

OWENS-BROCKWAY GLASS CONTAINER INC.

JOHNSON LAKE FISH TISSUE MONITORING STUDY MONITORING REPORT

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1 INTRODUCTION

Grette Associates is subcontracted to Dalton, Olmsted & Fuglevand, Inc. to conduct the Johnson Lake Fish Tissue Monitoring Study to satisfy the requirements set forth in the *Remediation Operations & Maintenance Plan, Sediment Remedial Action* (DOF 2012), hereafter “O&M Plan”. The O&M Plan, along with the Record of Decision (ROD) Amendment (DEQ 2009), hereafter “ROD”, describe the requirements for post-remediation monitoring of the Owens-Brockway Glass Container Inc. site, including Johnson Lake. The site is located at 5850 NE 92nd Drive in Portland, Oregon. Johnson Lake is located immediately north of the Owens-Brockway facility (Figure 1).

Figure 1. Site Location of the Johnson Lake Fish Tissue Monitoring Study.



Grette Associates conducted fish sample collection over four days (July 5-8, 2022) at Johnson Lake in accordance with the approved Sampling and Analysis Plan (SAP) (Grette Associates 2022). The objective of this study is to evaluate the concentration of polychlorinated biphenyls (PCBs), specifically PCB congener 126, in fish tissues sampled from Johnson Lake. General site photographs taken during the field effort may be found in Appendix A.

Grette Associates performed similar sample collection and reporting five years ago in 2017 (Grette Associates 2018).

The draft SAP was submitted to Oregon Department of Environmental Quality (ODEQ) on April 28, 2022, and was approved by ODEQ on May 25, 2022. An Oregon Department of Fish and Wildlife (ODFW) Scientific Taking Permit (#26458) was issued for the project on March 31, 2022.

1.1 BACKGROUND

Owens-Brockway Glass Container Inc. (Owens) owns and operates a glass manufacturing plant located at 5850 NE 92nd Drive, Portland, Oregon (the “Property”). Owens’ Property is approximately 43 acres in size and located on the south shore of Johnson Lake. The Owens Property and Johnson Lake are collectively referred to as the “Site”.

Sediments in Johnson Lake were previously found to contain PCBs, as described in the *Johnson Lake Investigation Work Plan* (ARCADIS 2004a) and the *Site Investigation Report* (ARCADIS 2004b). Based on the previous investigations and a Feasibility Study prepared in 2006, ODEQ selected a final remedy for the Site in the Record of Decision (October 2007) and ROD Amendment (July 2009). The final remedy for cleanup of the PCBs and other contaminants at the Site consisted of excavating surface soils from low-lying areas, constructing a stormwater bioswale, revegetating and adding clean soil to the excavated areas, and placing a thin layered cap over the sediments within a majority of Johnson Lake (Grette Associates 2022).

The Johnson Lake Fish Tissue Monitoring Study is a required component of the post-remediation monitoring described in the ROD Amendment and the O&M Plan. The study is required to evaluate the level of PCBs present in fish tissue collected in Johnson Lake to determine if levels are low enough for human consumption. In 2004, the ARCADIS mean total PCB was 200 µg/kg in the fillet and 260 µg/kg in the whole body (ARCADIS 2004b). By 2017, the mean total PCB had only dropped to 199 µg/kg in fillet samples but had dropped more significantly in whole body samples, to 106 µg/kg (Grette Associates 2018). Despite this drop, the PCB levels remained over the ROD standard. More specifically, in 2017 the PCB congener 126 levels ranged from 0.009 µg/kg in composite PF2-ES-12 to 0.135 µg/kg in composite RF1, while the ROD standard is 0.003 µg/kg.

1.2 JOHNSON LAKE

Johnson Lake extends over 18 acres and is directly connected to Whitaker Slough, which in turn is connected to the Columbia Slough and eventually connects to the Willamette River. Johnson Lake is bounded to the south by the Owens-Brockway facility and to the west and east, by other industrial facilities. Several stormwater outfalls enter the lake, draining the surrounding areas and facilities.

Johnson Lake is a relatively shallow, flat lake with a maximum depth of approximately 6 feet. The lake experiences significant algal blooms during the summer months likely due to high nutrient levels, warm water temperatures and the lengthening photoperiod (ARCADIS 2004). During the fish tissue study, brown algae was observed on and below the water surface. In addition, *Elodea* sp. (waterweed) and *Callitriche* sp. (water star-wort) were observed in many areas of the lake.

The edge of the lake is surrounded by riparian vegetation including willows (*Salix* spp.), red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), cattail (*Typha* spp.), yellow-flag iris (*Iris pseudacorus*) and various shrubs. Invasive vegetation was also present in the riparian zone and included Himalayan blackberry (*Rubus armeniacus*) and reed canarygrass (*Phalaris arundinacea*).

During recent years a number of homeless camps, including semi-industrial activities such as auto salvage, have occupied the shorelines of Johnson Lake and have discharged unknown substances directly into the lake and surrounding waterways, including Columbia Slough.

2 METHODS

2.1 FISH SAMPLE COLLECTION

As described in the SAP, Grette Associates utilized a variety of fish sampling equipment and methods in an effort to collect as many fish as practicable from Johnson Lake for analysis. The fish sampling methods used included:

