	M	5	0.290%	1.02
BL-UR2-AC14-G, 9/6/08			23.0	58.4	93.0	2637	F	7	2.06%	15.8
BL-UR2-AC15-G, 9/6/08			17.5	44.5	37.0	1049	M	4/5	0.405%	1.39
BL-UR2-AC16-G, 9/6/08			24.5	62.2	120	3402	F	7/8	7.55%	37.3
Mean Result for Adult Carp			20.4	51.8	67.4	1910	NA	5.63	3.08%	14.7
Minimum Results for Adult Carp			15.0	38.1	22.0	624	NA	4.00	0.290%	1.02
Maximum Results for Adult Carp			25.0	63.5	122	3459	NA	8.00	10.0%	47.7
Standard Deviation for Adult Carp			3.18	8.07	32.7	926	NA	1.43	2.96%	15.0
Coefficient of Variation for Adult Carp			0.156	0.156	0.485	0.485	NA	0.255	0.958	1.02
Distribution for Adult Carp			Gamma							
Upper 95% UCL for Adult Carp			21.9	55.7	83.4	2364	NA	6.33	4.53%	24.9

BL-UR2-AWS1-G, 8/21/08	Adult White Sucker	SO	11.0	27.9	8.00	227	M	3	0.960%	10.8
BL-UR2-AWS2-G, 8/21/08			13.0	33.0	15.0	425	M	3	1.32%	12.0
BL-UR2-AWS3-G, 8/21/08			14.0	35.6	18.0	510	M	3	1.14%	5.04
BL-UR2-AWS4-G, 8/21/08			9.00	22.9	7.00	198	M	2	0.715%	9.44
BL-UR2-AWS5-G, 9/6/08			10.0	25.4	9.00	255	M	3	0.355%	3.95
BL-UR2-AWS6-G, 9/6/08			13.5	34.3	16.0	454	M	3	1.28%	16.6
BL-UR2-AWS7-G, 9/6/08			14.0	35.6	19.0	539	M	3	1.12%	5.95
BL-UR2-AWS8-G, 9/6/08			13.0	33.0	17.0	482	M	3	0.840%	7.52
Mean Result for Adult White Sucker			12.2	31.0	13.6	386	NA	2.88	0.965%	8.92
Minimum Results for Adult White Sucker			9.00	22.9	7.00	198	NA	2.00	0.355%	3.95
Maximum Results for Adult White Sucker			14.0	35.6	19.0	539	NA	3.00	1.32%	16.6
Standard Deviation for Adult White Sucker			1.93	4.89	4.84	137	NA	0.354	0.322%	4.19
Coefficient of Variation for Adult White Sucker			0.158	0.158	0.355	0.355	NA	0.123	0.334	0.470
Distribution for Adult White Sucker			Normal							
Upper 95% UCL for Adult White Sucker			13.5	34.3	17.0	481	NA	3.12	1.19%	11.7

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - UPPER RIVER SITE 2 (UR2)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-UR2-JWS1-G, 8/21/08	Juvenile White Sucker	SO	6.00	15.2	5.00	142	M	1	0.510%	4.39
BL-UR2-JWS2-G, 8/21/08			7.00	17.8	4.00	113	M	1	0.450%	11.5
BL-UR2-JWS3-G, 8/21/08			6.00	15.2	1.00	28.3	M	1	0.580%	5.71
BL-UR2-JWS4-G, 8/21/08			5.00	12.7	1.00	28.3	M	1	0.440%	5.96
BL-UR2-JWS5-G, 8/21/08			5.00	12.7	1.00	28.3	M	1	0.490%	9.32
BL-UR2-JWS6-G, 8/21/08			7.00	17.8	2.00	56.7	M	1	0.410%	4.17
BL-UR2-JWS7-G, 8/21/08			8.00	20.3	3.00	85.0	M	2	0.595%	3.73
BL-UR2-JWS8-G, 8/21/08			7.00	17.8	2.00	56.7	M	1	0.510%	9.78
Mean Result for Juvenile White Sucker			6.38	16.2	2.38	67.3	NA	1.13	0.498%	6.82
Minimum Results for Juvenile White Sucker			5.00	12.7	1.00	28.3	NA	1.00	0.410%	3.73
Maximum Results for Juvenile White Sucker			8.00	20.3	5.00	142	NA	2.00	0.595%	11.5
Standard Deviation for Juvenile White Sucker			1.06	2.69	1.51	42.7	NA	0.354	0.065%	2.96
Coefficient of Variation for Juvenile White Sucker			0.166	0.166	0.634	0.634	NA	0.314	0.131	0.434
Distribution for Juvenile White Sucker			Normal							
Upper 95% UCL for Juvenile White Sucker			7.11	18.1	3.42	96.9	NA	1.37	0.543%	8.80
BL-UR2-SB1-G, 8/21/08	Smallmouth Bass	SO	11.0	27.9	9.00	255	F	3	1.78%	28.9
BL-UR2-SB2-G, 8/21/08			13.0	33.0	19.0	539	F	5	0.775%	5.34
BL-UR2-SB3-G, 8/21/08			11.0	27.9	11.0	312	M	3	1.16%	14.9
BL-UR2-SB4-G, 8/21/08			12.0	30.5	14.0	397	F	5	1.67%	33.5
BL-UR2-SB5-G, 8/2108			13.0	33.0	19.0	539	F	5	1.26%	3.12
BL-UR2-SB6-G, 8/21/08			10.0	25.4	10.0	283	M	3	0.970%	6.41
BL-UR2-SB7-G, 8/21/08			10.0	25.4	11.0	312	M	3	1.69%	13.5
BL-UR2-SB8-G, 8/21/08			10.0	25.4	8.00	227	M	3	1.29%	10.5
Mean Result for Smallmouth Bass			11.3	28.6	12.6	358	NA	3.75	1.32%	14.5
Minimum Results for Smallmouth Bass			10.0	25.4	8.00	227	NA	3.00	0.775%	3.12
Maximum Results for Smallmouth Bass			13.0	33.0	19.0	539	NA	5.00	1.78%	33.5
Standard Deviation for Smallmouth Bass			1.28	3.26	4.31	122	NA	1.04	0.361%	11.1
Coefficient of Variation for Smallmouth Bass			0.114	0.114	0.341	0.341	NA	0.276	0.273	0.765
Distribution for Smallmouth Bass			Normal							
Upper 95% UCL for Smallmouth Bass			12.1	30.8	15.6	443	NA	4.47	1.57%	22.0

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - UPPER RIVER SITE 2 (UR2)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-UR2-RB1-G, 8/21/08	Rock Bass	SO	9.00	22.9	9.00	255	F	5	0.405%	1.04
BL-UR2-RB2-G, 8/21/08			8.00	20.3	8.00	227	M	4	0.670%	4.24
BL-UR2-RB3-G, 8/21/08			6.00	15.2	2.00	56.7	M	4	0.980%	8.25
BL-UR2-RB4-G, 8/22/08			7.00	17.8	4.00	113	M	4	1.20%	8.72
BL-UR2-RB5-G, 8/22/08			8.00	20.3	7.00	198	M	5	0.470%	4.32
BL-UR2-RB6-G, 8/22/08			8.00	20.3	7.00	198	F	4	0.705%	3.78
BL-UR2-RB7-G, 8/22/08			8.00	20.3	7.00	198	M	4/5	0.580%	3.04
BL-UR2-RB8-G, 9/6/08			8.00	20.3	6.00	170	M	4	0.240%	0.739
Mean Result for Rock Bass			7.75	19.7	6.25	177	NA	4.31	0.656%	4.27
Minimum Results for Rock Bass			6.00	15.2	2.00	56.7	NA	4.00	0.240%	0.739
Maximum Results for Rock Bass			9.00	22.9	9.00	255	NA	5.00	1.200%	8.72
Standard Deviation for Rock Bass			0.886	2.25	2.25	63.8	NA	0.458	0.312%	2.94
Coefficient of Variation for Rock Bass			0.114	0.114	0.360	0.360	NA	0.106	0.475	0.688
Distribution for Rock Bass			Normal							
Upper 95% UCL for Rock Bass			8.36	21.2	7.81	221	NA	4.63	0.872%	6.23

NA - Not applicable
SO - Scale off, skin on fillet
SOF - Skin off fillet
W - Whole fish

[1] Where fish ages were in between ages, a half age was applied for the calculations. For example: 4/5 would be 4.5 years.

MIDDLE RIVER 1

FISH SAMPLE RESULTS - MIDDLE RIVER SITE 1 (MR1)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-MR1-AC1-G, 9/16/08	Adult Carp	SO	16.0	40.6	28.0	794	M	4	1.22%	2.06
BL-MR1-AC2-G, 9/16/08			16.0	40.6	23.0	652	M	4	0.770%	1.71
BL-MR1-AC3-G, 9/16/08			17.0	43.2	32.0	907	M	4	0.390%	1.33
BL-MR1-AC4-G, 9/16/08			17.0	43.2	36.0	1021	F	4	3.21%	2.51
BL-MR1-AC5-G, 9/16/08			15.5	39.4	28.0	794	M	4	0.845%	1.62
BL-MR1-AC6-G, 9/16/08			16.0	40.6	25.0	709	M	4	1.17%	1.28
BL-MR1-AC7-G, 9/16/08			17.5	44.5	36.0	1021	M	4	1.14%	2.21
BL-MR1-AC8-G, 9/16/08			20.5	52.1	74.0	2098	F	6	3.16%	22.8
Mean Result for Adult Carp			16.9	43.0	35.3	999	NA	4.25	1.49%	4.44
Minimum Results for Adult Carp			15.5	39.4	23.0	652	NA	4.00	0.390%	1.28
Maximum Results for Adult Carp			20.5	52.1	74.0	2098	NA	6.00	3.21%	22.8
Standard Deviation for Adult Carp			1.59	4.05	16.4	464	NA	0.707	1.08%	7.43
Coefficient of Variation for Adult Carp			0.094	0.094	0.464	0.464	NA	0.166	0.728	1.67
Distribution for Adult Carp			Non-Parametric							
Upper 95% UCL for Adult Carp			18.0	45.8	46.6	1321	NA	4.74	2.24%	15.89

BL-MR1-AWS1-G, 9/16/08	Adult White Sucker	SO	16.0	40.6	31.0	879	M	4	0.870%	3.72
BL-MR1-AWS2-G, 9/16/08			15.0	38.1	26.0	737	M	3	1.30%	11.8
BL-MR1-AWS3-G, 9/16/08			10.0	25.4	8.0	227	M	2	0.740%	3.24
BL-MR1-AWS4-G, 9/17/08			16.0	40.6	26.0	737	M	3/4	0.795%	19.9
BL-MR1-AWS5-G, 9/17/08			16.0	40.6	28.0	794	M	4	1.50%	8.79
BL-MR1-AWS6-G, 9/17/08			14.0	35.6	18.0	510	M	3	0.705%	4.68
BL-MR1-AWS7-G, 9/17/08			16.0	40.6	27.0	765	M	4	1.01%	9.23
Mean Result for Adult White Sucker			14.7	37.4	23.4	664	NA	3.36	0.987%	8.77
Minimum Results for Adult White Sucker			10.0	25.4	8.0	227	NA	2.00	0.705%	3.24
Maximum Results for Adult White Sucker			16.0	40.6	31.0	879	NA	4.00	1.50%	19.9
Standard Deviation for Adult White Sucker			2.21	5.62	7.87	223	NA	0.748	0.303%	5.86
Coefficient of Variation for Adult White Sucker			0.151	0.150	0.336	0.336	NA	0.223	0.307	0.669
Distribution for Adult White Sucker			Normal							
Upper 95% UCL for Adult White Sucker			16.4	41.5	29.3	829	NA	3.91	1.21%	13.07

Distribution for PCB results determined using Pro UCL, Version 4.00.02.

FISH SAMPLE RESULTS - MIDDLE RIVER SITE 1 (MR1)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-MR1-SB1-G, 9/16/08	Smallmouth Bass	SO	13.0	33.0	22.0	624	M	5	1.37%	14.1
BL-MR1-SB2-G, 9/16/08			15.0	38.1	32.0	907	F	6	2.27%	6.04
BL-MR1-SB3-G, 9/16/08			14.0	35.6	21.0	595	M	5	1.09%	5.77
BL-MR1-SB4-G, 9/16/08			14.0	35.6	21.0	595	F	5	0.815%	4.20
BL-MR1-SB5-G, 9/16/08			14.5	36.8	25.0	709	M	6	0.765%	7.46
BL-MR1-SB6-G, 9/16/08			12.0	30.5	18.0	510	M	5	0.680%	9.29
BL-MR1-SB7-G, 9/16/08			15.0	38.1	30.0	850	M	6	1.30%	18.2
BL-MR1-SB8-G, 9/16/08			11.0	27.9	11.0	312	M	4	0.830%	4.97
Mean Result for Smallmouth Bass			13.6	34.4	22.5	638	NA	5.25	1.14%	8.75
Minimum Results for Smallmouth Bass			11.0	27.9	11.0	312	NA	4.00	0.680%	4.20
Maximum Results for Smallmouth Bass			15.0	38.1	32.0	907	NA	6.00	2.27%	18.2
Standard Deviation for Smallmouth Bass			1.45	3.68	6.65	189	NA	0.707	0.521%	4.94
Coefficient of Variation for Smallmouth Bass			0.107	0.107	0.296	0.296	NA	0.135	0.458	0.565
Distribution for Smallmouth Bass			Normal							
Upper 95% UCL for Smallmouth Bass			14.6	37.0	27.1	769	NA	5.74	1.50%	12.1

BL-MR1-RB1-G, 9/17/08	Rock Bass	SO	7.00	17.8	6.00	170	M	4	0.810%	2.79
Mean Result for Rock Bass			7.00	17.8	6.00	170	NA	NA	0.810%	2.79
Minimum Results for Rock Bass			7.00	17.8	6.00	170	NA	NA	0.810%	2.79
Maximum Results for Rock Bass			7.00	17.8	6.00	170	NA	NA	0.810%	2.79
Standard Deviation for Rock Bass			NA	NA	NA	NA	NA	NA	NA	NA
Coefficient of Variation for Rock Bass			NA	NA	NA	NA	NA	NA	NA	NA
Distribution for Rock Bass			NA	NA	NA	NA	NA	NA	NA	NA
Upper 95% UCL for Rock Bass			NA	NA	NA	NA	NA	NA	NA	NA

Distribution for PCB results determined using Pro UCL, Version 4.00.02.

FISH SAMPLE RESULTS - MIDDLE RIVER SITE 1 (MR1)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-MR1-LD1-G, 9/10/08	Longnose Dace	W	4.00	10.2	0.330	9.36	TS	NA	5.82%	17.8
BL-MR1-LD2-G, 9/10/08			3.50	8.89	0.270	7.65	TS	NA	2.08%	8.35
BL-MR1-LD3-G, 9/10/08			2.00	5.08	0.080	2.27	TS	NA	3.64%	8.92
BL-MR1-LD4-G, 9/10/08			2.50	6.35	0.090	2.55	TS	NA	4.84%	7.08
BL-MR1-LD5-G, 9/11/08			2.00	5.08	0.060	1.70	TS	NA	2.70%	7.10
BL-MR1-LD6-G, 9/11/08			2.00	5.08	0.060	1.70	TS	NA	3.09%	7.56
Mean Result for Longnose Dace			2.67	6.78	0.148	4.21	NA	NA	3.70%	9.47
Minimum Results for Longnose Dace			2.00	5.08	0.060	1.70	NA	NA	2.08%	7.08
Maximum Results for Longnose Dace			4.00	10.2	0.330	9.36	NA	NA	5.82%	17.8
Standard Deviation for Longnose Dace			0.876	2.24	0.120	3.39	NA	NA	1.40%	4.15
Coefficient of Variation for Longnose Dace			0.328	0.330	0.806	0.806	NA	NA	0.379	0.438
Distribution for Longnose Dace			Non-Parametric							
Upper 95% UCL for Longnose Dace			3.37	8.57	0.244	6.92	NA	NA	4.81%	12.88

BL-MR1-CC1-G, 9/17/08	Channel Catfish	SOF	21.0	53.3	55.0	1559	M	8	4.02%	15.9
BL-MR1-CC2-G, 9/17/08			22.0	55.9	71.0	2013	M	8	12.6%	49.2
BL-MR1-CC3-G, 9/17/08			19.0	48.3	42.0	1191	F	6	6.34%	29.8
BL-MR1-CC4-G, 9/17/08			20.0	50.8	59.0	1673	F	6/7	5.27%	16.6
Mean Result for Channel Catfish			20.5	52.1	56.8	1609	NA	7.13	7.04%	27.9
Minimum Results for Channel Catfish			19.0	48.3	42.0	1191	NA	6.00	4.02%	15.9
Maximum Results for Channel Catfish			22.0	55.9	71.0	2013	NA	8.00	12.6%	49.2
Standard Deviation for Channel Catfish			1.29	3.28	12.0	339	NA	1.03	3.80%	15.6
Coefficient of Variation for Channel Catfish			0.063	0.063	0.211	0.211	NA	0.145	0.539	0.559
Distribution for Channel Catfish			To few samples to determine**							
Upper 95% UCL for Channel Catfish			21.8	55.3	68.5	1941	NA	8.135	10.8%	43.2

Distribution for PCB results determined using Pro UCL, Version 4.00.02.

FISH SAMPLE RESULTS - MIDDLE RIVER SITE 1 (MR1)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-MR1-W1-G, 9/16/08	Walleye	SO	21.0	53.3	58.0	1644	M	6	2.33%	16.8
BL-MR1-W2-G, 9/16/08			19.5	49.5	54.0	1531	M	5	2.11%	16.3
BL-MR1-W3-G, 9/16/08			12.5	31.8	12.0	340	M	2	0.595%	5.58
BL-MR1-W4-G, 9/16/08			16.0	40.6	22.0	624	M	3	1.52%	13.7
BL-MR1-W5-G, 9/16/08			16.0	40.6	22.0	624	M	3	0.695%	7.93
BL-MR1-W6-G, 9/16/08			17.5	44.5	33.0	936	M	4	1.61%	14.3
BL-MR1-W7-G, 9/16/08			13.0	33.0	12.0	340	M	2	0.465%	6.03
BL-MR1-W8-G, 9/16/08			15.5	39.4	20.0	567	M	3	1.00%	8.41
Mean Result for Walleye			16.4	41.6	29.1	826	NA	3.50	1.29%	11.1
Minimum Results for Walleye			12.5	31.8	12.0	340	NA	2.00	0.465%	5.58
Maximum Results for Walleye			21.0	53.3	58.0	1644	NA	6.00	2.33%	16.8
Standard Deviation for Walleye			2.92	7.43	17.9	507	NA	1.41	0.706%	4.63
Coefficient of Variation for Walleye			0.179	0.179	0.614	0.614	NA	0.404	0.548	0.416
Distribution for Walleye			Normal							
Upper 95% UCL for Walleye			18.4	46.7	41.5	1177	NA	4.48	1.78%	14.2

NA - Not applicable
TS - Too small to gender/age
SO - Scale off, skin on fillet
SOF - Skin off fillet
W - Whole fish

** ProUCL could not determine. Based on the coefficient of variation being less than 1.0 and the majority of other data being normal, it was assumed to be normal and 95% UCL was determined accordingly.

[1] Where fish ages were in between ages, a half age was applied for the calculations. For example: 4/5 would be 4.5 years.

MIDDLE RIVER 2

FISH SAMPLE RESULTS - MIDDLE RIVER SITE 2 (MR2)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-MR2-AC1-G, 9/15/08	Adult Carp	SO	19.0	48.3	44.0	1247	M	5	0.730%	1.27
Mean Result for Adult Carp			19.0	48.3	44.0	1247	NA	NA	0.730%	1.27
Minimum Results for Adult Carp			19.0	48.3	44.0	1247	NA	NA	0.730%	1.27
Maximum Results for Adult Carp			19.0	48.3	44.0	1247	NA	NA	0.730%	1.27
Standard Deviation for Adult Carp			NA	NA	NA	NA	NA	NA	NA	NA
Coefficient of Variation for Adult Carp			NA	NA	NA	NA	NA	NA	NA	NA
Distribution for Adult Carp			NA	NA	NA	NA	NA	NA	NA	NA
Upper 95% UCL for Adult Carp			NA	NA	NA	NA	NA	NA	NA	NA

BL-MR2-AWS1-G, 9/8/08	Adult White Sucker	SO	14.5	36.8	17.0	482	M	4	0.200%	3.24
BL-MR2-AWS2-G, 9/8/08			14.5	36.8	18.0	510	M	4	0.170%	2.37
BL-MR2-AWS3-G, 9/8/08			14.0	35.6	20.0	567	M	3	0.520%	3.51
BL-MR2-AWS4-G, 9/8/08			16.0	40.6	26.0	737	F	4	0.715%	3.48
BL-MR2-AWS5-G, 9/8/08			14.0	35.6	13.0	369	M	3	0.150%	0.925
BL-MR2-AWS6-G, 9/8/08			16.0	40.6	23.0	652	F	4	1.23%	6.36
BL-MR2-AWS7-G, 9/8/08			15.0	38.1	22.0	624	F	3	0.585%	6.98
BL-MR2-AWS8-G, 9/8/08			13.5	34.3	16.0	454	M	3	1.36%	4.83
Mean Result for Adult White Sucker			14.7	37.3	19.4	549	NA	3.50	0.616%	3.96
Minimum Results for Adult White Sucker			13.5	34.3	13.0	369	NA	3.00	0.150%	0.925
Maximum Results for Adult White Sucker			16.0	40.6	26.0	737	NA	4.00	1.36%	6.98
Standard Deviation for Adult White Sucker			0.923	2.35	4.21	119	NA	0.535	0.468%	2.01
Coefficient of Variation for Adult White Sucker			0.063	0.063	0.217	0.217	NA	0.153	0.760	0.508
Distribution for Adult White Sucker			Normal							
Upper 95% UCL for Adult White Sucker			15.3	38.9	22.3	632	NA	3.87	0.940%	5.31

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - MIDDLE RIVER SITE 2 (MR2)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-MR2-JWS1-G, 9/8/08	Juvenile White Sucker	SO	8.00	20.3	3.00	85.0	M	2	0.480%	2.03
BL-MR2-JWS2-G, 9/8/08			8.00	20.3	3.00	85.0	M	1	0.400%	1.20
BL-MR2-JWS3-G, 9/15/08			8.00	20.3	4.00	113	M	1	0.740%	1.76
BL-MR2-JWS4-G, 9/15/08			8.00	20.3	3.00	85.0	M	1	0.575%	1.13
BL-MR2-JWS5-G, 9/15/08			8.00	20.3	3.00	85.0	M	1	0.270%	0.98
BL-MR2-JWS6-G, 9/15/08			8.00	20.3	3.00	85.0	M	1	0.557%	1.08
BL-MR2-JWS7-G, 9/15/08			6.00	15.2	2.00	56.7	M	1	0.455%	1.40
Mean Result for Juvenile White Sucker			7.71	19.6	3.00	85.0	NA	1.14	0.497%	1.37
Minimum Results for Juvenile White Sucker			6.00	15.2	2.00	56.7	NA	1.00	0.270%	0.98
Maximum Results for Juvenile White Sucker			8.00	20.3	4.00	113	NA	2.00	0.740%	2.03
Standard Deviation for Juvenile White Sucker			0.756	1.92	0.577	16.4	NA	0.378	0.148%	0.39
Coefficient of Variation for Juvenile White Sucker			0.098	0.098	0.192	0.192	NA	0.331	0.298	0.28
Distribution for Juvenile White Sucker			Normal							
Upper 95% UCL for Juvenile White Sucker			8.27	21.0	3.43	97.2	NA	1.42	0.606%	1.66

BL-MR2-SB1-G, 9/8/08	Smallmouth Bass	SO	17.0	43.2	43.0	1219	F	8	0.875%	3.53
BL-MR2-SB2-G, 9/8/08			14.5	36.8	27.0	765	M	6	1.09%	7.65
BL-MR2-SB3-G, 9/8/08			12.0	30.5	16.0	454	F	4	2.00%	5.54
BL-MR2-SB4-G, 9/8/08			11.0	27.9	15.0	425	F	3	1.06%	2.64
BL-MR2-SB5-G, 9/8/08			11.5	29.2	16.0	454	F	3	1.12%	3.65
BL-MR2-SB6-G, 9/8/08			11.0	27.9	13.0	369	F	3	1.09%	3.08
BL-MR2-SB7-G, 9/8/08			10.0	25.4	11.0	312	M	3	1.30%	4.28
BL-MR2-SB8-G, 9/8/08			12.0	30.5	16.0	454	M	4	1.26%	4.05
Mean Result for Smallmouth Bass			12.4	31.4	19.6	556	NA	4.25	1.22%	4.30
Minimum Results for Smallmouth Bass			10.0	25.4	11.0	312	NA	3.00	0.875%	2.64
Maximum Results for Smallmouth Bass			17.0	43.2	43.0	1219	NA	8.00	2.00%	7.65
Standard Deviation for Smallmouth Bass			2.28	5.79	10.6	299	NA	1.83	0.338%	1.61
Coefficient of Variation for Smallmouth Bass			0.184	0.184	0.538	0.538	NA	0.431	0.277	0.374
Distribution for Smallmouth Bass			Normal							
Upper 95% UCL for Smallmouth Bass			14.0	35.4	26.9	764	NA	5.52	1.46%	5.38

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - MIDDLE RIVER SITE 2 (MR2)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-MR2-RB1-G, 9/8/08	Rock Bass	SO	7.00	17.8	4.00	113	M	4	0.480%	1.42
BL-MR2-RB2-G, 9/8/08			7.00	17.8	4.00	113	M	4	0.593%	2.09
BL-MR2-RB3-G, 9/15/08			7.00	17.8	6.00	170	M	3/4	1.24%	1.88
BL-MR2-RB4-G, 9/15/08			6.50	16.5	5.00	142	F	3	1.80%	3.47
BL-MR2-RB5-G, 9/15/08			5.50	14.0	2.00	56.7	M	3	1.02%	2.86
BL-MR2-RB6-G, 9/15/08			6.00	15.2	2.00	56.7	M	3	1.30%	3.70
BL-MR2-RB7-G, 9/15/08			6.00	15.2	2.00	56.7	M	3	0.583%	2.27
BL-MR2-RB8-G, 9/15/08			8.00	20.3	5.00	142	M	4	0.495%	2.20
Mean Result for Rock Bass			6.63	16.8	3.75	106	NA	3.44	0.939%	2.49
Minimum Results for Rock Bass			5.50	14.0	2.00	56.7	NA	3.00	0.480%	1.42
Maximum Results for Rock Bass			8.00	20.3	6.00	170	NA	4.00	1.80%	3.70
Standard Deviation for Rock Bass			0.791	2.01	1.58	44.8	NA	0.496	0.482%	0.790
Coefficient of Variation for Rock Bass			0.119	0.119	0.422	0.422	NA	0.144	0.513	0.318
Distribution for Rock Bass			Normal							
Upper 95% UCL for Rock Bass			7.17	18.2	4.85	137	NA	3.78	1.27%	3.02

BL-MR2-LD1-G, 9/10/08	Longnose Dace	W	3.50	8.89	0.210	5.95	M	NA	2.84%	6.20
BL-MR2-LD2-G, 9/10/08			3.50	8.89	0.340	9.64	TS	NA	5.02%	9.60
BL-MR2-LD3-G, 9/10/08			3.50	8.89	0.280	7.94	TS	NA	6.08%	10.9
BL-MR2-LD4-G, 9/10/08			4.00	10.2	0.390	11.1	TS	NA	5.50%	11.0
BL-MR2-LD5-G, 9/10/08			2.00	5.08	0.060	1.70	TS	NA	2.33%	4.86
BL-MR2-LD6-G, 9/10/08			2.50	6.35	0.110	3.12	TS	NA	5.09%	7.17
BL-MR2-LD7-G, 9/10/08			3.50	8.89	0.260	7.37	TS	NA	4.13%	9.86
BL-MR2-LD8-G, 9/10/08			3.00	7.62	0.240	6.80	TS	NA	5.74%	8.47
Mean Result for Longnose Dace			3.19	8.10	0.236	6.70	NA	NA	4.59%	8.51
Minimum Results for Longnose Dace			2.00	5.08	0.060	1.70	NA	NA	2.33%	4.86
Maximum Results for Longnose Dace			4.00	10.2	0.390	11.1	NA	NA	6.08%	11.0
Standard Deviation for Longnose Dace			0.651	1.65	0.110	3.12	NA	NA	1.37%	2.25
Coefficient of Variation for Longnose Dace			0.204	0.204	0.465	0.465	NA	NA	0.299	0.264
Distribution for Longnose Dace			Normal							
Upper 95% UCL for Longnose Dace			3.64	9.24	0.312	8.86	NA	NA	5.54%	10.0

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - MIDDLE RIVER SITE 2 (MR2)

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-MR2-CC1-G, 9/8/08	Channel Catfish	SOF	19.0	48.3	42.0	1191	F	7	4.21%	6.90
BL-MR2-CC2-G, 9/15/08			22.0	55.9	109	3090	M	7	6.01%	8.68
BL-MR2-CC3-G, 9/15/08			22.0	55.9	73.0	2070	M	6	3.45%	16.6
BL-MR2-CC4-G, 9/15/08			17.0	43.2	24.0	680	F	5	3.49%	0.532
Mean Result for Channel Catfish			20.0	50.8	62.0	1758	NA	6.25	4.29%	8.18
Minimum Results for Channel Catfish			17.0	43.2	24.0	680	NA	5.00	3.45%	0.532
Maximum Results for Channel Catfish			22.0	55.9	109	3090	NA	7.00	6.01%	16.6
Standard Deviation for Channel Catfish			2.45	6.22	37.3	1057	NA	0.957	1.20%	6.62
Coefficient of Variation for Channel Catfish			0.122	0.122	0.602	0.602	NA	0.153	0.280	0.809
Distribution for Channel Catfish			To few samples to determine**							
Upper 95% UCL for Channel Catfish			22.4	56.9	98.6	2794	NA	7.19	5.46%	14.7

NA - Not applicable
TS - Too small to gender/age
SO - Scale off, skin on fillet
SOF - Skin off fillet
W - Whole fish

** ProUCL could not determine. Based on the coefficient of variation being less than 1.0 and the majority of other data being normal, it was assumed to be normal and 95% UCL was determined accordingly.

