

SUMMARY REPORT

2017 Fish Sampling and Tissue Analysis for Waukegan Harbor Area of Concern

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Purpose

This document provides a summary of results for fish sampling activities performed in the Waukegan Harbor Area of Concern (AOC) as part of delisting efforts for the “Restriction on Fish and Wildlife Consumption” Beneficial Use Impairment (BUI). Included in this document are background information, project objectives, description of fish consumption advisories, sampling objectives, methods, outcomes, and tissue analysis results from the 2017 fish sampling season. Information collected during the 2017 sampling season will be used to assess the initial changes in contaminant levels following the 2012 and 2013 dredging of Waukegan Harbor by comparing the results of baseline pre-dredging sampling conducted in 2012 and post-dredging sampling conducted in 2015, 2016, and 2017. Tissue analysis data from sampling activities connected with the delisting efforts will be reviewed by the Fish Contaminant Monitoring Program (FCMP). FCMP will then provide additional data interpretations and recommendations for adjusting consumption advisory levels in Waukegan Harbor.

Distribution List

City of Waukegan

Illinois Department of Public Health

Illinois Department of Natural Resources

Illinois Environmental Protection Agency

US Environmental Protection Agency

Waukegan Harbor Citizens Advisory Group

Waukegan Port District

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Abbreviations and Acronyms

ASE	Accelerated Solvent Extraction
AOC	Area of Concern
BUI	Beneficial Use Impairment
FCMP	Fish Contaminant Monitoring Program
g	grams
IDNR	Illinois Department of Natural Resources
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
IJC	International Joint Commission
µg	microgram
mm	millimeters
OCM	Outboard Marine Corporation
PCB	Polychlorinated Biphenyl
ppm	parts per million
QAPP	Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

1. Background

Waukegan Harbor, located in northeastern Illinois, consists of a large, man-made commercial harbor (the north basin) and a recreational boat harbor (the south basin). The harbor abuts industrial, commercial, municipal, recreational, and vacant lands. Because of the harbor's proximity to industrial areas, in 1975, high levels of polychlorinated biphenyls (PCBs) were discovered in harbor sediments. The source of this pollution was linked to manufacturing activities at Outboard Marine Corporation (OMC), where hydraulic fluids containing PCBs were discharged into Waukegan Harbor (IEPA, 1999). Over 23 years, OMC released an estimated 300,000 pounds of PCBs into the harbor. Due to the contamination, in 1981, the International Joint Commission (IJC), U.S. Environmental Protection Agency (USEPA), and the Illinois Environmental Protection Agency (IEPA) designated the north basin of the harbor as an Area of Concern (AOC) (IEPA, 1999).

In conjunction with AOC listing, six beneficial use impairments (BUIs) were designated for Waukegan Harbor. BUIs indicate how contamination affects the chemical, physical, or biological integrity of a Great Lakes water body. The six impairments designated for Waukegan Harbor AOC were: 1) restrictions on fish and wildlife consumption, 2) degradation of benthos, 3) restrictions on dredging activities, 4) beach closings, 5) degradation of phytoplankton and zooplankton populations, and 6) loss of fish and wildlife habitat (USEPA, 2015). To date, four of the six BUIs have been removed (restrictions on dredging activities, beach closings, loss of fish and wildlife habitat, and degradation of benthos). Through several dredging efforts, outlined below, management actions for the AOC have been completed, and the harbor is now in the monitoring phase to assess lasting impacts of contamination and cleanup actions on the harbor's ecological and biological health.

Initial dredging of the Waukegan Harbor north basin, completed in 1993, reduced approximately 95% of the PCBs believed to be in the harbor (IEPA, 1999). In 2009, USEPA revised the acceptable PCB levels from the original 50 ppm PCB cleanup level to a new target clean up level of 0.5 ppm PCBs in sediment. Because of the change in clean up targets, USEPA and the U.S. Army Corps of Engineers (USACE) dredged the north basin at Waukegan Harbor again in 2012 and 2013 to address the remaining PCB sediment contamination.

This report is focused on fish contaminant monitoring to provide data towards decision making on the restrictions on fish and wildlife consumption BUI. To evaluate the effects of management actions in Waukegan Harbor on PCB levels in fish tissue, Illinois Department of Natural Resources (IDNR) has undertaken a pre- and post-dredging sampling approach in Waukegan Harbor and the non-contaminated reference sites of North Point Marina, IL and Jackson Harbor, IL (Figure 1). Some Waukegan Harbor species with consumption advisories are not routinely sampled for in the open waters of Lake Michigan, so a reference site is necessary to compare Waukegan Harbor fish to those from the lake at large. The fish species to be sampled in Waukegan Harbor are not generally characteristic of open lake habitat, therefore collection from North Point Marina and Jackson Harbor will act as the open lake reference sites. Like Waukegan Harbor, North Point Marina is a man-made harbor located on the

southwest shore of Lake Michigan, approximately 15 kilometers (km) north of Waukegan Harbor. If sufficient numbers of a particular species are not able to be collected at North Point Marina, Jackson Harbor will then be used to collect these species. Jackson Harbor, located on the south shore of Lake Michigan, is also a man-made non-commercial harbor. Because PCBs are responsible for Waukegan Harbor's designation as an Area of Concern, monitoring efforts highlighted in this report focus on this contaminant. IDNR developed a fish sampling plan and a quality assurance project plan (QAPP) with input from USEPA, IEPA, and Illinois Department of Public Health (IDPH) (Appendix A). The pre-dredging sampling was performed from May to July 2012 and the first round of post-dredging sampling was performed in summer 2015, with a second round in summer 2016, and a third round in summer 2017. If needed, additional sampling will occur on an annual basis.

Prior to pre-dredging sampling in 2012, IDPH placed fish consumption advisories on white sucker (*Catostomus commersonii*) and sunfish species (*Lepomis* spp.), with all sizes of both fish species restricted to one meal per month (IDPH, 2012). In 2012, IDNR collected fish tissue for contaminant analysis for these two listed species as well as black bullhead (*Ameiurus melas*) and rock bass (*Ambloplites rupestris*). Tissue analysis of these pre-dredging samples revealed that, in general, fish in Waukegan Harbor showed a higher level of PCB contamination than fish from the North Point Marina and Jackson Harbor reference sites, as would be expected. The average PCB concentrations in Waukegan Harbor fish were about 5 times greater for black bullhead, 30 times greater for rock bass, and 6.5 times greater for sunfish when compared to the reference sites. White suckers in Waukegan Harbor and the reference sites showed similar PCB levels, likely because the species is not a full-time resident of Waukegan Harbor (IDNR, 2013). According to IDNR fisheries biologists, white suckers frequently migrate between the open lake, shallow waters, and tributaries to spawn and are commonly caught in the open lake as well as all harbors surveyed in this report. Because they are not full-time residents of the harbor, PCB contaminants measured in white suckers are not representative of Waukegan Harbor alone and therefore will not be used in the evaluation of BUI removal. The data collected through the initial 2012 sampling effort filled existing sampling gaps and in 2013, IDPH had sufficient information to issue consumption advisories for rock bass of one meal per month and black bullhead of six meals per year, in addition to continuing the pre-existing advisories for white sucker and sunfish.

In the summer of 2015, IDNR performed the first year of post-dredging sampling to determine the effects of dredging activities on PCB levels in fish tissue. In general, PCB levels in fish from Waukegan Harbor were lower in 2015 than in 2012. Two consecutive years of data are required by the Fish Contaminant Monitoring Program (FCMP) before fish consumption advisories can be revised, therefore IDNR performed a second year of post-dredging sampling from June to October 2016. Because some of the 2016 fish tissue samples still showed elevated PCB levels in some sizes of sunfish, bass, and white sucker, IDNR performed a third year of post-dredging sampling from July to August 2017. IDNR again sampled at Waukegan Harbor, North Point Marina, and Jackson Harbor (Figure 1). This report provides results of the 2017 sampling and a comparison of the pre-dredging and post-dredging fish tissue analyses.