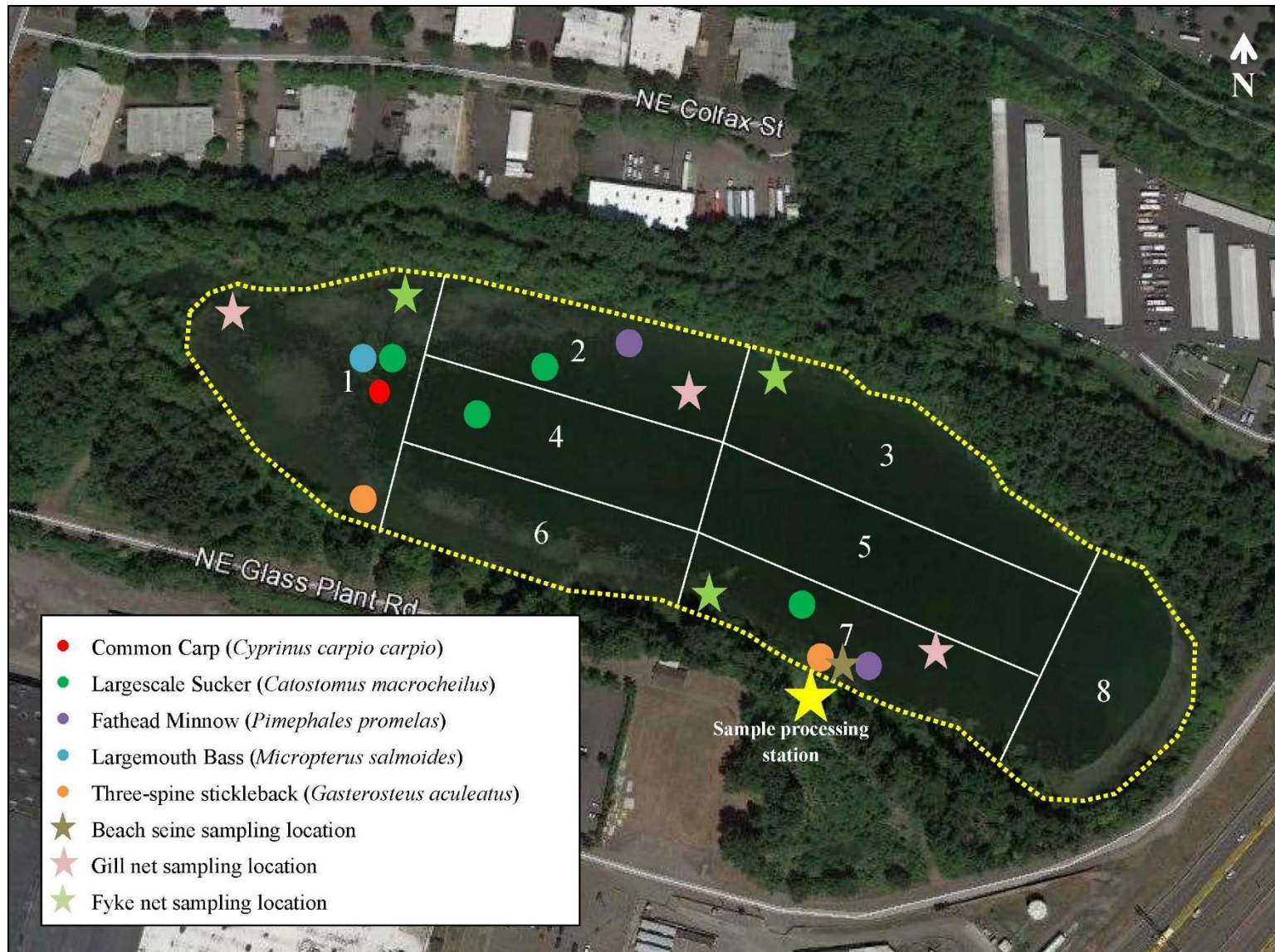
- modified Fyke net
- gill net
- beach seine
- Smith Root LR-24 backpack waveform electro-shocker
- fishing tackle.

Fish collection utilizing the electro-shocker was conducted on foot and from a small boat using a Smith Root LR-24 waveform electro-shocker and the guidelines outlined by the National Marine Fisheries Service (NMFS 2000; attached in Appendix B). This method was most successful from the boat, with which most areas of the lake were accessible. Traditional hook and line methods were also employed throughout the four-day effort when not engaged in other types of fishing, but did not prove successful in sample collection. The gill net was deployed overnight on three days in various locations throughout the lake where the algae and aquatic vegetation did not prohibit its use. The beach seine was deployed on south shore at the location of the sample processing area on July 6, 2022. The Fyke net was deployed on two days.

Fish collection was attempted from a variety of locations within the lake, as practicable, in an effort to represent general fish tissue concentrations lake wide. Grette Associates used the sediment sampling zones described in the O&M Plan to identify where specimens were collected in the lake. Figure 2 identifies the sections/sampling zones of Johnson Lake where sampling occurred.

The locations of hook and line and electroshocking sampling are not shown on Figure 2, as those activities occurred throughout Johnson Lake.

Figure 2. Location of fish captured/observed during the Johnson Lake Fish Tissue Monitoring Study in July 2022. Dots represent the approximate locations of where species of fish were captured (see legend), with each zone (number) separated by white lines. The boundary of Johnson Lake is represented by the dotted yellow line, and the yellow star represents the location of the sample processing station.



Fish collection targeted the following categories of fish per the O&M Plan: game fish, pan fish, rough fish, large whole-fish and small whole-fish. In order to satisfy the composite sample categories, fish of all species and sizes (age classes) were targeted for collection. The goal for each category was to collect enough fish for the lab to composite 5 samples of the same fish type and size range into a single composite sample for each category. In circumstances where there were not enough fish collected to complete two composites (5 fillets and 5 whole-body samples) for each species, the whole-body composite was prioritized. Due to the number and species of fish collected in 2022 efforts, deviations from the original plan were required when creating composites. DEQ reviewed all fish caught during 2022, and created a compositing plan which accounted for these changes. The total number of non-game fish within each composite ranged from 3 to 10 (instead of the originally proposed 5 samples per composite). An additional deviation was only 1 game fish (Largemouth bass) was collected during surveying efforts – two composites (fillet and whole body) were created from this single fish.

Fish collected in Johnson Lake were temporarily held in a decontaminated cooler filled with site water. Once sampling activities for each location and method were completed, the cooler was brought to the processing station set up south of Johnson Lake on Owens' Property (Figure 2).

2.1.1 Sample Preparation

Fish collected at each sampling site were identified to species, categorized (pan fish, rough fish, etc.), measured, and photographed. Fish targeted for tissue analysis were euthanized via CO₂ immersion (small fish) or blunt force and pithing (large fish). Any fish not required for tissue analysis was returned to the location in the lake from which they were collected without being euthanized.