[1] Where fish ages were in between ages, a half age was applied for the calculations. For example: 4/5 would be 4.5 years.

LOWER RIVER

FISH SAMPLE RESULTS - LOWER RIVER

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-LR-AC1-G, 8/25/08	Adult Carp	SO	17.5	44.5	32.0	907	M	4/5	2.46%	2.52
BL-LR-AC2-G, 8/25/08			24.5	62.2	112	3175	M	7/8	2.69%	15.7
BL-LR-AC3-G, 9/3/08			21.0	53.3	77.0	2183	F	6	5.51%	0.458
BL-LR-AC4-G, 9/3/08			17.5	44.5	44.0	1247	M	4/5	9.03%	44.9
BL-LR-AC5-G, 9/3/08			24.0	61.0	115	3260	M	7	6.40%	18.4
BL-LR-AC6-G, 9/3/08			24.0	61.0	111	3147	F	7	3.63%	4.46
BL-LR-AC7-G, 9/3/08			18.0	45.7	46.0	1304	M	5	0.825%	1.97
BL-LR-AC8-G, 9/3/08			19.5	49.5	60.0	1701	M	5/6	1.07%	1.89
Mean Result for Adult Carp			20.8	52.7	74.6	2116	NA	5.9	3.95%	11.3
Minimum Results for Adult Carp			17.5	44.5	32.0	907	NA	4.50	0.825%	0.458
Maximum Results for Adult Carp			24.5	62.2	115	3260	NA	7.50	9.03%	44.9
Standard Deviation for Adult Carp			3.06	7.76	34.1	967	NA	1.19	2.83%	15.2
Coefficient of Variation for Adult Carp			0.147	0.147	0.457	0.457	NA	0.202	0.717	1.35
Distribution for Adult Carp			Lognormal							
Upper 95% UCL for Adult Carp			22.9	58.1	98	2786	NA	6.70	5.91%	32.6

BL-LR-AWS1-G, 8/25/08	Adult White Sucker	SO	12.5	31.8	14.0	397	M	3	1.03%	4.96
BL-LR-AWS2-G, 8/25/08			13.5	34.3	16.0	454	M	3	0.705%	3.65
Mean Result for Adult White Sucker			13.0	33.0	15.0	425	NA	3.00	0.865%	4.31
Minimum Results for Adult White Sucker			12.5	31.8	14.0	397	NA	3.00	0.705%	3.65
Maximum Results for Adult White Sucker			13.5	34.3	16.0	454	NA	3.00	1.03%	4.96
Standard Deviation for Adult White Sucker			0.707	1.80	1.41	40.1	NA	0.00	0.226%	0.926
Coefficient of Variation for Adult White Sucker			0.054	0.054	0.094	0.094	NA	0.00	0.262	0.215
Distribution for Adult White Sucker			To few samples to determine							
Upper 95% UCL for Adult White Sucker			To few samples to determine							

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - LOWER RIVER

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-LR-JWS1-G, 8/25/08	Juvenile White Sucker	SO	7.00	17.8	2.00	56.7	M	1	0.140%	1.27
BL-LR-JWS2-G, 8/26/08			8.00	20.3	3.00	85.0	M	1	0.205%	1.64
BL-LR-JWS3-G, 8/26/08			6.50	16.5	2.00	56.7	M	1	0.245%	0.713
BL-LR-JWS4-G, 8/26/08			5.00	12.7	2.00	56.7	M	1	0.094%	0.587
BL-LR-JWS5-G, 9/3/08			7.00	17.8	2.00	56.7	M	2	0.405%	0.967
Mean Result for Juvenile White Sucker			6.70	17.0	2.20	62.4	NA	1.20	0.218%	1.04
Minimum Results for Juvenile White Sucker			5.00	12.7	2.00	56.7	NA	1.00	0.094%	0.587
Maximum Results for Juvenile White Sucker			8.00	20.3	3.00	85.0	NA	2.00	0.405%	1.64
Standard Deviation for Juvenile White Sucker			1.10	2.78	0.447	12.7	NA	0.447	0.120%	0.427
Coefficient of Variation for Juvenile White Sucker			0.163	0.163	0.203	0.203	NA	0.373	0.550	0.413
Distribution for Juvenile White Sucker			Normal							
Upper 95% UCL for Juvenile White Sucker			7.66	19.5	2.59	73.5	NA	1.59	0.323%	1.44

BL-LR-SB1-G, 8/25/08	Smallmouth Bass	SO	10.0	25.4	8.00	227	M	3	1.19%	8.17
BL-LR-SB2-G, 8/25/08			10.5	26.7	9.00	255	F	3/4	0.380%	5.14
BL-LR-SB3-G, 8/25/08			13.0	33.0	25.0	709	M	5	0.650%	2.02
BL-LR-SB4-G, 8/25/08			10.0	25.4	9.00	255	F	3	0.685%	1.78
BL-LR-SB5-G, 8/25/08			12.0	30.5	15.0	425	F	3/4	1.50%	7.01
BL-LR-SB6-G, 8/25/08			11.0	27.9	11.0	312	M	4	0.915%	4.84
BL-LR-SB7-G, 8/25/08			12.0	30.5	17.0	482	M	5	2.13%	10.9
BL-LR-SB8-G, 8/25/08			10.5	26.7	9.00	255	M	3	1.05%	6.30
Mean Result for Smallmouth Bass			11.1	28.3	12.9	365	NA	3.75	1.06%	5.77
Minimum Results for Smallmouth Bass			10.0	25.4	8.00	227	NA	3.00	0.380%	1.78
Maximum Results for Smallmouth Bass			13.0	33.0	25.0	709	NA	5.00	2.13%	10.9
Standard Deviation for Smallmouth Bass			1.09	2.78	5.87	166	NA	0.845	0.552%	3.05
Coefficient of Variation for Smallmouth Bass			0.098	0.098	0.456	0.456	NA	0.225	0.520	0.529
Distribution for Smallmouth Bass			Normal							
Upper 95% UCL for Smallmouth Bass			11.9	30.2	16.9	480	NA	4.34	1.44%	7.81

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - LOWER RIVER

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-LR-RB1-G, 8/26/08	Rock Bass	SO	7.00	17.8	4.00	113	M	3/4	0.510%	1.76
BL-LR-RB2-G, 8/26/08			6.50	16.5	4.00	113	M	3	0.410%	1.95
BL-LR-RB3-G, 8/26/08			5.50	14.0	3.00	85.0	M	3	0.283%	1.40
BL-LR-RB4-G, 8/26/08			5.00	12.7	2.00	56.7	M	2	0.982%	4.11
BL-LR-RB5-G, 8/26/08			6.50	16.5	4.00	113	M	3	0.980%	3.33
BL-LR-RB6-G, 8/26/08			6.50	16.5	4.00	113	M	3	0.445%	1.84
BL-LR-RB7-G, 8/26/08			6.00	15.2	3.00	85.0	M	3	0.393%	1.63
BL-LR-RB8-G, 8/26/08			7.00	17.8	4.00	113	M	3	0.915%	4.27
BL-LR-RB9-G, 8/26/08			6.50	16.5	4.00	113	M	3	0.300%	3.07
Mean Result for Rock Bass			6.28	15.9	3.56	101	NA	2.94	0.580%	2.60
Minimum Results for Rock Bass			5.00	12.7	2.00	56.7	NA	2.00	0.283%	1.40
Maximum Results for Rock Bass			7.00	17.8	4.00	113	NA	3.50	0.982%	4.27
Standard Deviation for Rock Bass			0.667	1.69	0.726	20.6	NA	0.391	0.293%	1.11
Coefficient of Variation for Rock Bass			0.106	0.106	0.204	0.204	NA	0.133	0.506	0.429
Distribution for Rock Bass			Normal							
Upper 95% UCL for Rock Bass			6.71	17.1	4.03	114	NA	3.20	0.771%	3.29

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - LOWER RIVER

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-LR-CC1-G, 8/25/08	Channel Catfish	SOF	19.0	48.3	44.0	1247	M	6	4.11%	8.49
BL-LR-CC2-G, 8/25/08			21.0	53.3	55.0	1559	M	7	4.34%	11.7
BL-LR-CC3-G, 8/25/08			20.0	50.8	58.0	1644	M	6	4.98%	6.37
BL-LR-CC4-G, 8/25/08			17.0	43.2	34.0	964	M	6	7.81%	28.4
Mean Result for Channel Catfish			19.3	48.9	47.8	1354	NA	6.25	5.31%	13.7
Minimum Results for Channel Catfish			17.0	43.2	34.0	964	NA	6.00	4.11%	6.37
Maximum Results for Channel Catfish			21.0	53.3	58.0	1644	NA	7.00	7.81%	28.4
Standard Deviation for Channel Catfish			1.71	4.33	11.0	311	NA	0.500	1.71%	10.0
Coefficient of Variation for Channel Catfish			0.089	0.089	0.230	0.230	NA	0.080	0.322	0.729
Distribution for Channel Catfish			To few samples to determine**							
Upper 95% UCL for Channel Catfish			20.9	53.1	58.5	1658	NA	6.74	6.98%	25.1

NA - Not applicable
SO - Scale off, skin on fillet
SOF - Skin off fillet
W - Whole fish

** ProUCL could not determine. Based on the coefficient of variation being less than 1.0 and the majority of other data being normal, it was assumed to be normal and 95% UCL was determined accordingly.

[1] Where fish ages were in between ages, a half age was applied for the calculations. For example: 4/5 would be 4.5 years.

INNER HARBOR

FISH SAMPLE RESULTS - INNER HARBOR

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)*[1]	*Fat (%)*	*PCB (mg/kg)*
BL-IH-AC1-G, 8/27/08	Adult Carp	SO	21.0	53.3	69.0	1956	M	6	3.83%	9.14
BL-IH-AC2-G, 8/27/08			23.0	58.4	112	3175	M	7	1.91%	3.21
BL-IH-AC3-G, 8/27/08			16.5	41.9	36.0	1021	F	5	2.52%	2.46
BL-IH-AC4-G, 8/27/08			17.0	43.2	37.0	1049	F	4	3.03%	5.02
BL-IH-AC5-G, 8/27/08			18.5	47.0	58.0	1644	M	5	4.04%	2.30
BL-IH-AC6-G, 8/27/08			16.5	41.9	36.0	1021	F	4/5	4.06%	2.05
BL-IH-AC7-G, 8/27/08			18.5	47.0	47.0	1332	M	5	1.29%	0.890
BL-IH-AC8-G, 8/27/08			19.0	48.3	53.0	1503	F	5	0.630%	0.243
Mean Result for Adult Carp			18.8	47.6	56.0	1588	NA	5.19	2.66%	3.16
Minimum Results for Adult Carp			16.5	41.9	36.0	1021	NA	4.00	0.630%	0.243
Maximum Results for Adult Carp			23.0	58.4	112	3175	NA	7.00	4.06%	9.14
Standard Deviation for Adult Carp			2.28	5.79	25.5	724	NA	0.923	1.31%	2.81
Coefficient of Variation for Adult Carp			0.122	0.122	0.456	0.456	NA	0.178	0.491	0.889
Distribution for Adult Carp			Normal							
Upper 95% UCL for Adult Carp			20.33	51.64	73.69	2089	NA	5.83	3.57%	5.05

BL-IH-SB1-G, 8/27/08	Smallmouth Bass	SO	15.0	38.1	31.0	879	M	6	0.680%	1.44
BL-IH-SB2-G, 8/27/08			14.0	35.6	26.0	737	F	5/6	0.855%	2.70
BL-IH-SB3-G, 8/27/08			12.0	30.5	16.0	454	M	4	0.935%	4.43
BL-IH-SB4-G, 8/27/08			13.0	33.0	18.0	510	F	4	1.00%	3.10
BL-IH-SB5-G, 8/27/08			11.5	29.2	14.0	397	F	3	0.980%	4.18
BL-IH-SB6-G, 8/27/08			11.0	27.9	13.0	369	F	3	1.13%	4.31
BL-IH-SB7-G, 8/27/08			14.0	35.6	25.0	709	F	5	1.58%	3.91
BL-IH-SB8-G, 9/2/08			17.0	43.2	46.0	1304	M	7/8	1.77%	2.83
Mean Result for Smallmouth Bass			13.4	34.1	23.6	670	NA	4.75	1.12%	3.36
Minimum Results for Smallmouth Bass			11.0	27.9	13.0	369	NA	3.00	0.680%	1.44
Maximum Results for Smallmouth Bass			17.0	43.2	46.0	1304	NA	7.50	1.77%	4.43
Standard Deviation for Smallmouth Bass			1.99	5.05	11.1	314	NA	1.56	0.369%	1.04
Coefficient of Variation for Smallmouth Bass			0.148	0.148	0.469	0.469	NA	0.328	0.331	0.308
Distribution for Smallmouth Bass			Normal							
Upper 95% UCL for Smallmouth Bass			14.82	37.63	31.30	887	NA	5.83	1.37%	4.06

Distribution of PCB results determined using ProUCL, Version 4.00.02.

FISH SAMPLE RESULTS - INNER HARBOR

Sample ID, Collection Date	*Sample Type*	*Sample Form*	*Length (in)*	*Length (cm)*	*Weight (ounces)*	*Weight (grams)*	*Gender (M/F)*	*Age (Yr)* [1]	*Fat (%)*	*PCB (mg/kg)*
BL-IH-CC1-G, 9/2/08	Channel Catfish	SOF	20.5	52.1	54.0	1531	M	6	12.16%	19.4
Mean Result for Channel Catfish			20.5	52.1	54.0	1531	NA	NA	12.16%	19.4
Minimum Results for Channel Catfish			20.5	52.1	54.0	1531	NA	NA	12.16%	19.4
Maximum Results for Channel Catfish			20.5	52.1	54.0	1531	NA	NA	12.16%	19.4
Standard Deviation for Channel Catfish			NA	NA	NA	NA	NA	NA	NA	NA
Coefficient of Variation for Channel Catfish			NA	NA	NA	NA	NA	NA	NA	NA
Distribution for Channel Catfish			NA	NA	NA	NA	NA	NA	NA	NA
Upper 95% UCL for Channel Catfish			NA	NA	NA	NA	NA	NA	NA	NA

BL-IH-W1-G, 8/27/08	Walleye	SO	21.0	53.3	79.0	2240	M	6	3.71%	3.00
BL-IH-W2-G, 9/5/08			21.0	53.3	72.0	2041	M	5/6	2.71%	1.36
BL-IH-W3-G, 9/5/08			22.0	55.9	81.0	2296	M	6	1.72%	1.74
Mean Result for Walleye			21.3	54.2	77.3	2192	NA	5.83	2.71%	2.03
Minimum Results for Walleye			21.0	53.3	72.0	2041	NA	5.50	1.72%	1.36
Maximum Results for Walleye			22.0	55.9	81.0	2296	NA	6.00	3.71%	3.00
Standard Deviation for Walleye			0.577	1.47	4.73	134	NA	0.289	1.00%	0.857
Coefficient of Variation for Walleye			0.027	0.027	0.061	0.061	NA	0.049	0.367	0.422
Distribution for Walleye			To few samples to determine**							
Upper 95% UCL for Walleye			21.99	55.85	82.68	2343.96	NA	6.16	3.84%	3.00

NA - Not applicable
SO - Scale off, skin on fillet
SOF - Skin off fillet
W - Whole fish

** ProUCL could not determine. Based on the coefficient of variation being less than 1.0 and the majority of other data being normal, it was assumed to be normal and 95% UCL was determined accordingly.

[1] Where fish ages were in between ages, a half age was applied for the calculations. For example: 4/5 would be 4.5 years.

Baseline Upper and Lower River Fish Monitoring Report
Appendix 2
Laboratory Analytical Reports
CD Contents

Report Date	Lab Report # (CD Link)	Sample Locations
08/26/08	408210	Upper River 1
08/26/08	408211	Upper River 1 & 2
08/28/08	408330	Upper River 2
08/28/08	408328	Upper River 2, Lower River
09/03/08	408460	Lower River, Inner Harbor
09/05/08	408619	Lower River, Inner Harbor
09/09/08	408719	Upper River 1 & 2, Inner Harbor
09/09/08	408721	Upper River 2, Middle River 2
09/11/08	408870	Middle River 2
09/18/08	409156	Upper River 1, Middle River 1 & 2
09/18/08	409155	Middle River 1 & 2
09/19/08	409244	Middle River 1
09/19/08	409245	Upper River 1, Middle River 1

Note: Click on blue CD link to access the report in a new window.