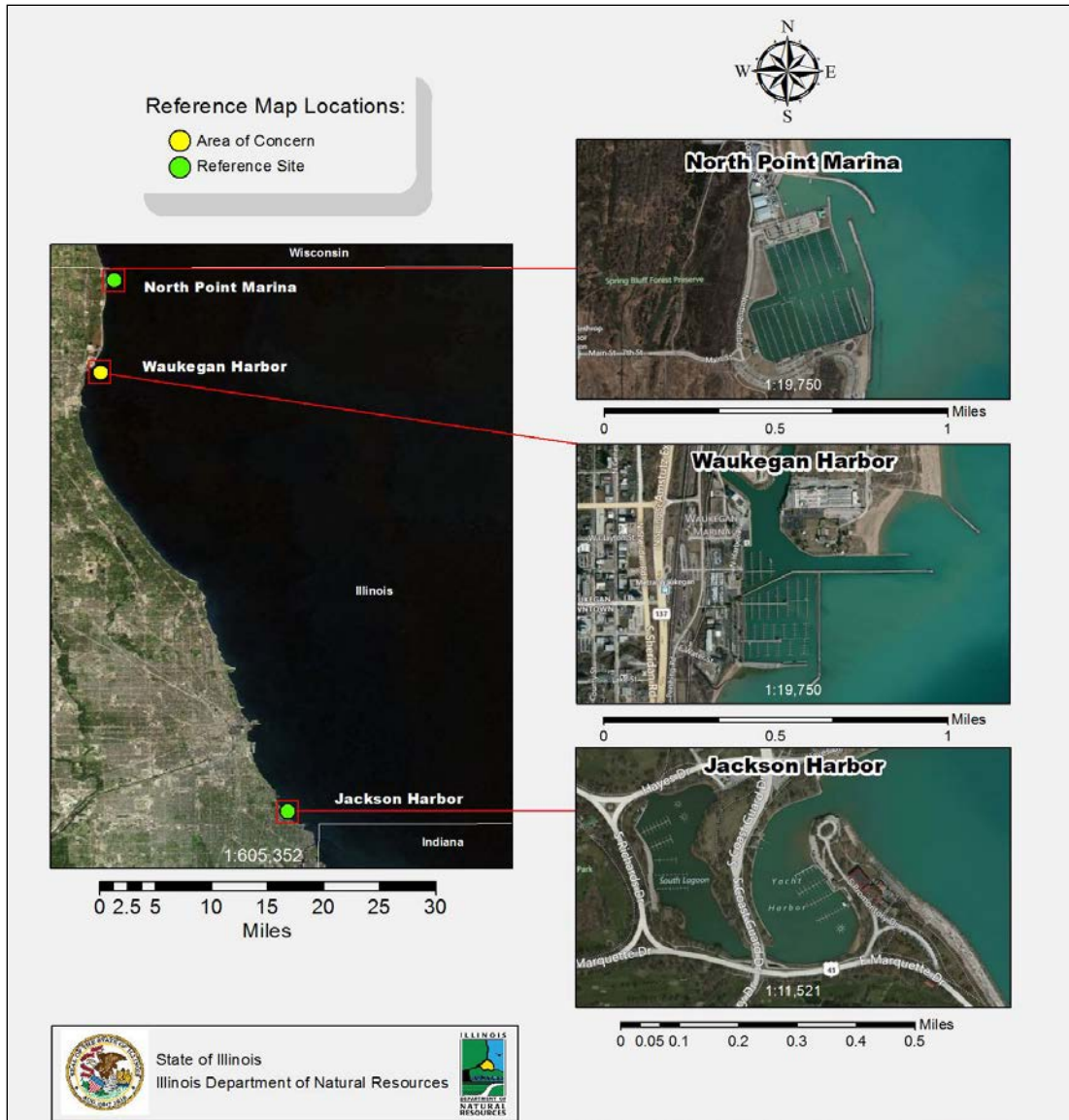


Figure 1: Waukegan Harbor AOC and North Point Marina and Jackson Harbor reference sites.

2. Project Goal and Objective

The goal of this project is to remove the fish consumption BUI from the Waukegan Harbor AOC. As described in the guidelines laid out in *Delisting Targets for the Waukegan Harbor Area of Concern: Final Report*, the fish consumption BUI can be considered for removal when fish consumption advisories in Waukegan Harbor are no more restrictive than advisories for the broader Illinois waters of Lake Michigan (Environmental Consulting & Technology, Inc., 2008). To evaluate advisory levels, we are taking a pre- and post-dredging approach. We will compare fish contaminant levels in 2012 pre-dredging samples with 2015, 2016, and 2017 (and beyond, if needed) post-dredging samples at Waukegan Harbor and the two reference sites (North Point Marina and Jackson Harbor), using the accepted Fish Consumption Advice Groups (Great Lakes Fish Advisory Task Force Protocol Drafting Committee, 1993) (Table 1). If the PCB contaminant levels at Waukegan Harbor result in the same Fish Consumption Advice

Group as the rest of the lake (as exemplified by the reference sites), the “Restriction on Fish and Wildlife Consumption” BUI meets the qualifications for removal.

PCB levels in fish tissue are a lagging indicator of water and sediment contamination levels because fish are relatively long-lived and persistent biological toxins such as PCBs tend to accumulate over the lifespan of the organism. We timed the initial post-dredging sampling efforts to allow for generational turnover in the species of interest, so the fish present in the harbor will be new cohorts that were not exposed prior to dredging. We also target smaller-sized and thus younger fish for all sampling efforts to target those fish that were not exposed to pre-dredging PCB levels.

3. Fish Consumption Advisories

The Illinois PCB fish advisories are grouped into five categories (Table 1). As mentioned previously, all sizes of sunfish, white sucker, and rock bass in Waukegan Harbor are restricted to one meal per month (0.23 -0.95 parts per million total PCBs) and black bullhead is restricted to six meals per year (0.96 – 1.9 parts per million total PCBs). Note that parts per million (ppm) used in the fish consumption advisories and microgram per gram ($\mu\text{g/g}$) reported in the fish tissue analyses are equivalent units of measure.

Consumption Advice Groups	Concentration of Total PCBs (ppm)
Unrestricted consumption	0 – 0.05
1 meal / week	0.06 – 0.22
1 meal / month	0.23 – 0.95
6 meals / year	0.96 – 1.9
Do not eat	>1.9

Table 1: Consumption advice groups for Total PCB aroclors, measured in parts per million (ppm) wet weight.

IDPH, IDNR, and IEPA collaborate on the posting of fish consumption advisories. IDNR samples fish species and IEPA processes the collected tissue samples. IDPH then draws from sample results to develop fish consumption advisories for public distribution. In 1989, a Memorandum of Agreement between these three state agencies established the Fish Contaminant Monitoring Program (FCMP), which convenes each year in late October to review and update the advisory information for Illinois sport fish.

FCMP prefers to assess fish consumption restrictions from a length versus concentration correlation, although most data sets are too small for such an approach. Thus, most decisions are based on whether the majority of the results fall into one consumption advice group (for example, 5 of 6 samples are one meal per week); if a clear break-point is evident in the results (for example, all samples less than 18 inches long are one meal per week and all samples greater than 18 inches long are one meal per month); or if the average contaminant concentration falls into a single consumption advice group. The last method typically applies to data sets such as panfish, where there is little size difference among the samples. After discussion, the FCMP members decide whether to accept the recommendation, modify it,

or determine that more data are needed before a decision can be made. It is expected that FCMP will use the same methods to evaluate the Waukegan AOC fish data.

4. Fish Sampling

A detailed fish sampling plan and Quality Assurance Project Plan was developed as part of the planning process. This plan guided Waukegan Harbor and Reference Site sampling activities along with sample processing and data analysis (Appendix A).