Each fish collected was assigned an alpha numeric sample ID. This ID provides information such as the composite category, the location in the lake the fish was collected, and the chronological order in which the fish was collected. For example, the first specimen collected had an ID number of SF-7-01 indicating it was a small fish (SF), collected in zone 7 (-7), and was the first fish collected during the study (01). The ID nomenclature used does not indicate what mode was used to capture each fish, but this information is included on the field datasheets in Appendix C.

Individual weights (in grams) and fork lengths (mm) of each specimen were recorded. When euthanized fish were prepared for transport to the lab, care was taken to avoid cross-contamination. Work surfaces were covered with aluminum foil, and between each sample nitrile gloves were changed and measuring boards were decontaminated. All fish retained for tissue analysis were rinsed with analyte free-ionized water, wrapped in aluminum foil, bagged, labeled, and placed in an on-site chest freezer for the duration of the field effort prior to delivery to the analytical laboratory. Field datasheets and photographs of all fish sampled are in Appendices C and F respectively.

During review of the laboratory results, it was discovered that a misidentification of ten of the large fish had occurred at the time of fish collection. The misidentification resulted in three composite samples that contain two different species of fish. When the misidentification was discovered, the laboratory was contacted and requested to preserve the homogenate samples from

each of the individual fish that were used in the multi-species composites. As such, future compositing and testing of single-species samples is possible if necessary.

2.1.2 Chain of Custody Procedures

The field representative logged each sample sent for analysis on a chain of custody (COC) form, noting sample identification, date and time of collection, requested analysis, and comments as appropriate (Appendix E).

After concluding the four-day field effort, Grette Associates delivered the fish specimens to the ALS Environmental Laboratory in Kelso, WA. Upon delivery, the chain-of-custody forms were signed by the persons transferring custody of the samples.

2.2 LABORATORY ANALYSIS

The collected fish were delivered to ALS Environmental Laboratory in Kelso, WA on July 8, 2022. Once delivered to the lab, the fish were held in secure storage pending an approved compositing plan from DEQ. Grette Associates submitted the fish sample data to DEQ, and DEQ prepared a compositing plan that addressed the categories and species/lengths collected (Appendix G). All tissue samples were processed in accordance with the approved compositing plan, the approved SAP, and the Laboratory Standard Operating Procedures (“SOP”; Appendix F). Following DEQ’s compositing plan, ALS Laboratories created composite samples for each category of fish collected (i.e., game fish, rough fish, large whole-fish, and small whole-fish). Fish filleting, descaling, and tissue sampling occurred within in the laboratory, not in the field. All skin and belly flaps were left remaining on the fish for tissue sampling. Each composite sample was homogenized, and frozen at 4°C for future analyses. Based on discussions with the Laboratory Project Manager, deviations from the SOP did not occur during tissue sample preparation. All composites were analyzed for lipid content by the ALS Laboratory in Kelso, and then sent to the ALS Burlington, Ontario Laboratory to analyze for PCB congeners within the composite samples.

2.2.1 Testing Methods

The composited samples were analyzed for PCB congeners using EPA method 1668C, and for lipid content using NOAA Lipid. Tissue samples were stored at 4°C with a holding time of no longer than 14 days (Table 1).

Table 1. Fish sample holding time and storage criteria.

Sample Type	EPA Method	Holding Time	Temperature	Sample condition
Fish tissue	1668C	14 days until extraction	4° C	fillets (with belly flap attached); whole fish
Fish tissue (lipids)	NOAA Lipid	14 days until extraction	4° C	fillets (with belly flap attached); whole fish

3 RESULTS

3.1 FIELD SAMPLING ACTIVITIES

3.1.1 Fish Collection

Fish Collection Effort

As described above, five different fish sampling strategies were used for this project: backpack electroshocker, modified Fyke net, gill net, beach seine, and rod and reel angling. These methods were used with varying success within Johnson Lake.

Use of the backpack electroshocker was initially conducted on foot along the southern shoreline of the lake where water depth allowed. This sampling method was quite successful for the capture of three-spine stickleback (*Gasterosteus aculeatus*) near the shoreline. However, the water level was too high to get beyond the vegetation to shock along the entirety of the shoreline. As a result, most of the shoreline areas were accessed via a small, rowed boat with a 3-person crew.

Angling was primarily conducted from the skiff, but also occurred along portions of the southern shoreline of the lake where access was possible. Dense brush, wood debris and depth prevented shore angling in other locations. All portions of the lake were fished with tackle. There was minimal algal surface mat during 2022 sampling as there was during the previous 2017 effort. A variety of tackle was used including spinners, spoons, Powerbait, jigs, worms, and bait/bobber.

Fish Collection Results

With the exception of pan fish, fish were collected from all of the categories described in Section 2.1. A total of 46 fish were collected for laboratory analysis. The desired number of fish representing each category could not be collected during the four-day effort. The specimens collected by category are presented in Table 2 and photographs of each specimen are presented in Appendix F.

Table 2. Number of fish collected by species and category.

Species Name	Game Fish	Rough Fish	Pan Fish	Small Whole-Fish	Large Whole-Fish	Total
Common carp (<i>Cyprinus carpio</i>)		7			1	8
Largescale Sucker (<i>Catostomus macrocheilus</i>)		2			8	10
Fathead minnow (<i>Pimephales promelas</i>)				2		2
Three-spine stickleback (<i>Gasterosteus aculeatus</i>)				25		25
Largemouth bass (<i>Micropterus salmoides</i>)	1					1
Total	1	9	0	27	9	46

The rough fish collected were common carp (*Cyprinus carpio*) and largescale sucker (*Catostomus macrocheilus*); all large whole fish collected were also common carp and largescale sucker; one

game fish was collected which was a largemouth bass (*Micropterus salmoides*); and the small whole fish category consisted of 25 three-spine stickleback (*Gasterosteus aculeatus*) and two fathead minnows (*Pimephales promelas*). No pan fish were collected.

The fish were captured using a combination of electroshocking, gill netting, beach seining, and fyke netting. The size of fish collected ranged from approximately 22mm to 618mm in length.