Appendix 3

Charts

Chart 1
2008 Baseline Fish Monitoring PCB Results - Sheboygan River

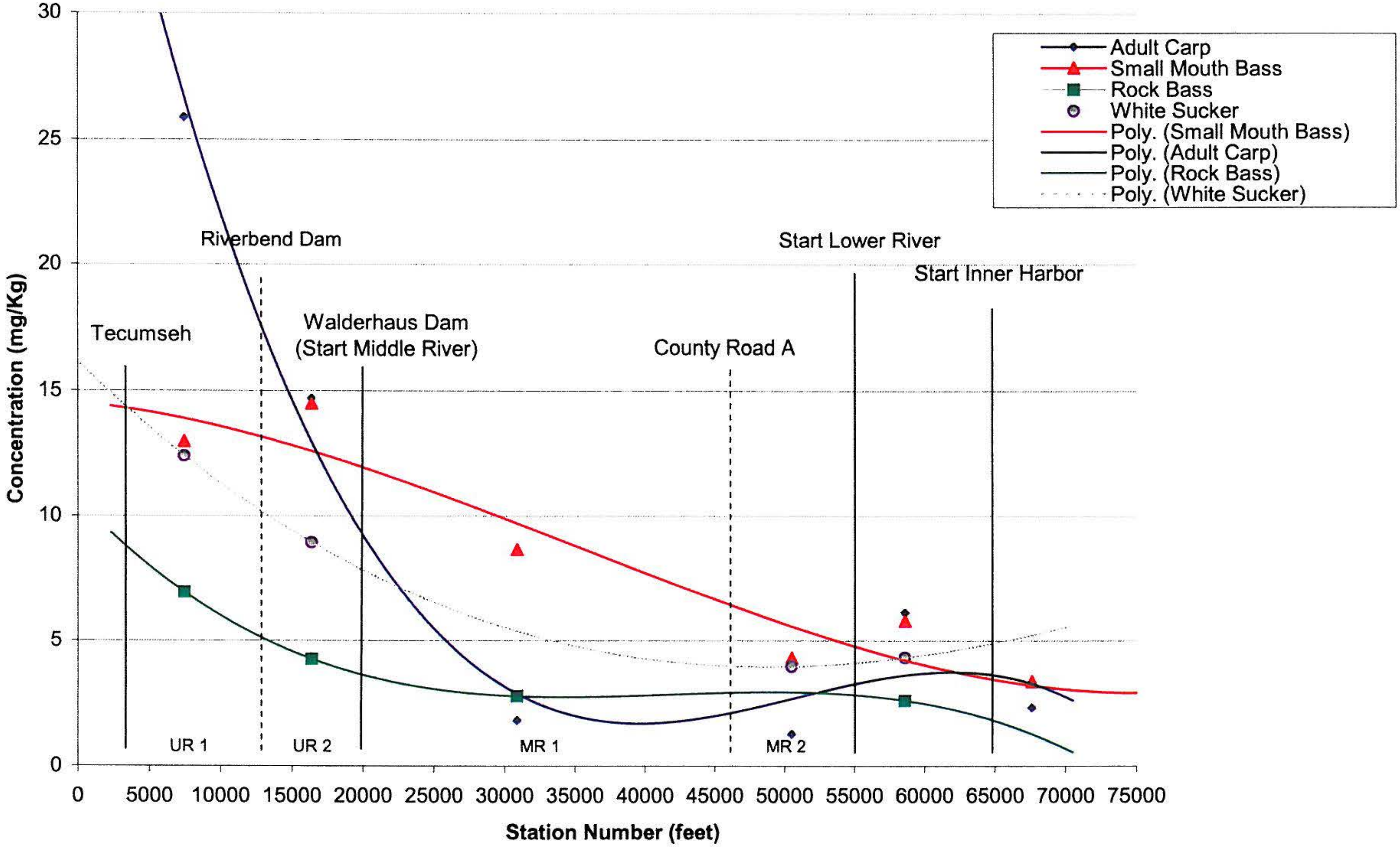


Chart 2
Upper River Site 1 PCB Results - Small Mouth Bass

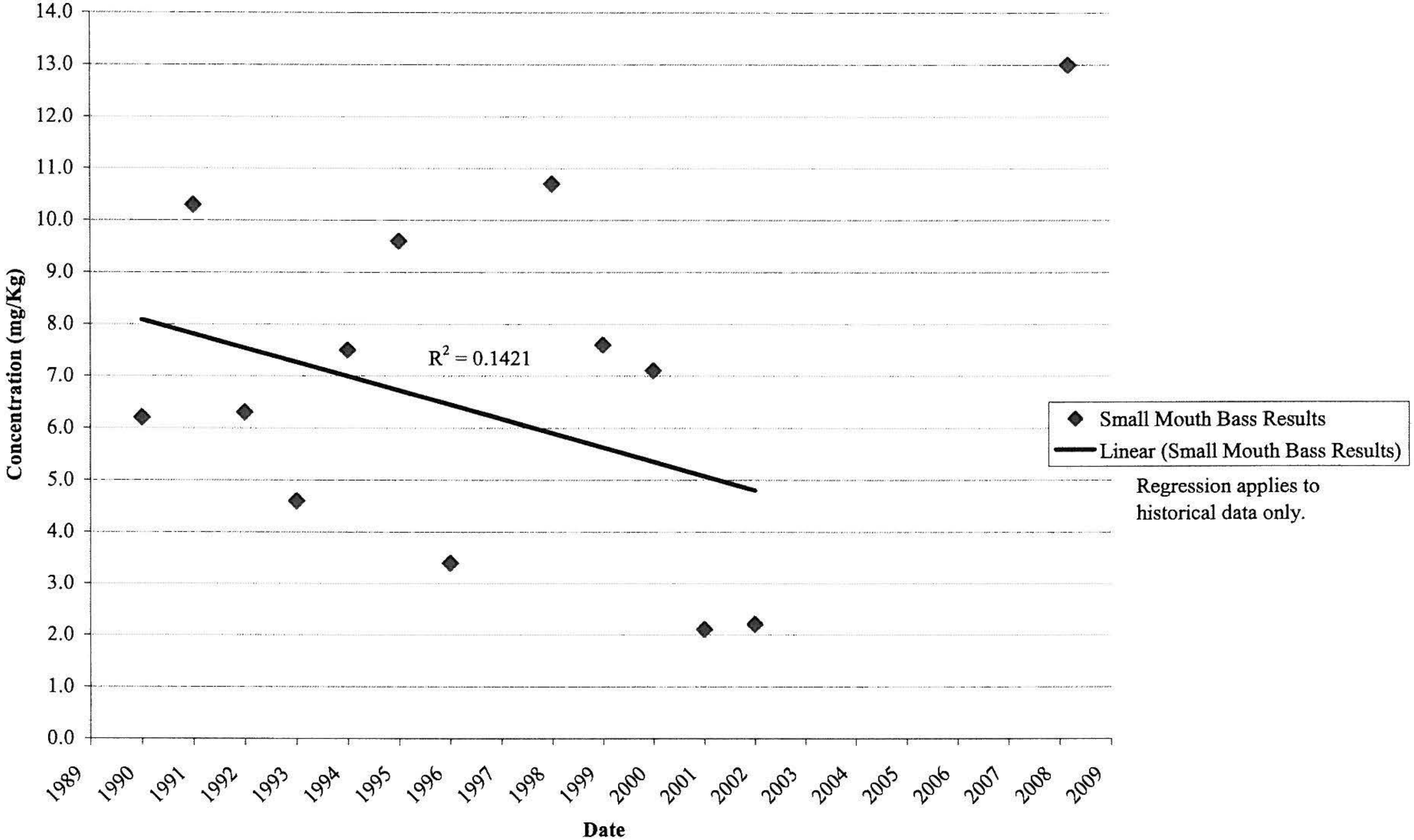


Chart 3
Upper River Site 2 PCB Results - Small Mouth Bass

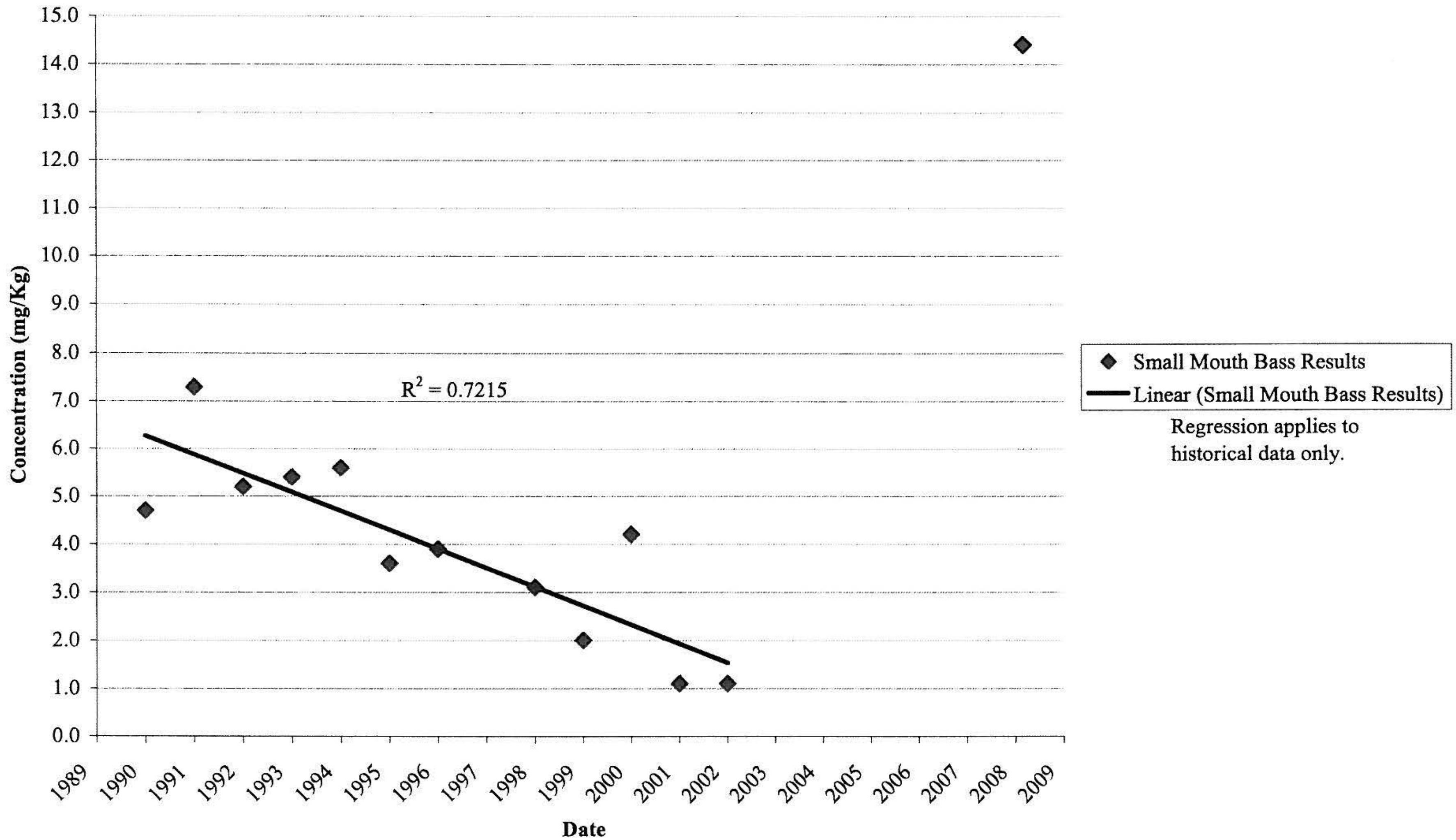


Chart 4
Upper River PCB Results - White Sucker

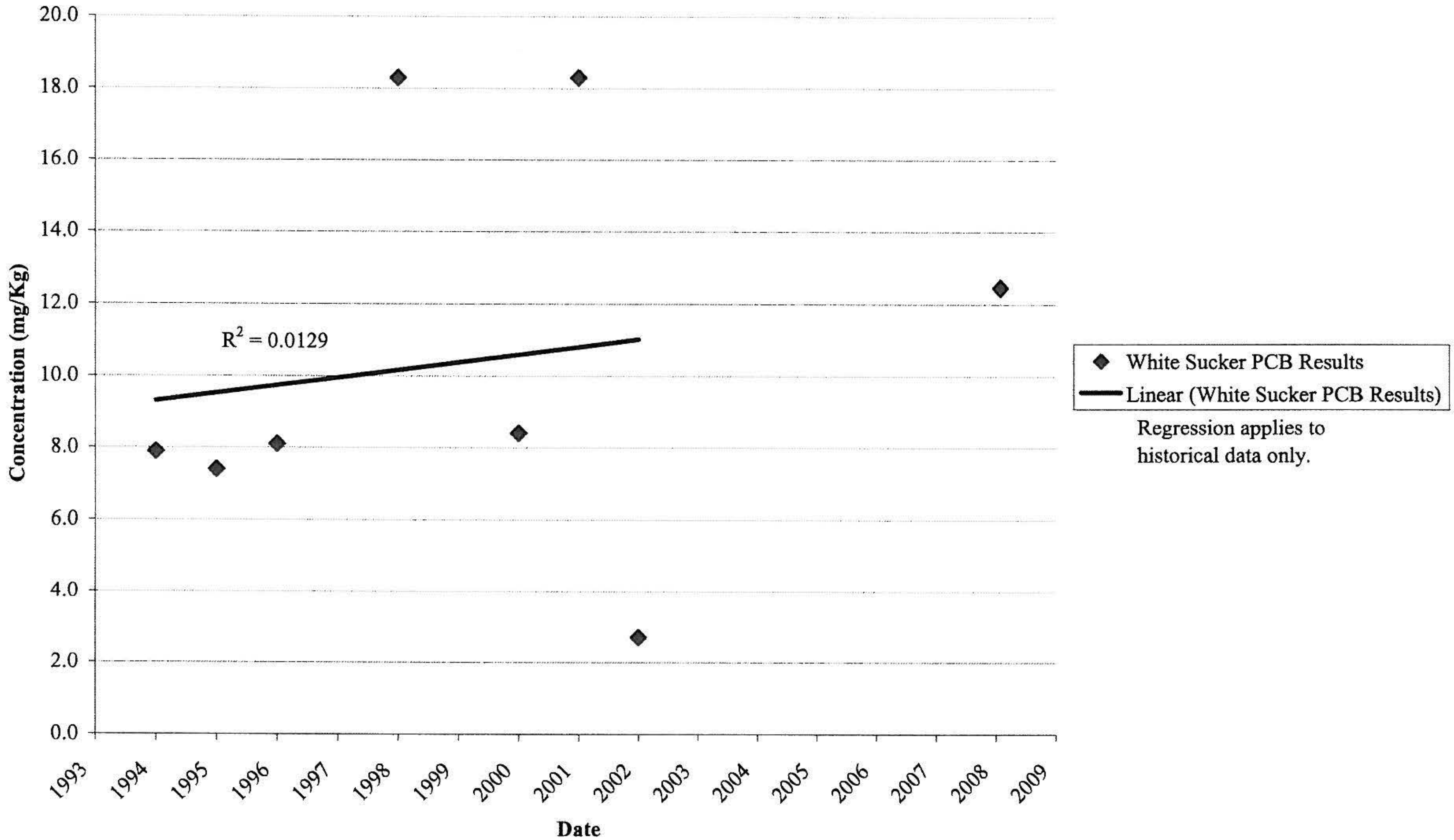


Chart 5
Upper River 2 PCB Results - White Suckers

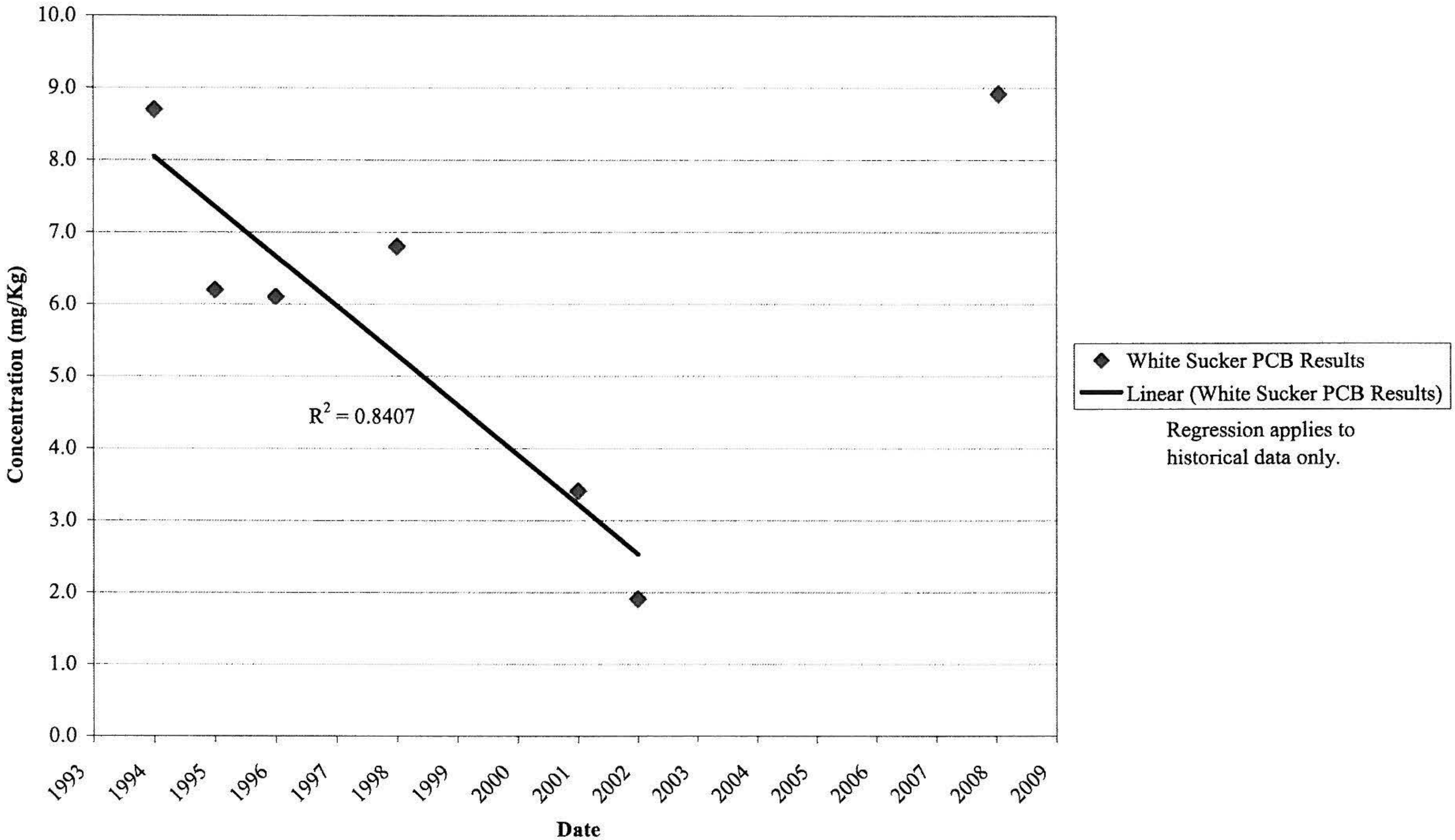


Chart 6
Upper River 1 Linear Regression Analysis of Selected Fish Species

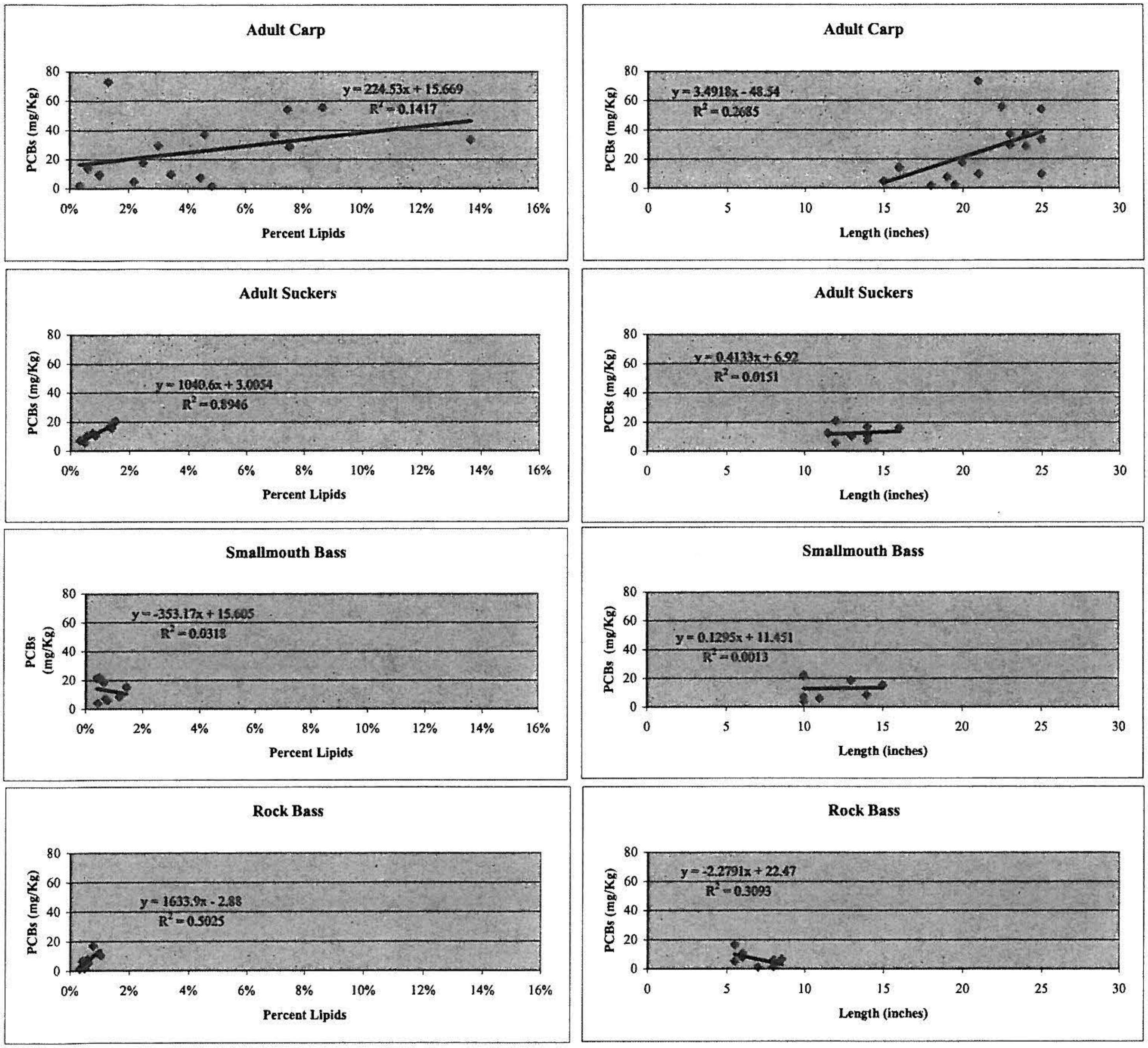
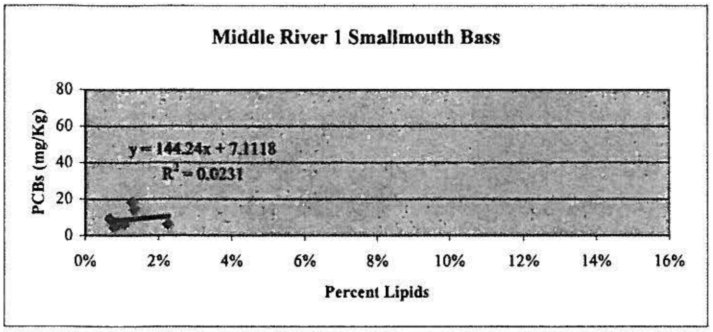
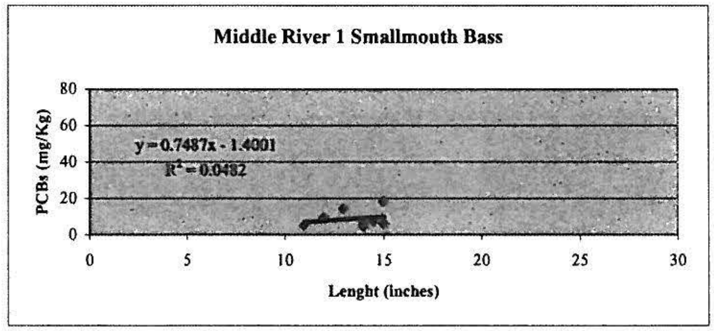
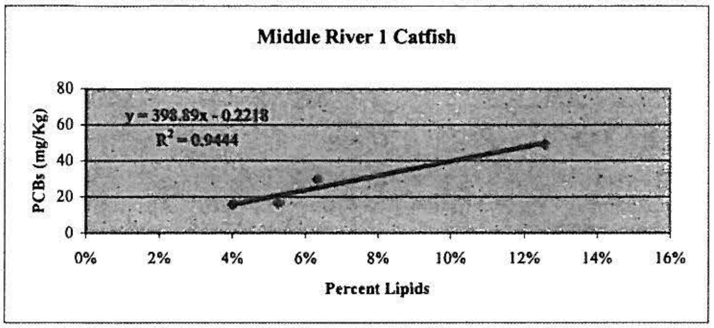
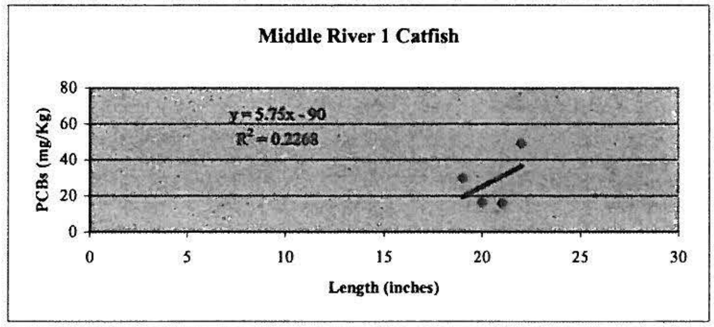


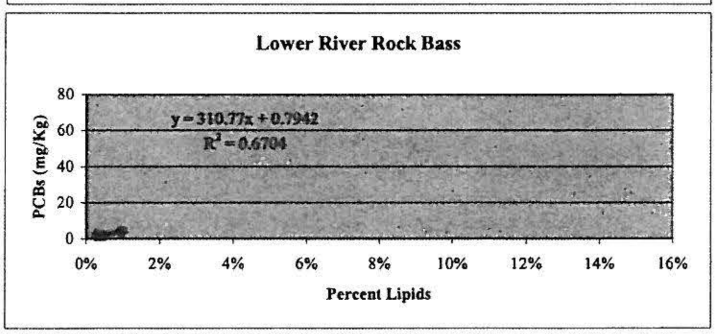
Chart 7
Other Reaches Linear Regression of Selected Fish Species

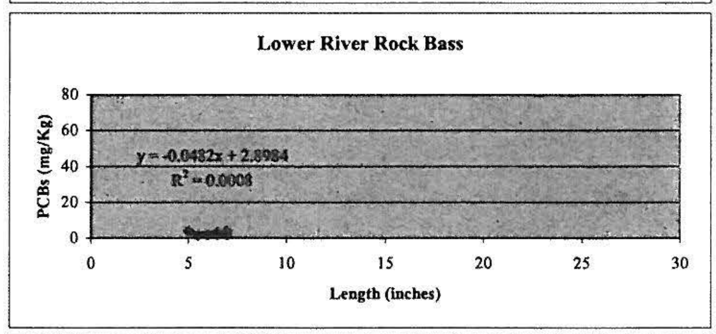


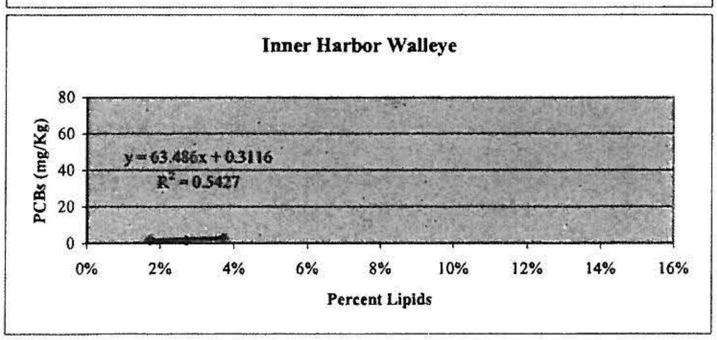


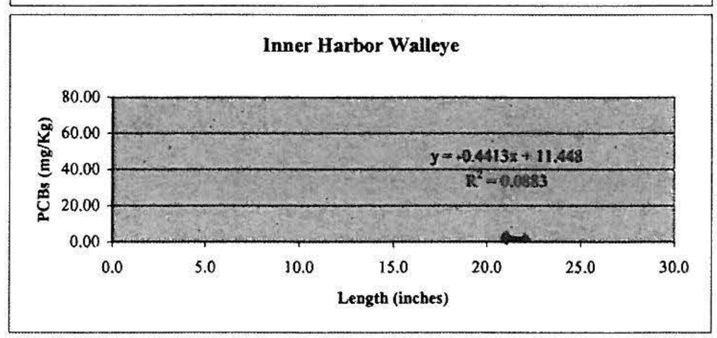












Appendix 4

ProUCL Documentation

UPPER RIVER 1

General UCL Statistics for Full Data Sets

User Selected Options	**Upper River 1**
From File	M:\Sheboygan River\5_Post-Remediation\2_Sampling Results\5_Fish Monitoring\Baseline Stats\UR1\UR1 Fish.
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

A. Carp

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.63	Minimum of Log Data	0.489
Maximum	73.1	Maximum of Log Data	4.292
Mean	25.88	Mean of log Data	2.784
Median	23	SD of log Data	1.154
SD	21.44		
Coefficient of Variation	0.829		
Skewness	0.789		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.912	Shapiro Wilk Test Statistic	0.927
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	35.28	95% H-UCL	75.78
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	71.19
95% Adjusted-CLT UCL	35.83	97.5% Chebyshev (MVUE) UCL	89.2
95% Modified-t UCL	35.45	99% Chebyshev (MVUE) UCL	124.6

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.021	Data appear Normal at 5% Significance Level	
Theta Star	25.34		
nu star	32.68		
Approximate Chi Square Value (.05)	20.61	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0335	95% CLT UCL	34.7
Adjusted Chi Square Value	19.52	95% Jackknife UCL	35.28
		95% Standard Bootstrap UCL	34.41
Anderson-Darling Test Statistic	0.274	95% Bootstrap-t UCL	37.24
Anderson-Darling 5% Critical Value	0.76	95% Hall's Bootstrap UCL	36.3
Kolmogorov-Smirnov Test Statistic	0.159	95% Percentile Bootstrap UCL	34.31
Kolmogorov-Smirnov 5% Critical Value	0.22	95% BCA Bootstrap UCL	35.14
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	49.24
		97.5% Chebyshev(Mean, Sd) UCL	59.35
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	79.22
95% Approximate Gamma UCL	41.03		
95% Adjusted Gamma UCL	43.32		
Potential UCL to Use		Use 95% Student's-t UCL	35.28

A. Sucker

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	5.74	Minimum of Log Data	1.747
Maximum	20.6	Maximum of Log Data	3.025
Mean	12.42	Mean of log Data	2.443
Median	11.45	SD of log Data	0.429
SD	4.996		
Coefficient of Variation	0.402		
Skewness	0.331		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.966	Shapiro Wilk Test Statistic	0.967
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

	A	B	C	D	E	F	G	H	I	J	K	L
83			Assuming Normal Distribution						Assuming Lognormal Distribution			
84					95% Student's-t UCL	15.77					95% H-UCL	18.13
85			95% UCLs (Adjusted for Skewness)								95% Chebyshev (MVUE) UCL	20.76
					95% Adjusted-CLT UCL	15.55					97.5% Chebyshev (MVUE) UCL	24.36
					95% Modified-t UCL	15.8					99% Chebyshev (MVUE) UCL	31.41
88												
89			Gamma Distribution Test						Data Distribution			
90					k star (bias corrected)	4.272			Data appear Normal at 5% Significance Level			
91					Theta Star	2.908						
92					nu star	68.35						
93					Approximate Chi Square Value (.05)	50.32			Nonparametric Statistics			
94					Adjusted Level of Significance	0.0195					95% CLT UCL	15.33
95					Adjusted Chi Square Value	46.43					95% Jackknife UCL	15.77
96											95% Standard Bootstrap UCL	15.15
97					Anderson-Darling Test Statistic	0.194					95% Bootstrap-t UCL	16.23
98					Anderson-Darling 5% Critical Value	0.718					95% Hall's Bootstrap UCL	15.74
99					Kolmogorov-Smirnov Test Statistic	0.161					95% Percentile Bootstrap UCL	15.15
100					Kolmogorov-Smirnov 5% Critical Value	0.295					95% BCA Bootstrap UCL	15.48
101			Data appear Gamma Distributed at 5% Significance Level								95% Chebyshev(Mean, Sd) UCL	20.12
102											97.5% Chebyshev(Mean, Sd) UCL	23.45
103			Assuming Gamma Distribution								99% Chebyshev(Mean, Sd) UCL	30
104					95% Approximate Gamma UCL	16.87						
105					95% Adjusted Gamma UCL	18.29						
106												
			Potential UCL to Use								Use 95% Student's-t UCL	15.77
108												
109												
110	J. Sucker											
111												
112							General Statistics					
113					Number of Valid Observations	8					Number of Distinct Observations	8
114												
115			Raw Statistics						Log-transformed Statistics			
116					Minimum	1.99					Minimum of Log Data	0.688
117					Maximum	9.71					Maximum of Log Data	2.273
118					Mean	6.014					Mean of log Data	1.66
119					Median	6.295					SD of log Data	0.6
120					SD	2.852						
121					Coefficient of Variation	0.474						
122					Skewness	-0.312						
123												
124												
125							Warning: There are only 8 Values in this data					
126							Note: It should be noted that even though bootstrap methods may be performed on this data set,					
							the resulting calculations may not be reliable enough to draw conclusions					
129							The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.					
130												

131	**Relevant UCL Statistics**			
132	**Normal Distribution Test**		**Lognormal Distribution Test**	
133	Shapiro Wilk Test Statistic	0.938	Shapiro Wilk Test Statistic	0.864
	Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
	Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
136				
137	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
138	95% Student's-t UCL	7.924	95% H-UCL	11.2
139	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	11.9
140	95% Adjusted-CLT UCL	7.554	97.5% Chebyshev (MVUE) UCL	14.39
141	95% Modified-t UCL	7.906	99% Chebyshev (MVUE) UCL	19.29
142				
143	**Gamma Distribution Test**		**Data Distribution**	
144	k star (bias corrected)	2.516	**Data appear Normal at 5% Significance Level**	
145	Theta Star	2.39		
146	nu star	40.26		
147	Approximate Chi Square Value (.05)	26.72	**Nonparametric Statistics**	
148	Adjusted Level of Significance	0.0195	95% CLT UCL	7.673
149	Adjusted Chi Square Value	23.97	95% Jackknife UCL	7.924
150			95% Standard Bootstrap UCL	7.558
151	Anderson-Darling Test Statistic	0.438	95% Bootstrap-t UCL	7.849
152	Anderson-Darling 5% Critical Value	0.719	95% Hall's Bootstrap UCL	7.512
153	Kolmogorov-Smirnov Test Statistic	0.201	95% Percentile Bootstrap UCL	7.506
154	Kolmogorov-Smirnov 5% Critical Value	0.295	95% BCA Bootstrap UCL	7.413
	Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10.41
156			97.5% Chebyshev(Mean, Sd) UCL	12.31
157	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	16.05
158	95% Approximate Gamma UCL	9.061		
159	95% Adjusted Gamma UCL	10.1		
160				
161	**Potential UCL to Use**		Use 95% Student's-t UCL	7.924
162				
163				
164	**SM Bass**			
165				
166	**General Statistics**			
167	Number of Valid Observations	8	Number of Distinct Observations	8
168				
169	**Raw Statistics**		**Log-transformed Statistics**	
170	Minimum	4.09	Minimum of Log Data	1.409
171	Maximum	22.2	Maximum of Log Data	3.1
172	Mean	12.96	Mean of log Data	2.397
173	Median	11.9	SD of log Data	0.64
174	SD	7.281		
	Coefficient of Variation	0.562		
	Skewness	0.163		
177				
178				

179	Warning: There are only 8 Values in this data			
180	Note: It should be noted that even though bootstrap methods may be performed on this data set,			
181	the resulting calculations may not be reliable enough to draw conclusions			
	The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.			
184				
185	**Relevant UCL Statistics**			
186	**Normal Distribution Test**		**Lognormal Distribution Test**	
187	Shapiro Wilk Test Statistic	0.888	Shapiro Wilk Test Statistic	0.909
188	Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
189	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
190				
191	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
192	95% Student's-t UCL	17.83	95% H-UCL	25.38
193	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	26.22
194	95% Adjusted-CLT UCL	17.35	97.5% Chebyshev (MVUE) UCL	31.9
195	95% Modified-t UCL	17.86	99% Chebyshev (MVUE) UCL	43.04
196				
197	**Gamma Distribution Test**		**Data Distribution**	
198	k star (bias corrected)	2.084	**Data appear Normal at 5% Significance Level**	
199	Theta Star	6.217		
200	nu star	33.34		
201	Approximate Chi Square Value (.05)	21.14	**Nonparametric Statistics**	
202	Adjusted Level of Significance	0.0195	95% CLT UCL	17.19
	Adjusted Chi Square Value	18.72	95% Jackknife UCL	17.83
204			95% Standard Bootstrap UCL	16.95
205	Anderson-Darling Test Statistic	0.41	95% Bootstrap-t UCL	18.01
206	Anderson-Darling 5% Critical Value	0.721	95% Hall's Bootstrap UCL	16.22
207	Kolmogorov-Smirnov Test Statistic	0.19	95% Percentile Bootstrap UCL	16.83
208	Kolmogorov-Smirnov 5% Critical Value	0.296	95% BCA Bootstrap UCL	17.21
209	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	24.18
210			97.5% Chebyshev(Mean, Sd) UCL	29.03
211	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	38.57
212	95% Approximate Gamma UCL	20.44		
213	95% Adjusted Gamma UCL	23.08		
214				
215	**Potential UCL to Use**		Use 95% Student's-t UCL	17.83
216				
217				

R. Bass

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8

Raw Statistics		Log-transformed Statistics	
Minimum	1.22	Minimum of Log Data	0.199
Maximum	16.8	Maximum of Log Data	2.821
Mean	6.944	Mean of log Data	1.648
Median	6.175	SD of log Data	0.897
SD	5.011		
Coefficient of Variation	0.722		
Skewness	0.985		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.92	Shapiro Wilk Test Statistic	0.908
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	10.3	95% H-UCL	22.82
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	17.59
95% Adjusted-CLT UCL	10.52	97.5% Chebyshev (MVUE) UCL	22.05
95% Modified-t UCL	10.4	99% Chebyshev (MVUE) UCL	30.8