4.1 Sampling Objectives

The 2017 sampling plan identified the composition of target fish and the number of required samples, focusing on species resident to the harbor and fish with consumption advisories. This plan included the following sampling objectives:

- **Sunfish** (bluegill, pumpkinseed sunfish, green sunfish) (small, 125-150 millimeters): 3-4 composites (consisting of 3-5 fish each) at each site, as available
- **Sunfish** (bluegill, pumpkinseed sunfish, green sunfish) (medium, 180-200 millimeters): 3-4 composites (consisting of 3-5 fish each) at each site, as available
- **White sucker** (small, 140-200 millimeters): 3-4 composites (3-5 fish each) at each site, as available (because this species is not a full-time resident of the harbor, white sucker data will not be used in the evaluation of BUI removal)
- **White sucker** (medium, 225-350 millimeters): 3-4 composites (3-5 fish each) at each site, as available (because this species is not a full-time resident of the harbor, white sucker data will not be used in the evaluation of BUI removal)
- **Rock bass** (small, 125-150 millimeters): 3-4 composites (3-5 fish each) at each site, as available
- **Rock bass** (medium, 200-260 millimeters): 3-4 composites (3-5 fish each) at each site, as available
- **Black bullhead** (small, 150-200 millimeters): 3-4 composites (3-5 fish each) at each site, as available
- **Black bullhead** (medium, 240-300 millimeters): 3-4 composites (3-5 fish each) at each site, as available
- **Black bass** (smallmouth bass, largemouth bass) (small, 120-170 millimeters): 1 composite (3-5 fish) at each site, as available
- **Black bass** (smallmouth bass, largemouth bass) (medium, 180-230 millimeters): 1 composite (3-5 fish) at each site, as available
- **Black bass** (smallmouth bass, largemouth bass) (large, 235-280 millimeters): 1 composite (3-5 fish) at each site, as available

The number of composite samples to be collected by IDNR starting in 2015 was increased from the 2012 sampling season to obtain richer information about PCB levels in fish tissue. Since 2015, IDNR has collected three to four composites for each species with a fish consumption advisory, as compared to the one to two composites for the 2012 pre-dredging data. For each species, composites were generally grouped into two size categories (Table 2). As noted above, sunfish, white sucker, rock bass, and black bullhead consumption advisories are present specifically for Waukegan Harbor; therefore, the collection

of these four species was considered critical for delisting of the consumption advisories. Black bass do not have any consumption advisories, but collection of this species allows for further assessment of conditions in Waukegan Harbor fish as both species of black bass (smallmouth bass and largemouth bass) are generally shallow-water fish and can thus be indicators of water quality in confined areas.

4.2 Sampling Methods

IDNR fisheries staff performed sampling on the following dates and in the following locations:

- July 6, 2017 – Jackson Harbor
- July 31, 2017 – Waukegan Harbor (south basin)
- August 18, 2017 – North Point Marina
- August 23, 2017 – Waukegan Harbor (north basin)

As noted above, sampling locations included Waukegan Harbor and two reference sites, North Point Marina and Jackson Harbor. As with previous sampling efforts, when we were unable to collect enough samples of a particular target species at North Point Marina, we sampled at Jackson Harbor. We again adapted the 2012 methodology to include sampling in the recreational south basin of Waukegan Harbor, when needed. Fish routinely move between the two basins, and therefore fish caught in the south basin should be representative of Waukegan Harbor as a whole. IDNR kept any fish samples from the south basin separate from north basin samples. Maps of the areas sampled during sampling events can be found in this project's QAPP (Appendix A).

IDNR staff collected fish using a boat-mounted Smith-Root Model 5.0 GPP Pulsed-DC electrofishing unit, operated at 8 to 10 amps and 60 pulses per second. We sampled in all portions of the harbors where the water depth was less than three meters deep, as is appropriate with electrofishing methodology. Field staff dip-netted fish affected by the electric current and placed them in five-gallon buckets. The field staff paid particular attention to locating less-common target species including sunfish, black bullhead, and largemouth bass. IDNR identified most fish species in the water, and generally did not collect non-target species. Some non-target species were caught in the dip-net if we were unable to accurately identify them in the water, but we allowed the organisms to revive from the shock by placing them in a separate bucket. IDNR then released these non-target fish at the end of sampling. All target fish species were placed together in the five-gallon buckets.

After completing electrofishing, we separated all collected fish by species. We laid fish samples out on prep boards and grouped them together based on an initial size assessment, dividing fish roughly into two composite groups based on size for those species with enough fish to do so. We then measured the fish and adjusted the composites accordingly to ensure all fish in a composite were within 75% of the same length. We recorded the total length measurement for each fish, accurate to the nearest five millimeters (mm) as well as the weight, accurate to the nearest 10 grams (g). IDNR measured to the nearest five millimeters in length and the nearest 10 grams in weight to account for changing conditions in the field (e.g. windy conditions that may impact scale weights) and changes in the fish sampled as a result of environmental conditions (e.g. fin wear during spawning, how tightly the caudal fin is squeezed, how wet the fish is). To prepare the samples, we scaled the fish and removed the right-side fillet for

larger fish and used fillets from both sides for smaller fish. In all cases, skin-on fillets were collected. We targeted smaller fish to collect younger, post-dredging individuals, and as a result, we used both fillets in many cases in order to meet the minimum threshold for tissue amount to perform contaminant analysis. We then packaged together in aluminum foil composite samples of fillets from three to five fish for each species. Fish tissue in any species composite all used the same method (i.e. all right-side fillets or all fillets from both sides). As outlined in the QAPP for this effort (Appendix A), we used composites to reduce within-sample variability so we could draw clearer conclusions regarding differences between samples from Waukegan Harbor and our reference sites. We wrapped the composite sample packets with masking tape, labeled them, and transported them to an IDNR facility in a cooler with ice. IDNR held the samples at the facility freezer until we collected all the samples needed. After collecting all the composites, we transported the samples to IEPA’s laboratory for analysis.

4.3 Sampling Outcomes

We collected black bullhead, sunfish (bluegill and pumpkinseed sunfish), black bass (smallmouth bass and largemouth bass), rock bass, and white sucker at both Waukegan Harbor and the reference sites. Based on the results from 2012 sampling efforts, IDNR increased its sampling numbers in 2015 to better inform decision making on the restrictions on fish and wildlife consumption BUI. As noted in the project background of this report, Waukegan Harbor is a small, man-made harbor. Over half of the harbor is part of a federal navigation channel that is regularly dredged to maintain the required depth and both dredging activities and large ship movements disrupt ecological habitat. As a result, Waukegan Harbor generally experiences low productivity, which makes fish sampling a challenge. Dredging activities, including regular maintenance dredging and the environmental dredging completed as part of the AOC management measures, and disruption of bottom sediments from ship propellers remove habitat and vegetation particularly important for black bullhead and black bass species. IDNR routinely collects low numbers of both black bullhead and black bass in Waukegan Harbor for this reason, although we regularly collect full composites of this species at the reference sites. Table 2 provides details on the composites for each species, as well as the number of fish included in each composite. Additional details on average composite fish length and weight can be found in Tables 4 and 5.

Species and size class	Waukegan Harbor		Reference Sites	
	Number of fish in composite 1	Number of fish in composite 2	Number of fish in composite 1	Number of fish in composite 2
Black Bullhead (150-200 mm)	-	-	5	-
Black Bullhead (240-300 mm)	4	-	5	5
Sunfish (125-150 mm)	5	5	5	5
Sunfish (180-200 mm)	-	-	4	-
Black Bass (120-170 mm)	5	-	5	5
Black Bass (180-230 mm)	-	-	5	-
Black Bass (235-280 mm)	-	-	5	-
Rock Bass (125-150 mm)	4	-	5	5
Rock Bass (200-260 mm)	5	5	5	5
White Sucker (140-200 mm)	5	5	4	-
White Sucker (225-350 mm)	5	5	3	3

Table 2: Number of composite samples and individuals included for each species.

There are no fish consumption advisories for largemouth bass or smallmouth bass in Waukegan Harbor, but this species has been collected and analyzed previously as a part of regular monitoring in both Waukegan Harbor and North Point Marina. Because they are generally shallow water species, the black bass data gathered can inform our understanding of general contamination trends in the harbor and will be used as supporting data for the removal of the fish consumption BUI.

5. Tissue Analysis Results

All fish tissue samples were submitted to the IEPA laboratory in Springfield on October 13, 2017. IEPA processed and analyzed the samples per the procedures outlined in its Standard Operating Procedures, *Extraction Procedures for the Determination of Chlorinated Hydrocarbon and Polychlorinated Biphenyls (PCBs) in Fish Using Sonication Extraction or Accelerated Solvent Extraction (ASE)*, Reference Number ORL017-02-0900 and *Analysis Procedures for the Determination of Chlorinated Hydrocarbon Pesticides and Polychlorinated Biphenyls (PCBs) in Fish*, Reference Number ORL018-02-0900.