All fish were collected from zones 1, 2, 4, and 7, with zones 1 and 7 containing the bulk of the sampled fish (Table 3; see Figure 2 for zone locations). Common carp was found in all zones where fish were captured, and three-spine stickleback was found in zones 1 and 7. All remaining species – the two fathead minnow and one largemouth bass – were found within the western portion of the lake. Although attempted, no fish were collected from zones 3, 5, 6, or 8.

During beach seining, large amounts of aquatic algae, vegetation, and mud were hauled in with the net. Large numbers of three-spine stickleback were intermixed within this debris, making it impossible to accurately count the number of fish retrieved in the seine hauls. All fish captured were kept for processing and analysis during the field collection.

Table 3. Summary of all fish collected for laboratory analysis.

Date Collected	Sample ID	Species	Zone Collected ¹	Fork Length (mm)	Mass (g)	Age Class	Native (Y/N)
7/5/2022	SF-7-01	Three-spine Stickleback	7	53	3	Adult	Y
7/5/2022	SF-7-02 ²	Three-spine Stickleback	7	20	<1	Juvenile	Y
7/5/2022	SF-7-03	Three-spine Stickleback	7	50	3	Adult	Y
7/5/2022	SF-7-04 ²	Fathead Minnow	1	60	4	Adult	N
7/5/2022	RF-1-05	Common Carp	1	155	86	Juvenile	N
7/5/2022	RF-1-06	Largescale Sucker	1	231	161	Juvenile	N
7/5/2022	RF-1-07	Common Carp	1	117	35	Juvenile	N
7/5/2022	RF-1-08	Common Carp	1	135	57	Juvenile	N
7/5/2022	RF-1-09	Common Carp	1	112	34	Juvenile	N
7/6/2022	LF-07-10	Largescale Sucker	7	578	2490	Adult	N
7/6/2022	LF-07-11	Largescale Sucker	7	420	960	Adult	N
7/6/2022	LF-07-12	Largescale Sucker	7	550	2080	Adult	N
7/6/2022	LF-07-13	Largescale Sucker	7	595	2680	Adult	N
7/6/2022	LF-07-14	Largescale Sucker	7	520	1940	Adult	N
7/6/2022	LF-07-15	Largescale Sucker	7	549	2070	Adult	N
7/6/2022	LF-07-16	Largescale Sucker	7	550	2040	Adult	N
7/6/2022	SF-01-17 ²	Three-spine Stickleback	1	61	5	Adult	Y

7/6/2022	SF-01-18 ²	Three-spine Stickleback	1	50	3	Adult	Y
7/6/2022	SF-01-19	Three-spine Stickleback	7	53	3	Adult	Y
7/6/2022	SF-01-20 ²	Three-spine Stickleback	7	47	2	Adult	Y
7/6/2022	SF-01-21	Three-spine Stickleback	7	62	4	Adult	Y
7/6/2022	SF-01-22	Three-spine Stickleback	7	55	2	Adult	Y
7/6/2022	SF-01-23	Three-spine Stickleback	7	54	4	Adult	Y
7/6/2022	SF-01-24	Three-spine Stickleback	7	55	4	Adult	Y
7/6/2022	SF-01-25	Three-spine Stickleback	7	61	4	Adult	Y
7/6/2022	SF-01-26	Three-spine Stickleback	7	61	4	Adult	Y
7/6/2022	SF-01-27	Three-spine Stickleback	7	49	3	Adult	Y
7/6/2022	SF-01-28	Three-spine Stickleback	7	51	3	Adult	Y
7/6/2022	SF-01-29	Three-spine Stickleback	7	55	4	Adult	Y
7/6/2022	SF-01-30	Three-spine Stickleback	7	49	2	Adult	Y
7/6/2022	SF-01-31	Three-spine Stickleback	7	55	4	Adult	Y
7/6/2022	SF-01-32	Three-spine Stickleback	7	56	3	Adult	Y
7/6/2022	SF-01-33	Three-spine Stickleback	7	54	3	Adult	Y
7/6/2022	SF-01-34 ²	Three-spine Stickleback	7	40	1	Juvenile	Y
7/6/2022	SF-01-35	Three-spine Stickleback	7	49	2	Adult	Y
7/6/2022	SF-01-36	Three-spine Stickleback	7	48	3	Adult	Y
7/6/2022	SF-01-37	Three-spine Stickleback	7	50	3	Adult	Y
7/6/2022	SF-01-38	Three-spine Stickleback	7	49	3	Adult	Y
7/7/2022	LF-02-39	Largescale Sucker	2	585	2220	Adult	N
7/7/2022	SF-02-40 ²	Fathead Minnow	2	64	4	Adult	N
7/8/2022	GF-1-41	Largemouth Bass	1	316	620	Adult	N
7/8/2022	RF-1-42	Common Carp	1	257	366	Adult	N
7/8/2022	LF-1-43	Common Carp	1	342	750	Adult	N
7/8/2022	LF-1-44	Common Carp	1	473	2030	Adult	N

7/8/2022	LF-4-45	Largescale Sucker	4	580	2320	Adult	N
7/8/2022	RF-1-46	Common Carp	1	144	72	Juvenile	N

¹ Zones are depicted on Figure 2.

² Specimens not included in composite analyses since they did not meet compositing requirements.

3.1.2 Weather Observations

During the four-day sampling effort, Grette Associates biologists noted that the lake water level appeared to be significantly higher than during the sampling effort in 2017. Water temperature ranged from the upper-50's to low-70's during the course of field activities. The air temperature highs during the course of field monitoring ranged from the mid-70's to low-80's. A light rain fell the first day of sampling (July 5), while overcast and partly sunny conditions predominated the rest of the study. While the lower-than-normal air temperatures and mild spring likely contributed to less surface algae on the lake than during the 2017 field effort, the lake still contained a significant amount of aquatic bed vegetation, making angling, seining and gill netting impracticable throughout most areas of the lake.