	A–E	F	G–K	L
251	**Gamma Distribution Test**		**Data Distribution**	
252	k star (bias corrected)	1.256	**Data appear Normal at 5% Significance Level**	
253	Theta Star	5.528		
	nu star	20.1		
	Approximate Chi Square Value (.05)	10.92	**Nonparametric Statistics**	
256	Adjusted Level of Significance	0.0195	95% CLT UCL	9.858
257	Adjusted Chi Square Value	9.262	95% Jackknife UCL	10.3
258			95% Standard Bootstrap UCL	9.619
259	Anderson-Darling Test Statistic	0.309	95% Bootstrap-t UCL	11.4
260	Anderson-Darling 5% Critical Value	0.725	95% Hall's Bootstrap UCL	16.87
261	Kolmogorov-Smirnov Test Statistic	0.209	95% Percentile Bootstrap UCL	9.888
262	Kolmogorov-Smirnov 5% Critical Value	0.298	95% BCA Bootstrap UCL	10.06
263	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	14.67
264			97.5% Chebyshev(Mean, Sd) UCL	18.01
265	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	24.57
266	95% Approximate Gamma UCL	12.78		
267	95% Adjusted Gamma UCL	15.07		
268				
269	**Potential UCL to Use**		Use 95% Student's-t UCL	10.3
270				
271				
272	LN Dace			
273				
274			**General Statistics**	
	Number of Valid Observations	6	Number of Distinct Observations	6
276				
277	**Raw Statistics**		**Log-transformed Statistics**	
278	Minimum	1.72	Minimum of Log Data	0.542
279	Maximum	17.6	Maximum of Log Data	2.868
280	Mean	7.67	Mean of log Data	1.685
281	Median	4.2	SD of log Data	0.926
282	SD	6.855		
283	Coefficient of Variation	0.894		
284	Skewness	0.921		
285				
286				
287	**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**			
288				
289	**It is suggested to collect at least 8 to 10 observations using these statistical methods!**			
290	**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**			
291				
292				

Warning: There are only 6 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.8	Shapiro Wilk Test Statistic	0.905
Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	13.31	95% H-UCL	40.82
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	19.91
95% Adjusted-CLT UCL	13.4	97.5% Chebyshev (MVUE) UCL	25.24
95% Modified-t UCL	13.48	99% Chebyshev (MVUE) UCL	35.72
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.894	**Data appear Normal at 5% Significance Level**	
Theta Star	8.583		
nu star	10.72		
Approximate Chi Square Value (.05)	4.399	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0122	95% CLT UCL	12.27
Adjusted Chi Square Value	3.062	95% Jackknife UCL	13.31
		95% Standard Bootstrap UCL	11.83
Anderson-Darling Test Statistic	0.491	95% Bootstrap-t UCL	29.03
Anderson-Darling 5% Critical Value	0.707	95% Hall's Bootstrap UCL	54.01
Kolmogorov-Smirnov Test Statistic	0.246	95% Percentile Bootstrap UCL	12.14
Kolmogorov-Smirnov 5% Critical Value	0.337	95% BCA Bootstrap UCL	12.3
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	19.87
		97.5% Chebyshev(Mean, Sd) UCL	25.15
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	35.51
95% Approximate Gamma UCL	18.7		
95% Adjusted Gamma UCL	26.86		
Potential UCL to Use		Use 95% Student's-t UCL	13.31

UPPER RIVER 2

General UCL Statistics for Full Data Sets

User Selected Options	Upper River 2
From File	M:\Sheboygan River\5_Post-Remediation\2_Sampling Results\5_Fish Monitoring\Baseline Stats\UR2\Fish UR 2
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

A. Carp

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.02	Minimum of Log Data	0.0198
Maximum	47.7	Maximum of Log Data	3.865
Mean	14.72	Mean of log Data	2.076
Median	8.535	SD of log Data	1.24
SD	15.04		
Coefficient of Variation	1.022		
Skewness	1.041		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.836	Shapiro Wilk Test Statistic	0.949
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	21.31	95% H-UCL	46.32
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	40.28
95% Adjusted-CLT UCL	21.95	97.5% Chebyshev (MVUE) UCL	50.81
95% Modified-t UCL	21.47	99% Chebyshev (MVUE) UCL	71.49

	A–E	F	G–K	L
35	**Gamma Distribution Test**		**Data Distribution**	
36	k star (bias corrected)	0.811	**Data appear Gamma Distributed at 5% Significance Level**	
37	Theta Star	18.14		
	nu star	25.96		
	Approximate Chi Square Value (.05)	15.35	**Nonparametric Statistics**	
40	Adjusted Level of Significance	0.0335	95% CLT UCL	20.9
41	Adjusted Chi Square Value	14.42	95% Jackknife UCL	21.31
42			95% Standard Bootstrap UCL	20.69
43	Anderson-Darling Test Statistic	0.385	95% Bootstrap-t UCL	23.25
44	Anderson-Darling 5% Critical Value	0.766	95% Hall's Bootstrap UCL	21.45
45	Kolmogorov-Smirnov Test Statistic	0.139	95% Percentile Bootstrap UCL	20.85
46	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	21.25
47	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	31.11
48			97.5% Chebyshev(Mean, Sd) UCL	38.2
49	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	52.13
50	95% Approximate Gamma UCL	24.89		
51	95% Adjusted Gamma UCL	26.49		
52				
53	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	24.89
54				
55				
56	**A. Sucker**			
57				
58	**General Statistics**			
	Number of Valid Observations	8	Number of Distinct Observations	8
60				
61	**Raw Statistics**		**Log-transformed Statistics**	
62	Minimum	3.95	Minimum of Log Data	1.374
63	Maximum	16.6	Maximum of Log Data	2.809
64	Mean	8.913	Mean of log Data	2.089
65	Median	8.48	SD of log Data	0.481
66	SD	4.189		
67	Coefficient of Variation	0.47		
68	Skewness	0.73		
69				
70				
71	**Warning: There are only 8 Values in this data**			
72	**Note: It should be noted that even though bootstrap methods may be performed on this data set,**			
73	**the resulting calculations may not be reliable enough to draw conclusions**			
74				
75	**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**			
76				
77	**Relevant UCL Statistics**			
78	**Normal Distribution Test**		**Lognormal Distribution Test**	
	Shapiro Wilk Test Statistic	0.952	Shapiro Wilk Test Statistic	0.982
	Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
81	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
82				

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11.72	95% H-UCL	13.82
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	15.6
95% Adjusted-CLT UCL	11.76	97.5% Chebyshev (MVUE) UCL	18.48
95% Modified-t UCL	11.78	99% Chebyshev (MVUE) UCL	24.16
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.354	**Data appear Normal at 5% Significance Level**	
Theta Star	2.658		
nu star	53.66		
Approximate Chi Square Value (.05)	37.83	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	11.35
Adjusted Chi Square Value	34.49	95% Jackknife UCL	11.72
		95% Standard Bootstrap UCL	11.26
Anderson-Darling Test Statistic	0.16	95% Bootstrap-t UCL	12.2
Anderson-Darling 5% Critical Value	0.719	95% Hall's Bootstrap UCL	12.3
Kolmogorov-Smirnov Test Statistic	0.138	95% Percentile Bootstrap UCL	11.25
Kolmogorov-Smirnov 5% Critical Value	0.295	95% BCA Bootstrap UCL	11.52
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	15.37
		97.5% Chebyshev(Mean, Sd) UCL	18.16
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	23.65
95% Approximate Gamma UCL	12.64		
95% Adjusted Gamma UCL	13.86		
Potential UCL to Use		Use 95% Student's-t UCL	11.72

J. Sucker

General Statistics			
Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	3.73	Minimum of Log Data	1.316
Maximum	11.5	Maximum of Log Data	2.442
Mean	6.82	Mean of log Data	1.838
Median	5.835	SD of log Data	0.43
SD	2.961		
Coefficient of Variation	0.434		
Skewness	0.584		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

	A–E	F	G–K	L
131		Relevant UCL Statistics		
132	Normal Distribution Test		Lognormal Distribution Test	
133	Shapiro Wilk Test Statistic	0.881	Shapiro Wilk Test Statistic	0.907
[illegible]	Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
[illegible]	Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
136				
137	Assuming Normal Distribution		Assuming Lognormal Distribution	
138	95% Student's-t UCL	8.803	95% H-UCL	9.929
139	95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11.37
140	95% Adjusted-CLT UCL	8.773	97.5% Chebyshev (MVUE) UCL	13.34
141	95% Modified-t UCL	8.839	99% Chebyshev (MVUE) UCL	17.21
142				
143	Gamma Distribution Test		Data Distribution	
144	k star (bias corrected)	4.013	Data appear Normal at 5% Significance Level	
145	Theta Star	1.7		
146	nu star	64.2		
147	Approximate Chi Square Value (.05)	46.77	Nonparametric Statistics	
148	Adjusted Level of Significance	0.0195	95% CLT UCL	8.542
149	Adjusted Chi Square Value	43.03	95% Jackknife UCL	8.803
150			95% Standard Bootstrap UCL	8.404
151	Anderson-Darling Test Statistic	0.447	95% Bootstrap-t UCL	9.368
152	Anderson-Darling 5% Critical Value	0.718	95% Hall's Bootstrap UCL	8.224
153	Kolmogorov-Smirnov Test Statistic	0.205	95% Percentile Bootstrap UCL	8.493
154	Kolmogorov-Smirnov 5% Critical Value	0.295	95% BCA Bootstrap UCL	8.675
[illegible]	Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	11.38
156			97.5% Chebyshev(Mean, Sd) UCL	13.36
157	Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	17.24
158	95% Approximate Gamma UCL	9.362		
159	95% Adjusted Gamma UCL	10.18		
160				
161	Potential UCL to Use		Use 95% Student's-t UCL	8.803
162				
163				
164	SM Bass			
165				
166		General Statistics		
167	Number of Valid Observations	8	Number of Distinct Observations	8
168				
169	Raw Statistics		Log-transformed Statistics	
170	Minimum	3.12	Minimum of Log Data	1.138
171	Maximum	33.5	Maximum of Log Data	3.512
172	Mean	14.52	Mean of log Data	2.4
173	Median	12	SD of log Data	0.82
174	SD	11.11		
[illegible]	Coefficient of Variation	0.765		
[illegible]	Skewness	0.965		
177				
178				

179	**Warning: There are only 8 Values in this data**			
180	**Note: It should be noted that even though bootstrap methods may be performed on this data set,**			
181	**the resulting calculations may not be reliable enough to draw conclusions**			
	The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.			
184				
185	**Relevant UCL Statistics**			
186	**Normal Distribution Test**		**Lognormal Distribution Test**	
187	Shapiro Wilk Test Statistic	0.874	Shapiro Wilk Test Statistic	0.965
188	Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
189	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
190				
191	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
192	95% Student's-t UCL	21.96	95% H-UCL	39.11
193	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	33.57
194	95% Adjusted-CLT UCL	22.42	97.5% Chebyshev (MVUE) UCL	41.74
195	95% Modified-t UCL	22.19	99% Chebyshev (MVUE) UCL	57.81
196				
197	**Gamma Distribution Test**		**Data Distribution**	
198	k star (bias corrected)	1.312	**Data appear Normal at 5% Significance Level**	
199	Theta Star	11.07		
200	nu star	20.99		
201	Approximate Chi Square Value (.05)	11.59	**Nonparametric Statistics**	
202	Adjusted Level of Significance	0.0195	95% CLT UCL	20.98
	Adjusted Chi Square Value	9.866	95% Jackknife UCL	21.96
204			95% Standard Bootstrap UCL	20.67
205	Anderson-Darling Test Statistic	0.245	95% Bootstrap-t UCL	28.89
206	Anderson-Darling 5% Critical Value	0.724	95% Hall's Bootstrap UCL	61.72
207	Kolmogorov-Smirnov Test Statistic	0.156	95% Percentile Bootstrap UCL	20.68
208	Kolmogorov-Smirnov 5% Critical Value	0.298	95% BCA Bootstrap UCL	22.01
209	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	31.65
210			97.5% Chebyshev(Mean, Sd) UCL	39.06
211	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	53.61
212	95% Approximate Gamma UCL	26.31		
213	95% Adjusted Gamma UCL	30.9		
214				
215	**Potential UCL to Use**		Use 95% Student's-t UCL	21.96
216				
217				
218	**R. Bass**			
219				

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.739	Minimum of Log Data	-0.302
Maximum	8.72	Maximum of Log Data	2.166
Mean	4.266	Mean of log Data	1.17
Median	4.01	SD of log Data	0.887
SD	2.935		
Coefficient of Variation	0.688		
Skewness	0.544		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.898	Shapiro Wilk Test Statistic	0.891
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.232	95% H-UCL	13.76
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.76
95% Adjusted-CLT UCL	6.186	97.5% Chebyshev (MVUE) UCL	13.47
95% Modified-t UCL	6.265	99% Chebyshev (MVUE) UCL	18.8
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.291	**Data appear Normal at 5% Significance Level**	
Theta Star	3.304		
nu star	20.66		
Approximate Chi Square Value (.05)	11.34	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	5.973
Adjusted Chi Square Value	9.642	95% Jackknife UCL	6.232
		95% Standard Bootstrap UCL	5.847
Anderson-Darling Test Statistic	0.372	95% Bootstrap-t UCL	7.051
Anderson-Darling 5% Critical Value	0.725	95% Hall's Bootstrap UCL	8.329
Kolmogorov-Smirnov Test Statistic	0.171	95% Percentile Bootstrap UCL	5.936
Kolmogorov-Smirnov 5% Critical Value	0.298	95% BCA Bootstrap UCL	6.027
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.789
		97.5% Chebyshev(Mean, Sd) UCL	10.75
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	14.59
95% Approximate Gamma UCL	7.773		
95% Adjusted Gamma UCL	9.142		
Potential UCL to Use		Use 95% Student's-t UCL	6.232

MIDDLE RIVER 1

General UCL Statistics for Full Data Sets

User Selected Options	
From File	M:\Sheboygan\4 Post-Remediation\3 PR Monitoring Activities\3 Fish Monitoring\Fish Sampling Data\Baseline\Ba
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

A. Carp

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.28	Minimum of Log Data	0.247
Maximum	22.8	Maximum of Log Data	3.127
Mean	4.44	Mean of log Data	0.889
Median	1.885	SD of log Data	0.934
SD	7.431		
Coefficient of Variation	1.674		
Skewness	2.81		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.473	Shapiro Wilk Test Statistic	0.66
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	9.417	95% H-UCL	11.93
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.676
95% Adjusted-CLT UCL	11.55	97.5% Chebyshev (MVUE) UCL	10.91
95% Modified-t UCL	9.852	99% Chebyshev (MVUE) UCL	15.3
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.686	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	6.474		
nu star	10.97		
Approximate Chi Square Value (.05)	4.558	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	8.761
Adjusted Chi Square Value	3.571	95% Jackknife UCL	9.417
		95% Standard Bootstrap UCL	8.431
Anderson-Darling Test Statistic	1.685	95% Bootstrap-t UCL	62.44

	A–E	F	G–K	L
51	Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL	40.14
52	Kolmogorov-Smirnov Test Statistic	0.437	95% Percentile Bootstrap UCL	9.643
53	Kolmogorov-Smirnov 5% Critical Value	0.302	95% BCA Bootstrap UCL	12.25
	Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	15.89
			97.5% Chebyshev(Mean, Sd) UCL	20.85
56	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	30.58
57	95% Approximate Gamma UCL	10.69		
58	95% Adjusted Gamma UCL	13.64		
59				
60	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	15.89
61				
62	**A. Sucker**			
63				
64		**General Statistics**		
65	Number of Valid Observations	7	Number of Distinct Observations	7
66				
67	**Raw Statistics**		**Log-transformed Statistics**	
68	Minimum	3.24	Minimum of Log Data	1.176
69	Maximum	19.9	Maximum of Log Data	2.991
70	Mean	8.766	Mean of log Data	1.984
71	Median	8.79	SD of log Data	0.663
72	SD	5.861		
73	Coefficient of Variation	0.669		
74	Skewness	1.209		
77	**Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!**			
78				
79	**It is suggested to collect at least 8 to 10 observations using these statistical methods!**			
80	**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**			
81				
82				
83	**Warning: There are only 7 Values in this data**			
84	**Note: It should be noted that even though bootstrap methods may be performed on this data set,**			
85	**the resulting calculations may not be reliable enough to draw conclusions**			
86				
87	**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**			
88				
89		**Relevant UCL Statistics**		
90	**Normal Distribution Test**		**Lognormal Distribution Test**	
91	Shapiro Wilk Test Statistic	0.881	Shapiro Wilk Test Statistic	0.942
92	Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
93	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
94				
	Assuming Normal Distribution		**Assuming Lognormal Distribution**	
	95% Student's-t UCL	13.07	95% H-UCL	19.41
97	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	18.35
98	95% Adjusted-CLT UCL	13.49	97.5% Chebyshev (MVUE) UCL	22.51
99	95% Modified-t UCL	13.24	99% Chebyshev (MVUE) UCL	30.68
100				

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.713	Data appear Normal at 5% Significance Level	
Theta Star	5.118		
nu star	23.98		
Approximate Chi Square Value (.05)	13.83	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	12.41
Adjusted Chi Square Value	11.57	95% Jackknife UCL	13.07
		95% Standard Bootstrap UCL	12.23
Anderson-Darling Test Statistic	0.296	95% Bootstrap-t UCL	14.66
Anderson-Darling 5% Critical Value	0.713	95% Hall's Bootstrap UCL	18.95
Kolmogorov-Smirnov Test Statistic	0.201	95% Percentile Bootstrap UCL	12.44
Kolmogorov-Smirnov 5% Critical Value	0.314	95% BCA Bootstrap UCL	12.88
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	18.42
		97.5% Chebyshev(Mean, Sd) UCL	22.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	30.81
95% Approximate Gamma UCL	15.2		
95% Adjusted Gamma UCL	18.16		
Potential UCL to Use		Use 95% Student's-t UCL	13.07

SM Bass

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8

Raw Statistics		Log-transformed Statistics	
Minimum	4.2	Minimum of Log Data	1.435
Maximum	18.2	Maximum of Log Data	2.901
Mean	8.754	Mean of log Data	2.047
Median	6.75	SD of log Data	0.513
SD	4.944		
Coefficient of Variation	0.565		
Skewness	1.259		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.849	Shapiro Wilk Test Statistic	0.934
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	12.07	95% H-UCL	14.01
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	15.61

	A–E	F	G–K	L
151	95% Adjusted-CLT UCL	12.46	97.5% Chebyshev (MVUE) UCL	18.61
152	95% Modified-t UCL	12.2	99% Chebyshev (MVUE) UCL	24.5
153				
	Gamma Distribution Test		**Data Distribution**	
	k star (bias corrected)	2.734	**Data appear Normal at 5% Significance Level**	
156	Theta Star	3.202		
157	nu star	43.74		
158	Approximate Chi Square Value (.05)	29.57	**Nonparametric Statistics**	
159	Adjusted Level of Significance	0.0195	95% CLT UCL	11.63
160	Adjusted Chi Square Value	26.66	95% Jackknife UCL	12.07
161			95% Standard Bootstrap UCL	11.43
162	Anderson-Darling Test Statistic	0.401	95% Bootstrap-t UCL	15.8
163	Anderson-Darling 5% Critical Value	0.719	95% Hall's Bootstrap UCL	26.7
164	Kolmogorov-Smirnov Test Statistic	0.21	95% Percentile Bootstrap UCL	11.63
165	Kolmogorov-Smirnov 5% Critical Value	0.295	95% BCA Bootstrap UCL	12.14
166	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	16.37
167			97.5% Chebyshev(Mean, Sd) UCL	19.67
168	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	26.15
169	95% Approximate Gamma UCL	12.95		
170	95% Adjusted Gamma UCL	14.36		
171				
172	**Potential UCL to Use**		Use 95% Student's-t UCL	12.07
173				
174	**LN Dace**			
			General Statistics	
177	Number of Valid Observations	6	Number of Distinct Observations	6
178				
179	**Raw Statistics**		**Log-transformed Statistics**	
180	Minimum	7.08	Minimum of Log Data	1.957
181	Maximum	17.8	Maximum of Log Data	2.879
182	Mean	9.468	Mean of log Data	2.188
183	Median	7.955	SD of log Data	0.351
184	SD	4.145		
185	Coefficient of Variation	0.438		
186	Skewness	2.286		
187				
188				
189	**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**			
190				
191	**It is suggested to collect at least 8 to 10 observations using these statistical methods!**			
192	**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**			
193				
194				
	Warning: There are only 6 Values in this data			
	Note: It should be noted that even though bootstrap methods may be performed on this data set,			
197	**the resulting calculations may not be reliable enough to draw conclusions**			
198				
199	**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**			
200				

	A–E	F	G–K	L
201	**Relevant UCL Statistics**			
202	**Normal Distribution Test**		**Lognormal Distribution Test**	
203	Shapiro Wilk Test Statistic	0.65	Shapiro Wilk Test Statistic	0.721
	Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
	Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
206				
207	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
208	95% Student's-t UCL	12.88	95% H-UCL	13.64
209	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	15.24
210	95% Adjusted-CLT UCL	13.94	97.5% Chebyshev (MVUE) UCL	17.77
211	95% Modified-t UCL	13.14	99% Chebyshev (MVUE) UCL	22.75
212				
213	**Gamma Distribution Test**		**Data Distribution**	
214	k star (bias corrected)	4.386	**Data do not follow a Discernable Distribution (0.05)**	
215	Theta Star	2.159		
216	nu star	52.63		
217	Approximate Chi Square Value (.05)	36.97	**Nonparametric Statistics**	
218	Adjusted Level of Significance	0.0122	95% CLT UCL	12.25
219	Adjusted Chi Square Value	32.29	95% Jackknife UCL	12.88
220			95% Standard Bootstrap UCL	12.03
221	Anderson-Darling Test Statistic	0.941	95% Bootstrap-t UCL	23.62
222	Anderson-Darling 5% Critical Value	0.698	95% Hall's Bootstrap UCL	24.98
223	Kolmogorov-Smirnov Test Statistic	0.356	95% Percentile Bootstrap UCL	12.6
224	Kolmogorov-Smirnov 5% Critical Value	0.333	95% BCA Bootstrap UCL	13.08
	Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	16.85
22			97.5% Chebyshev(Mean, Sd) UCL	20.04
227	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	26.31
228	95% Approximate Gamma UCL	13.48		
229	95% Adjusted Gamma UCL	15.43		
230				
231	**Potential UCL to Use**		Use 95% Student's-t UCL	12.88
232			or 95% Modified-t UCL	13.14
233				
234	**Walleye**			
235				
236	**General Statistics**			
237	Number of Valid Observations	8	Number of Distinct Observations	8
238				
239	**Raw Statistics**		**Log-transformed Statistics**	
240	Minimum	5.58	Minimum of Log Data	1.719
241	Maximum	16.8	Maximum of Log Data	2.821
242	Mean	11.13	Mean of log Data	2.326
243	Median	11.06	SD of log Data	0.449
244	SD	4.629		
	Coefficient of Variation	0.416		
	Skewness	0.0235		
247				
248				
249	**Warning: There are only 8 Values in this data**			
250	**Note: It should be noted that even though bootstrap methods may be performed on this data set,**			

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.874	Shapiro Wilk Test Statistic	0.876
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	14.23	95% H-UCL	16.64
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	18.96
95% Adjusted-CLT UCL	13.84	97.5% Chebyshev (MVUE) UCL	22.33
95% Modified-t UCL	14.23	99% Chebyshev (MVUE) UCL	28.95
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.906	**Data appear Normal at 5% Significance Level**	
Theta Star	2.85		
nu star	62.49		
Approximate Chi Square Value (.05)	45.31	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	13.82
Adjusted Chi Square Value	41.63	95% Jackknife UCL	14.23
		95% Standard Bootstrap UCL	13.63
Anderson-Darling Test Statistic	0.515	95% Bootstrap-t UCL	14.36
Anderson-Darling 5% Critical Value	0.718	95% Hall's Bootstrap UCL	13.23
Kolmogorov-Smirnov Test Statistic	0.247	95% Percentile Bootstrap UCL	13.72
Kolmogorov-Smirnov 5% Critical Value	0.295	95% BCA Bootstrap UCL	13.75
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	18.26
		97.5% Chebyshev(Mean, Sd) UCL	21.35
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	27.41
95% Approximate Gamma UCL	15.35		
95% Adjusted Gamma UCL	16.71		
Potential UCL to Use		Use 95% Student's-t UCL	14.23

Catfish

General Statistics

Number of Valid Observations	4	Number of Distinct Observations	4

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Catfish was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

MIDDLE RIVER 2

	General UCL Statistics for Full Data Sets
User Selected Options	**Middle River 2**
From File	M:\Sheboygan River\5_Post-Remediation\2_Sampling Results\5_Fish Monitoring\Baseline Stats\MR2\MR 2 Fish
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

A. Sucker

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.925	Minimum of Log Data	-0.078
Maximum	6.98	Maximum of Log Data	1.943
Mean	3.962	Mean of log Data	1.229
Median	3.495	SD of log Data	0.639
SD	2.012		
Coefficient of Variation	0.508		
Skewness	0.218		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.957	Shapiro Wilk Test Statistic	0.901
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	5.309	95% H-UCL	7.878
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.143
95% Adjusted-CLT UCL	5.19	97.5% Chebyshev (MVUE) UCL	9.905
95% Modified-t UCL	5.319	99% Chebyshev (MVUE) UCL	13.36
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.296	**Data appear Normal at 5% Significance Level**	
Theta Star	1.726		
nu star	36.74		
Approximate Chi Square Value (.05)	23.86	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	5.132
Adjusted Chi Square Value	21.27	95% Jackknife UCL	5.309
		95% Standard Bootstrap UCL	5.039
Anderson-Darling Test Statistic	0.286	95% Bootstrap-t UCL	5.547

	A–E	F	G–K	L
51	Anderson-Darling 5% Critical Value	0.72	95% Hall's Bootstrap UCL	5.976
52	Kolmogorov-Smirnov Test Statistic	0.177	95% Percentile Bootstrap UCL	5.06
53	Kolmogorov-Smirnov 5% Critical Value	0.296	95% BCA Bootstrap UCL	5.1
54	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	7.062
			97.5% Chebyshev(Mean, Sd) UCL	8.404
56	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	11.04
57	95% Approximate Gamma UCL	6.099		
58	95% Adjusted Gamma UCL	6.841		
59				
60	**Potential UCL to Use**		Use 95% Student's-t UCL	5.309
61				
62				
63	**J. Sucker**			
64				
65			**General Statistics**	
66	Number of Valid Observations	7	Number of Distinct Observations	7
67				
68	**Raw Statistics**		**Log-transformed Statistics**	
69	Minimum	0.98	Minimum of Log Data	-0.0202
70	Maximum	2.03	Maximum of Log Data	0.708
71	Mean	1.369	Mean of log Data	0.282
72	Median	1.2	SD of log Data	0.269
73	SD	0.39		
74	Coefficient of Variation	0.285		
	Skewness	0.979		
76				
77				
78	**Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!**			
79				
80	**It is suggested to collect at least 8 to 10 observations using these statistical methods!**			
81	**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**			
82				
83				
84	**Warning: There are only 7 Values in this data**			
85	**Note: It should be noted that even though bootstrap methods may be performed on this data set,**			
86	**the resulting calculations may not be reliable enough to draw conclusions**			
87				
88	**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**			
89				
90			**Relevant UCL Statistics**	
91	**Normal Distribution Test**		**Lognormal Distribution Test**	
92	Shapiro Wilk Test Statistic	0.886	Shapiro Wilk Test Statistic	0.921
93	Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
94	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
	Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97	95% Student's-t UCL	1.655	95% H-UCL	1.736
98	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	1.973
99	95% Adjusted-CLT UCL	1.669	97.5% Chebyshev (MVUE) UCL	2.236
100	95% Modified-t UCL	1.664	99% Chebyshev (MVUE) UCL	2.751