Results of the tissue analysis performed by IEPA are summarized in the tables below. Table 3 provides composite sample information and laboratory analysis results for fish collected in Waukegan Harbor while Table 4 provides the same information for the reference sites (North Point Marina and Jackson Harbor). For total PCBs, the reporting limit value was 0.05 µg/g while the method detection limit is 0.027 µg/g. Commonly, the reporting limit is defined as the smallest concentration of analyte that can be accurately measured by a laboratory and is based on the laboratory instrument's sensitivity. USEPA defines the method detection limit is defined as the "measured concentration at which there is 99% confidence that a given analyte is present in a given sample matrix" (CSC, 2005). Laboratory results that fall between the method detection limit and the reporting limit are estimated values and the validity of these values cannot be confirmed by the laboratory. As the tables below show, there were some instances of non-detect (ND) values for total PCBs in fish from the reference sites. In these instances, we assumed the non-detect value was half of the reporting limit of 0.05 µg/g, as is a standard practice, thus 0.025 µg/g was used for total PCB calculations involving ND values. Complete lab reports are attached in Appendix B.

It is important to note that for the analysis of samples in 2016 and 2017, the reporting limit was changed from 0.10 µg/g used in previous sampling years to 0.050 µg/g. The change was made because many of the 2015 total PCB levels for reference sites were below the reporting limit and therefore were reported as ND. For those samples, a standard calculated value was used for comparison purposes as there was no actual measured value. Following standard practice, ND values in 2012 and 2015 were treated as 0.05 µg/g, half of the reporting limit for sample analysis. For all samples in 2016 and beyond, ND values are treated as 0.025 µg/g, half of the reporting limit for sample analysis. This change makes comparisons across years slightly more difficult, but it brings greater accuracy to processed samples processed 2016, 2017, and all potential future sampling years.

Lab Sample ID	17J0727-01	17J0723-01	17J0724-01	17J0728-01	17J0721-01	17J0720-01	17J0725-01	17J0719-01	17J0718-01	17J0716-01	17J0722-01
DNR Sample ID	09458	09454	09455	09459	09452	09451	09456	09450	09449	09448	09453
Location	Waukegan South	Waukegan North	Waukegan North	Waukegan South	Waukegan North	Waukegan North	Waukegan North	Waukegan North	Waukegan North	Waukegan North	Waukegan North
Fish Species Length Group (mm)	Black Bullhead 240-300	Sunfish 125 – 150	Sunfish 125 – 150	Black Bass 120 – 170	Rock Bass 125 – 150	Rock Bass 200 – 260	Rock Bass 200 – 260	White Sucker 140 – 200	White Sucker 140 – 200	White Sucker 225 – 350	White Sucker 225 – 350
Count of Individuals	4	5	5	5	4	5	5	5	5	5	5
Avg. Length (mm)	243	138	137	141	135	233	202	170	178	256	258
Avg. Weight (g)	299	65	59	32	41	264	159	49	61	188	178
% Lipid Content	0.54	0.38	0.33	0.63	0.14	0.41	0.50	0.42	0.55	0.47	0.45
Total PCBs	0.091	0.19	0.11	0.20	0.046	0.29	0.18	0.054	0.10	0.14	0.13
Consumption Advice Group	1 meal/week	1 meal/week	1 meal/week	1 meal/week	unrestricted	1 meal/month	1 meal/week	unrestricted	1 meal/week	1 meal/week	1 meal/week

Table 3: 2017 Waukegan Harbor fish composites and tissue analysis results.

Lab Sample ID	17J0742-01	17J0741-01	17J0744-01	17J0738-01	17J0739-01	17J0743-01	17J0737-01	17J0736-01	17J0735-01	17J0740-01	17J0729-01	17J0734-01	17J0732-01	17J0733-01	17J0726-01	17J0730-01	17J0731-01	
DNR Sample ID	09473	09472	09477	09469	09470	09474	09468	09467	09466	09471	09460	09465	09463	09464	09457	09461	09462	
Location	Jackson Harbor	Jackson Harbor	Jackson Harbor	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	North Point Marina	
Fish Species Length Group	Black Bullhead 150 – 200	Black Bullhead 240 – 300	Black Bullhead 240 – 300	Sunfish 125 – 150	Sunfish 125 – 150	Sunfish 180 – 200	Black Bass 120 – 170	Black Bass 120 – 170	Black Bass 180 – 230	Black Bass 235 – 280	Rock Bass 125 – 150	Rock Bass 125 – 150	Rock Bass 200 – 260	Rock Bass 200 – 260	White Sucker 140 – 200	White Sucker 225 – 350	White Sucker 225 – 350	
Count of Individuals	5	5	5	5	5	4	5	5	5	5	5	5	5	5	4	3	3	
Avg. Length (mm)	173	280	278	138	135	184	145	148	206	257	142	136	236	232	165	297	288	
Avg. Weight (g)	60	257	280	57	55	161	39	46	113	296	57	52	324	308	43	302	271	
% Lipid Content	0.89	0.85	1.1	0.32	0.39	0.79	0.50	0.53	0.58	1.0	0.57	0.44	0.43	0.5	1.0	0.67	0.79	
Total PCBs	0.12	0.098	0.089	ND	ND	0.15	ND	0.032	0.038	ND	0.030	ND	0.071	0.038	0.046	0.033	0.031	
Consumption Advice Group	1 meal/week	1 meal/week	1 meal/week	unrestricted	unrestricted	1 meal/week	unrestricted	unrestricted	unrestricted	unrestricted	unrestricted	unrestricted	unrestricted	unrestricted	1 meal/week	unrestricted	unrestricted	unrestricted

Table 4: 2017 reference site fish composites and tissue analysis results.

ND: Analyte NOT DETECTED at or above the reporting limit. Standard practice for ND values is to assume total PCBs are half the reporting limit (0.05 µg/g), and are assumed to be 0.025 µg/g.

5.1 2017 Data Results

In general, fish from Waukegan Harbor continue to show higher levels of PCB contamination than fish from the reference sites. Due to a small sample size, statistical tests were not performed. As noted in the methodology section above, in some cases contaminant levels were very low and the lab instruments were unable to detect a value for analyte results (reported as non-detect, ND). For ND values of total PCBs, we assumed the analyte value was half the reporting limit, or 0.025 µg/g, as is standard practice.

- A single composite of medium-sized black bullhead (240-300 mm) from Waukegan Harbor contained 0.091 micrograms/gram (µg/g) total PCBs, similar to the average of 0.0935 µg/g total PCBs in two medium-sized black bullhead composites from the reference sites.
- Two small-sized sunfish (125-150 mm) composites from Waukegan Harbor averaged 0.15 µg/g of total PCBs, about 6 times higher than the average of 0.025 µg/g of total PCBs in two small-sized sunfish composites from the reference sites. Note: both reference site composites were recorded as non-detect values, so a value of 0.025 µg/g was used for this calculation.
- Small-sized black bass (120-170 mm) from Waukegan Harbor contained 0.20 µg/g total PCBs, about 7 times higher than the average of 0.0285 µg/g total PCBs in two small-sized black bass composites from the reference sites. Note: one reference site composite was recorded as a non-detect value, so a value of 0.025 µg/g was used for this calculation.
- Small-sized rock bass (125-150 mm) from Waukegan Harbor contained 0.046 µg/g total PCBs, about 1.5 times higher than the average of 0.0275 µg/g of total PCBs in two small-sized rock bass composites from the reference sites. Note: one reference site composite was recorded as a non-detect value, so a value of 0.025 µg/g was used for this calculation, as is standard practice.
- Two composites of medium-sized rock bass (200-260 mm) from Waukegan Harbor contained an average of 0.235 µg/g of total PCBs, about 4 times higher than the average of 0.0545 µg/g total PCBs in two composites of medium-sized rock bass from the reference sites.
- Two composites of small-sized white sucker (140-200 mm) from Waukegan Harbor averaged 0.077 µg/g of total PCBs, about 1.7 times higher than 0.046 µg/g of total PCBs in one composite of small-sized white sucker from the reference sites.
- Two composites of medium-sized white sucker (225-350 mm) from Waukegan Harbor averaged 0.135 µg/g of total PCBs, about 4 times higher than the average of 0.032 µg/g total PCBs in two composites of medium-sized white suckers from the reference sites.