3.1.3 Dissolved Oxygen

Due to an equipment malfunction, dissolved oxygen readings were not able to be collected at the time of sampling. Dissolved oxygen readings were collected at Johnson Lake on July 28, 2022, within all zones (Table 4).

Table 4. Dissolved oxygen readings from Johnson Lake, July 28, 2022.

Area Sampled	Water Depth (ft)	Sample Depth (ft)	Dissolved Oxygen (mg/L)
1	3.1	1.5	8.96
2	2.1	1.0	9.09
3	2.4	1.2	9.10
4	6.4	3.2	8.68
5	5.2	2.6	8.83
6	2.6	1.3	8.32
7	2.0	1.0	9.40
8	3.3	1.6	9.36

3.2 COMPOSITING SCHEME

Grette Associates collected a total of 46 fish, the majority of which were three-spine stickleback, largescale sucker, and common carp (Tables 2 and 3). Only one game fish was collected (largemouth bass) and no pan fish were collected. Additionally, two fathead minnows were collected. Table 3 summarizes the fish captured for the survey, with photographs of each individual fish presented in Appendix F. Seven fish were not included within the compositing scheme due to limited mass, which were all three-spine stickleback captured in Zone 1, and the fathead minnows. The DEQ-approved compositing plan is presented in Appendix G.

Fish were prepared and composited by ALS Environmental laboratory in Kelso, WA, according to their SOP (Appendix F) and Section 3 of the SAP (Grette 2022). The composite samples were then analyzed for percent lipid at the Kelso laboratory and for PCB congeners at ALS Environmental in Burlington, Ontario, Canada.

3.3 LABORATORY RESULTS

3.3.1 PCB Congener 126

The chemical of concern for this fish tissue study is PCB congener 126, as discussed in the 2009 ROD amendment. A primary goal of the remedial action is to prevent human consumption of fish with tissue concentrations greater than 0.003 µg/kg PCB congener 126. The laboratory results for PCB 126, presented in Table 5, were compared to this standard.

Results of the analyses for PCB congeners were received from ALS Laboratories on November 29, 2022, in addition to the lipid content (received September 30, 2022) in each sample. Table 5 presents the concentrations of PCB congener 126 in each non-game fish sample compared to the established standard, and Table 6 presents the non-game fish lipid analysis results. The largemouth bass (“Game Bass”) results were received September 14, 2022, are presented in Tables 7 and 8.

Table 5. PCB 126 analysis results for non-game fish tissue samples collected at Johnson Lake in 2022. All composite samples were analyzed by ALS Laboratories.

Composite Name	Species	Analysis Method	PCB 126 ¹ (µg/kg)	EDL ² (µg/kg)	ROD Standard (µg/kg)	Standard Met (Y/N)
LargeRough-WB-1	Largescale sucker	1668C	0.102	0.0099	0.003	N
LargeRough-Fillet-1	Largescale sucker	1668C	0.0264	0.0043	0.003	N
LargeRough-WB-1-DUP ³	Largescale sucker/Common carp	1668C	0.0771	0.0057	0.003	N
MediumRough-WB-1 ³	Largescale sucker/Common carp	1668C	0.0178	0.0041	0.003	N
MediumRough-WB-J1 ³	Largescale sucker/Common carp	1668C	<0.0082	0.0040	0.003	N
MediumRough-WB-J2	Common carp	1668C	0.0103	0.0032	0.003	N
Small-WB-Stick1	Three-spine stickleback	1668C	0.014	0.0041	0.003	N
Small-WB-Stick2	Three-spine stickleback	1668C	0.0135	0.0052	0.003	N

¹ PCB 126 results from ALS Laboratories were received in pg/g (wet weight), and were converted to µg/kg (wet weight).

² EDL = Estimated Detection Limit. The Method Detection Limit for this analytical method is 0.00006 µg/kg. However, the EDL is calculated based on the sample mass extracted, and is specific to each sample.

³ Due to a species identification error, largescale sucker were labeled as common carp at the time of collection and laboratory analysis. The error was rectified after the laboratory analyses were completed, and as such three of the resulting composite samples contain two different species of fish (largescale sucker and carp).

Nine of the ten composite samples had a PCB 126 concentration greater than the ROD standard of 0.003 µg/kg. Sample MediumRough-WB-J1 is listed as “<8.2 pg/g”. This designation by the laboratory is indicative of a non-detect. However, as the detection limit for this sample (0.0040 µg/kg) is above the ROD standard of 0.003 µg/kg, it is unknown if this sample contains congener PCB 126 at a concentration below 0.0040 µg/kg but above the ROD standard.

All PCB results from ALS Laboratories are presented in Appendix I.

3.3.2 Lipids

Lipids were analyzed to normalize the PCB results. Studies suggest there is a positive correlation between lipid content and the bioaccumulation of chemicals in many fish species. The higher the lipid content of an organism, the greater the bioaccumulation factor for many chemicals of concern (Schlechtriem et al. 2012). A comparison of the lipid content and PCB congener 126 concentrations for non-game fish are in Table 6. Lipid results from ALS Laboratories are in Appendix J.

Table 6. Lipid analysis results for non-game fish tissue samples collected at Johnson Lake in 2022. Lipids and PCB data were collected by ALS Laboratories.

Composite Name	Species	Analysis Method	Percent Lipid	Detection Limit (Percent Lipid)
LargeRough-WB-1	Largescale sucker	NOAA Lipid	9.5	0.22
LargeRough-Fillet-1	Largescale sucker	NOAA Lipid	3.5	0.23
LargeRough-WB-1-DUP ¹	Largescale sucker/Common carp	NOAA Lipid	7.3	0.22
MediumRough-WB-1 ¹	Largescale sucker/Common carp	NOAA Lipid	3.8	0.24
MediumRough-WB-J1 ¹	Largescale sucker/Common carp	NOAA Lipid	3.2	0.23
MediumRough-WB-J2	Common carp	NOAA Lipid	2.4	0.23
Small-WB-Stick1	Three-spine stickleback	NOAA Lipid	4.1	0.24
Small-WB-Stick2	Three-spine stickleback	NOAA Lipid	2.4	0.24

¹ Due to a species identification error, largescale sucker were labeled as common carp at the time of collection and laboratory analysis. The error was rectified after the laboratory analyses were completed, and as such three of the resulting composite samples contain two different species of fish (largescale sucker and carp).