	A	B	C	D	E	F	G	H	I	J	K	L
101												
102			Gamma Distribution Test						Data Distribution			
103					k star (bias corrected)	9.068			Data appear Normal at 5% Significance Level			
104					Theta Star	0.151						
[illegible]					nu star	127						
106					Approximate Chi Square Value (.05)	101.9			Nonparametric Statistics			
107					Adjusted Level of Significance	0.0158					95% CLT UCL	1.611
108					Adjusted Chi Square Value	95.17					95% Jackknife UCL	1.655
109											95% Standard Bootstrap UCL	1.59
110					Anderson-Darling Test Statistic	0.388					95% Bootstrap-t UCL	1.971
111					Anderson-Darling 5% Critical Value	0.707					95% Hall's Bootstrap UCL	1.973
112					Kolmogorov-Smirnov Test Statistic	0.236					95% Percentile Bootstrap UCL	1.606
113					Kolmogorov-Smirnov 5% Critical Value	0.312					95% BCA Bootstrap UCL	1.63
114			Data appear Gamma Distributed at 5% Significance Level								95% Chebyshev(Mean, Sd) UCL	2.011
115											97.5% Chebyshev(Mean, Sd) UCL	2.288
116			Assuming Gamma Distribution								99% Chebyshev(Mean, Sd) UCL	2.834
117					95% Approximate Gamma UCL	1.705						
118					95% Adjusted Gamma UCL	1.826						
119												
120			Potential UCL to Use								Use 95% Student's-t UCL	1.655
121												
122												
123	SM Bass											
124												
[illegible]							General Statistics					
126					Number of Valid Observations	8					Number of Distinct Observations	8
127												
128			Raw Statistics						Log-transformed Statistics			
129					Minimum	2.64					Minimum of Log Data	0.971
130					Maximum	7.65					Maximum of Log Data	2.035
131					Mean	4.303					Mean of log Data	1.406
132					Median	3.85					SD of log Data	0.337
133					SD	1.607						
134					Coefficient of Variation	0.374						
135					Skewness	1.479						
136												
137												
138							Warning: There are only 8 Values in this data					
139							Note: It should be noted that even though bootstrap methods may be performed on this data set,					
140							the resulting calculations may not be reliable enough to draw conclusions					
141												
142							The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.					
143												
144							Relevant UCL Statistics					
[illegible]			Normal Distribution Test						Lognormal Distribution Test			
[illegible]					Shapiro Wilk Test Statistic	0.869					Shapiro Wilk Test Statistic	0.952
147					Shapiro Wilk Critical Value	0.818					Shapiro Wilk Critical Value	0.818
148			Data appear Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level			
149												
150			Assuming Normal Distribution						Assuming Lognormal Distribution			

	A–E	F	G–K	L
151	95% Student's-t UCL	5.379	95% H-UCL	5.646
152	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	6.523
153	95% Adjusted-CLT UCL	5.555	97.5% Chebyshev (MVUE) UCL	7.49
154	95% Modified-t UCL	5.429	99% Chebyshev (MVUE) UCL	9.389
156	**Gamma Distribution Test**		**Data Distribution**	
157	k star (bias corrected)	6.103	**Data appear Normal at 5% Significance Level**	
158	Theta Star	0.705		
159	nu star	97.65		
160	Approximate Chi Square Value (.05)	75.86	**Nonparametric Statistics**	
161	Adjusted Level of Significance	0.0195	95% CLT UCL	5.237
162	Adjusted Chi Square Value	71.01	95% Jackknife UCL	5.379
163			95% Standard Bootstrap UCL	5.212
164	Anderson-Darling Test Statistic	0.336	95% Bootstrap-t UCL	6.593
165	Anderson-Darling 5% Critical Value	0.715	95% Hall's Bootstrap UCL	11
166	Kolmogorov-Smirnov Test Statistic	0.214	95% Percentile Bootstrap UCL	5.249
167	Kolmogorov-Smirnov 5% Critical Value	0.294	95% BCA Bootstrap UCL	5.536
168	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	6.779
169			97.5% Chebyshev(Mean, Sd) UCL	7.851
170	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	9.956
171	95% Approximate Gamma UCL	5.539		
172	95% Adjusted Gamma UCL	5.917		
173				
174	**Potential UCL to Use**		Use 95% Student's-t UCL	5.379
176				
177	**R. Bass**			
178				
179			**General Statistics**	
180	Number of Valid Observations	8	Number of Distinct Observations	8
181				
182	**Raw Statistics**		**Log-transformed Statistics**	
183	Minimum	1.42	Minimum of Log Data	0.351
184	Maximum	3.7	Maximum of Log Data	1.308
185	Mean	2.486	Mean of log Data	0.866
186	Median	2.235	SD of log Data	0.32
187	SD	0.79		
188	Coefficient of Variation	0.318		
189	Skewness	0.487		
190				
191				
192			**Warning: There are only 8 Values in this data**	
193			**Note: It should be noted that even though bootstrap methods may be performed on this data set,**	
194			**the resulting calculations may not be reliable enough to draw conclusions**	
			The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.	
197				
198			**Relevant UCL Statistics**	
199	**Normal Distribution Test**		**Lognormal Distribution Test**	
200	Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Test Statistic	0.959

	A–E	F	G–K	L
201	Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
202	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
203				
[illegible]	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
[illegible]	95% Student's-t UCL	3.016	95% H-UCL	3.222
206	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	3.72
207	95% Adjusted-CLT UCL	2.997	97.5% Chebyshev (MVUE) UCL	4.254
208	95% Modified-t UCL	3.024	99% Chebyshev (MVUE) UCL	5.302
209				
210	**Gamma Distribution Test**		**Data Distribution**	
211	k star (bias corrected)	7.217	**Data appear Normal at 5% Significance Level**	
212	Theta Star	0.345		
213	nu star	115.5		
214	Approximate Chi Square Value (.05)	91.66	**Nonparametric Statistics**	
215	Adjusted Level of Significance	0.0195	95% CLT UCL	2.946
216	Adjusted Chi Square Value	86.3	95% Jackknife UCL	3.016
217			95% Standard Bootstrap UCL	2.913
218	Anderson-Darling Test Statistic	0.27	95% Bootstrap-t UCL	3.167
219	Anderson-Darling 5% Critical Value	0.715	95% Hall's Bootstrap UCL	3.254
220	Kolmogorov-Smirnov Test Statistic	0.206	95% Percentile Bootstrap UCL	2.939
221	Kolmogorov-Smirnov 5% Critical Value	0.294	95% BCA Bootstrap UCL	2.924
222	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	3.704
223			97.5% Chebyshev(Mean, Sd) UCL	4.231
224	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	5.266
[illegible]	95% Approximate Gamma UCL	3.132		
226	95% Adjusted Gamma UCL	3.327		
227				
228	**Potential UCL to Use**		Use 95% Student's-t UCL	3.016
229				
230				
231	**LN Dace**			
232				
233	**General Statistics**			
234	Number of Valid Observations	8	Number of Distinct Observations	8
235				
236	**Raw Statistics**		**Log-transformed Statistics**	
237	Minimum	4.86	Minimum of Log Data	1.581
238	Maximum	11	Maximum of Log Data	2.398
239	Mean	8.508	Mean of log Data	2.106
240	Median	9.035	SD of log Data	0.292
241	SD	2.248		
242	Coefficient of Variation	0.264		
243	Skewness	-0.507		
244				
[illegible]				
[illegible]	**Warning: There are only 8 Values in this data**			
247	**Note: It should be noted that even though bootstrap methods may be performed on this data set,**			
248	**the resulting calculations may not be reliable enough to draw conclusions**			
249				
250	**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**			

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.93	Shapiro Wilk Test Statistic	0.906
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	10.01	95% H-UCL	10.75
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12.38
95% Adjusted-CLT UCL	9.663	97.5% Chebyshev (MVUE) UCL	14.05
95% Modified-t UCL	9.99	99% Chebyshev (MVUE) UCL	17.32
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	9.158	**Data appear Normal at 5% Significance Level**	
Theta Star	0.929		
nu star	146.5		
Approximate Chi Square Value (.05)	119.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	9.815
Adjusted Chi Square Value	113.4	95% Jackknife UCL	10.01
		95% Standard Bootstrap UCL	9.747
Anderson-Darling Test Statistic	0.349	95% Bootstrap-t UCL	9.877
Anderson-Darling 5% Critical Value	0.716	95% Hall's Bootstrap UCL	9.591
Kolmogorov-Smirnov Test Statistic	0.211	95% Percentile Bootstrap UCL	9.734
Kolmogorov-Smirnov 5% Critical Value	0.294	95% BCA Bootstrap UCL	9.598
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	11.97
		97.5% Chebyshev(Mean, Sd) UCL	13.47
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	16.42
95% Approximate Gamma UCL	10.43		
95% Adjusted Gamma UCL	10.99		
Potential UCL to Use		Use 95% Student's-t UCL	10.01
Catfish			
General Statistics			
Number of Valid Observations	4	Number of Distinct Observations	4
Warning: This data set only has 4 observations!			
Data set is too small to compute reliable and meaningful statistics and estimates!			
The data set for variable Catfish was not processed!			
It is suggested to collect at least 8 to 10 observations before using these statistical methods!			
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.			

LOWER RIVER

General UCL Statistics for Full Data Sets

User Selected Options	Lower River
From File	M:\Sheboygan River\5_Post-Remediation\2_Sampling Results\5_Fish Monitoring\Baseline Stats\LR\LR Fish no
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

A. Carp

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8

Raw Statistics		Log-transformed Statistics	
Minimum	0.458	Minimum of Log Data	-0.781
Maximum	44.9	Maximum of Log Data	3.804
Mean	10.99	Mean of log Data	1.456
Median	2.285	SD of log Data	1.532
SD	15.37		
Coefficient of Variation	1.399		
Skewness	1.865		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.721	Shapiro Wilk Test Statistic	0.911
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	21.28	95% H-UCL	227
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	36.71
95% Adjusted-CLT UCL	23.75	97.5% Chebyshev (MVUE) UCL	47.88
95% Modified-t UCL	21.88	99% Chebyshev (MVUE) UCL	69.83
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.489	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	22.46		
nu star	7.826		
Approximate Chi Square Value (.05)	2.634	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	19.92
Adjusted Chi Square Value	1.936	95% Jackknife UCL	21.28

		95% Standard Bootstrap UCL	19.19
Anderson-Darling Test Statistic	0.619	95% Bootstrap-t UCL	33.88
Anderson-Darling 5% Critical Value	0.752	95% Hall's Bootstrap UCL	45.35
Kolmogorov-Smirnov Test Statistic	0.32	95% Percentile Bootstrap UCL	20.1
Kolmogorov-Smirnov 5% Critical Value	0.306	95% BCA Bootstrap UCL	23.04
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	34.67
		97.5% Chebyshev(Mean, Sd) UCL	44.92
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	65.06
95% Approximate Gamma UCL	32.63		
95% Adjusted Gamma UCL	44.4		
Potential UCL to Use		Use 95% Approximate Gamma UCL	32.63

A. Sucker

General Statistics

Number of Valid Observations	2	Number of Distinct Observations	2

Warning: This data set only has 2 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable A. Sucker was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

J. Sucker

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.587	Minimum of Log Data	-0.533
Maximum	1.64	Maximum of Log Data	0.495
Mean	1.035	Mean of log Data	-0.0342
Median	0.967	SD of log Data	0.417
SD	0.427		
Coefficient of Variation	0.413		
Skewness	0.587		

Warning: A sample size of 'n' = 5 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 5 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

	A–E	F	G–K	L
99	the resulting calculations may not be reliable enough to draw conclusions			
100				
101	The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.			
	Relevant UCL Statistics			
104	**Normal Distribution Test**		**Lognormal Distribution Test**	
105	Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Test Statistic	0.972
106	Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
107	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
108				
109	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
110	95% Student's-t UCL	1.443	95% H-UCL	1.85
111	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	1.871
112	95% Adjusted-CLT UCL	1.403	97.5% Chebyshev (MVUE) UCL	2.233
113	95% Modified-t UCL	1.451	99% Chebyshev (MVUE) UCL	2.944
114				
115	**Gamma Distribution Test**		**Data Distribution**	
116	k star (bias corrected)	3.099	**Data appear Normal at 5% Significance Level**	
117	Theta Star	0.334		
118	nu star	30.99		
119	Approximate Chi Square Value (.05)	19.27	**Nonparametric Statistics**	
120	Adjusted Level of Significance	0.0086	95% CLT UCL	1.35
121	Adjusted Chi Square Value	15.37	95% Jackknife UCL	1.443
122			95% Standard Bootstrap UCL	1.315
	Anderson-Darling Test Statistic	0.214	95% Bootstrap-t UCL	1.653
12	Anderson-Darling 5% Critical Value	0.68	95% Hall's Bootstrap UCL	1.634
125	Kolmogorov-Smirnov Test Statistic	0.197	95% Percentile Bootstrap UCL	1.307
126	Kolmogorov-Smirnov 5% Critical Value	0.358	95% BCA Bootstrap UCL	1.357
127	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	1.868
128			97.5% Chebyshev(Mean, Sd) UCL	2.229
129	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	2.937
130	95% Approximate Gamma UCL	1.665		
131	95% Adjusted Gamma UCL	2.087		
132				
133	**Potential UCL to Use**		Use 95% Student's-t UCL	1.443
134				
135	**SM Bass**			
136				

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.78	Minimum of Log Data	0.577
Maximum	10.9	Maximum of Log Data	2.389
Mean	5.77	Mean of log Data	1.596
Median	5.72	SD of log Data	0.644
SD	3.051		
Coefficient of Variation	0.529		
Skewness	0.225		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.96	Shapiro Wilk Test Statistic	0.898
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	7.813	95% H-UCL	11.49
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11.84
95% Adjusted-CLT UCL	7.636	97.5% Chebyshev (MVUE) UCL	14.41
95% Modified-t UCL	7.828	99% Chebyshev (MVUE) UCL	19.45
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.181	**Data appear Normal at 5% Significance Level**	
Theta Star	2.646		
nu star	34.89		
Approximate Chi Square Value (.05)	22.38	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	7.544
Adjusted Chi Square Value	19.88	95% Jackknife UCL	7.813
		95% Standard Bootstrap UCL	7.421
Anderson-Darling Test Statistic	0.342	95% Bootstrap-t UCL	7.822
Anderson-Darling 5% Critical Value	0.72	95% Hall's Bootstrap UCL	7.83
Kolmogorov-Smirnov Test Statistic	0.199	95% Percentile Bootstrap UCL	7.393
Kolmogorov-Smirnov 5% Critical Value	0.296	95% BCA Bootstrap UCL	7.434
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10.47
		97.5% Chebyshev(Mean, Sd) UCL	12.51
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	16.5
95% Approximate Gamma UCL	8.996		
95% Adjusted Gamma UCL	10.13		
Potential UCL to Use		Use 95% Student's-t UCL	7.813

R. Bass

General Statistics

Number of Valid Observations	9	Number of Distinct Observations	9

Raw Statistics		Log-transformed Statistics	
Minimum	1.4	Minimum of Log Data	0.336
Maximum	4.27	Maximum of Log Data	1.452
Mean	2.596	Mean of log Data	0.873
Median	1.95	SD of log Data	0.424
SD	1.113		
Coefficient of Variation	0.429		
Skewness	0.557		

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.861	Shapiro Wilk Test Statistic	0.889
Shapiro Wilk Critical Value	0.829	Shapiro Wilk Critical Value	0.829
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.285	95% H-UCL	3.621
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4.206
95% Adjusted-CLT UCL	3.279	97.5% Chebyshev (MVUE) UCL	4.905
95% Modified-t UCL	3.297	99% Chebyshev (MVUE) UCL	6.277
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.311	**Data appear Normal at 5% Significance Level**	
Theta Star	0.602		
nu star	77.6		
Approximate Chi Square Value (.05)	58.31	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0231	95% CLT UCL	3.206
Adjusted Chi Square Value	54.79	95% Jackknife UCL	3.285
		95% Standard Bootstrap UCL	3.159
Anderson-Darling Test Statistic	0.567	95% Bootstrap-t UCL	3.377
Anderson-Darling 5% Critical Value	0.722	95% Hall's Bootstrap UCL	3.129
Kolmogorov-Smirnov Test Statistic	0.265	95% Percentile Bootstrap UCL	3.17
Kolmogorov-Smirnov 5% Critical Value	0.28	95% BCA Bootstrap UCL	3.176
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.213
		97.5% Chebyshev(Mean, Sd) UCL	4.912
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6.287
95% Approximate Gamma UCL	3.454		

	A	B	C	D	E	F	G	H	I	J	K	L
237					95% Adjusted Gamma UCL	3.676						
238												
239			Potential UCL to Use								Use 95% Student's-t UCL	3.285
240												
	atfish											
242												
243							General Statistics					
244					Number of Valid Observations	4					Number of Distinct Observations	4
245												
246												
247	Warning: This data set only has 4 observations!											
248	Data set is too small to compute reliable and meaningful statistics and estimates!											
249	The data set for variable Catfish was not processed!											
250												
251	It is suggested to collect at least 8 to 10 observations before using these statistical methods!											
252	If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.											

INNER HARBOR

General UCL Statistics for Full Data Sets

User Selected Options	**Inner Harbor**
From File	M:\Sheboygan River\5_Post-Remediation\2_Sampling Results\5_Fish Monitoring\Baseline Stats\IH\IH Fish no o
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

A. Carp

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.243	Minimum of Log Data	-1.415
Maximum	9.14	Maximum of Log Data	2.213
Mean	3.164	Mean of log Data	0.739
Median	2.38	SD of log Data	1.104
SD	2.812		
Coefficient of Variation	0.889		
Skewness	1.548		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.861	Shapiro Wilk Test Statistic	0.936
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	5.048	95% H-UCL	17.9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.49
95% Adjusted-CLT UCL	5.381	97.5% Chebyshev (MVUE) UCL	12.1
95% Modified-t UCL	5.138	99% Chebyshev (MVUE) UCL	17.21
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.929	**Data appear Normal at 5% Significance Level**	
Theta Star	3.405		
nu star	14.87		
Approximate Chi Square Value (.05)	7.17	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	4.799
Adjusted Chi Square Value	5.872	95% Jackknife UCL	5.048

	A–E	F	G–K	L
49			95% Standard Bootstrap UCL	4.685
50	Anderson-Darling Test Statistic	0.219	95% Bootstrap-t UCL	6.647
51	Anderson-Darling 5% Critical Value	0.73	95% Hall's Bootstrap UCL	14.73
52	Kolmogorov-Smirnov Test Statistic	0.181	95% Percentile Bootstrap UCL	4.761
53	Kolmogorov-Smirnov 5% Critical Value	0.3	95% BCA Bootstrap UCL	5.409
54	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	7.497
55			97.5% Chebyshev(Mean, Sd) UCL	9.373
56	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	13.06
57	95% Approximate Gamma UCL	6.561		
58	95% Adjusted Gamma UCL	8.012		
59				
60	**Potential UCL to Use**		Use 95% Student's-t UCL	5.048
61				
62	**SM Bass**			
63				
64		**General Statistics**		
65	Number of Valid Observations	8	Number of Distinct Observations	8
66				
67	**Raw Statistics**		**Log-transformed Statistics**	
68	Minimum	1.44	Minimum of Log Data	0.365
69	Maximum	4.43	Maximum of Log Data	1.488
70	Mean	3.363	Mean of log Data	1.159
71	Median	3.505	SD of log Data	0.376
72	SD	1.035		
73	Coefficient of Variation	0.308		
74	Skewness	-0.824		
75				
76				
77		**Warning: There are only 8 Values in this data**		
78		**Note: It should be noted that even though bootstrap methods may be performed on this data set,**		
79		**the resulting calculations may not be reliable enough to draw conclusions**		
80				
81		**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**		
82				
83		**Relevant UCL Statistics**		
84	**Normal Distribution Test**		**Lognormal Distribution Test**	
85	Shapiro Wilk Test Statistic	0.902	Shapiro Wilk Test Statistic	0.836
86	Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
87	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
88				

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4.056	95% H-UCL	4.648
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5.363
95% Adjusted-CLT UCL	3.85	97.5% Chebyshev (MVUE) UCL	6.218
95% Modified-t UCL	4.038	99% Chebyshev (MVUE) UCL	7.896
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	6.017	**Data appear Normal at 5% Significance Level**	
Theta Star	0.559		
nu star	96.27		
Approximate Chi Square Value (.05)	74.64	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	3.964
Adjusted Chi Square Value	69.83	95% Jackknife UCL	4.056
		95% Standard Bootstrap UCL	3.922
Anderson-Darling Test Statistic	0.499	95% Bootstrap-t UCL	3.964
Anderson-Darling 5% Critical Value	0.715	95% Hall's Bootstrap UCL	3.864
Kolmogorov-Smirnov Test Statistic	0.22	95% Percentile Bootstrap UCL	3.904
Kolmogorov-Smirnov 5% Critical Value	0.294	95% BCA Bootstrap UCL	3.873
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.957
		97.5% Chebyshev(Mean, Sd) UCL	5.647
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	7.002
95% Approximate Gamma UCL	4.337		
95% Adjusted Gamma UCL	4.635		
Potential UCL to Use		Use 95% Student's-t UCL	4.056

Walleye

General Statistics

Number of Valid Observations	3	Number of Distinct Observations	3

Warning: This data set only has 3 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Walleye was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Appendix 5

Fish Tissue Statistical Analysis

t-test, ANOVA, Mann Whitney Analysis
Box and Whisker Plots

t-test, ANOVA, Mann Whitney Analysis

Table A5-1
River Reach Sites Analysis of Means

Statistic	Carp		Sucker		Small Mouth Bass		Rock Bass		Dace	
	UR1	UR2	UR1	UR2	UR1	UR2	UR1	UR2	UR1	UR2
Upper River										
Mean	25.9	14.7	12.4	8.92	13	14.5	6.94	4.27	7.67	No Fish
Standard Deviation	21.4	15	5	4.19	7.28	11.1	5.01	2.94	6.85	
Count	16	16	8	8	8	8	8	8	6	
t	1.71		1.51		0.32		1.30		Not Applicable	
Critcal Value at $t_{0.1/2}$	1.75		1.86		1.86		1.86			
Significant Difference	No		No		No		No			
Statistic	**MR1**	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**
Middle River										
Mean	4.44	Too Few Fish	8.77	3.96	8.75	4.3	Too Few Fish	2.49	9.47	8.51
Standard Deviation	7.43		5.86	2.01	4.94	1.61		0.78	4.15	2.25
Count	8		7	8	8	8		8	6	8
t	Not Applicable		2.07		2.42		Not Applicable		0.51	
Critcal Value at $t_{0.1/2}$			1.86		1.86				1.86	
Significant Difference			Yes		Yes				No	

Mean and Standard Deviation in mg/Kg

Values in Red exceed the Critical Value and the means for the data sets are significantly different.

Table A5-2
River Reach Sites Analysis of Variance

Statistic	White Sucker UR 1/UR 2			White Sucker MR 1/MR 2			Carp UR 1/UR 2			Carp MR 1/MR 2		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	49.2	1	49.16	86.2	1	86.15	996.7	1	996.68	8.9	1	8.93
SSw	297.8	14	21.27	234.4	13	18.03	6247.9	30	208.26	386.5	7	55.22
SSt	346.9	15		320.6	14		7244.6	31		395.4	8	
F statistic	2.3			4.8			4.8			0.2		
$F_{0.05,1,SSwDF}$	4.6			4.67			4.17			5.59		
Significant Difference	No			Yes			Yes			No		

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-2
River Reach Sites Analysis of Variance

Statistic	SM Bass UR 1/UR 2			SM Bass MR 1/MR 2			Rock Bass UR 1/UR 2			Longnose Dace MR 1/MR 2		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	9.8	1	9.80	79.3	1	79.28	28.7	1	28.68	3.2	1	3.16
SSw	1235.5	14	88.25	189.1	14	13.51	236.1	14	16.86	121.3	12	10.11
SSt	1245.3	15		268.4	15		264.8	15		124.5	13	
F statistic	0.1			5.9			1.7			0.3		
$F_{0.05,1,SSwDF}$	4.6			4.6			4.6			4.67		
Significant Difference	No			Yes			No			No		

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-3
River Reach Analysis of Population

River Reach Sites Mann Whitney Test

UR1	UR2
37.0	34.5
73.1	5.14
1.63	3.18
7.44	7.84
4.77	3.73
14.0	30.2
17.6	9.23
2.08	22.7
53.9	3.55
28.4	1.71
9.48	47.7
29.4	10.5
33.3	1.02
9.55	15.8
55.5	1.39
36.9	37.3

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
16	16	170	0.117926*	0.058963*
normal approx z = 1.58293			0.1134364*	0.0567182*

*These values are approximate.

The two samples are not significantly different (P >= 0.05, two-tailed test).

Table A5-4
River Reach Analysis of Means

Statistic	Carp		Sucker		Small Mouth Bass		Rock Bass		Dace	
	UR	MR	UR	MR	UR	MR	UR	MR	UR	MR
Upper to Middle River										
Mean	20.3	4.1	10.7	6.2	13.7	6.5	5.6	2.5	7.7	8.9
Standard Deviation	19.1	7.0	4.8	4.8	9.1	4.2	4.2	0.7	6.9	3.1
Count	32	9	16	15	16	16	16	9	6	14
t	3.95		2.59		2.87		2.86		0.43	
Critcal Value at $t_{0.1/2}$	1.70		1.75		1.75		1.75		1.76	
Significant Difference	Yes		Yes		Yes		Yes		No	

Statistic	Carp		Sucker		Small Mouth Bass		Rock Bass		Catfish	
	MR	LR	MR	LR	MR	LR	MR	LR	MR	LR
Middle River to Lower River										
Mean	4.1	11.3	6.2	4.3	6.5	5.8	2.5	2.6	18.0	13.7
Standard Deviation	7.0	15.2	4.8	0.9	4.2	3.1	0.7	1.1	15.3	10.0
Count	9	8	15	2	16	8	9	9	8	4
t	1.23		1.36		0.50		0.17		0.58	
Critcal Value at $t_{0.1/2}$	1.83		1.75		1.75		1.83		1.86	
Significant Difference	No		No		No		No		No	

Statistic	Carp		Sucker		Small Mouth Bass		Rock Bass		Catfish	
	LR	IH	LR	IH	LR	IH	LR	IH	LR	IH
Lower River to Inner Harbor										
Mean	11.3	3.2			5.8	3.4	2.6		13.7	19.4
Standard Deviation	15.2	2.8	Too Few Fish		3.1	1.0	1.1	Too Few Fish	10.0	0
Count	8	8			8	8	9		4	1
t	1.49				2.11				1.13	
Critcal Value at $t_{0.1/2}$	1.86		Not Applicable		1.86		Not Applicable		2.13	
Significant Difference	No				Yes				No	

Mean and Standard Deviation in mg/Kg
Values in Red exceed the Critical Value and the means for the data sets are significantly different.

Table A5-5
River Reach Analysis of Variance

Statistic	White Sucker UR/MR			Carp UR/MR			Smallmouth Bass UR/MR		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	154.4	1	154.41	1846.0	1	1846.03	415.9	1	415.92
SSw	524.1	29	18.07	9859.0	39	252.80	1347.5	30	44.92
SSt	678.5	30		11705.1	40		1763.5	31	
F statistic	8.5			7.3			9.3		
$F_{0.05,1,SSwDF}$	4.18			4.1			4.17		
Significant Difference	Yes			Yes			Yes		

Values in Red exceed the F Value and the data sets are significantly

Table A5-5
River Reach Analysis of Variance

Statistic	Rock Bass UR/MR			Dace UR/MR			White Sucker MR/LR		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	54.8	1	54.81	6.6	1	6.56	6.4	1	6.36
SSw	264.4	23	11.50	124.4	18	6.91	321.4	15	21.43
SSt	319.2	24		117.8	19		327.8	16	
F statistic	4.8			0.9			0.3		
$F_{0.05,1,SSwDF}$	4.28			4.41			4.54		
Significant Difference	Yes			No			No		

Values in Red exceed the F Value and the data sets are significantly

Table A5-5
River Reach Analysis of Variance

Statistic	Carp MR/LR			Smallmouth Bass MR/LR			Rock Bass Bass MR/LR		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	219.5	1	219.53	3.1	1	3.07	0.0	1	0.03
SSw	2011.2	15	134.08	333.6	22	15.16	4.9	16	0.31
SSt	2230.7	16		336.6	23		5.0	17	
F statistic	1.6			0.2			0.1		
$F_{0.05,1,SSwDF}$	4.54			4.3			4.49		
Significant Difference	No			No			No		

Values in Red exceed the F Value and the data sets are significantly

Table A5-5
River Reach Analysis of Variance

Statistic	Catfish MR/LR			White Sucker LR/IH			Carp LR/IH		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	49.0	1	49.00	Species not collected in a reach; can not calculate.			263.9	1	263.94
SSw	1937.2	10	193.72				1671.1	14	119.36
SSt	1986.2	11					1935.0	15	
F statistic	0.3						2.2		
$F_{0.05,1,SSwDF}$	4.96						4.6		
Significant Difference	No						No		

Values in Red exceed the F Value and the data sets are significantly

Table A5-5
River Reach Analysis of Variance

Statistic	Smallmouth Bass LR/IH			Rock Bass LR/IH			Catfish LR/IH			Longnose Dace		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	23.2	1	23.17				25.6	1	25.63			
SSw	72.6	14	5.19				301.0	3	100.32			
SSt	95.8	15		Species not collected in a reach; can not calculate.			326.6	4		Species not collected in a reach; can not calculate.		
F statistic	4.5						0.3					
$F_{0.05,1,SSwDF}$	4.6						10.1					
Significant Difference	No						No					

Values in Red exceed the F Value and the data sets are significantly

Table A5-6
River Reach Analysis of Population

River Reaches Mann Whitney Test

Smallmouth Bass

LR	IH
8.17	1.44
5.14	2.70
2.02	4.43
1.78	3.10
7.01	4.18
4.84	4.31
10.9	3.91
6.30	2.83

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
8	8	50	0.0649572	0.0324786
normal approx z = 1.89038			0.0587074*	0.0293537*

*These values are approximate.