The raw averages of all species of Waukegan Harbor fish as compared to all species of fish from the reference sites, while a crude estimate, shows that Waukegan Harbor fish at an average of 0.139 µg/g contain about 2.6 times higher total PCBs than the average amount of total PCBs in all fish species from the reference sites at 0.053 µg/g, assuming the non-detect value is half the reporting limit.

Fish Consumption Advisories

- The single black bullhead composite from Waukegan Harbor falls into the one meal per week fish consumption advisory category (0.06 – 0.22 µg/g). In 2016, a single black bullhead composite also fell within the one meal per week fish consumption advisory category. The current listed advisory for black bullhead is six meals per year.
- Both small-sized sunfish (125-150 mm) composites from Waukegan Harbor both fall into the one meal per week fish consumption advisory category. In 2016, one small-sized sunfish composite from Waukegan Harbor fell in the one meal per month fish consumption advisory category (0.23 – 0.95 ppm) while the other composite fell in the one meal per week fish consumption advisory category. The current listed advisory for sunfish is one meal per month.
- The single small-sized black bass (120-170 mm) composite from Waukegan Harbor falls into the one meal per week fish consumption advisory category. In 2016, the two small-sized black bass composites from Waukegan Harbor also fell in the one meal per week fish consumption advisory. There is currently no listed fish consumption advisory for largemouth or smallmouth bass.
- The single composite of small-sized rock bass (125-150 mm) from Waukegan Harbor falls into the unrestricted fish consumption advisory category (0 – 0.05 ppm). One of the large-sized rock bass (200-260 mm) composites from Waukegan Harbor falls into the one meal per week fish consumption advisory category, while the other large-sized composite falls into the one meal per month fish consumption advisory category. In 2016, all rock bass composites fell into the one meal per week fish consumption advisory category. The current listed advisory for rock bass is one meal per month.
- One composite of small-sized white sucker (140-200 mm) from Waukegan Harbor falls into the unrestricted fish consumption advisory category, while the other small-sized composite falls into the one meal per week category. Both composites of medium-sized white sucker (225-350 mm) from Waukegan Harbor fall into the one meal per week fish consumption advisory category. In 2016, one small-sized composite of white sucker from Waukegan Harbor fell into the one meal per week fish consumption advisory category while the other composite fell into the one meal per month fish consumption advisory category. Both Waukegan Harbor medium-sized white sucker composites from 2016 fell into the one meal per month fish consumption advisory category. The current listed advisory for white sucker is one meal per month.

Fish tissue data from 2012 pre-dredging sampling through the 2017 sampling year are summarized below in Figure 2 and Figure 3 for Waukegan Harbor and the reference sites, respectively.

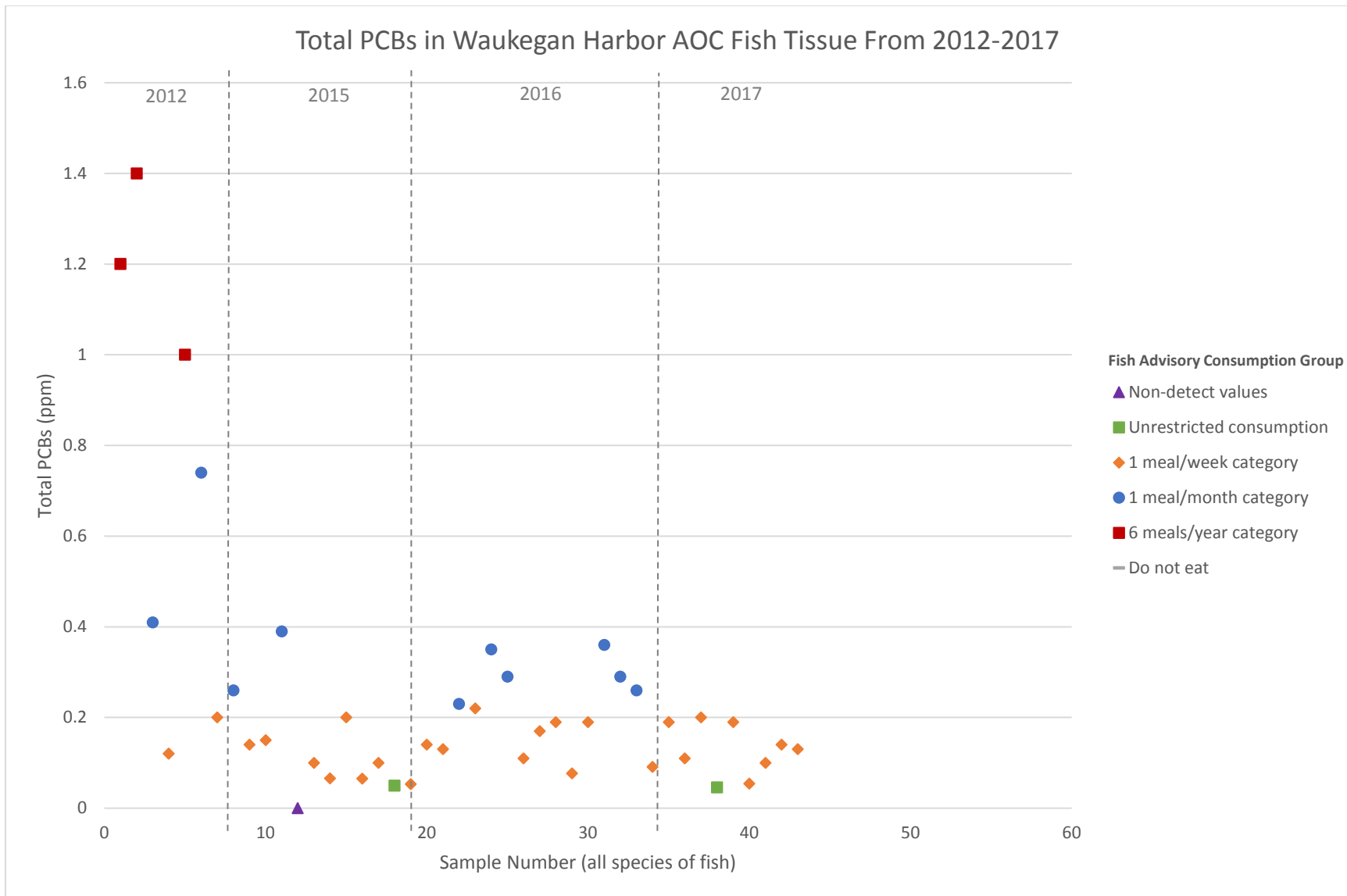


Figure 2: Summary chart representing pre- and post-dredging total PCB concentrations in Waukegan Harbor fish tissue. Dashed lines denote sampling years and shape and color indicates fish consumption advisory levels. Current Waukegan Harbor fish consumption advisories are as follows: Black Bullhead – 6 meals/year, Sunfish – 1 meal/month, Rock Bass – 1 meal/month, White Sucker – 1 meal/month.