When analyzing non-game fish, the LargeRough-WB-1 composite containing largescale sucker had the highest lipid content at 9.5 percent, and highest concentration of PCB congener 126 at 0.102 µg/kg (Tables 5 and 6). The non-game fish composites with the lowest lipid content were the three-spine stickleback in Small-WB-Stick 2, and the common carp juveniles in Medium Rough-WB-J2, each at 2.4 percent (Table 6). The composite with the lowest concentration of PCB congener 126 was MediumRough-WB-J1 consisting of juvenile fish (Table 5). However, this

composite sample contained homogenate from two different species of fish (largescale sucker and common carp).

3.3.3 Game Bass Results

Each composite for the largemouth bass exceeded the PCB congener 126 ROD standard of 0.003 µg/kg (Tables 7 and 8). Though the PCB standard was exceeded, when compared to all non-game composite samples, the game-bass fillet contained the lowest percentage of PCB congener 126 (Table 5, Table 7), and both game-bass composites contained less lipids in tissue samples (Table 6, Table 8). All ALS laboratories results (PCB concentrations and lipid content) for the largemouth bass are presented in Appendix K.

Table 7. PCB 126 results for the adult largemouth bass collected at Johnson Lake in 2022. PCB concentrations were recorded by ALS Laboratories.

Composite Name ¹	Analysis Method	PCB 126 ² (µg/kg)	EDL ³ (µg/kg)	ROD Standard (µg/kg)	Standard Met (Y/N)
Game-Bass Fillet	1668C	0.0036	0.0010	0.003	N
Game-Bass Carcass	1668C	0.038	0.0017	0.003	N

¹ Only 1 Largemouth bass was collected during surveying efforts, but two composites (Game-Bass Fillet and Game-Bass Carcass) were created from the single fish.

² PCB results from ALS Environmental were received in pg/g (wet weight) and were converted to µg/kg (wet weight).

³ EDL = Estimated Detection Limit.

Table 8. Lipid and PCB results for the adult largemouth bass

Composite Name	Percent Lipid	Total PCB ¹ (µg/kg)	Lipid-Normal Total PCB (µg/kg)	Midpoint PCB TEQ (µg/kg) ¹	PCB 126 (µg/kg) ¹
Game-Bass Fillet	0.29	19.8	68.3	0.00059	0.0036
Game-Bass Carcass	0.46	216	470	0.00660	0.038

¹ PCB results from ALS Environmental were received in pg/g (wet weight) and were converted to µg/kg (wet weight).

3.3.4 Results Summary

Table 9 presents a summary of fish samples and associated results for the 2022 Johnson Lake Fish Monitoring Study.

Table 9. Summary of fish sample and composite results for game and non-game fish

Composite Name	Date Collected	Sample ID	Species	Fork Length (mm)	Mass (g)	Lipid (%)	Total PCB (µg/kg)	Midpoint PCB TEQ (µg/kg)	Lipid - Normal Total PCB (µg/kg)	PCB Congener 126 (µg/kg)
Game-Bass Fillet	7/8/2022	GF-1-41	Largemouth Bass	316	620	0.29	19.8	0.00059	68.3	0.0036
Game-Bass Carcass	7/8/2022					0.46	216	0.0066	470	0.038
LargeRough-WB-1	7/6/2022	LF-07-13	Largescale Sucker	595	2680	9.5	487	0.0112	51.3	0.102
	7/7/2022	LF-02-39	Largescale Sucker	585	2220					
	7/8/2022	LWF-4-45	Largescale Sucker	580	2320					
LargeRough-Fillet-1	7/6/2022	LF-07-10	Largescale Sucker	578	2490	3.5	109	0.00287	31.1	0.0264
	7/6/2022	LF-07-12	Largescale Sucker	550	2080					
	7/6/2022	LF-07-16	Largescale Sucker	550	2040					
LargeRough-WB-1-Dup ¹	7/6/2022	LF-07-15	Largescale Sucker	549	2070	7.3	378	0.00858	51.8	0.0771
	7/6/2022	LF-07-14	Largescale Sucker	520	1940					
	7/8/2022	LF-1-44	Common Carp	473	2030					
MediumRough-WB-1 ¹	7/6/2022	LF-07-11	Largescale Sucker	420	960	3.8	70.4	0.00188	18.5	0.0178
	7/8/2022	LF-1-43	Common Carp	342	750					
	7/8/2022	RF-1-42	Common Carp	257	366					
MediumRough-WB-J1 ¹	7/5/2022	RF-1-06	Largescale Sucker	231	161	3.2	33.6	0.00088	10.5	<0.0082
	7/5/2022	RF-1-05	Common Carp	155	86					
	7/8/2022	RF-1-46	Common Carp	144	72					
MediumRough-WB-J2	7/5/2022	RF-1-08	Common Carp	135	57	2.4	46.6	0.00119	19.4	0.0103
	7/5/2022	RF-1-07	Common Carp	117	35					
	7/5/2022	RF-1-09	Common Carp	112	34					