The two samples are not significantly different (P >= 0.05, two-tailed test).

Catfish

LR	IH
8.49	19.4
11.7	
6.37	
28.4	

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
4	1	3	0.8	0.4
normal approx z = 0.707107			0.4795*	0.23975*

The two samples are not significantly different (P >= 0.05, two-tailed test).

Table A5-7
Fish Species Analysis of Means

Statistic	Carp		Sucker		Small Mouth Bass		Rock Bass		Dace		Catfish		Walleye	
	Carp	**All***	**Sucker**	**All***	**SM Bass**	**All***	**Rock Bass**	**All***	**Dace**	**All***	**Catfish**	**All***	**Walleye**	**All***
Mean	13.43	7.94	8.25	9.58	8.28	9.69	3.99	10.40	8.54	9.46	15.85	8.98	8.65	9.41
Standard Deviation	17.07	6.87	5.17	11.40	7.08	11.52	3.29	11.28	4.39	11.13	12.96	10.43	5.76	10.89
Count	54	158	33	179	48	164	34	178	20	192	12	200	11	189
t	2.30		1.07		1.04		6.30		0.72		1.80		0.40	
Significant Difference	Yes		No		No		Yes		No		Yes		No	

Mean and Standard Deviation in mg/Kg

Critcal Value at $t_{0.1/2}$ = 1.64

Values in Red exceed the Critical Value and the means for the data sets are significantly different.

* - Excluding the fish species being compared.

Table A5-8
Fish Species Analysis of Variance

Source	Adult Carp/All Fish			Adult Sucker/All Fish			SM Bass/All Fish		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	1488.5	1	1488.5	79.8	1	79.8	122.2	1	122.2
SSw	10056.8	214	47.0	452.7	214	2.1	1293.7	214	6.0
SSt	11156.9	215		144.2	215		1559.8	215	
F	31.7			37.7			20.2		
$F_{0.05,1,SSwDF}$	3.89			3.89			3.89		
Significant Difference	Yes			Yes			Yes		

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-8
Fish Species Analysis of Variance

Source	Rock Bass/All Fish			Long Nose Dace/All Fish			Adult Catfish/All Fish			Adult Walleye/All Fish		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	1308.0	1	1308.0	28.7	1	28.7	702.8	1	702.8	12.4	1	12.4
SSw	557.8	214	2.6	1225.1	214	5.7	3517.1	214	16.4	1715.9	214	8.0
SSt	1477.4	215		865.4	215		3202.7	215		1728.3	215	
F	501.9			5.0			42.8			1.5		
$F_{0.05,1,SSwDF}$	3.89			3.89			3.89			3.89		
Significant Difference	Yes			Yes			Yes			No		

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-9
Fish Species Analysis of Population

Fish Species Mann Whitney Test

Smallmouth Bass

18.6	21.5	15.2	22.2	7.3	6.1	8.6	4.1
28.9	5.3	14.9	33.5	3.1	6.4	13.5	10.5
14.1	6.0	5.8	4.2	7.5	9.3	18.2	5.0
3.5	7.7	5.5	2.6	3.7	3.1	4.3	4.1
8.2	5.1	2.0	1.8	7.0	4.8	10.9	6.3
1.4	2.7	4.4	3.1	4.2	4.3	3.9	2.8

All Other Species

37.0	73.1	1.6	7.4	4.8	14.0	17.6	2.1
53.9	28.4	9.5	29.4	33.3	9.6	55.5	36.9
34.5	5.1	3.2	7.8	3.7	30.2	9.2	22.7
3.6	1.7	47.7	10.5	1.0	15.8	1.4	37.3
2.1	1.7	1.3	2.5	22.8	1.6	1.3	2.2
1.3	2.5	15.7	0.5	44.9	18.4	4.5	2.0
1.9	3.2	2.5	5.0	9.1	2.3	2.1	0.9
0.2	15.9	16.6	10.3	20.6	10.6	5.7	7.3
12.3	10.8	12.0	5.0	9.4	4.0	16.6	6.0
7.5	3.7	11.8	3.2	19.9	8.8	4.7	9.2
3.2	2.4	3.5	3.5	0.9	6.4	7.0	4.8
5.0	3.7						
Smallmouth Bass							
		6.5	5.8	16.8	10.4	7.9	1.2
1.6	5.3	1.0	4.2	8.3	8.7	4.3	3.8
3.0	0.7	2.8	1.4	2.1	1.9	3.5	2.9
3.7	2.3	2.2	1.8	2.0	1.4	4.1	3.3
1.8	1.6	4.3	3.1	17.6	3.2	1.7	3.3
15.1	5.1	17.8	8.4	8.9	7.1	7.1	7.6
6.2	9.6	10.9	11.0	4.9	7.2	9.9	8.5
15.9	49.2	29.8	16.6	6.9	8.7	16.6	0.5
8.5	11.7	6.4	28.4	19.4	16.8	16.3	5.6
13.7	7.9	14.3	6.0	8.4	3.0	1.4	1.7

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
168	48	4140	0.778912*	0.389456*
normal approx z = 0.282819			0.777316*	0.388658*

*These values are approximate.

The two samples are not significantly different (P >= 0.05, two-tailed test).

Table A5-9
Fish Species Analysis of Population

Fish Species Mann Whitney Test

Dace

17.6	3.2	1.7	3.3	15.1	5.1	17.8	8.4
8.9	7.1	7.1	7.6	6.2	9.6	10.9	11.0
4.9	7.2	9.9	8.5				

All Other Species

37.0	73.1	1.6	7.4	4.8	14.0	17.6	2.1
53.9	28.4	9.5	29.4	33.3	9.6	55.5	36.9
34.5	5.1	3.2	7.8	3.7	30.2	9.2	22.7
3.6	1.7	47.7	10.5	1.0	15.8	1.4	37.3
2.1	1.7	1.3	2.5	22.8	1.6	1.3	2.2
1.3	2.5	15.7	0.5	44.9	18.4	4.5	2.0
1.9	3.2	2.5	5.0	9.1	2.3	2.1	0.9
0.2	15.9	16.6	10.3	20.6	10.6	5.7	7.3
12.3	10.8	12.0	5.0	9.4	4.0	16.6	6.0
7.5	3.7	11.8	3.2	19.9	8.8	4.7	9.2
3.2	2.4	3.5	3.5	0.9	6.4	7.0	4.8
5.0	3.7	18.6	21.5	15.2	22.2	7.3	6.1
8.6	4.1	28.9	5.3	14.9	33.5	3.1	6.4
13.5	10.5	14.1	6.0	5.8	4.2	7.5	9.3
18.2	5.0	3.5	7.7	5.5	2.6	3.7	3.1
4.3	4.1	8.2	5.1	2.0	1.8	7.0	4.8
10.9	6.3	1.4	2.7	4.4	3.1	4.2	4.3
3.9	2.8	6.5	5.8	16.8	10.4	7.9	1.2
1.6	5.3	1.0	4.2	8.3	8.7	4.3	3.8
3.0	0.7	2.8	1.4	2.1	1.9	3.5	2.9
3.7	2.3	2.2	1.8	2.0	1.4	4.1	3.3
1.8	1.6	4.3	3.1				
Dace							
15.9	49.2	29.8	16.6	6.9	8.7	16.6	0.5
8.5	11.7	6.4	28.4	19.4	16.8	16.3	5.6
13.7	7.9	14.3	6.0	8.4	3.0	1.4	1.7

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
196	20	2325	0.17171*	0.085855*
normal approx z = 1.37092			0.1704014*	0.0852007*

*These values are approximate.

The two samples are not significantly different (P >= 0.05, two-tailed test).

Table A5-9
Fish Species Analysis of Population

Fish Species Mann Whitney Test

Suckers

15.9	16.6	10.3	20.6	10.6	5.7	7.3	12.3
10.8	12.0	5.0	9.4	4.0	16.6	6.0	7.5
3.7	11.8	3.2	19.9	8.8	4.7	9.2	3.2
2.4	3.5	3.5	0.9	6.4	7.0	4.8	5.0
3.7							

All Other Species

37.0	73.1	1.6	7.4	4.8	14.0	17.6	2.1
53.9	28.4	9.5	29.4	33.3	9.6	55.5	36.9
34.5	5.1	3.2	7.8	3.7	30.2	9.2	22.7
3.6	1.7	47.7	10.5	1.0	15.8	1.4	37.3
2.1	1.7	1.3	2.5	22.8	1.6	1.3	2.2
1.3	2.5	15.7	0.5	44.9	18.4	4.5	2.0
1.9	3.2	2.5	5.0	9.1	2.3	2.1	0.9
0.2							
White Suckers							
		18.6	21.5	15.2	22.2	7.3	6.1
8.6	4.1	28.9	5.3	14.9	33.5	3.1	6.4
13.5	10.5	14.1	6.0	5.8	4.2	7.5	9.3
18.2	5.0	3.5	7.7	5.5	2.6	3.7	3.1
4.3	4.1	8.2	5.1	2.0	1.8	7.0	4.8
10.9	6.3	1.4	2.7	4.4	3.1	4.2	4.3
3.9	2.8	6.5	5.8	16.8	10.4	7.9	1.2
1.6	5.3	1.0	4.2	8.3	8.7	4.3	3.8
3.0	0.7	2.8	1.4	2.1	1.9	3.5	2.9
3.7	2.3	2.2	1.8	2.0	1.4	4.1	3.3
1.8	1.6	4.3	3.1	17.6	3.2	1.7	3.3
15.1	5.1	17.8	8.4	8.9	7.1	7.1	7.6
6.2	9.6	10.9	11.0	4.9	7.2	9.9	8.5
15.9	49.2	29.8	16.6	6.9	8.7	16.6	0.5
8.5	11.7	6.4	28.4	19.4	16.8	16.3	5.6
13.7	7.9	14.3	6.0	8.4	3.0	1.4	1.7

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
183	33	3358.5	0.306272*	0.153136*
normal approx z = 1.02584			0.304968*	0.152484*

*These values are approximate.

The two samples are not significantly different (P >= 0.05, two-tailed test).

Table A5-10
Baseline and Historical Data Analysis of Means

	Carp		Sucker		Small Mouth Bass		Rock Bass		Catfish	
	2000	**2008**	**2002**	**2008**	**2002**	**2008**	**2004**	**2008**	**2004**	**2008**
Upper River 1										
Mean	16.4	25.9	2.7	12.4	2.14	13	3.5	6.94	7.5	None
Standard Deviation	15.32	21.4	0.98	5	0.76	7.28	2.02	5.01	0.566	
Count	6	16	25	8	11	8	3	8	2	
t	1.15		5.45		4.20		1.62		Not Applicable	
Critcal Value at $t_{0.1/2}$	1.75		1.71		1.80		1.86			
Significant Difference	No		Yes		Yes		No			
	2004	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**
Upper River 2										
Mean	12.5	14.7	4.6	8.92	2.7	14.5	0.906	4.27	7.5	None
Standard Deviation	6.36	15	3	4.19	1.31	11.1	0.231	2.94	0.57	
Count	2	16	5	8	6	8	5	8	2	
t	0.38		2.16		2.98		3.22		Not Applicable	
Critcal Value at $t_{0.1/2}$	1.75		1.86		1.86		1.86			
Significant Difference	No		Yes		Yes		Yes			
	2004	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**
Lower River										
Mean	2.32	11.3	2.5	4.31	1.3	5.77	None	2.6	3.25	13.7
Standard Deviation	1.03	15.2	1.11	0.926	0.93	3.05		1.11	0.21	10
Count	5	9	5	2	5	8		8	2	4
t	5.09		0.82		1.16		Not Applicable		5.00	
Critcal Value at $t_{0.1/2}$	1.86		2.01		1.86				2.35	
Significant Difference	Yes		No		No				Yes	

Mean and Standard Deviation in mg/Kg

Values in Red exceed the Critical Value and the means for the data sets are significantly different.

Table A5-11
Baseline and Historical Data Analysis of Variance

Statistic	Upper River 1 Suckers			Upper River 2 Suckers			Lower River Suckers		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	573.4	1	573.36	57.9	1	57.87	4.5	1	4.45
SSw	197.9	31	6.38	159.1	11	14.47	5.8	5	1.16
SSt	771.3	32		217.0	12		10.2	6	
F Statistic	89.8			4.0			3.8		
$F_{0.05,1,SSwDF}$	4.16			4.84			6.61		
Significant Diffference	Yes			No			No		

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-11
Baseline and Historical Data Analysis of Variance

Statistic	Upper River 1 Carp			Upper River 2 Carp			Lower River Carp		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	389.4	1	389.40	8.7	1	8.75	No individual historical results. Can not calculate.		
SSw	2235.1	20	111.76	610.8	16	38.17			
SSt	1845.7	21		602.0	17				
F Statistic	3.5			0.2					
$F_{0.05,1,SSwDF}$	4.35			4.49					
Significant Diffference	No			No					

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-11
Baseline and Historical Data Analysis of Variance

Statistic	Upper River 1 Small Mouth Bass			Upper River 2 Small Mouth Bass			Lower River Small Mouth Bass		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	542.2	1	542.22	476.8	1	476.82	60.2	1	60.17
SSw	377.0	17	22.17	873.0	12	72.75	68.6	11	6.24
SSt	919.2	18		1349.8	13		128.8	12	
F Statistic	24.5			6.6			9.6		
$F_{0.05,1,SSwDF}$	4.45			4.75			4.84		
Significant Diffference	Yes			Yes			Yes		

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-11
Baseline and Historical Data Analysis of Variance

Statistic	Upper River 1 Rock Bass			Upper River 2 Rock Bass			Lower River Catfish		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	25.9	1	25.88	No individual historical results. Can not calculate.			146.7	1	146.72
SSw	184.0	9	20.44				301.0	4	75.25
SSt	209.9	10					447.7	5	
F Statistic	1.3						1.9		
$F_{0.05,1,SSwDF}$	5.12						7.71		
Significant Diffference	No						No		

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-12
Baseline and Historical Data Analysis of Population

Baseline & Historical Mann Whitney Test
Upper River 2 Suckers

Historical	Baseline
2.2	10.8
4.3	12.03
2.6	5.04
4.1	9.44
9.7	3.95
	16.6
	5.95
	7.52

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
n_1	n_2	U	P (two-tailed)	P (one-tailed)
8	5	38	0.006216	0.003108
normal approx z = 2.63493			0.00841546*	0.00420773*

The two samples are not significantly different (P >= 0.05, two-tailed test).

Lower River Smallmouth Bass

Historical	Baseline
1.7	8.17
2.8	5.14
0.86	2.02
0.93	1.78
0.45	7.01
	4.84
	10.9
	6.30

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
n_1	n_2	U	P (two-tailed)	P (one-tailed)
8	5	33	0.065268	0.032634
normal approx z = 1.90301			0.0570398*	0.0285199*

The two samples are significantly different (P < 0.01, two-tailed test).

Table A5-12
Baseline and Historical Data Analysis of Population

Lower River Catfish

Historical	Baseline
3.4	8.49
3.1	11.7
	6.37
	28.4

Results in mg/Kg

n_1	n_2	U	P (two-tailed)	P (one-tailed)
n_1	n_2	U	P (two-tailed)	P (one-tailed)
4	2	8	0.1333334	0.0666667
normal approx z = 1.85164			0.0640776*	0.0320388*

The two samples are significantly different (P < 0.01, two-tailed test).

Table A5-13
Baseline and Historical Data Analysis of Lipid Normalized Means

	Carp		Sucker		Small Mouth Bass		Rock Bass		Catfish	
	2000	**2008**	**2002**	**2008**	**2002**	**2008**	**2004**	**2008**	**2004**	**2008**
Upper River 1										
Mean	1213	937	210	1490	362	2186	703	1083	No Fish in 2008	
Standard Deviation	1579	1325	94	389	188	1866	396	614		
Count	6	16	25	8	11	8	3	8		
t	0.38		9.22		2.75		1.21		Not Applicable	
Critcal Value at $t_{0.1/2}$	1.75		1.71		1.80		1.86			
Significant Difference	No		Yes		Yes		No			
	2004	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**
Upper River 2										
Mean	543	513	289	955	297	1018	183	593	No Fish in 2008	
Standard Deviation	61	283	173	327	135	579	58	236		
Count	2	16	5	8	6	8	5	8		
t	0.36		4.79		3.40		4.69		Not Applicable	
Critcal Value at $t_{0.1/2}$	1.75		1.86		1.86		1.86			
Significant Difference	No		Yes		Yes		Yes			
	2004	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**	**2004**	**2008**
Lower River										
Mean	40	252	280	501	212	590	No Fish in 2004		58	242
Standard Deviation	45	198	9	24	167	339			6	100
Count	5	8	5	2	5	8			2	3
t	72.84		17.44		141.22		Not Applicable		57.89	
Critcal Value at $t_{0.1/2}$	1.86		2.01		1.86				2.35	
Significant Difference	Yes		Yes		Yes				Yes	

Mean and Standard Deviation in mg/Kg

Values in Red exceed the Critical Value and the means for the data sets are significantly different.

Table A5-14
Baseline and Historical Data Analysis of Lipid Normalized Variance

Statistic	Upper River 1 Suckers			Upper River 2 Suckers			Lower River Suckers		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	9777363.5	1	9777363	1364960.9	1	1364961	69848.3	1	69848.33
SSw	1269848.7	31	40963	867611.0	11	78874	925.0	5	185.00
SSt	11047212.2	32		2232571.9	12		70773.3	6	
F Statistic	238.7			17.3			377.6		
$F_{0.05,1,SSwDF}$	4.16			4.84			6.61		
Significant Diffference	Yes			Yes			Yes		

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-14
Baseline and Historical Data Analysis of Lipid Normalized Variance

Statistic	Upper River 1 Carp			Upper River 2 Carp			Lower River Carp		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	331468.6	1	331469	1662.9	1	1662.94	No individual historical results. Can not calculate.		
SSw	35474118.1	20	1773706	1518256.1	16	94891.01			
SSt	35805586.7	21		1516593.2	17				
F Statistic	0.2			0.02					
$F_{0.05,1,SSwDF}$	4.35			4.49					
Significant Diffference	No			No					

Values in Red exceed the F Value and the data sets are significantly different.

Table A5-14
Baseline and Historical Data Analysis of Lipid Normalized Variance

Statistic	Upper River 1 Small Mouth Bass			Upper River 2 Small Mouth Bass			Lower River Small Mouth Bass		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	15422004.4	1	15422004	1782151.3	1	1782151	60.2	1	60.17
SSw	24722887.9	17	1454288	2440220.2	12	203352	68.6	11	6.24
SSt	40144892.3	18		4222371.5	13		128.8	12	
F Statistic	10.6			8.8			9.6		
$F_{0.05,1,SSwDF}$	4.45			4.75			4.84		
Significant Diffference	Yes			Yes			Yes		

Values in Red exceed the F Value and the data sets are significantly different.

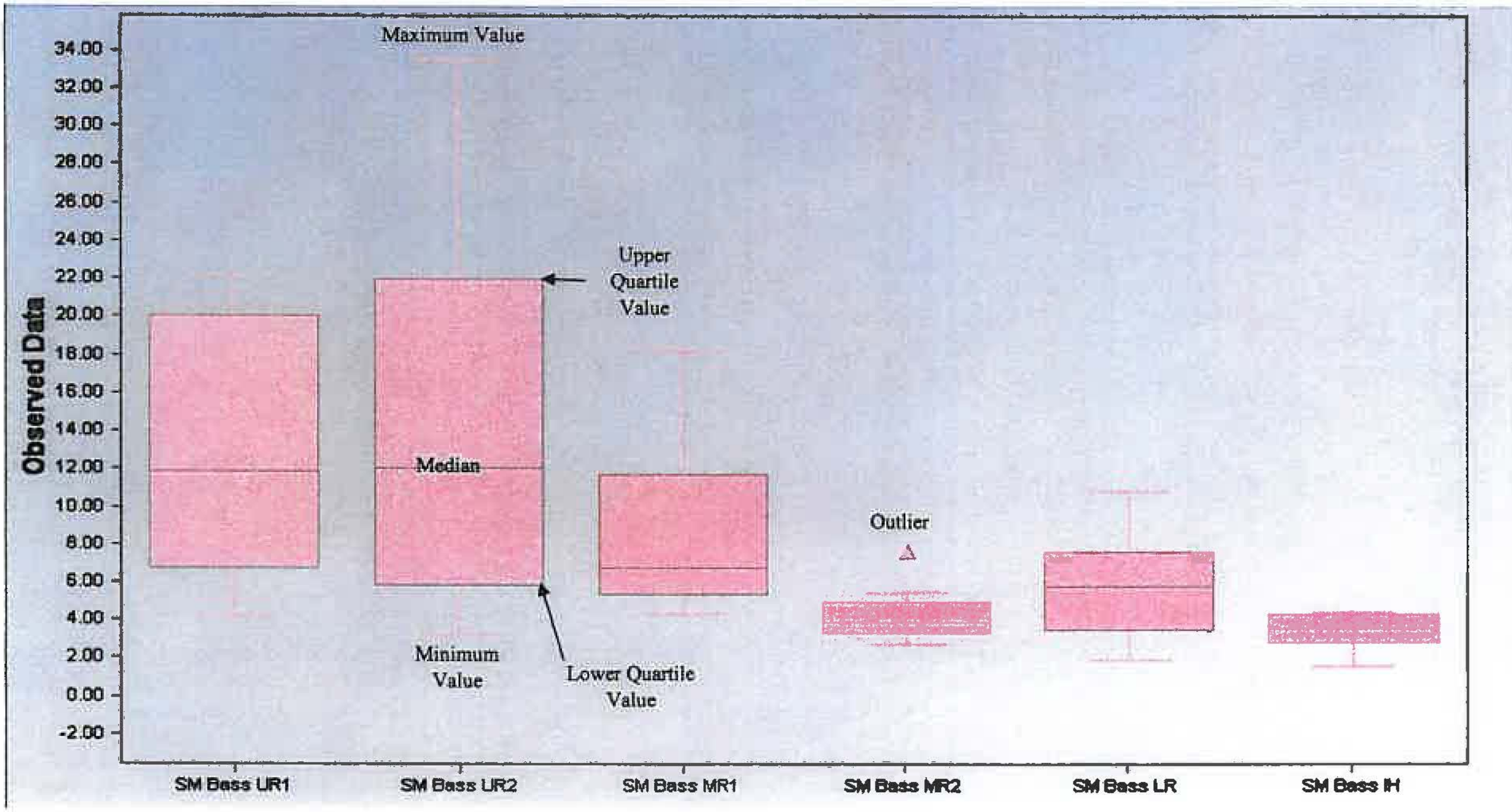
Table A5-14
Baseline and Historical Data Analysis of Lipid Normalized Variance

Statistic	Upper River 1 Rock Bass			Upper River 2 Rock Bass			Lower River Catfish		
	SS	DF	Mean Square	SS	DF	Mean Square	SS	DF	Mean Square
SSc	314511.6	1	314512	No individual historical results. Can not calculate.			195072.0	1	195072
SSw	2950858.5	9	327873				520628.3	9	57848
SSt	3265370.1	10					325556.2	10	
F Statistic	1.0						3.4		
$F_{0.05,1,SSwDF}$	5.12						10.1		
Significant Diffference	No						No		

Values in Red exceed the F Value and the data sets are significantly different.

Box and Whisker Plots

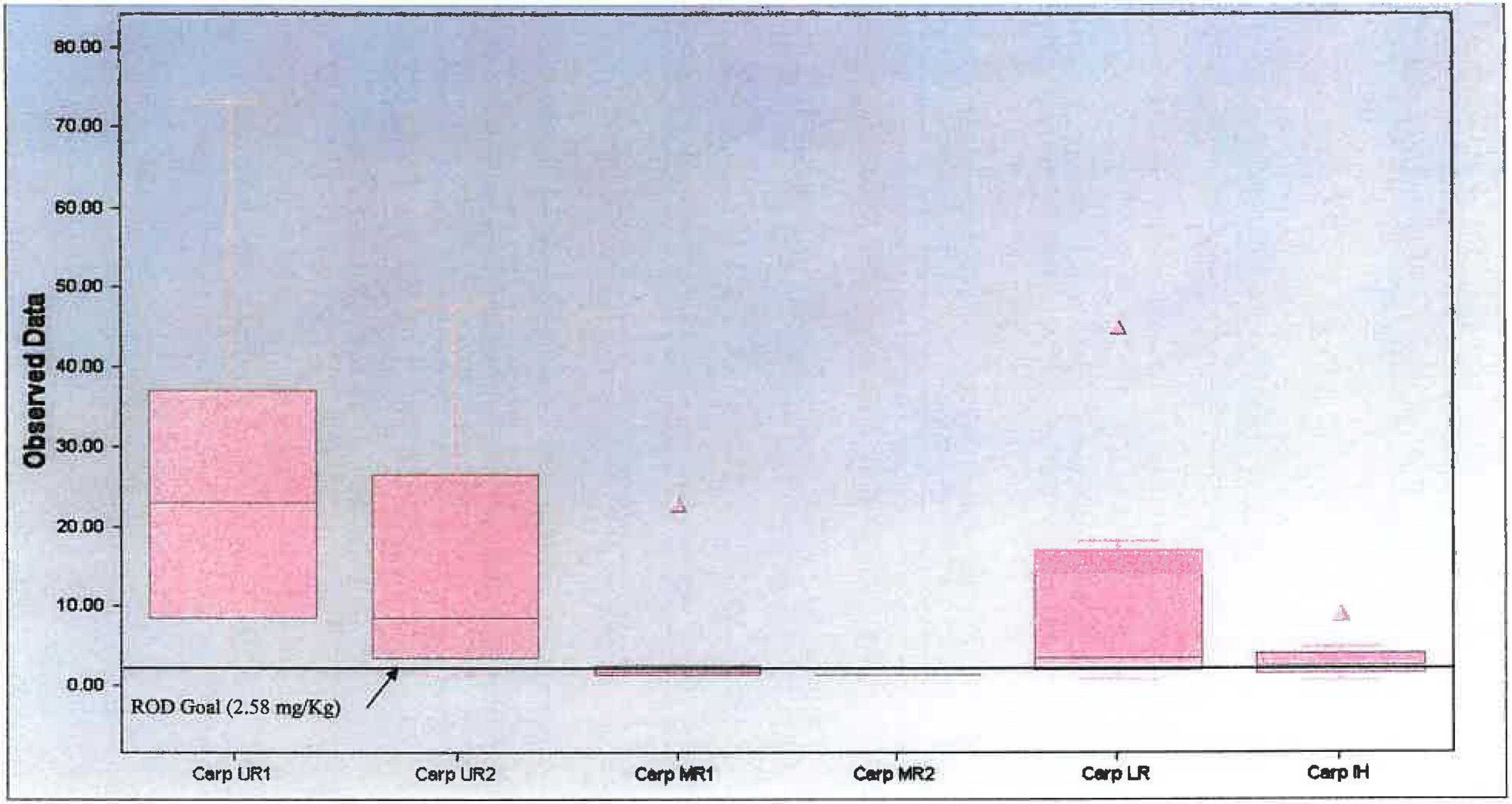
Example of Box and Whisker Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg)

UR1 and UR2 -	Upper River site 1 and Upper River site 2
MR1 and MR2 -	Middle River site 1 and Middle River site 2
LR and IH -	Lower River and Inner Harbor

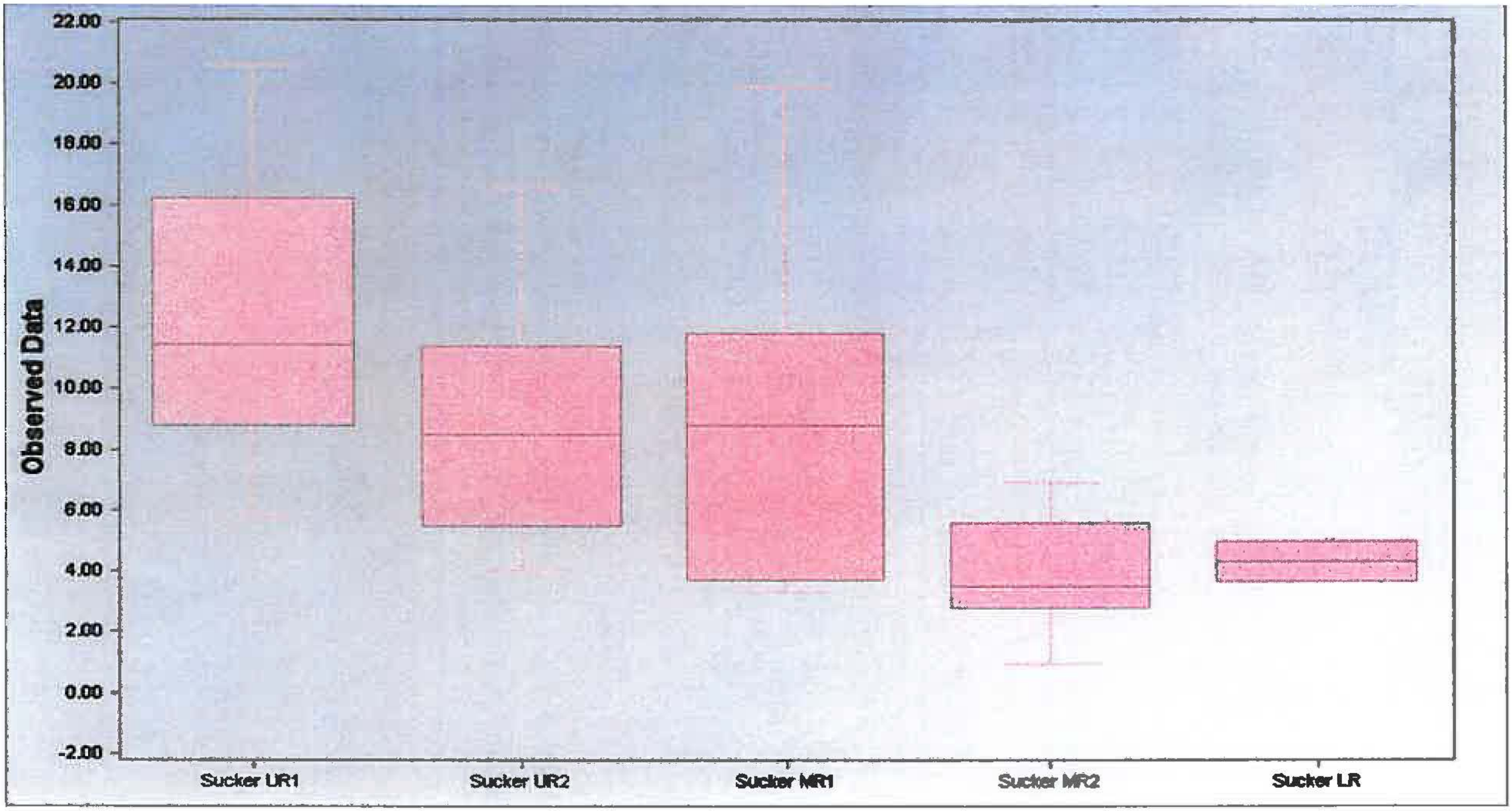
Adult Carp Box and Whisker Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg).
There was only one carp collected in Middle River 2.
For Middle River 1, minimum and 1st quartile values too close to differentiate on plot. Maximum and 4th quartile values were equal.