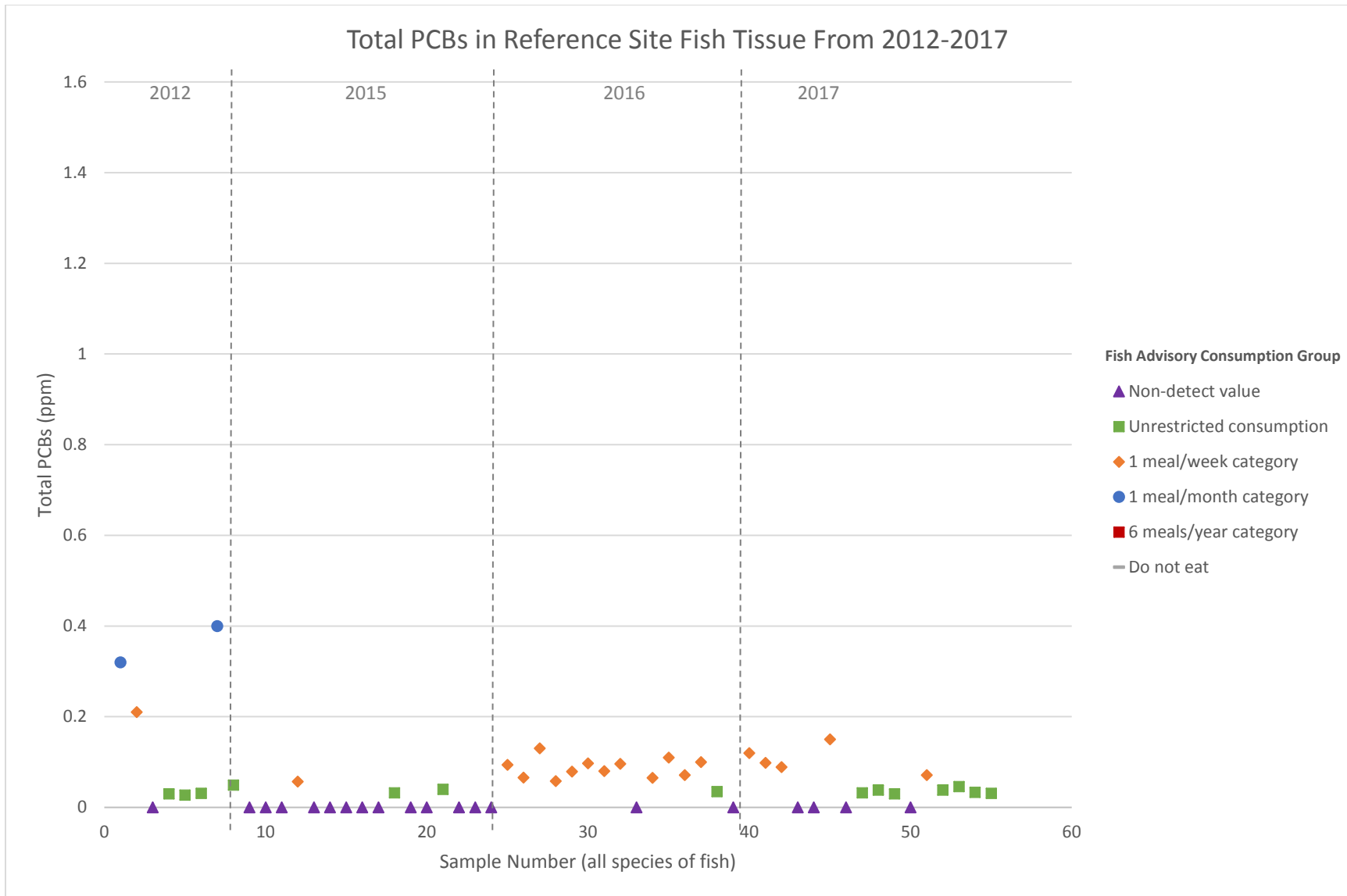


Figure 3: Summary chart representing 2012 through 2017 total PCB concentrations in reference site fish tissue. Dashed lines denote sampling years and shape and color indicates fish consumption advisory levels. Current Waukegan Harbor fish consumption advisories are as follows: Black Bullhead – 6 meals/year, Sunfish – 1 meal/month, Rock Bass – 1 meal/month, White Sucker – 1 meal/month.

Length and Lipid Concentration versus Total PCB Concentrations

PCB concentrations are typically directly related to length and lipid concentrations¹ and need to be interpreted accordingly. The above comparisons are generalized statements based on average values, without accounting for lipid content. However, there are three comparisons from the 2017 sampling year in which the Waukegan Harbor and reference site composites are most similar with respect to length and lipid content, therefore allowing for direct comparison of PCB levels (summarized in Table 5).

2017						
	<i>Waukegan Harbor</i>	<i>North Point Marina</i>	<i>Waukegan Harbor</i>	<i>North Point Marina</i>	<i>Waukegan Harbor</i>	<i>North Point Marina</i>
Fish Species	Sunfish	Sunfish	Black Bass	Black Bass	Rock Bass	Rock Bass
Average Length (mm)	137	138	141	148	233	236
Lipid Content (%)	0.33	0.32	0.63	0.53	0.41	0.43
Total PCBs (µg/g)	0.11	ND*	0.20	0.032	0.29	0.071
Consumption Advice Group	1 meal/week	unrestricted	1 meal/week	unrestricted	1 meal/month	1 meal/week

Table 5: Summary of 2017 composite samples from Waukegan Harbor and reference sites compared by lipid content and total PCBs. *Standard practice for non-detect values is to assume total PCBs are half the reporting limit (0.05 µg/g), or 0.025 µg/g.

Waukegan Harbor 137-mm sunfish sample with 0.33% lipid content (lab sample ID 17J0724-01) and North Point Marina 138-mm sunfish sample with 0.32% lipid content (lab sample ID 17J0738-01).

- The Waukegan Harbor sample contained 0.11 µg/g of total PCBs, while the North Point Marina sample came back as a non-detect value. For this comparison, we assume the non-detect value is half the reporting limit, or 0.025 µg/g, thus the Waukegan Harbor sample contained 4.4 times higher total PCBs than the reference sample. In a comparison of similarly-sized sunfish samples with comparable lipid content across multiple sample years, the Waukegan Harbor sample contained 2.4 times higher total PCBs than those from the reference site in 2016 and 3 times higher total PCBs in 2015. (Table 6)

¹ Larger fish, with a longer growth time, generally exhibit greater PCB concentrations. See SB Gewurtz, SP Bhavsar, and R Fletcher. 2011. Influence of fish size and sex on mercury/PCB concentration: Important for fish consumption advisories. *Environment International* 37(2): 425-434.

	2017		2016		2015	
	<i>Waukegan Harbor</i>	<i>North Point Marina</i>	<i>Waukegan Harbor</i>	<i>North Point Marina</i>	<i>Waukegan Harbor</i>	<i>North Point Marina</i>
Lab Sample ID	17J0724-01	17J0738-01	17A0114-01	17A0109-01	SK50737-01	SK50388-01
Fish Species	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish
Average Length (mm)	137	138	130	128	128	131
Lipid Content (%)	0.33	0.32	0.27	0.35	0.16	0.17
Total PCBs (µg/g)	0.11	ND*	0.23	0.097	0.15	ND**
Consumption Advice Group	1 meal/week	unrestricted	1 meal/month	1 meal/week	1 meal/week	unrestricted

Table 6: Comparison of sunfish (bluegill, pumpkinseed sunfish, green sunfish) samples from Waukegan Harbor and reference sites by lipid content and total PCBs across multiple sampling years. *For 2017, a non-detect value is assumed to be half the reporting limit (0.05 µg/g), or 0.025 µg/g. **For 2015, a non-detect value is assumed to be half the reporting limit (0.10 µg/g), or 0.05 µg/g.

Waukegan Harbor 141-mm black bass sample with 0.63% lipid content (lab sample ID 17J0728-01) and North Point Marina 148-mm black bass sample with 0.53% lipid content (lab sample ID 17J0736-01).

- The Waukegan Harbor sample contained 0.20 µg/g of total PCBs, while the North Point Marina sample contained 0.032 µg/g of total PCBs, therefore the Waukegan Harbor sample contained 6.3 times higher total PCBs than the reference sample. In a comparison of similarly-sized black bass samples with comparable lipid content across multiple sample years, the Waukegan Harbor sample contained 14 times higher total PCBs than those from the reference site in 2016 and 1.6 times higher total PCBs in 2015. (Table 7)

	2017		2016		2015	
	<i>Waukegan Harbor</i>	<i>North Point Marina</i>	<i>Waukegan Harbor</i>	<i>North Point Marina</i>	<i>Waukegan Harbor</i>	<i>North Point Marina</i>
Lab Sample ID	17J0728-01	17J0736-01	17A0117-01	17A0119-01	SK50727-01	SK50732-01
Fish Species	Black Bass	Black Bass	Black Bass	Black Bass	Black Bass	Black Bass
Average Length (mm)	141	148	205	210	247	258
Lipid Content (%)	0.63	0.53	0.40	0.45	0.18	0.21
Total PCBs (µg/g)	0.20	0.032	0.35	ND*	ND**	0.032***
Consumption Advice Group	1 meal/week	unrestricted	1 meal/month	unrestricted	unrestricted	unrestricted

Table 7: Comparison of black bass (largemouth bass, smallmouth bass) samples from Waukegan Harbor and reference sites by lipid content and total PCBs across multiple sampling years. *For 2016, a non-detect value is assumed to be half the reporting limit (0.05 µg/g), or 0.025 µg/g. **For 2015, a non-detect value is assumed to be half the reporting limit (0.10 µg/g), or 0.05 µg/g. ***Estimated value. The laboratory cannot support the validity of this number because the result is between the method detection limit and the reporting limit.