Small-WB-Stick1	7/6/2022	SF-7-21	Three-spine Stickleback	62	4	4.1	48.9	0.00155	11.9	0.014
	7/6/2022	SF-7-25	Three-spine Stickleback	61	4					
	7/6/2022	SF-7-26	Three-spine Stickleback	61	4					
	7/6/2022	SF-7-32	Three-spine Stickleback	56	3					
	7/6/2022	SF-7-22	Three-spine Stickleback	55	2					
	7/6/2022	SF-7-24	Three-spine Stickleback	55	4					
	7/6/2022	SF-7-29	Three-spine Stickleback	55	4					
	7/6/2022	SF-7-31	Three-spine Stickleback	55	4					
	7/6/2022	SF-7-23	Three-spine Stickleback	54	4					
	7/6/2022	SF-7-33	Three-spine Stickleback	54	3					
Small-WB-Stick2	7/6/2022	SWF-7-01	Three-spine Stickleback	53	3	2.4	66.2	0.00157	27.6	0.0135
	7/6/2022	SF-7-19	Three-spine Stickleback	53	3					
	7/6/2022	SF-7-28	Three-spine Stickleback	51	3					
	7/6/2022	SWF-7-03	Three-spine Stickleback	50	3					
	7/6/2022	SF-7-37	Three-spine Stickleback	50	3					
	7/6/2022	SF-7-27	Three-spine Stickleback	49	3					
	7/6/2022	SF-7-30	Three-spine Stickleback	49	2					
	7/6/2022	SF-7-35	Three-spine Stickleback	49	2					
	7/6/2022	SF-7-38	Three-spine Stickleback	49	3					
	7/6/2022	SF-01-36	Three-spine Stickleback	48	3					
Not Analyzed per DEQ	7/6/2022	SF-01-17	Three-spine Stickleback	61	5					
	7/6/2022	SF-01-18	Three-spine Stickleback	50	3					
	7/6/2022	SF-7-20	Three-spine Stickleback	47	2					
	7/6/2022	SF-7-34	Three-spine Stickleback	40	1					
	7/6/2022	SWF-7-02	Three-spine Stickleback	20	<1					
Small-WB-Min1 (Not Analyzed per DEQ)	7/7/2022	SF-02-10	Fathead Minnow	64	4					
	7/5/2022	SWF-7-04	Fathead Minnow	60	4					

¹ Due to a species identification error, these composite samples contain homogenate from two different species.

4 DISCUSSION

4.1 2022 FISH MONITORING STUDY

Based on the results of the fish tissue analysis, all of the composited samples exceed the established PCB 126 standard of 0.003 µg/kg for human consumption in Johnson Lake (Table 9). The LargeRough-WB-1 composite sample contained the highest concentration of PCB 126 (0.102 µg/kg) while the single largemouth bass fillet (Game-Bass Fillet) contained the lowest concentration (0.0036 µg/kg). Similarly, the highest Total PCB concentration was observed in the LargeRough-WB-1 sample (487 µg/kg), while the lowest Total PCB concentration was observed in the Game-Bass Fillet sample (19.8 µg/kg). However, when normalized against lipid content the highest lipid-normal Total PCB concentration was in the Game-Bass Carcass sample (470 µg/kg). The lowest lipid-normal Total PCB concentration was in the MediumRough-WB-J2 sample (10.5 µg/kg). The MediumRough-WB-J2 composite sample contained sample homogenate from both largescale sucker and common carp juveniles.

As noted in 2017, the results presented above correlate somewhat with the life histories of the species representative of the sample categories and the age and size classes. Largescale suckers and common carp are bottom feeding species, which presents an increased risk of these fish accumulating contaminants present within the sediment. Largescale suckers (along with common carp) are also fairly long-lived, capable of living up to 15 years in the wild (Dauble 1986). Because these fish are long-lived, some of the larger largescale suckers and common carp (particularly the adults in the LargeRough composites) sampled within Johnson Lake may have been present prior to the remediation actions in 2012; therefore, potentially accumulating contaminants prior to the remediation. The lipid content within the largescale suckers was also the highest of any of the other samples (LargeRough-WB-1), which correlates with higher potential for bioaccumulation of contaminants within organisms. Conversely, the composite sample with the lowest concentration of PCB 126 (Game-Bass Fillet) also had the lowest lipid content of composites analyzed. While bass are also a long-lived species, their muscle tissue contains far less lipid, limiting the bioaccumulation potential for PCBs in bass.

Of the five categories of fish outlined in the ROD and O&M, four categories were represented in the fish captured at Johnson Lake. Over the course of the four-day sampling effort, extensive effort was made to capture Pan Fish at the site using all five methods. Over the four-day effort, the field crew were not able to capture a representative of the Pan Fish category.

4.2 MIGRATION POTENTIAL OF FISH SPECIES CAPTURED AND ANALYZED AT JOHNSON LAKE

Johnson Lake has an unrestricted, permanent connection to the Whitaker/Columbia Slough system at the western end of the lake (Figure 2). Fish within the lake are free to enter the slough system and return to the lake unrestricted throughout the year and over their lifespan. This presents the potential for fish to accumulate contaminants within the slough system and then return to the lake. It is therefore possible that fish sampled during this study accumulated contaminants from the slough system rather than from within Johnson Lake.

The following sections discuss the life history strategies related to migration of the fish captured and analyzed for this study.

4.2.1 largescale Sucker

Largescale suckers are native to the Willamette Basin and are the most widely distributed fish in the Willamette River system (Williams, Giannico, and Withrow-Robinson 2014). They are common in main river channels and sloughs, as well as lowland lakes (Page and Burr 1991). Largescale suckers have been shown to exhibit lengthy migrations during spawning, but will also migrate between preferred habitats on a daily and hourly basis (McEvoy 1998; Dauble 1986). Largescale suckers within Johnson Lake likely migrate to various areas of the Johnson Lake/Whitaker Slough system depending on spawning and foraging behaviors and habitat preferences.

4.2.2 Common Carp

Common carp are native to Eurasia, but are common throughout North America (Page and Burr 1991). They inhabit main river channels and sloughs, as well as lakes and manmade ponds. Common carp often move to productive, shallow lakes in the spring to spawn, while spending summers moving between habitats to forage. They exhibit a seasonal homing migratory strategy that is well-suited to productive and interconnected freshwater environments (Banet, Fieberg, and Sorensen 2021), and would thus be expected to seasonally migrate into and out of Johnson Lake.

4.2.3 Three-Spine Stickleback

Three-spine stickleback are native to the Willamette Basin (Williams, Giannico, and Withrow-Robinson 2014). They exhibit two main types of life history, freshwater resident and anadromous (Arai et al. 2020). Within the freshwater type, of which the stickleback at Johnson Lake belong (lacking significant armor plating), fluvial migratory behavior is common. The freshwater resident type may have originated from the anadromous type migrating upstream and becoming resident in freshwater habitats (Arai et al. 2020). As stickleback are shown to exhibit fluvial migratory behavior within freshwater habitats, it is highly plausible that some number of stickleback present in Johnson Lake migrate to and from Whitaker Slough.