UR1 and UR2 -	Upper River site 1 and Upper River site 2
MR1 and MR2 -	Middle River site 1 and Middle River site 2
LR and IH -	Lower River and Inner Harbor

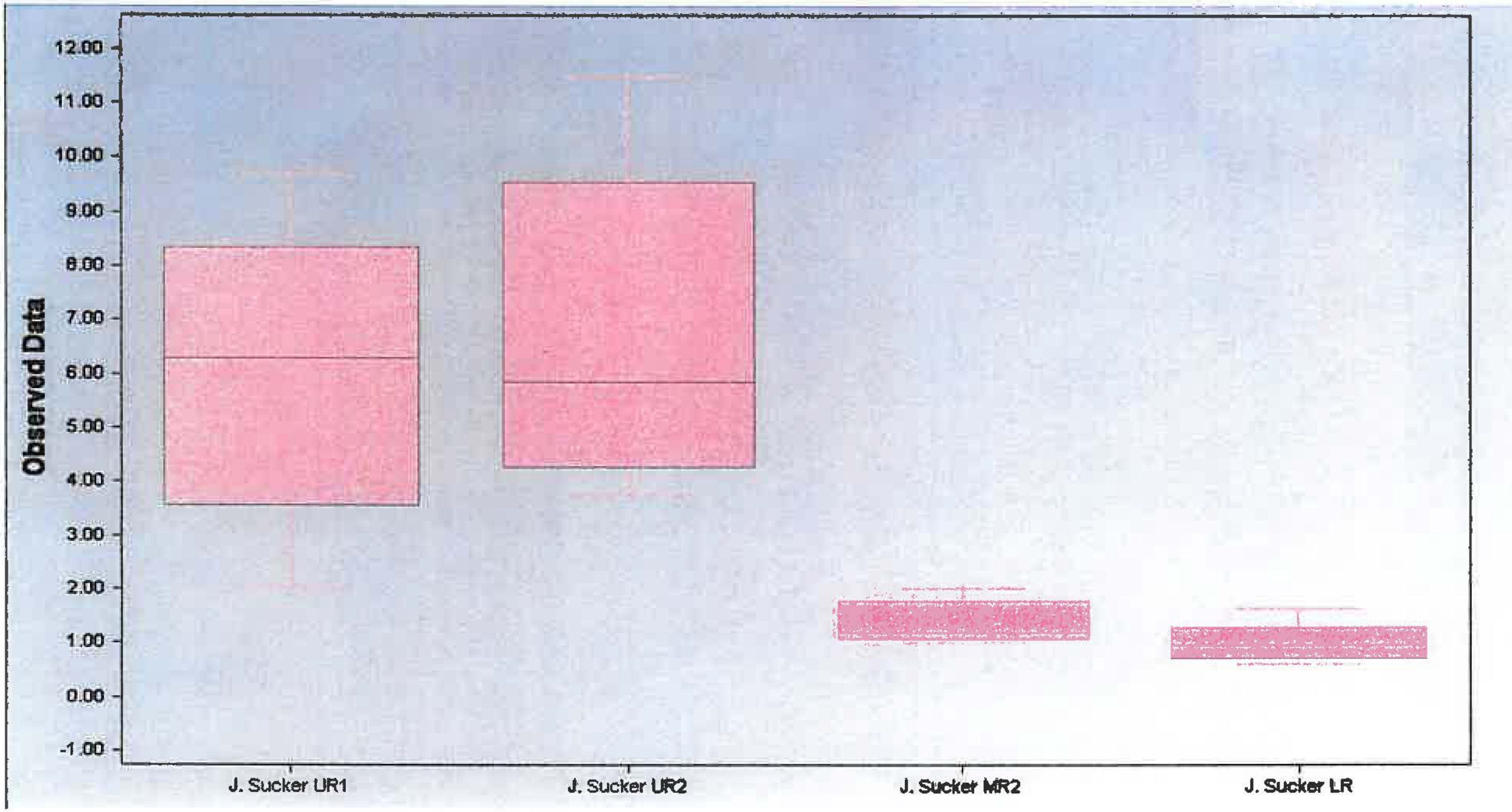
Adult Sucker Box and Whisket Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg).
No adult suckers collected in Inner Harbor.
Only two adult suckers collected in Lower River.
No minimum and maximum shown on box plot.

UR1 and UR2 -	Upper River site 1 and Upper River site 2
MR1 and MR2 -	Middle River site 1 and Middle River site 2
LR -	Lower River

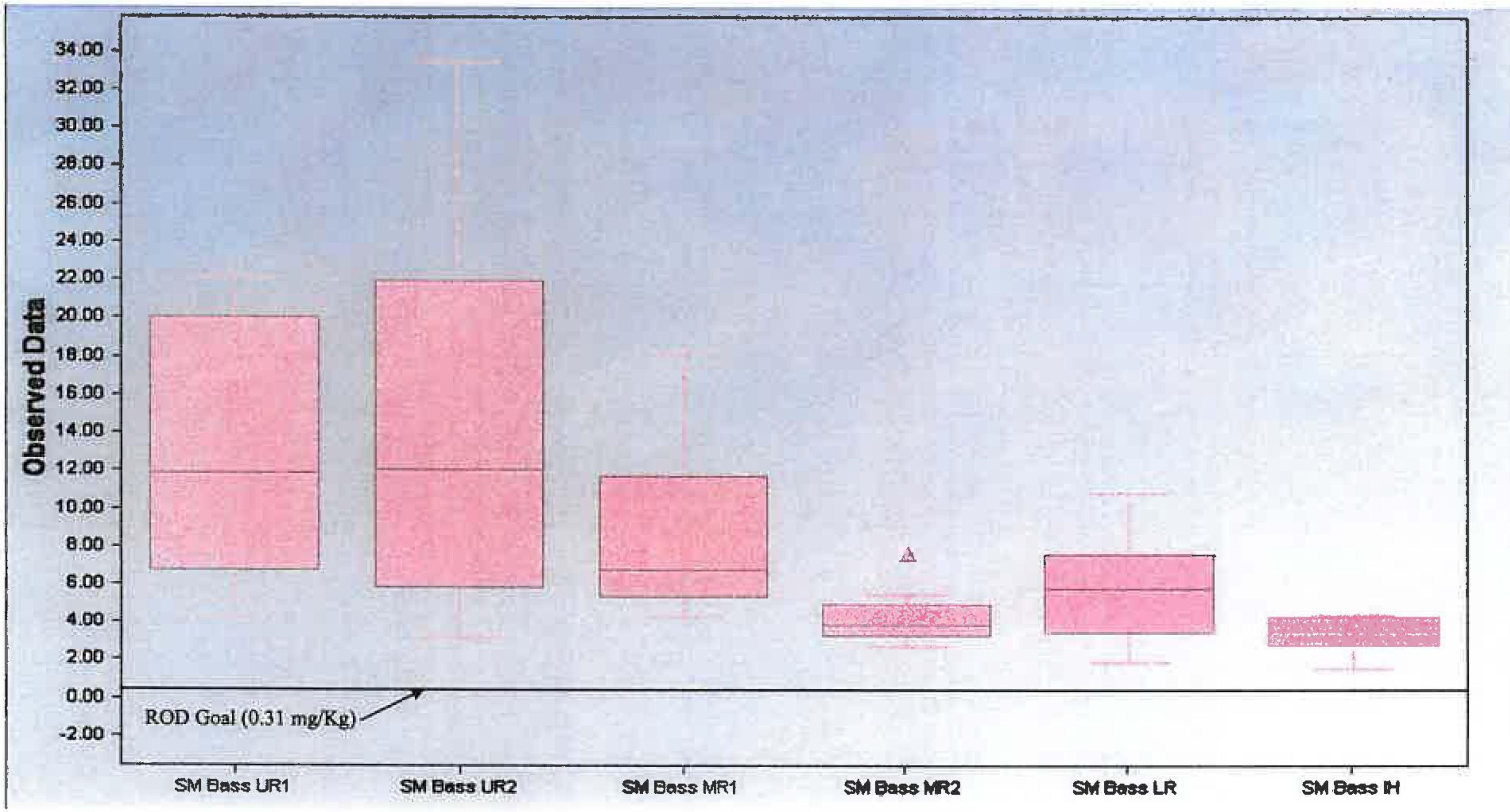
Juvenile Sucker Box and Whisker Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg).
No juvenile suckers collected in Middle River 1 and Inner Harbor.

UR1 and UR2 -	Upper River site 1 and Upper River site 2
MR2 -	Middle River site 2
LR -	Lower River

Smallmouth Bass Box and Whisker Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg).

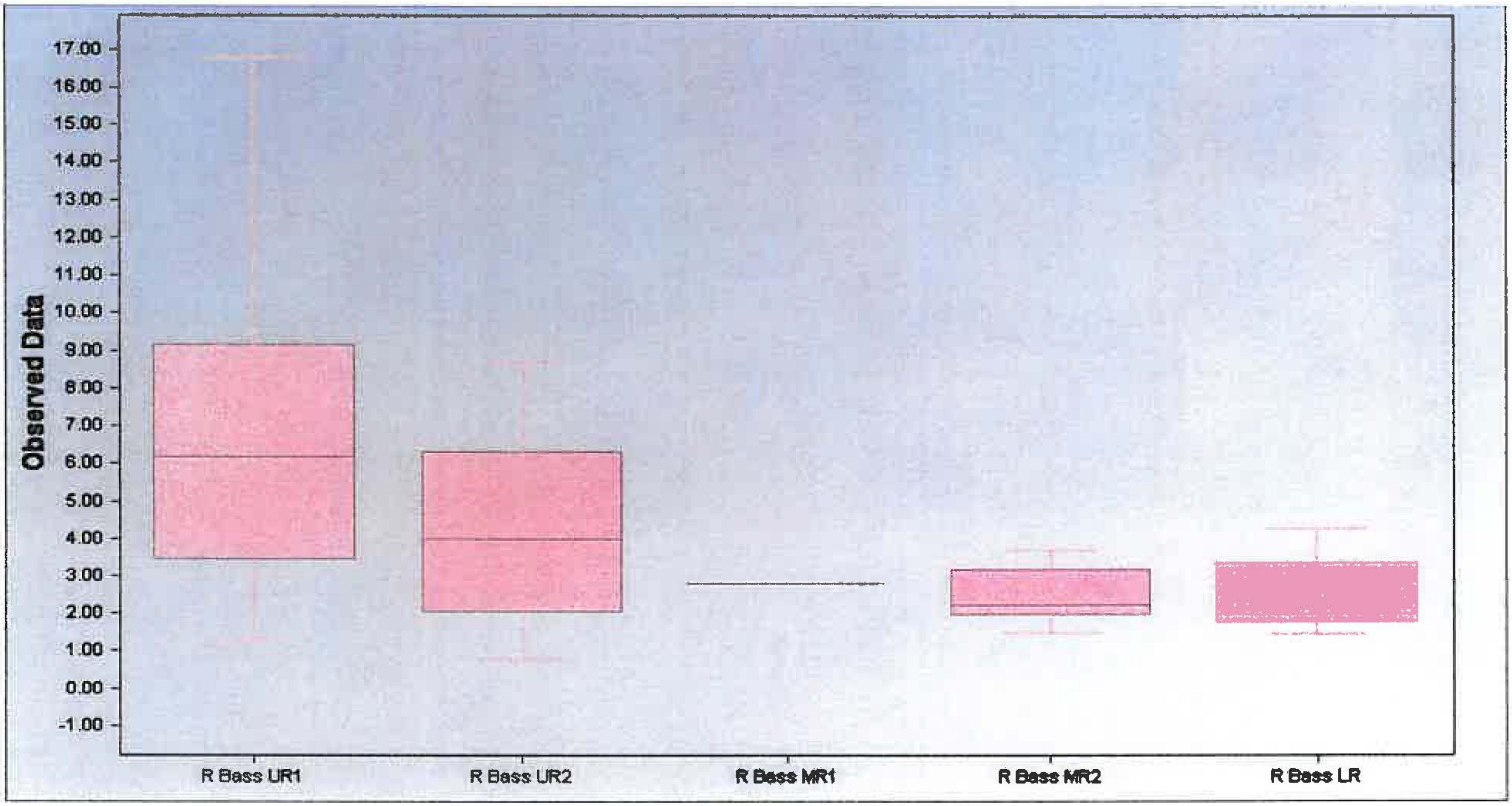
▲ Outlier identified during box and whisker plotting not identified during previous outlier analysis.

UR1 and UR2 - Upper River site 1 and Upper River site 2

MR1 and MR2 - Middle River site 1 and Middle River site 2

LR and IH - Lower River and Inner Harbor

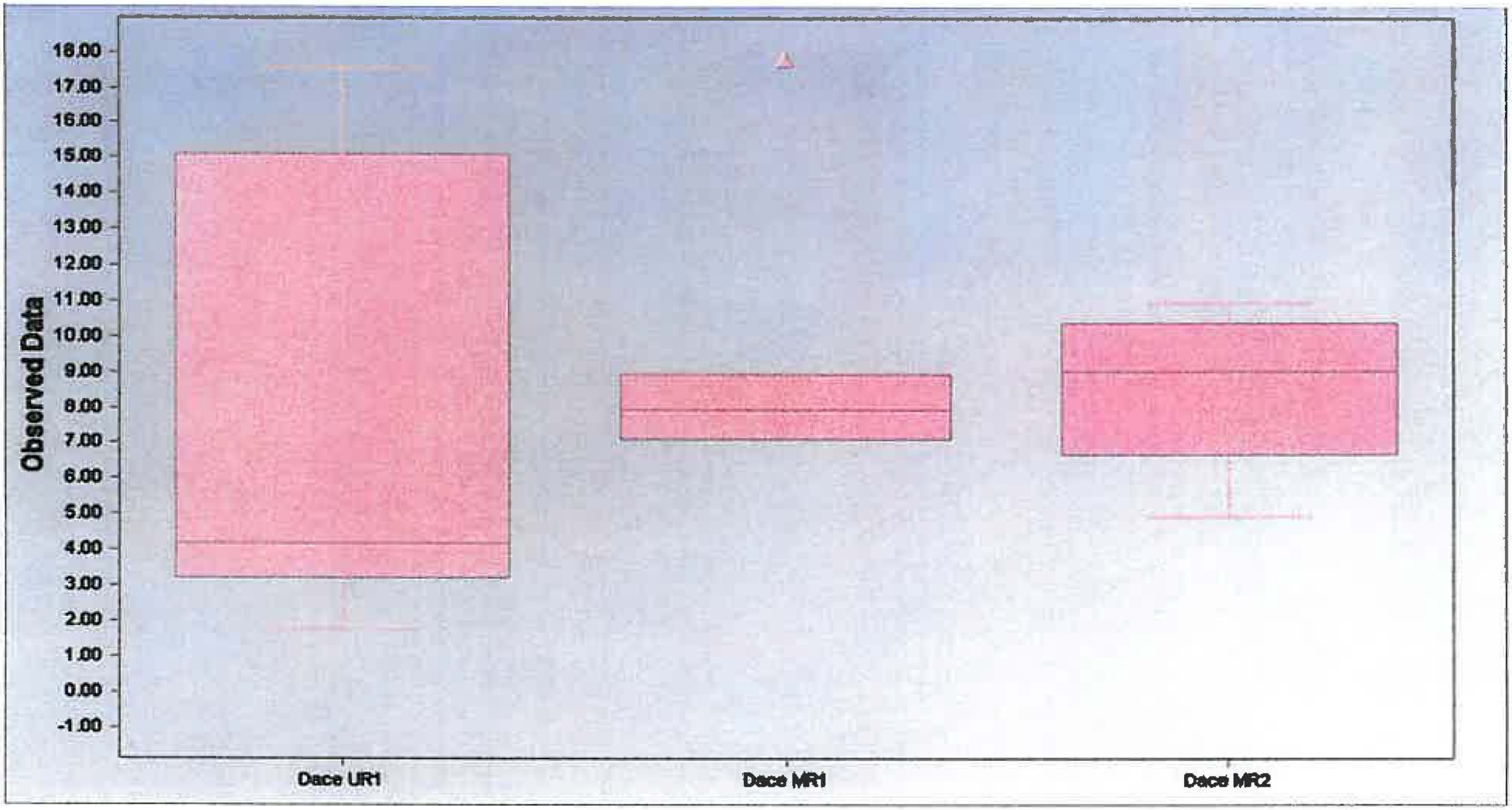
Rock Bass Box and Whisker Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg).
No rock bass collected in Inner Harbor.
There was only one rock bass collected in Middle River 1.

UR1 and UR2 -	Upper River site 1 and Upper River site 2
MR1 and MR2 -	Middle River site 1 and Middle River site 2
LR -	Lower River

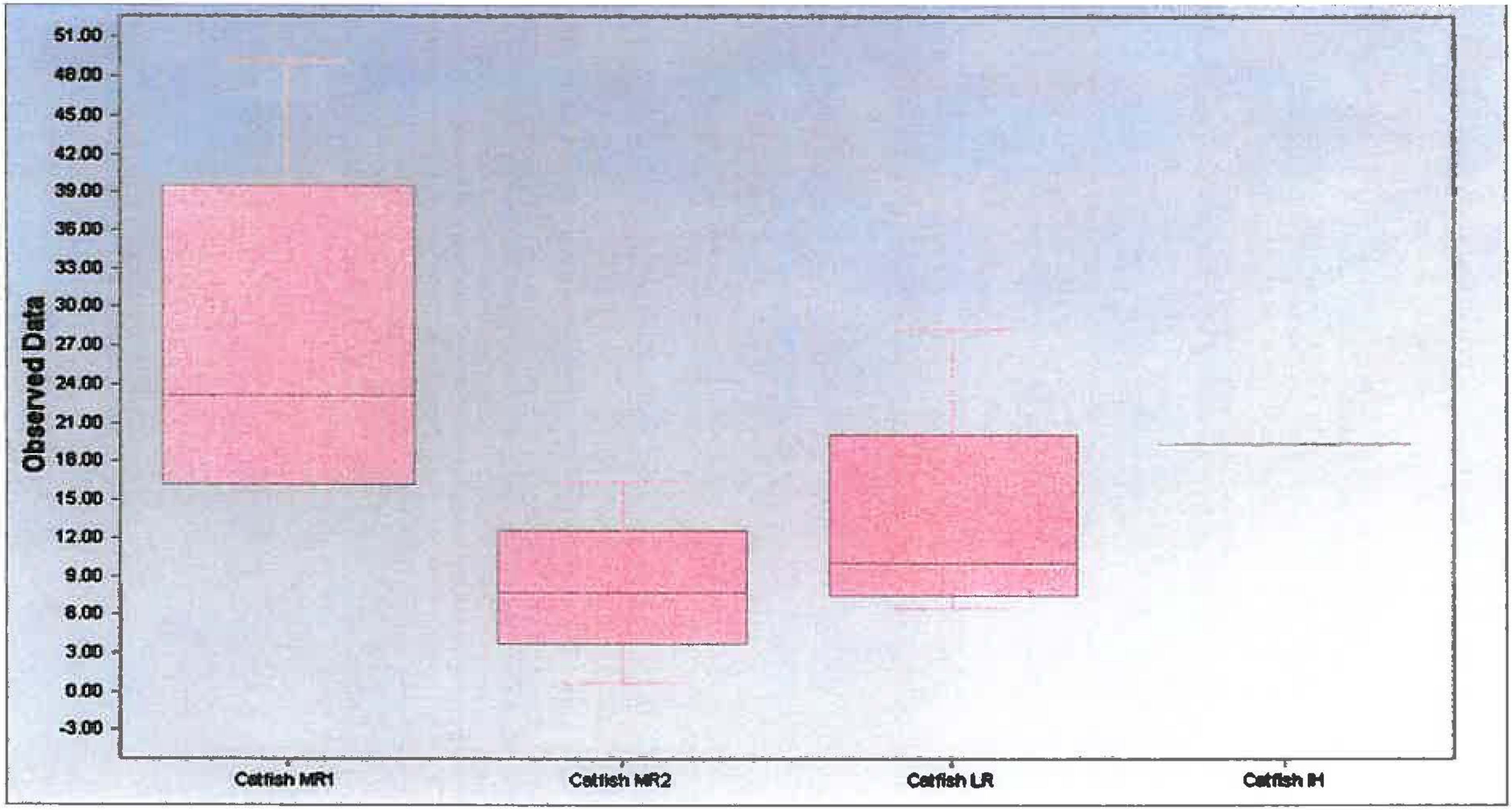
Longnose Dace Box and Whisker Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg).
No dace collected in Upper River 2, Lower River, and Inner Harbor.
For Middle River 1, the minimum and 1st quartile values were the same.

UR1 - Upper River site 1
MR1 and MR2 - Middle River site 1 and Middle River site 2

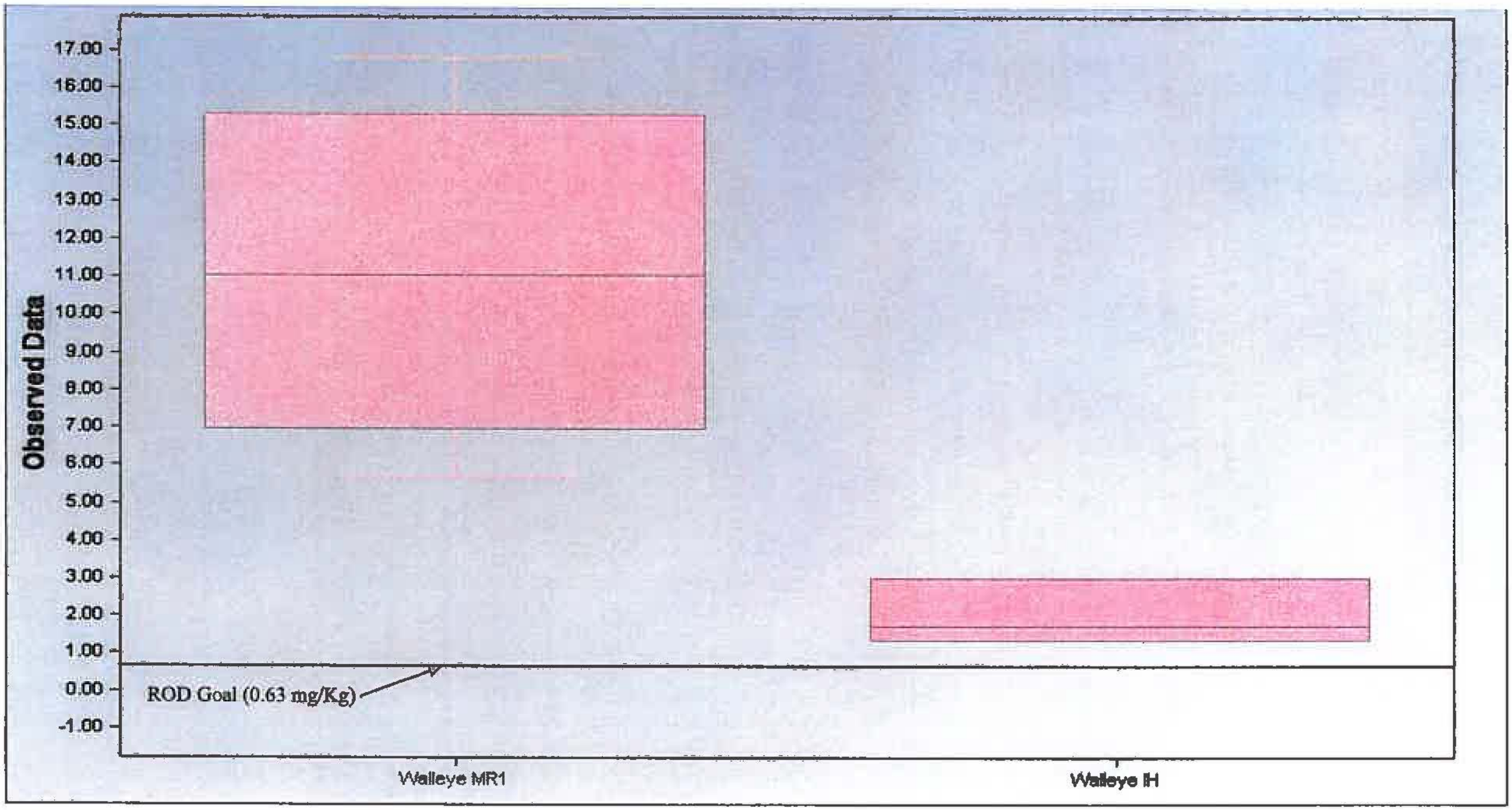
Catfish Box and Whisker Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg).
No catfish collected in Upper River sites.
There was only one catfish collected in Inner Harbor.
Only three Lower River catfish plotted. Minimum and 1st quartile values too close to differentiate on plot. Maximum and 4th quartile values were equal.

MR1 and MR2 -	Middle River site 1 and Middle River site 2
LR and IH -	Lower River and Inner Harbor

Walleye Box and Whisker Plots



Observed Data is PCB concentration in fish tissue in (mg/Kg).
No adult walleyes collected in Inner Harbor.
Only three walleye collected in Inner Harbor. Minimum and 1st quartile values too close to differentiate on plot. Maximum and 4th quartile values were equal.