Waukegan Harbor 233-mm rock bass sample with 0.41% lipid content (lab sample ID 17J0720-01) and North Point Marina 236-mm rock bass sample with 0.43% lipid content (lab sample ID 17J0732-01).

- The Waukegan Harbor sample contained 0.29 µg/g of total PCBs, while the North Point Marina sample contained 0.071 µg/g of total PCBs, therefore the Waukegan Harbor sample contained 4.1 times higher total PCBs than the reference sample. In a comparison of similarly-sized rock bass samples with comparable lipid content across multiple sample years, the Waukegan Harbor sample contained comparable total PCBs than those from the reference site in 2016 and 5 times higher total PCBs in 2015. (Table 8)

	2017		2016		2015	
	Waukegan Harbor	North Point Marina	Waukegan Harbor	North Point Marina	Waukegan Harbor	North Point Marina
Lab Sample ID	17J0720-01	17J0732-01	17A0115-01	17A0101-01	SK50736-01	SK50387-01
Fish Species	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass
Average Length (mm)	233	236	220	232	226	227
Lipid Content (%)	0.41	0.43	0.22	0.27	0.22	0.11
Total PCBs (µg/g)	0.29	0.071	0.077	0.071	0.20	0.040*
Consumption Advice Group	1 meal/month	1 meal/week	1 meal/week	1 meal/week	1 meal/week	unrestricted

Table 8: Comparison of rock bass samples from Waukegan Harbor and Reference Sites by lipid content and total PCBs across multiple sampling years. *Estimated value, the laboratory cannot support the validity of this number because the result is between the method detection limit and the reporting limit.

5.2 Comparison of Pre- and Post-Dredging Data

As noted above, total PCB levels remain elevated in tissue samples from Waukegan Harbor as compared to those from the reference sites. However, except for one composite of rock bass from Waukegan Harbor, all composites for all species fell in the same or a less stringent fish consumption advice category. When comparing 2017 post-dredging data with 2012 pre-dredging data, 2017 total PCB levels in fish from Waukegan Harbor are significantly lower.

Sunfish (bluegill, pumpkinseed sunfish, green sunfish) (Table 9)

- In 2017, 125-150 mm sunfish from Waukegan Harbor averaged 0.15 µg/g total PCBs, 6 times higher than the average total PCBs in reference site sunfish.
- In 2016, Waukegan Harbor sunfish from the same size class averaged 0.18 µg/g, 2.0 times higher than those from reference sites.
- In 2015, total PCBs from Waukegan Harbor sunfish were 2.9 times greater than those from reference sites.
- In 2012, pre-dredging total PCBs from Waukegan Harbor sunfish with an average length of 128.5 mm were 6.6 times higher than 162.5 mm average-length sunfish from the reference sites.

Waukegan Harbor				
	2017	2016	2015	2012
Fish Species	Sunfish	Sunfish	Sunfish	Sunfish
Count of Individuals in Composite	10	10	8	10
Avg. Length (mm)	137.5	127.5	130.5	128.5
Avg. Weight (g)	62	32.5	43.5	49
Avg. Total PCBs	0.15	0.18	0.145	0.265
Consumption Advice Group	1 meal/week	1 meal/week	1 meal/week	1 meal/month

Reference Sites					
	2017	2017	2016	2015	2012
Fish Species	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish
Count of Individuals in Composite	10	4	10	10	10
Avg. Length (mm)	136.5	184	133	133.5	162.5
Avg. Weight (g)	56	161	42	49.5	88
Avg. Total PCBs	ND*	0.15	0.088	ND**	0.04***
Consumption Advice Group	unrestricted	1 meal/week	1 meal/week	unrestricted	unrestricted

Table 9: Comparison of 2017, 2016, 2015, and 2012 total PCBs for Waukegan Harbor and reference site sunfish samples. * For 2017, a non-detect value is assumed to be half the reporting limit (0.05 µg/g), or 0.025 µg/g. ** For 2015, a non-detect value is assumed to be half the reporting limit (0.10 µg/g), or 0.05 µg/g. *** Estimated value, the result is between the method detection limit and the reporting limit.

Black Bass (smallmouth bass, largemouth bass) (Table 10)

- In 2017, Waukegan Harbor black bass averaged 0.20 µg/g total PCBs for a composite with a length between 120-170 mm, 7.0 times higher than small-length composites from the reference sites.
- In 2016, Waukegan Harbor black bass from the same size class averaged 0.22 µg/g total PCBs, 2.5 times higher than the reference site average for the same size class. Medium-length composites with lengths between 180-230 mm contained 14 times higher average total PCBs than the reference site averages from the same size class.
- In 2015, Waukegan Harbor black bass average total PCBs were 7.8 times and 5.6 times greater than the reference site averages for the small- and large-length composites, respectively.
- No comparisons of largemouth bass can be made between 2017 and 2012 because there were no black bass collected in 2012.

Waukegan Harbor								
	2017	2016	2016	2016	2015	2015		
Fish Species	Black Bass	Black Bass	Black Bass	Black Bass	Black Bass	Black Bass		
Count of Individuals in Composite	5	1	2	5	4	3		
Avg. Length (mm)	141	170	205	264	165	247		
Avg. Weight (g)	32	70	125	278	59	237		
Avg. Total PCBs	0.20	0.22	0.35	0.2	0.39	0.18		
Consumption Advice Group	1 meal/week	1 meal/week	1 meal/month	1 meal/week	1 meal/month	1 meal/week		
Reference Sites								
	2017	2017	2017	2016	2016	2015	2015	2015
Fish Species	Black Bass	Black Bass	Black Bass	Black Bass	Black Bass	Black Bass	Black Bass	Black Bass
Count of Individuals in Composite	10	5	5	10	4	9	4	5
Avg. Length (mm)	146.5	206	257	138.5	210	139.5	211	258
Avg. Weight (g)	42.5	113	296	43	155	39	150	241
Avg. Total PCBs	0.0285	0.038	ND*	0.088	ND	ND	ND	0.032**
Consumption Advice Group	unrestricted	unrestricted	unrestricted	1 meal/week	unrestricted	unrestricted	unrestricted	unrestricted

Table 10: Comparison of 2017, 2016, 2015, and 2012 total PCBs for Waukegan Harbor and reference site black bass samples. *For 2017, a non-detect value is assumed to be half the reporting limit (0.05 µg/g), or 0.025 µg/g. **Estimated value, the result is between the method detection limit and the reporting limit.

Rock Bass (Table 11)

- In 2017, Waukegan Harbor rock bass averaged 0.046 µg/g for composites with a length between 125-150 mm and 0.235 µg/g for composites with a length between 200-260 mm, 1.7 times higher and 4.3 times higher than the reference sites, respectively.
- In 2016, Waukegan Harbor rock bass from the same size classes averaged 0.18 µg/g total PCBs for small-length composites and 0.077 µg/g for large-length composites, 2.1 times higher and slightly lower than the reference site small- and large-length composites, respectively.
- In 2015, average total PCBs from Waukegan Harbor small-length rock bass were 7.6 times higher than those from the reference sites and average total PCBs from large-length composites were 5 times higher than those from the reference sites.
- In 2012, a pre-dredging Waukegan Harbor rock bass composite with an average length of 150 mm contained 37 times higher total PCBs than a 170-mm composite from the reference sites and a 173-mm average length composite from Waukegan Harbor contained 24 times higher total PCBs than a 195-mm average length composite from the reference sites.