4.2.4 Largemouth Bass

Largemouth bass are native to eastern and east-central North America, and were introduced to the Willamette Basin (Williams, Giannico, and Withrow-Robinson 2014). They inhabit warm, vegetated lakes, ponds and sloughs, typically over mud and sand substrates (Page and Burr 1991). Bass typically migrate from deeper waters onshore to spawn in the late spring (WDFW 2023). They stay in shallow, productive waters with dense vegetative cover through the summer and into the fall. During winter, they move back into deeper waters. Largemouth bass prefer lakes and ponds, but will also inhabit stream backwaters (Montana Field Guide 2023). While Johnson Lake appears to provide preferred habitat for largemouth bass foraging and spawning, bass may move out of Johnson Lake in search of deeper waters in which to overwinter.

4.3 COMPARISONS BETWEEN PAST AND CURRENT STUDIES

The ARCADIS *Site Investigation Report* (2004b) and the Grette Associates Johnson Lake Fish Tissue Monitoring Study Monitoring Report (2018) were reviewed to compare the results of the 2004 and 2017 studies to the 2022 results. Table 10 presents the available, comparable PCB data from those reports. Comparable PCB data from the 2004 Arcadis report is limited to Total PCB. It is important to note that the number of fillet and whole-body samples are not the same across all years, in addition to the species that were sampled and analyzed.

Table 10. Comparison of mean Total PCB concentrations from fillet and whole-body samples from 2004 to 2022. The Site investigation in 2004 was completed by ARCADIS, and the 2017 and 2022 results were collected by Grette Associates.

Sample Type	2004 ARCADIS MeanTotal PCB (µg/kg)	2017 MeanTotal PCB (µg/kg)	2022 MeanTotal PCB (µg/kg)
Fillet	200	199	64
Whole Body	260	106	168

Table 10 generally shows a declining trend in Total PCB concentrations from 2004 to 2022 in fish fillet tissue samples. Total PCB concentrations in whole body samples have decreased but show variability.

Total PCB data reported in the 2004 Arcadis report is a mean concentration across several species of fish. Furthermore, lipid data from the 2004 study were not reported, preventing a comparison of lipid-normal Total PCB across study years that include 2004.

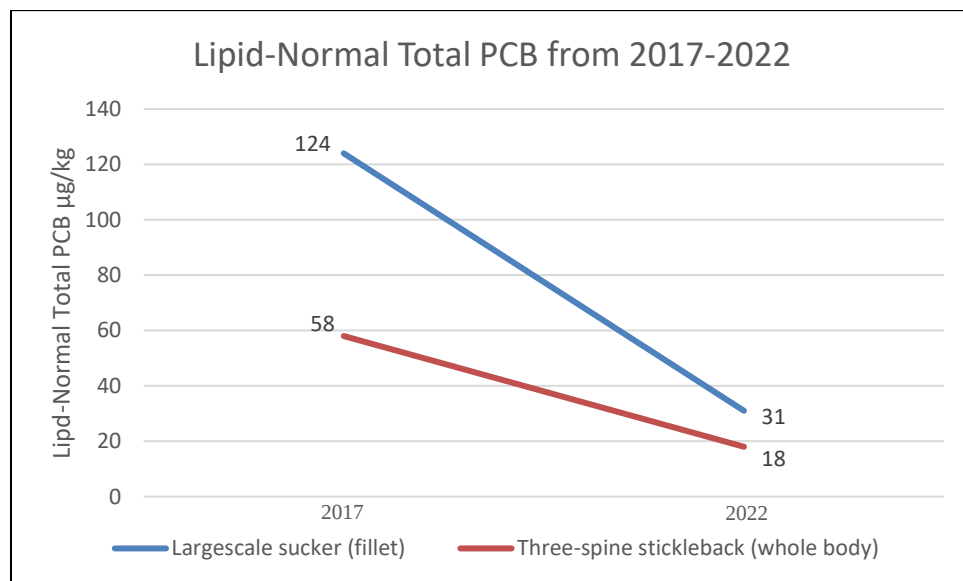
A more comprehensive comparison is possible for the samples collected in 2017 and 2022 (Table 11), as both years include analytical results for both PCB and lipid content. In both 2017 and 2022, largescale sucker and three-spine stickleback were the most common fish collected from Johnson Lake. The results of composites of these two species (sucker fillet and stickleback whole body) are presented in Table 11. These results show a decline in lipid-normal Total PCB from 2017 to 2022 across both species (Figure 3).

Table 11. Comparison of results from 2017 and 2022 for largescale sucker and three-spine stickleback.

2017						
Species	Mean Fork Length (mm)	Total PCB (µg/kg)	Lipid (%)	Lipid-Normal Total PCB (µg/kg)	PCB TEQ (µg/kg)	PCB Congener 126 (µg/kg) [ROD Standard 0.003 µg/kg]
Largescale sucker (fillet)	526	484	3.9	124	0.0176	0.135
Three-spine stickleback (whole body)	56 ¹	122	2.1	58	0.00446	0.034
2022						
Largescale sucker (fillet)	559	109	3.5	31	0.00287	0.026
Three-spine stickleback (whole body)	53	58	3.3	18	0.00156	0.014

¹ The composite whole body three-spine stickleback sample from 2017 included one sculpin. The sculpin had a fork length of 101 mm. Removing the sculpin fork length from the mean, the mean fork length of the three-spine stickleback in the composite sample was 46 mm.

Figure 3. Comparison of lipid-normal Total PCB from 2017 to 2022.



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JOHNSON LAKE FISH TISSUE MONITORING

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APPENDIX B: NMFS ELECTROFISHING GUIDELINES (2000)

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APPENDIX K: LABORATORY ANALYTICAL REPORT FOR LARGEMOUTH BASS

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APPENDIX L: APPROVED SAMPLING AND ANALYSIS PLAN