MR1 - Middle River site 1
IH - Inner Harbor

Appendix 6

Phase 1 Sampling Requirements

Fish Needs Statistical Analysis
Lower Fox River Method
(Upper River)

Upper River 1 Species/Location	α	β	MDRD	C/V	N	#
Smallmouth Bass	0.1	0.2	0.5	0.56	6	8
Adult Carp	0.1	0.2	0.5	0.83	12	12
Juvenile Carp	0.1	0.2	0.5	N/A	N/A	16
Adult Suckers	0.1	0.2	0.5	0.4	3	8
Juvenile Suckers	0.1	0.2	0.5	0.47	4	8
Rock Bass	0.1	0.2	0.5	0.72	9	8
Longnose Dace	0.1	0.2	0.5	0.89	14	8
Walleye	0.1	0.2	0.5	N/A	N/A	8
Catfish	0.1	0.2	0.5	N/A	N/A	8

Upper River 2 Species/Location	α	β	MDRD	C/V	N	#
Smallmouth Bass	0.1	0.2	0.5	0.77	11	8
Adult Carp	0.1	0.2	0.5	1.02	19	16
Juvenile Carp	0.1	0.2	0.5	N/A	N/A	16
Adult Suckers	0.1	0.2	0.5	0.47	4	8
Juvenile Suckers	0.1	0.2	0.5	0.43	3	8
Rock Bass	0.1	0.2	0.5	0.69	9	8
Longnose Dace	0.1	0.2	0.5	N/A	N/A	8
Walleye	0.1	0.2	0.5	N/A	N/A	8
Catfish	0.1	0.2	0.5	N/A	N/A	8

Fish Needs Statistical Analysis
Lower Fox River Method
(Middle River)

Middle River 1 Species/Location	α	β	MDRD	C/V	N	#
Smallmouth Bass	0.1	0.2	0.5	0.56	6	8
Adult Carp	0.1	0.2	0.5	1.67	50	8
Juvenile Carp	0.1	0.2	0.5	N/A	N/A	8
Adult Suckers	0.1	0.2	0.5	0.669	8	8
Juvenile Suckers	0.1	0.2	0.5	0.47	4	8
Rock Bass	0.1	0.2	0.5	N/A	N/A	8
Longnose Dace	0.1	0.2	0.5	0.438	3	8
Walleye	0.1	0.2	0.5	0.42	3	8
Catfish	0.1	0.2	0.5	0.56	6	8

Middle River 2 Species/Location	α	β	MDRD	C/V	N	#
Smallmouth Bass	0.1	0.2	0.5	0.37	2	8
Adult Carp	0.1	0.2	0.5	N/A	N/A	8
Juvenile Carp	0.1	0.2	0.5	N/A	N/A	8
Adult Suckers	0.1	0.2	0.5	0.51	5	8
Juvenile Suckers	0.1	0.2	0.5	0.28	1	8
Rock Bass	0.1	0.2	0.5	0.32	2	8
Longnose Dace	0.1	0.2	0.5	0.26	N/A	8
Walleye	0.1	0.2	0.5	N/A	N/A	8
Catfish	0.1	0.2	0.5	0.81	N/A	8

Fish Needs Statistical Analysis
Lower Fox River Method
(Lower River Inner Harbor)

Lower River Species/Location	α	β	MDRD	C/V	N	#
Smallmouth Bass	0.1	0.2	0.5	0.53	5	8
Adult Carp	0.1	0.2	0.5	1.35	33	8
Juvenile Carp	0.1	0.2	0.5	N/A	N/A	8
Adult Suckers	0.1	0.2	0.5	0.22	1	8
Juvenile Suckers	0.1	0.2	0.5	0.41	3	8
Rock Bass	0.1	0.2	0.5	0.43	3	8
Longnose Dace	0.1	0.2	0.5	N/A	N/A	8
Walleye	0.1	0.2	0.5	N/A	N/A	9
Catfish	0.1	0.2	0.5	0.73	10	8

Inner Harbor Species/Location	α	β	MDRD	C/V	N	#
Smallmouth Bass	0.1	0.2	0.5	0.31	2	8
Adult Carp	0.1	0.2	0.5	0.89	14	8
Juvenile Carp	0.1	0.2	0.5	N/A	N/A	8
Adult Suckers	0.1	0.2	0.5	N/A	N/A	8
Juvenile Suckers	0.1	0.2	0.5	N/A	N/A	8
Rock Bass	0.1	0.2	0.5	N/A	N/A	9
Longnose Dace	0.1	0.2	0.5	N/A	N/A	8
Walleye	0.1	0.2	0.5	0.42	3	8
Catfish	0.1	0.2	0.5	0.3	2	8

Appendix 7

Foth Multiple Regression Analysis

Foth Infrastructure & Environment, LLC
Memorandum

November 11, 2008

TO: Keith Egan, PRS; Ken Aukerman, PRS

CC: Steve Laszewski, Foth

FR: Steve Lehrke, Foth

RE: Analysis of Sheboygan River Fish Tissue Covariates

Background

Fish tissue PCB sample results collected during August and September of 2008 were received by Foth Infrastructure & Environment, LLC (Foth) from PRS for the purpose of conducting a multiple regression analysis. This data is included as Attachment 1. The analysis was performed to develop preliminary conclusions on the effectiveness of including covariates in future statistical tests for determining trends in fish tissue PCB levels. The covariates under consideration are fish length and percent lipids. Including these covariates in future statistical tests could potentially remove additional variation (or noise) from the data and allow a clearer determination to be made of fish tissue PCB concentration trends.

Covariate Approach (Future Analysis)

A statistical method of determining significant changes in fish tissue PCB concentrations between baseline and post-remediation results is to utilize multiple regression analysis. In a multiple regression model, the covariates of fish length and percent lipids could be included to more easily detect changes between the baseline and post-remediation concentration levels. Possible models include a linear model of the form:

$$PCB = B_0 + B_1 Length + B_2 Lipids + B_3 Remediation \qquad \text{(Equation 1)}$$

and an exponential model of the form:

$$PCB = e^{B0 + B1Length + B2Lipids + B3Remediation}. \qquad \text{(Equation 2)}$$

In both models *Remediation* is an indicator variable taking on a value of 0 for baseline data and 1 for post-remediation data. A test of the effect of remediation on average PCB concentrations could then be constructed as

$$H_0:\ B_3 \geq 0 \ \text{ v.s. } H_A:\ B_3 < 0.$$

If the test is significant, that is the coefficient B_3 is significantly less than 0, the conclusion is made that remediation on average has reduced PCB concentration levels.

Results of Current Data

The data included in Attachment 1 was utilized in various multiple regression analyses to verify if there was potential use in including fish length and percent lipids as covariates. Data sets were included for two sites in the Upper River, two sites in the Middle River, one site in the Lower River and one site in the Inner Harbor. Fish Types include adult carp, adult suckers, juvenile suckers, smallmouth bass, rock bass, longnose dace, walleye and catfish.

To do this, linear multiple regression models were developed in the form of:

$$PCB = B_0 + B_1 Length + B_2 Lipids \qquad \text{(Equation 3)}$$

and exponential models in the form of:

$$PCB = e^{B0 + B1Length + B2Lipids}. \qquad \text{(Equation 4)}$$

In order for the covariates to be useful in removing noise in the PCB data, they need to "explain" a significant amount of variation in the PCB concentrations. The results of the multiple regression models in equations 3 and 4 provide metrics which are useful in determining how much variation is being explained by the covariates. These metrics include:

- R^2:
  Provides a measure of how much variation in the PCB data is being explained by the entire model. Values fall between 0 and 1, with a value of 0 implying no variation is explained and a value of 1 implying all the variation is explained.

- Coefficients B_1 and B_2:
  In the linear model, estimates of these indicate the proportional change in PCB concentrations for a unit change in the corresponding covariate. In the exponential model the estimates indicate the proportional change in the logarithm of the PCB concentrations.

- Standard Errors of B_1 and B_2 estimates:
  The standard errors indicate how much variability can be expected in the estimates of B_1 and B_2.

- p-Level:
  The corresponding p-level indicates the probability of a coefficient (B_1 or B_2) being equal to zero. If a coefficient is significantly different from zero, the corresponding factor (*Length* or *Lipids*) has a significant impact on PCB concentrations. A p-level of less than 0.1 indicates the coefficient is significantly different from zero at a 10% error rate, and a p-level of less than 0.05 indicates significance at a 5% error rate.

The results of these metrics are given in Attachment 2 (Table 4). For each data set the model (linear or exponential) was chosen which gave the highest R^2 value. There are several data sets for which the coefficients corresponding to length and lipids are significantly different from zero, which indicates these factors significantly affect tissue PCB concentrations. The data sets illustrating significance with these factors are as follows:

Upper River 1:

- Adult Carp (length only)
- Adult Suckers (lipids only)
- Longnose Dace (length only)

Upper River 2:

- Adult Carp (length and lipids)
- Adult Suckers (length and lipids)
- Smallmouth Bass (lipids)
- Rock Bass (length and lipids)

Middle River 1:

- Adult Carp (length)
- Walleye (lipids)

Middle River 2:

- Rock Bass (lipids)
- Longnose Dace (length and lipids)

Lower River

- Adult Carp (lipids)
- Juvenile Suckers (length)
- Smallmouth Bass (lipids)
- Rock Bass (lipids)

Inner Harbor

- Adult Carp (lipids)
- Smallmouth Bass (lipids)

Since the coefficients for either length, lipids or both length and lipids were significantly different from zero in the above data sets, these are likely good factors to include in the covariate approach described above.

Note that in the above data sets several coefficients for length were negative (Attachment 2). This was the case for adult suckers and rock bass in the Upper River 2 data set, and smallmouth bass in the Inner Harbor data set. In these three cases length had an inverse effect on tissue PCB concentrations, meaning that the larger fish had lower concentrations.

Conclusions

In summary, fish tissue PCB sample results collected during August and September of 2008 (Attachment 1) were analyzed by multiple regression techniques to determine the usefulness of including covariate measures of fish length and percent lipids in future analysis. The future analysis would use these covariates to reduce additional variation in the data so that conclusions concerning PCB concentration trends can be more readily made. Based on the results, the inclusion of fish length and percent lipids significantly reduced variation noise in several of the data sets as listed above.

Attachment 1

Fish Tissue PCB Data Sets

Upper River Fish Tissue Results - Site 1

Adult Carp Length	Adult Carp % Lipid	Adult Carp PCB	Ln Adult Carp PCB	Adult White Sucker Length	Adult White Sucker % Lipid	Adult White Sucker PCB	Ln Adult White Sucker PCB	Juvenile White Sucker Length	Juvenile White Sucker % Lipid	Juvenile White Sucker PCB	Ln Juvenile White Sucker PCB
24.0	4.60%	37.0	3.6	16.0	1.40%	15.9	2.8	6.00	0.151%	9.71	2.3
21.0	1.33%	73.1	4.3	14.0	1.33%	16.6	2.8	6.00	0.367%	8.93	2.2
18.0	4.84%	1.63	0.5	13.0	0.555%	10.3	2.3	5.00	0.462%	6.08	1.8
19.0	4.45%	7.44	2.0	12.0	1.52%	20.6	3.0	6.00	0.248%	4.85	1.6
15.0	2.19%	4.77	1.6	14.0	0.855%	10.6	2.4	7.00	0.330%	7.76	2.0
16.0	0.625%	14.0	2.6	12.0	0.495%	5.74	1.7	6.00	0.638%	6.51	1.9
20.0	2.50%	17.6	2.9	14.0	0.330%	7.34	2.0	6.50	0.281%	2.28	0.8
19.5	0.340%	2.08	0.7	11.5	0.760%	12.3	2.5	6.00	0.275%	1.99	0.7
25.0	7.49%	53.9	4.0								
24.0	7.55%	28.4	3.3								
21.0	3.44%	9.48	2.2								
23.0	3.02%	29.4	3.4								
25.0	13.7%	33.3	3.5								
25.0	1.01%	9.55	2.3								
22.5	8.70%	55.5	4.0								
23.0	7.03%	36.9	3.6								

Upper River Fish Tissue Results - Site 1

Smallmouth Bass Length	Smallmouth Bass % Lipid	Smallmouth Bass PCB	Ln Smallmouth Bass PCB	Rock Bass Length	*Rock Bass % Lipid	Rock Bass PCB	Ln Rock Bass PCB	Longnose Dace Length	Longnose Dace % Lipid	Longnose Dace PCB	Longnose Dace PCB
13.0	0.625%	18.6	2.9	8.50	0.415%	6.53	1.9	3.00	2.77%	17.6	2.9
10.0	0.400%	21.5	3.1	8.00	0.590%	5.82	1.8	2.50	1.24%	3.20	1.2
15.0	1.43%	15.2	2.7	5.50	0.775%	16.8	2.8	2.00	1.14%	1.72	0.5
10.0	0.490%	22.2	3.1	6.00	1.02%	10.4	2.3	2.50	2.30%	3.29	1.2
10.0	0.695%	7.33	2.0	6.00	0.581%	7.91	2.1	3.50	4.00%	15.1	2.7
11.0	0.765%	6.14	1.8	7.00	0.325%	1.22	0.2	2.50	4.40%	5.11	1.6
14.0	1 17%	8.59	2.2	8.00	0.485%	1.57	0.5				
10.0	0.430%	4.09	1.4	5.50	0.619%	5.30	1.7				

Upper River Fish Tissue Results - Site 2

Adult Carp Length	Adult Carp % Lipid	Adult Carp PCB	Ln Adult Carp PCB	Adult White Sucker Length	Adult White Sucker % Lipid	Adult White Sucker PCB	Ln Adult White Sucker PCB	Juvenile White Sucker Length	Juvenile White Sucker % Lipid	Juvenile White Sucker PCB	Ln Juvenile White Sucker PCB
21.0	7.39%	34.5	3.5	11.0	0.960%	10.8	2.4	6.00	0.510%	4.39	1.5
23.0	2.05%	5.14	1.6	13.0	1.32%	12.0	2.5	7.00	0.450%	11.5	2.4
18.0	3.99%	3.18	1.2	14.0	1.14%	5.04	1.6	6.00	0.580%	5.71	1.7
15.0	4.64%	7.84	2.1	9.00	0.715%	9.44	2.2	5.00	0.440%	5.96	1.8
18.0	1.26%	3.73	1.3	10.0	0.355%	3.95	1.4	5.00	0.490%	9.32	2.2
23.5	3.25%	30.2	3.4	13.5	1.28%	16.6	2.8	7.00	0.410%	4.17	1.4
21.5	0.975%	9.23	2.2	14.0	1.12%	5.95	1.8	8.00	0.595%	3.73	1.3
22.5	3.16%	22.7	3.1	13.0	0.840%	7.52	2.0	7.00	0.510%	9.78	2.3
18.0	0.955%	3.55	1.3								
15.0	0.315%	1.71	0.5								
25.0	10.0%	47.7	3.9								
20.5	1.06%	10.5	2.4								
20.0	0.290%	1.02	0.0								
23.0	2.06%	15.8	2.8								
17.5	0.405%	1.39	0.3								
24.5	7.55%	37.3	3.6								

Upper River Fish Tissue Results - Site 2

Smallmouth Bass Length	Smallmouth Bass % Lipid	Smallmouth Bass PCB	Ln Smallmouth Bass PCB	Rock Bass Length	Rock Bass % Lipid	Rock Bass PCB	Ln Rock Bass PCB
11.0	1.78%	28.9	3.4	9.00	0.405%	1.04	0.0
13.0	0.775%	5.34	1.7	8.00	0.670%	4.24	1.4
11.0	1.16%	14.9	2.7	6.00	0.980%	8.25	2.1
12.0	1.67%	33.5	3.5	7.00	1.20%	8.72	2.2
13.0	1.26%	3.12	1.1	8.00	0.470%	4.32	1.5
10.0	0.970%	6.41	1.9	8.00	0.705%	3.78	1.3
10.0	1.69%	13.5	2.6	8.00	0.580%	3.04	1.1
10.0	1.29%	10.5	2.4	8.00	0.240%	0.739	-0.3

Middle River Fish Tissue Results - Site 1

Adult Carp Length	Adult Carp % Lipid	Adult Carp PCB	Ln Adult Carp PCB	Adult White Sucker Length	Adult White Sucker % Lipid	Adult White Sucker PCB	Ln Adult White Sucker PCB	Smallmouth Bass Length	Smallmouth Bass % Lipid	Smallmouth Bass PCB	Ln Smallmouth Bass PCB
16.0	1.22%	2.06	0.7	16.0	0.870%	3.72	1.3	13.0	1.37%	14.1	2.6
16.0	0.770%	1.71	0.5	15.0	1.30%	11.8	2.5	15.0	2.27%	6.04	1.8
17.0	0.390%	1.33	0.3	10.0	0.740%	3.24	1.2	14.0	1.09%	5.77	1.8
17.0	3.21%	2.51	0.9	16.0	0.795%	19.9	3.0	14.0	0.815%	4.20	1.4
15.5	0.845%	1.62	0.5	16.0	1.50%	8.79	2.2	14.5	0.765%	7.46	2.0
16.0	1.17%	1.28	0.2	14.0	0.705%	4.68	1.5	12.0	0.680%	9.29	2.2
17.5	1.14%	2.21	0.8	16.0	1.01%	9.23	2.2	15.0	1.30%	18.2	2.9
20.5	3.16%	22.8	3.1					11.0	0.830%	4.97	1.6

Middle River Fish Tissue Results - Site 1

Rock Bass Length	Rock Bass % Lipid	Rock Bass PCB	Ln Rock Bass PCB	Longnose Dace Length	Longnose Dace % Lipid	Longnose Dace PCB	Ln Longnose Dace PCB	Channel Catfish Length	Channel Catfish % Lipid	Channel Catfish PCB	Ln Channel Catfish PCB	Walleye Length	Walleye % Lipid	Walleye PCB	Walleye PCB
7.00	0.810%	2.79	1.0	4.00	5.82%	17.8	2.9	21.0	4.02%	15.9	2.8	21.0	2.33%	16.8	2.8
				3.50	2.08%	8.35	2.1	22.0	12.6%	49.2	3.9	19.5	2.11%	16.3	2.8
				2.00	3.64%	8.92	2.2	19.0	6.34%	29.8	3.4	12.5	0.595%	5.58	1.7
				2.50	4.84%	7.08	2.0	20.0	5.27%	16.6	2.8	16.0	1.52%	13.7	2.6
				2.00	2.70%	7.10	2.0					16.0	0.695%	7.93	2.1
				2.00	3.09%	7.56	2.0					17.5	1.61%	14.3	2.7
												13.0	0.465%	6.03	1.8
												15.5	1.00%	8.41	2.1

Middle River Fish Tissue Results - Site 2

Adult Carp Length	Adult Carp % Lipid	Adult Carp PCB	Adult White Sucker Length	Adult White Sucker % Lipid	Adult White Sucker PCB	Ln Adult White Sucker PCB	Juvenile White Sucker Length	Juvenile White Sucker % Lipid	Juvenile White Sucker PCB	Ln Juvenile White Sucker PCB
19.0	0.730%	1.27	14.5	0.200%	3.24	1.2	8.00	0.480%	2.03	0.7
			14.5	0.170%	2.37	0.9	8.00	0.400%	1.20	0.2
			14.0	0.520%	3.51	1.3	8.00	0.740%	1.76	0.6
			16.0	0.715%	3.48	1.2	8.00	0.575%	1.13	0.1
			14.0	0.150%	0.925	-0.1	8.00	0.270%	0.980	0.0
			16.0	1.23%	6.36	1.9	8.00	0.557%	1.08	0.1
			15.0	0.585%	6.98	1.9	6.00	0.455%	1.40	0.3
			13.5	1.36%	4.83	1.6				

Middle River Fish Tissue Results - Site 2

Smallmouth Bass Length	Smallmouth Bass % Lipid	Smallmouth Bass PCB	Ln Smallmouth Bass PCB	Rock Bass Length	Rock Bass % Lipid	Rock Bass PCB	Ln Rock Bass PCB	Longnose Dace Length	Longnose Dace % Lipid	Longnose Dace PCB	Ln Longnose Dace PCB	Channel Catfish Length	Channel Catfish % Lipid	Channel Catfish PCB	Channel Catfish
17.0	0.875%	3.53	1.3	7.00	0.480%	1.42	0.4	3.50	2.84%	6.20	1.8	19.0	4.21%	6.90	1.9
14.5	1.09%	7.65	2.0	7.00	0.593%	2.09	0.7	3.50	5.02%	9.60	2.3	22.0	6.01%	8.68	2.2
12.0	2.00%	5.54	1.7	7.00	1.24%	1.88	0.6	3.50	6.08%	10.9	2.4	22.0	3.45%	16.6	2.8
11.0	1.06%	2.64	1.0	6.50	1.80%	3.47	1.2	4.00	5.50%	11.0	2.4	17.0	3.49%	0.532	-0.6
11.5	1.12%	3.65	1.3	5.50	1.02%	2.86	1.1	2.00	2.33%	4.86	1.6				
11.0	1.09%	3.08	1.1	6.00	1.30%	3.70	1.3	2.50	5.09%	7.17	2.0				
10.0	1.30%	4.28	1.5	6.00	0.583%	2.27	0.8	3.50	4.13%	9.86	2.3				
12.0	1.26%	4.05	1.4	8.00	0.495%	2.20	0.8	3.00	5.74%	8.47	2.1				

Lower River Fish Tissue Results

Adult Carp Length	Adult Carp % Lipid	Adult Carp PCB	Ln Adult Carp PCB	Adult White Sucker Length	Adult White Sucker % Lipid	Adult White Sucker PCB	Juvenile White Sucker Length	Juvenile White Sucker % Lipid	Juvenile White Sucker PCB	Ln Juvenile White Sucker PCB
17.5	2.455%	2.52	0.9	12.5	1.025%	4.96	7.00	0.140%	1.27	0.2
24.5	2.69%	15.7	2.8	13.5	0.705%	3.65	8.00	0.205%	1.64	0.5
21.0	5.51%	0.458	-0.8				6.50	0.245%	0.713	-0.3
17.5	9.03%	44.9	3.8				5.00	0.094%	0.587	-0.5
24.0	6.40%	18.4	2.9				7.00	0.405%	0.967	0.0
24.0	3.63%	4.46	1.5							
18.0	0.825%	1.97	0.7							
19.5	1.07%	1.89	0.6							

Lower River Fish Tissue Results

Smallmouth Bass Length	Smallmouth Bass % Lipid	Smallmouth Bass PCB	Ln Smallmouth Bass PCB	Rock Bass Length	Rock Bass % Lipid	Rock Bass PCB	Ln Rock Bass PCB	Channel Catfish Length	Channel Catfish % Lipid	Channel Catfish PCB	Channel Catfish
10.0	1.19%	8.17	2.1	7.00	0.510%	1.76	0.6	19.0	4.11%	8.49	2.1
10.5	0.380%	5.14	1.6	6.50	0.410%	1.95	0.7	21.0	4.34%	11.7	2.5
13.0	0.650%	2.02	0.7	5.50	0.283%	1.40	0.3	20.0	4.98%	6.37	1.9
10.0	0.685%	1.78	0.6	5.00	0.982%	4.11	1.4	17.0	7.81%	28.4	3.3
12.0	1.50%	7.01	1.9	6.50	0.980%	3.33	1.2				
11.0	0.915%	4.84	1.6	6.50	0.445%	1.84	0.6				
12.0	2.13%	10.9	2.4	6.00	0.393%	1.63	0.5				
10.5	1.05%	6.30	1.8	7.00	0.915%	4.27	1.5				
				6.50	0.300%	3.07	1.1				

Inner Harbor Fish Tissue Results

Adult Carp Length	Adult Carp % Lipid	Adult Carp PCB	Ln Adult Carp PCB	Smallmouth Bass Length	Smallmouth Bass % Lipid	Smallmouth Bass PCB	Ln Smallmouth Bass PCB	Channel Catfish Length	Channel Catfish % Lipid	Channel Catfish PCB	Walleye Length	Walleye % Lipid	Walleye PCB	Walleye PCB
21.0	3.83%	9.14	2.2	15.0	0.680%	1.44	0.4	20.5	12.2%	19.4	21.0	3.71%	3.00	1.1
23.0	1.91%	3.21	1.2	14.0	0.855%	2.70	1.0				21.0	2.71%	1.36	0.3
16.5	2.52%	2.46	0.9	12.0	0.935%	4.43	1.5				22.0	1.72%	1.74	0.6
17.0	3.03%	5.02	1.6	13.0	1.00%	3.10	1.1							
18.5	4.04%	2.30	0.8	11.5	0.980%	4.18	1.4							
16.5	4.06%	2.05	0.7	11.0	1.13%	4.31	1.5							
18.5	1.29%	0.890	-0.1	14.0	1.58%	3.91	1.4							
19.0	0.630%	0.243	-1.4	17.0	1.77%	2.83	1.0							

Attachment 2

Regression Analysis Summary

Table 4
Two-Variable Regression Results

Reach	Statistic	Adult Carp		Adult Suckers		Juvenile Suckers		Smallmouth Bass		Rock Bass		Longnose Dace		Walleye		Catfish	
		Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids	Length	Lipids
Upper River 1	N	16		8		8		8		8		6		0		0	
	R^2	0.39		0.91		0.02		0.20		0.53		0.85		-		-	
	Coefficient	0.195	4.59	-0.485	1083.66	-0.036	57.48	3.137	-1911.86	-0.876	1344.79	1.503	8.67	-	-	-	-
	Standard Error	0.093	8.24	0.458	150.04	0.490	184.79	3.008	1690.26	1.548	870.67	0.507	19.21	-	-	-	-
	p (2-tail)	0.056	0.587	0.338	0.001	0.944	0.768	0.345	0.309	0.596	0.183	0.059	0.682	-	-	-	-
	Model	Exponential		Linear		Exponential		Linear		Linear		Exponential		-		-	
Upper River 2	N	16		8		8		8		8		0		0		0	
	R^2	0.88		0.69		0.09		0.59		0.95		-		-		-	
	Coefficient	1.925	341.85	-0.224	191.41	-0.072	-136.27	1.033	2442.65	-1.153	645.16	-	-	-	-	-	-
	Standard Error	0.517	55.57	0.096	57.33	0.180	291.98	2.564	910.63	0.514	146.26	-	-	-	-	-	-
	p (2-tail)	0.003	0.000	0.067	0.021	0.707	0.660	0.704	0.044	0.075	0.007	-	-	-	-	-	-
	Model	Linear		Exponential		Exponential		Linear		Linear		-		-		-	
Middle River 1	N	8		7		0		8		1		6		8		4	
	R^2	0.88		0.37		-		0.05		-		0.77		0.96		0.96	
	Coefficient	0.445	20.95	0.159	33.50	-	-	0.655	50.73	-	-	2.716	140.90	0.017	635.96	-1.850	436.13
	Standard Error	0.123	18.07	0.131	96.16	-	-	1.731	481.56	-	-	1.428	89.31	0.399	165.11	3.011	102.35
	p (2-tail)	0.015	0.299	0.294	0.745	-	-	0.721	0.920	-	-	0.153	0.213	0.967	0.012	0.649	0.147
	Model	Exponential		Exponential		-		Linear		-		Linear		Linear		Linear	
Middle River 2	N	1		8		7		8		8		8		0		4	
	R^2	-		0.53		0.25		0.37		0.62		0.91		-		0.97	
	Coefficient	-	-	0.615	265.92	-0.054	89.09	0.072	57.54	-0.299	102.52	0.238	12.56	-	-	3.040	-298.64
	Standard Error	-	-	0.680	134.30	0.155	79.19	0.056	37.53	0.297	48.80	0.068	3.23	-	-	0.491	100.24
	p (2-tail)	-	-	0.407	0.105	0.746	0.324	0.255	0.186	0.360	0.090	0.017	0.012	-	-	0.102	0.206
	Model	-		Linear		Exponential		Exponential		Linear		Exponential		-		Linear	
Lower River	N	8		2		5		8		9		0		0		4	
	R^2	0.64		-		0.93		0.76		0.67		-		-		0.86	
	Coefficient	-0.639	425.64	-	-	0.414	-145.70	-0.710	506.71	0.022	311.03	-	-	-	-	-0.508	499.45
	Standard Error	1.341	144.76	-	-	0.083	75.92	0.635	125.95	0.392	89.06	-	-	-	-	4.001	400.02
	p (2-tail)	0.654	0.032	-	-	0.038	0.195	0.315	0.010	0.957	0.013	-	-	-	-	0.920	0.430
	Model	Linear		-		Linear		Linear		Linear		-		-		Linear	
Inner Harbor	N	8		0		0		8		0		0		3		1	
	R^2	0.64		-		-		0.90		-		-		-		-	
	Coefficient	0.165	67.67	-	-	-	-	-0.533	196.02	-	-	-	-	-	-	-	-
	Standard Error	0.133	23.19	-	-	-	-	0.081	43.76	-	-	-	-	-	-	-	-
	p (2-tail)	0.269	0.033	-	-	-	-	0.001	0.007	-	-	-	-	-	-	-	-
	Model	Exponential		-		-		Linear		-		-		-		-	

$p<0.05$	Signicance level is below 0.05
$0.05<p<0.1$	Signicance level is greater than 0.05 and less than 0.1

Note: p-Level indicates the probability of the coeffiecient being equal to zero. Lower values of p indicate higher probabilities that the factors of length or percent lipids significantly affect fish tissue PCB concentrations.

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