Waukegan Harbor								
	2017	2017	2016	2016	2015	2015	2012	2012
Fish Species	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass
Count of Individuals in Composite	4	10	10	4	10	5	5	5
Avg. Length (mm)	135	217.5	136	220	136	226	150	173
Avg. Weight (g)	41	211.5	53	236	51	251	80	130
Avg. Total PCBs	0.046	0.235	0.18	0.077	0.38	0.20	1.0	0.74
Consumption Advice Group	unrestricted	1 meal/month	1 meal/week	1 meal/week	1 meal/month	1 meal/week	6 meals/year	1 meal/month
Reference Sites								
	2017	2017	2016	2016	2015	2015	2012	2012
Fish Species	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass	Rock Bass
Count of Individuals in Composite	10	10	10	10	10	10	5	5
Avg. Length (mm)	139	234	136.5	231	145.5	249	170	195
Avg. Weight (g)	54.5	316	60	338	69.5	261	87	147
Avg. Total PCBs	0.0275	0.0545	0.0875	0.0855	ND*	0.040**	0.027**	0.031**
Consumption Advice Group	unrestricted	unrestricted	1 meal/week	1 meal/week	unrestricted	unrestricted	unrestricted	unrestricted

Table 11: Comparison of 2017, 2016, 2015, and 2012 total PCBs for Waukegan Harbor and reference site rock bass samples. *For 2015, a non-detect value is assumed to be half the reporting limit (0.10 µg/g), or 0.05 µg/g. **Estimated value, the result is between the method detection limit and the reporting limit.

Black Bullhead (Table 12)

- In 2017, Waukegan Harbor black bullhead averaged 0.091 µg/g for a composite with a length between 240-300 mm, comparable to the large-length composites from the reference sites.
- In 2016, Waukegan Harbor black bullhead from a smaller size class averaged 0.14 µg/g, 1.75 times higher than small-length composites from the reference sites
- In 2015, no comparisons could be made between black bullhead from Waukegan Harbor and black bullhead from the reference sites because no black bullhead were collected from Waukegan Harbor.
- In 2012, a pre-dredging black bullhead composite averaging 202 mm contained 5.7 times higher total PCBs than a 243-mm average composite from the reference site and a 255-mm average composite from Waukegan Harbor contained 4.4 times higher total PCBs than a 271-mm average composite from the reference sites.

Waukegan Harbor								
	2017	2016	2015	2012	2012			
Fish Species	Black Bullhead	Black Bullhead	Black Bullhead	Black Bullhead	Black Bullhead			
Count of Individuals in Composite	4	2	n/a	3	3			
Avg. Length (mm)	243	200	n/a	202	255			
Avg. Weight (g)	299	155	n/a	180	332			
Avg. Total PCBs	0.091	0.14	n/a	1.2	1.4			
Consumption Advice Group	1 meal/week	1 meal/week	n/a	6 meals/year	6 meals/year			
Reference Sites								
	2017	2017	2016	2016	2015	2015	2012	2012
Fish Species	Black Bullhead	Black Bullhead	Black Bullhead	Black Bullhead	Black Bullhead	Black Bullhead	Black Bullhead	Black Bullhead
Count of Individuals in Composite	5	10	10	10	10	10	4	5
Avg. Length (mm)	173	279	189.5	263	177.5	269.5	243	271
Avg. Weight (g)	60	268.5	102	346	86	354	225	308
Avg. Total PCBs	0.12	0.0935	0.08	0.094	ND*	0.057**	0.21	0.32
Consumption Advice Group	1 meal/week	1 meal/week	1 meal/week	1 meal/week	unrestricted	1 meal/week	1 meal/week	1 meal/month

Table 12: Comparison of 2017, 2016, 2015, and 2012 total PCBs for Waukegan Harbor and reference site rock bass samples. *For 2015, a non-detect value is assumed to be half the reporting limit (0.10 µg/g), or 0.05 µg/g. **Estimated value, the result is between the method detection limit and the reporting limit.

White suckers are not known to be full-time residents of Waukegan Harbor, so while examining data related to this species of fish is useful for discerning general lake trends, for the purpose of removing the fish and wildlife consumption BUI from Waukegan Harbor, data related to white sucker will not be used. The 2017 raw averages of total PCBs for all species of Waukegan Harbor fish, excluding white sucker is 0.158 µg/g, 2.7 times higher than the average total PCBs of 0.058 µg/g for all species of reference site fish, again excluding white sucker. In 2016, the average total PCBs of all species of Waukegan Harbor fish, excluding white sucker, was 0.191 µg/g, 2.3 times higher than the amount of total PCBs in all fish species from the reference sites, excluding white sucker, which averaged 0.082 µg/g. In 2015, the averages of all species of Waukegan Harbor fish, excluding white sucker, as compared to that of the reference sites, shows that Waukegan fish at 0.145 µg/g have 3.0 times the amount of PCBs as the reference sites at 0.049 µg/g. In 2012, average total PCBs for all Waukegan fish, excluding white sucker, at 0.812 µg/g, had 7.3 times higher total PCBs as the reference sites at 0.111 µg/g. While a crude estimate, this again shows a decline in PCB contamination since environmental dredging activities occurred (Table 13).

	2017	2016	2015	2012
Avg. Total PCBs, all Waukegan Harbor fish species ($\mu\text{g/g}$)	0.139	0.215	0.119	0.666
Avg. Consumption Advice Group	1 meal/ week	1 meal/ week	1 meal/ week	1 meal/ month
Avg. Total PCBs, all reference site fish species ($\mu\text{g/g}$)	0.053	0.075	0.088	0.140
Avg. Consumption Advice Group	unrestricted	1 meal/ week	1 meal/ week	1 meal/ week

Table 13: Comparison of average total PCBs for all species of fish (excluding white sucker as they are not full residents of the harbor) for 2017, 2016, 2015, and 2012 sampling years for Waukegan Harbor and reference sites, along with corresponding fish consumption advice group.

6. Summary

Fish collected during the 2017 post-dredging sampling activities included black bullhead, sunfish, black bass, rock bass, and white sucker. In general, samples from Waukegan Harbor contained higher levels of total PCB contamination than samples from reference sites, except for one composite sample of black bullhead, which contained a similar total PCB level. Approximately 70% of the composites taken from Waukegan Harbor in 2017 contain lower average PCB levels that comparable samples from 2016 (excluding white sucker, which are not used in the data analysis for this BUI), but concrete conclusions cannot be drawn based on length classes alone as PCB bioaccumulation is positively correlated to lipid content. When comparing species composites of similar size and lipid content (Tables 5-8), average total PCB concentrations in Waukegan Harbor sunfish have declined and average total PCB concentrations in Waukegan Harbor rock bass have increased. Sound comparisons between black bass across multiple years cannot be made due to the high variability in length and lipid content across composites. Overall, PCB levels in fish tissue collected from Waukegan Harbor have declined as compared to 2012 pre-dredge data.

Total PCB concentrations may be confounded by many factors outside of environmental condition, such as sampling species that are not full-time residents of Waukegan Harbor and sampling like-sized species with vastly differing lipid content since lipid content is positively correlated with bioaccumulation of PCBs in fish species². In addition, for the analysis of 2017 and 2016 samples, the reporting limit was changed from 0.10 $\mu\text{g/g}$ as in previous sampling years to 0.050 $\mu\text{g/g}$. This change makes comparisons across years slightly more difficult. In previous sampling years, non-detect values were treated as 0.05 $\mu\text{g/g}$, half of the reporting limit for sample analysis. For the 2017 and 2016 samples, however, non-detect values were treated as 0.025 $\mu\text{g/g}$. This change in reporting limit affects samples from reference sites only. In 2017, five out of 17 reference site samples returned a non-detect reading for total PCBs; in 2016, only two out of 15 samples had a non-detect value; and in 2015, 13 out of 16 reference site samples had a value of non-detect for total PCBs.

This report provides a summary of results only; it does not interpret fish advisories for Waukegan Harbor. Data obtained from the 2017 sampling activities will be provided to IEPA, IDPH, and other

² See P Rasmussen, C Shrank, and M. Williams.2014. Trends of PCB concentrations in Lake Michigan coho and chinook salmon, 1975-2010. *Journal of Great Lakes Research* 40: 748-754.

agencies that may require use of this data. Comparison analysis and evaluation of fish advisories will be performed by the Fish Contaminant Monitoring Program after post-dredging sampling and analysis is complete and recommendations will be made on whether further sampling is required.

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APPENDIX A
Fish Sampling Quality Assurance Project Plan (QAPP)

APPENDIX B
Illinois Environmental Protection Agency (IEPA) Lab Reports